THE POOR MAN'S GEIGER COUNTER

RADIO-ELECTRONICS

JULY 1955

TELEVISION • SERVICING • HIGH FIDELITY

HUGO GERNSBACK, Editor

In this issue:

An Automatic Lawn Watering Indicator

•

Corner Horn Systems

•

Use the TV Signal As Its Own Marker

35¢
U. S. and CANADA

Servicing Light Plan

(See page 4)

RADIO-ELECTRONICS

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ON THE COVER:

(Story on page 53) Service technician George Welkey working on a piece of aviation radio equipment at the bench of his all-aircraft service shop at Teterboro (N. J.) Airport.

Color original by Dan Rubin

JULY 1955 — Vol. XXVI, No. 7

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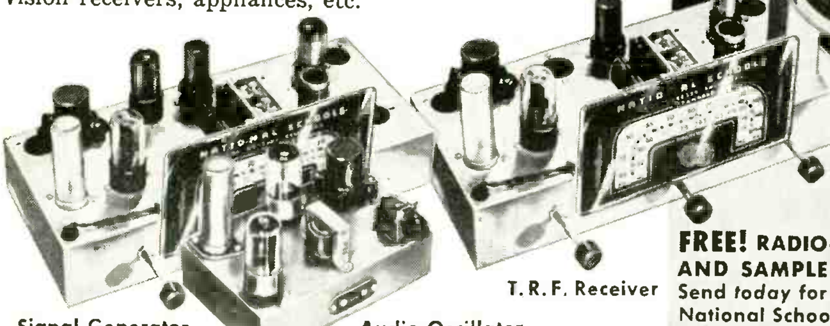

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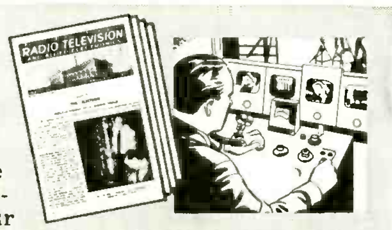

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the Radio month

GLASS SHADOW MASK for color picture tubes is under development at Corning Glass. Called by the company "the most marvelous article ever made of glass," it is intended as a substitute for the conventional metal mask. The unit contains some 400,000 holes made by a photo-etching process and has a rim of photoceramic glass.

RCA states that as yet it hasn't received any samples and it is too early to tell whether glass has any major advantages over metal. The major problems at present involve the fastening and positioning of the glass mask and the elimination of the "charging effect" of glass. This will require a special coating on the mask.

TRANSISTORIZED AUTO RADIO will be special equipment on Chrysler and Imperial cars this fall, marking the first time a fully transistorized radio will be built into a line of new cars. The radio, developed by Philco, uses 11 surface-barrier transistors.

The Philco unit (see photo) requires less than one-tenth the battery power used by standard automobile radios, drawing between 200 and 300 ma.

Operating without vacuum tubes, vibrator or power transformer, the radio is about 20% smaller than conventional units. Laboratory and road tests indicate the receiver is extremely rugged, withstanding shock and vibration many times in excess of that encountered under the most severe road conditions. Transistorizing the radio has eliminated hum, mechanical noises and the usual warmup time.

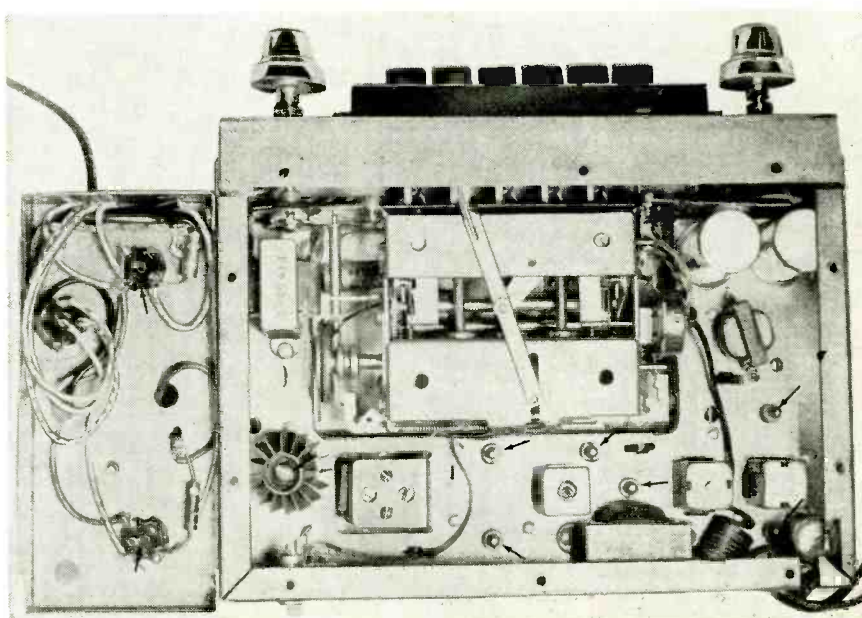
TAPE-RECORDED COLOR TV program made history on May 12, marking the first time a color television program recorded on magnetic tape was transmitted over commercial television network facilities. The tape-recorded telecast, originating at the NBC studios in New York, was sent over a closed circuit to St. Paul, Minn., as part of the dedication ceremonies of the new research center of the Minnesota Mining and Manufacturing Co., producers of the magnetic tape.

The recorded program, sent over microwave relay, included remarks by David Sarnoff of RCA on the "historic occasion," a brief explanation of the system by Dr. Harry F. Olson of the RCA Laboratories and professional entertainment.

ONE TV STATION has gone on the air since our report last month: WBIQ, Birmingham, Ala., channel 10.

KTVU, Stockton, Calif., channel 36, has gone off the air.

WTIQ, Munford, Ala., channel 7, omitted previously, is operating.



The new Philco all-transistor auto radio. Arrows point out nine of the transistors.

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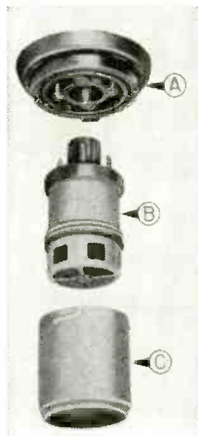
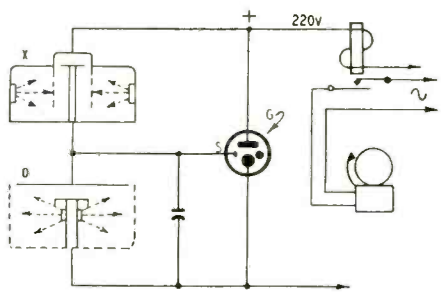
D.T.I.'s training is available in Canada.

ELECTRONIC FIRE DETECTOR was recently put on the market by the manufacturers of Pyrene. It consists of two ionization chambers (see photo), one exposed to the air and one practically shielded from it, though operating at atmospheric pressure. Each of the chambers contains a small amount of radioactive material which ionizes the air around it. The chamber exposed to air (through metal screening) is at the bottom of B in the photograph. The sealed chamber is just above it, and the partition between the two is an electrode common to both





chambers. A supervisory tube is included in the unit, which plugs into the ceiling fixture A and is covered by the protective locking shell C.

The two chambers (X and O in the schematic) are connected in series across a d.c. voltage, with the common electrode between them connected to grid S of supervisory tube G. Thus a voltage divider is formed. Normally the drop across each chamber is equal. Smoke or gases from a fire entering the lower chamber unbalance the divider, since the larger molecules of smoke or gas have the effect of raising the resistance of that chamber, larger molecules not being as readily ionized by the radioactive material. Thus the voltage on control elements of the supervisory tube rises, the tube fires and the relay is activated, ringing the bell, flashing lights or transmitting signals to a remote point.

In an actual test, the detector — known as the C-O-Two predetector system — triggered in approximately one-third the time required by older systems. Several types of fires were used in the tests.

TRANSISTOR PRICE TAGS are giving way to the effects of more efficient and larger-quantity production. Leading this downward advance is the Radio Receptor Company whose new transistor prices, in quantity lots, range from a low of 75 cents up to $4.50.

G-E recently announced a 22–45% slash in the price of their transistors, selling in quantity lots to manufacturers from $1.90 to $5.95 per unit. Raytheon, largest transistor manufacturer in the United States, sells quantity lots at a unit price ranging from $1.70 to $6. This is about half the price Raytheon was getting a year ago.

In announcing its price reduction, Radio Receptor predicted that within 2 years the price of transistors may be below 50 cents each.

HIGH-FREQUENCY TRANSISTORS made by a new "meltback" process have been announced by G-E. Operating efficiently at frequencies five times higher than ordinary transistors, they show greatly improved power-amplification characteristics.

In previous processes, crystals were formed from a pool of molten metal, and layers created by cycling the rate of growth. In the meltback process the cooling time has been reduced from 20 minutes to less than 1 second and there is less intermixing between layers. This produces thinner layers, allowing electrons to travel more quickly from one side of the crystal to the other, increasing the frequency at which the transistor can operate.

COMMUNITY ANTENNA systems are apparently far more extensive than might be expected. A recent issue of the *Northwest Electronic World*, covering Alaska and the states of Washington, Montana, Oregon and Idaho, carried no less than 17 items relating to cable franchises and the organization of community antenna associations. There were numerous other stories concerning cable rates, maintenance and experimentation.

COLOR TV FOR MEDICAL USE was demonstrated at an exhibition sponsored by the National Academy of Sciences in Washington, D. C., recently. Developed by RCA, this is the first compatible color TV system designed specifically for medical use. The system is built around a compact new color TV camera using three Vidicon pickup tubes.

The tubes (one each for the red, green and blue primary colors) are arranged in a vertical array within the camera. A system of dichroic mirrors divide the light from the televised scene into the three separate colors. The camera is focused remotely by a small reversible motor that moves the entire Vidicon assembly.

The compatibility of this system makes it possible to televise information in color from the operating room or the medical laboratory to doctors and research workers across the country by commercial broadcast as readily as over a closed circuit. The compactness of the camera permits televising surgical operations. A simple lens fitting converts the camera for use with a microscope. END

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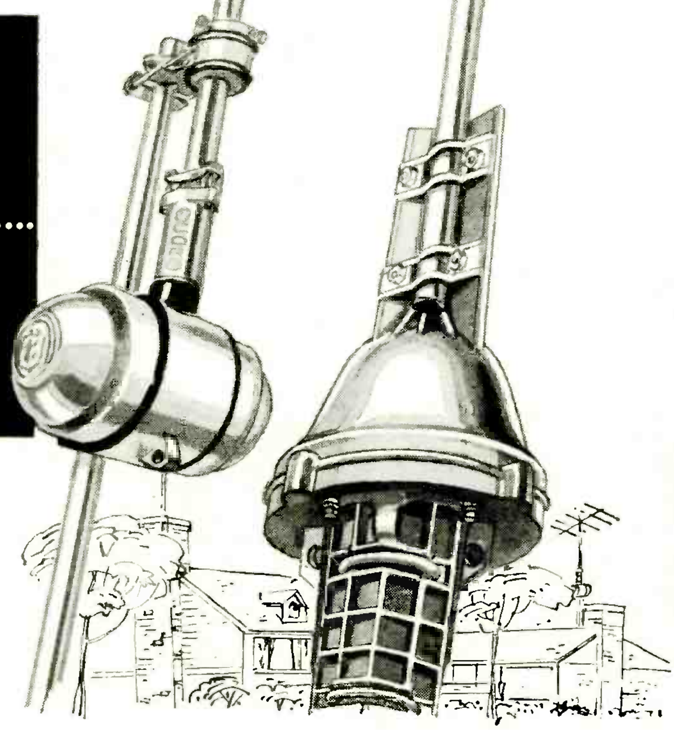

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THOSE HORN TYPE SPEAKERS

Dear Editor:

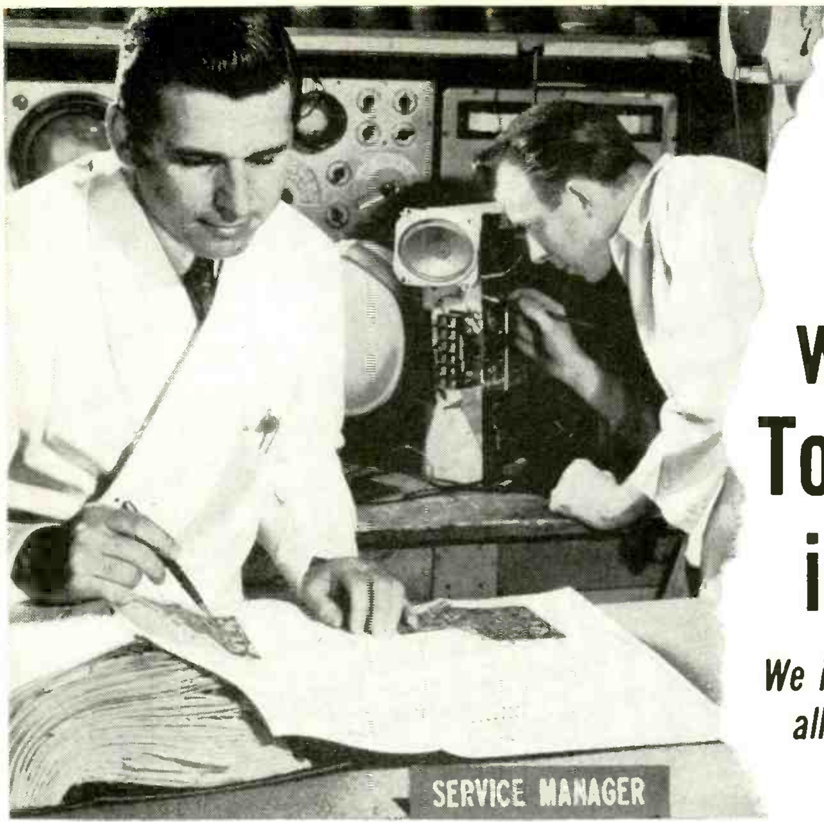
We think it is only fair to correct some of the assumptions made regarding the Frazier-May horn in "Horn Type Speaker Systems" in your April issue.

1. The only thing referred to as a revolutionary concept in our literature is our damping. Tested in an anechoic chamber, it was found that at a sound pressure level of 104 db at a distance of 1 meter from the horn bell, the total harmonic distortion at 100 cycles was 1.65%. The second harmonic accounted for 1.5% of that. Above 200 cycles, the harmonic distortion dropped to 0.8%, all of which was second harmonic. Our damping formula takes into consideration the horn throat with respect to the actual horn bell, the volume of air between the cone and the throat and the volume of inert air in the back chamber. Fiberglas is used in the chamber because it seems to be the best agent for absorbing back radiation.

2. The horn is not an accident—it is computed on the basis of a 50-cycle rate of taper. It is a series of straight-sided sections of a true exponential horn, short enough that the deviation from the true exponential curve is very slight except in the final section which deviates approximately ⅛ inch from the true 50-cycle taper rate. The six dividing fins mentioned are all in the outer section of the horn and their displacement is allowed for in the total air mass. Mr. Augspurger evidently missed the four additional fins set diagonally at the first horn. The spacers mentioned are used, not as a bridge from one section to another, but for stiffening the walls to cut down resonance. There is a remarkably small amount of "talk" from the cabinet itself.

When the stiffness of the material used with its present spacers is considered, we believe if you make a true analysis you will find no acoustic short circuit at all. The material is broken up in such a manner acoustically that any resonance would be of a higher frequency than is transmitted by the woofer. Several years ago we used standoff bushings in the manner suggested in your article and found they did not kill the resonance in the horn sections; therefore great portions of the frequency spectrum were cancelled.

3. We realize the bell opening of our model 8-50 is a far cry from optimum at extremely low frequencies.



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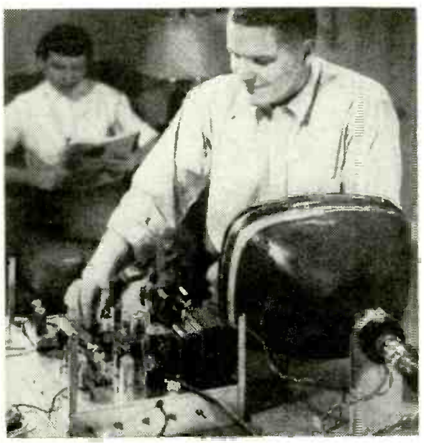

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So we do not reproduce 30-cycle fundamental tones. Neither does a symphony unless someone has smuggled in a pipe organ with a few 16-foot or longer Bourdon pipes.

4. The thing (which you did not mention) that we think is the greatest attribute in our speakers is the fact that we leave the midrange in the spectrum rather than design for the "boom-boom, tweet, tweet" school. We think this is probably more apparent on speech, vocals and on music of percussive qualities where intermodulation distortion and hangover can and do louse up the performance of many higher-priced speakers.

5. You have neglected to mention the importance of damping and of cone breakup. We have found through more than 20 years of experimenting that recovery time from the drive of the cone in either direction is all-important in the ability to handle steep wavefronts without mushiness. We have determined that this can be done successfully only when both the front and back of the radiator have equal loads.

6. We would appreciate an explanation of the so-called paradox that our unit does not operate as a horn. The low-frequency driver unit used (driven with 1 watt of electrical energy) produces a maximum sound level of approximately 94 db in a dead box with more than 4 cubic feet of air behind it or in a conventional type ported cabinet. Its efficiency is 10 db higher in the Frazier-May enclosure. This has all the indications of the efficiency of the exponential horn down to its bell cutoff frequency, which due to small size is fairly high but a great deal lower than the actual 209 square inches net air space in the horn bell.

J. A. FRAZIER
International Electronics Corporation
Dallas, Tex.

REPLY TO THE ABOVE

At Mr. Frazier's request, the above letter was forwarded to Mr. Augspurger for his comment and reply:

Dear Editor:

In reply to Mr. Frazier's letter, permit me to emphasize that both of us agree that his small horn *sounds* pretty good. The question seems to be: Does the Frazier-May model 8-50 operate as a true horn or not?

I admit that I erred as to the frequency range of a symphony orchestra. I'll even be happy to class a 50–12,000-cycle system in the ultra-fidelity class if its response is really uniform over that range. But if the Frazier-May is operating as a theoretical horn, its dimensions are such that it will become a tuned column below 100 cycles or so. Such a tuned column has the aural qualities of an organ pipe or a tuba and couldn't be used as a reproducing instrument without additional acoustic tricks to smooth out the response curve. My argument is simply that since the 8-50 *sounds* reasonably balanced in the bass range, factors other than true horn

loading must be entering into the act.

As to the question of the "sounding board effect." I may have overemphasized the tonal coloring effects of wooden panels, but I have heard identical designs built of both plywood and concrete and there is a noticeable improvement with ceramic construction.

My objection to the word "revolutionary" is one of semantics and not physics. I still don't see how the normal calculation of proper backwave volume puts a design into the "revolutionary" category. Mr. Frazier makes a great deal of this point, assuring us that special damping techniques are necessary if the driver is to effectively handle steep wave fronts. Damping is necessary to prevent "ringing" effects, but the damping is theoretically provided by the resistive loading of the horn and it is hard to see how this could be "equal" to the capacitative loading of the backwave chamber except for a narrow band of frequencies.

In conclusion we come to the word "accidental" which has caused Mr. Frazier some understandably ruffled feelings. I meant to imply that good acoustic design is still largely a "cut and try" proposition in spite of all the excellent theoretical work which is gradually accumulating. I meant "accidental" in the sense of being opposed to pure paperwork design, *not* the idea of, "By George, this wastebasket with the speaker in the bottom sounds pretty good. Quick, take out a patent on a revolutionary new speaker system!"

I hope that this clears up my comments on the Frazier-May horn. I apologize to Mr. Frazier for the choice of the word "accidental," but my reaction to the 8-50 "by ear" is honest, if personal, and will have to remain.

GEORGE L. AUGSPURGER

VOIGT AND LOWTHER

Dear Editor:

I am very disappointed indeed that in the article by George L. Augspurger in your May issue once again the confusion exists in mentioning the name of P. G. A. H. Voigt in the development of Lowther drive units. Nothing is further from the truth than this statement. The Voigt patent of the twin cone had already expired when we developed our P.M. 2 diaphragm used in conjunction with a magnet system for which I hold all rights and patents.

I should be most grateful therefore if you could find space to correct the statement that Mr. Voigt had any connection in the development of either our loudspeaker driver units or horns. The only point is the Voigt corner horn which is no concern of mine whatsoever and as I pointed out in my previous letter does not exist any more. It is a fact however that in this country many of our P.M. 2 and P.M. 4 units are working in many of these horns.

I think your articles on horn type loudspeakers are excellent and necessary, and I look forward to others.

DONALD M. CHASE
Bromley, Kent, England

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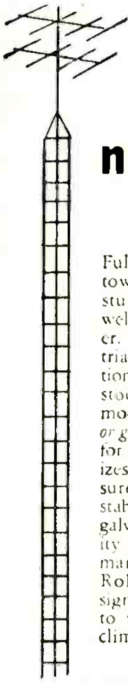

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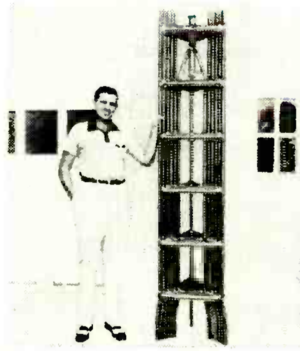

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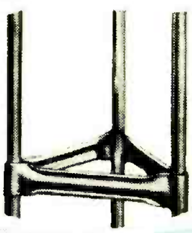

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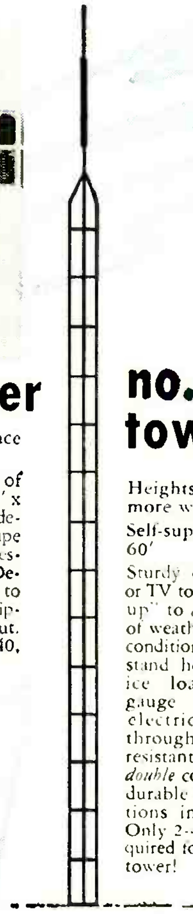

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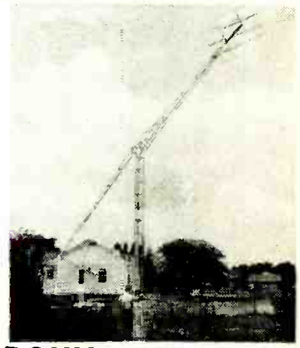
Sturdy communication or TV tower that "stands up" to *all* the stresses of weather and climatic conditions . . will withstand heavy wind and ice loading. Heavy gauge tubular steel, electrically welded throughout. Weather resistant, non-corrosive *double* coating provides durable finish. All sections in 10′ lengths. Only 2-4 manhours required for installing 50′ tower!

also



ROHN Fold-over tower

For experimenters, TV service departments and retailers. Use this kit with regular Rohn tower sections. Simple and easy to use.

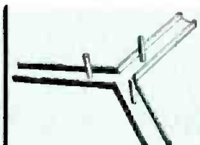
ROHN Telescoping Masts

Heavy-duty hot-dipped galvanized steel tubing and rigid joints give extraordinary strength. *Quick installation* . . . mast attached to base—antenna fixed, then mast hoisted quickly to desired height. Utilizes special clamp and guy ring arrangement. Flanged interior section; crimped exterior section gives mast stability that can't be beat. Complete with guy rings and necessary erection parts. In 20, 30, 40 and 50 ft. sizes. Bases and ground mounts available.

and a complete line of ROHN accessories —*all galvanized*

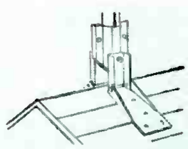
PEAK ROOF MOUNT

Heavy duty for quick, secure mounting of tower to top of peak roof. Flanges hinged, fastened to roof with 2 lag screws in each flange.



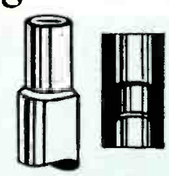
FLAT ROOF MOUNT

For all types flat surfaces. 3-1″ solid steel projections permit first section of tower to be mounted directly on roof mount by inserting usual ⅜″ bolts.



MAST BASES

Complete line of telescoping mast bases for every requirement, accommodating masts from 1″-2¼″ diameter. Also available—drive-in mast bases.

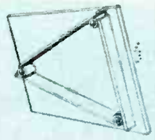


MAST 'N TV TUBING

Heavy-duty, hot-dipped galvanized steel tubing. Machined to perfection. Extra sturdy joints slotted for full, perfect coupling.

PEAK and WALL MOUNTS

For mounting of mast or pole to roof or wall. Heavy-duty steel. Variable sizes. Models for most every need.



DRIVE-IN BASE

Set on top of ground . . . 3-4′ drive rods driven through base into ground. First tower section secured to rods with single bolt in each leg. Instant erection.

SERVICE TABLE

Perfect answer for television servicing, display and storage. Truly one of the finest of its kind in economy price range.

ALSO AVAILABLE

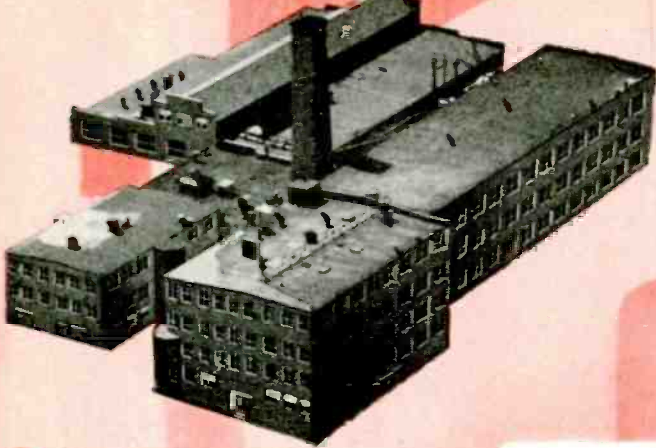
Rotator posts for mounting rotator to tower; House Brackets; Guying Brackets; UHF Side Arm Mounts; Mounts for Additional Antennae on a Tower; Erection Fixtures; Guy Rings; Installation Accessories; and dozens of other items!

For complete catalog and prices, see your authorized Rohn Representative or Distributor; or write or wire direct.

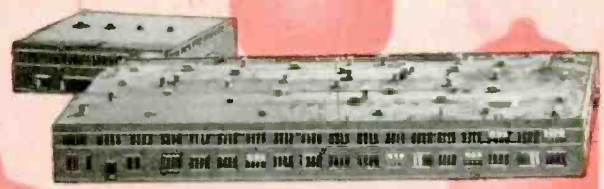
Designed and Manufactured Exclusively by

ROHN *Manufacturing Company*

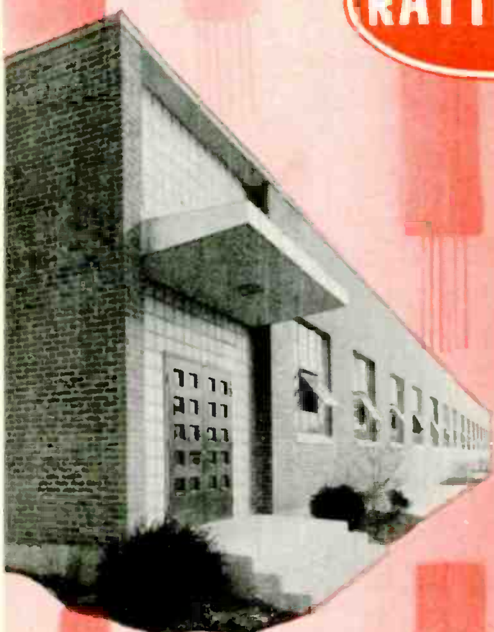
Dept. RE 116 Limestone, Bellevue Peoria, Illinois



Raytheon's Receiving Tube Plant No. 1 — Newton, Mass.



Raytheon's Microwave and Power Tube Plant No. 1 Waltham, Mass.



Raytheon's Research Center Waltham, Mass.

RAYTHEON LEADS THE WAY

In TUBES and SEMICONDUCTORS

Here are a few reasons why:

RAYTHEON employs 18,000 people. Approximately 10,000 of them work in Raytheon's modern tube and semiconductor manufacturing plants.

RAYTHEON has more than 1,000,000 square feet devoted exclusively to the manufacture of Raytheon quality tubes and semiconductors.

RAYTHEON employs over 500 engineers and scientists who work exclusively in the electron tube and semiconductor fields.

RAYTHEON has had 33 years' experience in the manufacture of electron tubes.

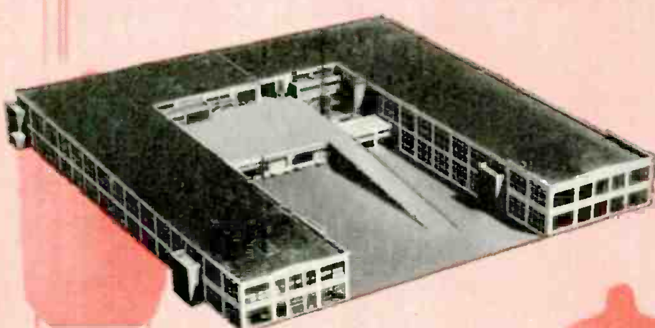
RAYTHEON has made tubes of every type of construction — Standard Glass, "G", GT, Bantal, Lock In, Metal, Miniature and Subminiature Tubes.

RAYTHEON Receiving and Cathode Ray Tube Operations have produced more than a third of a billion tubes and semiconductors.

RAYTHEON perfected the first practical rectifier tube types (BA and BH) to eliminate the need for "B" batteries to operate home radios. This revolutionized the design of home radio sets. Raytheon later developed the cold cathode rectifier tube for auto radios and has produced more of these tubes than all other companies combined.

RAYTHEON developed the famous 4-pillar construction that strengthened internal structure resulting in sturdier tube design.

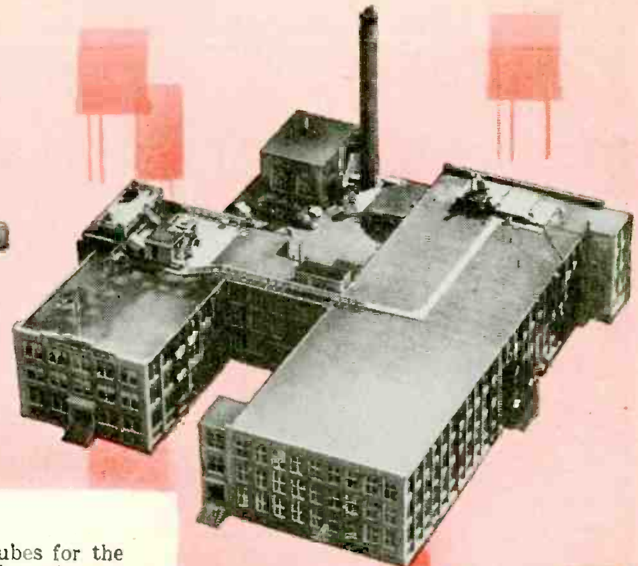
RAYTHEON developed and was first to mass-produce the octal button stem receiving tube — today's most imitated construction for premium TV performance. Raytheon was first to make millions of these tubes as far back as 1946. These tubes featured a planar button stem and 8 straight leads (8-pillar) which go directly into a standard octal base. Raytheon's Patent Numbers 2310237, 2321600 and 2340879 apply to this invention.



Raytheon's Semiconductor Plant No. 2 and Raytheon's Special Tube Plant No. 2 Boston, Mass.

Raytheon's Cathode Ray Tube Plant Quincy, Mass.

Raytheon's Receiving Tube Plant
No. 2 — Quincy, Mass.



Raytheon's Semiconductor Plant
Newton, Mass.
(Being Assigned to Semiconductor
Division starting Dec. 1, 1955)

RAYTHEON developed and first mass-produced subminiature tubes for the hearing aid industry — the forerunners of the fuse tubes which made possible the famous proximity fuses of World War II. There are more commercial Raytheon subminiature tubes in use today than all other makes combined.

RAYTHEON developed a method of mass producing magnetrons (the power tube that is the heart of radar) early in World War II, that broke a serious bottleneck, and continues to produce more magnetrons than all other manufacturers combined.

RAYTHEON is the largest producer of klystrons and has manufactured more than all other companies combined.

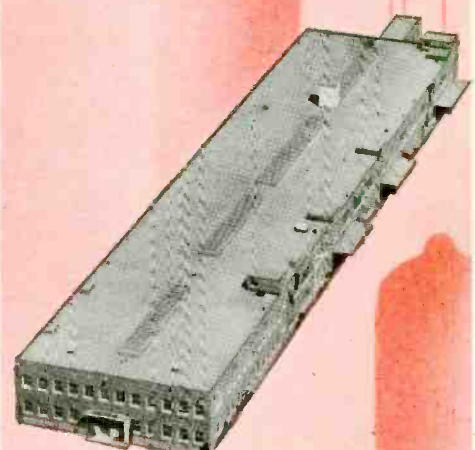
RAYTHEON was the first commercial producer of Transistors — the "mighty mite" — a Raytheon achievement that revolutionized the hearing aid industry.

RAYTHEON first commercially produced fusion-alloy RF Transistors, expected to revolutionize the portable radio, auto radio and computer industries.

RAYTHEON has produced many more transistors than all other manufacturers combined — nearly 2,000,000 in use.

TODAY, RAYTHEON makes Receiving and Picture Tubes, Reliable Miniature and Subminiature Tubes, Semiconductor Diodes and Transistors, Nucleonic Tubes and Microwave Tubes.

These facts and figures show why you can use Raytheon Television and Radio Tubes with complete confidence that they are Right . . . for Sound and Sight — Right for you and your customers, too.



Raytheon's Microwave and
Power Tube Plant No. 2
Waltham, Mass.

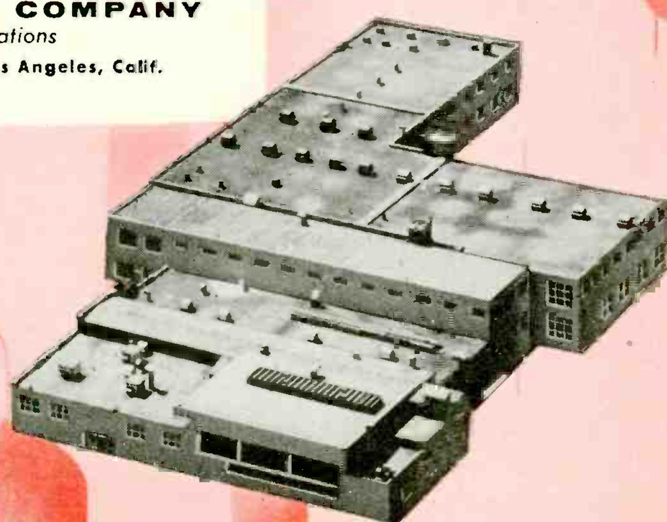
A Company second to none in
Excellence in Electronics

RAYTHEON

RAYTHEON MANUFACTURING COMPANY

Receiving and Cathode Ray Tube Operations

Newton, Mass. • Chicago, Ill. • Atlanta, Ga. • Los Angeles, Calif.



Raytheon's Special Tube Plant No. 1
Newton, Mass.

WIN-TRONIX

LOW COST TV TEST INSTRUMENTS

NEW

Buy Now for BL. & WH. Service —and be *ready* for COLOR

COMPATIBLE FOR COLOR and BLACK AND WHITE

CHECK THESE FEATURES!

√ *COMPATIBLE ADVANCED DESIGN* PREVENTS OBSOLESCENCE.
√ *LOW COST* WITH *HIGH QUALITY.*
√ *PORTABILITY.*
√ *STANDARD WARRANTY* ON ALL INSTRUMENTS.

SEE YOUR PARTS JOBBER! WRITE TODAY FOR LITERATURE!

FOR COLOR OR BLACK & WHITE

WHITE-DOT and LINEARITY GENERATOR

▶ **COLOR CONVERGENCE—** A must on every color service call—gives large and small white dots.

▶ **BLACK & WHITE**—Linearity & picture size adjustments.

Model 160 $79^{95}

Model 150 $49^{95}

PATENT PENDING

RAINBOW GENERATOR

This Color Pattern Generator produces New Linear Phase Sweep for faster color TV servicing.

▶ **APPLICATIONS:**

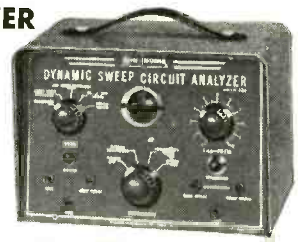
- All chroma circuit tests.
- Color demod. phase alignment.
- Color gain adjustments.
- Matrix test and alignment.
- 3.58 mc traps and coils.

SWEEP CIRCUIT ANALYZER

NEW! *The complete sweep circuit* tester—takes the guesswork out of sweep circuit troubleshooting.

▶ **TWO INSTRUMENTS IN ONE**

1. Horizontal and vertical sawtooth for signal substitution. (15KC and 60 CPS.)
2. Complete flyback and yoke testers.



Model 820

$59^{95}

FOR COLOR OR BLACK & WHITE

FLYBACK and YOKE TESTER

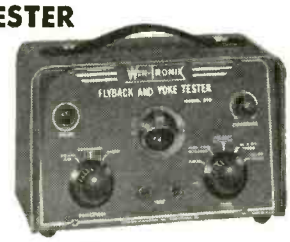
NEW! Sensitive circuit checks *one turn shorts* in yokes *as well* as xfmrs.

▶ Oscillating neon indicator *more sensitive than a meter.*

▶ Advanced design also tests color yokes and xfmrs.

▶ Saves time with fast test of—

- Flyback transformers
- Deflection yokes
- Bypass and electrolytic condensers
- Continuity of coils, xfmrs



Model 810

$29^{95}

FOR COLOR OR BLACK & WHITE

COMPATIBLE FIELD STRENGTH METER

VHF and UHF

NEW! *Here is the FSM that won't be made obsolete by color TV!*

For good antenna installations (color or bl. & wh.) **YOU NEED:**

1. Microvolt testing
2. Bandwidth testing

FEATURES:

▶ Tests for color performance on antenna installations.

▶ Tests for bandwidth for better bl. & wh. pictures.

▶ Reads microvolts *directly* on 5 scales.

▶ Channels 2-13; extra coils available for UHF channels.

Model 330

$129^{95}

FOR COLOR OR BLACK & WHITE

COMPATIBLE CRYSTAL CALIBRATOR

NEW! Crystal controlled generator and crystal tester

FOR:

▶ Color and bl. & wh. servicing

▶ Labs and factories

▶ Amateurs and experimenters

FEATURES:

▶ Accurate 3.579545MC color subcarrier standard, *factory calibrated* (crystal supplied).

▶ Three external crystals* and a crystal switch permit quick selection of precise frequencies.

APPLICATIONS:

- 3.579545MC color oscillator alignment.
- Crystal tester.
- RF and IF marker and calibrator.*
- Color TV 3.58MC generator.
- Microsecond time marker for scopes.*

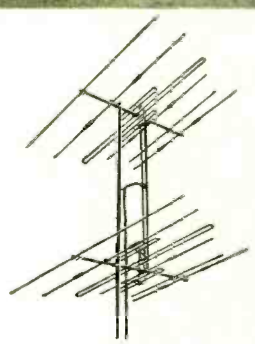
Model 120

$59^{95}

FOR COLOR OR BLACK & WHITE

*These crystals available extra

WINSTON ELECTRONICS, INC. RE-755, 4312 Main St., Philadelphia 27, Pa.



NEW!
Narrow-space stacking!

Channel Master's RAINBOW and SUPER RAINBOW can now be stacked only 60" apart. These new, extremely efficient, 2-stage, impedance-matching stacking rods permit easier installations with an absolute minimum sacrifice of gain.

model no. 331-7

Champion Rainbow 330 series
Super Rainbow 331 series
Challenger Rainbow 332 series

Warm weather is profit weather!

*Patent No. 2,691,730
Other Patents Pending

Copyright 1955, Channel Master Corp.

The weather's warmer! Days are longer! *This* is the time of year to go after that gold mine in your own backyard: the replacement of the antennas in your area that are damaged, worn, and obsolete.

Channel Master's RAINBOW is the favorite replacement antenna of America's TV installation men — and here's why:

- There's a RAINBOW model for every installation ... for every signal area ... for every budget.
- Regardless of competitive claims—Channel Master's RAINBOW antennas are *still* the most powerful antenna series available today! Advanced engineering and the exclusive Tri-Pole make the difference!
- Featuring the fastest and strongest of all preassemblies: trigger-fast "Snap-Lock" action, Channel Master's fabulous preassembly that *snaps* open, *locks* open, without hardware or tightening.
- All-aluminum construction. Rugged, durable, reinforced at all stress points.

Today's greatest all-channel antenna value — bar none!

CHANNEL MASTER'S RAINBOW*

the ideal replacement antenna

CHANNEL MASTER CORP.

ELLENVILLE, N. Y.

The World's Largest Manufacturer of Television Antennas

you can't argue with acceptance

proven quality
100% inspected
accurate replacement
prompt delivery

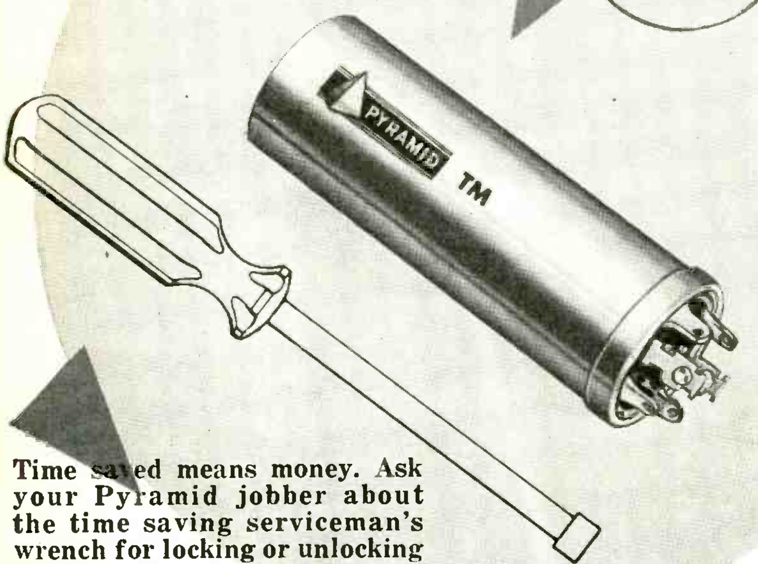
the most complete line of twist mount dry electrolytic capacitors

Burton Browne / New York

Better than any claims we could make is the unqualified and enthusiastic acceptance by engineers and servicemen alike. These are some of the features on which this acceptance is based:

- Aluminum containers provide maximum protection against moisture.
- Low leakage, long shelf life.
- Designed for 85° C. operation.
- Complete with metal and bakelite mounting plates.
- Easy to mount.
- Extremely compact—yet highly dependable.

Pyramid capacitors are listed in Sams' Photofacts



Time saved means money. Ask your Pyramid jobber about the time saving serviceman's wrench for locking or unlocking the mounting ears of Pyramid's twist mounts.

DISTRIBUTOR DIVISION
PYRAMID
ELECTRIC COMPANY
1445 Hudson Blvd., North Bergen, N. J.

America's Most Dependable Rotator

NOW *America's Most Beautiful* . . . .

control cases available in four glorious colors . . .

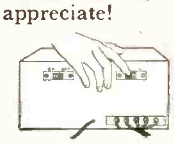
TRIO, manufacturer of the "Aristocrat", has set the pace in the design of a rotator control unit as beautiful as it is functional. Its sleek, unbroken lines are unmarred by switches or knobs and only the handsome, lighted dial identifies it as a rotator control unit.

A new TRIO plan enables the dealer to carry a complete line of the various colored cases without substantially increasing inventory costs. Thus the home-maker has choice of colors, even as late as the time of installation, because it takes only a moment to change the "works" from one case to another.

FACTORY ATTACHED AND TESTED CABLE

Every TRIO rotator is now supplied with either 65' or 90' control cable factory attached and ready for easier, faster installation. Each unit is bench-tested with its control cable, thus assuring trouble-free performance. These are features that servicemen like and appreciate!

Switch and directional control are located at top rear of case for handy finger-tip operation.



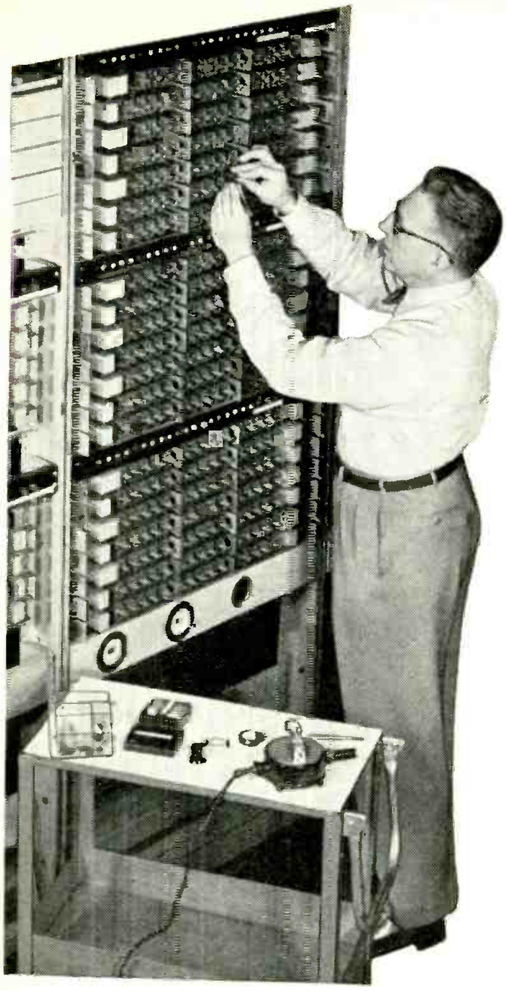
THE TRIO
"ARISTOCRAT"
. . . CULMINATION OF SIX YEARS RESEARCH AND PRODUCTION

- Only rotator with 2 year warranty.
- Only rotator with control cases available in four glorious colors.

TRIO *Manufacturing Co.*
GRIGGSVILLE, ILLINOIS

Write FOR ILLUSTRATED, FOUR COLOR BROCHURE

EXPORT SALES DIV., SCHEEL INTERNATIONAL INC.,
4237 N. Lincoln Ave., Chicago, U.S.A. Cable Address: HARSCHEEL

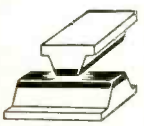


He's "fingerprinting" a relay contact

Bell Laboratories microchemists have perfected an ingenious new technique for "fingerprinting" relay contacts, the tiny switches on which a dial telephone system critically depends.

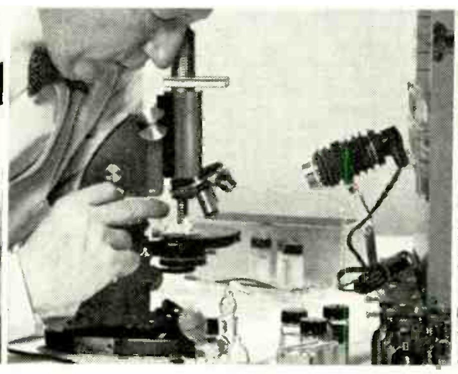
Using a portable test set, a chemist makes a plastic print of a contact. On-the-spot examination of the print with a microscope and chemical reagents quickly reveals the effects, if any, of arcing, friction, dust or corrosive vapors. While the chemist studies the print, urgently needed contacts continue in service. Findings point the way to improve relay performance.

This is another example of how Bell Telephone Laboratories research helps to keep your telephone system the world's best.

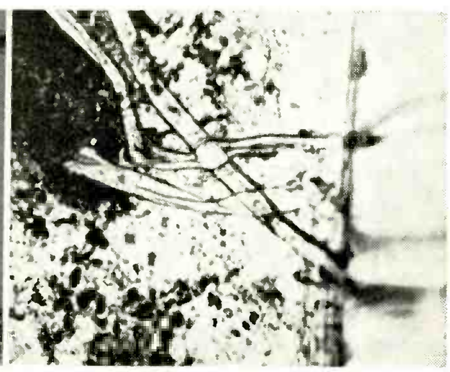


Above, Bell Laboratories microchemist applies plastic disc in heated clamp to relay contact. Imprint reveals contours of surface and picks up contaminants, if any. Part of portable test set is shown on table. Contacts, shown in small sketches, are of precious metal fused to base metal.

Preparing disc for microscopic examination. On-the-spot examination may reveal acid, alkali, sulfur, soot or other polluting agents peculiar to an area.



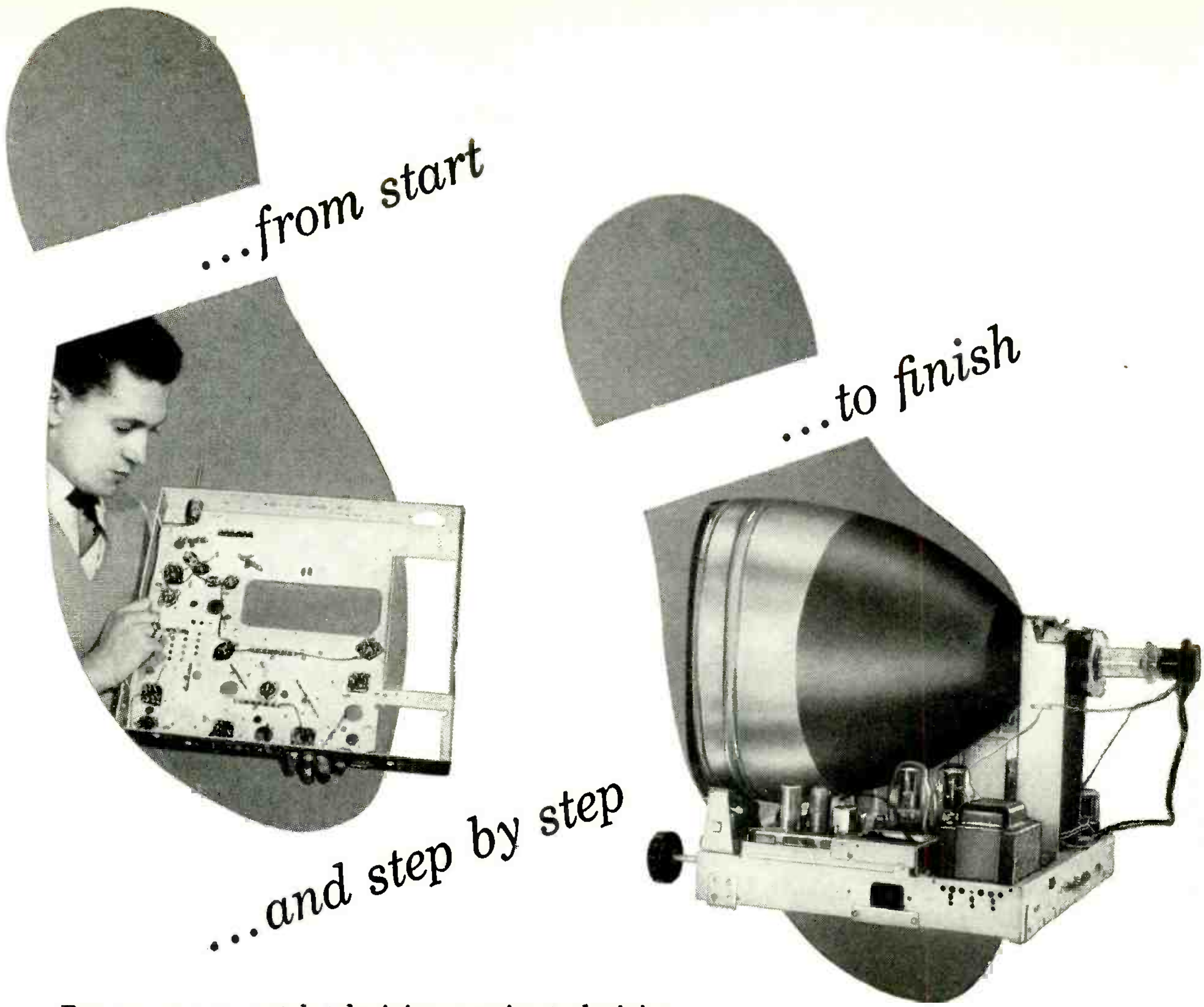
A microscopic look at disc often provides lead to nature of trouble. Unlike actual contact, print can be examined with transmitted light and high magnification.



Here the plastic disc has picked up microscopic lint that insulates contact, stops current. (Picture enlarged 200 times.) Traces of contaminants are identified in microgram quantities. Inert plastic resists test chemicals that would damage contact.

Bell Telephone Laboratories

Improving telephone service for America provides careers for creative men in scientific and technical fields



Become a top-notch television service technician

Now . . . RCA INSTITUTES offers modern TV KIT with Comprehensive Television Servicing Course

START to build with a TV Kit developed by one of America's foremost radio-tv schools—RCA Institutes. LEARN with simple step-by-step instruction how to build a modern, large-screen receiver. TEST each stage, *as you build,* and see how it works. Learn how "trouble-shooting" is applied. FINISH your Home Study Course ready and able to service all make and model sets!

Easy-to-follow instructions are planned and prepared for you through the efforts of RCA Institutes' instructors, engineers at RCA Laboratories, and training specialists of the RCA Service Company.

The RCA Institutes' TV Kit utilizes up-to-date circuits including:

- *Synchro-Guide horizontal automatic frequency control circuit.*
- *Horizontal magnetic reaction scanning.*
- *Latest deflection circuits.*
- *FM sound discriminator.*
- *High-gain, low-noise cascode tuner.*

Join the many thousands who have been successfully trained by RCA Institutes for a good job (or business of their own) in television servicing.

BASIC KNOWLEDGE OF RADIO NECESSARY
NO NEED FOR PREVIOUS TV TRAINING

FREE BOOKLET! MAIL COUPON NOW.

RCA INSTITUTES, INC., Home Study Dept. EK-7-55
350 West Fourth Street, New York 14, N.Y.

With no obligation on my part, please send me a copy of your booklet on the TV Servicing Home Study Course and Kit. I understand no salesman will call.

Name: ______________________ (Please print)

Address: ______________________

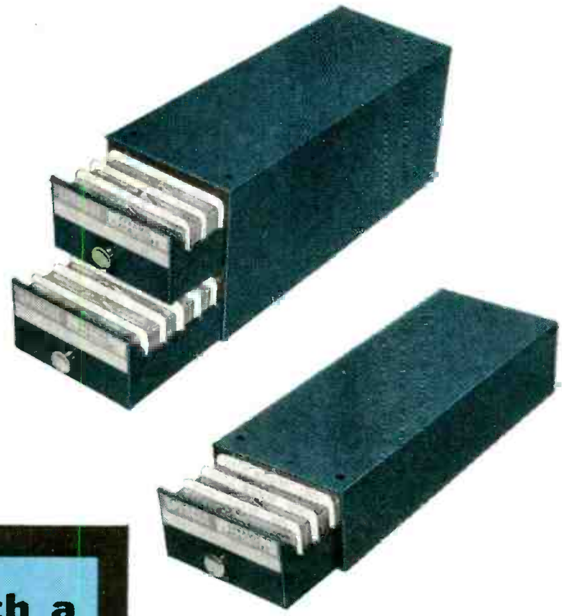
City: __________ Zone: ______ State: __________

RCA®

RCA INSTITUTES, INC.

A SERVICE OF RADIO CORPORATION of AMERICA
350 WEST FOURTH STREET, NEW YORK 14, N.Y.

NOW *New* SPRAGUE CERAMIKITS



Get these cabinets FREE with a basic order of ceramic capacitors

● NOW . . . stock ceramics so you can find 'em when you want 'em . . . have your own neat and complete cabinet . . . at the cost of the capacitors alone.

● Sprague has pre-stocked these handsome, blue, heavy-gauge steel CERAMIKIT cabinets with its famous Cera-Mite capacitors. Ratings and quantities are based on popularity. No dogs! Stand-up indexes separate reusable plastic boxes. Catalog numbers and ratings can be seen at a glance.

● Whether you use many ceramics, or just a few, there's a Ceramikit sized and priced just right for you. Kit CK-2 is a two-drawer model holding 150 capacitors in 27 different ratings. Kit CK-3 is a single-drawer unit holding 75 capacitors in 12 different ratings. Remember there's not a dog in either Ceramikit.

● Kits interlock so You Can Build With Sprague as you buy your Ceramikits. Use the extra cabinets for handy indexed stocking of all your small parts.

● See your distributor *now* about Ceramikits, or request complete facts in Sheet M-711 from Sprague Products Co., 81 Marshall St., North Adams, Massachusetts.

CERAMIKIT CK-3

CONTENTS
3½"x9¼"x2"
$19.25 List

Quan.	Cat. No.	Quan.	Cat. No.
5	5GA-Q1	5	5GA-T47
5	5GA-Q22	5	5GA-T5
5	5GA-Q5	10	5GA-D1
10	5GA-T1	5	5GA-D2
5	5GA-T15	5	5HK-D5
5	5GA-T22	10	5HK-S1

CERAMIKIT CK-2

CONTENTS
3½"x9¼"x4"
$38.00 List

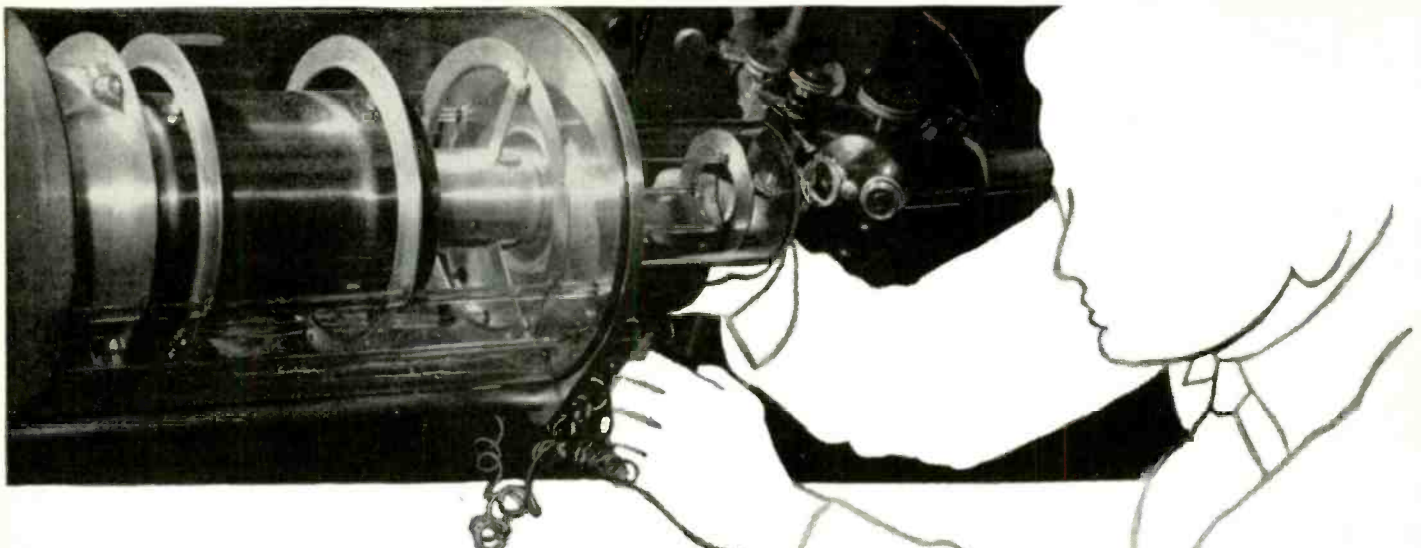
Quan.	Cat. No.	Quan.	Cat. No.
5	5GA-V5	5	5GA-T27
5	5GA-Q1	5	5GA-T33
5	5GA-Q15	5	5GA-T39
5	5GA-Q22	5	5GA-T47
5	5GA-Q33	5	5GA-T5
5	5GA-Q33	5	5GA-T68
5	5GA-Q47	10	5GA-D1
5	5GA-Q5	5	5GA-D15
5	5GA-Q63	5	5GA-D2
5	5GA-Q82	5	5GA-D33
10	5GA-T1	5	5GA-D4
5	5GA-T12	5	5HK-D5
5	5GA-T15	10	5HK-S1
5	5GA-T22		

don't be vague . . . major in

SPRAGUE®

YOU CAN BUILD WITH SPRAGUE

Sprague Products Co. is the Distributors' Division of the Sprague Electric Co.



If you're willing to lose your job tomorrow to a technically-trained man,

turn the page, mister

But, if you're interested in an honest-to-goodness career in the vigorous young electronics industry, here's how you can step ahead of competition, move up to a better job, earn more money, and be sure of holding your technical job even if the brass is firing instead of hiring.

The "how" is CREI training in radio-television-electronics.

You don't have to be a college graduate. You *do* have to be willing to study—at home. You can do it while holding down a full-time job. Thousands have. Since 1927 CREI has provided alert young men with the technical knowledge that leads to more responsibility, more job security, more money. More than a quarter century of experience qualifies CREI to train you.

What qualifies *you* for CREI? If you have a high school education, you're off to a good start. If you have a knack for math, so much the better. If you are currently working in some phase of the electronics industry, you'll get going faster. But remember this: CREI starts with fundamentals and takes you along at your own speed. You are not held back by a class, not pushed to keep up with others who have more experience or education. You set your own pace. Your CREI instructors guide you through the lesson material and *grade* your written work personally. You master the fundamentals, then get into more advanced phases of electronics engineering principles and practice. Finally you may elect training at career level in highly specialized applications of radio or television engineering or aeronautical radio.

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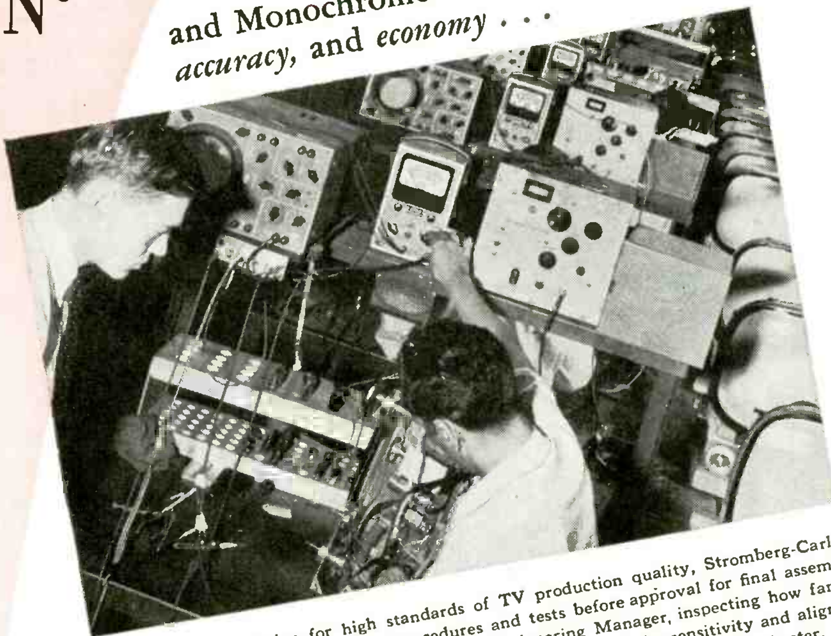

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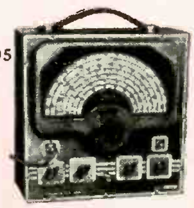

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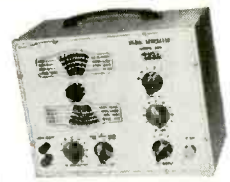

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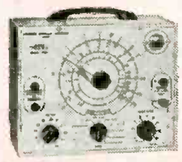

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RADIO-ELECTRONICS
Hugo Gernsback, Editor

STATUS OF THE ELECTRONIC INDUSTRY

. . . Comprehensive survey of a new giant . . .

Recently C. M. Odorizzi, executive vice president of the Radio Corporation of America, addressed the Cleveland Society of Security Analysts, giving a comprehensive view of the electronic industry. The following is a condensed report of this most informative talk.

FEW if any industries, in such a relatively short period of time, have experienced such amazing growth as electronics. From 1940 to the war's end in 1945, the annual dollar volume of the industry increased from $500 million to $4.6 billion.

Then followed a post-war dip that quickly was corrected by three principal factors: first the rise of the new television industry; second the industrial adoption of electronic controls; and third, the implementing of a realistic concept and standard of national defense requirements. So rapid was the upturn that in a little more than six years after the war's end—by 1952—the electronics industry had achieved a $7 billion annual volume.

Today, the curve continues to rise. By latest estimates, the electronics industry should show a total business that will reach close to $9 billion by the end of 1955. According to surveys by RCA, these figures will maintain their climb and by the end of 1957 the annual total should be nearly $12 billion.

All of you will recollect how the television receiver industry made its spectacular advance from a mere $1 million at factory prices in 1946 to its peak of $1.4 billion in 1950. By 1957, a year when color television is expected to be making rapid progress, black-and-white sales are expected to drop back to less than $400 million. By that time, it is estimated the industry factory billings of color sets will be near the billion mark. Thus, the estimated total of television set sales to the consumer, namely 6.4 million units in black-and-white and color, will then be approaching the total sales of 6.6 million units reached by black-and-white sales alone in 1950.

Government purchases of electronic equipment, which will total $2.5 billion for the industry this year, are estimated to increase to approximately $2.9 billion by 1957.

In only one broad classification of electronics, that of automobile radios, industry sales seem to have reached a condition of stability. For several years auto radios have maintained annual sales slightly in excess of $100 million, a total that is likely to remain constant for the next few years at least.

The majority of remaining classifications in the electronics field provide food for thought for the optimist. These include the sales of repair parts and replacement tubes, broadcasting and communications, industrial and commercial equipment, service and installation, and, of course, color television.

Let me give you an idea of the potentials of these groups by comparing the industry's going rate with rates projected into 1957.

Repair parts and replacement tubes, which will gross about $250 million this year at factory prices, will total $453 million in 1957. The present and future totals for the broadcasting and communications industry are $1 billion and $1½ billion, respectively. Industrial and commercial equipment will increase from $274 million to $520 million; color television, now a mere infant, will expand to $950 million in four years.

Servicing

Servicing, in my opinion, is a subject that has not been given its due importance in most industrial analyses. Today, however, industrialists are paying more and more attention to its role in successful manufacturing and merchandising. Service with a capital "S" has become a vital building block in the foundation of American business.

Would the automobile have developed into a $45 billion industry if owners had been forced to repair and maintain their own cars? Would the electronics industry have made giant strides toward its present $9 billion position if buyers had not known that trained technicians were available to keep their instruments in operating condition?

The answer obviously is "No." The attitude of the manufacturer toward service was certain to change as he recognized the irresistible changes in life and customs.

Service, therefore, has become an important facet of the nation's business structure. The consumer knows the value and economy of keeping the products of modern science and industry at peak efficiency. When properly organized, service pays its own way. It is a good investment that produced manifold returns in many forms.

Some measure of the importance of service to electronics is shown by the fact that today nearly 100,000 service technicians are employed in the industry, most of whom are in radio and television service for the home. With the expected growth of the electronics industry, *more than 125,000 technicians will be needed in 1957.*

I know of no merchandiser who is more thoroughly sold on the role of service in making and repeating sales than Frank M. Folsom, president of the Radio Corporation of America. Often he has said:

"In every city of the United States there is a successful business that is a living monument to some man with the simple but fundamental objective of making sure his customers were properly taken care of."

In 1946, when television emerged from behind the curtain of war to begin its phenomenal growth, the industry's return for servicing home television and radio sets was less than $145 million, not including the cost of parts. Four years later, in 1950, comparable figures had increased to $710 million. In 1953, the total was $1.4 billion and by the end of 1957, this part of the electronics industry will contribute $2.7 billion annually to the national economy for the home installation and maintenance. In other words, during the next four years, from January 1, 1954, to January 1, 1958, the industry's gross income from this service will have almost doubled.

With these figures in hand, it is only natural that they should be compared with the overall volume of business produced by the electronics industry. Total annual sales of this industry grew from $1.6 billion in 1946 to $8.4 billion in 1953. Thus, in 1953, service was responsible for 16.4% of electronic industry sales. This is almost as much as the total sales of all electronic products, to both consumers and the Government, in 1946. As the use of electronic apparatus increases with automation and the application of electronic controls to industry, plus the spread of television service, the sales of service will increase accordingly.

Electronics Is Core of Automation

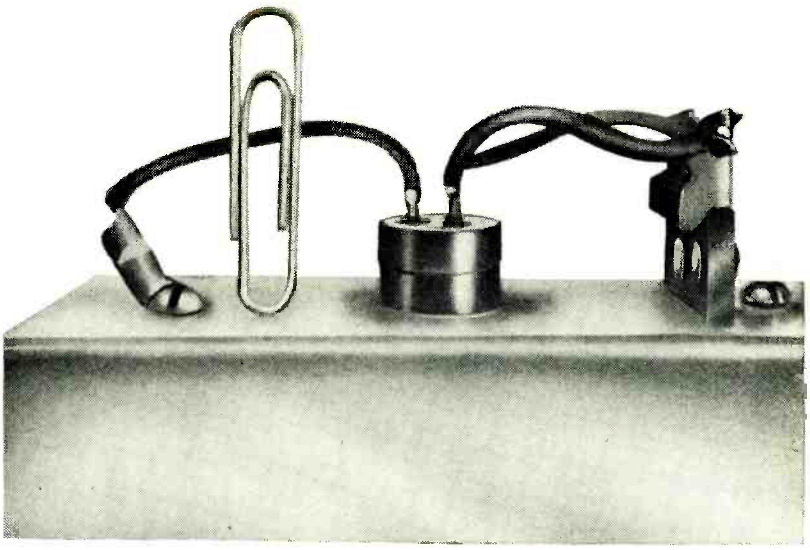
Undoubtedly, you have frequently encountered the word *automation*. You will hear more of this trend of industry to conceive, design and build the automatic factory—automatic to a great extent from raw material to finished product. We have not yet arrived at the latter state but we are making good progress, for electronics is the core of automation, and the electron is one of the world's most versatile and flexible tools.

We are succeeding through electronic controls and automation in speeding up the progress of industry, and by so doing are reducing the time lag that heretofore has slowed up the conversion of raw materials into finished goods. This increased impetus of production also has made it possible materially to reduce the costs to the ultimate consumer. By taking the developments of scientists and engineers and merchandising them with modern, efficient methods we have contributed substantially to the nation's economy.

Although this record of achievement is outstanding, the promise of the electronics industry in the future is even brighter. One of the most impressive long-range views was expressed a short time ago by Brig. Gen. David Sarnoff, chairman of the board of RCA, who said:

"Whatever the size of the electronics, television and radio business seven years hence may be, I am sure that more than 50% of the volume will be in products and services that do not exist today."

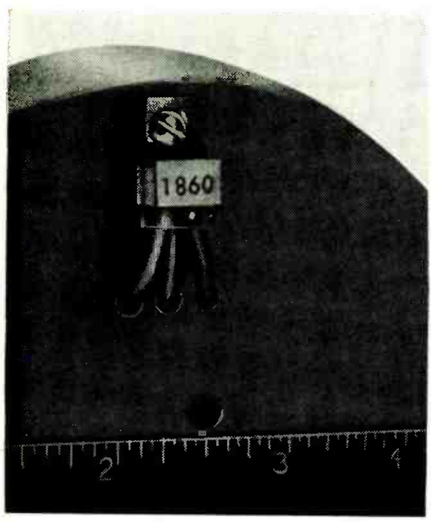
Practical Transistor Tests



A 2N57 attached to chassis.

Measuring important semiconductor characteristics with scope or simple meters

By EDWARD D. PADGETT



Silicon junction power transistor attached directly to metal chassis.

SERVICE technicians must learn to determine transistor properties quickly and economically. They must know when a transistor is "clean," when junctions are satisfactory and if noise level is O.K. Whenever possible, comparisons with vacuum tubes will be made in this article. However, transistors are new electronic devices which require new language to describe their behavior.

In most cases vacuum tubes operate as temperature-saturated devices (Child's law). They are used chiefly as voltage or power amplifiers, with their important characteristics described by the symbols: μ, g_m and r_p.

Transistors are current amplifiers. Their greatest limitation is that they are *temperature-sensitive*. That is, their characteristics vary with temperature. Important transistor characteristics are described by the symbols: I_{co}, I_{cbo}, β and R_{out}. I_{co} and I_{cbo} are leakage currents; β is current gain. R_{out} is the output impedance of a common (grounded) emitter transistor.

Test methods for these parameters are important because these measurements are the most economical way to identify satisfactory transistors. Usually there is no need to measure other parameters. For instance, base resistance r_b and emitter resistance r_e are relatively unimportant in general service work (unless either is open- or short-circuited, in which case replacement is obviously required) and need no further discussion. The general specifications for good transistors are that r_b shall be less than 1,000 ohms and r_e less than 50 ohms, at room temperature, when emitter current is 1 ma and collector voltage is 6.

To simplify measurement use the common (grounded) emitter connection and divide transistors into two groups according to the kind of semiconductor used: germanium and silicon junction transistors. Tests for point-contact transistors are omitted because these units have negligible commercial value. Industry engineers feel that junction transistors eventually will replace point-contact units in most applications.

Measuring I_{co} and I_{cbo}

Fig. 1 shows I_{co}, the d.c. leakage between collector and base when the emitter is open-circuited. I_{co} increases

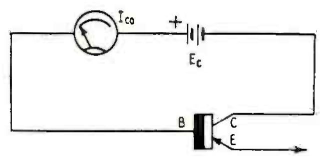


Fig. 1—Measuring leakage current I_{co}.

with temperature, and should be smaller than I_{cbo}—the smaller it is, the "cleaner" the transistor. Clean transistors have longer life because they are relatively free of contaminating materials.

Fig. 2 shows I_{cbo}, the d.c. leakage between collector and emitter when the base is open-circuited. I_{cbo} increases with temperature. It is a measure of collector efficiency—the smaller it is, the higher the efficiency.

Both I_{co} and I_{cbo} increase with age. The tests in Figs. 1 and 2 are the first step in determining whether a transistor can still be used or if replacement is necessary. If I_{co} and I_{cbo} are erratic, or larger than specified, the transistor should not be used.

Current gain in common-emitter

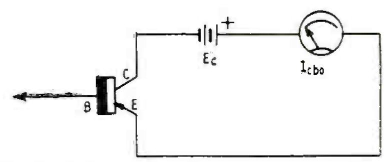


Fig. 2—Measuring leakage current I_{cbo}.

transistors is described in three ways. By d.c. current gain, $\beta = I_c/I_b$; by incremental d.c. current gain, $b = \Delta I_c/\Delta I_b$, and small signal current gain, beta or $\beta = di_c/di_b$. The ratio I_c/I_b is often used to describe d.c. current gain in power transistors. It is substituted for a.c. measurements when the huge current passed through some high-power units exceeds the rating of available radio components. Incremental current gain b is the ratio of incremental changes in collector and base d.c. (for constant collector voltage V_c). Small-signal (a.c.) current gain β is the gain from collector to base with the output short-circuited (for constant E_c). The latter two items describe gain for medium- and low-powered transistors.

R_{out} is the output impedance of a common-emitter transistor. It should be large because it decreases with increasing temperature.

Germanium junction transistors

Early plastic-encapsuled transistors were unreliable. Moisture and impurities, trapped during the encapsulation process, "poisoned" the germanium *heart* of the transistor. This slow killing process caused unstable operation and failure. Several important facts were learned during the evaluation of plastic-coated transistors. First, transistors must be assembled under surgically clean conditions. Second, rigorous factory tests were necessary if quality and performance were to be maintained. Third, the units had to be enclosed in hermetically sealed containers. For example, transistors encapsuled in plastic had relatively large I_{co} and I_{cbo} readings. When the same units were assembled under surgical conditions and mounted in hermetically sealed cases, these current readings dropped appreciably.

The I_{co} reading (Fig. 1) for most hermetically sealed, small-signal transistors should be less than 18 μamp at room temperature, with $-22\frac{1}{2}$ volts between collector and base. The manufacturer of 2N43 and 2N43A p-n-p transistors specifies that I_{co} shall be less than 10 μamp at room temperature, with -45 volts between collector and base. This should become an industry-wide standard.

The I_{cbo} reading (Fig. 2) for most hermetically sealed, small-signal transistors should be less than 125 μamp at room temperature, with -6 volts between collector and emitter.

Both I_{cbo} and I_{co} increase when a warm soldering iron is held near a transistor or even if the unit is held in the fingers while making measurements. This is another way of emphasizing that current increases with temperature. It is illustrated in graphs of I_{co} versus temperature on data sheets that accompany most transistors. If current increases slightly with temperature, there is no cause for alarm unless the current is unsteady. This often means defective junctions.

To investigate this further use the circuit in Fig. 3, with an oscilloscope in the d.c. position and a slow sweep (approximately 200 to 500 μsec per centimeter). Two switches (S1, S2) are used so you can see both the collector-to-base and emitter-to-base patterns on the scope. When either switch is flipped off–on–off, the d.c. voltage across the resistor deflects the scope beam. Set S3 and the scope gain so the pattern jumps about 1 inch. Good transistors generate patterns that are well defined step functions (*a*). If the pattern has poor rise (*b*) or fall time (*c*) or is unstable or shows appreciable noise (*d*), the transistor has a faulty junction.

Let's clarify the confusion that exists about transistor noise. The confusion began only because the point-contact unit appeared on the market before the junction type. Point-contact transistors have poor noise properties—a great disadvantage. Junction transistors have excellent noise properties. Noise in many junction transistors measures only 3 or 4 db above theoretical (Johnson) noise. Compare this with about 8 db of noise from the 1620 vacuum tube—the best tube as far as noise is concerned. But tube noise increases when

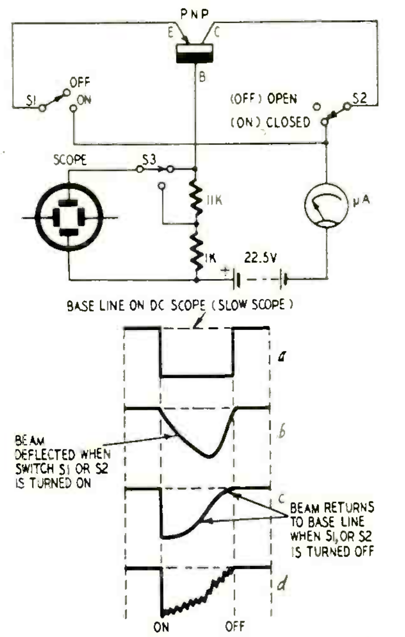


Fig. 3—Circuit tests p-n-p junctions.

the electrodes are subjected to vibration or shock. In junction transistors, noise is related to the ratio of the sizes of collector and emitter junctions. Hence, noise for a given transistor is fixed and does not change appreciably with vibration or shock. Nominally, noise in good junction transistors is from about 10 to 20 db.

The duality concept is useful when comparing transistors and vacuum tubes. Base current bias is the dual of grid voltage bias; collector current the dual of plate voltage and collector voltage replaces plate current. In other words, current and voltage functions are interchanged when comparing static characteristics of transistors and tubes.

Fig. 4 shows part of a set of transistor static characteristics. The diagram shows how to measure incremental d.c. current gain. R1 adjusts base bias current from about 1 to 130 μamp. With E_c at -6 volts, adjust R1 so that I_c is about 0.3 ma. Note the values of I_c and I_b. Then change R1 slightly and note the new readings in I_c and I_b. Differences in readings are the incremental changes ΔI_c and ΔI_b. Values of b vary widely for various transistors of a given type. For this test, practical working limits for b are from about 18 to 140. If b is less than 18, insufficient gain will be obtained. If it is greater than 140, the transistor probably is unstable.

The small-signal current gain beta in low-powered transistors is the dual of μ in a triode vacuum tube. A circuit for the measurement of β is shown in Fig. 5. The choke should be a UTC HQB-6 or equivalent, and the capacitors pyranol or equivalent nonpolarized. The beta factor is defined as collector-to-base current gain with the output short-circuited. Adjust R1 so that I_c is 1 ma. Set E1 to 1 volt at 1 kc. Resistor R2 essentially shorts out the output. The current gain is 10,000 times the voltage E2. It is derived as follows:

$$\beta = \frac{di_c}{di_b} = \frac{\dfrac{E2}{10^2}}{\dfrac{E1}{10^6}} = \frac{(10^6)(E2)}{(10^2)(E1)} =$$

$$(10^4)(E2) = 10{,}000\ E2$$

since E1 was set at unity. For example, if the v.t.v.m. reads .004 volt, beta is 40.

Values of β vary widely for various transistors—from about 15 to more

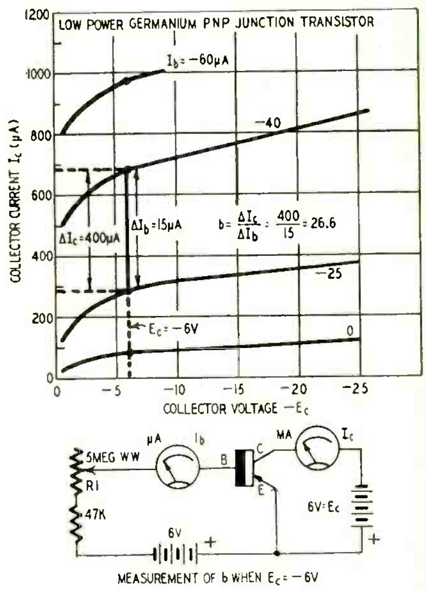


Fig. 4—Diagram shows method of measuring incremental d.c. current gain b.

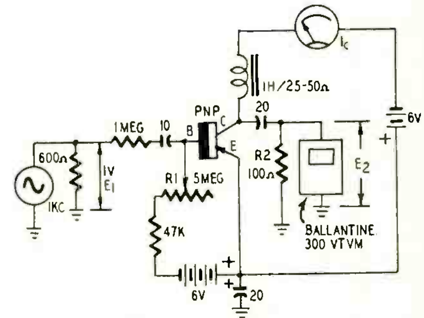


Fig. 5—Circuit for measuring beta.

than 200. However, if a designer learns to use transistors with an interim β spread, say 18 to 36 (some designers like 25 to 50), which is good practice, and designs accordingly, the service technician can replace or interchange transistors without much difficulty if he uses units with the same β spread. If the original design requires transistors with very low or very high β factors, replacements cannot be made indiscriminately. Such circuits require especially selected transistors as replacements; otherwise the circuits do not function. The problem of having to *select* transistors with special characteristics has been a headache in servicing many preamplifier circuits.

The alpha factor (collector-to-emitter current gain for the common-base transistor) need not be measured for two reasons. First, alpha can be calculated if beta is known; that is,

$$\alpha = \frac{\beta}{\beta + 1}$$

Secondly, beta magnifies or amplifies transistor properties more accurately. For example, reconsider the problem of having to *select* transistors to make an amplifier work. Specifying a beta spread from about 25 to 50 to obtain reliable amplification describes the situation more adequately than an alpha spread of from about 0.961 to about 0.980.

The output impedance R_{out} of a common-emitter transistor (the dual of a grounded-cathode triode tube) is the other parameter about which information is needed to determine transistor reliability. The value of R_{out} should be large because it decreases with increasing temperature, high collector currents and voltage and with age.

There are several circuits for measuring output impedance, but most of them are lacking in one or more respects. Probably the most economical way to establish the magnitude of R_{out} is to take data for a given transistor and plot the $I_c - E_c$ common-emitter characteristic and then determine R_{out} when I_c is 1 ma and E_c is 10 volts. Fig. 6 shows the process for a n-p-n transistor. R_{out} is the cotangent of the angle θ or the ratio of $\frac{\Delta E_c}{\Delta I_c}$ and varies widely from transistor to transistor. Practical working limits are from about 25,000 to 65,000 ohms, with an average value of about 40,000.

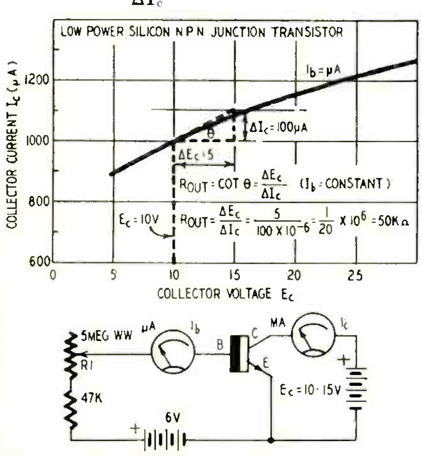


Fig. 6—Measuring output impedance.

Power transistors

Germanium power transistors have a different design than the small-signal units just described. Essentially, power units have a larger collector junction area. And since large amounts of heat are liberated in this area (about 1/50 square inch in the Minneapolis-Honeywell type 2N57 p-n-p power transistor), adequate cooling must be provided. Otherwise, the junction would overheat and be destroyed. The 2N57 is cooled by mounting the collector junction on a copper stud. Then the stud (Fig. 7) is attached to a metal chassis (heat sink) to permit rapid dissipation of heat. A photograph shows a 2N57 attached to a chassis. Because of this design, the 2N57 is rated at a d.c. collector dissipation of 20 watts, of which 6 watts, theoretically, can be converted to useful a.c. output power.

Measurements of I_{co} and I_{cbo} for power transistors are made with the circuit of Figs. 1 and 2. But a milliammeter is substituted for the microammeter and a larger battery is used. The manufacturer specifies that I_{co} for the 2N57 shall be less than 5 ma with -70 volts between collector and base at room temperature, and I_{cbo} shall be less than 27 ma with -70 volts on the collector.

Since available radio components will not handle the large currents passed by some high-power transistors, probably the best gain parameter to measure is d.c. current gain. For example, attach a 2N57 to a chassis in the common-emitter circuit (Fig. 8). With E_c at 2.5 volts, adjust R1 until I_c is 100 ma. The d.c. current gain,

$$\beta = \frac{I_c}{I_b}$$

should fall between the limits of 10 and 20 for good transistors. For the d.c. current gain measurement of other power transistors, check the data sheets for the upper limit of I_c and I_b to avoid damaging the transistors or test equipment by excessively large currents (up to 5 amperes in some high-power transistors).

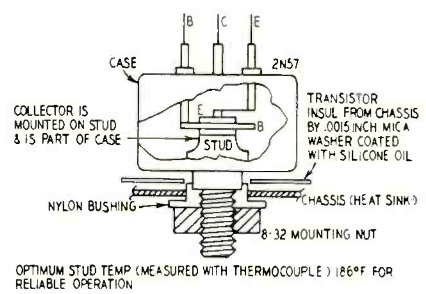


Fig. 7—Diagram shows how to attach 2N57 power transistor to the chassis.

The collector load resistance for most germanium power transistors is determined by the upper design limits of collector voltage and current. For the 2N57 these limits are 60 volts peak, and 0.8 ampere. Thus, collector load resistance for maximum power is $60/0.8 = 75$ ohms. High-powered units rated at 50 to 60 watts d.c. collector dissipation ($I_c = 5$ amperes) will require load resistances of about 10 ohms.

Silicon junction transistors

Available silicon junction transistors are of the n-p-n grown junction type. Their principal value is that they can be used at higher temperatures—around 150° C for example. This is because silicon has a higher energy gap (1.1 electron volts) than germanium (0.72 electron volt). So since the energy gap between filled and conduction bands is large, the intrinsic contribution to conductivity is reduced greatly.

As far as test methods are concerned, we are interested in the same parameters mentioned earlier. The same test circuits can be used (except that battery and meter connections must be reversed for n-p-n transistors).

At room temperature, I_{co} and I_{cbo} for low- and medium-powered units should be less than 2 μamp with 22½ volts on the collector. When a silicon unit is operated at 100° C, I_{co} should be less than 12 μamp. Noise in silicon units is slightly higher than in germanium units, but is objectionable only in units with high beta factors.

Since β adequately describes the performance of available silicon units, and

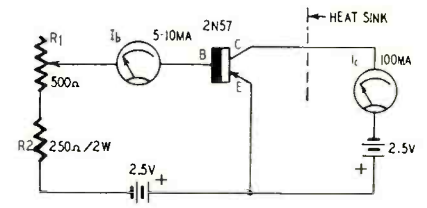


Fig. 8—Measuring d.c. current gain.

since leakage currents are so small, the d.c. and incremental d.c. current gain tests can be postponed until high-power (10 watts or greater) units are available.

The spread in β for both low- and medium-powered silicon units is from about 4 to more than 75. There is no official recommendation regarding practical working limits. Some designers and service technicians use an unofficial rule of thumb from about 18 to 36 (as measured with 6 volts on the collector).

Output impedances (Fig. 6) of between 15,000 and 80,000 ohms (common-emitter circuit) give satisfactory results. R_{out} varies widely from unit to unit.

The I_{co} and I_{cbo} readings of silicon medium-power units are small. One experimental unit has readings of less than 10 μamp at room temperature with 45 volts on the collector. These I_{co} and I_{cbo} readings for the Texas Instrument type X-15 power unit (rated at 1 watt) should be less than 5 μamp at room temperature with 45 volts on the collector. An X-15 attached to a chassis (heat sink) appears in one of the photos. END

Instrument features tuner substitution test

NEW *Simpson Portable Field-Strength* METER

By ROBERT G. MIDDLETON*

THE new battery-operated Simpson model 498 field-strength meter (see photo) has a unique feature in the form of a front-end substitution test. The first i.f. stage (6BH6) uses an unbypassed cathode resistor of 47 ohms (see diagram), which drops the output signal from the tuner contained in the field-strength meter. This drop is conducted to a front-panel connector on the instrument via a coaxial cable.

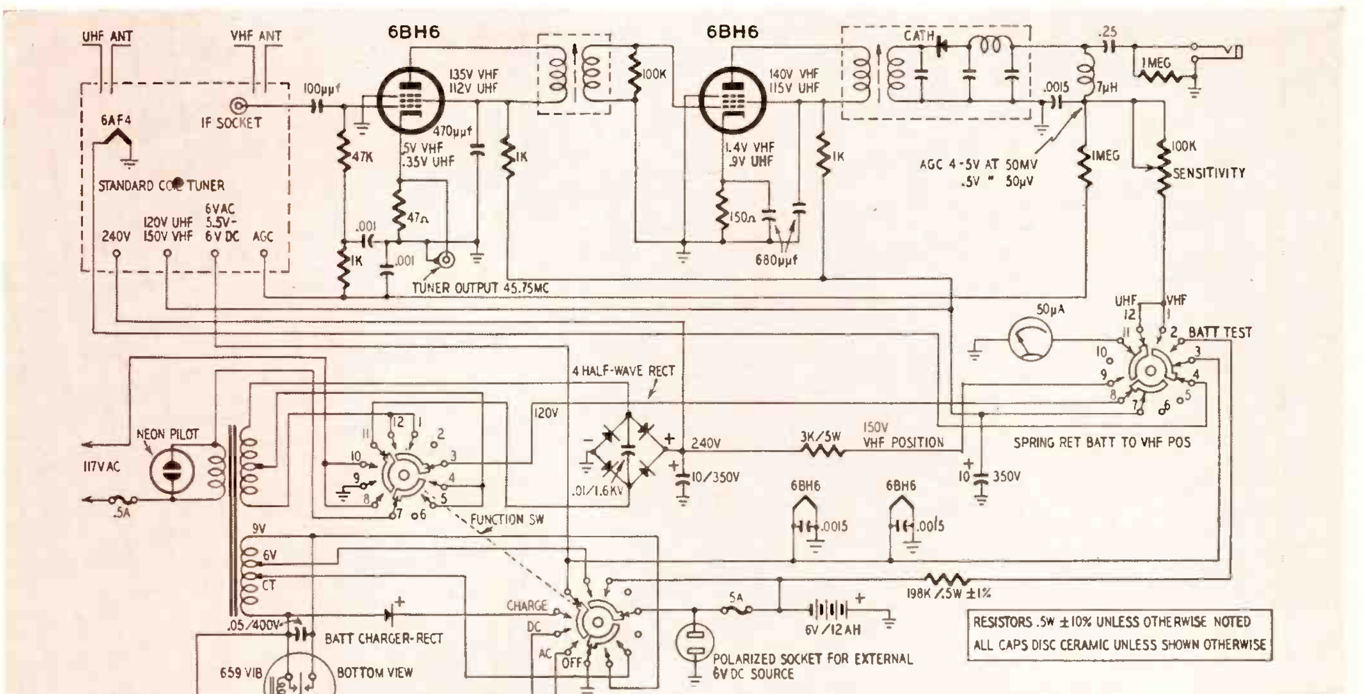
To make a tuner substitution test on a TV receiver, the cable supplied with the field-strength meter is fastened to the front-panel connector, and the alligator clips at the other end of the cable are connected to the grid of the first i.f. tube in the receiver and to chassis ground. Then, if the field-strength meter is tuned to a station, a picture appears on the screen of the TV receiver and the field-strength meter indicates the number of microvolts of signal present (if the instrument is properly calibrated).

This procedure not only answers the question: "Is it the front end or is it some other section of the receiver?" it also provides information concerning weak and borderline tuners which often cause dog receivers to find their way to the service bench.

The new field-strength meter provides relative field-strength readings over all u.h.f. and v.h.f. channels and a number of valuable and novel operating features:

1. Relative field strength can be measured in weak-signal areas from well below 50 to 50,000 µv in strong-signal areas.
2. The model 498 operates, if desired, from a 117-volt 60-cycle source with No. 12 leads up to 100 feet in length.
3. It operates, if desired, from an internal storage battery which can power the instrument for over 2 hours continuously without recharging.
4. Battery is rechargeable from a built-in recharging device which operates from a 117-volt 60-cycle power line.

*Chief field engineer, Simpson Electric Co.



Schematic diagram of the Simpson model 498 portable field-strength meter.

The model 498 field-strength meter.

5. Battery may be recharged, if desired, from a cigarette-lighter outlet on the dashboard of a service truck en route from one job to another. Observe the battery polarity: usually a positive ground on Fords, Chryslers, Packards, Studebakers and Kaiser-Frasers; negative on Nash and Willys.
6. The instrument, when connected to a 117-volt 60-cycle power line, can also recharge any external or accessory 6-volt storage battery.
7. The model 498 also provides a tuner substitution test, with an accessory output cable which can be used to determine the operation and sensitivity of the front end in a TV receiver in approximately 15 seconds. This novel and valuable test can be made to determine immediately whether the tuner is dead, weak or normally operative. It answers the often-perplexing question: "Is poor reception due to low field strength, to a defective tuner or to a fault in the receiver circuits following the tuner?"

A phone plug is provided for listening to the TV signal for detecting and identifying interference. A shoulder strap is also supplied for carrying convenience. This new compact field-strength meter is lighter in weight than any similar instrument providing comparable facilities. The instrument is available in two models, one powered by 117-volts a.c. only and the other powered by either the 117-volt line or an internal storage battery. The battery is supplied as an accessory or replacement item.

The design of the new Simpson meter offers striking advantages in power-supply efficiency and weight reduction, as follows:

Output voltage: 6 at 1.38 amp; 235 at 50 ma
Watt-hour capacity: 72
Battery: Storage type, with accurate voltmeter charge indicator
Weight: 6 pounds, 15 ounces (12 pounds, 4 ounces with self-contained rechargeable battery)

Some field-strength meters of the portable type are dry-battery-powered; the batteries must accordingly be replaced when exhausted, instead of being recharged. In spite of this use of dry batteries instead of a lead storage battery, a typical instrument of this type weighs 16 pounds as against 12 pounds 4 ounces for the new model 498. Most instruments of this type do not provide a tuner substitution test and have an oversimplified u.h.f. tuner section which consists of the elimination of the u.h.f. tuner as such and the insertion of a pair of crystal diodes in series with the input leads to the continuous type v.h.f. tuner. The local oscillator reradiates into the crystal diodes and harmonics of the local oscillator frequency heterodyne with the incoming u.h.f. signal for conversion to v.h.f., energizing the tuner in the instrument.

The price paid for this oversimplification, however, is the development of an excessive number of crossbeats and spurious responses which are avoided in the new Simpson meter by using a complete Standard Coil u.h.f.-v.h.f. tuner.

Normal operating voltages and circuit constants are set forth clearly in the circuit diagram. The instrument is calibrated at the factory with laboratory signal generators for a full-scale sensitivity of 50 μv on the first range. In the service shop, calibrating equipment of this type is not practical—in most cases—because of its high cost. However, accurate signal generators of somewhat limited frequency range and reasonable cost are available to the service trade.

Because the field-strength meter may be expected to drift slowly out of calibration after a long period of field use, in the absence of a calibrated signal generator for periodic checkup, the indications of the field-strength meter should be considered only as relative field-strength readings.

The i.f. used in the new field-strength meter is 45.75 mc, and for this reason, the tuner substitution test is useful only with the newer TV receivers having this i.f. END

AN UNUSUAL METER REPAIR

While making a routine maintenance check on a Simpson multimeter model 260 I encountered an unusual problem.

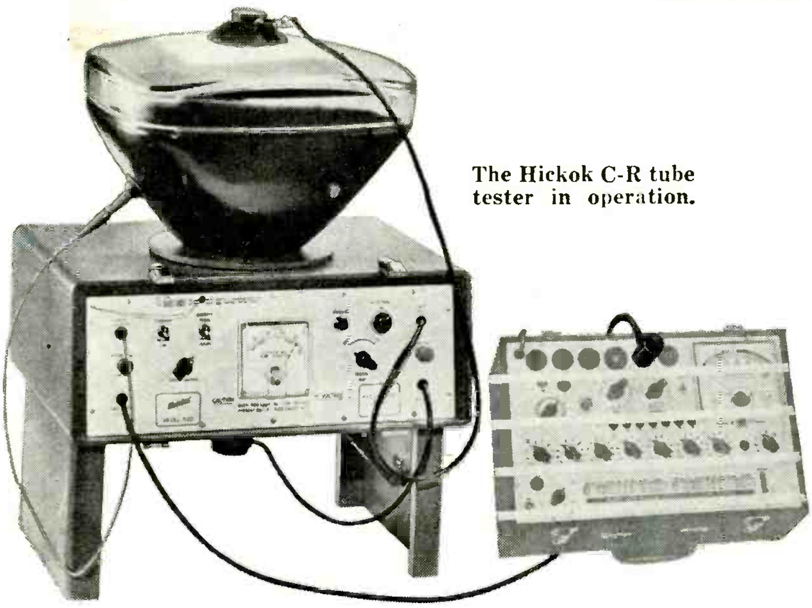
The maintenance check in our standards shop includes a complete battery change and a calibration check of the various ranges. It was after the batteries had been replaced and I was calibrating the meter against the standards we have set up that I ran into difficulty. The various current ranges were out of tolerance from 5–6% instead of the maximum 2%. The normal cause of this is resistors changing in value due to age or overheating. Not so in this case.

Suspecting the meter was in error I removed it from the circuit and checked it on the standard for full-scale deflection at 50 μa. The meter was O.K. Deciding that something was definitely goofed in the current circuits, I proceeded to check the d.c. volt ranges—these were also found to be out of calibration by 6–7%. Again the usual procedure of replacing the suspected defective resistors was tried with negative results. This was the first time that new resistors had failed to bring this particular instrument within its rated tolerance.

While removing the test leads from the Simpson in preparation for further troubleshooting the 1.5-volt flashlight cell was accidentally knocked from its spring contacts and fell on the work bench. I tried the d.c. volt ranges again to verify the first results. To my consternation they checked within the 3% tolerance for these ranges. Then I noticed the 1.5-volt cell that had been knocked out was still on my bench. But what could this cell have to do with the voltage and current circuits? Its only purpose is to supply voltage for the ohmmeter circuit. I replaced it and again calibration was off the same 6–7%.

I noticed that the 1.5-volt cell lay right against the back of the meter with only a thin piece of Bakelite separating the magnet of the meter from the cell. I had an idea—the cell had a steel case. This was stripped off and the cell replaced in its proper position. Calibration was now O.K. The steel case had been shunting the meter magnet just enough to reduce the sensitivity by 3 or 4%.

This case was exceptional—we maintain around 250 Simpsons and it has never been necessary to go to this extreme before. I suspect that two factors may have been involved in this defect: the steel-cased cell and a slight weakening of the magnet, as the cell has not affected calibration in other cases.—*George W. Bartlett*



The Hickok C-R tube tester in operation.

Circuit descriptions of recently developed TV test instruments

NEW PICTURE TUBE TESTERS

By ROBERT F. SCOTT
Technical Editor

PICTURE tubes are not usually carried on service calls so tests by substitution are made only after an exhaustive series of hit-or-miss checks have failed to pinpoint the trouble. Within the last year several precision picture tube testers have been developed. With a tester such as the new Hickok model 590 or Jackson model 707 in the service truck, the technician can quickly eliminate much of the guesswork usually connected with the testing of picture tubes. Details on these two new instruments are given in this article. The schematic of each unit is shown and its operation described.

The Jackson model 707 analyzer

The Jackson *Dynamic Cathode-Ray Tube Analyzer* (see photo) measures

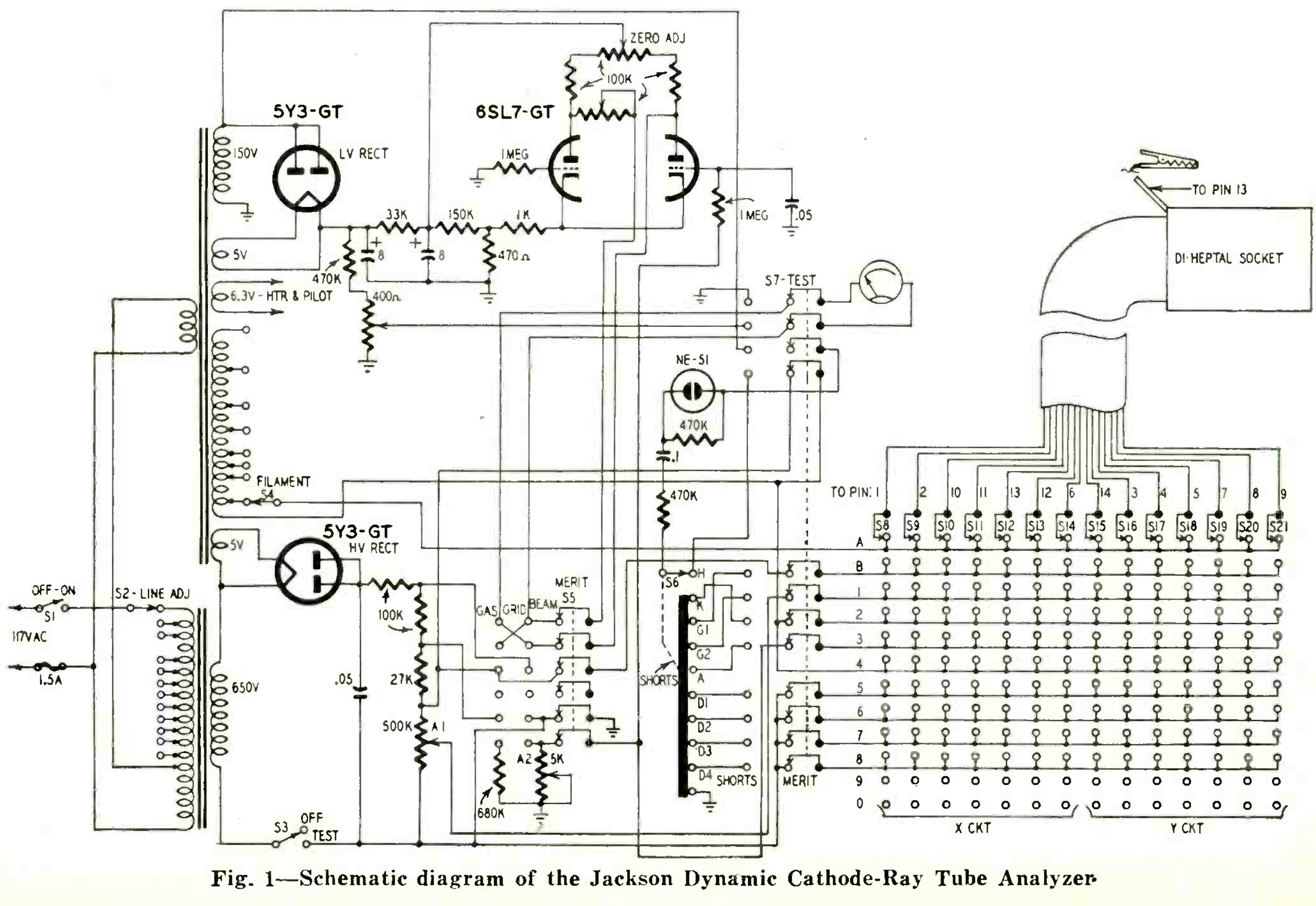
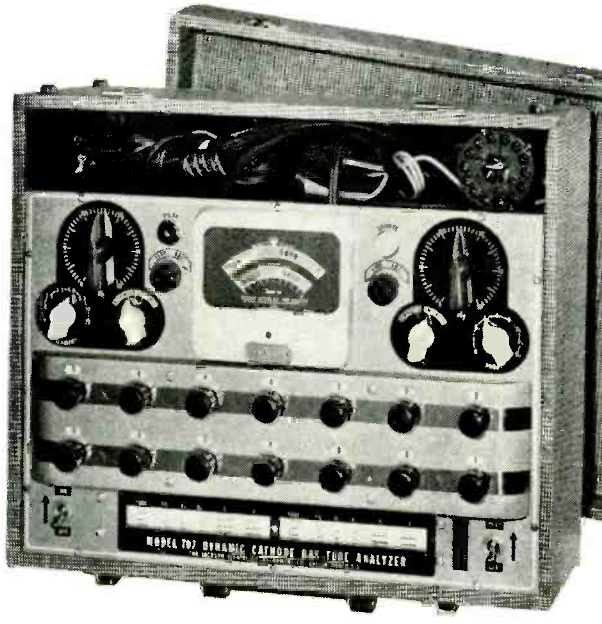


Fig. 1—Schematic diagram of the Jackson Dynamic Cathode-Ray Tube Analyzer



Panel view of the Jackson tube analyzer.

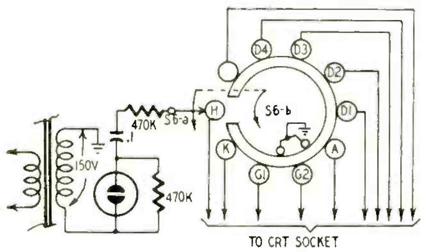


Fig. 2—Circuit used in the SHORTS test.

gas content, beam current and grid control and tests for shorts and leakage in all types of cathode-ray tubes. Its operation, appearance and circuit (Fig. 1) are similar to standard receiving tube testers. Tube sockets—a 14-pin diheptal, a 12-pin duodecal adapter and a universal adapter—are on the end of a 5-foot cable to permit testing tubes without removing them from the TV set, oscilloscope or carton. Control settings for various types of tubes are recorded on a roll chart, and tube quality is shown on a meter scale and a neon type short-leakage indicator.

Circuit operation

The first step in setting up the analyzer is to adjust the line voltage input. With S1 closed, turn TEST switch S7 to SHORTS and set S2 so the meter pointer falls on the line-voltage index point. The meter reads a d.c. voltage developed across the 400-ohm semi-adjustable resistor in the voltage divider string between ground and the cathode of the low-voltage rectifier.

Consult the roll chart and set FILAMENT switch S4 and circuit selectors X and Y as indicated. Then place the correct socket over the tube base. Rotate SHORTS test switch S6 through its range, watching the neon lamp for glow or flicker.

The basic circuit used in this test is shown in Fig. 2. A voltage of approximately 150 a.c. is applied between an isolated element selected by S6-a and all other elements shorted together by S6-b. When the indicator flashes in two or more positions, the panel markings under the switch pointer indicate the elements that are shorted or leaky.

Qualitative tests

Throwing S7 (Fig. 1) to MERIT connects the v.t.v.m. and sets up the analyzer for checking the quality of the tube under test. The meter is balanced with the zero adjust control and then controls A1 and A2 are set as indicated on the chart. A1 sets the high voltage to the value desired for the test; A2 sets the meter sensitivity to the value required for beam-current and grid-control tests on different types of tubes.

MERIT switch S5 is then thrown to BEAM and S3 is closed to deflect the meter. Tubes that cause the meter to read in the GOOD portion of the scale have sufficient beam current for acceptable contrast and brightness. The intersection of the GOOD–BAD areas of the scale is a diagonal covering a few degrees of the pointer range. A tube reading in this area has less beam current than specified in the tube manufacturer's tolerances and it may be rejected or kept in service, depending on the owner's demands for maximum brightness and contrast. Tubes that deflect the pointer into the "?" area may be gassy or damaged and should be suspected.

Operation of the control grid is tested by throwing S5 to GRID and watching the meter. This places a bias voltage on the grid, and the pointer should fall to zero (or to a predetermined value indicated on the chart) on the bottom reference scale.

Tests for gas content are made with S5 in the GAS position and the meter is read on the middle (NORMAL–GASSY) scale.

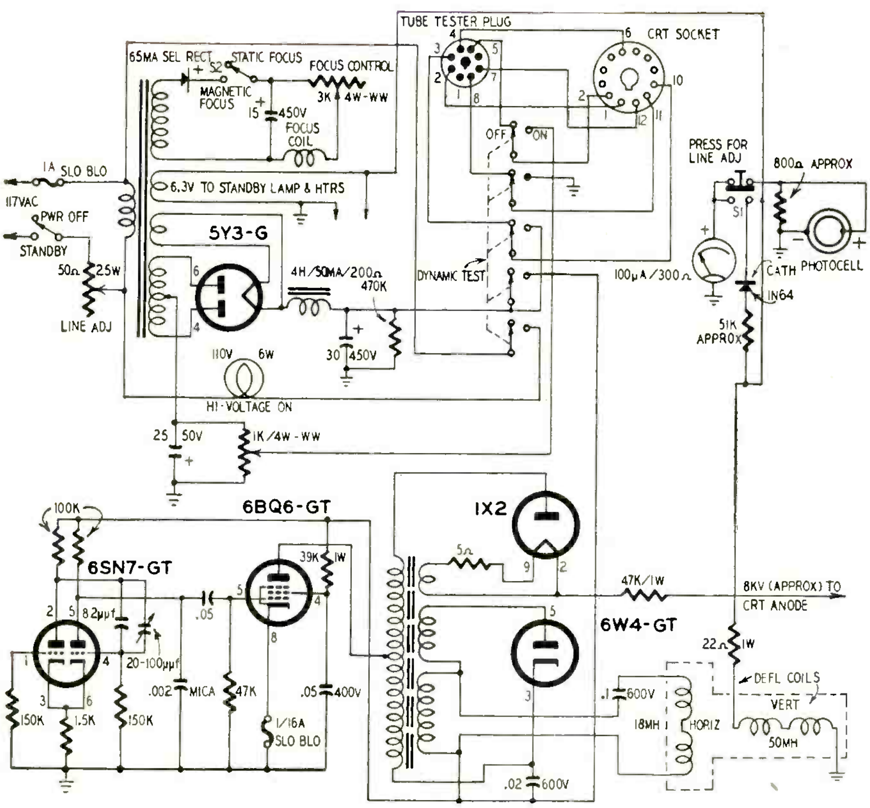


Fig. 3—Schematic diagram of the Hickok model 590 cathode-ray tube tester.

The Hickok model 590

This new instrument is used with any conventional Hickock receiving tube tester to test all magnetically deflected 10–30-inch tubes under the same dynamic conditions as in the TV receiver. It tests tubes first by measuring the light output from a raster and second by enabling the technician to see spots on the face of the tube. Light output is measured with a self-generating photocell and meter on the front of the tester. A tube with adequate brightness produces a reading in the GOOD portion of the meter scale while one with low emission or an inactive screen reads in the "?" or REPLACE area.

The setup for using the 590 is shown in the photograph. Accessories include single- and double-field ion-trap magnets, safety goggles, anode connectors and a collar ring. The collar ring supports the tube firmly by its bulb.

Theory of operation

The tester plug is inserted in the octal socket of a Hickock receiving-tube tester to tap off heater and certain other voltages. After setting up the picture tube and installing the ion-trap magnet around the tube neck, the receiving tube tester is adjusted to test for shorts, gas and grid control. (Instructions for these tests with different models of tube testers are included in the 590's operating manual.)

The circuit of the 590 is shown in Fig. 3. The 60-cycle vertical deflection voltage is obtained from a winding on the power transformer. The horizontal deflection system consists of a 6SN7-GT cathode-coupled multivibrator, a 6BQ6-GT amplifier, a 6W4-GT damper and a 1X2-GT high-voltage rectifier to supply approximately 8 kv to the second anode of the tube under test.

A tube that passes the grid-control, gas and shorts tests (these indications are read on the receiving tube tester) is then ready for the dynamic test. With the receiving tube tested adjusted as instructed in the manual, the photocell is placed in the center of the C-R tube screen where it is held in place by a suction cup.

Throwing the DYNAMIC TEST switch on disconnects the cathode and grids 1 and 2 from the receiving tube tester and connects the cathode to ground, grid 1 to a bias voltage, grid 2 to B plus and applies line voltage to the power supply in the 590 picture tube tester.

Pressing S1 disconnects the meter from the photocell and connects it across a 6-volt winding through a rectifier and multiplier resistor. The potentiometer in the primary circuit is then adjusted so the meter pointer lies on the line-voltage index on the meter scale.

The ion-trap magnet is then adjusted on the neck of the tube for maximum brightness as indicated by *maximum* deflection of the meter. If the tube under test uses magnetic focusing, S2 is closed and the focus control adjusted for *minimum* deflection. The condition of the tube is then read on the REPLACE–?–GOOD scale. END

Television Bar Generator Modifications Reduce Drift

By T. F. PROSSER

THE Superior Instrument Company's television bar generator is typical of several instruments now on the market that provide a series of horizontal and vertical lines for adjusting the linearity of home television receivers. This type of instrument consists of a low- and a high-frequency oscillator.

The low-frequency oscillator operates at some multiple of either the field or line frequencies of the television set. The vertical and horizontal oscillators of the TV set lock on a subharmonic of this oscillator and produce a bar pattern on the TV screen. The high-frequency oscillator is modulated by the low-frequency oscillator and tunes through v.h.f. channels, serving as a carrier for the generator's low-frequency oscillator.

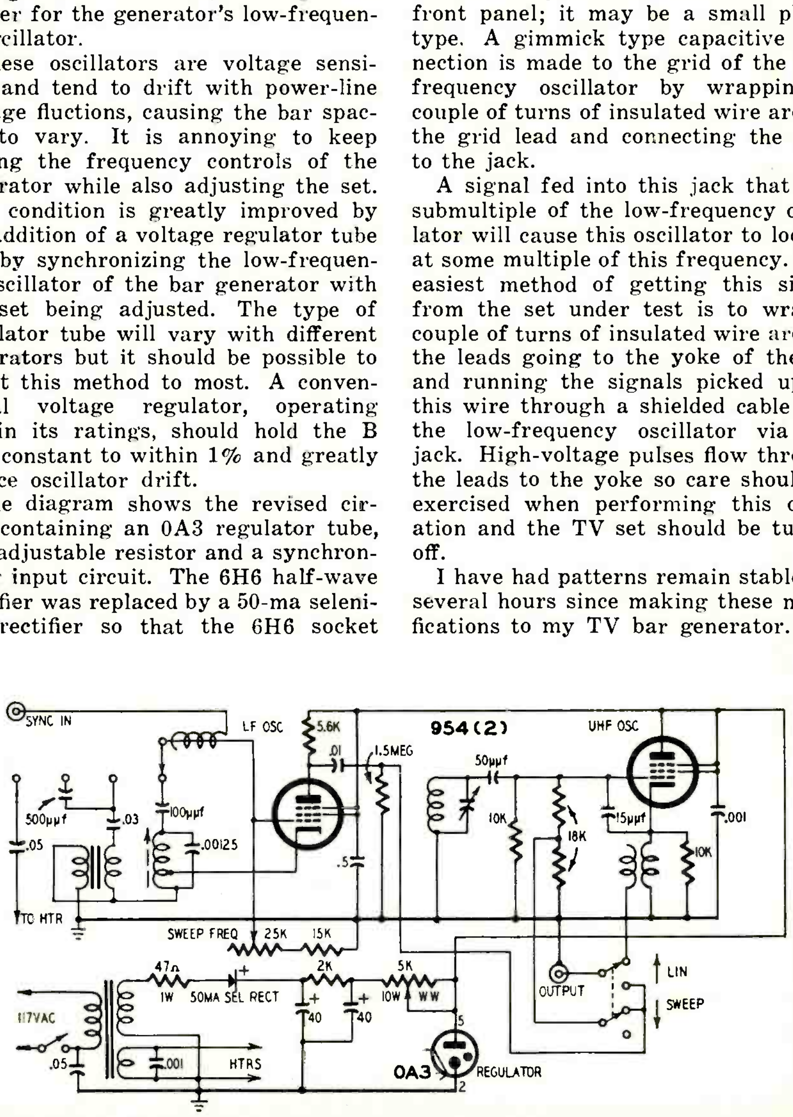
These oscillators are voltage sensitive and tend to drift with power-line voltage fluctions, causing the bar spacing to vary. It is annoying to keep setting the frequency controls of the generator while also adjusting the set. This condition is greatly improved by the addition of a voltage regulator tube and by synchronizing the low-frequency oscillator of the bar generator with the set being adjusted. The type of regulator tube will vary with different generators but it should be possible to adapt this method to most. A conventional voltage regulator, operating within its ratings, should hold the B plus constant to within 1% and greatly reduce oscillator drift.

The diagram shows the revised circuit containing an 0A3 regulator tube, and adjustable resistor and a synchronizing input circuit. The 6H6 half-wave rectifier was replaced by a 50-ma selenium rectifier so that the 6H6 socket could be rewired for the 0A3. A 5,000-ohm 10-watt adjustable wire-wound resistor may be connected from pin 4 to pin 6 of this socket as these pins are not now used. All parts may be added without drilling or punching the chassis but a hole must be made in the front panel for installing the synchronizing input jack.

The 5,000-ohm adjustable resistor is set by disconnecting the lead from pin 2 of the 0A3 and inserting a milliammeter from pin 2 to ground. Slide the tap on the resistor until the meter reads 10 ma. Then reconnect the lead to pin 2. This allows the regulator tube to operate within its ratings. Further stabilization of this units was made as follows: A jack was installed on the front panel; it may be a small phono type. A gimmick type capacitive connection is made to the grid of the low-frequency oscillator by wrapping a couple of turns of insulated wire around the grid lead and connecting the wire to the jack.

A signal fed into this jack that is a submultiple of the low-frequency oscillator will cause this oscillator to lock in at some multiple of this frequency. The easiest method of getting this signal from the set under test is to wrap a couple of turns of insulated wire around the leads going to the yoke of the set and running the signals picked up by this wire through a shielded cable into the low-frequency oscillator via the jack. High-voltage pulses flow through the leads to the yoke so care should be exercised when performing this operation and the TV set should be turned off.

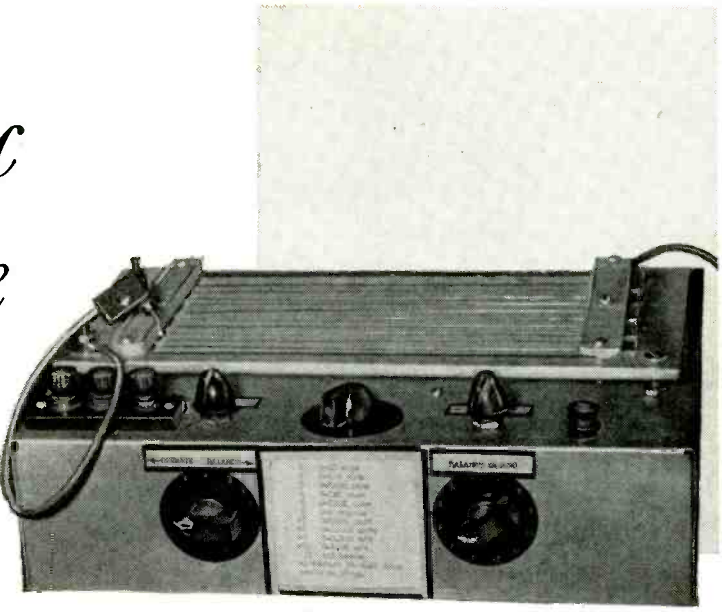
I have had patterns remain stable for several hours since making these modifications to my TV bar generator. END



An Electronic A.C. Bridge

Extremely accurate ohmmeter measures resistance and capacitance

By CARROLL W. COLEMAN



The complete electronic a.c. bridge.

ALTHOUGH the ohmmeter provides a rapid and direct means for measuring resistance, some other instrument must be used when accuracy to more than two significant figures is desired. An a.c. bridge provides this accuracy and gives the added advantage of capacitance measurement. The expense of an accurate bridge, however, generally limits its use to laboratory or industrial applications. A sizable proportion of this expense is represented by the decades of precision components, decade switches and decade wiring. Elimination of these greatly reduces the cost and complexity of the instrument.

Simplified arrangements of bridge circuits are shown in Figs. 1 and 2. The circuit of Fig. 1 measures unknown resistance R_x and that of Fig. 2 measures unknown capacitance C_x. When these circuits are balanced

$$R_x = \frac{R_s R_a}{R_b}$$

$$C_x = \frac{C_s R_a}{R_b}$$

Two factors must be known if the value of unknown capacitor C_x or unknown resistor R_x is to be found. These factors are the value of the standard (R_s or C_s) and the ratio of R_a to R_b. Note especially that the *value* of neither R_a nor R_b need be known—simply their ratio. If R_b is fixed, R_s is a standard (say 1,000 ohms) and R_a is variable with a maximum value of R_b and minimum value of zero, the ratio of R_a to R_b will be variable from 1 to 0.

Dividing R_a into 1,000 divisions of resistance (starting the first at point A, Fig. 1) will give 1,000 ratios between R_a and R_b, each ratio representing a value of R_x between 0 and 1,000 ohms. If R_s and R_x are replaced by C_x and C_s, the ratio values will then represent the capacitance of C_x. Suppose that C_s is 1,000 μμf. If the bridge balances at the 150th resistance division from point A, capacitance C_x is 150 μμf (assuming no residuals).

Dividing R_a into 1,000 parts is quite simple. Since resistance varies directly as the length of a conductor having a fixed cross-section, the problem can be made one of division in terms of length instead of resistance. In this electronic bridge, 8 feet of 0.5-ohm-per-inch resistance wire are used as the conductor. The wire is arranged on a 5 x 12-inch rectangle of ¼-inch Lucite (Fig. 3). On the face of the Lucite a sheet of graph paper having 100 horizontal divisions and 10 major vertical divisions is placed. These effectively divide the resistance wire into 1,000 units of length. A thin protective sheet of cellulose acetate is cemented over the graph paper. The wire is laced on the Lucite form so that it gives 10 parallel lengths, each divided into 100 parts.

The cross-section paper is labeled so that zero is at the upper left-hand corner. The 100 point occurs at the right-hand end of the first horizontal line, 200 at the left-hand end of the second horizontal line, etc. Since the length of resistance wire extending beyond the graph paper is not included in the calibrated length, it must be shunted from the circuit. This is done with small metal calibrating strips which terminate the two ends of the resistance wire precisely at divisions 1,000 and 0. They also short the right-hand end of the first horizontal length to the second length, etc. Thus the only active resistance between the terminals is that length of wire lying over the calibrated scale.

When completed, this resistance-wire assembly gives the appearance of a large, slide-rule type dial. Resistance is varied by a probe placed on a 10-inch length of test lead terminated at the 1,000 terminal. The probe may be placed at any point along the wire between 0 and 1,000. A closeup view of the assembly is shown in Fig. 4 with the calibrating strips removed from one end to show the method of stringing the resistance wire.

Fig. 5 is the schematic of the complete bridge. Sine-wave generator V1-a is a simple phase-shift oscillator. The 500-μμf capacitor across the primary of the plate transformer and the 200-μμf capacitor shunting the grid circuit suppress parasitic oscillations. With the values shown the oscillator will produce a clear 1-kc tone. The 1-ohm resistors in series with the secondary prevent overloading the oscillator when measuring low-value resistances. The isolation transformer reduces shock hazard.

Added bridge sensitivity is obtained by the two stages of audio amplification V2-a and V2-b. Amplifier response is narrowed by the low values of coupling

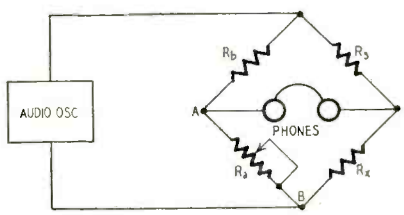


Fig. 1—A.c. bridge measures resistance.

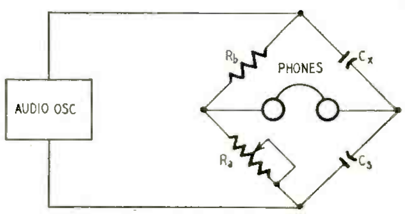


Fig. 2—Bridge measures capacitance.

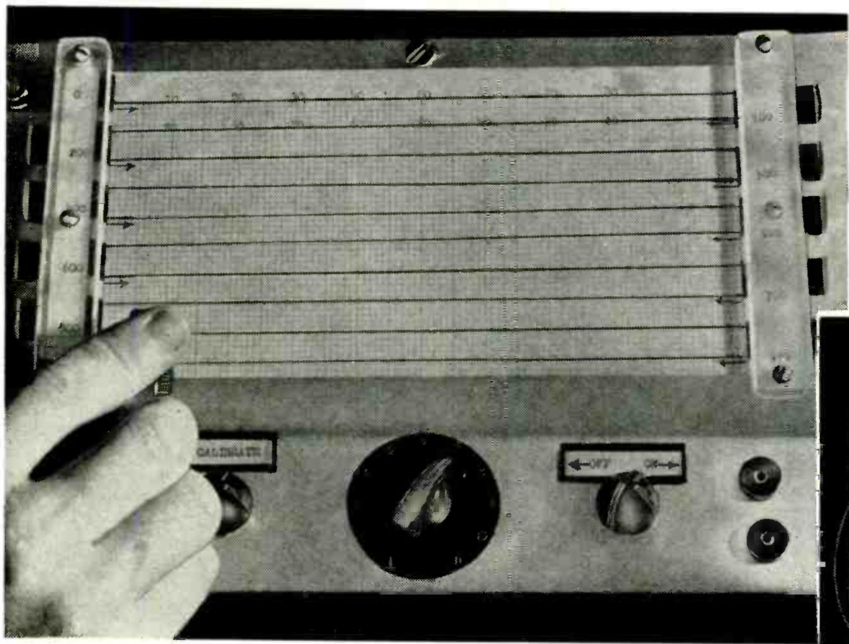


Fig. 3—Layout of the resistance wire.

Fig. 4—View shows how wire is strung.

capacitors and the 50-$\mu\mu$f shunt across the input of the final stage. The narrow response greatly reduces hum pickup and high-frequency noise. Transformer input is used to convert the balanced-to-ground bridge impedance to the unbalanced amplifier impedance.

The bridge circuit uses a Wagner ground. This arrangement minimizes bridge unbalance due to the effects of stray capacitance from the arms of the bridge to ground. Capacitor C1 across one side of grounding potentiometer R1 helps balance the fairly high capacitance to ground of the resistance-wire assembly in the opposite leg. Its value will vary from .001 to .005 μf, depending on the arrangement of circuit components.

Six ranges for resistance measurement and four for capacitance measurement are provided by standards R3 through R8, and C2 through C5. The value of the unknown component may be read directly from the calibrated resistance-wire scale. On each range the maximum reading will be the value of the standard (R_s or C_s); the minimum reading will be zero. For example, if the 10-ohm standard were switched in for measurements of a resistance of less than 10 ohms and if the bridge balanced at division 113, R_x would be 1.13 ohms. On the 1-megohm range the balance null becomes very broad.

For the capacitance standards shown the null is clear-cut on all ranges. There will be residual capacitance between the C_x terminals when they are open. This residual will be apparent on the first two capacitance ranges. On these two ranges the bridge will balance with the open terminals somewhere between 50 and 100 $\mu\mu$f. However this is no particular disadvantage. Since the value of the residual capacitance is known, it may be subtracted from the scale reading. The model in Fig. 4 showed a residual capacitance of 60 $\mu\mu$f.

Parts for electronic bridge

Resistors: 2—1, 1—47, 3—120,000, 2—220,000, 2—1 megohm, ½ watt; 1—150, 1—2,000 ohms, 1 watt; 1—100 ohms, 2 watts; 2—100, 1—1,000, 1—10,000, 1—100,000, 1—1 megohm, 1%, 1 watt (IRC Precister, type DCF, or equivalent); 1—10 ohms, 1%, 1 watt (Continental Carbon X-type or equivalent); 1—resistance-wire assembly (see text); 2—1,000-ohm potentiometers.

Capacitors: 1—50 $\mu\mu$f, 3—200 $\mu\mu$f, 1—500 $\mu\mu$f, 3—600 $\mu\mu$f, 1—.001 μf (5%), 1—.01 μf (5%), mica, 500 volts; 2—0.1 μf, 200 volts; 1—1 μf, 200 volts; 1—8 μf, 2—20 μf, 150 volts, electrolytic; 1—25 μf, 25 volts, electrolytic; 1—balancing capacitor (C1, see text).

Miscellaneous: 1—output transformer, 2,000-ohm primary, 3.2-ohm secondary (Stancor A3332 or equivalent); 1—power transformer, 117-volt secondary, 6.3-volt filament winding (Stancor PA8421 or equivalent); 1—audio transformer, 1:3 stepup, single plate to single grid; 1—s.p.s.t. switch (Switchcraft 2001L or equivalent); 1—2-gang 11-position rotary switch (Mallory 176C or equivalent); 1—117N7 and socket; 1—6SC7 and socket; 1 chassis.

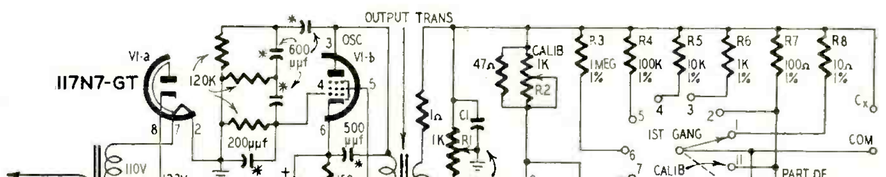


Fig. 5—The electronic R-C bridge. The power transformer is run over ratings but temperature rise is not excessive and voltage output is O.K.

Calibrating the bridge

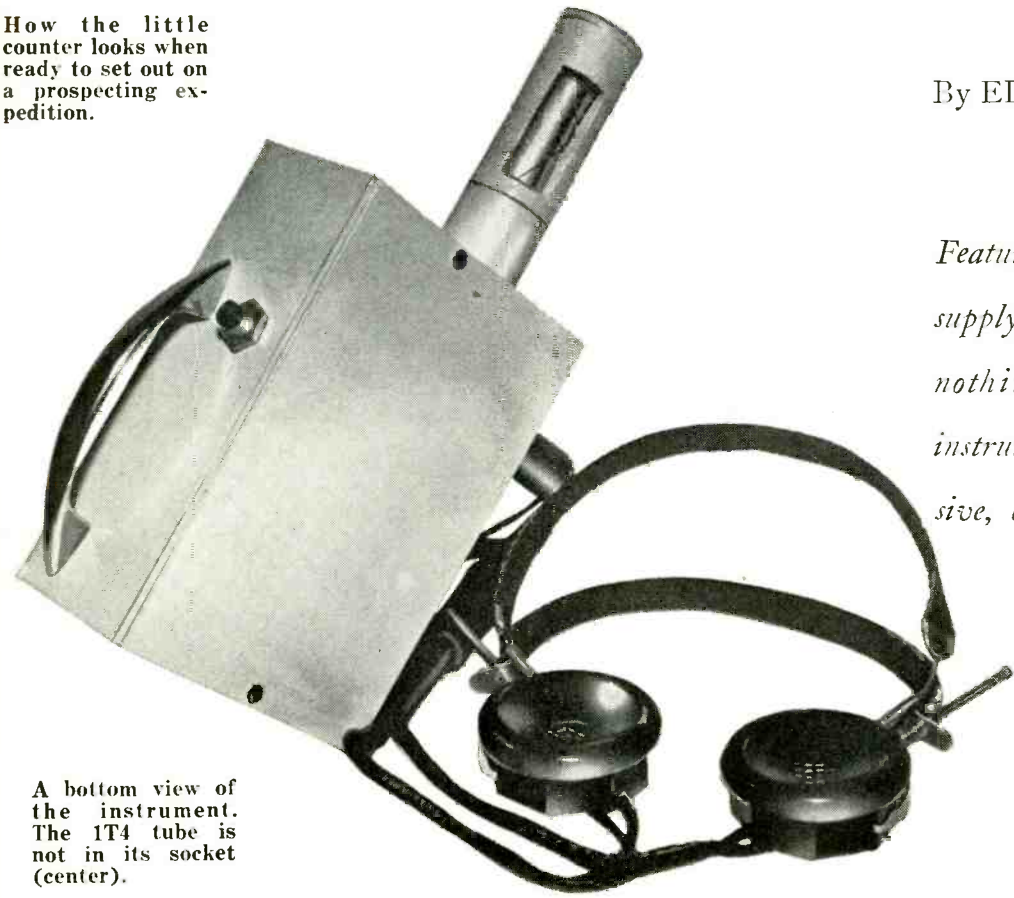
Turn the range switch to the CALIBRATE position. In this position two 100-ohm standards (R7, R9) are placed in the right-hand legs. The bridge is then balanced by tuning calibrating potentiometer R2 for a null. The Wagner ground is balanced by turning the OPERATE–BALANCE switch to BALANCE position and by then tuning ground potentiometer R1 for a null. Since there is some interaction between the calibrating and ground potentiometers, several retunings may be required for good balance.

Terminals R_x and C_x must be open when calibrating. Zeroing of the Wagner ground will be sharp and clear if the proper value of balance capacitor C1 is used on the leg opposite the resistance-wire assembly. This value may be quickly determined with a capacitor decade.

A light 12 x 7 x 3-inch chassis allows compact construction without overcrowding. This size also gives a neat fit for the resistance-wire assembly. The sine-wave generator and amplifier are in a 4 x 10 x 2½-inch channel-lock subchassis. END

POOR MAN'S

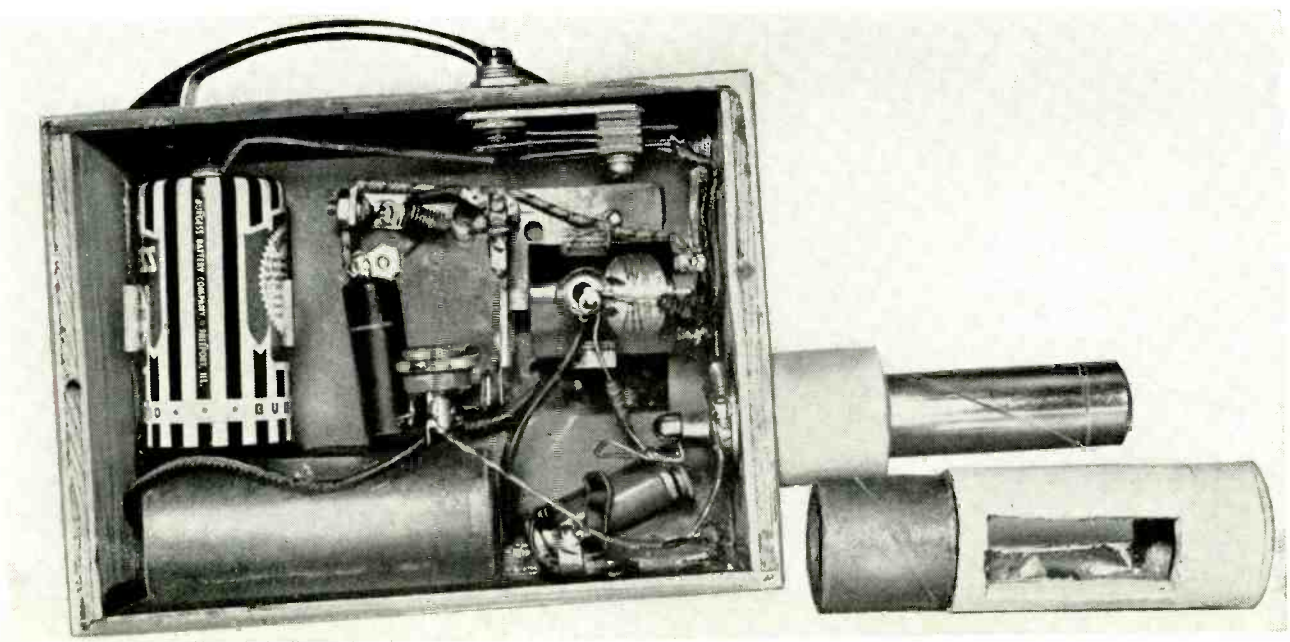
How the little counter looks when ready to set out on a prospecting expedition.



By ELLIOTT A. McCREADY

Featuring an ingenious power supply using "something-for-nothing" circuitry, this instrument is very inexpensive, compact and lightweight

A bottom view of the instrument. The 1T4 tube is not in its socket (center).



GEIGER COUNTER

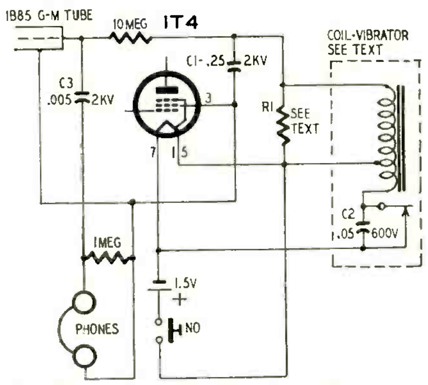
WITH all the talk of radioactive fall-out and the H-bomb, I came to the conclusion that it was high time I constructed a Geiger counter. With such an instrument, I would probably have several minutes' warning before I became a statistic; also, the gadget would be handy to have on our next visit to my father-in-law's ranch in the uranium state of Colorado.

I dug up all the back issues of the various technical magazines containing articles on Geiger counters. What I had in mind was something very light and inexpensive to construct and operate. Here I ran into a dead end; the numerous construction articles all had one or more drawbacks—either they used 300-volt batteries (at $7.85 a throw) or two Minimaxs and an r.f. high-voltage supply with expensive audio chokes and things. The most promising power supply appeared to be a vibrator, but experiment soon proved it too costly to operate. But two other articles fascinated me, the "something-for-nothing" circuit in the article by Richard H. Dorf (RADIO-ELECTRONICS, October, 1949) and a few pages further on in the same issue "Home-Built Snooperscope" by Harold Pallatz. The power supply for the snooperscope was ingenious. The output voltage was much too high for a counter tube but I felt that, with a few modifications, this and the "something-for-nothing" circuit were just what I was looking for.

The schematic shows the final results of quite a bit of experimenting. The coil–vibrator assembly was constructed from a model airplane ignition coil and a surplus 6-volt relay. The Bakelite relay base was used to mount the coil. The relay armature, contacts, spring, etc., were modified to fit at the end of the ignition coil to form a buzzer, the magnet of which is the coil's core. If an old relay is not available, a doorbell armature and contacts mounted on a plastic or Masonite base will probably do just as well.

The tube socket, C2 and R1 were mounted on the coil–vibrator assembly as shown in the photo. C2 reduces arcing at the vibrator points. A 1T4 miniature tube serves as a rectifier with the screen grid connected as the anode. Grid and plate connections are left floating. As the ignition coil delivers in the neighborhood of several thousand volts, load resistor R1 was shunted across the secondary. The value of this resistor must be determined experimentally, as the type of ignition coil used and the tension of the armature spring will determine the voltage delivered to capacitor C1. Start with a value of 25,000 ohms and work up until a voltage of 800–900 is delivered to the anode of the Geiger tube. Small voltage variations may be obtained by varying the tension of the armature spring.

As the ordinary v.t.v.m. will load down the power supply to a point where accurate readings of the output voltage cannot be made, adjusting R1 and spring tension was somewhat of a problem. I used a high-voltage probe and set the v.t.v.m. on a range that would give a 900-volt reading at a fairly low point on the meter scale. The power supply was then energized for several seconds and a measurement taken directly across C1. The peak reading on the v.t.v.m. was used in adjusting the voltage output. Make initial adjustments of R1 and spring tension with the Geiger tube disconnected, as excessive anode voltage will reduce its life. The 1B85, incidentally, uses negligible current at low (background) counting rates.



The Geiger counter, complete schematic.

After looking at the schematic and reading this far, the reader will probably comment that both the 1T4 and resistor R1 are being operated at many times their maximum ratings. Due to the extremely low current delivered by the model aircraft ignition coil and the intermittent operation of the power supply, this overload seems to have no effect on the life of these parts. The unit has been in operation for some time now and both the 1T4 and resistor R1 are still functioning normally.

C1 and C3 must be very high quality units with extremely low leakage current if counting time is to be maximum with one charging. As no amplification is provided, a pair of very sensitive phones must be used to provide adequate volume. A Victoreen 1B85 counter tube was chosen because of its relatively low cost and self-quenching characteristics.

The unit was constructed in a 2 by 4 x 5½-inch Masonite and plywood case. The 1B85 carton was modified slightly and used as a probe. A slot in each side of the probe gives maximum sensitivity to low-powered radiation. The photo shows how compactness is attained with no crowding of parts. C1, shown in the lower left corner of the inside view, is a .05-μf 6,000-volt unit. It was later replaced by the Glassmike specified in the parts list.

To operate the counter, depress the switch for several seconds until C1 builds up to operating voltage and a normal background count of between 25 and 40 counts per minute is received. With one charging, the instrument will operate anywhere from several minutes to several hours, depending upon radiation intensity. In normal use, the single flashlight cell will last for weeks.

If all parts must be purchased new, this counter can be built for about $20—less than half the cost of a commercial model. With parts found in the average experimenter's junkbox, this figure can be pared considerably. It performs very satisfactorily. Its simplicity and low cost truly qualify it for its descriptive name—*Poor Man's Geiger Counter!* END

Parts for Geiger counter

Resistors: 1—1 megohm, 1—10 megohms, ½ watt, 1 load resistor (see text).

Capacitors: 1—.005 μf, 2,000 volts (Condenser Products Co. Glassmike 502-2M); 1—.05 μf, 600 volts; 1—0.25 μf, 2,000 volts (Glassmike 254-2M).

Tubes: 1—1T4; 1—1B85 Geiger tube (Victoreen Corp.)

Miscellaneous: model aircraft ignition coil (Modelectric Corp.); relay or doorbell; crystal phones (Brush A200 or equivalent); phone jack; No. 9 flashlight cell; miniature socket; s.p.s.t. pushbutton switch; miscellaneous hardware, case, wiring, etc.

AUTOMATIC LAWN WATERING INDICATOR

By R. J. SANDRETTO

Device is extremely simple and compact.

DESIGNED to respond to the presence or absence of moisture in the soil this control unit indicates when a lawn should be watered and when watering should be stopped.

Its operation is simple: First the selector switch is turned to START (Fig. 1). Then, when the lawn needs watering, the 0A4-G fires. A low-wattage pilot lamp glows steadily until the watering is begun. The selector switch is then turned to STOP. The lamp goes out and remains out until the water has seeped to a proper depth. When the watering should be stopped, the pilot lamp begins to flash brightly at frequent intervals. These flashes are accompanied by attention-getting clicks from the relay. Turning the selector switch back to START completes the operational cycle.

The control unit features extremely low power consumption. It draws about 0.2 watt while standing by, about 2 watts when indicating to start and about 4 watts when indicating to stop.

Circuit description

When the selector switch is in its start position, current flowing through the selenium rectifier charges the electrolytic capacitor. During this first quick charging, the pilot lamp acts as a protective current-limiting resistance. Current flow through the rectifier circuit is ordinarily so low that the lamp does not even glow. Under these conditions the resistance of the pilot lamp has practically no effect on the circuit.

The tube will now fire if a suitable voltage is placed on the starter anode. The 150-$\mu\mu f$ capacitor between the starter anode and the arms of R1 and R2 acts as a protective reactance of about 18 megohms to prevent excessive current from flowing between the starter anode and cathode. The capacitor was used instead of a 18-megohm ½-watt resistor because one was not immediately available during construction. This closes the relay contacts but no effect on the circuit because they are already bypassed by the selector switch. The steady discharge through the tube draws more current through the rectifier and the pilot lamp than before. This causes the lamp to glow continuously.

When the selector switch is turned to STOP, the rectifier charges the filter capacitor as before. But this time, when the tube fires, the closing of the relay contacts cuts off the power to the rectifier circuit and connects the lamp directly across the power line.

Meanwhile, the voltage across the discharging capacitor has been falling until it has reached a point where conduction through the tube stops and the relay drops out. The circuit is then reset, and the cycle will be repeated as long as there is a favorable voltage on the starter anode of the 0A4-G. During each cycle, the relay sounds a click when the lamp lights and again when it goes out. The flashing rate is determined by the resistance of the pilot lamp, the capacitance of the filter capacitor, the resistance of the plate circuit relay and the value of the resistor across its terminals. The parts values specified resulted in a flashing rate of about 50 times per minute. The duration of each flash was about ½ second, and the interval between flashes was about the same.

A length of plastic insulated hookup wire is buried underground to a depth of about 1 inch. One end is connected to the control unit. The tip of the

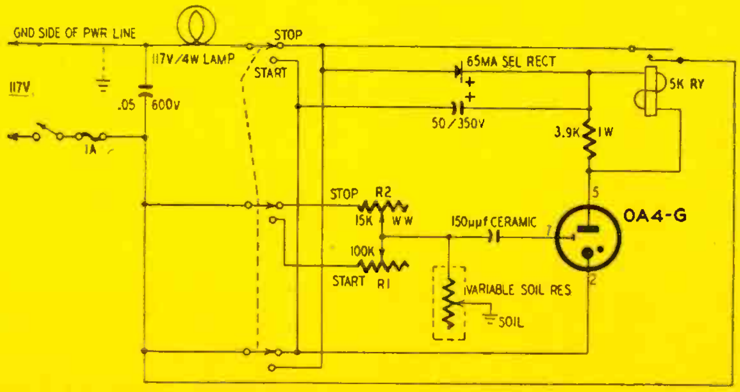


Fig. 1—Schematic of the watering indicator. Unit has only a single control.

other end has its insulation stripped back about ⅛ inch. When the soil is wet, the resistance between this buried tip and the grounded side of the power line is rather low. As the soil dries, this resistance increases gradually. This varying resistance is used as one arm of a voltage-divider circuit. Indications of the unit are based on the immediate area of soil in contact with the buried tip. This gives a reliable indication if the watering is done evenly over the entire lawn area.

First experiments were conducted with a slightly different circuit and a length of completely insulated wire underground. It was thought that the change in capacitance between the conductor in the wire and the ground could be used to control the unit. When the ground was extremely dry, this capacitance was 2,000 $\mu\mu$f, with very wet ground it gradually changed to 2,200 $\mu\mu$f. This amounted to only a 10% increase. This was not great enough, so the present method was devised.

The resistance method produced startling results. The resistance of wet soil was about 10,000 ohms. As the soil dried out this resistance increased to over 500,000 ohms. This amounted to an increase of about 5,000%!

Fig. 2 shows the simplified voltage-divider circuit for start indication. The tube is made to fire by increasing the voltage between the cathode and the starter anode. This is caused by an increase in resistance between these two points. As the soil resistance increases, a corresponding voltage rise occurs which causes the unit to fire. Once adjusted, R1 is not changed.

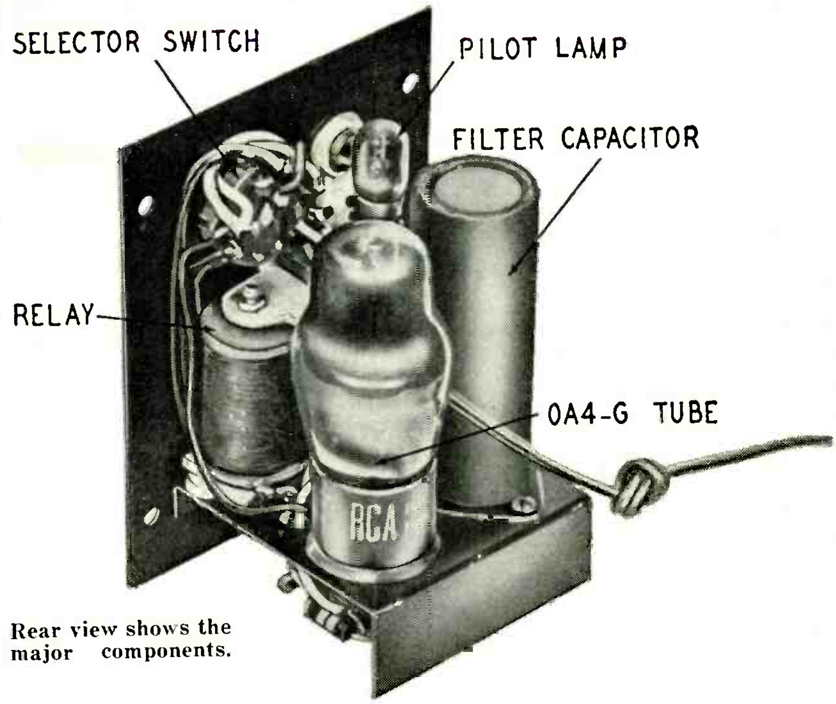
The selector switch changes the polarity of the power circuit so that the equivalent of the circuit shown in Fig. 3 is obtained when the switch has been turned to its stop position. The unit fires when decreasing soil resistance causes a voltage increase across the preadjusted control R2.

Since individual installations and desires of how wet or dry the ground should be vary, adjustment of indication is provided by two preset controls R1 and R2. Adjustment procedure will be discussed in detail later. If the ground is to become *extremely* dry before the unit gives the signal to start, a higher value control should be used for R1. Once the setting for each control has been determined, fixed resistors could be inserted in their places.

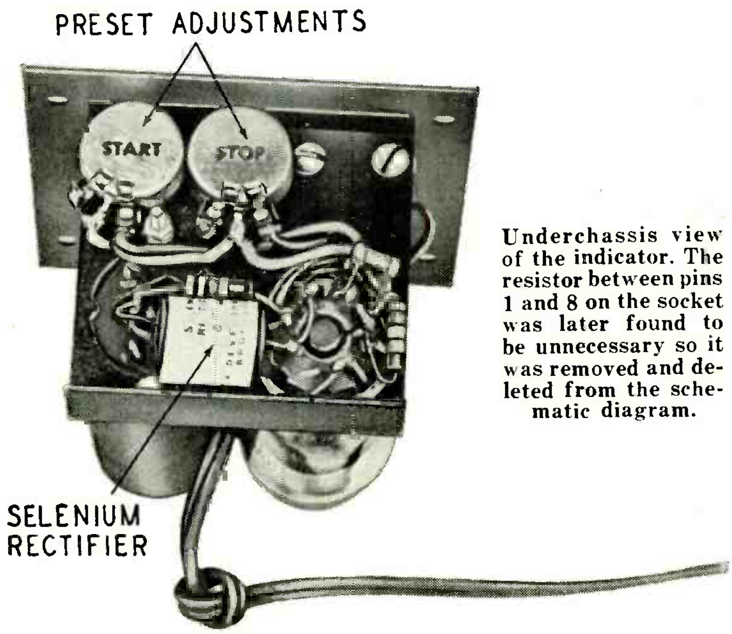
Construction

As the photographs show, a careful parts layout will result in a very compact unit. I used an ICA 3817 combination chassis and cabinet measuring 4 x 3 x 5 inches. Except for the 3,900-ohm resistor across the relay coil, whose value may have to be determined experimentally, values are not critical.

Only three pins of the octal socket are used for the tube connections. The remaining five may be used for wiring terminals.



Rear view shows the major components.



Underchassis view of the indicator. The resistor between pins 1 and 8 on the socket was later found to be unnecessary so it was removed and deleted from the schematic diagram.

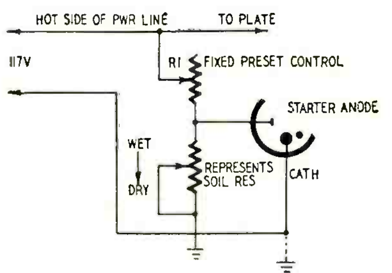


Fig. 2—Circuit for start indication.

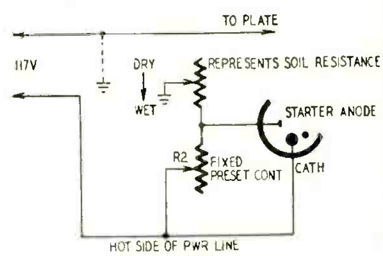


Fig. 3—Circuit for stop indication.

Another value of plate relay resistance may be used as long as the relay has good sensitivity. One having a resistance lower than 5,000 ohms would be preferred because the start indication would then be brighter due to the increased current drain through the rectifier circuit. A different value of shunting resistance might be needed.

A type C4, 4-watt 115-volt pilot lamp was chosen for its small size and low wattage. Any other small incandescent 115-volt pilot lamp may be used instead.

The fuse was included for additional safety, but it may be omitted. A selenium rectifier with a rating of 35 ma or greater may be used. The selector switch is a small four-pole two-position unit, whose fourth section is not used. Lower values of filter capacitance will give shorter relay hold-in periods. However, the working voltage rating of this capacitor should be high to allow a sufficiently high safety margin. There will be a voltage of about 160 on it for long periods (1.41 times the power-line mean value of 115 volts).

While wiring the unit, leave the 3,900-ohm resistor unsoldered. Then, after the wiring has been checked, disconnect the ground wire, turn the selector switch to START and plug the unit in. Whatever the polarity of the power plug, the tube should now fire, the relay close and the pilot lamp glow. If the relay won't close, use a higher value of shunting resistance. If the relay does close; but it is desired that the pilot lamp glow brighter, use a lower-value shunting resistor.

Plastic insulated hookup wire will last longer underground and provides better insulation than pushback type wire. The location of the buried wire will show at first, but it will not be long before the lawn grows over the narrow disturbed area.

Occasional r.f. pulses along the power line are bypassed by the .05-uf. 600-volt capacitor connected across it. Otherwise they might fire the unit and cause a false start indication. Perhaps in some localities this capacitor may be omitted from the circuit.

Adjustment procedure

Water the soil well, connect the ground wire, set the selector switch to STOP, turn the appropriate control to its maximum resistance setting and plug in the unit. If flashing doesn't start immediately, reverse the power plug and make some mark for identification purposes later. Next, slowly decrease the resistance setting of the control until the flashing stops. Back up this control slightly until the unit is again flashing at a steady rate. This completes the adjustment for the stop signal.

Parts for lawn watering indicator

1—3,900-ohm 1-watt resistor; 1—15,000-ohm potentiometer; 1—100,000-ohm potentiometer; 1—150-μμf capacitor, ceramic; 1—.05-μf 600-volt capacitor; 1—50-μf 350-volt capacitor; 1—0A4-G and socket; 1—4-watt 115-volt lamp, type C4; 1—3-pole 2-position selector switch; 1—65-ma selenium rectifier; 1—pilot-light assembly; 1—1-ampere fuse and holder; 1—cabinet and chassis (ICA 3817 or equivalent); 1—5,000-ohm plate relay; 1—line cord.

Adjustment for the start signal is made after the ground has had time to dry to the desired extent. At this time, however, do the following in preparation for the adjustment of the watering indicator:

1. Turn the selector switch to START. This must be done during the interval between flashes of the pilot lamp. Otherwise, the unit will not be reset and another attempt must be made.
2. Turn the start adjustment control to its maximum resistance setting.

After the soil has dried, slowly decrease the resistance setting of the start control until the unit fires. Adjustment is now complete.

Possible variations

A simpler system could substitute a resistor for the pilot lamp and utilize the purple glow from the fired 0A4-G tube as a means of signaling start. Instead of the blinking pilot lamp to indicate stop, the flashing purple glow and the clicking of the relay would give the indication. A single-note chime might be used to signal stop rather than a blinking lamp.

Some constructors might want to experiment with this type of unit to control a completely automatic sprinkler system. The flow of water could be regulated by a motor- or solenoid-controlled water valve.

Perhaps a number of buried probe wires might be connected to a single controller by a selector switch. Then, a person rotating the selector switch could check on several independent areas of a very large lawn. END

Transistor Amplification Data

By RUFUS P. TURNER*

THE high current amplification factor obtained with base-input transistor circuits is attractive in d.c. amplifier, relay, control and measurement applications. The two types of base-input circuit — the grounded-emitter and grounded-collector, also known as common-emitter and common-collector—give current amplification many times the emitter-to-collector alpha figure for a given transistor.

Junction transistors are the superior performers in each of the base-input circuits, since in these connections their input and output resistances are positive and since the junction transistor is short-circuit stable. Base-to-emitter and base-to-collector current amplification, beta (β), is related to alpha. And its numerical value is governed by transistor and external-circuit values r_b, r_c, r_e, r_g, R_L and r_m. The following approximate formulas apply under the arranged conditions of r_b much less than r_c, r_e much less than $r_c - r_m$, R_L very small compared with respect to $r_c - r_m$, and r_g very small with respect to r_e:

For the grounded-emitter: $\beta = \dfrac{\alpha}{1 - \alpha}$

For the grounded-collector: $\beta = \dfrac{1}{1 - \alpha}$

*Author, *Transistors, Theory and Practice.*

The tables shown here are for ready reference when working between alpha and beta values. Table I lists grounded-emitter and grounded-collector current amplification values calculated for 28 common alpha values found in commercial transistors. This compilation will be of interest to practical circuit designers for quickly selecting alphas required for proposed base-input current amplification values and betas corresponding to measured or rated alpha values. Table II lists commercial junction transistors together with their alpha ratings.

Where alpha is not specified by the manufacturer, base-to-emitter *beta* is given and is designated by β. END.

TABLE I—Junction Transistor Current Amplification for Common Alpha Values.

Alpha (grounded-base)	Beta	
	Grounded-Emitter	Grounded-Collector
0.80	4.00	5.00
0.81	4.26	5.26
0.82	4.55	5.55
0.83	4.88	5.88
0.84	5.25	6.25
0.85	5.66	6.66
0.86	6.14	7.14
0.87	6.69	7.69
0.88	7.33	8.33
0.89	8.09	9.09
0.90	9.00	10.00
0.91	10.1	11.1
0.92	11.5	12.5
0.93	13.3	14.3
0.94	15.7	16.7
0.95	19.0	20.0
0.96	24.0	25.0
0.965	27.6	28.6
0.97	32.3	33.3
0.975	39.0	40.0
0.98	49.0	50.0
0.985	65.7	66.7
0.99	99.0	100
0.995	199	200
0.996	249	250
0.997	332	333
0.998	499	500
0.999	999	1,000

TABLE II—Alpha Ratings of Junction Transistors (Except Where Labeled β).

Manufacturer	Type	Alpha
CBS-Hytron	2N36	45 (β)
	2N37	30 (β)
	2N38	15 (β)
Federated Semi-Conductor	RD-2517	0.93
	RD-2520	0.975
	RD-2521	0.975
	RD-2525	0.994
G-E	2N43	0.98
	2N44	0.955
	2N45	0.92
National Union	RR34	10 (β)
	2N39	> 0.94
	2N40	> 0.90
	2N42	> 0.85
Raytheon	CK721	0.975
	CK722	0.90
	CK723	0.90
	CK727	0.975
RCA	2N34	0.98
	2N35	0.98
Sylvania	2N34	40 (β)
Texas Instruments	200	0.90
	201	0.95
Transistor Products	X-22	0.90
	X-23	0.95
Westinghouse	WX-4813	0.96

Instrument aids in new surgery technique

THERMISTOR THERMOMETER

By ALFRED HAAS

HIBERNATING animals not only have a greatly reduced body temperature, but their organic activities are also slowed down greatly. Research has shown that microbic infections do not spread in a hibernating animal. In certain surgical operations (especially pulmonary ones) it is hard to stop the spread of infection. It has been found that in such operations (and in certain other types) it is desirable to produce a sort of artificial hibernation or cooling. This is known to the medical profession as *hypothermia*.

But the human body is a thermostatically regulated device, maintaining its temperature at a little over 98° F in spite of variation in ambient temperature. If the uncovered body is exposed to a cold environment, sufficient energy is dissipated to keep it at a constant temperature. Surgical operating rooms are kept well heated just to avoid this loss of energy.

Biological research has recently discovered a drug that inhibits the thermic regulation center. If this drug is injected, the body tends to assume the temperature of its surroundings, just

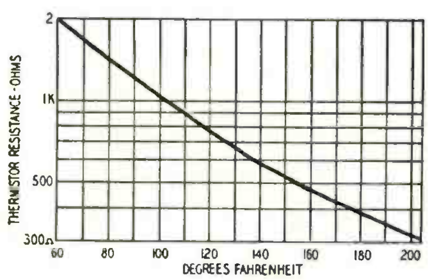


Fig. 1—Thermistor characteristic curve.

as would a dead object, and no energy is dissipated to maintain the normal temperature. With the help of this drug, patients have been kept at body temperature between 77 and 90° F for periods as long as a week. Tissue contamination was definitely halted during these periods.

The operation of cooling can be critical, and it is necessary to have exact kn ledge of the temperature of various parts of the patient's body during the process. Ordinary medical thermometers are not accurate enough (and are confined to the range of 96–108° F, considered ample for perhaps a hundred years). Therefore a special electric thermometer was developed for hypothermia. It covers the range from 77 to 108° F, so can also replace any medical thermometer.

Thermistor as a sensing device

The best temperature-sensitive device available is the thermistor. Its temperature coefficient is much greater than that of other materials. Thermistors are sold in various shapes to suit any use; there is a special model for thermometry, a thin tube ended by a little bulb. The sensitive element is sealed in this bulb and the two connecting wires pass through the tube. The whole device is made of glass and easily cleaned and disinfected, an important point.

A typical characteristic showing the variation of internal resistance as a function of temperature is given in Fig. 1. It can be seen that the temperature coefficient is negative: as the temperature rises, the resistance falls. The resistance scale is logarithmic. This means that the variation of resistance practically halves between 77 and 108° F.

Thermistors may be obtained with resistances ranging from a few ohms to several meghoms. This resistance is generally given at room temperature (68° F). Since a battery is to be used to transform the resistance change into a measurable voltage drop, the thermistor resistance has to be sufficiently high not to be heated appreciably by the battery current. As the resistance falls when passing current, the thermistor may be burnt out if no current-limiting resistor is provided. However, too high a resistance would result in a loss of sensitivity, as the galvanometer (Fig. 2) used for zeroing the bridge is necessarily of low internal resistance. It was found that thermistors ranging from 3,000 to 10,000 ohms at 68° F are suitable.

Circuitry

For accuracy and reliability, a Wheatstone bridge was used. In case of battery failure, sensitivity will be impaired, but there will be no false reading. Potentiometer R2, a good-quality wirewound unit, is used to zero the bridge. To spread the useful range of from 77 to 108° F all over the scale, resistors R1 and R3 are connected in series with R2. The logarithmic law of resistance variation in thermistor resistance would result in severe crowding of the high end of the scale were R1 and R3 equal. Good linearity was obtained with the unequal-proportion arms shown.

While resistors R2, R1 and R3 are definite, R4 has to be adjusted to match the thermistor. For thermistors ranging from 3,000 to 10,000 ohms, R4 was between 10,000 and 1,500 ohms.

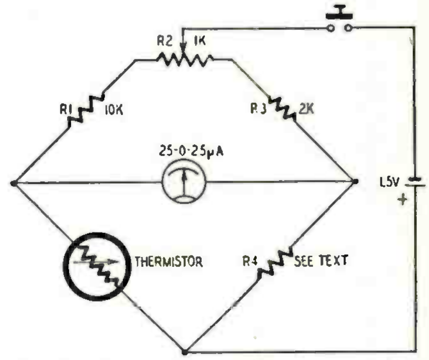


Fig. 2—Schematic of the thermometer.

A sensitive galvanometer is required. A zero center 25–0–25-ma instrument was used, resulting in a reading accuracy of about 0.3° F. Accuracy can be increased by using a more sensitive instrument.

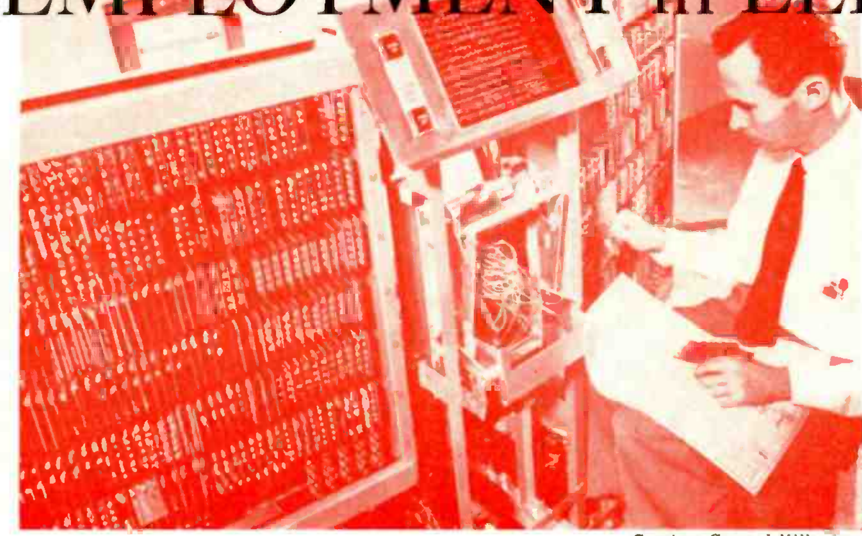
The bridge is powered by a single dry cell. As current flows only during the reading while the pushbutton is pressed, the battery lasts a long time.

Calibration

To calibrate the instrument (see photo), water of different temperatures was prepared, the calibrating standard being a good mercury thermometer. By using several cloth-covered jars, different readings can be taken rapidly by putting the thermistor in each jar. The bridge is zeroed each time by pressing the pushbutton and rotating the potentiometer dial. Temperatures are marked with a pencil, and can be engraved or redrawn later.

To be easily transported, the instrument is housed in a small metal box with a removable lid. Several units are in use in the municipal hospitals at Paris. END

EMPLOYMENT in ELECTRONICS



Courtesy General Mills, Inc.

Partial view of the calculating unit of IBM's experimental transistor computer.

Accelerated expansion of this field provides almost limitless opportunities for the electronic technician

By RONALD A. LANE

THE electronics industry offers two types of economic opportunity—business and employment. In the electronics field—more than in most others—endless openings exist for a man with very little capital to go into business. There are also almost infinite possibilities of employment with others. Eight general groups of employment opportunities will be explored.

The best-paying of these eight varieties probably are employment as a technical writer and as a radio officer in the merchant marine. The other six, listed in order of possible earnings, are employment in broadcasting and telecasting stations, radio communications stations, telephone installation and repair work, telegraph installation and repair work, 16-millimeter motion-picture work and electronic manufacturing.

This listing is far from rigid; pay scales vary very greatly within each group. For example, broadcast station employes *may* earn as much as $168 a week or as little as $49, while the *average* pay of electronics factory employes for a 40-hour week is $58.40, according to the Department of Labor. In general, broadcasting work is better paid, but some factory workers earn more than some broadcasters. Such variations exist throughout the entire field.

Technical writer

With the possible exception of radio officers in the merchant marine, the technical writer in electronics is, on the average, the best paid electronics employe. Despite the title, the technical writer does not need literary ability. A literary style could be a handicap and, if he had one, he would have to get rid of it. Ability to write and punctuate an ordinary grammatical paragraph is the only literary skill required. Proficiency in electronics is far more important.

Experienced electronics writers can earn up to $150 or more for a 40-hour week. And there is often opportunity for overtime. The chief requirement, is a very intimate knowledge of electronic techniques. Loyalty clearance is sometimes also a requisite.

The work consists of writing instruction manuals for use by the armed forces. The technical writer, however, works, not for the Government, but for a private corporation. The armed forces use a great deal of electronic gear. Service personnel must be taught to operate, maintain and repair complex equipment. All the services rely very heavily on illustrated instruction manuals. Their preparation has become a substantial industry. Writing (and illustrating) them provides a well-paid employment.

Each of the armed services has its own fixed style, which the technical writer follows. He does not need and cannot use a literary style of his own. He writes "by the book." But he must know his electronics.

A technical writer will very likely be handed a mass of blueprints and left to figure them out as best he can. Conferences with engineers who designed the equipment can be arranged, but they are busy people without the time to teach electronics fundamentals. High salaries are paid to those technical writers who can figure out for themselves most of what they need to know and trouble the engineers as little as possible.

Many large companies that contract with the Government to supply military equipment maintain staffs of technical writers to prepare the accompanying instruction manuals. But they may also contract some of their manual writing to outside companies specializing in such work. Smaller companies may not have enough manual writing to justify a department for that purpose and these companies will also contract with a manual-writing concern. Lastly, the armed services themselves may grant instruction-book contracts.

Technical writer jobs are advertised in the "help-wanted" columns of city newspapers. This does not mean that the job is necessarily in a large city. It may be in any small town that has an armaments factory or a Government base.

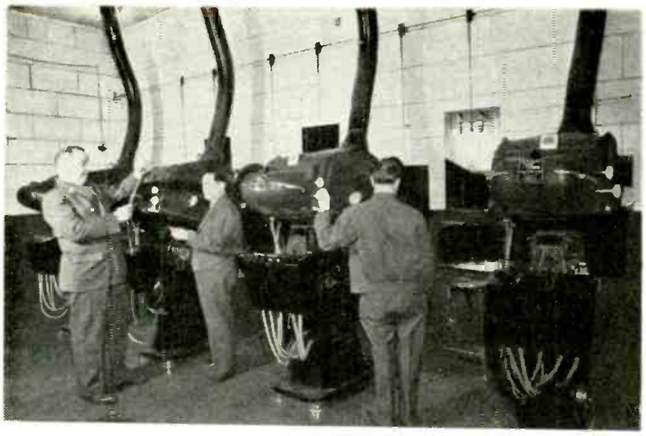
Beginners with no experience in this type of work, but with the background and qualifications for it, might be able to start at, possibly, $75 to $85 a week, and work up from there as their skill and usefulness increase.

Related employment opportunities are those of technical-manual illustrators and draftsmen and of parts listers. Illustrators and draftsmen are often women. Parts listers are men who draw up the detailed information which the Government requires in the way of spare parts lists and bills of materials for each item of equipment. Thus, a set of tubes for a radio receiver would be spare parts, and the spare parts list must describe them so accurately and completely that when the GI in the field requisitions new tubes he will get the right ones. Sockets are not spare parts; they would be listed in the bill of materials. These jobs as a rule are not as well paid as technical writers.

Merchant-marine radio officer

Opportunities open to radiomen in the merchant-marine radio service were outlined in "The Ship Radio Operator" (RADIO-ELECTRONICS, September, 1951). Conditions have changed since. There are not so many jobs, but pay is higher. This apparent paradox results from the existence of two strong unions, one AFL and one CIO. At present the basic wage of a radio officer—it varies somewhat with type of ship, etc.—is between $400 and $500 a month, but overtime and other extras add on. According to the secretary-treasurer of the Radio Officers Union, "No one earns less than $150 a week." Plus room, board and travel, but before taxes.

Vacations also are generous: three weeks a year on dry cargo ships; four



Courtesy Radio City Music Hall

The projection department of the Radio City Music Hall, world's largest theater. At left is Charles Muller, chief projectionist.

Courtesy Bell Telephone

Cable splicer and helper installing buried cable.

weeks a year on tankers. Reason for the difference is that loading and unloading cargo ships is a lengthy process during which the radio officer can take a good deal of unofficial vacation ashore; tankers are pumped out rapidly and "turn around" after only a few hours in port.

The work of the radio officer aboard ship becomes increasingly varied as the science of electronics expands—he is no longer merely a "wireless operator." Greater numbers of merchant ships are carrying radar; somebody must maintain that gear. Someone must maintain sonar—the electronic "lead" that measures depth of water by bouncing an audio vibration off the sea bottom and catching its echo. Someone must maintain the ship-to-shore radiotelephone, radio direction finder and electronic-servo automatic helmsman. Since all this work carries overtime pay, other ship's officers claim as much of it as they can; but only the radio officer has the requisite knowledge and training as a rule. Not even all radio officers have the training; those competent to repair radar, for example, can have a "radar endorsement" added to their FCC licenses on passing an appropriate examination.

Two licenses are needed before any man can sail as radio officer. One is granted by the FCC upon examination in electronics and in proficiency in Continental Morse code. Radio schools prepare candidates for the FCC examination. Aside from schools, books that will prove helpful are: *Radio Operating Questions and Answers*, McGraw-Hill Book Co., New York; *Radio Operators License Q and A Manual*, John F. Rider Publisher, Inc., New York, and *Study Guide and Reference Material for Commercial Radio Operator Examinations*, Superintendent of Documents, Washington, D. C. To become proficient in Morse code, practice it. Setting up and operating a ham radio station offers excellent practice. The grade of license granted by the FCC depends on the technical examination the candidate takes (and passes) upon his speed in Morse code, and on his past experience in military or civilian wireless operation.

An entirely different type of examination is given by the Coast Guard. It has to do only with the candidate's rank as an officer aboard an American ship. He must pass a physical examination, a loyalty check and a test of his knowledge of first aid. The last is required of *all* ship's officers. Two books helpful in preparing for the first-aid exam are: *Ship's Medicine Chest and First Aid at Sea*, Superintendent of Documents, Washington, D.C., and *Manual on Ship Sanitation and First Aid*, Seamen's Church Institute, 25 South Street, New York, N. Y.

FCC and Coast Guard examinations for radio officer are held all over the United States. For places and dates, inquire of Director of Information, Federal Communications Commission, Washington, D. C., and U. S. Coast Guard, 1300 E Street N. W., Washington, D. C.

Once the necessary licenses have been obtained, inquiries concerning employment may be directed to the U. S. Maritime Administration, Washington, D. C.; Radio Officers Union, 1440 Broadway, New York, N. Y.; American Communications Association, 5 Beekman Street, New York, N. Y., or any steamship company.

Broadcasting and telecasting

The work of an electronics technician in a broadcasting or telecasting station is divided into three broad groups. In the smallest stations a single man may take care of all three. In larger stations there is a separate staff for each. The three functions are studio operation, transmitter operation and maintenance. Maintenance may be further divided into studio and transmitter maintenance.

The latest available Government statistics are several years old and represent pay scales undoubtedly lower than at present. The statistics do make very plain two facts that probably have not altered: The highest pay is to be found in the largest "key" broadcasting stations, particularly the first 10, and the poorest in the little one-man stations in very small cities. The second fact is that almost invariably the aspirant for one of the highly paid posts must first acquire experience in the poorly paid small-town enterprises. The key stations, according to available figures, paid transmitter operators \$107 a week; studio operators, \$112; chief engineers and other electronic supervisors, \$160–\$170. In stations with fewer than 15 employes even a chief engineer might be paid as little as \$64 a week.

Studio personnel handle microphones, TV cameras and studio controls. They also go out on location with a sound or TV truck for remote pickup of newsworthy special occasions. They may or may not repair and maintain their equipment.

Transmitter operators switch and stand by transmitting equipment, observe its meters, watch it for overheating or other signs of trouble, substitute emergency panels by switching when necessary, and monitor the broadcast signal for quality. They may or may not repair and maintain apparatus.

To get started in broadcasting or television the radiomen should apply to the smallest stations only, either those in very small cities or smaller stations in a large city, where he will gain not only experience but all-around experience. The pay will be small; but with the experience gained, he can apply to the larger stations and networks and key stations where pay is higher.

For studio work — placing microphones, etc. — an FCC license is not necessary; but those men who control the emissions of a broadcasting or telecasting station must have an FCC license. The applicant for employment in a small station must be an all-round man; therefore he needs an FCC license. Requirements are somewhat similar to those for a merchant-marine radio officer's license. Inquire at the nearest office of the FCC or its Washington, D. C., headquarters.

Union membership is often necessary for employment in the larger stations but not required—or may even be a barrier—in smaller ones. The beginner, therefore, will probably not be a union member, but will join a union as he advances. Which union he joins will depend on which one controls the job he wants.

Radio communications

American stations which are part of a world-wide radio-communications network need operators and technical personnel. Merchant-marine radio officers at sea keep in communication with the land through land stations, specially operated for that purpose. These also need operators and technical personnel.

According to available Government figures, Morse-code radio operators were paid $1.94 an hour; radio operating technicians, $2.12; technical supervisors, $2.53; engineers and engineering assistants, $2.78. Present rates are presumably higher.

Any of these employes who actually control the emission of radio-frequency energy must have FCC licenses. Since most personnel, including repairmen, may have occasion to put a signal on the air, an FCC license is always an asset and often a necessity.

The largest single employer is RCA Communications, Inc.; next largest is Mackay Radio and Telegraph Co. Third largest is Radiomarine Corporation of America (as distinct from RCA Communications, Inc.) and fourth Tropical Radio Telegraph Co.

Telephone technicians

One of the easiest roads into the electronics industry for the absolute beginner is through his local telephone company. Telephone companies in general, and the Bell System in particular, prefer to train their own people. The reason is, of course, the interlocking nature of a telephone system. There is no place for the rugged individualist who must do things his own way. The inexperienced but willing and intelligent young man is hired and taught to do things the telephone-way.

Foremen of telephone craftsmen were paid an average of $2.68 an hour; central office testboard men and repeatermen, $1.99; central office repairmen, $1.83; cable splicers, $1.89; installers, $1.72. These figures are for 1950; there have been increases since. Pay scales vary to some extent; Bell System companies pay fractionally higher than the non-Bell telephone companies.

Telegraph technicians

Telegraph technicians are not quite as well paid as their opposite numbers in the telephone service. Foremen of telegraph technicians draw only $2.09 an hour; traffic testing and regulating employes, $1.80; subscribers' equipment maintainers, $1.65; linemen and cablemen, $1.54; installation and maintenance employes, $1.66; Morse telegraph operators, $1.41.

Morse telegraph operators are almost obsolete. The grand old profession of Thomas Edison and so many other pioneers has been almost completely displaced by teletype, telephone and facsimile. In October, 1950, in the continental United States, Western Union had only 1,218 Morse operators. Teletype operators (essentially typists) drew $1.17 an hour.

16-millimeter motion pictures

"Narrow-Gauge Motion Pictures" (RADIO-ELECTRONICS, April and May, 1953) described the mechanisms used to project half-width (16-mm) motion-picture films (standard theatre film is 35 mm wide).

Large city or county school systems use considerable numbers of these machines. Some hire a full-time employe to repair their 16-mm equipment.

The electronic equipment to be maintained is merely a photoelectric cell or magnetic reproducer or both, an audio amplifier and one or more loudspeakers. The associated electrical, optical and mechanical devices are maintained by the same technician, but present little difficulty because all 16-mm equipment manufacturers provide very complete instruction manuals.

In addition to large-scale users dealers and distributors in 16-mm sound motion-picture machines maintain service departments. Such dealers and distributors are listed under "Motion-Picture Equipment" in the classified directory of any reasonably large city.

My inquiries were not numerous enough to provide any reliable statistics; scattered replies indicate that full-time repair and maintenance of 16-mm projectors is paid at rates ranging from $48 to $85 a week.

Electronics manufacturing

Very definite figures are provided by the Government for employment in electronics manufacturing. The average pay of electronics workers as of February, 1952, was $1.46 an hour as against $1.64 an hour for all other manufacturing. Employment in electronics manufacturing is concentrated in a few areas: 36.6% is in the Chicago, New York and Philadelphia areas, with Chicago leading.

Available statistics indicate that TV production-line workers may earn $40–$52 for a 40-hour week; TV lab technicians, $65; TV aligners as much as $75. TV factory engineers are paid up to $125 a week, average.

Miscellaneous employment

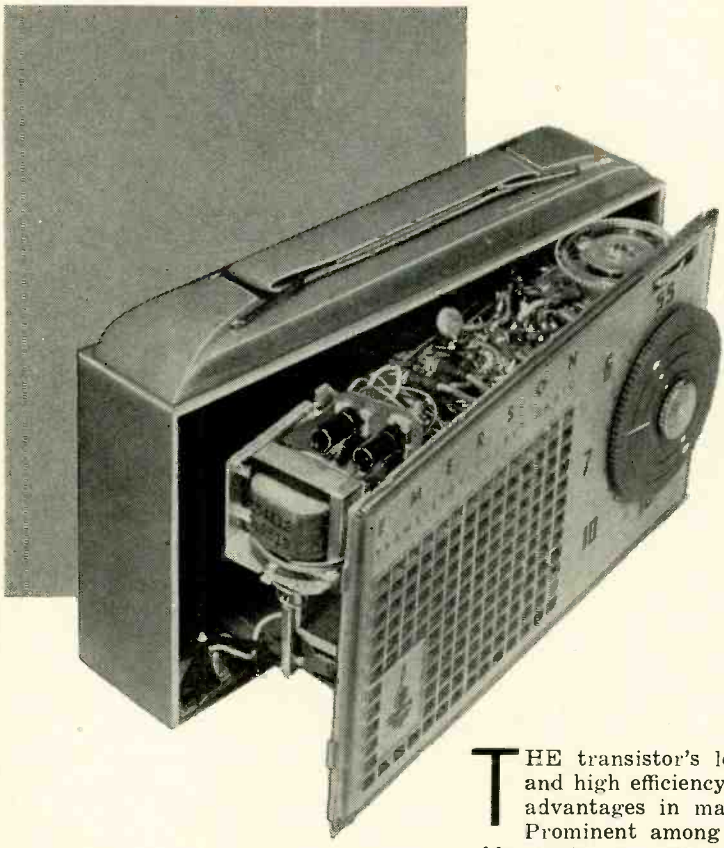
Several electronics servicing organizations (RCA Service Company, Inc. is perhaps the largest) are devoted to maintenance of industrial, commercial and military electronic installations. These companies hire electronic engineers and technicians at salaries that run well above $100 a week plus traveling expenses. Such men may be sent all over the world. They may service a large factory television installation, a multiple-outlet sound system in a hospital or school, sound equipment in motion-picture theatres or military gear of many kinds. (It is hardly necessary to point out the opportunities in consumer radio-TV service to readers of this magazine.)

Wages vary greatly, but the men in principal theaters in such cities as Chicago, New York or Los Angeles may be paid $125 to $150 a week for a 3-day, 24-hour week. Some of these men have other occupations also; some have businesses of their own.

Such employment is obtained only through a union, and never by beginners. The beginner may start in smaller theaters that pay their men very much less for far longer hours. The smaller theater need not be in a key city; it can be anywhere. A single union represents most of these employes in the United States and Canada, and members can take out traveling cards whenever they want to change to some other location. After acquiring working experience and union membership almost anywhere, a man can move to a large metropolitan center where the best jobs are found. As a newcomer to the place he will have to start at the bottom there also, but with persistence, ability and luck he may eventually reach one of the best jobs. The union is the International Alliance of Theatrical Stage Employes and Motion-Picture Machine Operators, AFL, Rockefeller Plaza, New York, N. Y. This union also represents some, but not all, broadcasting and television technicians as well as sound technicians in the Hollywood studios, a very well rewarded group of technicians.

Finally (the subject is inexhaustible, but one must stop sometime) substantial opportunities exist in Civil Service. The Government uses large quantities of electronic equipment and hires people to operate, maintain and sometimes revamp it. At present, electronics civilian personnel are very largely used by the armed forces to share and supplement the electronics activities of uniformed GI's. For more detailed information, write to U. S. Civil Service, Washington, D. C. END

Varied sources were consulted for the data given. Among these are many Government publications ("Employment Outlook in Electronics Manufacturing," "Employment Outlook in Radio and Television Broadcasting Occupations," "Statistics of the Communications Industry in the United States," "Employment Outlook in the Merchant Marine," etc.). Information also has been drawn from the "help-wanted" advertisements in leading newspapers. Kamen and Dorf's *TV and Electronics as a Career* (John F. Rider Publisher) has been consulted as well as various other sources for facts relating to opportunities.



Portable has TRANSISTOR OUTPUT

By ERIC LESLIE

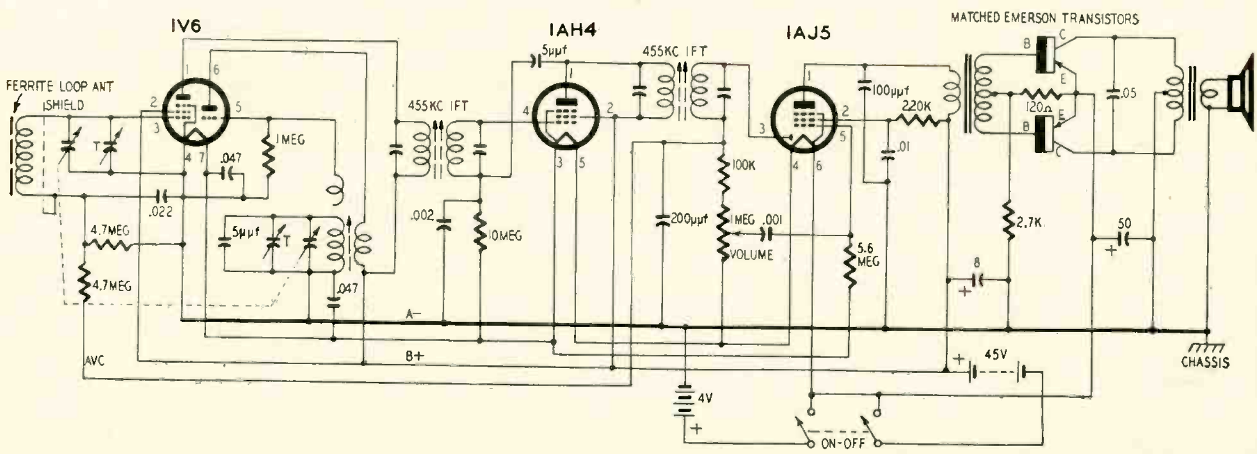
New set combines tubes and transistors for optimum performance and economy

THE transistor's low power drain and high efficiency are remarkable advantages in many applications. Prominent among these are portable radios or emergency (civil defense) receivers which have to work for long periods without battery replacement. The transistor is doubtless without a peer in the emergency equipment field. More than one consideration works against its immediate and universal acceptance in portable radio circuitry.

There are many types of transistors. Some have a frequency range limited to a few kilocycles; others operate reliably above 50 mc. Some units have so high a noise factor as to be useful in trigger circuits only; others equal good tubes. And most important, they range from $1.95 to a price comparable to that of a complete tube type portable radio.

This problem of cost is possibly the greatest one to be solved if the transistor is to take over in the portable field. Another—almost equally important from the manufacturing point of view—is that of uniformity. All units in a mass-produced receiver must have rather narrow tolerances. Transistors usually exceed normal tolerance ratings for tubes—sometimes to a staggering extent. While they can be selected and matched carefully in expensive emergency and military equipment, they do not lend themselves—as yet—to mass production at competitive prices. The result is that transistor radio receivers are rare and somewhat costly.

Yet the advantages of transistors are so great that a few transistor portables actually are on the market, in spite of the many difficulties which exist, especially in certain circuits. It is not surprising that some engineers have hit on the principle of dividing the labor—using transistors where their advantages are greatest and their limitations are not taxed, and tubes in



A schematic diagram of the Emerson model 838 transistor pocket radio.

the high-frequency circuits where transistors work at the greatest disadvantage.

Such hybrid sets have been described in this magazine, notably in the March and September, 1954, issues on pages 84 and 90, respectively. Transistors were used in the audio end, which accounts for so much of the battery consumption of a tube portable, and where low-priced transistors will work efficiently well within their frequency limits. Tubes were considered more economical and reliable in the radio end. Now a commercial receiver—a little Emerson—is using the same principle in an improved form.

The new Emerson model 838 receiver uses a push-pull class-B transistor output stage, operating from a 4.0-volt battery (which also supplies filament current for the tubes).

Except for the output stage, the circuit (see schematic) essentially follows that of the Emerson 747, one of the smallest of tube portables. But the A-battery drain is down from 160 ma to a little more than 50, including all power for the transistors. The B-battery drain is also considerably lower, since there is no output tube to feed. And the undistorted power output of the set is more than doubled, while the maximum power output is about trebled. The A battery—three mercury cells in series—lasts about 50 hours and the B battery around 100.

Even though the set uses only one transistor stage, there were problems of theory and design. Obviously, class B is the efficient way to operate a transistor push-pull stage. Yet, to take advantage of transistor characteristics in that mode of operation, special transformers had to be designed. And it was found that biasing the bases a fraction of a volt was needed to give that added touch which brought down the distortion at low signal levels. Special matched transistors (Emerson 815003's) are also used.

The new model 838 portable makes possible louder and better-quality reproduction in a set using less battery power than former portables. Possibly even more important is that it has called attention to something that previously was overlooked. There is no need to use a component at a disadvantage merely for the sake of uniformity, to have an all-this or all-that piece of equipment. Tubes have given an excellent account of themselves as r.f. and i.f. amplifiers and mixers, and there is ample justification for using them until the time comes—perhaps in the near future—when they will be replaced by transistors already invented and now in experimental development stages.

The transistor will make more progress and find wider use if it is permitted to work in the applications most suited to its capabilities. Tubes and transistors will—in suitable applications—no doubt continue to work together far into the future. END

BATTERY CALCULATIONS

By GEORGE P. PEARCE

SUPPOSE you have a small electronic device requiring 300 milliamperes for its correct operation. The resistance of the device is 5 ohms and you have a 7.5-volt battery. What is the correct method of wiring the circuit?

This looks easy. Ohm's law tells us exactly how much resistance is needed in the circuit to limit the current flow to 300 ma. By Ohm's law the resistance would be 7.5/0.3 or 25 ohms. The device has a resistance of 5 ohms, so apparently it would be necessary to add 20 ohms to the circuit. A 20-ohm resistor is put in series with the battery, the device is connected and it fails to work properly. The current flow is checked and found to be only 267 ma. Where are the missing 33 ma? Can Ohm's law be wrong? No, the law is correct but we have forgotten to include the battery resistance.

How are you going to find the internal resistance of the battery? You certainly cannot measure it with an ohmmeter, and it may damage the meter to even try. Fortunately the internal resistance of a battery is easy to measure and all the necessary equipment is on hand. Assume we have a common 1,000-ohms-per-volt meter. If it is of higher resistance, so much the better. (When using high-resistance meters it is not necessary to make correction for meter current).

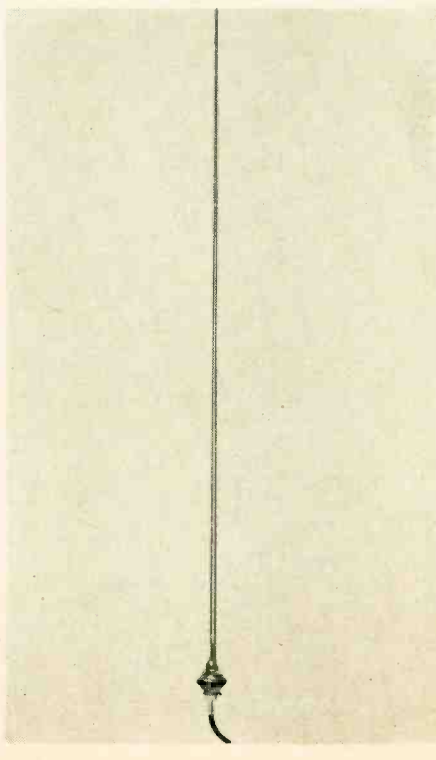
To find a battery's internal resistance, disconnect the battery and measure the open-circuit voltage across the terminals; the battery involved measured 7.5 volts, as expected. Take the 20-ohm resistor, connect it across the battery terminals and measure the voltage drop across the resistor. The potential drop was 6.52 volts. We now have the following data: Battery open-circuit voltage, 7.5; resistance between terminals, 20 ohms; voltage drop across 20-ohm resistor, 6.52.

The internal resistance of any battery is equal to battery voltage divided by current, minus external resistance. The current flowing is equal to the voltage drop across the resistor divided by the resistance, or 6.52 divided by 20 = 0.326 ampere. The battery internal resistance is thus $\frac{7.5}{0.326} - 20$, or 3 ohms. We have thus found that the internal resistance of the battery is 3 ohms.

We now have all the data to calculate the required resistance. The resistance of the device is 5 ohms and the internal resistance of the battery is 3 ohms, a total of 8 ohms. It will be necessary to insert only an additional 17 ohms.

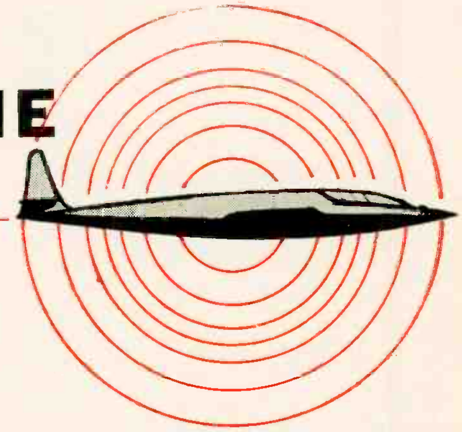
If the required current is critical, it would be better to use a 25-ohm 25-watt rheostat—the nearest standard size—and set it at 17 ohms. As the battery is used up, the internal resistance will increase and the rheostat resistance can be decreased, keeping the total circuit resistance constant. END

NEW AUTOMOBILE ANTENNA



A considerable departure from conventional antennas has been made with the introduction of a re-enforced Fiberglas unit (see photo). The antenna rod, approximately 36 inches long, is inserted into a metal stud which connects it electrically to the lead feeding the radio antenna input. The rod contains four conductors located at the center of the antenna along its axis. These wires connect mechanically and electrically to the metal stud holding the Fiberglas rod. The wires extend the full length of the antenna. Using pigmented resins, the Fiberglas antennas are manufactured in six different colors by the Ward Products Corp.

SERVICING LIGHT PLANE RADIOS



By JAMES HOLAHAN

Aircraft radio serves two purposes: communications and navigation. For communications aircraft use various types of radio equipment to maintain contact with airport control towers, airways radio stations and traffic controllers and, at times, with other aircraft. For navigation, radio is the principal means of an airplane obtaining a fix.

The main users of aircraft radio are the military and the airlines. Radio equipment worth $50,000 is not uncommon for such aircraft. However, this article is concerned with light planes[1] which, for the purpose of this discussion, include single-engine, two- and four-passenger, low-horsepower (under 300 h.p.) propeller-driven airplanes.

Surprisingly, there is no general rule, regulation or law which says that an aircraft must have radio equipment. Most of the larger airports, however, demand that aircraft using their facilities have a two-way radio telephone capable of communicating with the airport control tower.

The Civil Aeronautics Administration requires that all aircraft using the civil airways (aerial highways 10 miles wide which extend in a network over the United States) have at least a two-way radio for communications and a receiver capable of picking up the radio signals which mark the airway.

A typical minimum-equipment installation adequate for most local flying is a low-frequency receiver (200–400 kc) and a v.h.f. transmitter which operates on two channels. The receiver is used for picking up signals from airport control towers and airways radio stations.

A fairly complete installation would consist of the following:

1. Low-frequency (200–400 kc) radio receiver
2. Radio-compass receiver (covering the frequency range of 200–1750 kc in three bands; equipped with an automatic loop antenna and indicating device which gives the bearing of the radio station relative to the aircraft)
3. Omnirange receiver (a v.h.f. 112–118-mc receiver designed to receive and visually present signals from ground omnirange stations, for navigation)
4. Instrument landing system (two receivers, one a localizer receiver for receiving signals from ground localizer transmitters operating at specific frequencies in the 108–110-mc range; the other a glide-path receiver designed to pick up signals from ground glide-path transmitters operating at specific frequencies in the 329–335-mc range. Both transmitters project their beams over the landing runway of an airport and are used to bring aircraft down to a low enough altitude so that they can see the runway when it is obscured by bad weather.)
5. V.h.f. transmitter operating on 12 crystal-controlled channels for frequencies in the 118–127-mc range
6. V.h.f. communications receiver tunable over the 108–132-mc range
7. Marker-beacon receiver (capable of picking up keyed 75-mc signals for navigational purposes)

[1]At present there are approximately 60,000 light planes in the United States, about half of which are radio equipped.

Radio for communications

The communications equipment that may be carried by a light airplane thus consists, in the main, of receivers (low frequency or v.h.f.) and transmitters (operating on specified frequencies). Aircraft communications (see table) use AM. The receivers are of the superheterodyne type (a double superhet is normally used in the v.h.f. receivers) and contain one or more r.f. stages before the first detector. They are designed for high sensitivity and sharp selectivity. V.h.f. receivers, because of their static-free reception, are preferred over the low-frequency sets.

Light plane transmitters are crystal-controlled, having a frequency stability of about .01%. Those operating on m.h.f. (medium high frequency) have a nominal power output of 10 to 25 watts; those on v.h.f. put out between 2 and 5 watts. The higher-frequency transmitters are preferable; their range is slightly greater than line of sight.

Radio for navigation

Navigational radio may be divided in accordance with the particular type of navigation the unit is designed to work with. To navigate from one place to another three systems can be used: low-frequency radio ranges, visual omniranges (VOR) and radio direction finding.

To navigate by the low-frequency ranges, only a low-frequency receiver tunable over the 200–400-kc range is necessary. The low-frequency range signals are keyed CW from a ground transmitter having two r.f. channels spaced 1,020 cycles apart. The effect produced in the airborne receiver is similar to receiving a signal modulated by 1,020 cycles. The same receiver used for communications on the low-frequency band may also be used to pick up the radio-range signals.

Navigation by the visual omnirange is the modern system being used throughout the country. It is superior in most respects to the older low-frequency range system and it is anticipated that VOR will soon replace the low-frequency ranges. VOR functions in the v.h.f. spectrum between 112 and 118 mc.

Ground stations are placed along the airways, approximately 90 miles apart. Each station emits a carrier amplitude-

Courtesy Safair, Inc.

Single-engine Piper carries a v.h.f. antenna directly above the cabin.

Courtesy National Aeronautical Corp.

Narco Simplexer contains a 12-channel v.h.f transmitter and v.h.f. receiver. An omnirange adapter is mounted above.

modulated by three different frequencies: voice (for station identification), a reference phase signal and a variable phase signal. The airborne receiving equipment receives and detects the signal. The phase difference between the fixed and variable phase of the modulation signals is proportional to the bearing of the aircraft to the omnirange station. An instrument panel meter detects this relative phase angle and translates it into bearing, thus giving the pilot the direction in which he must fly. By following set procedures the pilot is able to approach the station from any desired track.

The third system of navigation, radio direction finding, uses the directional characteristics of the loop antenna and works on the principle that minimum signal is picked up by the loop when the plane of the loop is broadside to the source of the signal. When a loop is used, provision is made to switch the antenna input of the receiver from its normal nondirectional antenna to the loop antenna.

There are various types of loops: fixed loops, manually rotatable loops and loops which are motor-driven and automatically positioned to point to the signal source. Ground stations normally used for direction finding are either the airways stations in the low-frequency aviation band or standard broadcast stations in the 500–1500-kc band. The broadcast stations are exceptionally good for direction finding because of their high power output.

Receivers using manual or fixed loops are of the superhetrodyne type with an extra r.f. stage. A switch is provided to select the loop or nondirectional antenna.

In the automatic direction finder the loop is electronically driven through thyratron tubes and comes to rest at the true null position. The angular position of the loop is transmitted by a selsyn to an indicator on the pilot's instrument panel. The indication tells the direction of the radio station relative to the aircraft and thus furnishes him with information which helps him determine his position.

Power supplies

Light airplanes which carry electrical equipment, for the most part, use a 6- or 12-volt battery generator supply. The negative side of the battery is grounded to the fuselage in metal aircraft and to the metal framework in fabric-covered planes. Vibrators, dynamotors or inverter-transformer supplies are used to develop B plus voltages for the radio equipment.

All radio equipment is protected by fuses or circuit breakers. Frequently the power supply in an aircraft radio is a separate unit installed in a remote section of the fuselage and having its output voltages cabled to its associated units.

Equipment construction

For the most part, light plane radios, like those used on larger craft, are built on aluminum chassis and are designed for plug-in rack mounting. Operating controls are either built into a special control unit or mounted on the front panel of one of the system units. In either case they are within reach of the pilot, on the aircraft instrument panel or near by. Associated units of a set are interconnected by cabling.

Present-day manufacturers use what is termed "building block" construction. For instance, starting out with such basic units as a v.h.f. receiver, v.h.f. transmitter and power supply, the aircraft owner may add omnirange equipment, an extra transmitter, a low-frequency receiver and a marker beacon transmitter to the fundamental system.

Hand, pushbutton or lip type microphones are normally used to originate voice transmission. The audio output of airborne receivers is heard over headphones or, in craft with low cabin noise levels, over a speaker. Where more than one receiver is installed, a switching arrangement must be used to permit selection of the desired audio and prevent cross-talk between two receivers. A similar audio and keying switch arrangement must be used for the microphone inputs where more than one transmitter is installed.

Antennas

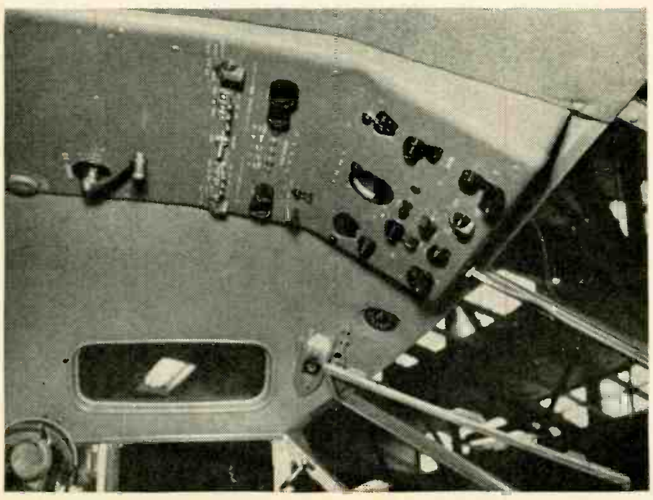
Antennas used with m.h.f. transmitters on light planes are horizontal straight copper-covered wires usually running from a point above or behind the cockpit or cabin to the vertical fin on the tail section. At times, for longer length, the m.h.f. antenna is run from wing tip to wing tip but this arrangement is less desirable—it is in the way when the aircraft is on the ground and is frequently broken. The m.h.f. antenna is resonated to the desired operating frequency by a variable series inductance. The same antenna picks up low-frequency and broadcast-band signals for the appropriate receivers.

Some light aircraft use a trailing wire antenna for m.h.f. transmission. This consists of a reel of wire at the end of which is a lead weight. The weight is dropped from a special opening in the fuselage and reels out the antenna with it. This action is stopped by a brake when the wire reaches the desired length, as indicated by an antenna current meter. The antenna and weight are retracted by a d.c. motor.

V.h.f antennas are quarter-wave-length (about 24 inches) vertical whips mounted on the top or bottom of the fuselage. The ground plane is the fuselage in metal airplanes or about a 2-foot-square aluminum plate in fabric-covered craft.

For reception of omnirange and localizer signals a horizontal V dipole is used to pick up the horizontally polarized transmissions. The V type is generally used because it does not have the directional characteristics of the common dipole and it picks up signals well at all angles of azimuth. For the glide-path signals a quarter-wave horizontal dipole catwhisker is used. The v.h.f. antennas are connected to the receiving and transmitting equipment by coaxial cable.

Placement of v.h.f. antennas is important. They must be located far enough away from the engine and



Courtesy Beechcraft Corp.

A custom radio installation on the cockpit roof of a Beechcraft plane.

propeller so as not to pick up disturbing radiations. Also, the antenna must not be situated where it can be blocked out by the wing, tail fuselage or other structural member.

Test equipment for servicing

Besides the normal array of basic servicing equipment (multimeter, signal generator, sweep generator, oscilloscope, capacitor checker, tube tester, v.t.v.m.), test gear for checking the operation of transmitters and special type receivers are necessary for the aircraft radio shop.

For transmitter servicing the following are needed: a simple field-strength meter capable of picking up r.f. signals over the m.h.f. and v.h.f. bands, an accurate frequency meter and a thermocouple type r.f. ammeter.

For testing special equipment such as omnirange receivers and instrument-landing-system or marker-beacon receivers special test sets are required. These can usually be obtained from the manufacturer of the equipment. They duplicate the transmission from the ground stations.

The well-equipped shop will have mockups of the equipment generally serviced and patch cables for those sets serviced less often. Through the use of mockups the process of trouble isolation is simplified, troubleshooting time is minimized and units can be tested and adjusted on the bench under near operating conditions.

Transmitters are connected to dummy antennas when making output checks, although final checks can be made with an appropriate antenna on the shop roof by calling the control tower during moments when the operators are not busy directing airport traffic. Frequently dx checks can be made by prearrangement with aircraft flying outside the local area.

AERONAUTICAL FREQUENCIES

(reception and transmission unless noted)

Service	Frequency
LOW-FREQUENCY BAND	
Radio ranges*	200—400 kc
Radio communications*	200—400 kc
Nondirectional homing beacons*	200—400 kc
MEDIUM-HIGH-FREQUENCY BAND	
Aircraft to control towers and airway stations**	3023.5 kc
VERY-HIGH-FREQUENCY BAND	
ILS localizer signals and special type VOR signals*	108.1—111.9 mc
Standard VOR signals*	112.0—117.9 mc
Air traffic control	118.1—121.3 mc 123.7—126.5 mc
Emergency	121.5 mc
Airport utility	121.7, 121.9 mc
Private aircraft en route	122.1, 122.3 mc
Private aircraft to towers	122.5, 122.7, 122.9 mc
Aeronautical advisory stations	122.8 mc
Flight test and flying schools	123.1—123.5 mc
All civil aircraft to airway stations	126.7 mc
All carriers (airlines) en route	126.9—131.9 mc
Government	132.1 mc and higher

*Reception only
**Transmission only

Installations

Many radiomen in the aircraft radio field are judged more by their ability to make fine custom-built installations rather than for the more important ability to render top maintenance. And herein lies the greater percentage of the radio shop's per-hour profit.

New aircraft generally do not come completely equipped with radios. The factory, for the most part installs the minimum unless otherwise directed by the purchaser. Most owners prefer to add radio equipment as they use the aircraft.

A good radio installation is a simple one. All the information and instructions furnished by the manufacturer of the equipment should be used and his recommendations should not be ignored without good reason.

In light planes available space is minimum and it therefore has to be used to the best advantage. Cables must be firmly laced, clamped every few feet, routed so as not to be exposed to damage and must be properly dressed. Remotely mounted units must be firmly attached to the aircraft structure and there the chassis bonded to the aircraft ground. If shock mounts are not an integral part of the unit's case or mounting, they should be supplied. Otherwise, the equipment will not long survive the g-forces imposed by rough landings and turbulent air.

Instrument-panel-mounted equipment such as controls, indicators or components designed for panel mounting have to be installed with great care since this is the pilot's operating console and is in full view of all critical eyes. Where more than one receiver and transmitter are installed, it is often necessary to construct (from sheet aluminum) a receiver and transmitter selector panel to fit in some accessible but unused space.

Throughout the entire installation simplicity and utility should be the bywords. An excess of switches and controls might look very imposing but in the long run serve to confuse. The pilot has enough gadgets, even in the average light plane, to bother his attention. If possible all radio controls should be grouped together on one panel or in a specific area and clearly labeled.

Qualifications

To be legally qualified to maintain and install aircraft radios the technician must possess a repairman's certificate issued by the CAA. This certificate is virtually automatically issued, provided the technician is employed by an authorized maintenance company. It is good only when working under the supervision of the repair station.

A further requirement demanded by most repair shops is that a technician possess a current first- or second-class radiotelephone license. This is necessary since the CAA regulations[2] read "all transmitter adjustments or tests during and coincident with installation servicing or maintenance of a radio station licensed by the Federal Communications Commission which may affect the proper operation of that station must be made by or under the supervision of a person holding a first- or second-class FCC license." Since an installed aircraft radio transmitter is classified as a radio station, a licensed technician is responsible for its maintenance.

Other qualifications are similar to those required of any good radio repairman, with special emphasis placed on thoroughness. Radio failure in the air is a serious matter and has contributed to many an accident, some fatal. Once a repair, installation or adjustment is completed it should be checked by another qualified technician. END

[2]FCC regulations also specify the same; in fact, this regulation was in part taken from FCC regulations.

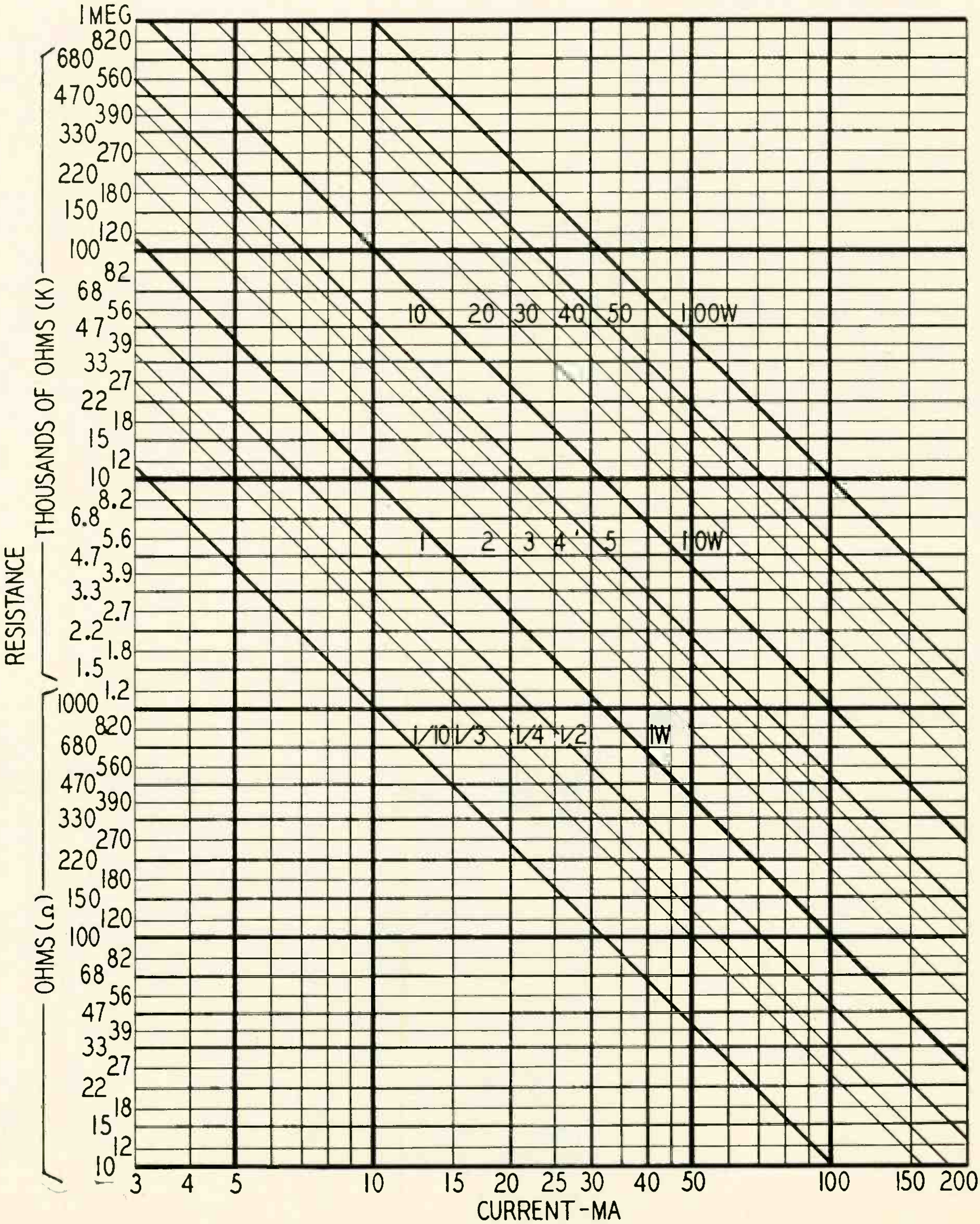
Courtesy Lear, Inc.

Panel of Aero Commander. Unit contains, left to right, a 36-channel v.h.f. transmitter–receiver, continuously tunable v.h.f. receiver, automatic direction finder, v.h.f. receiver (with VOR function), 12-channel v.h.f. transmitter and low-frequency receiver.

How Much Will a Resistor Take?

The ins and outs of wattage ratings

By H. P. MANLY



Wattage rating chart. Wattage is read on nearest diagonal line above intersection of current and resistance lines.

AT 4:45 pm the new flyback transformer was in place, connections checked, joints soldered, leads dressed where they belonged. Less than 30 seconds after turning on the power a picture appeared and it didn't look bad. At 4:48 pm the picture flickered, and smoke curled up through ventilating holes around the power rectifier.

It happens to all of us sooner or later, maybe both times. One of the hundred-odd resistors under the chassis burn out. Locating the victim isn't too difficult. We may look for the black and blistered remains, feel for the heat, smell around for the unmistakable aroma of a burnout or, as a last resort, use the ohmmeter.

There is just one reason why a resistor burns out. Of course, the contributing cause may have been a shorted capacitor; the coating may have dropped off a cathode and landed against the plate of a rectifier; some tube might have gone suddenly gassy—but none of these are the *direct* reason for the burnout. The burnout occurred only because the resistor carried *too much current*. It carried too much current because it was subjected to too much voltage.

Let's consider what actually might happen. Assume that a short or some other fault applies 200 volts across an 8,200-ohm resistor. That resistor then carries about 24 ma. (Volts multiplied by 1,000, and the product divided by ohms, equals milliamperes.) When that much current is forced to flow against that much resistance, heat is produced. In this case nearly 5 watts of electric power is being used in the production of heat. (Current squared, and multiplied by resistance, equals power.)

A resistor of good quality, rated at 5 watts, will stand that heating indefinitely, although running moderately warm. An 8,200-ohm unit rated at only 2 watts, in which heat is produced at the rate of 5 watts, starts to darken all over in about 1 minute. At 2 minutes it would fry an egg. At 4 minutes the color-code markings are all but illegible, and resistance may rise by about 10%. But there is no smoke, and usually the 2-watt resistor carries the overload almost indefinitely.

Although a resistor which is overheated to a temperature as high as 350° F may not be damaged, heat radiated from it may do a lot of damage to nearby components. Wax-impregnated paper capacitors, and electrolytics too, may be ruined.

Should 200 volts get across an 8,200-ohm resistor rated at only ½ watt there is blistering, blackening of coding colors and smoking begins within a minute. At 3 minutes the whole unit is black, there is a great deal of smoke and the resistance is dropping sharply. At 4 minutes the resistance is down around 4,000 ohms and, if the voltage holds up, current increases to around 50 ma. Then heat is produced at the rate of 10 watts and the end of the resistor is near.

If you find a resistor badly discolored and showing unmistakable signs of having been overheated, measure its resistance. You are likely to find such things as a unit coded for 8,200 ohms measuring something like 3,500 ohms—and causing trouble difficult to locate.

Selecting the right resistor

There is no use installing a new resistor until the contributing cause for the burnout has been determined and removed—we all know that. Neither is there any use putting in a new resistor whose wattage rating is too small for the current it must carry. The chart shows how much current may flow without overheating a resistor of any standard wattage rating, also what wattage rating is needed for any current flowing in a resistor of any standard value from 10 ohms to 1 megohm.

Extra-heavy horizontal lines are for resistances of 10 ohms and multiples of 10 up to 1 megohm. In between are medium-heavy lines for values of each resistor regularly made with 20% tolerance. Light lines are for all values added when tolerance is 10%. All the lines together take in every resistance value regularly used for service replacements. For still other values added in the 5% series, imagine lines approximately midway between those drawn on the chart.

Three quick steps allow selecting a resistor of wattage rating just right for the job: not so small that you take chances on a burnout, not so large that you pay for a unit bigger than needed:

1. Locate the horizontal line for resistor ohms.
2. Locate on the bottom scale a vertical line for resistor current.
3. Find the intersection of these lines.

Any resistor whose wattage rating is equal to or greater than the value marked on any diagonal line *above* the intersection will not overheat unless tightly boxed in by surrounding parts. The higher you go in wattage rating, the cooler the resistor will run. But lower on the chart, at lesser wattage ratings, resistor temperature will go up as wattage goes down.

Rating vs. actual dissipation

It seems illogical to many beginners that the number of ohms in a composition resistor is not related to its physical size. They see an 820,000-ohm unit only about one-tenth the bulk of another providing only 82 ohms, or a 22-megohm resistor may have but one-tenth the bulk of a 2.2-ohm unit. It's all a matter of wattage ratings.

Another fact not at all illogical, yet sometimes not appreciated, is that there need be no relation at all between the wattage rating of a resistor and actual power in watts changed to heat within the unit.

The rating of a resistor specifies only the number of watts or fraction of a watt of power that the unit is designed to get rid of (dissipate) without heating to a temperature which may harm the resistor and nearby circuit components.

On the other hand, the number of watts of electric power actually changed into heat depends only on the number of ohms of resistance and on the current in this resistance, nothing else. If you locate any combination of ohms and current on the chart, the diagonal line for watts at that intersection shows how much power will be transformed into heat.

How much heat may be produced and safely dissipated depends chiefly on surface area of the resistor and to a minor extent on bulk and kind of material in the insulation. That's why higher wattage ratings require bigger resistors.

A resistor retains within itself only a negligible part of the heat produced. The rest must be gotten rid of or dissipated into the surroundings just as fast as produced, or else the resistor would burn up. Heat is dissipated into surrounding air only while the resistor is hotter than the air, and rate of dissipation is proportional to temperature difference. Unfortunately, we cannot get rid of much extra heat by increasing the temperature difference, because we don't want hot resistors.

However, we may increase heat dissipation and hold resistor temperature down by increasing the surface area from which heat is dissipated. Composition resistors rated for ½-watt dissipation commonly have total surface areas of about 0.20 square inch. A 1-watt unit has a total area of about 0.45 square inch. The 2-watt sizes have about 0.85 square inch. These areas are so closely proportional to wattage ratings that, were all the resistors to run at the same temperature, the 2-watt surface would dissipate about twice as much heat to surrounding air as would the 1-watt size, and the 1-watt surface would dissipate about twice as much heat as the ½ watt.

If resistor surfaces are to dissipate heat into the surrounding air, they should not be pushed tightly together, shutting off part of the area. Furthermore, crowding prevents heated air from moving away to be replaced by cooler air. Placing a resistor close to chassis metal might appear to be good practice, because heat flows into and through steel better than into and through air, assuming the air to be still. But heated air circulates and floats the heat away, while the chassis doesn't—at least not in present designs.

In some recent electronic equipment there has been a trend toward the use of resistors wrapped in a metal band and fastened to the chassis. Reports indicate that this procedure, depending upon the size of the band, may increase the wattage rating of the unit as much as 100%. END

TV Signal Marks Response Curve

Setups and procedures for using incoming station carriers as markers

By Engineering Staff, Scala Radio Co.

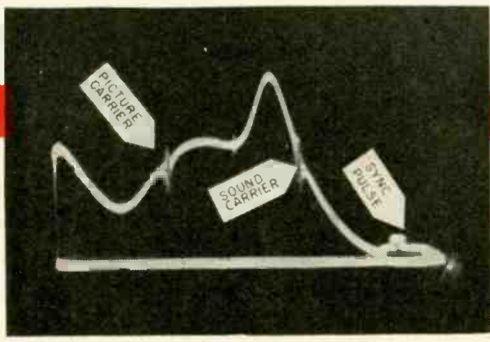


Fig. 1—An r.f. response curve showing picture and sound carrier points.

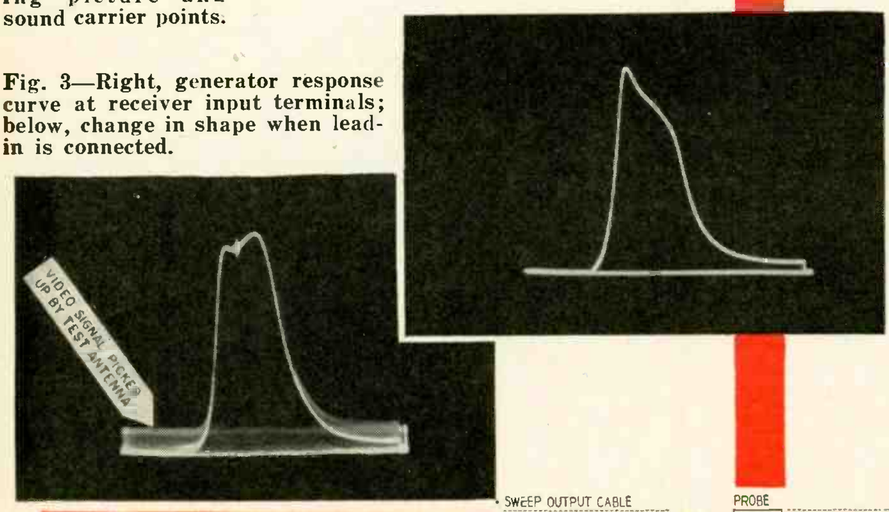


Fig. 3—Right, generator response curve at receiver input terminals; below, change in shape when lead-in is connected.

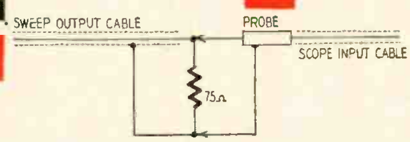


Fig. 4—Test setup for checking flatness of sweep generator output voltage.

Fig. 5—A crystal demodulator probe.

QUESTIONS which often arise when a TV station signal is used for marking response curves are: how much signal level from the antenna is necessary to produce satisfactory markers; and how

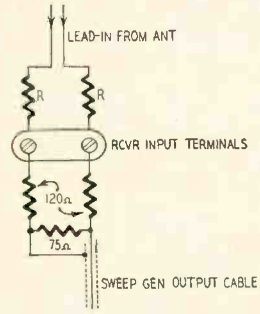


Fig. 2—Diagram of test setup for developing signal markers on response curve.

can the video carrier marker be distinguished from the sound carrier marker? A typical r.f. response curve with markers at the picture and sound carrier points is shown in Fig. 1. A prominent characteristic of this display is the appearance of a distorted vertical-sync pulse, which always appears somewhere in the pattern when the picture carrier marker is reasonably high on the response curve.

The test setup used to develop the TV station-signal markers on the response curve is shown in Fig. 2. The chief requirement in this arrangement is that series attenuating resistors R, between the lead-in and the input terminals of the receiver, have a suitable value. This value must be suffi-

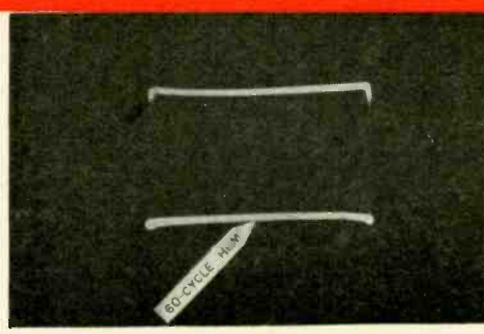


Fig. 6—Output of flat sweep generator.

ciently small that ample marking voltage is applied to the receiver circuits, but sufficiently large to isolate the receiver effectively from the lead-in. Otherwise the characteristics of the antenna and lead-in system will distort the shape of the response curve on the scope screen.

Situations may be encountered in which these requirements conflict. For example, if the available field strength is relatively low, the series resistors must be cut down to obtain visible markers on the response curve. But low-valued resistors may cause the shape of the response curve to change when the lead-in is connected to the test circuit. In such cases, it is still possible to use the station-signal markers indirectly. Note the horizontal positions of the markers on the scope screen and mark their horizontal distances with a wax pencil. Then the lead-in may be disconnected from the test circuit to obtain an undistorted response curve and the previously determined horizontal distances will indicate the positions of the picture and sound carrier markers on the response curve.

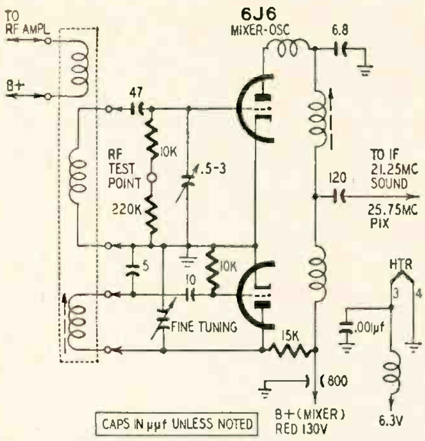


Fig. 7—Mixer-oscillator circuit of the Standard Coil tuner, model TV-2232.

The problem of weak marker voltages is helped considerably by use of a bypass marker injector. When the lead-in is connected to the marker generator and ground terminals of the unit, considerable amplification of the weak marker voltage is made available at the oscilloscope output terminal of the marker injector, and much smaller antenna signals can be used to produce satisfactory markers.

The effect of the antenna and lead-in characteristic on the shape of the response curve (with too small a value for the series isolating resistors) is shown in Fig. 3. It may come as a surprise to some to find that the characteristic of the antenna system is not flat. The characteristic of a commercial antenna is often flat only over a limited number of channels. Hence the necessity for using reasonably high values for the isolating resistors or a bypass marker injector in such alignment applications.

Sweep generator requirements

The technician must be careful not to confuse the antenna characteristic with lack of flat output from the sweep generator. Lack of flatness in the swept output from the sweep generator is an equally serious matter which can be checked on each channel with the test setup shown in Fig. 4.

A crystal demodulator probe (see Fig. 5) is required which has a flat characteristic from channel 2 to 13. The 75-ohm terminating resistor provides the necessary impedance to match the 75-ohm cable from the sweep generator properly. This prevents standing waves from appearing on the cable which would give a misleading indication on a scope screen.

A suitable crystal demodulator probe is used in this procedure, as shown in Fig. 5. The chief requirement for the probe is that its characteristic should be flat from 50 to 200 mc. As a result of the test shown in Fig. 4, a flat trace such as shown in Fig. 6 should be obtained. Otherwise, the technician should either check the generator to find out why the r.f. output is not flat or allow for the distortion insofar as possible. The trace in Fig. 6 is the output of a generator sweeping through channel 2. There is some 60-cycle hum voltage present which causes a small curvature in the sweep pattern. This curvature must be taken into consideration when viewing receiver response curves.

Practical test setups

There is sometimes confusion concerning the proper manner in which to connect the scope to the front end for r.f. alignment work. Should the scope be connected directly, through a crystal demodulator probe, or through an isolating resistor? Should the scope be connected at the grid or at the plate of the mixer circuit?

With reference to Fig. 7, it is seen that a test point is provided as a tap on the mixer grid leak. This point is the conventional scope-connection point. A demodulator probe is not required when the test point is used because the grid circuit of the mixer tube is equivalent to a diode detector and provides demodulation of the r.f. sweep signal. In fact, the response curve would be distorted if a demodulator probe were used at the test point, since the response-curve sweep voltage would then undergo a process of double demodulation.

The test point is provided as a tap-down point on the mixer grid leak to avoid capacitive loading of the mixer-grid circuit by the input capacitance of the scope. Hence the scope may be connected directly to the test point, if desired. However, a sharper marker is usually obtained if the technician uses a 50,000-ohm isolating resistor between the test point and the scope input cable. Such an isolating resistor provides lowpass filter action which filters out the unwanted higher beat frequencies from the marker indication. This leaves only the low-frequency beats in the vicinity of the zero-beat marking point. The series isolating resistor works into the shunt capacitance of the scope input cable and constitutes an effective lowpass filter (integrating circuit) action.

Spurious markers, as shown in Fig. 8, are often a source of confusion. They arise from various causes such as crossbeats which are sometimes produced in the sweep generator, from the presence of nearby high-frequency equipment which radiates in the band under test, from oscillation in faulty front-end circuits and from interharmonic beats of sweep and local oscillators. Eliminating these spurious markers is not always easy, but it is assisted by the use of good generators and by operation in a low-interference area. In some cases, the technician will find it impossible or impractical to eliminate all spurious markers, and it becomes necessary to disregard the undesired ones.

All r.f. leads must be kept as short as possible when running front-end response curves. This precaution applies to ground as well as to hot leads. A long ground lead produces partial resonances which distort the shape of the reproduced sweep-response curve. It is good practice to connect the generator output-cable terminations as close to the input terminals of the receiver as practical.

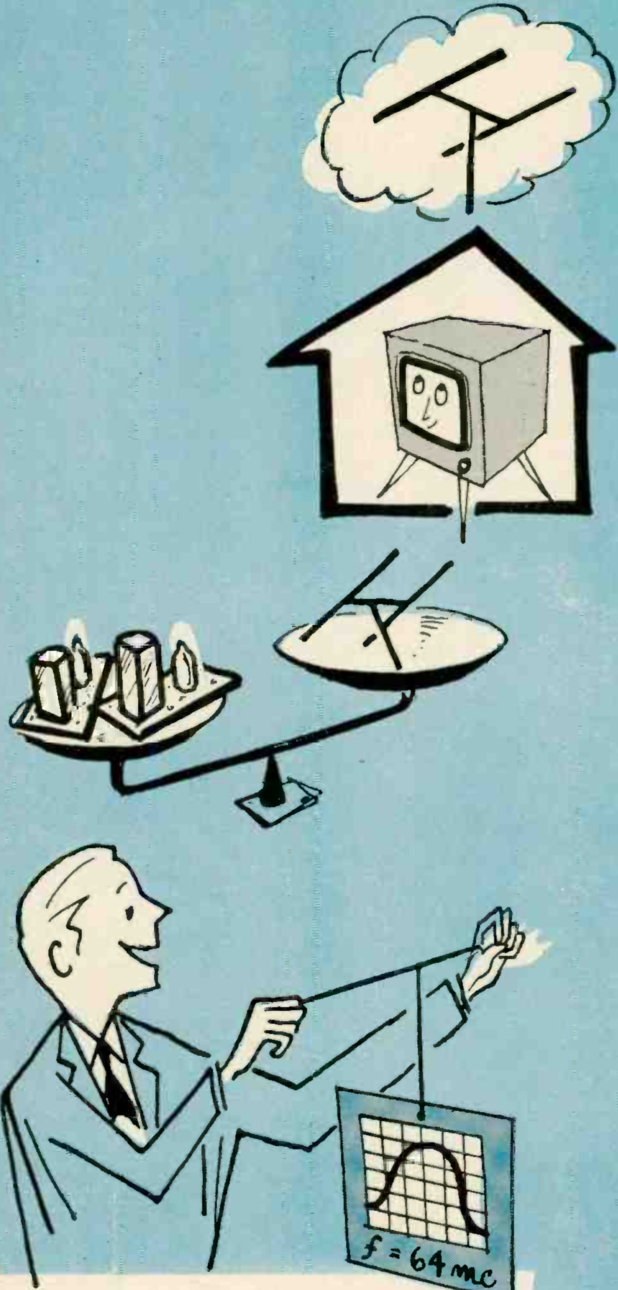
Other practical considerations include the use of override a.g.c. bias in the front-end circuits, good seating of the tube shields over the r.f. and mixer tubes and proper termination of the generator output cable. END

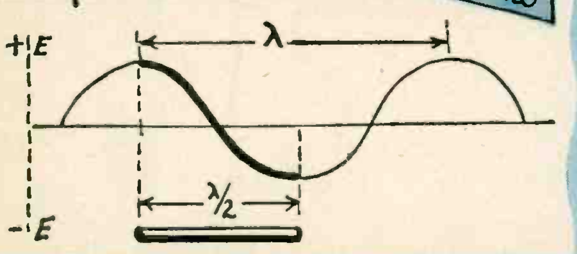
Fig. 8—View of r.f. response curve showing desired and spurious markers.

The TV set is okay, but he can't locate the intermittent in his scope."

TELEVISION . . . it's a cinch

Seventeenth conversation, first half: Capturing the TV signals; the half-wave antenna; problem of the pass-band; the lead-in and the apartment stairs





WILL—Well, we seem to be pretty well away! Now that we've learned to supply our televiser with low, high and very high voltage . . .

KEN—Do you really think you've got the job done? Do you think the set will be satisfied with your menu?

WILL—Why, is it going to want a special dessert of some kind?

KEN—Have you forgotten what puts life on your screen—the video signals that are brought to your set by an r.f. carrier? How are you going to capture them?

WILL—I didn't forget! It just isn't a problem. All I have to do is hook a piece of wire on the TV set, call it an antenna, and I'm off!

KEN—Further than you think, Will, further than you think! Unless you're close enough to the transmitter to be in a very strong signal field, your piece of wire will be a pretty sorry collector of waves at television frequencies!

WILL—I can't see why TV should be so different from radio. After all, they're radio waves!

KEN—Don't forget that the lowest TV frequencies are far higher than the broadcast band and even most of the short-wave radio you've been receiving. The TV waves are shorter—are absorbed by conducting objects in their way and can't get around obstacles like the longer broadcast waves. That's one reason the receiving range of TV is so much shorter, by the way.

WILL—So we've got to take a lot more trouble with our TV antennas?

KEN—Will, the antenna is the most important part of the whole receiving installation. Well designed and well installed, your antenna is as good as one or two extra r.f. stages. In television the waves are short enough so that you can make your antenna length as long as a TV wavelength, unlike broadcast reception where the antenna must be a small fraction of the wavelength being received. You can make quite a profit out of that fundamental difference—because you can *tune* your TV antenna to the frequencies being received.

WILL—Wait a minute, Ken! Do you mean to tell me you can make a tuned circuit out of a piece of wire—no coil, no capacitor, no nothin'? And it will have a resonant frequency and a resonance curve and everything?

KEN—Exactly, Will. And the resonance curve of a television antenna has to be pretty wide at times. Even an antenna intended for only one channel has to receive a band 6 mc wide, without attenuating either end. That's particularly important in color TV, for the color information is out near one end of the band received.

WILL—Well, if I didn't see TV antennas every day, I'd say they must be very complex, with tuning capacitors and damping resistors to widen the passband . . .

KEN—But you know they aren't. The facts are infinitely more simple, and even you can figure them out if you do a little reasoning. What are these radio–TV waves?

WILL—Well, they're electromagnetic fields, created at the transmitting antenna and moving through space at about 186,000 miles a second.

KEN—You have the idea O.K., if not the exact terms. You understand that these waves produce electromotive forces—currents—in any conductors they find in their way? Can you tell me the minimum distance in a conductor in which a given wave can produce a maximum voltage?

WILL—The greatest voltage a wave could produce would be between the crest of a positive alternation and the trough of the following negative one. That would be a half-wavelength.

KEN—So, if I want an antenna that will get the most voltage possible from a signal of a given wavelength, I'll use a wire, strip or rod a half-wavelength long. Such a conductor is a *half-wave antenna.*

WILL—But how long a piece do you pick out for one of these all-wave antennas I've seen advertised?

KEN—We'll come to that. Meanwhile, let's stick to a single channel till we understand it.

A tuned rod

WILL—Let's see, it'll work about this way. The waves passing by your rod set up voltages or currents in it, depending on whether you're thinking about the electric or the magnetic field. So during one alternation the electrons sweep from one end of the antenna toward the other, and during the next alternation they come back and go toward the end they just left.

KEN—And that—of course—takes place in exactly one cycle of the transmitting frequency.

WILL—That's why you use a tuned antenna, I suppose.

KEN—Exactly. Even if they were disturbed by a single pulse, the electrons in our antenna would oscillate back and forth at its natural frequency. So if a wave of that frequency comes along, it's easy to build up big currents or voltages. But remember all this is a little theoretical. It would be exactly correct for a very fine wire suspended far from the earth or any other conductor. In real life, the mast, the ground or roof and any nearby conductors create capacitances that increase the wavelength of the antenna. We have to shorten it a little to compensate for this *end effect*—cut it down about 6%.

WILL—So if I were going to receive channel 4 pictures, at 67.25 mc, which is just about 4½ meters, I wouldn't cut my antenna 2¼ meters long, but a little less than 2⅛?

KEN—Better get a chart where it's all figured out in inches for you, Will. But if you want to get the channel 4 sound at 71.75 mc equally well, you'll have to cut your antenna a little shorter. And if you want to get channel 6—up beyond 80 mc—as well as channel 4—you'll have to go still shorter.

WILL—That's going to call for quite some passband! How are we going to get it?

KEN—One of the most effective ways to broaden the response curve of the antenna is to increase the diameter—or more precisely, the ratio of diameter to length. That's why TV antennas are usually made of tubing.

WILL—I suppose that if you wanted a really wide passband, you could go in for a cage, made of several wires in the form of a cylinder, like some old commercial and ship antennas?

KEN—Believe it or not, that's exactly what's done, though you can't recognize the cage. You know that they bring the wires of the cage together at a point to take off the lead-in. And that's at the center of a TV antenna. So your cage becomes a sort of double cone. Then it was found possible to leave out some of the wires. So a "conical" antenna now consists of two pairs of three rods each, radiating in opposite directions from the lead-in. In some cases there are only two rods, and it's then often called an "X" antenna.

WILL—But how about the channels from 7 to 13? They're up around 200 mc.

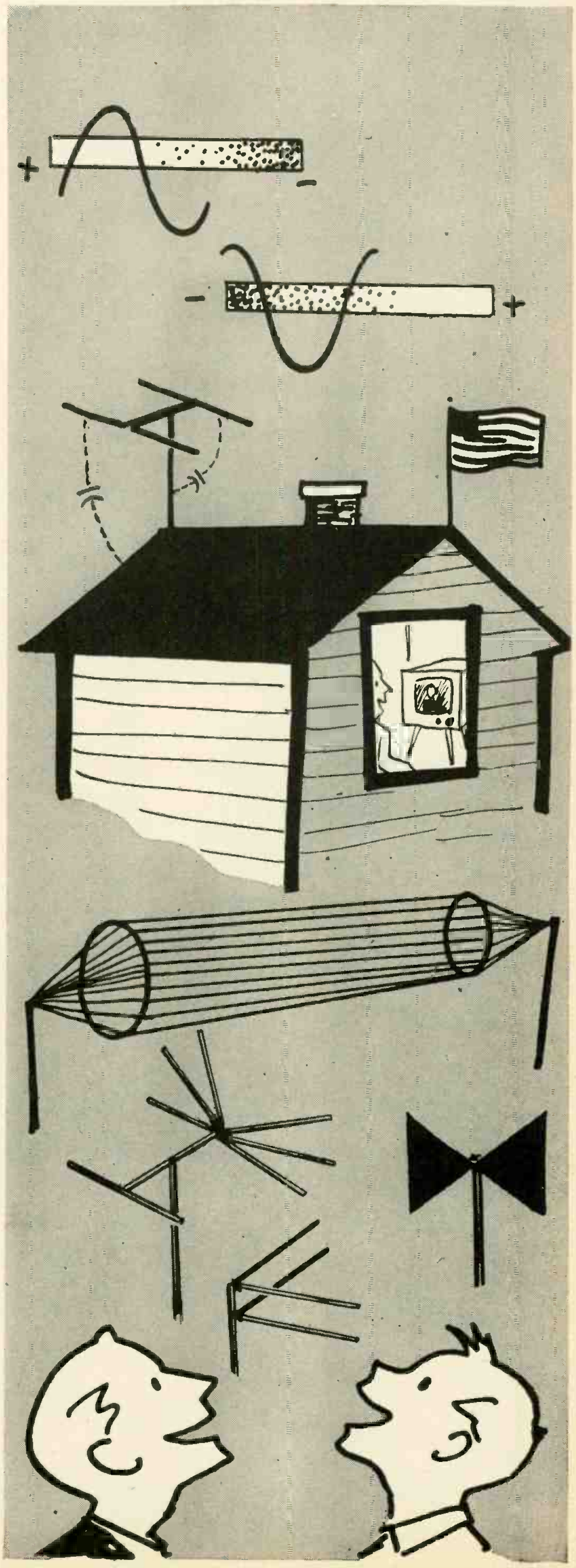
KEN—You'll notice that the whole upper section of the v.h.f. TV spectrum is about three times the frequency of the lower part. That means that a half-wave antenna for channels 3 and 4 will be approximately three half-waves on channels 8 to 12.

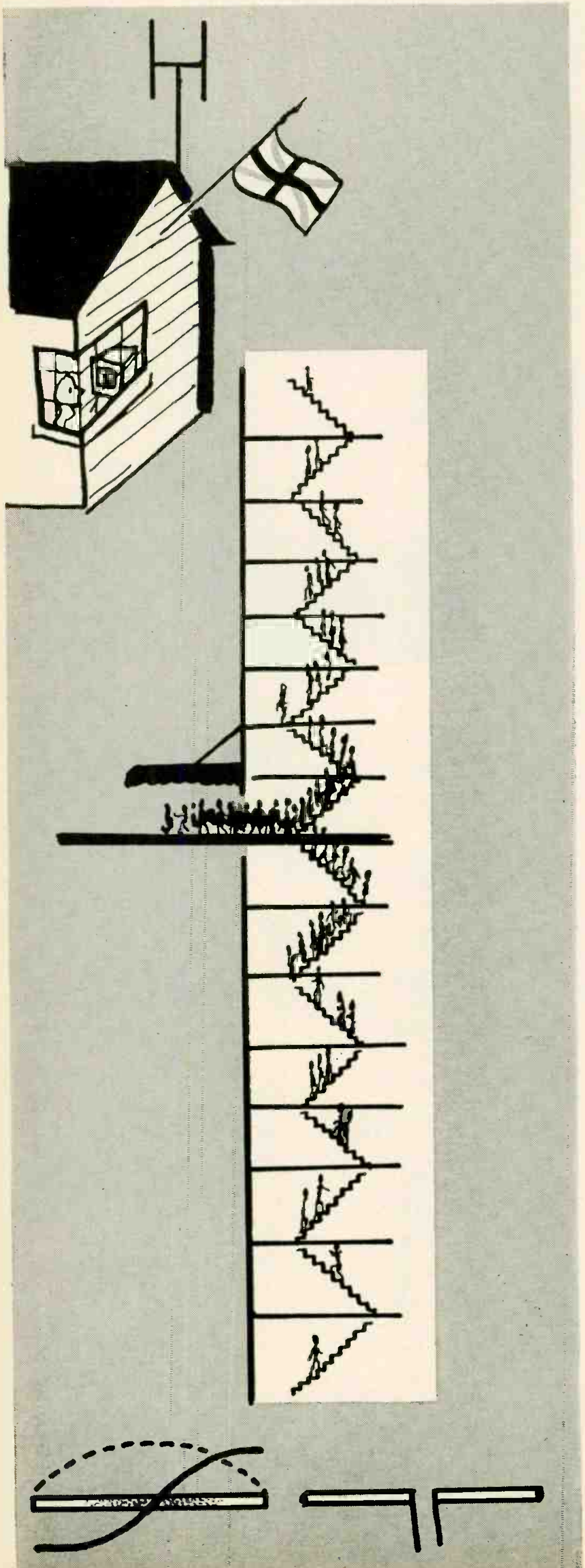
WILL—And a three-half-wave antenna works like a half-wave one?

KEN—Much the same, though not quite so well. But a few tricks are used and compromises made that give us antennas that work fairly well over the whole v.h.f. band. For example, the way the ends of a conical are tipped ahead is to help it on the upper part of the band.

WILL—And these double-V's are dipoles with a lot of tip-ahead?

KEN—No, they belong to a different group of antennas, the so-called "long-wire" type, and are even better on the upper than the lower section of the band. In fact, they can be used on u.h.f. too, as well as the rhombic, another member of the long-wire family. But if you have to receive both





u.h.f. and v.h.f. stations, it's usually best to have separate antennas. The most common are simple dipoles, fanned out into bowties to make their response curve broader.

WILL—Another thing. Why do the English stand their antennas up on end, while we lay ours flat?

KEN—That's because of the polarization of the electromagnetic field. The English use vertical transmitting antennas, which send out vertically polarized waves, and you have to use a vertical antenna to receive them. In the early days of TV it was thought there were certain advantages in vertical polarization. For instance, a vertical transmitting antenna sends out equally strong signals in all directions, but a horizontal one sends best in a direction broadside to the antenna and transmits very little in the direction of its ends. The pickup of receiving antennas follows the same pattern. But our horizontal polarization is—among other things—less susceptible to certain types of interference, and I believe the latest European systems—for instance, the French 819-line setup—also use horizontal polarization.

Atom-age apartment house

WILL—Tell me, why does the lead-in come from the middle of a TV antenna? You have the greatest voltage at the ends. That's where you should be able to get the most signal.

KEN—You tell me—where is the stair carpet in your house worn the most?

WILL—Along the middle, naturally, but a stair carpet isn't a TV antenna! How does it get in on this?

KEN—Simply because it may give us the clearest explanation of the way currents and voltages are distributed in our antenna. But let's go a little further. Let's imagine an atomic-age apartment house built with the thought of hydrogen-bomb attacks in mind. It has eight stories above ground and eight below. Each floor has approximately the same number of tenants. The place is a walkup—we can't depend on elevators in emergencies, or at least so the landlord says. Now, do you imagine all the stairs would be equally worn?

WILL—Of course not. You'll have only a few fresh-air lovers and safety-first enthusiasts on the very top and bottom floors. Their part of the stairs will get very little wear. But the first flight up and down from the entrance would be used by everyone in that half of the building.

KEN—Now you see the analogy between the tenants in our 16-story walkup and the electrons in our antenna?

WILL—I get it! There can be very little motion of electrons at the ends of the antenna—they have nowhere to go. But as you approach the middle, the number of electrons increases and the very maximum is right at the center.

KEN—So you see the example was useful, if it did seem a little far-fetched at first. Now you know where the current is greatest, you can tell what point the lead-in should come from.

WILL—I do know there are two wires in a piece of flat lead-in, and they are attached to the inner ends of a pair of straight aluminum tubes—in the simple antenna you've been talking about, that is. But how can these be half-wave antennas? They are really two antennas in line. Surely the currents can't jump the space between two antennas—especially if we are going to have the most current there. How do you go about attaching the lead-in to a *real* half-wave antenna?

KEN—Don't worry, Will. The job you're talking about is a real half-wave antenna and is the most commonly used of all antennas, in some form or another. It is the ***dipole***, made of two quarter-wave sections. The current has no problem, for as it flows toward the center of the antenna, the lead-in offers it the same impedance that the rod itself would if you had a straight dipole with no lead attached to it. So if you make a gap in the center just long enough that the impedance at the ends of it is about 72 ohms and attach a 72-ohm lead-in, the current acts just as if it were flowing on a straight rod. Of course, you have to remember to cut your antenna short enough to account for the end effect due to the mast and other things, as I explained a few minutes ago.

TO BE CONTINUED

Heathkit PRINTED CIRCUIT 5" COLOR TV *Oscilloscope Kit*

MODEL 0-10

$69.50

Shpg. Wt. 27 lbs.

The technical specifications for this fine instrument speak for themselves. Vertical channel sensitivity is 0.025 volts RMS/inch at 1 Kc. Vertical frequency response is essentially flat to 5 Mc, and down only 1.5 db at 3.58 Mc. Ideal for Color TV work!

Extended sweep generator range is from 20 cps to 500 Kc in five steps, far beyond the range normally encountered at this price level.

Other features are: plastic-molded capacitors for coupling and by-pass—preformed and cabled wiring harness—Z axis input for intensity modulation—peak-to-peak voltage calibrating source built-in—retrace blanking amplifier—regulated power supply—high insulation printed circuit boards—step attenuated and frequency compensated vertical input circuit—push-pull horizontal and vertical amplifiers—excellent sync. characteristics—sharp, hairline focusing—uses 5UP1 CRT—extremely attractive physical appearance.

An essential instrument for professional Laboratory, or for servicing monochrome or color TV.

Heathkit PRINTED CIRCUIT 3" OSCILLOSCOPE KIT

This light, portable 3" oscilloscope is just the ticket for the ham, for service calls, or as an "extra" scope in the shop, or lab. Measures only 9½" H x 6½" W x 11¾" D, and weighs only 11 lbs.

Employs printed circuit board for improved circuit performance. Vertical amplifiers flat within +3 db from 2 cps to 200 Kc. Vertical sensitivity 0.25 volts RMS/inch peak-to-peak, and sweep generator operates from 20 cps to 100,000 cps. R.F. connection to deflection plates.

MODEL OL-1

$29.50

Shpg. Wt. 14 lbs.

Heathkit PRINTED CIRCUIT 5" OSCILLOSCOPE KIT

This full-size 5" Oscilloscope incorporates many outstanding features.

Vertical channel flat within +3 db. 2 cps to 200 Kc, with 0.09 volts RMS/inch peak-to-peak sensitivity at 1 Kc. Sweep operation from 20 cps to 100,000 cps. Built-in peak-to-peak voltage calibration—3 step frequency compensated input attenuator—phasing control—push-pull deflection amplifiers. Printed circuits for reliable performance and reduced construction time.

MODEL OM-1

$49.50

Shpg. Wt. 26 lbs.

Heathkit PRINTED CIRCUIT VACUUM TUBE VOLTMETER KIT

MODEL V-7

$24.50

Shpg. Wt. 7 lbs.

This VTVM has set a new standard for accuracy and reliability in kit-form electronic instruments. Features modern, time-saving printed circuits, and functional arrangement of controls and scales. Includes new peak-to-peak scale for FM and TV work.

Measures AC (RMS) and DC voltage at 0-1.5, 5, 15, 50, 150, 500, and 1500; peak-to-peak AC voltage at 0-4, 14, 40, 140, 400, 1400, and 4000; center-scale resistance readings of 10, 100, 1000, 10,000, 100 K, 1 meg., and 10 meg. DB scale provided also. Zero-center operation within range of front panel controls Polarity reversal switch—200 μa 4½ meter-transformer power supply—11 megohm input impedance — 1% precision resistors — high quality components used throughout.

Heathkit 20,000 ohms/volt MULTIMETER KIT

MODEL MM-1

$29.50

Shpg. Wt. 6 lbs.

Features comprehensive range coverage. 20,000 Ω/V D.C. and 5000 Ω/V A.C. Ranges: 0-1.5, 5, 50, 150, 500, 1500, and 5000 V. direct current from 0 to 150 μa., 15 a. in 5 steps. Center-scale resistance of 15, 1500 and 150,000 ohms, and db from —10 to +65.

Uses 1% precision resistors—50 μa. meter—molded bakelite case.

Heathkit DIRECT-READING CAPACITY METER KIT

Extremely valuable where speed and convenience are essential. Quality control work, production line checking, etc. Reads capacity directly on meter scale, from 0-100 mmfd, 1000 mmfd, .01 mfd, and .1 mfd. Residual capacity less than 1 mmfd. Not susceptible to hand capacity.

MODEL CM-1

$29.50

Shpg. Wt. 7 lbs.

Heathkit A. C. VACUUM TUBE VOLTMETER KIT

MODEL AV-2

$29.50

Shpg. Wt. 5 lbs.

Measures AC voltage only, from 10 cps to 50 Kc. Covers the range from 1 millivolt to 300 volts in 10 steps at high impedance input. Incorporates full 10 ranges of db scale from −52 db to +52 db. Essential in the audio laboratory or for audio enthusiasts and experimenters. Provides sensitivity essential for low level audio measurements.

Heathkit ELECTRONIC SWITCH KIT

This device will electronically switch between 2 input signals to produce both signals alternately at the output. Used in conjunction with an oscilloscope, it will permit the observation of 2 signals simultaneously. Provides switching rates from 10 cps to 200 cps.

MODEL S-2

$23.50

Shpg. Wt. 11 lbs.

Heathkit VOLTAGE CALIBRATOR KIT

Once calibrated, this instrument provides a known peak-to-peak voltage standard for comparison with unknown voltage values on an oscilloscope. Panel calibrated directly—no involved calculations required. Operates within a voltage range of .01 to 100 volts peak-to-peak.

MODEL VC-2

$11.50

Shpg. Wt. 4 lbs

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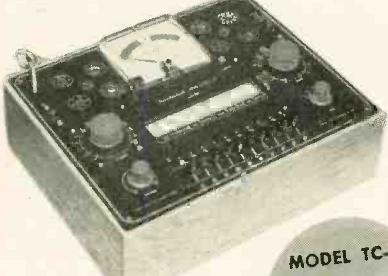
SELECT YOUR NEXT HEATHKIT FROM

Heathkit TUBE CHECKER KIT



MODEL TC-2
$29.50
Shpg. Wt. 12 lbs.

Because of its low price this fine tube tester is available, not only to the service shop and laboratory, but to part-time servicemen, experimenters, and radio amateurs, as well. Will test all tubes commonly encountered in radio and TV service work. Simple "GOOD—BAD" scale on the 4½" meter. Tests for open, short, and quality on the basis of total emission. Includes illuminated roll chart. Fourteen different filament voltage values available. Separate lever switch for each tube element.

Model TC-2P is the same electrically as TC-2, except that it is housed in a beautiful two-toned portable carrying case. Only $34.50. Shpg. Wt. 15 lbs.

Portable carrying case available separately for Model TC-2, or older model TC-1. Cab. No. 91-8, $7.50. Shpg. Wt. 7 lbs.

CRT Test Adapter, Model 355 for use with the TC-2, $4.50. Shpg. Wt. 1 lb.

Heathkit TV ALIGNMENT GENERATOR KIT

Here is the complete R.F. signal source for FM and TV alignment, (both monochrome and color). Provides output on fundamentals from 3.6 Mc to 220 Mc in four bands, with harmonic output usable up through the UHF channels. Electronic sweep circuit eliminates mechanical gadgets and accompanying noise, hum, and vibration. Continuously variable sweep up to 0—42 Mc, depending on base frequency.

Variable marker (19—60 Mc on fundamentals) and crystal marker (4.5 Mc and multiples thereof) generators built-in. Crystal included with kit. Provision for external marker if desired.

Packed with outstanding features. 50 ohm output impedance — exceptionally good linearity—effective AGC action—plenty of R.F. output. An essential instrument for the up-to-date service shop.

$49.50

MODEL TS-4
Shpg. Wt. 16 lbs.

Heathkit SIGNAL GENERATOR KIT

Shpg. Wt. 8 lbs.

MODEL SG-8
$19.50

This is one of our most popular kits, and is "serviceman engineered" to fulfill the signal source requirements of the radio serviceman and experimenter.

Covers 160 Kc to 110 Mc on fundamentals (5 bands), with output in excess of 100,000 microvolts. Calibrated harmonics extend usefulness up to 220 Mc. Choice of unmodulated R.F. output, 400 cps modulated R.F. output, or 400 cps audio output. Step-type and continuously variable output attenuation controls.

Coils are prewound, and construction manual is complete. Calibration unnecessary for service applications.

Heathkit RESISTANCE SUBSTITUTION BOX KIT

Model RS-1

Provides switch selection of 36 RTMA 1 watt standard 10% resistors, ranging from 15 ohms to 10 megohms. Numerous applications in radio and TV work.

$5.50
Shpg. Wt. 2 lbs.

Heathkit CONDENSER SUBSTITUTION BOX KIT

Model CS-1
$5.50
Shpg. Wt. 2 lbs.

Very popular companion to Heathkit RS-1. Individual selection of 18 RTMA standard condenser values from .0001 mfd to .22 mfd. Aluminum panel, bakelite case, and includes 18" flexible leads with alligator clips.

Heathkit DECADE RESISTANCE KIT

Model DR-1

Twenty 1% precision resistors provide resistance from 1—99,999 ohms in 1 ohm steps. Indispensable around service shop, laboratory, ham shack, or home workshop.

$19.50
Shpg. Wt. 4 lbs.

Heathkit DECADE CONDENSER KIT

Model DC-1

Provides capacity values from 100 mmf to 0.111 mfd in steps of 100 mmfs. ±1% precision silver-mica condensers used. High quality ceramic wafer switches for reduced leakage.

Shpg. Wt. 3 lbs.
$16.50

Heathkit CONDENSER CHECKER KIT

Model C-3
$19.50
Shpg. Wt. 7 lbs.

Measures capacity in four ranges from .00001 to 1000 mfds. Power factor control is provided for indication of electrolytic condenser efficiency. Tests capacitors under actual load conditions. Checks resistance from 100 ohms to 5 megohms. Direct reading scales for all tests. No calculation necessary.

Heathkit LABORATORY GENERATOR KIT

Model LG-1

Here is a signal generator for use where high accuracy and metered performance are essential. Covers 150 Kc to 30 Mc on fundamentals in 5 bands. 400 cps modulation variable from 0 to 50%. R.F. output at 50 Ω from 100,000 to 1 µv. Meter reads R.F. output in µv. or modulation percentage. Fixed-step and variable output.

$39.50
Shpg. Wt. 16 lbs.

Heathkit VISUAL-AURAL SIGNAL TRACER KIT

Model T-3

$23.50
Shpg. Wt. 9 lbs.

This signal tracer features a high-gain R.F. channel and probe to permit signal tracing from the receiver antenna input through the R.F. and I.F. stages. Separate low gain channel for audio circuits. Both visual and aural indication by means of speaker and electron beam "eye" tube.

Also noise locater circuit, wattmeter, and terminals for "patching" output transformer or speaker into external circuit.

Heathkit HANDITESTER KIT

Model M-1

$14.50
Shpg. Wt. 3 lbs.

The M-1 is literally pocket size to fit in your coat pocket, tool-box, glove compartment, or desk drawer. Measures A.C. or D.C. v. in 5 steps from a full scale minimum of 0—10 v. to a maximum of 0—5000 v. Measures direct current at 0—10 Ma and 0—100 Ma, and provides ohmmeter ranges of 0—3000 and 0—300,000 ohms. Sensitivity of 1,000 ohms/v. 1% precision divider resistors employed.

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THESE HIGH QUALITY INSTRUMENTS

Heathkit HARMONIC DISTORTION METER KIT

Performs the functions of more elaborate and much more expensive audio distortion testing devices and yet is simple to operate and inexpensive to own. Used with a sine wave generator, it will check the harmonic distortion output of audio amplifiers under a variety of conditions. Essential in audio design work.

The HD-1 reads harmonic distortion directly on the meter as a percentage of the original signal input. It operates from 20 to 20,000 cps in 3 ranges, and incorporates a VTVM circuit for initial reference settings and final harmonic distortion readings. VTVM ranges are 0—1, 3, 10, and 30 volts full scale. 1% precision voltage divider resistors used. Distortion meter scales are 0—1, 3, 10, 30 and 100% full scale. Having a high input impedance the HD-1 requires only .3 volt input for distortion tests.

MODEL HD-1
$49.50
Shpg. Wt. 13 lbs

Heathkit AUDIO ANALYZER KIT

MODEL AA-1
$59.50
Shpg. Wt. 13 lbs.

The AA-1 consists of an audio wattmeter, an AC VTVM, and a complete IM analyzer, all in one compact unit. It offers a tremendous saving over the price of these instruments purchased separately.

Use the VTVM to measure noise, frequency response, output gain, power supply ripple, etc. Use the wattmeter for measurement of power output. Internal loads provided for 4, 8, 16, or 600 ohms. VTVM also calibrated for DBM units so db gain or loss can be noted quickly.

High or low impedance IM measurements can be made. High (6 Kc) and low (60 cps) frequency generators built-in. Only 4 meter scales are employed, and one of these is in color so that results are easily read on the scale. Full scale VTVM ranges are .01 to 300 volts in 10 steps, full scale wattmeter ranges are .15 mw to 150 w in 7 steps. IM analyzer scales are 1%, 3%, 10%, 30% and 100%.

Heathkit AUDIO GENERATOR KIT

This basic audio reference generator deserves a place in your Laboratory. Complete frequency coverage is afforded from 20 cps to 1 Mc in 5 ranges, and output is constant within ±1 db from 20 cps to 400 Kc, down only 3 db at 600 Kc., and 8 db at 1 Mc. An extremely good sine wave is produced, with a distortion percentage below 0.4% from 100 cps through the audible range.

Plenty of audio output for all applications; up to 10 v. under no load conditions. Output controllable with a continuously variable or step-type attenuator with settings of 1 µv, 100 µv, 1 v, and 10 v. Cathode follower output.

MODEL AG-8
$29.50
Shpg. Wt. 11 lbs.

Heathkit VARIABLE VOLTAGE POWER SUPPLY KIT

Model PS-3
$35.50
Shpg. Wt. 17 lbs.

Provides regulated DC output for B+, and 6.3 v. AC at 4 amps. for filaments. Output variable from 0 to 500 v. DC at no load, linear from 0—10 ma at 450 vdc and 0—130 ma at 200 vdc! Essential for circuit design and development. Voltage or current read on 4½" meter.

Heathkit "Q" METER KIT

Model QM-1
$44.50
Shpg. Wt. 14 lbs.

Will measure Q of condensers, RF resistance and distributed capacity of coils, etc. Uses 4½" 50 µa meter for direct indication. Will test at 150 Kc to 18 Mc in 4 ranges. Measures capacity from 40 mmf to 450 mmf within ±3 mmf. Useful for checking wave traps, chokes, peaking coils. Indispensable for coil winding and determining unknown condenser values.

Heathkit AUDIO OSCILLATOR KIT

MODEL AO-1
$24.50
Shpg. Wt. 10 lbs.

(SINE WAVE — SQUARE WAVE)

Features sine or square wave coverage from 20 to 20,000 cps in 3 ranges. An instrument specifically designed to completely fulfill the needs of the serviceman and high fidelity enthusiast. Offers high-level output across the entire frequency range, low distortion and low impedance output. Uses a thermistor in the second amplifier stage to maintain essentially flat output through the entire frequency range. Produces good, clean square waves with a rise time of only 2 microseconds.

Heathkit IMPEDANCE BRIDGE KIT

Model IB-2
$59.50
Shpg. Wt. 12 lbs.

Measures resistance, capacitance, inductance, dissipation factors of condensers, and the storage factor of inductance. Employs 2-section CRL dial. D, Q and DQ functions are combined in one control. ½% resistors and capacitors used in critical circuits. 100—0—100 microammeter for null indications. 1000 cycle oscillator, 4 tube detector-amplifier, and power supply built-in.

Heathkit 6-12 VOLT BATTERY ELIMINATOR KIT

Model BE-4
$31.50
Shpg. Wt. 17 lbs.

Furnishes 6 or 12 volt output for the new 12 v. car radios in addition to 6 v. models. Two continuously variable output voltage ranges; 0—8 v. DC at 10 A. continuously or 15 A. intermittent, 0—16 v. DC at 5 A. continuously or 7.5 A. intermittent. Output voltage is clean and well filtered by two 10,000 mfd condensers. Panel meters read voltage and current output.

Heathkit BROADCAST BAND RECEIVER KIT

MODEL BR-2
$17.50
(Less Cabinet)
Shpg. Wt. 10 lbs.

Build your own receiver with confidence. Complete instruction book anticipates your every question.

Features transformer-type power supply, high-gain miniature tubes, built-in antenna, planetary tuning from 550 Kc to 1600 Kc, 5½" speaker. Also adaptable for use as AM tuner or phono amplifier.

CABINET: Fabric covered plywood cabinet available, complete with aluminum panel and re-inforced speaker grille. Part No. 91-9, Shpg. Wt. 5 lbs., $4.50

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New Heathkit DX-100 PHONE AND CW TRANSMITTER KIT

This one compact package contains complete transmitter, with built-in VFO, modulator, and power supplies. Provides phone or CW operation—VFO or crystal excitation—and bandswitching from 160 meters through 10 meters. R.F. power output 100—125 watts phone, 120—140 CW. Parallel 6146's modulated by push-pull 1625's. Pi network interstage and output coupling for reduced harmonic output. Will match non-reactive antennas between 50 ohms and 600 ohms. TVI suppressed with extensive shielding and filtering. Rugged metal cabinet has inter-locking seams.

The high-quality transmitter is packed with desirable features not expected at this price level. Copper plated chassis—potted transformers—wide spaced tuning capacitors—ceramic insulation—illuminated VFO dial and meter face—remote control socket—preformed wiring harness—concentric control shafts—high quality, well rated components used throughout. Overall dimensions 20⅞" wide x 13¾" high x 16" deep.

Supplied complete with all components, tubes, cabinet and detailed construction Manual. (Less crystals.) Don't be deceived by the low price! This is a top-quality transmitter designed to give you years of reliable service and dependable performance.

MODEL DX-100

$189.50

Shpg. Wt. 120 lbs.

Shipped motor freight unless otherwise requested. $50.00 deposit required for C.O.D. orders.

Heathkit AMATEUR TRANSMITTER KIT

MODEL AT-1 **$29.50** Shpg. Wt. 15 lbs.

Enjoy the trouble-free operation of commercially designed equipment while still benefiting from the economies and personal satisfaction of "building it yourself."

This CW Transmitter is complete with its own power supply, and covers 80, 40, 20, 15, 11 and 10 meters. Single knob bandswitching eliminates coil changing. Panel meter indicates grid or plate current for the final. Crystal operation, or can be excited by external VFO. Crystal not included in kit. Incorporates features one would not expect in this price range, such as key-click filter, line-filter, copper plated chassis, prewound coils, 52 ohm coaxial output, and high quality components throughout. Instruction Book simplifies assembly. Uses 6AG7 oscillator, 6L6 final and 5U4G rectifier. Up to 35 watts plate power input.

Heathkit GRID DIP METER KIT

Model GD-1B **$19.50** Shpg. Wt. 4 lbs.

This is an extremely valuable tool for Hams, Engineers or Servicemen. Covering from 2 Mc to 250 Mc, it uses 500 μa meter for indication. Kit includes prewound coils and rack. Will accomplish literally hundreds of jobs on all types of equipment.

Heathkit ANTENNA IMPEDANCE METER KIT

Use in conjunction with a signal source for measuring antenna impedance, line matching purposes, etc. Will double, also, as a phone monitor or relative field strength indicator.

100 μa meter employed. Covers the range from 0 to 600 ohms. An instrument of many uses for the amateur.

Model AM-1 **$14.50** Shpg. Wt. 2 lbs.

Heathkit VFO KIT

MODEL VF-1 **$19.50** Shpg. Wt. 7 lbs.

Weigh the cost of this kit against the cost of crystals—and consider the convenience and flexibility of VFO operation. This is one of the most outstanding kits we have ever offered for the radio amateur.

Covers 160—80—40—20—15—11 and 10 meters with three basic oscillator frequencies. Illuminated and precalibrated dial scale clearly indicates frequency on all bands and provides more than two feet of dial calibration. Reflects quality design in the use of ceramic coil forms and tuning capacitor insulation, and copper plated chassis. Simply plugs into crystal socket of any modern transmitter to provide coverage of the bands from 160 meters through 10 meters. Uses 6AU6 Clapp oscillator, and OA2 voltage regulator for stability. May be powered from plug on Heathkit Model AT-1 Transmitter, or supplied with power from most transmitters.

Heathkit ANTENNA COUPLER KIT

Model AC-1 **$14.50** Shpg. Wt. 4 lbs.

Poor matching allows valuable communications energy to be lost. The Model AC-1 will match your low power transmitter to an end-fed long wire antenna. Also attenuates signals above 36 Mc, reducing TVI. 52 ohm coaxial input—power up to 75 watts—10 through 80 meters.

Heathkit COMMUNICATIONS RECEIVER KIT

Covers 550 Kc to 35 Mc in 4 bands. Features electrical bandspread—separate R.F. and A.F. gain controls—noise limiter—AGC—BFO—phone jack—5½" PM speaker.
CABINET: Fabric covered plywood cabinet. Part No. 91-10. Shpg. Wt. 5 lbs. $4.50

Model AR-2 **$25.50** Shpg. Wt. 12 lbs. (Less Cabinet)

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Heathkit DUAL-CHASSIS WILLIAMSON TYPE HIGH FIDELITY AMPLIFIER KIT

Main amplifier and power supply each have their separate chassis for flexibility of installation. Features the Acrosound "ultra-linear" output transformer. Frequency response within ±1 db from 10 cps to 100,000 cps. Power output is over 20 watts.

KIT COMBINATIONS

W-3M: Consists of main amplifier and power supply for separate construction. Includes all tubes, components, and complete assembly instructions. Shpg. Wt. 29 lbs., Exp. Only $49.75

W-3: Consists of W-3M Kit listed above *plus* Heathkit Model WA-P2 Preamplifier. Shpg. Wt. 37 lbs., Exp. Only . . . $69.50

Heathkit ADVANCED DESIGN *High Fidelity* AMPLIFIER KIT

This advanced-design 25 watt Hi-Fi Amplifier features a new-design Peerless output transformer, improved circuitry, and uses KT-66 output tubes. This results in higher power output; improved bass and high frequency response; and reduced IM and harmonic distortion. Incorporates all the "extra" features that make for real listening enjoyment. Power handling capabilities increased to follow instantaneous power peak of full orchestra. Also new type balancing circuit, and "tweeter saver" to suppress HF oscillation. New physical design results in attractive appearance suitable for use either in or out of a cabinet.

KIT COMBINATIONS

W-5M: Consists of main amplifier and power supply for single chassis construction. Includes all tubes, components, and complete assembly instructions. Shpg. Wt. 31 lbs., Exp. Only $59.75

W-5: Consists of W-5M Kit listed above *plus* Heathkit Model WA-P2 Preamplifier. Shpg. Wt. 38 lbs., Exp. Only $79.50

Heathkit SINGLE-CHASSIS WILLIAMSON TYPE HIGH FIDELITY AMPLIFIER KIT

This is the lowest priced Williamson-type Amplifier ever offered in kit form. Main amplifier and power supply on a single chassis. Features Chicago output transformer. Flat within ±1 db from 10 cps to 100,000 cps. Maximum power output over 20 watts.

KIT COMBINATIONS

W-4M: Consists of main amplifier and power supply for single chassis construction. Includes all tubes, components, and complete assembly instructions. Shpg. Wt. 28 lbs., Exp. Only $39.75

W-4: Consists of W-4M Kit listed above *plus* Heathkit Model WA-P2 Preamplifier. Shpg. Wt. 35 lbs., Exp. Only $59.50

Heathkit 6-WATT AMPLIFIER KIT

Model A-7B

$15.50

Shpg. Wt. 10 lbs.

Model A-7B; although not classified as a true high fidelity amplifier, this Heathkit Amplifier provides full 6 watts power output, more than adequate for normal home installation, and frequency characteristics are ± 1½ db from 20 to 20,000 cps. Push-pull output—detailed construction manual—top-quality parts. Output transformer tapped at 4, 8, and 15 ohms. Bass and treble tone controls provided. Two input channels.

MODEL A-7C: Same as Model A-7B except with preamplifier stage. Shpg Wt. 10 lbs., $17.50

Heathkit 20-WATT HIGH FIDELITY AMPLIFIER KIT

Model A-9B

$35.50

Shpg. Wt. 23 lbs.

Here is your least expensive route to real high fidelity performance. Full 20 watt output—separate bass and treble tone controls—frequency response ±1 db 20—20,000 cps—four switch-selected, compensated inputs—low hum and noise level—output transformer tapped at 4, 8, 16, and 500 ohms. Single chassis construction combines preamplifier, main amplifier, and power supply in one unit.

Heathkit HIGH FIDELITY PREAMPLIFIER KIT

Model WA-P2

$19.75

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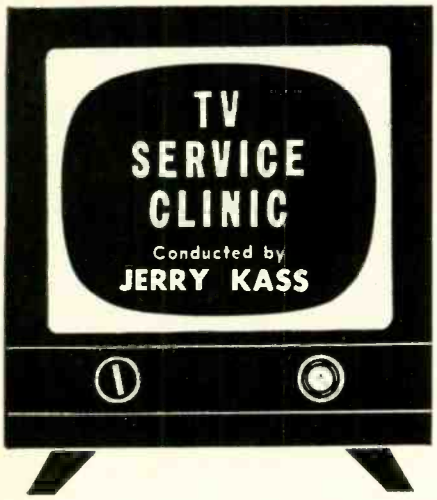


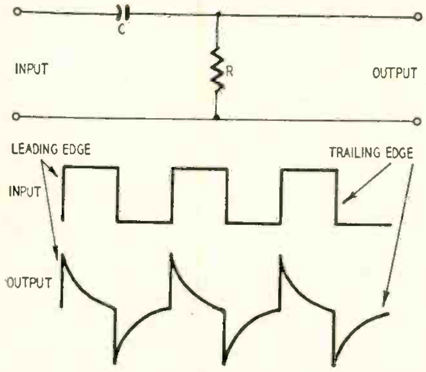


Fig. 1—A differentiating network.

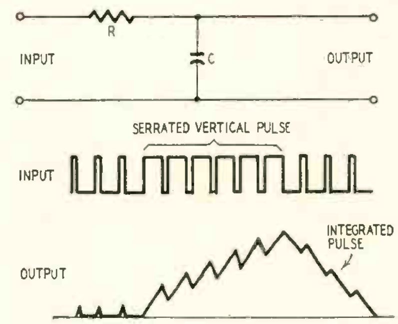


Fig. 2—Simple integrating network.

AFTER being separated from the composite video signal, sync pulses must be shaped and undergo further separation—the vertical from the horizontal—for triggering the circuits to which they are applied. Should this separation be incomplete, the result will be picture jitter, lack of interlace and general sync instability. Separation is obtained with differentiation and integration circuits.

Since all sync pulses have the same amplitude, separation is based upon the differences in their pulse width and frequency. The horizontal pulses are narrow, approximately 5 μsec and occur at a frequency of 15,750 cycles. The broad serrated vertical pulse occupies approximately 190 μsec, occurring at a frequency of 60 cycles. Using differentiators and integrators with the proper R-C time constants, sync pulses can be separated.

Differentiation

Fig. 1 shows a simple R-C network with the output taken across R. The input consists of pulses or square waves. The leading edge of a square wave has the effect of a high-frequency voltage. As a result, the reactance of C is extremely low during this time—for all practical purposes, a short circuit. Thus the leading edge of the input waveform produces a large and immediate voltage drop across R and appears in the output waveform as a sharp pulse.

Having reached its peak amplitude, the input voltage remains constant for its duration. During this time C charges exponentially to the peak input voltage at a rate determined by the R-C time constant. At the same time the voltage across R decays exponentially, since the voltage drop across it is proportional to the charging current through it. The capacitor is fully charged when the output voltage drops to zero. The arrival of the falling (trailing) edge of the pulse abruptly removes the signal voltage and an opposite action takes place. With the input voltage removed, the capacitor discharges through R, reversing the polarity of the current flow and the output waveform. Thus, if the time constant of R-C is short with respect to the pulse width, each input pulse will produce two sharp output pulses—one positive and one negative with respect to some reference point.

The output of the differentiator is usually fed to the a.f.c. circuit of a horizontal sweep system. Various sweep circuits make use of either positive or negative pips, depending upon their design. However, it is always the leading—not the lagging—edge that controls the triggering. Since this starts retrace action the lagging pip is of no importance—it is not even necessary to remove it.

The short time constant of the differentiator offers a certain amount of noise immunity. A noise pulse will place a charge on C, but the capacitor will rapidly discharge. This lessens the possibility of a noise-pulse voltage occurring at the same time as the sync voltage.

If C opens, no voltage appears across R and all horizontal sync is lost. If either R or C decreases in value, shortening the time constant, the pips become sharper, causing the horizontal hold control to become unstable and very critical.

Should R open, causing the output to be fed into a floating grid, horizontal synchronization will be lost. However, if there is some other high resistance in the circuit, or should R greatly increase in value, the time constant and the width of the pips will increase. This will reduce the noise immunity of the circuit, permitting noise pulses to produce broader pips.

The output of a differentiation circuit depends upon the rate of change of the input waveform rather than upon its duration. This we see in Fig. 1 where the output waveform is independent of the pulse width, containing sharp pulses only at the leading and trailing edges of the pulse.

Integration

An R-C network having a long time constant with respect to the width of the horizontal pulses but short with respect to vertical pulse duration shapes the vertical oscillator triggering pulse. In this circuit, called an integrator, the positions of R and C are reversed and the output appears across C. Having a long time constant, the horizontal pulses charge C to a small part of the applied voltage. Because of the long interval between pulses, C discharges completely.

The serrated vertical pulse consists of six broad pulses (27 μsec) having serrations of only 4 μsec. The first broad pulse charges C to a high portion of its peak amplitude. During the short serration there is very little time for C to discharge, so its discharge is slight. The next broad pulse finds C with a charge and increases it slightly to a higher value than was produced by the first pulse.

In this way each vertical pulse produces a slightly higher voltage across C (Fig. 2) until a point is reached where the vertical oscillator is triggered. Following the six vertical pulses the incoming signal returns to a series of narrow pulses having long time intervals between pulses. This causes the voltage across C to decrease rapidly in amplitude. Thus, the vertical pulses produce at the output of the integrator a broad triangular pulse, 60 times per second. This circuit obtains its name because it combines (integrates) the broad serrated pulses.

Cascaded integrator

No attempt is made to remove vertical sync pulses from the differentiator. In fact, the serrations are necessary to maintain horizontal sync during vertical retrace. However, should the horizontal pulses reach the integrator they will improperly trigger the vertical oscillator, causing poor vertical synchronization; thus they must be filtered.

If the time constant of the vertical integrator is very long, it will completely reject the horizontal pulses but will seriously reduce the amplitude of the integrator output because of the slow charging time. If it is made short, horizontal-pulse filtering will be poor, though the output is high.

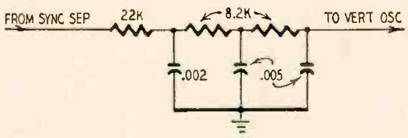


Fig. 3—Three-section sync integrator.

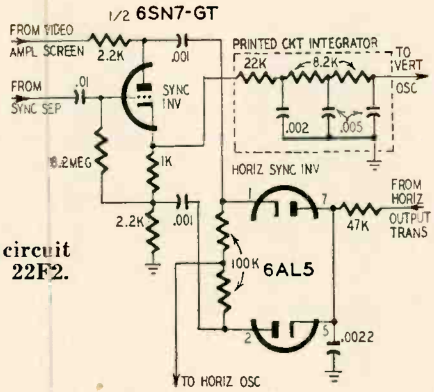
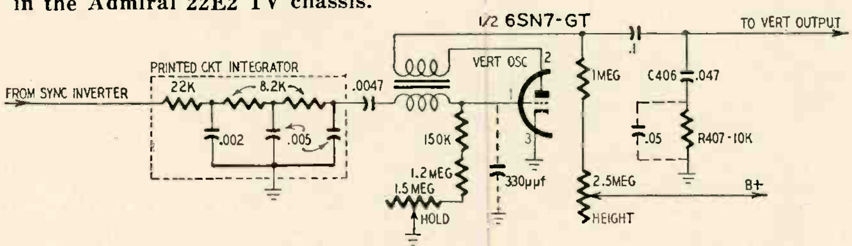


Fig. 4—Sync circuit in Admiral 22F2.

Fig. 5—Vertical oscillator circuit used in the Admiral 22E2 TV chassis.



For optimum vertical synchronization the integrated voltage should rise quickly and smoothly to the amplitude required to trigger the vertical oscillator. As a compromise between good horizontal filtering and a high amplitude output, the integrating circuit usually consists of two or three R-C sections in cascade (Fig. 3).

The overall time constant for a two-section network is long enough to filter out the horizontal pulses properly, while the shorter time constant of each section permits the integrator output voltage to rise rapidly. A three-section network provides still further attenuation of the horizontal sync-pulse ripple without any appreciable reduction in the vertical sync-pulse output amplitude.

Should the value of any resistor or capacitor in the integrator network decrease, the time constant of the circuit will decrease. This will permit the horizontal pulses to charge the integrator. As a result, picture interlacing will be reduced because the effects of the equalizing pulses will be unbalanced. In addition, vertical synchronization will become critical. If any of the integrator resistors increase in value, or should any capacitors become leaky, the time constant increases and the integrator output drops and causes poor vertical synchronization.

Common troubles

Incomplete sync separation is a common cause of trouble in the integrator. If video information is not completely removed, it will be integrated to produce unwanted vertical sync pulses. This can cause the vertical oscillator to trigger slightly before the normal pulse time, making the picture bounce or jitter up and down as each vertical sweep begins sooner than it should, by differing amounts.

Besides filtering out horizontal pulses, the integrator network helps to maintain good interlacing. Picture interlace can be easily checked by observing the lines of the horizontal wedge in a test pattern. The pairing of adjacent scanning lines causes a crisscross effect to appear in the horizontal wedge lines.

Interlace may be impaired by horizontal signals fed back from the horizontal oscillator through its sync input lead and into the vertical sync-pulse input lead. A small amount of pickup can completely destroy interlacing. Horizontal pulses make successive vertical-retrace time intervals unequal. Similarly, they make successive vertical sweep amplitudes unequal.

With the values of the components in integrator circuits becoming so standardized, several components manufacturers are producing printed integrating circuits. They are extremely compact but, should any component in the unit become defective, the entire assembly usually has to be replaced.

Fig. 4 shows the sync inverter circuit in the Admiral 22F2 chassis. It provides two series of oppositely phased pulses to the horizontal sync discriminator circuit and also feeds the vertical oscillator. This circuit is typical of vertical and horizontal separators in use today. (For an interesting and entertaining treatment of integrators and differentiators, see "Television—it's a cinch" in the March, 1955, issue.)

Vertical roll

A Magnavox model CTD445AA came in with no vertical deflection. Replacing the vertical output transformer gave some sweep but it was insufficient and the linearity was poor. I then checked and overhauled the entire vertical sweep circuit, producing good sweep and linearity. However, I now have a vertical roll during warmup. This lasts about 5 minutes. All components in the vertical oscillator and output circuits are either new or have been checked. I would appreciate any ideas on the subject.—L. K., New Haven

Since you have "overhauled" the entire vertical sweep circuit, check all wiring against the manufacturer's schematic. Look for any poorly soldered joints and for any errors in component values, such as 150,000 ohms instead of 1.5 megohms.

With the receiver settling down after 5 minutes of operation, check any components that might change characteristics with temperature. Replace the vertical oscillator tube and the coupling capacitor between the two sections of the vertical oscillator multivibrator. This capacitor is a .0027-μf silver mica unit. If you are using anything but a silver mica capacitor, it is probably causing the frequency drift during warmup.

Poor interlace

On an Admiral 22E2 chassis the complaint was a disturbing lack of interlace. The pairing or wide spacing did not change with variation of the vertical hold control. I measured about −27 volts on the grid of the vertical oscillator tube and about 200 volts peak-to-peak signal. The signal, though easy to synchronize on my scope, was extremely unsteady and had a slight bounce.

The plate circuit was about the same, with a good amplitude waveform but also unsteady. The signal in the oscillator plate circuit seemed more round than trapezoidal as called for. Every component seems to check O.K. Except for the pairing and some poor linearity, the picture is excellent. What further checks should be made?—R. B., Alemeda, Calif.

It appears that you may have a defective integrator filter. Horizontal sync or noise pulses may be getting through to the grid of the vertical oscillator. This could be causing the bounce. If you have not already done so, replace the vertical integrator network (Fig. 5). Also, replace components C406 and R407, the vertical wave-forming network, and the vertical oscillator tube.

It is entirely possible that even with the proper components there will be poor interlace in some receivers. An effective remedy on most circuits of the blocking oscillator type is the following: Connect a 330-μμf capacitor from the control grid of the vertical oscillator to ground. This will improve oscillator synchronization, thus improving interlace.

Also, connect a .05-μf capacitor across R407 (8,200 or 10,000 ohms). This will usually improve interlace and help stabilize the circuit.

Poor horizontal sync

My Philco model 51-T1443 television receiver is unable to hold horizontal sync on only one station. Three other stations located in many miles from me come in fine and are in sync. The troublesome station is only a few miles distant. If I place an attenuator in the antenna's transmission line, the local *signal will maintain sync but distant stations come in poorly. By using an antenna switch I can adjust the signal input for each station. However, this should not be necessary as this trouble developed only recently.—L. L., Cranston, R. I.*

The sync trouble caused by the strong local station is probably due to sync-pulse clipping. In addition, improper operation of the a.g.c. circuit or an overloaded i.f. amplifier may be causing the sync clipping. Substitute i.f. amplifier, detector and sync circuit tubes. Also, check all components in these circuits, replacing any that fall beyond their tolerance limits. The best check is to observe the poor-sync signal with an oscilloscope. Follow the sync pulses through the i.f. amplifier, watching for sync compression.

Poor focus

I have installed a low-voltage electrostatic-focus picture tube in a Sentinel model 714 receiver. I made no circuit changes other than the physical replacement of the tube, but focus is very poor. What changes can be made to clear it up?—A. M., Tampa, Fla.

You may have disturbed the focus by poor adjustment of the ion-trap magnet. Adjust this magnet for maximum brightness and best line structure. In addition, it may be possible to obtain better focus by connecting the focus anode to a point other than the recommended 270-volt B plus line. Try connecting it to chassis ground, 140-volt B plus and 530-volt B boost (pin 3 of the 6W4-GT damper). Use the point providing best focus.

Intermittent vertical deflection

I have a Crosley model 431-1 in which every few minutes the vertical deflection on the raster disappears, accompanied by a loud arc. I have checked all capacitors in the vertical sweep circuits that could possibly be breaking down. As a last resort I replaced the flyback transformer but that did not help. All wiring has been checked that could possibly be causing arcing. The trouble occurs so fast that I do not have time to analyze it. I thought I had it repaired once, but the customer called back a short time later. Perhaps you have some clues to the trouble?—R. G., Waco, Tex.

The loud arc accompanying the loss of vertical deflection indicates that the trouble lies somewhere between the plate of the 12BH7 vertical output tube and the vertical deflection coils. The sweep voltage at the plate of the 12BH7 is in excess of 1,000 peak to peak. Since there is very little circuitry following the plate of the 12BH7, trace it all out carefully for any possible point of high-voltage breakdown.

In some early models of this set arcing of the type you describe took place between the plate (pin 6) and filament (pin 5) of the vertical output tube. This occurred when the height control was misadjusted to the extreme end of its range, producing an abnormally high pulse voltage. Later models corrected this by reversing the two triode sections, making pin 1 the plate of the output tube. If this is the trouble, back down on the height setting and clean the socket between pins 6 and 5 of the 12BH7.

Intermittent sound and sync

In an RCA 9T147 I have a condition of an intermittent sharp loss in sound accompanied by poor synchronizing action and a slight loss in contrast. Since the sound takeoff is after the second i.f. amplifier, I have gone on the basis that the trouble is before that point. However, I could find nothing wrong after checking all tubes in the tuner and sound and video i.f. amplifiers. I have also noticed that, if I turn off the set for a few minutes, when I turn it back on it operates perfectly for several minutes. I have checked the audio i.f. circuits thoroughly and found that the only change during the defective period is in a lowering of the plate voltage, but I am unable to trace to the source of the trouble. Can you give me some idea of what to look for. —A. H., Spokane, Wash.

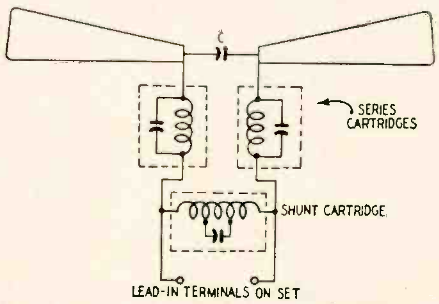
The fact that the plate voltage of the sound i.f. amplifiers dropped during the time of trouble indicates that the trouble is probably due to a defective component connected to the B plus line. The cathodes of the first and second video amplifiers are returned to the same B plus potential as the plates of the sound i.f. amplifiers, and a heater to cathode short or leakage in this tube could be causing the trouble. In addition, the d.c. restorer and sync separator are fed by the second video amplifier, accounting for the poor synchronization. END

CARTRIDGE-TUNED U.H.F.-V.H.F. ANTENNA

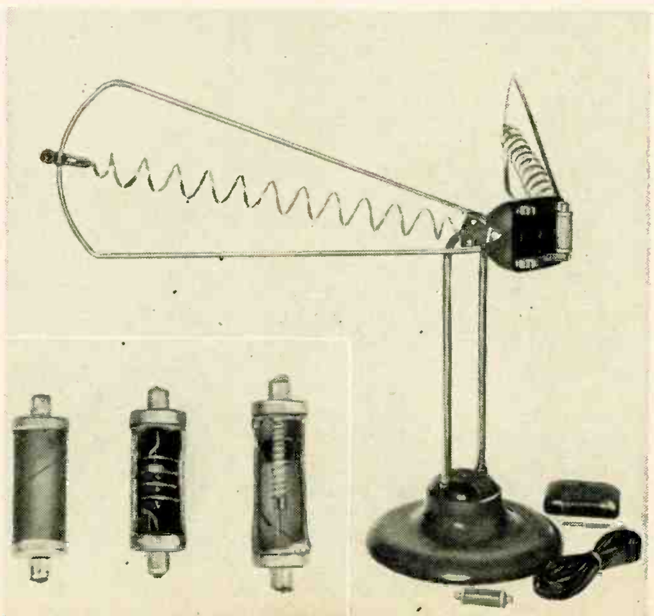
Something new has been introduced in indoor antennas—the use of "power coupler cartridges" for the lower v.h.f. band. The cartridges are fixed inductance–capacitance units that tune the antenna to a desired channel. The *Vidonair* antenna is a dipole (see photo) with "wings" approximately 100° apart. (The coils mounted within each wing are for decoration only.)

The cartridges used with the *Vidonair* are designed specifically for the low-band channels. (High-band v.h.f. and u.h.f. gain is inherent in the basic antenna design.) When the cartridges are inserted in the antenna, they peak the reception on that particular channel. They do not affect high-band v.h.f. and u.h.f. operation.

Three cartridges are used with the antenna. Two are in series with the two halves of the dipole (see diagram) and the third is in shunt with the transmission line. The shunt cartridge is the same for all



low-band v.h.f. stations. The series units may be selected for the weakest station, or changed from channel to channel. The *Vidonair* is manufactured by Tunkl Industries, Chicago.



View of Vidonair shows how cartridges are mounted. Internal view of cartridges can be seen in lower left-hand corner.

tv dx

July-September

WITH the spring dx reports just beginning to arrive in volume, it is not yet clear just how good the 1955 season is going to be. It appears to be well on the way toward the best since TV dx chasing became a major hobby, and there is still plenty of time to get in on the fun.

Dx should continue frequent through the end of July and through the first week of August, perhaps longer. But when the sporadic-E (skip) variety of dx runs out, the best period of the year for tropospheric dx is just coming up. Late August and all September will be a particularly productive period for highband and u.h.f. dx. Watch the morning hours, the period around sundown and the late evening, particularly on fair, calm, high-barometer days. Tropospheric propagation along both coasts, in the Great Lakes region and near other large bodies of water should be particularly good in the month of September.

OVER 50 TV DX CLUB

Listed below are changes in standing and new members only. The yearly summary of TV dx will list all members. To join or to keep your record up to date merely send in the number of TV stations you have positively identified. (Verifications not required.) Note the number of u.h.f. stations, your best dx, the number of calls photographed and any other information about your record that might be of interest to other dx-ers. For the form and style of your report, see "The Planets and TV Dx" by J. H. Nelson in the May issue. A model form, listing date, time, station, city, distance and comments, is included in that article.

Name	Location	Total	Uhf
Robert Seybold	Dunkirk, N. Y.	187	27
Bedford Brown, Jr.	Hot Springs, Ark.	181	
Louis Matullo	Washington, Pa.	155	19
Robert Weems, Jr.	State College, Miss.	121	
Tommy Larkins	Clarksville, Tenn.	77	
Kenneth Neal	Hamlin, Tex.	62	
	New Members		
Joseph Rombach	Arabi, La.	113	
J. K. Bettersworth	State College, Miss.	109	
Raymond Sloss	Baton Rouge, La.	76	
Clyde C. Barber	Okmulgee, Okla.	70	
Edward Rugel	Independence, Kan.	87	
Floyd Schnakenberg	Honesdale, Pa.	59	5

Leading photographers are Fred Von Gunten, Berne, Ind., with 126 identification slides recorded on film. Matullo is second with 115. Seybold leads the u.h.f. huntsmen with 27 stations.

An important feature of these dx reports is that, besides them being records of an extremely fascinating hobby, they are also valuable contributions to the study of signal transmission at television frequencies. END

SMALL CORNER HORN SYSTEMS

The evolution of the Rebel V speaker

By PAUL W. KLIPSCH*

THE first practical corner horn appears to have been developed U. S. Patent 1,984,550 (1934). This by Sandeman and described in speaker was characterized by "trihedral symmetry." The same speaker was re-invented 17 years later as the patent was expiring; it was redescribed in *Audio Engineering* in 1951.

This particular design, while functionally correct and capable of maximum performance per cubic foot of actual occupied space, proved to be difficult to style. Its shape was such that mid-range and tweeter speaker placements were troublesome and its chargeable space was much larger than its occupied space. In a home one may consider the chargeable space as the floor area times the height of any article of furniture. The occupied space may be less than the chargeable space because of shape—a sloping front for example. The Sandeman design utilized only approximately one-third of its chargeable space and therefore its chargeable floor area and vertical height were approximately three times as great as what could be accomplished with an optimum design.

*Klipsch and Associates
Hope, Arkansas

In 1940 I started development of a dihedrally symmetric speaker system which was described in the Klipsch patent 2,310,243 (1943). In its original conception, it was intended to function as a combination of corner-horn loading with direct radiation such that the upper frequencies would propagate from the front of the cone and the lower frequencies via the horn loading from the back of the cone.

The disparity in efficiency between the two radiation ranges produced severe boominess. As knowledge of the art was acquired, it become evident that using the front and back of the same cone to cover the entire audio spectrum would result in severe distortion.

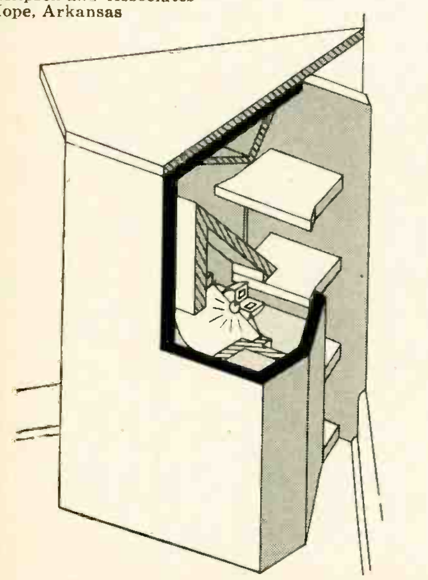
The result of these and further studies was the development of a separate two-way horn-loading loudspeaker system which was commercially developed under the name *Klipschorn*[1] and which, in 1951, became a three-speaker or so-called "three-way" system.

The first successful development, typified by the Klipschorn, was very complicated and expensive. The woofer horn was partially contained within a prismatic-shaped housing and partly between that housing and the wall. A cutaway drawing of this is shown in Fig. 1. Over 80 parts are required, some of which involve tolerances of the order of .016 inch. While the Klipschorn remains the standard of comparison and major product at Klipsch and Associates, some transducer in the "middle-price bracket" was recognized as needed.

In 1950 the early developmental work of 1940 was reviewed and it was decided that it would be worth while to try to achieve economy with the combined front and back loading. It was found that the introduction of an acoustic low-pass filter would control the boominess.

The result of these experiments was a small horn to cover the range from about 50 cycles to a little over 100 and a direct radiation function from there up as high as a cone may properly be expected to perform as a rigid piston; in the case of the 12-inch cone approximately 1,000 cycles is the limit. From that frequency into the upper treble range one could use a tweeter or a mid-range tweeter combination—either in the form of a coaxial loudspeaker or a group of separately arrayed speaker units.

The name *Rebel* was chosen because the speaker-system design was a revolt against conventional resonant-box systems. That the writer is an adoptive Southerner was admittedly an influence, and the double meaning is admittedly premeditated. The Rebels are designed to give the closest possible approach to Klipschorn performance at much lower prices and with considerably less bulk and weight. Using the same principles of mirror images produced by walls at a corner as does the Klipschorn, they offer the maximum possible performance per cubic foot per dollar's worth of horn and per driving element.



(*Courtesy Acoustical Society of America*)
Fig. 1—Original Klipschorn woofer.

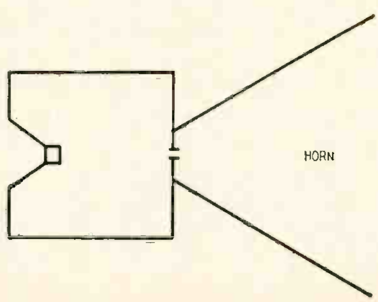


Fig. 2—The Rebel in simplified form.

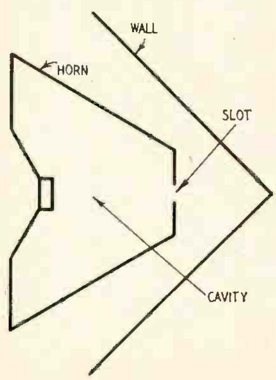
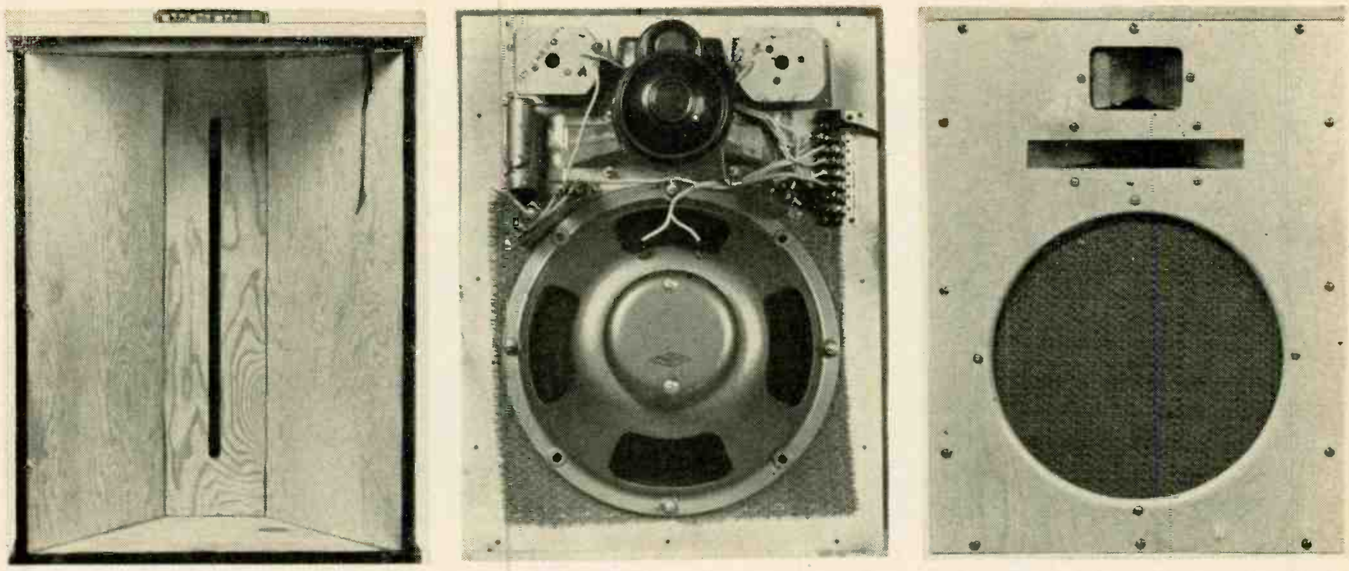


Fig. 3—Plan view of Rebel enclosure.



Three views of the Rebel V, the corner horn that carries its own corner.

The evolution of the Rebel was actually a regression to the idea of the back loading of a direct radiator. The first Rebel, a rather complicated horn, included a cavity and slot behind the cone to constitute a low-pass acoustic filter. The next stage of evolution was the reduction of the horn to that which lies between the prismatic-shaped housing and the room walls at a corner, the interior of the box becoming a larger back air chamber or acoustic capacitance. The result of this, contrary to expectations, was an improved response. (Later copiers have missed the point and deteriorated the results by attempting to lengthen the horn without increasing total size.)

Incidentally, I take exception to the remark on page 82 of the May issue, ". . . smaller Klipsch-licensed units, is a corner horn partly by virtue of advertising copy." While the horn is short (hence our "Shorthorn" trademark) it is nonetheless a true horn, and has been demonstrated to come closer to reproduction (by comparison with original sound) than some more elaborate and expensive horns. In fact, our original Rebel was a complicated and expensive thing: the present Rebel III as executed by Cabinart is a precise copy of our Rebel III which was an improvement over the original Rebel I, while also being simpler and less expensive to build. I might add that the Rebel, "generalized" in Fig. 2 on page 82 of the May issue, has been tested alongside a similarly sized "box" of a type shown on the same page, with identical drives, and the Rebel won on a listening test.

So many authors miss the point—deliberately or otherwise—in reviewing such equipment. The Rebel was indicated in Fig. 2 of the article referred to above in such a manner as to misguide a reader about the rear port; the text is likewise only partly right. The cavity and slot form an acoustic low-pass filter, and together form a transmission with a sloping curve compensating for the oppositely sloping curve of efficiency of the short horn.

This Rebel became known as the "II," the prototype of all subsequent Rebel designs. This is illustrated in simplified form in Fig. 2. The plan view of this is Fig. 3 and the electric equivalent shown in Fig. 4. The slot is an acoustic inertance—equivalent to inductance—and the cavity equivalent to an acoustic capacitance.

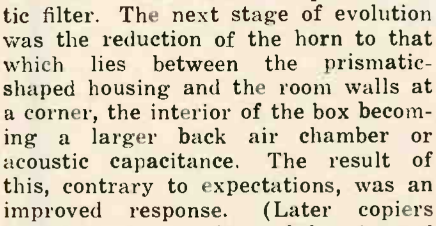


Fig. 4—Electrical equivalent of Rebel systems. I_C—inertance of driving cone; C_C—compliance of cone suspension; R_{A-1}—cone frontal radiation resistance; I_A—inertance of exhaust slot; C_A—capacitance of cavity; Z_{A-H}—complex impedance at horn throat, comprising reactance and resistance.

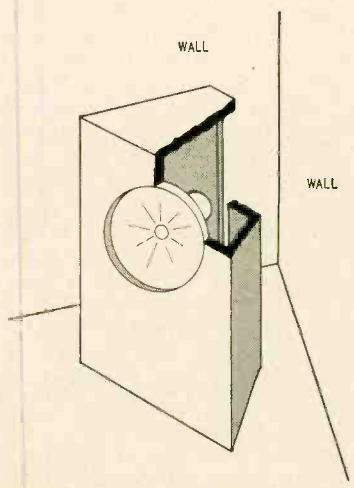


Fig. 5—Basic design, earlier Rebels.

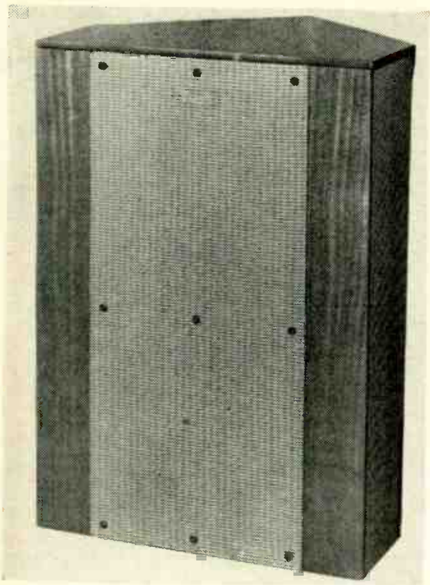
As a result of the purchase of a Stinson Voyager airplane which was too small to carry the Rebel III, a smaller version approximately 32 inches high was developed which was still capable of accommodating up to 15-inch woofer drive units and either two- or three-way separate or coaxial drive units. The Cabinart people, Brooklyn, N. Y., were licensed exclusively in 1953 under this design called the Rebel IV. They have now taken over the entire Rebel series—Rebels III, IV and the new Rebel V.*

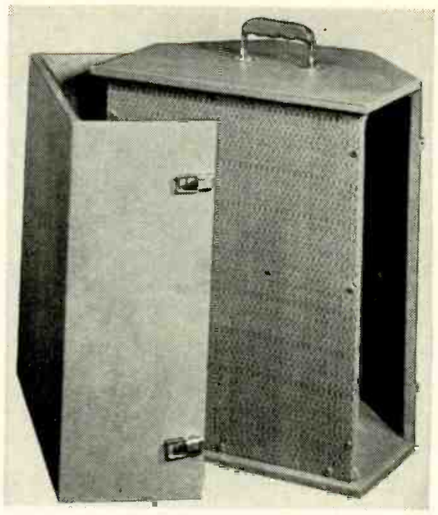
The Rebel V

Early in 1954 a study was undertaken to see what could be done in the matter of very small speakers of the order of 20 to 24 inches high, such as one might use to illustrate slide lectures, with portable 16-mm movies and the like. The result was a corner-horn design called the Rebel V. Its aim is not to make a "cheap" speaker but to make the best speaker that would be possible in the space. While crowded, it is possible to use a separate three-way system with a 12-inch woofer with a crossover at 1,000 and 5,000 cycles, as is preferred in the Rebels III and IV. This design is not intended to give a great powerful boomy bass nor to approach the tonal response of a Klipschorn, but rather to give a response as smooth as possible in the size and as free of distortion as possible with the necessarily high crossover frequencies.

The end result has been that response is adequate for speech and for music that does not contain extremely heavy bass. Naturally, the minimization of distortion has required that the response at the extreme bass end droop. Therefore, if one compares the Rebel V with the Klipschorn when playing

*Similar corner horns are in production by Klipsch and Associates under the trade name *Shorthorn*.





Left—Rebel V, a good home speaker. Above—A portable version, Rebel KR-5.

organ music, naturally the bottom couple of octaves are attenuated. But the sound output remains free of distortion because the bass has not been permitted to have a boomy peak of response which would permit the diaphragm to "free-wheel," generating its own frequencies and crossmodulating these with the signal. On lighter music (for example, a piano and especially if the piano repertoire avoids the lower octave), one has to listen closely to detect the difference between the little Rebel V and the Klipschorn, or between either and the original sound! Of course it is assumed that the components of the Rebel V are assembled like the developmental sample, which used a 12-inch base cone with a 2½-pound magnet, a horn-loaded mid-range unit with a two-inch phenolic diaphragm and heavy magnet, and an extended-range tweeter of the type which would not be called "super tweeter."

The Rebel V is a housing of 11 x 15 x 20 inches in size, following the plan shown in Fig. 5 except that short wall sections are included as part of the structure. Thus, whereas the Rebels III and IV are structures which become horns when placed in a corner, the Rebel V carries its own small section of corner. For reproduction of voice only it may be set on a chair; for an increased bass range, corner placement adds at least a half-octave of bass response.

It is impossible to achieve both wide range and efficiency except by using structures adequate in size in comparison to wavelength. To put this another way, the deep bass tones involving upward of 30-foot wavelengths require structures with dimensions comparable to a quarter-wavelength. In other words, the structure must be around 7 to 8 feet in equivalent diameter. By using wall reflections to produce mirror images the size of the structure can be brought down to around 4 feet. But any reduction below this 4-foot minimum must necessarily sacrifice one or more of the following:

1. The maximum wavelength which the system can produce.
2. The smoothness of response (reduction in size invariably introduces peaks in the bass range).
3. Introduction of distortion because of the large excursions the diaphragm must perform if the structure is too small. This is usually associated with peaked response.

The three Rebels in 36-, 32- and 20-inch size all violate these principles necessarily. The trick in retaining high level of quality is to coordinate the design of the acoustic low-pass filter with the short length of horn exterior to the housing and to introduce an effective cutoff of gradual slope such that the output, instead of becoming highly distorted in the extreme bass range, merely attenuates without introducing frequency doubling and resultant intermodulation of higher frequencies.

Since the Rebel V is roughly half as big as Rebel III, it may be expected to produce—and does—about half as much maximum wavelength. With good bass drivers, the slow fadeout of bass occurs around 50, 60 and 90 cycles, respectively, for the Rebels III, IV and V.

Actually the design of the combination horn and low-pass filter was a combination of arbitrary functional design with a cut-and-try procedure. First, the dimensions of the horn itself were selected. Next, while watching the output indicated on an oscillograph at the frequency at which the bass output is at maximum and where distortion is also at maximum, the slot, or "inertive element" of the low-pass filter was adjusted until the distortion was a minimum. This adjustment ignores frequency response, but it so happens that the adjustment for minimum distortion gives the optimum frequency response. If the acoustic filter is allowed to pass more energy to augment the bass, the augmentation takes the form of a peak or boominess such as one gets with ordinary resonant radiation systems, with the distortion associated with such systems. But in the Rebels the resonance effect has been largely minimized by matching the energy fed from the acoustic low-pass filter against the peculiar horn-throat impedance which, in the case of a very short horn, exhibits a curve of impedance plotted against frequency which rises rapidly at the low-frequency end of the horn's spectrum.[2]

Regardless of the engineering design and physical execution the proof is in the listening. For the past year a favorite way of demonstrating the Klipschorn has been to record a piano and play it back while the pianist alternates with the recording so the original sound may be compared directly with the reproduced sound. The Klipschorn appears to be the only speaker capable of rendering a reproduction imperceptibly different from the original. A vast number of comparative listening tests have been made with the three Rebels, using a Klipschorn as a reference and live tape recordings as the subject matter. It appears that each of the three Rebels offers the closest possible approach to Klipschorn performance commensurate in each case with the size of the Rebel and the drive system adopted.

When using separate three-way drive systems in the Rebel, it is possible to achieve the same response and freedom from distortion above 1,000 cycles available in the Klipschorn in the same frequency range. This means that the reduction in size and cost has resulted in sacrifice in tonal response only, and this confined to the region below 1,000 cycles.

There is some latitude in the choice of driving components. The Rebels III and IV accommodate drive systems ranging from coaxials up to separate three-way systems, with the choice of either 15- or 12-inch woofers. The maximum-size woofer that can be accommodated in the Rebel V is 12 inches. The laboratory models at Klipsch and Associates have been set up with three types of drive systems: a 12-inch coaxial in the $50 class; a separate three-way and a heavy 12-inch woofer driver or a separate three-way with a heavy 15-inch woofer driver, these last two in approximately the $100 and $150 price levels.

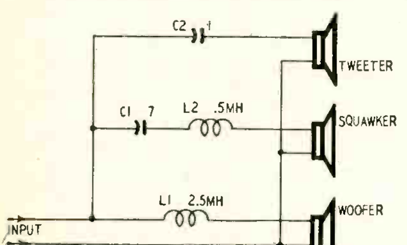


Fig. 6—Three-way crossover network.

AUDIO—HIGH FIDELITY

Optimum driver components

The choice of drivers for the Rebel may be based upon the following:

In the lowest-price class (generally $40 to $60), the only approach is to use a two-way coaxial.

In the price range from about $80 to $120, one may select a woofer costing approximately $30 for a 12-inch bass type cone, a mid-range unit with a short horn driven by a "ball park" type compression unit and a small tweeter, preferably not a "super tweeter."

In the $140 to $160 price range, a heavy 15-inch cone takes the place of the 12-inch unit in the "$100 system."

In the case of woofers, high-efficiency units with light magnets should be avoided because the high efficiency demands a high flux density which—with a light magnet—must be achieved with small clearances between the voice coil and air gap. It has been found that several units of excellent performance fail because of dragging voice coil after a short period of time. It would be more economical to get the high efficiency with heavier magnets.

The mid-range system or "squawker" as applied to the Rebel must cover a trifle more than two octaves. This can be done with any of a considerable variety of speaker drive units; we prefer the public-address type compression units using a 2-inch diameter phenolic diaphragm, as they are capable of handling the frequency range from 1,000 to 5,000 cycles quite adequately.

The tweeter must be of a type free of peaks in the 5,000- to 10,000-cycle region or an unnatural "presence" peak will exist. We prefer a diaphragm not larger than ¾-inch, preferably of the phenolic type, to produce the internal damping of transverse waves within the diaphragm, with a horn not to exceed 3 inches in length and preferably with an adequately small throat diameter to provide proper loading.

If you want to name names, the following driver complements are optimum in the present state of the art:

16-ohm, 12-inch woofers: Stephens 120LX or Electro-Voice 12-BW-1.

16-ohm, 15-inch woofers: Electro-Voice 15-W or Stephens 103-LX.

16-ohm squawker: University SA-HF or MA-25 driving suitable mid-range horn. We demonstrate using the MA-25 on our own K-1000 shorthorn mid-range horn.

Tweeters: University 4401, deliberately mismatched at 16 ohms to compensate for efficiency. This is the most extended-range tweeter so far tested.

An authority disputed

Many years of experimental work on crossover networks has evolved the thinking that 6-decibel-per-octave slopes are generally better than steeper ones. In this respect this writer disagrees with the subject matter of his own paper in *Electronics*.[3] The crossover network as shown in the diagram of Fig. 6 has been used with success for the past couple of years and represents some 14 years of development experience based on measurements and listening tests. It differs from the crossover network used in the Klipschorn only in the lower crossover frequency being 1,000 cycles instead of 500 and the fact that the mid-range unit in the Klipschorn has its lower cutoff protected by a 12-decibel slope, which is not necessary with the 1,000-cycle crossover point.

The reader should look askance at claims of "30 to 20,000 cycles" made by some manufacturers of drivers; one such manufacturer points with pride to a ±4-db variation at that range! That cannot happen in any drive system known at Klipsch and Associates—not even in Klipschorn! But the Rebel will make almost any drive unit come closer to its manufacturer's claims. END

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[1] P. W. Klipsch, "A Low-Frequency Horn of Small Dimensions," *Jour. Acous. Soc. Am. 13, 2*; pages 137–144; October, 1941.

P. W. Klipsch, "Improved Low-Frequency Horn," *Jour. Acous. Soc. Am. 14, 3*; pages 179-182; January, 1943.

P. W. Klipsch, "A High-Quality Loudspeaker of Small Dimensions," *Jour. Acous. Soc. Am. 17, 3*; pages 254–258; January, 1946.

[2] P. W. Klipsch, "A Note on Acoustic Horns," *Proc. IRE, 33, 7*; pages 447–449; July, 1945.

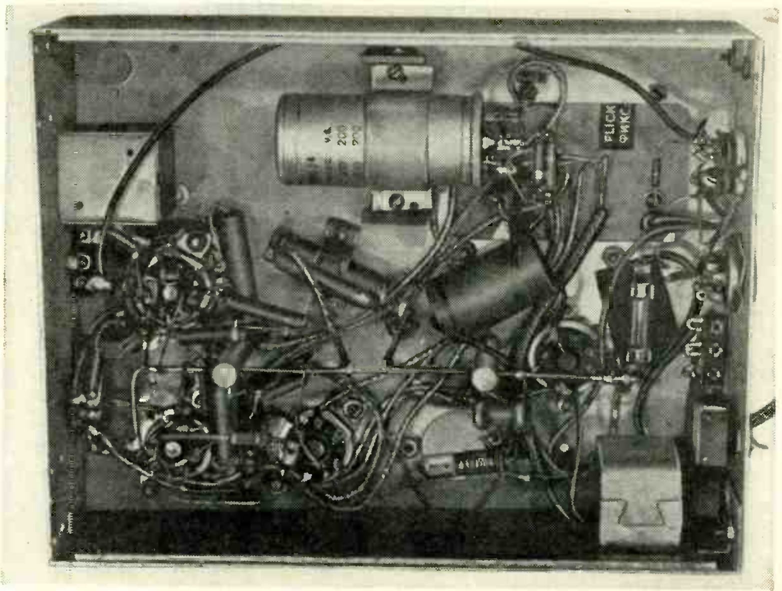
[3] P. W. Klipsch, "Woofer-Tweeter Crossover Network," *Electronics*, November, 1945.

"The brain says it's an intermittent."

Baby-Listening INTERCOM

Unit features unusually high gain and low background noise

By J. P. C. McMATH*



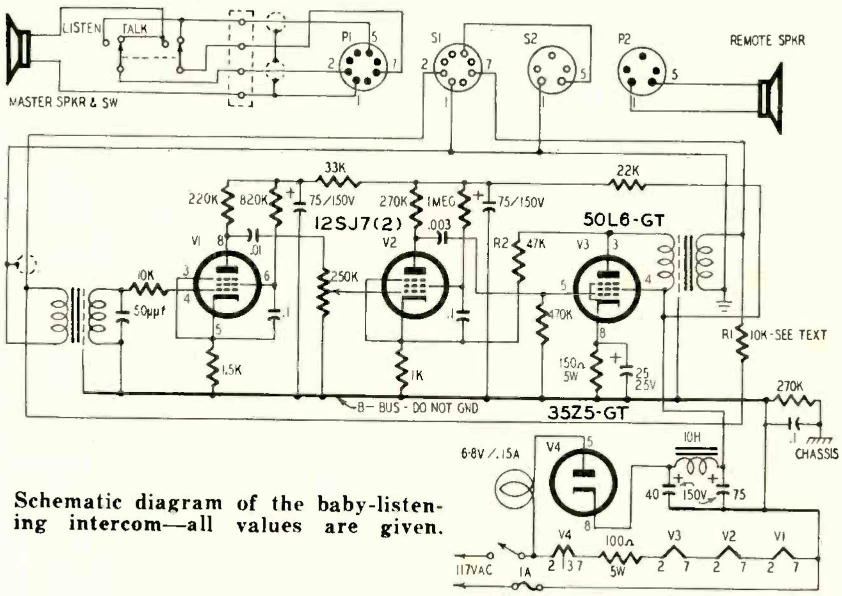
An underchassis view of the intercom.

DESIGNED particularly for baby-listening, this intercom system was used in my basement workshop for communication to a second-story room. As is usual in simple intercoms, 4-inch PM speakers were used as combination speakers and microphones. The outstanding feature of this design is the unusually high gain. With the speaker some 6 feet from the baby's bed, his breathing could be heard in exaggerated form, giving an effect somewhat similar to listening with a stethoscope. At full gain, ample output is obtainable by speaking softly several feet from the input. For normal speech, close to the input, excellent operation is obtained by setting the gain control at a low level.

Even with this unusually high gain, a transformerless power supply, and unshielded wire to the remote speaker, the hum is almost inaudible. This is due to thorough filtering and decoupling, input and output transformers having interwinding shields, and considerable negative feedback.

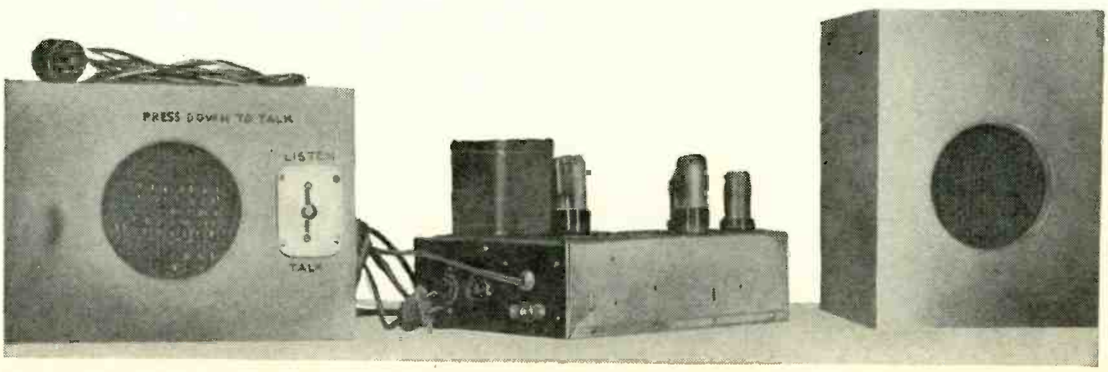
As is often done in the case of low-level input stages, the volume control (see diagram) is placed between the first and second stages to reduce noise. The cathode resistors of the first two stages are left unbypassed, providing negative current feedback. Negative voltage feedback is taken from the plate of the 50L6, through R2, to the cathode of V2. The cathode resistor of V3 is bypassed, mainly to prevent negative current feedback in this stage, which if present, would increase the output impedance of the stage—not a desirable result when feeding a loudspeaker load.

In addition, feedback is provided from output to input through 10,000-ohm resistor R1. This loop had only a



Schematic diagram of the baby-listening intercom—all values are given.

*Associate Professor in Electrical Engineering, University of Manitoba, Winnipeg, Can.



Complete unit—amplifier with speakers.

very slight effect on audio gain, but resulted in a significant reduction in noise or hiss. In my installation there were no signs of instability. However, it is possible that in some cases (depending on the characteristics of the transformers used) instability might occur. If it does, the value of R1 should be increased. If instability persists, the R1 network should be omitted.

The output transformer, a surplus item marked RCA 113807-501, is a power transformer for a vibrator type supply, having excellent shielding. Any output transformer providing the necessary voltages could be used, although an interwinding shield is of value. The shielded input transformer was also surplus, from the No. 19 wireless set, marked PC 77370 C. However, any low-level shielded input transformer with a turns ratio of about 1:100 would be satisfactory.

I used a surplus chassis measuring 3 x 7 x 10 inches, considerably larger than necessary. The extra space made layout easy and probably contributes to some extent to the low hum level and cool operation. The 0.15-amp pilot lamp was inserted largely as protection for the choke and output transformer—it is not essential. The speakers were mounted in open-backed baffle boxes made from ¾-inch pine, overall dimensions being approximately 8 inches wide, 10 inches high and 6 inches deep.

As shown in the photograph, the TALK-LISTEN switch is mounted with the master speaker. An octal plug and socket is used for the master speaker connection and a five-pin plug and socket for the remote speaker to avoid any possibility of wrong connections. Shielded wire is used for the portion of the input circuit that is cabled together with part of the output circuit—this prevents undesirable feedback effects. One other word remains to be said—the TALK-LISTEN switch should be spring-loaded to remain normally in the LISTEN position so that the baby will not be awakened by a blast from the speaker. This could easily occur if a standard switch was left accidentally in the wrong position!

This design may be of interest not only for baby- or invalid-listening, but for any intercom application in which unusually high gain and sensitivity, with very low background noise, is desired. END

Parts for Baby-Listening Intercom

Resistors: 1—1,000, 1—1,500, 2—10,000, 1—22,000, 1—33,000, 1—470,000, ½ watt; 1—47,000, 3—270,000, 1—820,000, 1—1 megohm, 1 watt; 1—100, 1—150, 5-watt wirewound; 1—250,000-ohm potentiometer, audio taper.

Capacitors: 1—50 μμf, mica; 1—.003 μf, 1—.01, 3—0.1 μf, 600 volts; 1—25 μf, 25 volts, electrolytic; 1—40 μf, 3—75 μf, 150 volts, electrolytic.

Miscellaneous: 1—shielded input transformer, voice coil to grid (see text); 1—output transformer, 50L6 to voice coil (see text); 1—filter choke, 10 h @ 75 ma; 2—12SJ7; 1—50L6-GT; 1—35Z5-GT; 4—octal tube sockets; 1—s.p.s.t. switch; 1—1-amp fuse and holder; 1—d.p.d.t. spring-loaded switch; 2—4-inch PM speakers; 1—octal plug and socket; 1—5-pin plug and socket; 1—chassis, approximately 7 x 9 x 2 inches; 1—6.3-volt 0.15-amp pilot lamp and holder; 1—line cord; 2—cabinets for speakers.

FOR GOLDEN EARS ONLY

The Hallicrafters SX-62 receiver; Ronette crystal phono cartridges; Electro-Voice Slimair microphone; new records review

By MONITOR

SEVERAL of my correspondents who are either shortwave fans or hams, as well as audio enthusiasts, have asked more or less: "How about the Hallicrafters SX-62 as a combination shortwave or ham receiver and high-fidelity tuner?" The answer in brief is: Except for the hum level which is higher than desirable for high-fidelity use (but can be corrected easily) the SX-62 makes a superb tuner. With a good speaker it isn't at all bad as a complete system.

The output stage is fed straight from the rectifier cathode and the other audio stage through a one-section filter. Hum attenuation is understandably not complete, although not too bad even with a fine speaker system. This could be fixed for a few dollars by inserting a miniature choke and a 40–80-μf capacitor in the B plus line leading to the inverter stage.

As a tuner the SX-62 deserves superlatives, on both AM and FM. The receiver is well known for extreme sensitivity on AM bands, but it may be news to many that the FM section is right in the running for the title of the most sensitive FM tuner. I estimate the sensitivity as around 2 microvolts for 40 db of quieting. The surprise disappears when one notes that it uses two r.f. and three i.f. stages, plus a limiter.

The AM portion not only provides extreme sensitivity but adjustable selectivity and therefore a means of adjusting fidelity to suit the receiving conditions. The i.f. bandwidth is variable in three steps. The BROAD position yields a curve about 15 kc wide. With three i.f. stages the sides of the curve are very steep and the skirts narrow so that beat-note and monkey-chatter interference from adjoining channels isn't bad even on distant stations.

An audio generator and v.t.v.m. were used to measure the response of the SX-62's audio section (Fig. 1). With the tone control switch in the HI-FI, MED and LOW positions response is flat within about 3 db in the range of approximately 25 to 1,000 cycles. In the BASS position there is a boost beginning at about 20 cycles, rising to 12 db at 80 to 100 cycles and dropping gradually to about 600 cycles. The response begins to drop at around 5 kc in the HI-FI position and is about 3 db down at 15 kc on the 500-ohm output tap and 6 db down on the 8-ohm tap. In the MED and LOW positions of the tone control response is down 3 and 8 db, respectively, at 2 kc.

Clearly the best takeoff point is the 500-ohm tap of the output transformer. A fairly long cable could be used with little further attenuation of the highs because of the low impedance. For permanent connection in a hi-fi system a 500-ohm resistor could be used as a lead. Removing the output tubes is not recommended. For one thing, the increased voltage applied to the r.f. and i.f. stages might well result in regeneration or instability. For another thing, the output from the phone jack at the plate of the first audio stage is considerably poorer in high-frequency response because the feedback loop is broken and its beneficial action voided. The output from the 500-ohm tap will compare favorably with that taken from most hi-fi tuners and the 5-db drop at 20 kc is of little practical importance.

Fig. 2 gives the distortion, which is high by high-fidelity standards at levels above 1 watt but satisfactory at levels below 500 milliwatts. A 1- or 2-volt output from the 500-ohm tap also falls in the range below 2% intermodulation distortion. Such a voltage should drive most hi-fi systems easily.

I tried the SX-62 as a completely independent system, using several excellent speaker systems ranging from the Diminuette to the Hartley combination of two 215's and the big Boffle. The resultant sound is by no means bad and many people would be completely happy with it. Phono reproduction (Fig. 3) with the new ceramic pickup was pretty good, too, although the gain through the phone channel is a little low for LP use and the hum level is therefore bothersome. With the hum level cor-

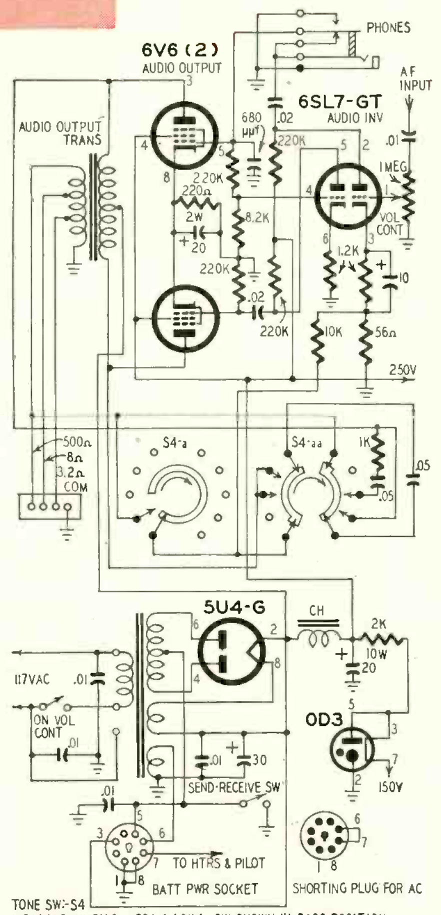


Fig. 1—Audio section of the SX-62.

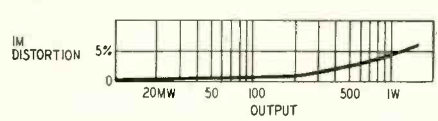


Fig. 2—SX-62 distortion characteristic.

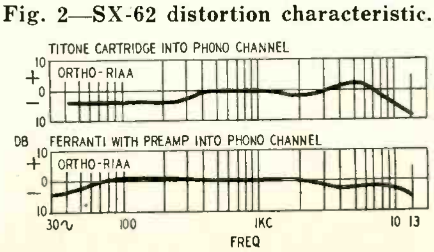


Fig. 3—Response with ceramic pickups.

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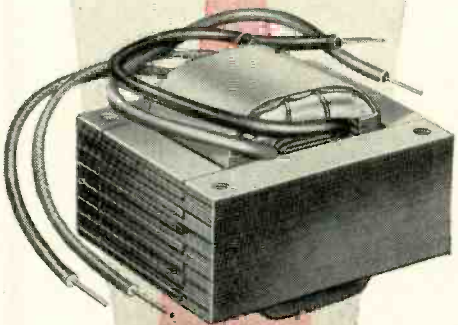
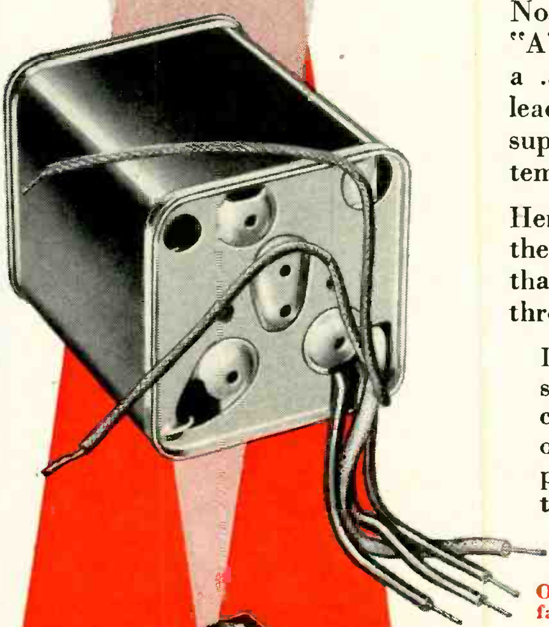


UNCASED MODEL 6055, ABOVE
BELOW, CASED MODEL 6060.



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DISTRIBUTED BY ELECTRONICS DISTRIBUTORS EVERYWHERE rected, the tone control could be used in the bass position which would equalize the ceramics very nicely at the low end and provide a little bass boost, to boot.

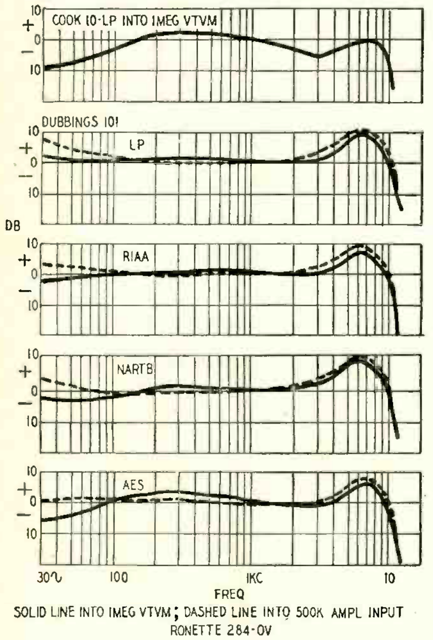


Fig. 4—Response of the Ronette 284-OV.

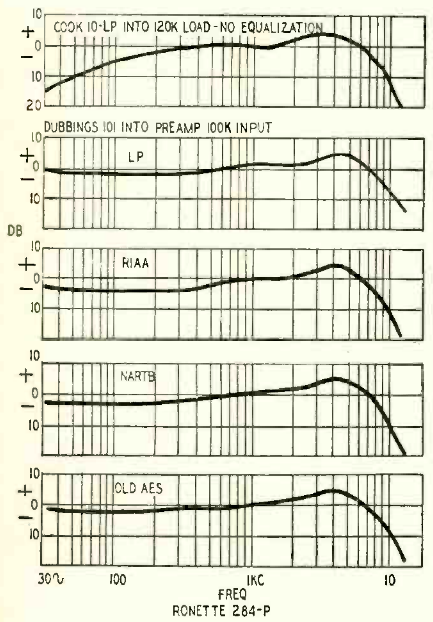


Fig. 5—Response of the Ronette 284-P.

Ronette crystal phono cartridges

High fidelity is full of surprises and contradictions. Take the two sets of curves in Figs. 4 and 5. Those in Fig. 4 show a high peak in the region between 5 and 8 kc. We have grown to believe that such peaks lead to high distortion, high scratch and noise levels and, generally, to unsatisfactory performance from a hi-fi point of view. The peaks in Fig. 5 are both broader and much gentler but the slope at the high end is greater. The curves are by no means bad, however they are not what we expect of equipment suitable for high fidelity. There is a rule of thumb which all old-timers in hi-fi know well: "Never mind the curves, what does the thing sound like." And when subjected to this test both Ronette pickups turn in amazing results.

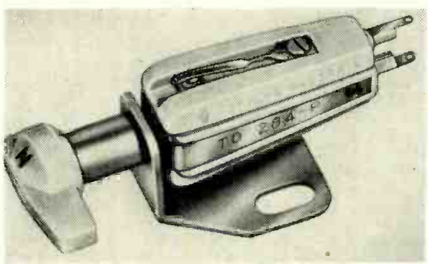
It takes very critical listening indeed to discern the loss of highs above 10,000 cycles even on A–B comparisons with wide-range pickups and the exceptional recordings which possess material in this region. On the average high-fidelity recording the loss is all but indiscernible. Unlike most piezoelectric pickups which seem low on low bass even when fully equalized, these two deliver an excellent bass, round and well defined.

The model 284-P (see photo) seems to go as far down as any pickup I've used; the 284-OV apparently cuts off somewhere below 30 cycles to minimize rumble. The high ends are remarkably clean, sharp and, allowing for a personal predilection for a sharp treble, they seem very pleasant to listen to.

One answer to the seeming paradox is the very low distortion of the cartridges. Their own curves indicate an IM of 1% by European standards—equivalent to 4% by American standards. Actually, my measurements, though not trustworthy enough for objective rating, indicate that the distortion of the cartridges alone is considerably less than that; I would say the IM rise due to the cartridges is less than 2%. On a comparative basis, the distortion figures were about as good or better than that of top-quality magnetic cartridges.

Another part of the answer is provided by the very smooth slopes of the resonant peaks, similar to those of good treble boost controls. A considerable boost is thus provided but with less distortion than normally accompanies boosts with boosting networks. Still another part of the answer is the fact that these cartridges are very insensitive to vertical stimulation, which produces a good deal of scratch noise.

The two cartridges have some additional endearing virtues. Almost all piezoelectric cartridges need to work into a high load impedance—2 to 5 megohms—to provide adequate bass response. Only a few commercial models of amplifiers provide such high input loads. The Ronette 284-OV works into



The Ronette model 284-P cartridge.

the normal 500,000-ohm load of a typical high-level input channel, and increasing the load makes no significant difference. The dotted curves in Fig. 4 were run through a Regency HF-80 amplifier which has a 500,000-ohm input load; the solid lines into the 1-megohm input of a Heathkit a.c. v.t.v.m. Here then is an inexpensive cartridge which provides adequate equalization of American curves without any modification of the input load. The output averages 0.75 volt and is sufficient on peaks to drive almost any modern hi-fi amplifier to maximum output.

The model 284-P is even more extraordinary for it provides a constant-velocity response, like a magnetic cartridge, when loaded with only 120,000 ohms. The output is about 150 mv on LP records. It can replace a magnetic cartridge if the preamp provides a load of around 100,000 to 120,000 ohms and will be equalized nicely by the magnetic equalization networks as indicated by the curves in Fig. 5, obtained through a copy of the Golden Ear preamp. This cartridge tracks nicely with pressures as low as 3 grams in arms with low-friction bearings.

Both cartridges are turnover combinations of two separate needles, nicely compact. The turnover lever permits a middle or neutral position in which both needles are protected. Needles are easily changed by loosening and tightening one screw. Both cartridges are available with brackets to fit all American arms. The 284-P is also available with an excellent plastic and tubular steel arm and an adjustment for needle pressure.

Electro-Voice Slimair 636 microphone

When tape recorders had a restricted frequency range, the microphone used was not a limiting factor and any of the inexpensive ham or PA type mikes was good enough. Today, however, many recorders, even inexpensive ones, are reasonably flat to 12,000 or 15,000 cycles; and many an owner of one of these excellent machines is throwing away an octave or more of hard-bought fidelity by using a microphone of inferior range. I asked Electro-Voice to submit for test the high-fidelity mike in their line which in their opinion provided the best performance for the least money and was best suited for the amateur audiophile. They sent me the Slimair Dynamic (see photo) which sells for about $40. Having used it several months with various recorders, I agree that it fills the bill.

Fig. 6 gives the manufacturer's curve of the frequency response. The overall response is as good or better than that of most high-fidelity speaker systems. To improve upon it significantly one would have to be prepared to spend $100 or so more, and this would be useful only if the speaker system were also better at the extremes. Recordings made on the Ampex 600, which is nicely flat from 20 to 15,000 cycles, are distinguishable from the live sound only by the most critical listening and appear to be just about as good as most commercial high-fidelity recordings. Even a recording of a fair pipe organ sounded

(*Continued on page* 84)

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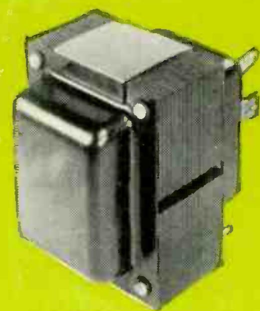
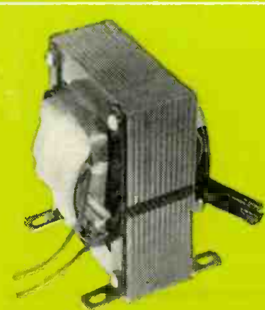


Power transformers

P-3059 *this and 57 others.*



Vertical output transformers

A-3035 *with 6 companion types*

Line voltage regulators

P-3138 *and* **P-3139**

MERIT

COIL AND TRANSFORMER CORPORATION

4427 N. Clark Street, Chicago, Ill.

Superior's new Model 670-A

SUPER METER

A COMBINATION VOLT-OHM MILLIAMMETER PLUS CAPACITY REACTANCE INDUCTANCE AND DECIBEL MEASUREMENTS

SPECIFICATIONS:

D.C. VOLTS: 0 to 7.5/15/75/150/750/1,500/7,500 Volts

A.C. VOLTS: 0 to 15/30/150/300/1,500/3,000 Volts

OUTPUT VOLTS: 0 to 15/30/150/300/1,500/3,000 Volts

D.C. CURRENT: 0 to 1.5/15/150 Ma. 0 to 1.5/15 Amperes

RESISTANCE: 0 to 1,000/100,000 Ohms 0 to 10 Megohms

CAPACITY: .001 to 1 Mfd. 1 to 50 Mfd. (Good-Bad scale for checking quality of electrolytic condensers)

REACTANCE: 50 to 2,500 Ohms, 2,500 Ohms to 2.5 Megohms

INDUCTANCE: .15 to 7 Henries 7 to 7,000 Henries

DECIBELS: —6 to +18, +14 to +38, +34 to +58

ADDED FEATURE:

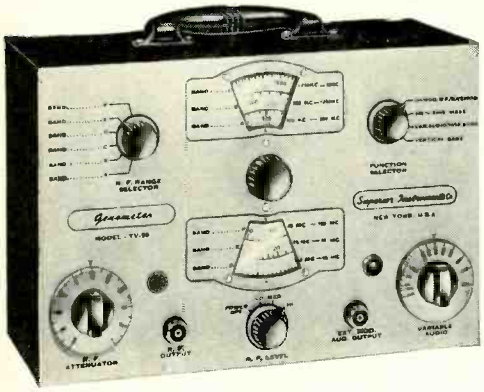
Built-in ISOLATION TRANSFORMER reduces possibility of burning out meter through misuse.

The Model 670-A comes housed in a rugged crackle-finished steel cabinet complete with test leads and operating instructions.

$28.40 NET

Superior's New Model TV-50

GENOMETER



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

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

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

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

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

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

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

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

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

$47.50 NET

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Try any of the above instruments for 10 days before you buy. If completely satisfied *then* send down payment and pay balance as indicated on coupon. **No Interest or Finance Charges Added!** If not completely satisfied return unit to us, no explanation necessary.

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☐ Model 670-A.................................Total Price $28.40
$7.40 within 10 days. Balance $3.50 monthly for 6 months.

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☐ Model TV-50.................................Total Price $47.50
$11.50 within 10 days. Balance $6.00 monthly for 6 months.

Superior's New Model TV-11

TUBE TESTER

SPECIFICATIONS

★ Tests all tubes, including 4, 5, 6, 7, Octal, Lockin, Peanut, Bantam, Hearing Aid, Thyratron Miniatures, Sub-miniatures, Novals, Sub-minars, Proximity fuse types, etc.

★ Uses the new self-cleaning Lever Action Switches for individual element testing. Because *all elements are numbered according to pin-number in the RMA base numbering system*, the user can instantly identify which element is under test. Tubes having tapped filaments and tubes with filaments terminating in more than one pin are truly tested with the Model TV-11 as any of the pins may be placed in the neutral position when necessary.

★ The Model TV-11 does not use any combination type sockets. Instead individual sockets are used for each type of tube. Thus *it is impossible to damage a tube by inserting it in the wrong socket.*

★ Free-moving built-in roll chart provides complete data for all tubes.

★ Newly designed Line Voltage Control compensates for variation of any Line Voltage between 105 Volts and 130 Volts.

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

The model TV-11 operates on 105-130 Volt 60 Cycles A.C. Comes housed in a beautiful handrubbed oak cabinet complete with portable cover

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EXTRA SERVICE—The Model TV-11 may be used as an extremely sensitive Condenser Leakage Checker. A relaxation type oscillator incorporated in this model will detect leakages even when the frequency is one per minute.

Superior's new Model TV-40

C. R. T. TUBE TESTER

★ **A complete picture tube tester for little more than the price of a "make-shift" adapter!!**

★ **Tests all magnetically deflected tubes . . . in the set . . . out of the set . . . in the carton!!**

The Model TV-40 is absolutely complete! Self-contained, including built-in power supply, it tests picture tubes in the only practical way to efficiently test such tubes; that is, by the use of a separate instrument which is designed exclusively to test the ever increasing number of picture tubes!

EASY TO USE:

Simply insert line cord into any 110 volt A.C. outlet, then attach tester socket to tube base (*ion trap need not be on tube*). Throw switch up for quality test . . . read direct on Good-Bad scale. Throw switch down for all leakage tests.

SPECIFICATIONS

- Tests *all* magnetically deflected picture tubes from 7 inch to 30 inch types.
- Tests for quality by the well established emission method. All readings on "Good-Bad" scale.
- Tests for inter-element shorts and leakages up to 5 megohms.
- Tests for open elements.

Model TV-40 C.R.T. Tube Tester comes absolutely complete—nothing else to buy. Housed in round cornered, molded bakelite case. Only........

$15.85 NET

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about as good as commercial organ recordings. In short, the frequency response seems to be as good as is really usable for any application short of master tapes for highest-fidelity recordings.

Especially notable was the improvement the mike gives to recordings made with inexpensive recorders. Tapes made with it on the Pentron at 7½ i.p.s.

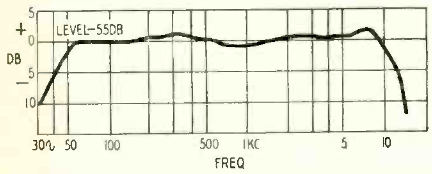


Fig. 6—E-V 636 microphone response.

were almost as good as those made on the Ampex. The differences were principally greater flutter and wow and an

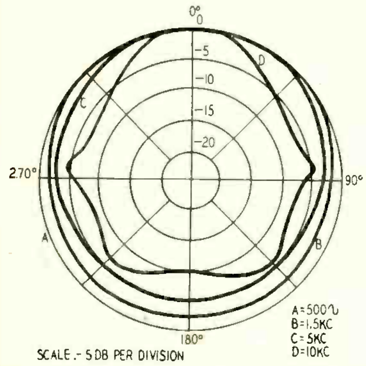
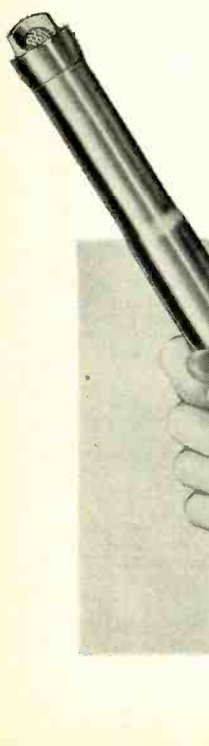


Fig. 7—Slimair pickup sensitivity.

inferior signal-to-noise ratio, all due to the recorder. I don't mean to say that this mike will make a Pentron 9T3M as good as an Ampex, but it does a lot to close the gap between them.

Directional characteristics and pickup sensitivity (Fig. 7) are well adapted to amateur and semipro use. When the mike is used vertically, the response is omnidirectional; used horizontally there is some control of directivity but it is never pronounced. This might result in feedback troubles when used in PA work, but for recording it produces a very realistic sound. This is because the directional sensitivity is about the same as that of human ears when the listener is facing the source of the sound, and one hears not only the direct component but also all the reflected components and surrounding noises, just as one's ears do. This effect is all the more spectacular because of the high pickup sensitivity.

As far as I can tell, the 636 will pick up, at just about the natural "ear level" and signal-to-noise ratio, any sound audible to a very acute ear in a given spot, no matter how far away.



The Electro-Voice Slimair microphone.

New records . . .

KAY - BALANCHINE: *Western Symphony*
THOMSON - CHRISTENSEN: *Filling Station*
Leon Barzin and New York City Ballet Orchestra
Vox PL-9050

The *Western Symphony* is a demonstration or showoff recording which not only has brilliant highs and lows, drums, bass horns, triangles, etc., but whose music is enjoyable to practically everyone. A ballet, rather than a symphony, it is based on such popular hillbilly tunes as *Red River Valley*, *Rye Whiskey*, *Them Golden Slippers* and many others. The tunes are not only recognizable, but are brilliantly arranged with a minimum of "modernizations." They are underlaid with a fine toe-tapping rhythm and played with enthusiasm. There are more awesome records but, given a good boost of bass, the sound should be spectacular enough to satisfy almost anyone. The cheerful frame of mind produced by the tuneful music should predispose all hearers in favor of the high-fidelity system on which it is played. From the top of top-drawer hi-fi records.

The reverse side, *Filling Station*, is equally good demonstration material but more conventionally "modern." The folk tunes are more modified and less recognizable, the music more sophisticated. It will be less appealing to the average man. But there is some lovely sound in it, big drums, a nice double bass and an amusing bass horn.

BIZET: *Carmen Suite*
GOUNOD: *Ballet Music from Faust*
Golschmann and St. Louis Orchestra
Capitol P-8288

Another showoff recording with plenty of brilliant highs, good drums, a good illusion of presence and music which is familiar and pleasing to most people. The recording is very well defined and those with enough musical sophistication and good enough ears can thoroughly enjoy the orchestration and tone coloration which in the Bizet suite is considered to be a model of opulently romantic classical sound. I just don't see how anybody could be displeased with this and the *Western Symphony* for showoff and demonstration purposes.

OFFENBACH: *Suites from Bluebeard and Helen of Troy*
Arrangement by Antal Dorati
Ballet Theatre Orchestra conducted by Joseph Levine
Capitol P-8277

These Capitol recordings of music for modern ballets are based on some more of Offenbach's *opera boufée* music. Though not overpowering, the characteristic Offenbach bass beat is there throughout this pleasant music, much of which will be novel even to experienced music-goers for these particular works are only about a dozen years old and the music, though much older, comes from seldom-played works of Offenbach. It is very easy to take, even by young 'uns. The drums are good, the triangles and other "tinkler's" nicely present. The story line of these two ballets is very amusing and easily followed in the music. All in all, I think this recording will be welcomed not only for the good quality of the sound but also for the music itself.

ANTHEIL: *Capital of the World*
BANFIELD: *The Combat*
Joseph Levine and Ballet Theatre Orchestra
Capitol P-8278

This is a month for ballet music and this particular record is an excellent demonstration piece. The Antheil ballet, based on Hemingway's well-known short story, was first presented on TV about two years ago. This is modern music but it is set in Spain and there is something about Spain which mellows the sharpness of even so modern a composer as Antheil. This music is easy to take even at first hearing and grows with rehearing. Though Capitol has not joined the competition for the most awesome basses, there is plenty of good bass here, as well as a plentitude of castanets, tambourines and other high-high shimmer. In addition, and this makes this recording especially valuable, it has a passage of flamenca dancing with all its hand clapping, heel clicking, finger snapping and thigh slapping. This is not recorded as sharply and cleanly as the Cook *Fiesta Flamenca* but provides an excellent measure of transient response and should impress the listener with its naturalness.

The reverse side, *The Combat*, as you might expect gives the brasses and drums a good workout in spots, but also has some very soft romantic music for contrast. All in all, a little of everything on the two sides, and it sounds good, too.

BACH: *Brandenburg Concertos* (complete) With ancient instruments.
Special ensemble conducted by Jascha Horenstein
Vox DL-122 (two 12-inch discs)

Bach is an acquired taste but, for those who have acquired it, he is untiring and always fascinating. The more homophonic music of Brahms and Beethoven will pall the palate when heard too much — and nowadays, unfortunately, it is heard too much—but the polyphony of Bach seems to reveal new facets every time it is heard. The Brandenburg Concertos are not only Bach at his best but would have to be included, I feel sure, in any list of musical masterpieces of all time. No music leads one to thank the powers that be more for the availability of high-fidelity playback systems; to hear all the marvelous detail of music and tone coloration, the always awe-inspiring virtuosity of Bach's invention, a system of the finest definition is needed. In fact, one doesn't hear Bach at all on the ordinary radio or cheap phonograph, merely a shallow reflection of him.

We have several good renditions of the *Concertos* but this new one by Vox is just about everything one could ask for. The instrumentation has been kept as close to the original as possible but with no sacrifice of musical value for quaintness of sound. I doubt that this music ever sounded this well in Bach's time, for the instruments are not only in the hands of very fine musicians but are played with modern techniques. The resulting sound does not differ tremendously from versions played with modern instruments. There is, however, a most fascinating difference in tone color which makes the music all the more enjoyable.

The presence of this recording is most noteworthy. Played with a fair volume the orchestra seems to enter the room. The definition is superb, the highs clean and sharp. END

Names and addresses of manufacturers of any items mentioned in this column may be obtained by writing Monitor, RADIO ELECTRONICS, 25 West Broadway, New York 7, N.Y.

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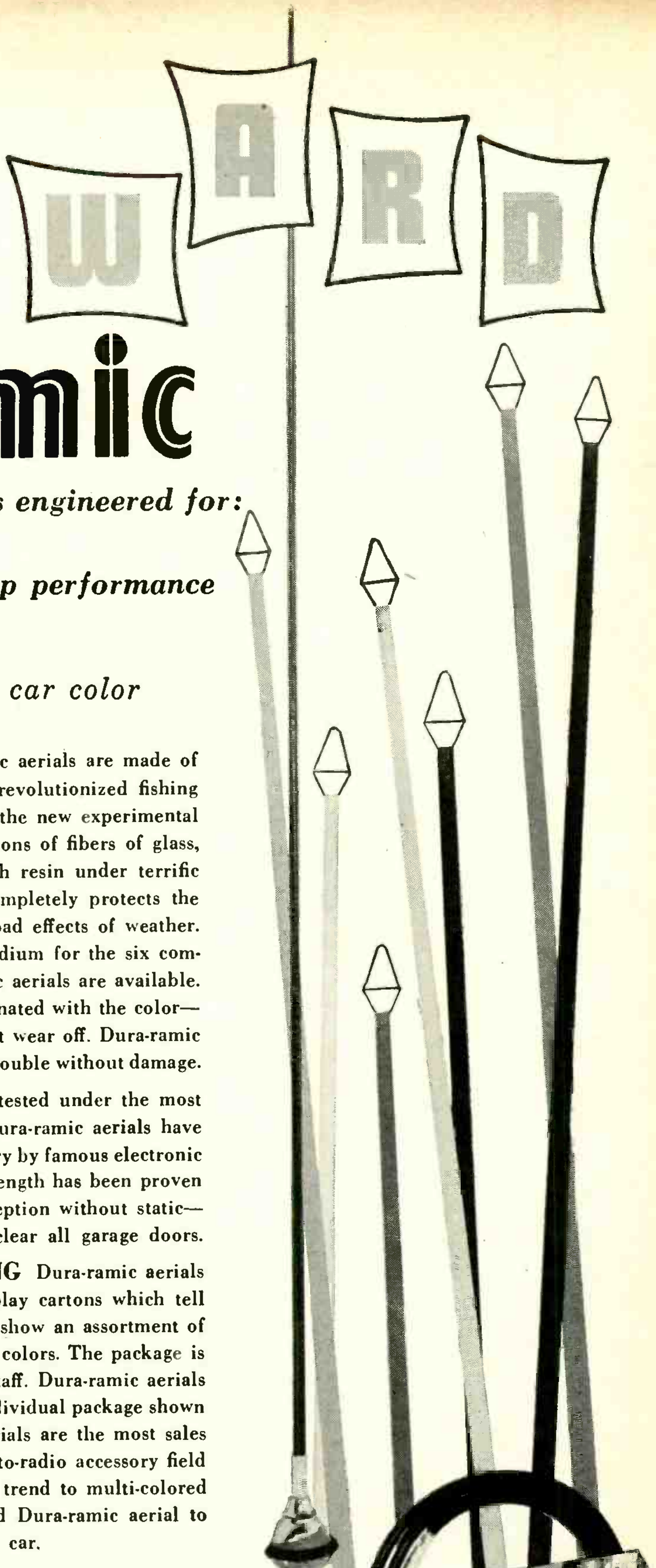

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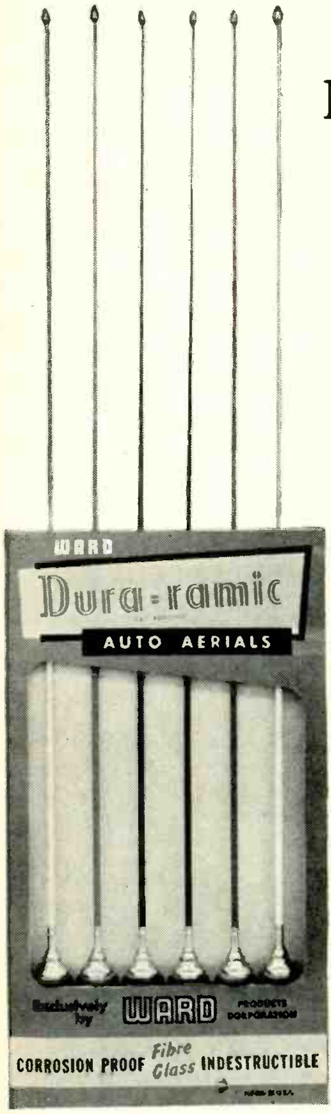

FIBERGLAS ® T.M. Reg. O-C F Corp. Ward Dura-ramic aerials are made of the same miracle material that has revolutionized fishing rods and is being widely used in the new experimental automobile bodies. Made from millions of fibers of glass, woven together and impregnated with resin under terrific pressures, the FIBERGLAS completely protects the imbedded electronic wires from all bad effects of weather. The FIBERGLAS is also the medium for the six complimentary colors in which Dura-ramic aerials are available. The FIBERGLAS is actually impregnated with the color—color cannot fade, cannot rust, cannot wear off. Dura-ramic FIBERGLAS aerials will bend almost double without damage.

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SELF SELLING PACKAGING Dura-ramic aerials are available in handsome display cartons which tell the whole Dura-ramic story and show an assortment of the six complimentary Dura-ramic colors. The package is a salesman you add to your staff. Dura-ramic aerials are also offered in the attractive individual package shown below. Ward Dura-ramic aerials are the most sales stimulating revolution in the auto-radio accessory field today. Cash in on the great trend to multi-colored autos. Sell the superior Ward Dura-ramic aerial to compliment any color car.

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WARD PRODUCTS CORPORATION Cleveland 15, Ohio

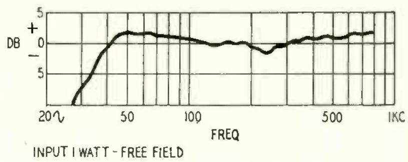
The VILLCHUR SPEAKER SYSTEM

By J. M. KRECH

"Infinite" baffle of small size provides extended low-frequency response

NO idea is more firmly entrenched in the high-fidelity field than that a speaker system of very large size is necessary to obtain adequate and clean bass reproduction to 30 cycles or lower. Typical is Edgar Villchur's comment in his *Handbook of Sound Reproduction:* "Unless the cubic capacity of the enclosure is great enough . . . the low-frequency rolloff point is raised and bass response suffers." One of the greatest shocks provided by the 1954 Audio Fair, therefore, was the speaker system of Acoustic Research, Inc., which, though only 25 inches long, 14 inches high and 11 inches deep in *outside* dimensions, reproduced the full range of bass, even the pedal tones of the organ, cleanly and spectacularly. On occasion, it even shook the concrete re-enforced floors of the Hotel New Yorker as thoroughly as systems 20 times as large. And equally surprising was the discovery that the system was the brain-child of the same Edgar Villchur previously quoted.

The curve (see diagram) is the open-field response of the bass end of the system. (Mid- and high frequencies are handled by a separate speaker and are disregarded for the moment.) The response was taken with the speaker flush with the ground (see photo). The notable features of this curve are the very unusual smoothness and flatness of the curve above 40 cycles and the fact that response is down only 6 db at 32 cycles. These are curves of which the largest and most elaborate systems could be proud.



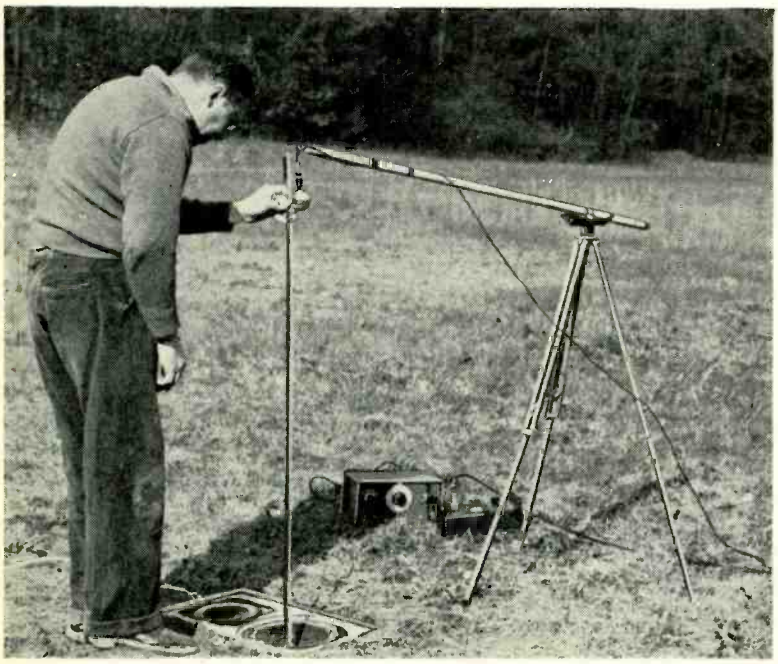
Open field response of the bass end.

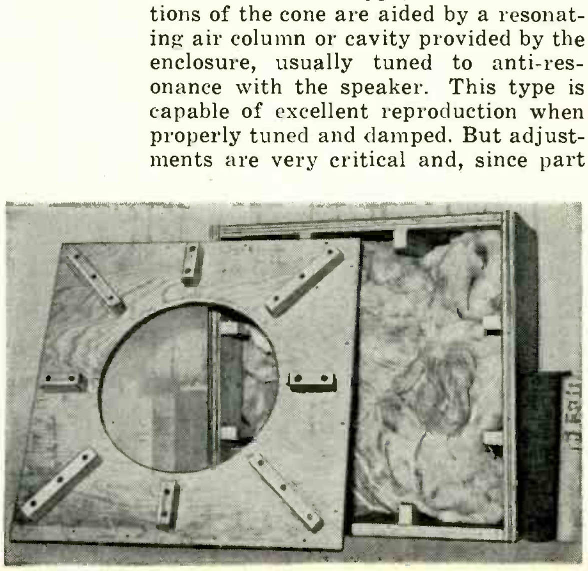
Although the performance can be called unprecedented, the design itself is revolutionary in only one respect. For the rest it involves merely a logical exploitation and synthesis of well known acoustic principles. There are two problems in obtaining an adequate bass response: producing it in the transducer; coupling the transducer to the air efficiently, particularly avoiding the loss produced by cancellation of out-of-phase front and rear waves.

Speaker systems can be divided broadly into three categories:

1. The horn type, in which the vibrations of the cone or diaphragm are coupled to the air through a tube of progressively increasing diameter. This greatly increases the effective radiating area, and efficiency at low frequencies soars. However, the rate of flare must be slow and the mouth area large, and this calls for a very large structure. When compromises are made, bass reproduction suffers in two ways: loss of extreme lows because a horn has a severe attenuation slope below cutoff, proportional to the rate of flare; boominess of the upper bass caused by reflections from the mouth when its diameter is not equal to at least one-third and preferably two-thirds of the wavelength.

2. The resonant type, in which vibrations of the cone are aided by a resonating air column or cavity provided by the enclosure, usually tuned to anti-resonance with the speaker. This type is capable of excellent reproduction when properly tuned and damped. But adjustments are very critical and, since part





Above, equipment setup for making response test. Right, experimental enclosure shows Fiberglas packing.

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7. Transformer winding resistances appear on the schematic.
8. Schematics are keyed to photos and parts lists.

FULL PHOTOGRAPHIC COVERAGE

9. Exclusive photo coverage of all chassis views is provided for each receiver.
10. All parts are numbered and keyed to the schematic and parts lists.
11. Photo coverage provides quicker parts identifications and location.

ALIGNMENT INSTRUCTIONS

12. Complete, detailed alignment data is standard and uniformly presented in all Folders.
13. Alignment frequencies are shown on radio photos adjacent to adjustment number—adjustments are keyed to schematic and photos.

TUBE PLACEMENT CHARTS

14. Top and bottom views are shown. Top view is positioned as chassis would be viewed from back of cabinet.
15. Blank pin or locating key on each tube is shown on placement chart.
16. Tube charts include fuse location for quick service reference.

TUBE FAILURE CHECK CHARTS

17. Shows common trouble symptoms and indicates tubes generally responsible for such troubles.
18. Series filament strings are schematically presented for quick reference.

COMPLETE PARTS LISTS

19. A complete and detailed parts list is given for each receiver.
20. Proper replacement parts are listed, together with installation notes where required.
21. All parts are keyed to the photos and schematics for quick reference.

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22. Each Folder includes time-saving tips for servicing in the customer's home.
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25. Includes advice for localizing commonly recurring troubles.
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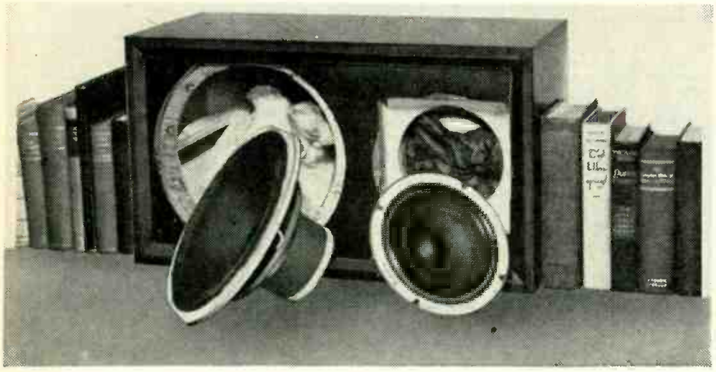
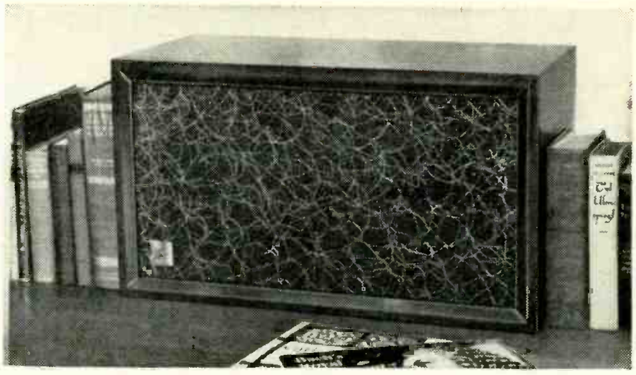




Above left, internal view of the AR-1, showing separate high-frequency enclosure. Right, external view of the AR-1.

of the range is based on acoustic resonance, the reproduction of certain instruments is likely to be unnatural if the resonance is not properly controlled.

3. The direct radiator type, where the speaker cone is unaided except by a baffle which separates front and back waves, minimizes or eliminates cancellation when out-of-phase front and back waves meet. Examples are the infinite-baffle wall or stairwell type and very large totally enclosed and unvented cabinets.

Because an ideal infinite baffle has no acoustic resonances it is capable, with suitable speakers, of producing extremely natural reproduction. But (aside from the necessity of separating front and back waves) an infinite baffle, as used hitherto, had to meet another condition: the volume of air into which the back of the cone works must be large enough to provide negligible stiffness to the back of the cone. This condition is easily met in wall, closet and stairwell type installations, but in a closed cabinet it calls for an enclosure of at least 10 cubic feet.

In his *Boffle*, H. A. Hartley solved very cleverly the problem of making the infinite baffle more finite without increasing the stiffness of the enclosed air. He achieved it first by closing off the rear of a small cabinet with several layers of loosely stretched burlap and felt. This is sufficiently flexible to absorb the compression of the air and thus relieve the speaker cone of the load the compression would provide if the cabinet were closed with a solid back. He then absorbed the rear wave with seven partitions of felt, forming a sort of acoustic filter network. In this way he produced a finite infinite baffle less than 5 cubic feet in overall volume, with performance which approached that of a real infinite baffle.

However, another problem arises with infinite baffles. Since there are no resonances to help the speakers or to extend speaker range, the speakers themselves must be capable of covering the desired range smoothly and with reasonable efficiency. In other words, in an infinite baffle the speaker must do all the work all by itself. It is no easy problem to design speakers capable of developing an adequate bass all by themselves, and Hartley's *Boffle* produces its excellent results largely because he has developed special loudspeakers, very flat in the low end and capable of producing a 30-cycle or lower bass without help from cabinet resonances.

Mr. Villchur takes a parallel road in providing an infinite baffle in a very finite enclosure. One step is to enclose the speaker in a small box chock-full of sound-absorbing material capable of absorbing all the high frequencies in the rear wave and of damping the standing waves. This is not as simple a solution as it sounds. Unfortunately it will not work with conventional speakers for a very simple reason: if we filled the box completely full of sound-absorbing material and eliminated the air completely, the solid sound-absorbing material would present an impossible load on the back of the cone. On the other hand, if we leave some air, that air will be compressed. And the less air we leave, the more impossible the stiffness presented to the cone. Here we have a paradox and a seemingly insoluble problem.

Speaker elasticity

It is here that Mr. Villchur comes up with a different approach which not only solves the paradox but also greatly simplifies the task of producing a good low-frequency speaker. One difficulty in designing an efficient low-frequency speaker is this: the speaker must have enough elastic stiffness to stay within control of the magnetic field which actuates it. When, for example, it is pushed out by the positive cycle of the signal, it must not be allowed to travel so far that it leaves the uniform portion of the magnetic field before it is pulled back by the negative cycle. If, for instance, the suspension of cone and voice coil had no resistance whatever, the cone could travel until—as it were —it reached the end of its rope when it would suddenly be snapped to a stop.

The speaker must possess enough elasticity to provide "restoring force." That is, it must have a built-in spring capable of returning the cone to the starting point or neutral position of its cycle. By analogy, it must to some degree be like a toy paddle with a rubber ball on a rubber band. When the ball is hit by the paddle, it moves out, but the elasticity of the rubber band returns the ball to the paddle for the next cycle.

Theoretically, a speaker with no elastic stiffness would be completely nonresonant and would conform in movement merely to the changes in the magnetic field produced by the signal. However, it would still have to have restoring force to center the cone, and this restoring force would have to be provided by some means other than the suspension of cone and voice coil. Hartley and others come close to doing this and produce speakers with very free cones, little elasticity in the suspension and highly unusual voice-coil and motor designs.

Since the difficulty of achieving restoring force without an elastic suspension is so great, most speakers are designed to provide restoring force in the suspension of cone and voice coil. The suspension acts as a spring against which the motor works. But there is a great disadvantage in using such a mechanical spring: it becomes nonlinear when stretched and the motion of the cone is not linearly proportional to the force which actuates it. The practical effect is that high excursions of the cone produce a disproportionally higher distortion.

The design of a good low-frequency speaker is therefore a very fine art, calling for suspensions with enough spring to provide restoring force, but for a spring whose nonlinearity over the required dynamic range is tolerable. This is an extremely difficult combination to achieve and the difficulty accounts for the very wide variety of designs to be found in fine wide-range speakers.

Villchur's speaker system exploits the faults of both the infinite baffle and the nonelastic speaker to produce a synthesis of considerable virtue and attainable with relatively simple means. We have seen that as we decrease the cubic volume of air in a box either by making the box small or by stuffing it with sound-absorbing material in an attempt to produce a finite infinite baffle, we increase the stiffness of the remaining air in the box. Why not then use this stiffness to provide the elasticity or restoring force for a speaker which itself has little or no restoring force? Why not proportion the volume of air in the enclosure so that the stiffness it provides is exactly what is needed to provide elasticity for the cone? *And that is* *precisely what Mr. Villchur does do.*

The Villchur speaker uses a suspension so loose that it is unusable in any conventional enclosure. The resonant point is below 15 cycles. However, in his enclosure, the stiffness of the air is carefully proportioned by the use of just the right volume to provide the restoring force or elasticity the speaker itself lacks.

Specifically, the speaker is designed to work best at a final resonance of about 43 or 45 cycles. The Fiberglas-filled baffle provides this resonance. At first one might think that the stiffness of the trapped air would work in only one direction. Actually, it works both ways for all springs work both ways. There is a great advantage in using this *acoustic* spring. The elastic properties of air are linear whereas the elasticity of a mechanical suspension is not. Therefore distortion is greatly reduced. Mr. Villchur says the reduction of distortion over an equivalent infinite baffle with a conventional speaker amounts to a factor of about four.

Furthermore, the restoring force of the acoustic spring is applied uniformly to the entire cone, instead of merely the edges. This improves the smoothness of the frequency response and minimizes cone breakup caused by the suspension. The system as a whole is resonant at about 44 cycles but the response continues to 30 cycles or lower.

The specific curve of the commercial model does not constitute the limit of performance for the system. The idea permits considerable leeway in establishing overall response. In this specific model the system was deliberately proportioned to deliver this performance which in Mr. Villchur's view more than adequately meets the needs of high fidelity today.

As in all things, there is a price to pay. In this case, it is lower efficiency. However, with the excellent amplifiers available today the increased power can be supplied easily. And a few additional watts of amplifier output will seem to many a good trade for excellent performance in a small package.

Some of the principles involved have been applied previously, though perhaps not with a full appreciation of what was being done. Thus in the Klipsch type horns in which the horn loads one side, the other side works into a stiff air load. Speakers for this usage have very soft, nonelastic suspensions and clearly obtain part of their restoring force from the stiffness of the trapped air, if Mr. Villchur is right. Several British workers beside Mr. Hartley have also explored similar paths though they have not produced a commercial end product. The Villchur speaker should be at least a signpost on the way to perfect sound from a small package. It is certainly a dramatic example of how the most entrenched preconceptions in the electronic and audio fields can be disposed of in one fell swoop, and how vices can be exploited into virtue. END

HIGH-FIDELITY DICTIONARY

(CONCLUSION)

VU

Abbreviation of volume unit.

Walls

The sides of the grooves in a disc recording.

Woofer

A loudspeaker designed for low frequencies and used in conjunction with one or more other speakers designed for other portions of the audio spectrum.

Wow

Cyclic variations of recorded or reproduced frequencies due to non-uniform motion of the turntable.

70-volt line

A line connected to the 70-volt tap on the output transformer of an amplifier. The position of this tap is such that it will provide 70 volts when the amplifier is delivering its rated power output. This system simplifies the mathematics of impedance matching since, with 70 volts taken as a standard, loudspeakers and matching transformers may be labeled in watts as well as ohms. Loudspeaker impedances are non-uniform; the lower wattage ones having highest impedance. With this constant-voltage system, impedance matching reduces to the rule: Connect any number of loudspeakers to the 70-volt line as long as their wattages add up to the rated power output of the amplifier.

TAPE-RECORDING GLOSSARY

The subject of tape recording has become very popular in recent years and, like high fidelity, it has produced a jargon all its own. Because of the somewhat parallel growth and relationship of hi - fi and tape recording, many technical terms are common to both. The following is a list of terms specifically associated with the field of tape recording, prepared by the Minnesota Mining and Manufacturing Co., makers of *Scotch* brand tape.

Acetate Film

The super-smooth, transparent plastic film which forms the tough backing for approximately 90% of magnetic recording tape made in the world today.

A wind (rhymes with kind)

Magnetic tape wound on the reel with the dull, oxide-coated side of the tape toward the inside. This wind is almost universally used today. Recorder design determines whether A or B wind tape is required.

B wind

Tape wound with oxide out. It is seldom used today. Wind can be changed from A to B by putting a half twist in the tape and rewinding on the recorder.

Bias

A high-frequency alternating current fed into the recording circuit to eliminate distortion.

Bulk eraser

A 117-volt a.c. device used to erase an entire reel of magnetic tape at once without running it through a recorder. A strong magnetic field neutralizes the magnetic patterns on the tape.

Capstan

The spindle or shaft — often the motor shaft itself — which rotates against the tape, pulling it along at a constant speed on recording and playback.

Dual-track recorder

Usually a tape recorder with a recording head that covers half of the tape width, making it possible to record one track on the tape, then turn the reels over and record a second track in the opposite direction. Sometimes called a *half-track recorder*.

Dupe

Sometimes called a *dub* or *dubbing*. A copy of a tape recording made by recording on one machine what another machine is playing. Tape recordings are easy to duplicate by re-recording and there is a minimum loss in quality from the original to the copy.

Dynamic range

The ratio between the softest and loudest sounds a tape recorder or other device can reproduce without undesirable distortion. Usually measured in db.

Editing

Selecting certain sections of a tape recording or of a number of different tape recordings, then splicing them together in the desired sequence. Magnetic tape is unsurpassed for editing purposes since it can be easily cut and spliced.

Gap

The tiny distance between the poles of the recording head, measured in mils. The head gap of home recorders may range from 1 mil (.001 inch) down to ¼ mil. The smaller the gap, the higher the frequency range of the tape recorder can be.

Head

The ring-shaped electromagnet across which the tape is drawn and which magnetizes the iron-oxide-coated tape in a series of patterns. Most tape recorders use a combination record-playback head and also an erase head. Some professional machines also have a monitor head for listening to the recorded sound a split second after it has been put on the tape.

Index counter

An odometer type counter which makes it possible to note the location of any particular selection of a tape, thereby making it easier to find. Many late model tape recorders feature built-in index counters.

AUDIO—HIGH FIDELITY

Leader and timing tape

Special, tough, nonmagnetic tape which can be spliced to either end of a tape to prevent damage or breaking off of the magnetic tape ends and possible loss of part of the recorded material. White in color, it features a 1-inch plaid marker every 15 inches. Used as a timing tape, therefore, it can be spliced between musical selections on a tape, providing a pause of a given number of seconds, depending on the tape speed.

Level indicator

A device on the tape recorder to indicate the level at which the recording is being made, and which serves as a warning against underrecording or overrecording. It may be a neon bulb, a "magic eye" or a VU meter.

Magnetic tape

A high-quality plastic or paper tape which has been precision-coated by the manufacturer with a layer of magnetizable, iron-oxide particles. The result is a recording media that is subject to virtually no wear, can be erased and reused and offers the highest fidelity of reproduction possible today.

Motor board

Also called *tape transport mechanism*. The platform or assembly of a tape recorder on which the motor (or motors), the reels, the heads and the controls are mounted. It includes those parts of the recorder other than the amplifier, preamplifier, loudspeaker and case.

Oxide

Microscopically small particles of ferric oxide dispersed in a liquid binder and coated on a tape backing. Red oxide is most common; some magnetic tapes use a dark green oxide. These oxides are magnetically "hard" — that is, once magnetized, they remain magnetized permanently, unless they are demagnetized by exposure to a strong magnetic field.

Polyester film

Plastic film backing for magnetic tape used for special purposes where strength and resistance to humidity change are important.

Pressure pads

Felt pads mounted on spring-brass arms which hold the magnetic tape in close contact with the heads on some machines.

Pressure roller

Also called *capstan idler* or *puck*. A rubber-tired roller which holds the magnetic tape tight against the capstan by spring pressure to insure constant tape speed and prevent slippage.

Raw tape

A term sometimes used to describe tape that has not been recorded. Also called *virgin* tape.

Self-powered recorder

Tape recorder containing its own power supply, either a combination of wet and dry cells to power the unit or dry cells in conjunction with a spring-driven motor.

Single-track recorder

A tape recorder which records only one track on the tape. Usually a full-track recording head is used which covers the full width of the ¼-inch tape although some machines use a narrower, half-track recording head which records a single track down the middle of the tape. Output of a full-track recording is theoretically double that of a half-track recording, although actually it is only slightly greater because of improved half-track head design.

Splicing tape

A special, pressure-sensitive, nonmagnetic tape used for splicing magnetic tape. Its "hard" adhesive will not ooze and consequently will not gum up the recording head or cause adjacent layers of tape on the reel to stick together. *Cellophane* tape should never be used.

Tape guides

Grooved pins of nonmagnetic material mounted at either side of the recording head assembly to position the magnetic tape on the head as it is being recorded or played.

Tape loop

A length of magnetic tape with the ends joined together to form an endless loop. Used either on a standard recorder, special "message-repeater" type units or in conjunction with a cartridge device, it makes it possible to play back a recorded message repetitively without rewinding the tape.

Tape speed

Speed at which tape moves past the recording head. Standard tape speeds for home use are 3¾ and 7½ inches per second (i.p.s.). Faster speeds are 15 and 30 i.p.s. Slower speeds sometimes used are 1⅞ and 15/16 i.p.s. Faster speed makes possible improved high-frequency response, while slower speed means greater tape economy. If a tape is recorded at 3¾ i.p.s., then played back at 7½ i.p.s., all sounds will be raised 1 octave in pitch. Cutting the speed in half lowers a tone 1 octave.

Threading slot

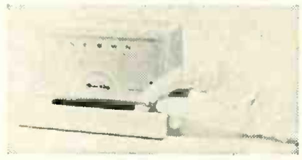
Slot in recording head assembly cover plate into which tape is slipped in threading up the reels for use of the recorder.

VTR

Video tape recording. Recording and reproducing television picture-tube signals on standard — but highest quality — magnetic tape. It is extremely difficult to design a tape recorder capable of handling a wide frequency range up to 4 mc. Usually several magnetic tracks are recorded side by side on a ½-inch tape at a considerably higher speed than used in home recording, each track recording a certain range of frequencies. Improved quality and lower operating cost are expected to enable it to replace movie film for TV use. END

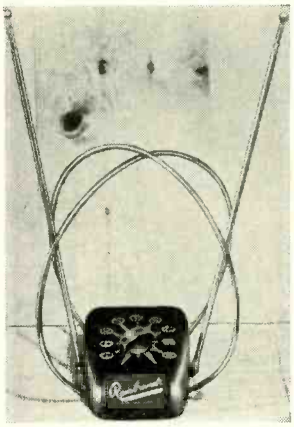
new Devices

NEW ROTATOR, *JFD Roto-King RT400,* differs from original model only in control box. Pushbutton and panel-light in-



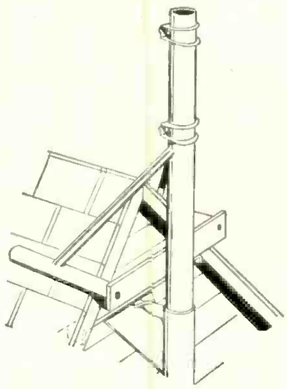
dication added to right of control bar.—**JFD Manufacturing Co., Inc.,** 6101 16th Ave., Brooklyn 4, N. Y.

INDOOR TV ANTENNA, *All Channel Rembrandt,* has 9-position low-loss electronic ori-



entation switch. Available in 3 finishes.—**All Channel Antenna Corp.,** 47-39 49th St., Woodside 77, N. Y.

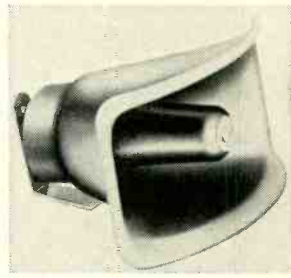
GABLE ROOF MOUNT, *Rohn,* for secure durable antenna mounting. Can be mounted by loosening one bolt. Accommodates tubing to 1½-inch diameter.—**Rohn Manufacturing Co.,** 116 Limestone, Bellevue, Peoria, Ill.



AUTO ANTENNA, *Tenna Nautilus,* mounts either at front or rear of car. Adjustable 0–25° to match different mounting locations. *Model NT-3,* for front installation, equipped with 4-foot cable. *Model NT3-15,* for rear mounting, equipped with

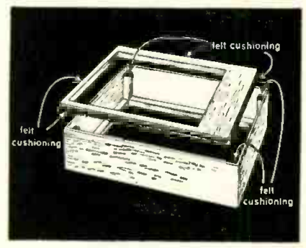
15-foot cable.—**Tenna Manufacturing Co.,** 7580 Garfield Blvd., Cleveland 25, Ohio.

LOUDSPEAKER, *Atlas Cobra-Jector,* for paging, talk-back, intercom, industrial, marine and mobile applications. Wide-angle dispersion for crisp, sharp, penetrating articulation. Fiberglas construction of the main flare. Input power, 5 watts; input impedance, 8 ohms (45-ohm impedance in



model CJ14/45); response, 400–9,000 cycles; dispersion, 120–60°.—**Atlas Sound Corp.,** 1451 39th St., Brooklyn 18, N. Y.

NEW BASE, *JKM,* for mounting Rek-O-Kut Rondine *models B-12H* and *B-12* 3-speed turntables. Felt cushioning at mounting-board contact points provides effective isolation. Takes any transcription arm to 16 inches. Installation of turntable and arm is easy as mounting board lifts out from base. 17 x 6½ x 21 inches.



Available in mahogany *(model 12M)*, blonde *(model 12B)*.—**JKM, Inc.**, 13 W. Hubbard St., Chicago 10, Ill.

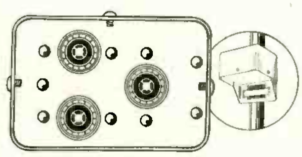
LOUDSPEAKERS, *University models CIB* and *CMIL*. Reflexed cobra air column for wide-angle horizontal sound dispersion. Efficient pickup and delivery for paging and talk-back.

Model CIB: built-in hermetically sealed driver unit assembled to reflex air column ter-

minating in cobra-shaped wide-angle bell. Rated 12 watts continuous duty with response of 300–13,000 cycles. Horizontal dispersion of sound, 120°; vertical dispersion, 60°. 7⅜ x 14 x 12 inches.

Model CMIL: similar to *CIB*, except screw-in driver unit with ⅞–18 screw thread is used. Rated 3 watts continuous duty with response of 400–13,000 cycles. 6-7/32 x 9½ x 8-7/16 inches.—**University Loudspeakers, Inc.**, 80 S. Kensico Ave., White Plains, N. Y.

DIRECTIONAL COUPLERS, *Blonder-Tongue*, for master TV lines and outlets. *Models MDC-2* (illustrated) for 2 outlets and *MDC-4* for 4, supply effective reverse isolation from 14 to 30 db over entire v.h.f. band. Permit direct TV outlets and branch cables from



MODEL MDC-2

which tapoffs may be made. Splitting loss only 3 db for *MDC-2*, 6 db for *MDC-4*. Require no power. May be mast- or pole-mounted with bracket and strap. Weather shield protects cable connections. Impedance-matched coax receptacles handle either RG-11/U or RG-59/U coax lines. — **Blonder-Tongue Labs., Inc.**, 526-536 North Ave., Westfield, N. J.

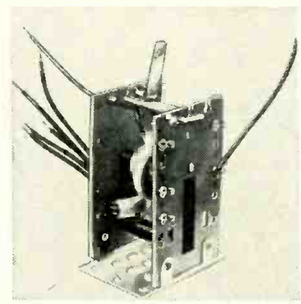
MICA CAPACITORS, *Cornell-Dubilier Super Micadon*, provide 5 to 6 times capacitance, 10 to 34 times higher insulation resistance, nearly 20 times the moisture resistance, and up to

19 times the life expectancy possible in conventional units of same size.—**Cornell-Dubilier Electric Corp.**, South Plainfield, N. J.

CERAMIC CARTRIDGE, *Shure Music Lover*, (furnished with magnetic input adapter) eliminates induced hum, cartridge drag caused by magnetic attraction to steel turntables;

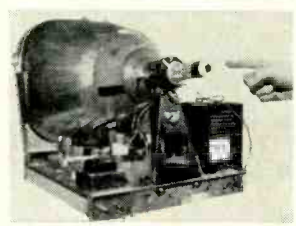
improves tone quality; increases record and needle life; has higher output. Relative response not affected by load resistance. Twin-lever needle shift transport — no cumbersome turnover mechanisms.—**Shure Brothers**, 225 W. Huron St., Chicago 10, Ill.

REPLACEMENT FLYBACKS, *Stancor A-8138* and *A-8261*. *A-8138* replaces Emerson 738-079 and 738084 in 60 models and chassis. *A-8261* exact replacement for Majestic and



Muntz part numbers C9.253-1, -2, -E and C9.259. Used in over 48 models and chassis.—**Chicago Standard Transformer Corp.**, Addison and Elston, Chicago 18, Ill.

PROTECTIVE CAP, *Sylvania Pin Cushion*, fits snugly over base pins of TV picture tube, reducing accidental damage to them. Prevents bent or broken pins, especially in shipping or

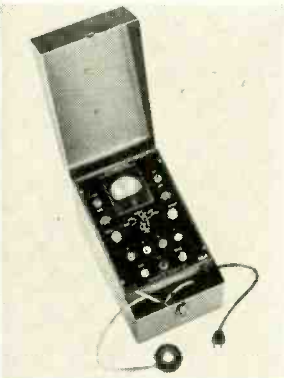


when socket is removed during servicing; keeps pins clean and makes it easier to slide ion-trap magnet over tube base. Plastic, lightweight, durable, easy to handle.—**Sylvania Electric Products Inc.**, Seneca Falls, N. Y.

CAPACITY METER, *Heath CM-1*, stresses speed and convenience, as in quality control

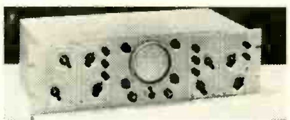
work or production-line testing, service shop or laboratory. Measures capacitance directly, without calculation, from 100 $\mu\mu$f to 0.1 μf. Capacitor is connected to binding posts, correct range selected and capacitance value read directly on 4½-inch meter. Residual capacitance less than 1 $\mu\mu$f. Not subject to hand-capacitance effects. Lowest range indicates capacitance of tuning capacitor as it is rotated.—**Heath Co.**, Benton Harbor, Mich.

REACTIVATOR, *Electronic Test Instrument Vitameter*, maintains and improves C-R tube. Facilities to analyze performance characteristics, locate and remove interelement shorts, repair open elements, weld open filament circuits, restore emission. Reactivation of pic-



ture-tube cathode accomplished by dynamic sweep between cathode and grid, removing gas ions and stale emitting material from cathode surface. Provides information as to tube's approximate life expectancy.—**Electronic Test Instrument Corp.**, 13224 Livernois Ave., Detroit 38, Mich.

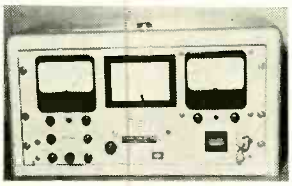
THREE-INCH OSCILLOSCOPE, *Hickok model 385R*, available in rack mount. Has 6-section unitized circuit construction similar to Armed Forces equipment. Sections available as individual replacement units. Provision for Z-axis modulation. D.c. vertical and horizontal amplifiers, fully



compensated horizontal and vertical attenuators, C-R tube inclined at 20° with retractable light shield. Frequency range: vertical amplifier, d.c. to 4 mc, 3 db down; horizontal amplifier, d.c. to 500 kc, 3 db down; sweep circuit oscillator, 3 cycles to 50 kc. Input impedance: vertical amplifier, 2.2 megohms, 25 $\mu\mu$f; horizontal amplifier, 2.2 megohms, 25 $\mu\mu$f.—**Hickok Electrical Instrument Co.**, 10531 Dupont Ave., Cleveland 8, Ohio.

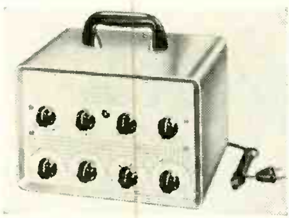
TRANSISTOR NOISE METER, *Radio Receptor*, furnishes information on noise figure of transistor in single reading by inserting transistor into socket. Noise meter contains novel, rapid-insertion transistor socket so that it may be used in conjunction with other transistor test equipment with single insertion of a transistor.

Useful for large-scale users—manufacturers of radio receivers, hearing aids. 10⅞ x 21½ x



16¼ inches.—**Radio Receptor Co., Inc.**, 240 Wythe Ave., Brooklyn, N. Y.

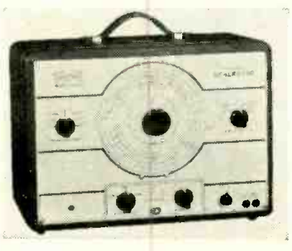
TEST EQUIPMENT, *Simpson Varidot* white dot generator, *model 434* has 300-ohm r.f. output, adjustable vertical synchronization, adjustable dot size which provides receiver transient-response check, positive or negative video output. Checks hum in color and black-



and-white receivers. Line quality tester, *model 397*, indicates adequacy of existing power line to furnish current value from

13 to 50 amp.—**Simpson Electric Co.**, 5200 W. Kinzie St., Chicago 44, Ill.

SIGNAL GENERATOR, *Triplett 3432-A*, covers 160 kc to 110 mc with no frequency skips, for AM-FM radio, monochrome or color TV servicing. R.f. circuits double shielded with copper steel. Cathode-follower output provides stability by acting as buffer to oscillator.



Jacks, for internal modulation or audio output, both controlled by audio control for variable modulation or a.f. output. Large etched aluminum dial, step type 3-position attenuator, and planetary drive action.—**Triplett Electrical Instrument Co.**, Bluffton, Ohio. END

All specifications given on these pages are from manufacturers' data.

new Tubes & Transistors

6DE6

A sharp-cutoff pentode of the seven-pin miniature type, the 6DE6, has been announced by RCA. Designed especially for use in the gain-controlled video i.f. stages of television receivers using a 40-mc i.f., it is also well suited for use as an r.f. amplifier in v.h.f. TV tuners.

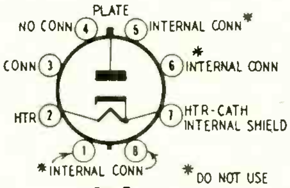
The 6DE6 features a controlled grid-1 voltage of −5.5 for a transconductance of 600 micromhos minimum. This cutoff characteristic makes an a.g.c. amplifier unnecessary in certain TV receiver designs and minimizes overload distortion and cross-modulation effects in i.f. stages. In addition, this tube has high transconductance combined with low capacitance values which contribute to high gain per stage.

The 6DE6 has separate base pins for grid 3 and cathode. This arrangement facilitates the use of an unbypassed cathode resistor to minimize changes in input loading and input capacitances with change in bias without causing oscillation which might otherwise result if grid 3 were internally connected to the cathode.

3B2

The 3B2, a glass-octal type of half-wave vacuum rectifier using an indirectly heated cathode, has been announced by RCA. The double-ended tube is designed for use as a rectifier of high-voltage pulses produced in the scanning systems of black-and-white and color television receivers.

Rated to withstand a maximum peak inverse plate voltage of 35,000, the 3B2 can supply a maximum peak plate current of 80 ma and a maximum average plate current of 1.1 ma. Socket connections are shown in the diagram.



3B2

To aid in corona reduction, any or all of the following socket terminal connections are permissible: pins 1, 3, 5 and 7 may be connected together; pins 2, 6, and 8 may be connected together; pin 4 may be connected to either pin 2 or 7 or may be used as a tie point for a heater dropping resistor. The heater of the 3B2 is designed for operation at 3.15 volts which may be obtained from the high-voltage pulse transformer.

NEW TUBES AND TRANSISTORS *(Continued)*

6CN7, 6BH8

Two new tubes designed for 600-ma series-string operation have been announced by G-E.

The 6CN7 is a combination duplex-diode and high-mu triode which features a center-tapped heater that can be used either in series-string or parallel-heater circuits. The triode section is electrically identical to the triode of a 6T8, and the tube is designed for service as a combined horizontal phase detector and reactance tube. The triode section may also be used in sync separator, sync amplifier and audio amplifier circuits.

Maximum triode plate voltage is 300; plate dissipation is 1 watt. In typical class-A amplifier service the amplification factor is 70. The maximum continuous current rating of each high-perveance diode is 5 ma.

The 6BH8 is a general-purpose sharp-cutoff pentode and medium-mu triode, similar to the 6AU8 but usable where lower triode amplification is desired. The triode section, designed for use as a phase detector or vertical oscillator, may also be connected as a diode for video detector service. The high figure of merit of the pentode section makes it particularly suitable as an i.f. or video amplifier.

Maximum pentode plate voltage rating is 300; plate dissipation 3 watts. In typical class-A service its transconductance is 7,000 micromhos. The triode plate is also rated at 300 volts, the plate dissipation is 2.5 watts and the amplification factor is 17 in class-A service.

G-E service-designed tubes

Six new tubes, especially developed for replacement in TV receivers, have been announced by G-E. They feature sturdier construction and in some cases the envelope size has been changed either to save space or increase heat dissipation.

The 6BG6-GA features a new beam shield that masks stray electron bombardment from the micas and bulb. The new bulb is straight-sided, narrower and shorter than its prototype. The tube is highly shock-resistant, with the bottom mica now braced against the glass.

The 6CD6-GA and 25CD6-GA have a new mica design that prevents arc-over which causes horizontal picture streaking. Plate areas have been increased to provide for 7,000-volt positive-pulse peaks and 20-watt plate dissipation (as compared with 6,600-volt and 15-watt ratings of prototypes). The tubes are smaller in size and sturdier in construction.

The 6SN7-GTB features 10.5-second heater warmup to match other heaters in series-string circuits. The new tube has all the features of the 6SN7-GTA with which it is interchangeable.

The 6J6 elements and structure have been redesigned to reduce microphonics greatly.

The 6AV5-GA features a larger bulb and larger plate, permitting greater heat radiation and cooler operation. This tube also contains a beam shield to mask stray electron bombardment from the micas and bulb, stabilizing tube performance. The redesigned micas reduce high-voltage arcing.

2N38A

A p-n-p junction transistor designed for hearing-aid applications, the 2N38A has been announced by CBS-Hytron. This new transistor is especially designed for low-noise operation. Its peak maximum noise rating is 27 db per microvolt at a frequency of 1 kc, with a load resistance of 20,000 ohms and an input resistance of 1,000 ohms.

This germanium transistor is directly interchangeable with the 2N38, differing only in the special low-noise characteristic. Its nickel silver can, 0.330 inch long by 0.225 inch in diameter, is hermetically sealed. Its maximum ratings are: d.c. collector voltage, −20; d.c. collector current, 8 ma; collector dissipation at 25° C, 50 mw.

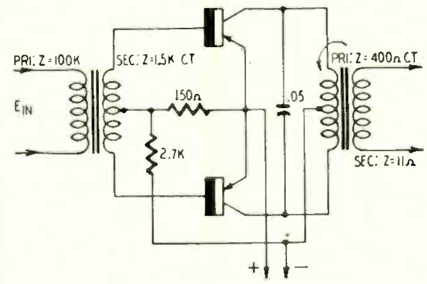
2N108

Another CBS-Hytron transistor development is type 2N108, a matched pair of transistors now being used in the class-B audio output stage of portable radios. The high efficiency of these transistors combines with that of their class-B circuit to give nearly doubled battery life.

The 2N108 pair is capable of at least 35 mw of power output with a total harmonic distortion not exceeding 10% at 400 cycles and with an efficiency of over 50% from a 3.5-volt battery.

Construction of the 2N108 pair features heremetic sealing. Their dimensions are the same as those of the 2N38A.

When used in a typical push-pull

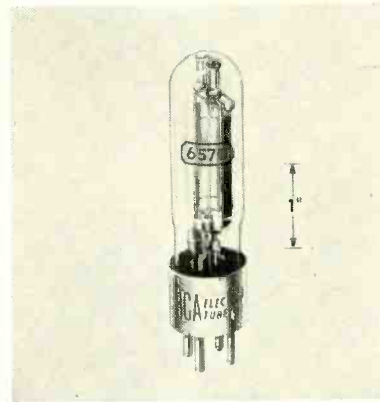


class-B circuit (see diagram), typical operating conditions are: collector voltage, −3.5; effective load resistance (collector to collector), 400 ohms; input signal (for power output given), 3.5 volts; base bias, −0.125 volt; collector current (zero signal), 6 ma; collector current (for 35-mw power output), 21 ma; power output, 35 mw; distortion, 10%.

6570

A new vacuum type phototube with operating characteristics that make it suitable for industrial applications such as electronic beverage- and ampule-inspection equipment has been announced by RCA.

The tube, the 6570 (see photo), is designed for use where a low order of microphonics and high sensitivity in the red and near-infra-red region of the spectrum are required. Because of this response the tube may be used with an incandescent light source.



The nonhygroscopic base of the 6570 increases the resistance between anode and cathode pins about 10 times higher than conventional bases and makes possible a greater output for a given light input under conditions of high humidity.

The 6570 has a maximum anode-supply voltage rating of 55, a maximum average cathode current rating of 5 μamp, and an average luminous sensitivity of 30 μamp per lumen.

4W300B

This radial-beam tetrode has been announced by Eitel-McCullough. The tube is rated at 300 watts plate dissipation and delivers 140 watts useful power at 500 mc in coaxial-cavity amplifier circuit. END

Radio Thirty-Five Years Ago

In Gernsback Publications

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Founder

Modern Electrics	1908
Wireless Association of America	1908
Electrical Experimenter	1913
Radio News	1919
Science & Invention	1920
Television	1927
Radio-Craft	1929
Short-Wave Craft	1930
Television News	1931

Some of the larger libraries still have copies of ELECTRICAL EXPERIMENTER on file for interested readers.

In July, 1921, *Science and Invention (formerly Electrical Experimenter)*

Chicago Police Use Radiophone
Radio Lullaby
Working Two Radio Watches Simultaneously, by Arthur H. Lynch

CORRECTION

In Fig. 3 of the article "TV Signal Circuit Feedback" in the June issue, the scope is shown connected across the peaking coil. It should be connected across the detector load resistor connected between the coil and ground.

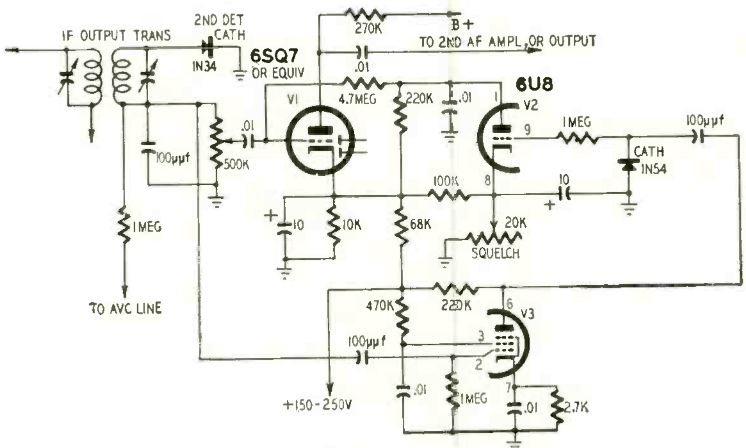
Our thanks to the author, Robert G. Middleton, for spotting and reporting this error.

radio-electronic Circuits

NOVEL SQUELCH

Most squelch circuits depend on the amplitude rather than the readability of the incoming signal. They cannot distinguish between noise and signal. The a.v.c. voltage controls the squelch, so annoying noise bursts appear in the output.

The squelch circuit shown in the diagram is independent of signal strength. It works on the basis of signal-to-noise ratio and will open on any readable signal—even in the presence of the rapidly varying noise common to mobile operation. The circuit is controlled by the voltage fed to the grid of the receiver's first audio amplifier, thus no elaborate circuit modifications are needed. I have installed this squelch on AM, FM, v.h.f., and low-frequency receivers with equally good results. It uses only one tube and a few small components.



In any high-gain receiver there is considerable quieting (reduction in background noise) when a signal is received. This is most apparent in the high-frequency noise and hiss components above 5,000 cycles.

In this circuit the pentode section of the 6U8 is used as a bandpass amplifier for frequencies above about 5,000 cycles. In communications circuits of the type where squelch circuits are normally required, little or no audio signal will be fed to the bandpass amplifier. In the absence of a signal, background noise in the receiver is high. Frequencies above 5 kc are passed by V3 and are rectified by the 1N54 diode to produce a positive voltage on the grid of the d.c. amplifier (V2). This tube controls the bias on the grid of V1, the set's first a.f. amplifier. When no signal is being received, the grid of V2 is several volts positive, causing it to conduct heavily and drive V1 to cutoff.

An incoming signal high enough above the noise to be readable reduces the receiver noise so the bias on V1 drops and allows it to conduct normally. A burst of atmospheric static closes the squelch if it is open but will not open it if it is closed. In the presence of heavy atmospheric static the receiver silences itself at each crash—a very desirable feature for anyone who has to monitor a low-frequency circuit for hours during a heavy thunderstorm.

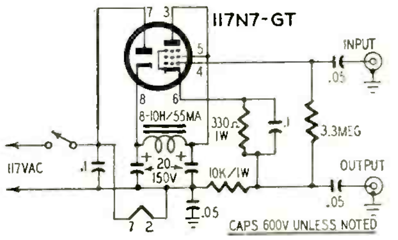
Parts values are not critical except for the cathode resistor of V1. About 10,000 ohms is optimum for a 6SQ7 with a 180-volt B supply. Its value varies with the type of audio tube. Try a variable resistor and set it at a point that gives sharp, definite opening and closing of the squelch.

A few words of caution when using this circuit: The receiver must have relatively high gain and must not have regeneration in its r.f. or i.f. circuit. Poor operation of this circuit can occur if the receiver's noise actually increases when receiving a weak signal. This is a common fault of surplus v.h.f. receivers.

The squelch will not open on a weak signal that is beating with another to produce an audio note above about 4 kc. Don't use it if you expect heterodyne interference. *John S. Hill*

CATHODE FOLLOWER

The information on cathode followers in the June, 1954, installment of "High-Quality Audio" was a great help in solving a problem that troubled me for a long time. There was a considerable amount of hum pickup on the audio line between my record player and the console radio used as an amplifier. After reading the article, I decided to try a cathode follower and built the unit shown with a 117N7-GT and other parts salvaged from the junkbox.



I don't have equipment for measuring distortion but the unit sounds good and eliminates the hum so I'm well satisfied. I now use 20 feet of lamp cord between the player and radio without any increase in hum level. This circuit will probably not find much use among owners of expensive high-fidelity equipment, but it is certainly a solution to the problem for those of us who cannot afford expensive equipment and must separate the record player and amplifier.—*Robert B. Boyd*

TRANSISTOR CIRCUITS

Amateurs and experimenters interested in subminiature shortwave transmitters have asked for circuits using transistors. Some laboratory technicians and experienced experimenters have constructed transistorized oscillators operating above the 2-meter band but the beginner will find it much better to start with circuits operating in the lower-frequency amateur bands. British and New Zealand amateurs have been active in developing transistorized transmitters for 160 meters. Experimental transmitter circuits described in G and ZL amateur magazines are shown here.

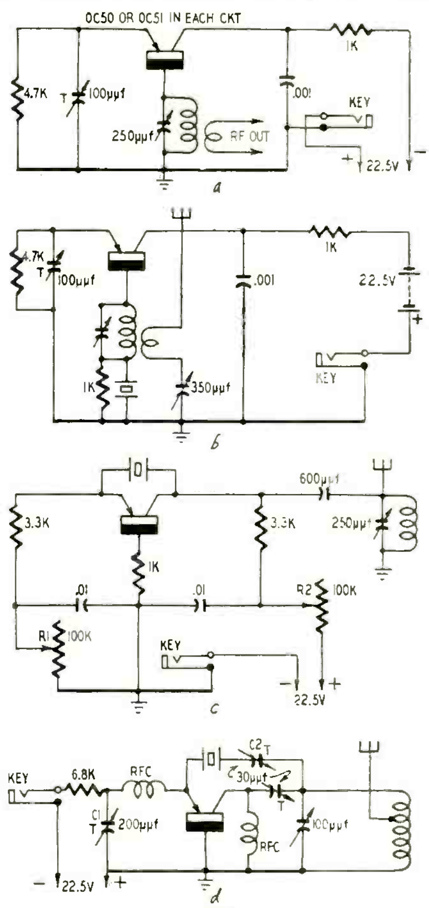


Fig. 1

Most of the experimenters are using homemade point-contact transistors or 0C50 and 0C51 types made by Philips and Amperex. Junction transistors will not usually oscillate above the broadcast band. The circuits in Fig. 1 appeared in *Break-In*, a New Zealand publication. ZL4GP used the circuit at *a* for a 200-mile CW contact on 1890 kc. Power input was 125 mw. The oscillator is tuned by the L-C network between

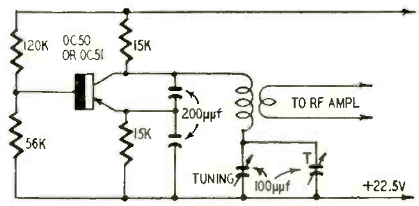


Fig. 2

the base and ground. The coil is wound to cover 160 and 80 meters with a 250-μμf capacitor. It may be necessary to reduce the value of the .001-μf capacitor to obtain oscillation. If the circuit still does not oscillate, try connecting a resistor of up to 500 ohms between the tuned circuit and ground. Antenna coupling should be as tight as possible.

Experimental crystal-controlled circuits are shown at *b*, *c* and *d*. Circuit constants may have to be varied slightly to obtain oscillation. In the circuit at *c* set the collector voltage to the desired value (about 10) with R2 and then adjust R1 for oscillation. In circuit *d* C1 and C2 must be set for good clean keying.

Fig. 2 shows G3CCA's transistorized v.f.o. as described in *The Short Wave Magazine*. Running 50-mw input on 1.8 mc, CW transmissions were received 170 miles away and phone signals were heard at 100 miles.

The oscillator is a Clapp type in a grounded-base circuit. Emitter bias is developed across the 56,000-ohm resistor. A .02-μf bypass capacitor (accidentally omitted from the diagram) grounds the base at radio frequencies. Output is taken from the collector and appears across the coil and the two series-connected 200-μμf capacitors. The voltage across the lower capacitor is fed to the emitter to sustain oscillation. The tuning control is shunted with a 100-μμf negative temperature coefficient trimmer for bandsetting and to compensate for drift.

The tuned coil was wound on a British commercial form of unknown dimensions. A Millen 74001 form with 80–100 closewound turns of No. 32 wire should be about right. A grid-dip meter will simplify pruning the coil for the desired range. Output is taken from a three-turn link around the center of the tuned coil. END

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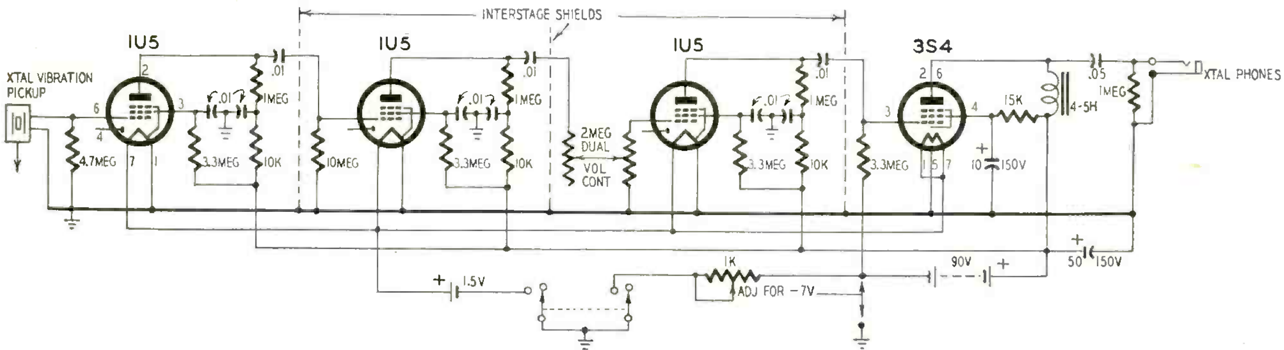
Question Box

LEAK DETECTOR

I want to build an electronic device that will enable me to locate leaks in water and gasoline pipelines buried 2 to 3 feet underground. The equipment must be compact and lightweight for portability.—G. L., Tulsa, Okla.

The circuit shows a high-gain battery-powered a.f. amplifier that may be used with a Brush BL-301 or similar crystal type vibration transducer to pick up vibrations produced by the liquid escaping under pressure. The instrument is easy to use. Simply force the pickup probe into the ground at various points along the pipeline—making contact with it wherever possible—and listen for low-frequency vibrations produced by the leak. The sound is loudest when the probe is closest to the leak. A metal detector is a handy accessory when the exact route of the pipeline is unknown.

The BL-301 has a probe ½ inch in diameter and 8½ inches long with a removable tip. This tip can be replaced with a ½-inch steel rod about 3½ feet long. One end should be ground to a sharp point and the other threaded to fit the probe on the pickup. A 1-foot length of ¾-inch rod or pipe can be welded crosswise about 2 inches from the threaded end to simplify forcing the probe into the ground.

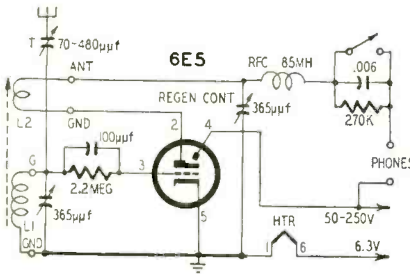


CYCLOPS RECEIVER

Some years ago you described a one-tube receiver that used a 6E5 electron-ray indicator tube. Please print this circuit with all values.—F. D., Los Angeles, Calif.

The "Cyclops" receiver circuit is reprinted from the May, 1937, issue of RADIO-CRAFT. It is a conventional regenerative detector with regeneration controlled by a variable capacitor.

The tuning circuit consists of a modified broadcast-band antenna transformer with approximately two-thirds of the turns removed from primary L2. It

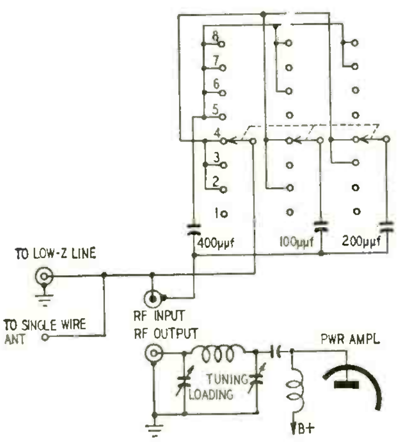


may be necessary to reverse the connections to either L1 or L2 to obtain oscillations. On weak signals, you can obtain greater volume by closing the switch in the plate circuit. However, this eliminates the shadow angle.

PI-SECTION COUPLER

I recently constructed a novice transmitter with a combination pi-section output circuit and antenna coupler using two 100-μμf variable capacitors. I'm very discouraged because the rig will not load and I can't get out. I'm using a half-wave dipole fed with 72-ohm line. —E. S. T., Brooklyn, N. Y.

The pi network in your rig is designed for a high-impedance output (a range of approximately 500 to 5,000 ohms) so you will have to increase the value of the output loading capacitor. The diagram shows an adaptation of a scheme used by ZS6AHI and described in *The Short Wave Magazine* (London, England). The author connected a three-gang eight-position switch and three 2,500-volt mica capacitors as a decade capacitor across the output tuning (loading control) capacitor so the total capacitance can be increased to 800 μμf in steps of 100 μμf. Since it may



not be practical to install the switch and capacitors in your transmitter, we have shown how they may be assembled on a separate chassis and connected to the output of the transmitter through a short length of coaxial cable. The lead-in then connects to terminals on the decade capacitor. The total output capacitance required varies inversely as the antenna or transmission-line impedance and inversely as the loading. Antenna loading increases as the capacitance of the loading capacitor is *decreased.*

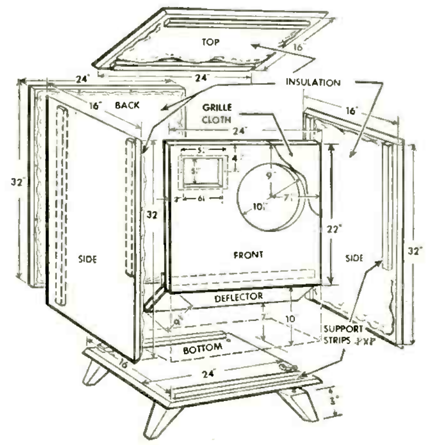
To tune the transmitter and antenna, quickly set the tuning capacitor for maximum dip with the decade switch set for maximum capacitance (position 8). Turn the LOADING control toward minimum capacitance while simultaneously adjusting the TUNING control to maintain resonance. If the antenna does not take the load, return the LOADING control to maximum capacitance and repeat the operation in each successive position of the decade switch until the antenna takes the load as required.

12-INCH REFLEX ENCLOSURE

Please print construction details on a horn-loaded reflex enclosure for a 12-inch speaker.—E. O. C., Brentwood, N. Y.

The drawing shows the construction of a 6-cubic-foot horn-loaded reflex enclosure that University Loudspeakers suggest home constructors use with their 6200, 6201 and *Diffusicone* 12 speakers. *Kimsul* insulation is applied to the top, sides and back. All material except the support strips for the front and back panels should be ¾-inch plywood.

The support strips are glued and



screwed to the top, sides and bottom and then the cabinet is glued together. The removable back is fastened securely in place with No. 8 1¼-inch wood screws spaced about 6 inches apart around the edges. Absolute rigidity is essential in this type of enclosure.

The rectangular opening in the upper left corner is for a tweeter such as the University HF-206, 4401, 4408 or 4409. If the tweeter is not installed immediately, cover the hole with a piece of ¼-inch plywood measuring about 7⅜ x 5⅞ inches. When the tweeter is installed, it fits over a suitable cutout in this subpanel.

All dimensions are given and should be adhered to closely. Once an error is made it has a tendency to multiply and the finished product may not give optimum performance. So, check all measurements carefully. END

Technotes

YOKE-TO-TUBE ARCING

An arc was visible and audible from the deflection yoke to the picture tube of a Muntz 17B1. The yoke was replaced—this did not help. A picture tube of the same type was temporarily placed in the set—this did not cure the trouble. The high-voltage section from another receiver of the same model was placed in the defective receiver, and the arcing disappeared. I therefore assumed that the transformer in the original set was defective.

I installed a replacement unit, but the arcing reappeared. The only thing left to be defective in the high-voltage section was the standoff insulator from the socket of the 1B3 to ground. The insulator was replaced with a 500-$\mu\mu$f 20,000-volt capacitor and the arcing disappeared.—*Ozzie W. Willingham, Jr.*

PHILCO 41-605

This receiver came in with oscillations on the high end of the dial. Upon inspecting the chassis, it was found that a 14AF7 tube had been substituted for the original XXD. As an XXD was not available at the time, I connected a 5,000-ohm resistor in the plate circuit of the oscillator in place of the original 10,000-ohm unit and oscillations ceased.

U.H.F. SOUND DRIFT

I recently had a case of sound drift on u.h.f. New oscillator tubes in the converter and in the tuner brought no improvement. In addition, broadening the i.f. response did not correct the trouble.

I corrected the trouble by removing the metallic shield over the receiver's r.f. oscillator. Possibly lowering the tube's operating temperature made for more stable operation.—*Jack T. Steinbacker*

WEAK SOUND AND PIX

Conditions of weak sound and pix may occur in the Du Mont RA 112 and 113 if the lead-in from the front end (the Inputuner) is dressed too close to the chassis. The lead-in acts as a link coupling between the front end and the i.f. amplifier. Since it is passing high frequencies, it is very easy for excess capacitance to chassis to attenuate the signal (sound and pix) severely. Small fiber standoffs will anchor the lead-in if there is any difficulty with it maintaining its shape.—*J. A. McRoberts*

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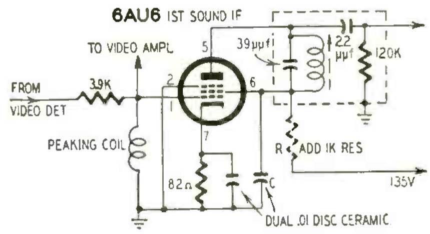
DISTORTED SOUND

An RCA Victor TV, model 21-T-363, was brought in with the complaint that the sound became very distorted within 30 minutes after the set was turned on and remained distorted.

The chassis was removed and—naturally—the described condition would not occur with the set on the bench. A thermal condition was suspected and the various resistors and capacitors associated with the sound i.f. amplifiers were heated with a soldering gun.



When capacitor C (see diagram) was heated, the sound disappeared almost completely within a couple of seconds. The capacitor was removed and its capacitance measured. The normal value of .01 μf varied over of 4-to-1 range from .02 to .005 μf when heated to normal operating temperatures.

The 135-volt supply lead was very close to the peaking coil in the grid circuit of the tube. Apparently feedback took place between the plate and grid circuits when the bypass capacitor decreased in value. The solution was to replace the capacitor, add 1,000-ohm decoupling resistor R and dress the 135-volt supply lead away from the grid coil.—*Robert A. Sharpe*

INTERMITTENT RCA 17T154

Recently this receiver came into the shop with an intermittent front end. It was getting channel 4 on channel 3, channel 9 on channel 7. The front end uses a 6X8 oscillator and a 6BQ7 r.f. amplifier. The customer did not want to pay for a new tuner.

As a rule these front ends cannot be serviced. I took a small soldering iron and reheated the 22-μμf capacitor beneath the 6X8 oscillator—it worked like a new front end. The 6X8 had been pulled out of the socket so many times that it had worked this capacitor loose, causing the front end to be intermittent.—*Donald L. Sauls*

CORONADO 05RA4-43-9876B

When servicing one of these a.c.-d.c. battery portables, check the handle nuts on the cabinet. In two recent cases several tubes were shorted out and other damage done. This happened because the nuts holding the handle on the cabinet worked loose. Since the set rides upside down in the cabinet, the nuts (and washers) landed on the filter capacitor lugs, shorting out the set. To prevent costly trouble to the owners of these sets, take a few minutes out and tighten the nuts. The bolt coming through the cabinet is just long enough to grasp the nut and washer.
—*A. von Zook* END

Technicians' News

MINNESOTA ORGANIZES

A statewide TV service organization has been formed in Minnesota, with headquarters in Minneapolis. The new group, called the Minnesota Television Service Engineers, is at present a management organization. Technician members will however be accepted, according to John Hemak, veteran service engineer and president of the new association.

The society was launched as the result of careful study and preparation going back to late last fall. The organizing groups cooperated with and received the assistance of the State Department of Labor and the State Industrial Commission. Its organization meeting was attended by 30 members.

Officers, besides Mr. Hemak, are Harold Simonson, vice president; Warren Schel, secretary, and Robert Rohweder, treasurer. Mr. Rohweder is also treasurer of the Radio-Television Service Association of St. Paul.

NETSDA SEEKS UNITY

By unanimous action, the National Electronic Technicians and Service Dealers Associations moved to support a joint meeting of all national, state and regional service technicians' groups to foster unity in the service industry. The action took place at a meeting in Trenton, N. J., May 1.

NETSDA also went on record opposing the policy of Philco in setting up distributor service in Chicago (or any other area) in direct competition with the service technician and the authorized Philco service agencies.

NATESA MEETS

The spring meeting of the National Alliance of Television and Electronic Service Associations was held at the Hotel Statler, Buffalo, N. Y., on April 24. Two delegates' business meetings were held during the day, plus a service clinic presided over by Sylvania. Mr. Robert Hester was elected secretary-general of NATESA. Details of other business transacted were not released.

The banquet following the meeting was addressed by Erik Isgrig of Zenith, who spoke on Phonevision. Frank Moch made an official address as president, cautioning that we must take the bull by the horns and realize our basic value to the American public. Many of our shortcomings, said Mr. Moch, can justifiably be blamed on the men in the trade, who refuse to elevate themselves into the professional status they so deserve.

Friends of Service Awards were given to Dan Creato, for RCA; Howard Sams; Sprague Electric Products; Walter Bieda of Sylvania; Sylvania Electric Products; Bill Ashby and Carroll Hoshour of Magnecord, and A. C. W. Saunders.

LICENSE BILLS COMPARED

Recognizing the interest the subject of licensing holds among service groups throughout the country, *The Guild News*, organ of the Radio Television Guild of Long Island, devoted a full page of its April issue to comparing the contents of proposed licensing bills in various cities and states. The article concludes with the statement which was accepted as official policy of the guild at their March business meeting: "Our stand for licensing therefore is not blind acceptance of any legislation, but an open-minded willingness to sit down and discuss a fair and just law rather than oppose all licensing without listening."

RACKETEERS PUNISHED

With continuing pressure being brought to bear against unscrupulous operators by television service organizations and local Better Business Bureaus, reports of crackdowns are appearing at an ever-increasing rate. The most recent involve two West Coast outfits.

An Oakland, Calif., television service technician was accused of business racketeering and jailed on 13 misdemeanor charges after being trapped by two policemen who posed as householders owning sets in need of repair. The charges including misleading or false advertising.

In San Francisco one principal in an alleged television repair racket received a 90-day jail term. His partner was put on 1-year probation. Both were fined.

MILWAUKEE CLEANUP

Members of the Milwaukee Association of Radio and Television Services began a crackdown on bait advertising and dishonesty in replacing tubes and parts as practiced by local TV service firms. To combat the malpractices, the group set up an honest-practice committee, headed by Walter Gregg as chairman. Among steps proposed was the formation, under the Wisconsin Department of Agriculture, of a code of fair trade practices and the bringing of criminal warrants against firms fraudulently charging for services not performed. END

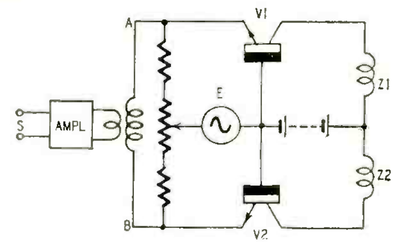
Patents

PHASE DETECTOR

Patent No. 2,698,392

Sidney Herman, Brooklyn, N. Y.

This circuit (see diagram) can be used to control a polarized relay, motor or other "two-way" device. It contains a pair of n-p-n transistors. Impedances Z1, Z2 may be the coils of a differential or polar relay, the split field of a motor, etc. When equal (and opposite) currents flow through these impedances, the useful output is zero. Under this condition the armature of a relay remains in neutral; the motor does not turn over.



The potentiometer is set for equal currents through the transistors to balance the circuit. An a.c. source E (which may be 60 cycles) provides the phase standard with which signal S is compared. We need consider only the times when E is negative. At other times the diodes are blocked.

Assume that S drives point A negative and B positive. Transistor V1 will pass considerably more current than V2, for S is aiding E at A. These voltages oppose at B. Thus if the load is a relay, its armature is attracted to one of the pole pieces. If it is a motor, it will rotate. If the phase of S is reversed, a relay armature in the load circuit would contact the other pole piece, and the motor would reverse.

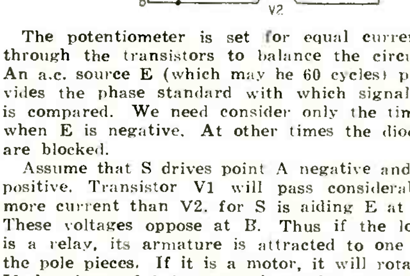
The difference in phase between S and E controls the magnitude and direction of current fed to the load. When no signal is present, the load receives no useful output and the motor will remain either stationary or rotating in the direction indicated by the last signal received.

PUSH-PULL TRANSISTOR OSCILLATOR

Patent No. 2,698,386

Everett Eberhard, Phoenix, Ariz. and Richard O. Endres, Morristown, N. J. (Assigned to Radio Corporation of America)

A pair of point-contact transistors are used in this circuit to obtain higher power output and better waveform. The tank circuit is tapped for optimum impedance match to the transistors. Resistors R1, R2 determine emitter bias and guard against current surges. Resistors R3, R4 determine the amplitude of the output power and prevent bypassing the r.f. or a.f. back to the input.



OPPORTUNITY ADLETS

Rates—45c 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 Sept. issue must reach us before July 15, 1955.

Radio-Electronics
25 W. Broadway, New York 7, N. Y.

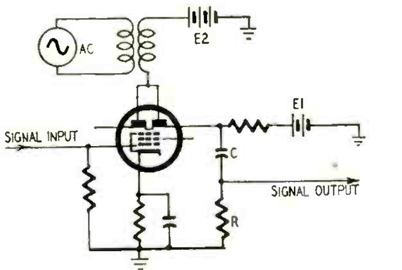
DIAMOND AMPLIFIER

Patent No. 2,694,112

Kenneth G. McKay, Summit, N. J. (Assigned to Bell Telephone Labs., Inc.)

A diamond can be useful as well as ornamental. If the stone is bombarded by X-rays, electrons or gamma rays, its conductivity is greatly increased. If an alternating voltage is impressed across a diamond while it is bombarded, an a.c. meter in the circuit shows a small current flow.

The figure shows a practical form of the invention. A high-gain beam pentode is fitted with diamond anodes. If the diamond gain is 10



and the tube g_m 5,000, the effective conductance is 50,000 micromhos. E1 is the usual B supply for the tube. E2 is chosen for optimum excitation of the diamonds in conjunction with the low-frequency a.c. R-C is series-tuned to the a.c. frequency, thus effectively shorting it out.

It has been found that it is better to excite the diamond with a.c. superimposed on d.c. When d.c. alone is used, electrons move over a short distance within the crystal before becoming "trapped." Periodic reversal (for example at 20 cycles) of the exciting voltage minimizes the trapping.

SUBMARINE ATTACK METHOD

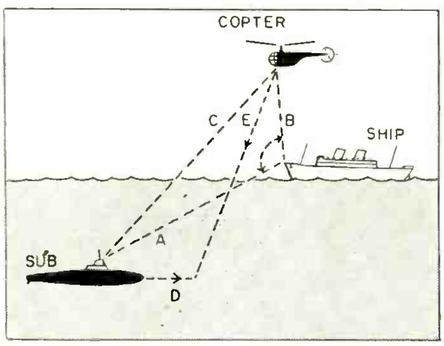
Patent No. 2,689,083

John Hays Hammond, Jr., Gloucester, Mass.

Detecting and tracking of submarines are exact sciences, and our Navy has many specialists trained in these fields. Likewise, radiolocation and automatic computation have been perfected in recent years.

Radar, sonar, television and computation are combined in this invention for the quick detection and destruction of submarines. The patent also describes a new mechanical device which solves problems in triangulation to provide rapidly the correct course and speed of the target submarine.

A ship equipped with radar and sonar locates the sub, determining line A in the figure. It also calculates the distance to a friendly helicopter (line B) with which it is in communication. A mechanical computer, utilizing gears,



wheels and synchros, completes the triangle so line C is known.

Periodic tracking of the sub reveals its course and speed, so that line D is determined. Line E may now be drawn or calculated. It indicates the course to be taken by the copter to overtake and destroy the sub.

This information is transmitted to the helicopter by TV so that no time is lost. As changes are made in the course, speed or position of the sub, this information becomes known immediately to the crew of the helicopter.

GUN LOCATOR

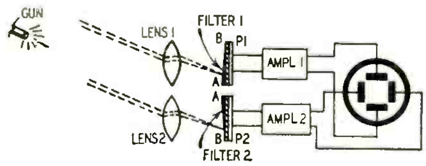
Patent No. 2,700,318

James Snyder, Asbury Park, N. J. (Assigned to United States of America as represented by the Secretary of the Army)

This direction finder (see diagram) indicates the azimuth angle of a gun blast or bomb explosion. A dual optical system focuses radiation (infra-red or visible) originating at the gun muzzle. Direction is indicated on the screen of a cathode-ray tube.

Lenses 1 and 2 are collinear, each having the same angle of refraction for any given light beam. The beam is thrown on filters 1 and 2, the density of which varies from maximum at A to minimum at B. Photosensitive surfaces P1 and P2 lie behind the filters.

If a gun is located directly in front of the lenses, its focused image will pass through the optical system in a straight line. Focus will take place at the *centers* of the filters where the densi-



ties are equal. Thus the amplifiers feed equal signals to the horizontal and vertical deflection plates of the scope. The result is a diagonal trace, which by turning the tube may be set at zero degrees.

If the gun is located to the right of the lenses (as shown in the diagram), filter 1 will focus near A, filter 2 near B. A weak signal arrives at amplifier 1 and a strong signal at amplifier 2. In this case the scope deflection will be stronger in the horizontal than the vertical direction, changing the angle of the trace.

When correctly calibrated, the oscilloscope shows the direction of the target without need for calculation.

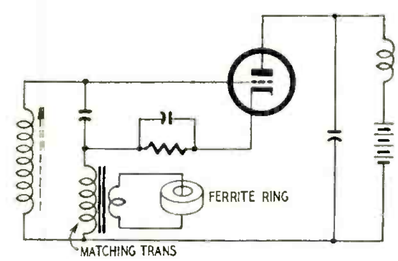
MAGNETOSTRICTIVE R.F. OSCILLATOR

Patent No. 2,696,560

Walter van Braam Roberts, Princeton, N. J. (Assigned to Radio Corp. of America)

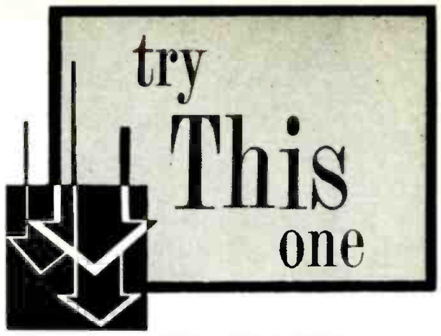
With stability comparable to that of a quartz crystal, this oscillator is effective at relatively low r.f. or i.f. The controlling element is a magnetostrictive ring made of ferrite. This is coupled to the tank through a matching transformer, as shown in diagram. Like quartz, the ferrite has a natural resonant frequency for maximum vibrations. Above resonance, the ferrite reflects a *capacitive* effect into the tank.

To generate oscillations, the tank is tuned to a



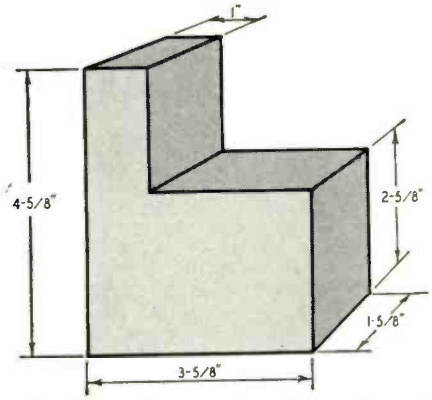
frequency above the point of ferrite resonance. Then the circuit becomes a Colpitts oscillator with a tapped capacitance across the coil.

In one experimental arrangement the ferrite dimensions were: 6.8 mm long, 8.2 mm outside diameter, 1 mm hole diameter. This cylinder has two modes of vibration: longitudinal and transverse. The oscillation frequencies were 360 or 580 kc, depending upon coil tuning. END



CHASSIS BLOCKS

After attempting to work on radios and other electronic gear while propping the chassis with solder spools, small boxes and miscellaneous components, I thought there must be a better way. After a few chassis fell down, bending tuning capacitor plates and damaging other components, I *knew* that something must be done. Chassis mounts are available but the cost seemed

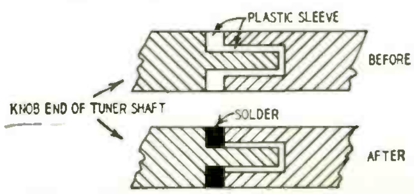


rather high for occasional use so I cut up some scrap 2 x 4-inch lumber, as shown in the above sketch. Use three of these and the average chassis will be as steady as a milking stool. They will provide five different heights and are quite stable. If you are working on larger amplifier chassis, better make a second set. By combining two blocks at a time, it is possible to handle anything that comes into the shop. — *W. W. Wheelock*

SLIPPING TV TUNER SHAFT

The channel-selector shaft on a Truetone model 2D2424A turned free without changing channels. Removing the drum, we found that the shaft was made in two sections with the front section turned down to receive a plastic sleeve fitted in a hole in the rear section attached to the drum (see drawings). The plastic sleeve was slipping and there was no room for an adhesive so we cut away a part of the sleeve and soldered the two sections together as shown.— *R. P. Balin*

(The plastic sleeve insulates the knob end from the drum end and re-



duces shock hazard in sets with transformerless B supplies. Soldering the shaft removes this protection. The shaft should be replaced or repaired by drilling a small hole through the shaft sections and sleeve and locking the parts together with a hard plastic or fiber pin.—*Editor*)

BROADCAST PRESELECTOR

Many European experimenters and constructors use outboard preselectors (r.f. amplifiers) and rotatable directional antennas ahead of their broadcast receivers to increase the sensitivity and to minimize co-channel and adjacent-channel interference. One of these units was described in the article "Unirotor" in *Radio Bulletin*, published in the Netherlands. It consists of a special ferrite rod type antenna mounted horizontally on a rotatable mount and an EF86 pentode amplifier. We have modified the circuit and construction details for readers who would likely find some of the original components unobtainable.

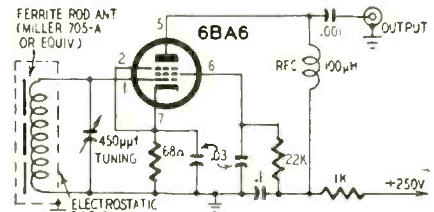


Fig 1

Fig. 1 shows the diagram of the amplifier as modified to use a 6BA6 tube. The original rod antenna consists of 50 turns of Litz wire closewound on a fiberboard tube fitted tightly over the center of a ¼-inch diameter ferrite rod about 5½ inches long. The antenna is cemented to a Bakelite fitting—a round control knob can be used—and leads brought down through the hollow spindle. The antenna rod is centered in a copper-screen Faraday shield in the form of a split tube 5 inches long and about 2½ inches in diameter. Fig. 2 shows the construction of the antenna

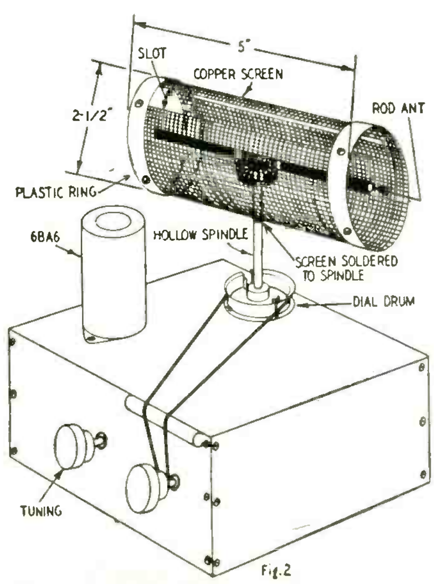


Fig.2

and the method of mounting and rotating. Rings of plastic or other nonmetallic material hold the shield in shape. It is held in place by soldering the screen to the metal tube used as a spindle.

Constructors can duplicate the performance of this unit by substituting a ferrite rod loop antenna such as the J. W. Miller type 705-A or equivalent. Modify the shield dimensions and mounting arrangement to fit the components on hand.

DRYER FOR TV SETS

In areas where humidity is consistently high, TV sets often develop trouble when they are not used enough to keep the components dried out. This trouble is usually reported after the set owner has returned from a vacation or an extended trip.

We prevent a lot of this by installing a 7.5-watt ceramic-enclosed heating element inside the set and connecting it directly across the power line ahead of the switch. The cost of power consumed by the heater is negligible when compared to the cost of a service call to repair a set damaged by moisture.—*Stanley Clark*

TURRET SOCKETS

Here is a neat and inexpensive way to mount resistors and capacitors under a socket. For miniature tubes, select a seven- or nine-pin saddle or shield base socket as required. Cut the head off a No. 6 screw 1½ inches long and solder one end of the screw into the small, circular shield at the center of the socket. This one mounts directly on the chassis.

A retainer-ring or clinch type socket, the kind without a metal mounting plate, is then soldered to the other end of the screw in the same way. Resistors, capacitors and other components can now be soldered between the terminals of the tube socket and the terminals of the lower, dummy socket.

If octal tubes are used, suspend a Bakelite wafer socket below the tube socket on two 2-inch No. 6 screws passed through the socket mounting holes. Either bushings or nuts can be used to hold the lower socket in place.—*Allan J. Ferres*

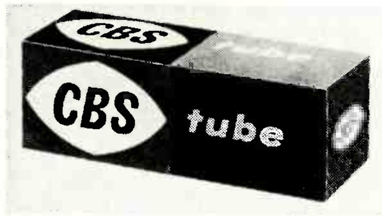
WARPED PHONO RECORDS

Phonograph records often become badly warped due to inadvertent exposure to excess heat. To straighten them immerse the record in hot water (140–160° F) in a flat-bottom pan about 1 inch deep. Invert a dinner plate over the record so its weight is applied only around the outside edge of the record. Add about a pound more weight on top of the dinner plate. Leave the record this way until the water has cooled to room temperature.

Don't try to rush this process! If any high-speed cooling methods are used, the record will immediately warp again.
—*Louis M. Long* END

Merchandising and Promotion

CBS-Hytron, Danvers, Mass., is directing its consumer radio and TV tube advertising campaign toward women as the result of a survey which showed



that women make 88.5% of all telephone requests for TV service and that the woman of the house is present during 76.95% of the calls, while the man is home for only 24.5%. The Good Housekeeping Guaranty Seal now appears on new CBS tube cartons.

Electronic Instrument Co., Brooklyn, N. Y., designed a package display

merchandiser for distributors of its TV alignment crystals.

Astron Corp., East Newark, N. J., is promoting its capacitor line as a means of simplifying inventories. The company has streamlined its selection of models, eliminating numbers found inactive in recent research on capacitor inventories.

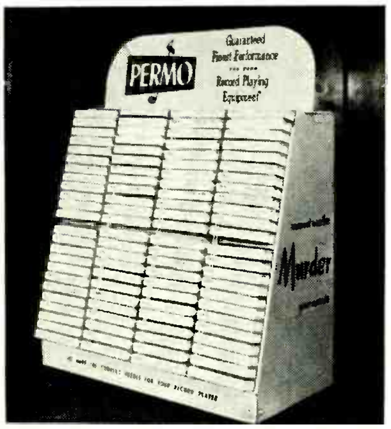
Walsco Electronics, Los Angeles, Calif., introduced a counter display featuring a complete assortment of its phono and recorder drives. The company also announced a new dealer kit which contains 23 different drives covering 85% of all changers now on the

market, packed in a transparent plastic case.

Ward Products Corp., Cleveland, introduced a new four-color counter display for jobbers for its *Invader* fringe antennas.

Astatic Corp., Conneaut, Ohio, designed a new *Twelv-Pak* cartridge replacement kit which contains the twelve most popular cartridges packaged in a transparent plastic case. Included with the kit are a jeweler's screwdriver and an eight-page master cross-index replacement chart, listing every cartridge made.

Permo Inc., Chicago, designed a new needle cabinet to serve as a display, storage bin and self-service dispenser for replacement needles.



Production and Sales

RETMA reported that 35,616,771 TV sets were shipped to dealers in the nine-year period from 1946 through

(Continued)

1954. Last year 7,161,362 sets were shipped.

RETMA reported that TV set production of 2,188,252 for the first three months of 1955 was 50% ahead of production for the same period in 1954. Radio set output of 3,640,144 for the first quarter of this year was 40% ahead of the 1954 quarter.

> ### Calendar of Events
>
> **Western Electronic Show and Convention**, Aug. 24–26, Civic Auditorium, San Francisco, Calif.
>
> **British National Radio Show**, Aug. 24–Sept. 3, Earls Court, London, England.
>
> **German Radio, Phonograph and TV Exhibition**, Aug. 26–Sept. 4, Düsseldorf, Germany.

Mergers and Expansions

Telautograph Corp., New York and Los Angeles, merged with **Walsco Electronics**, Los Angeles, which will operate as a division of Telautograph. Walter L. Schott, president of Walsco, will continue in that capacity and there will be no personnel changes in the Walsco firm.

Permo Inc., Chicago, purchased **Zim Products** of the same city. Permo will now manufacture both *Zim* record brushes under that trade name and its own *Fidelitone* and *Permo* record brushes.

General Dynamics Corp., which built the atomic-powered submarine Nautilus, merged with **Stromberg-Carlson**, Rochester, N. Y.

Texas Instruments, Dallas, purchased the business and assets of **Radell Corp.**, Indianapolis resistor manufacturer, and will transfer production operations to Dallas.

Raytheon Manufacturing Co., Waltham, Mass., set up a joint venture with Minneapolis-Honeywell Regulator Co. for the engineering and marketing of high-speed electronic data-processing systems for business and government. The project will be carried out by a jointly owned company, **Datamatic Corp.**, Waltham. Raytheon also announced the opening of a new warehouse and sales office for its electronic tubes and semiconductors in Franklin Park, Ill.

Sylvania Radio Tube Division opened a new 210,000-square-foot plant near Williamsport, Pa., for finishing and packaging operations on receiving tubes.

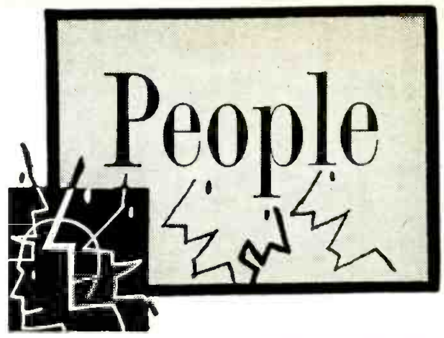
Cornell-Dubilier, of South Plainfield, N. J., formed a new Printed Wiring Division with headquarters at its home office.

Daystrom Inc., Elizabeth, N. J., merged with **Weston Electrical Instrument Co.**, Newark, N. J.

Radio Receptor Co., leased an additional building in Brooklyn, N. Y.

Business Briefs

. . . **National Co.**, Malden, Mass., was provided with $2,000,000 in capital on loans from Easy Washing Machine Corp., Syracuse, N. Y., in conjunction with Sid W. Richardson, Perry Bass and Clint W. Murchison END



People

R. B. Davison

Robert B. Davison was apponted distributor sales manager of Cannon Electric Co., Los Angeles. He has a wide background in sales and jobber organization and was most recently sales manager for Pacific Electricord.

L. A. Appley

Lawrence A. Appley, president of the American Management Association, was elected a director of Sylvania Electric Products, New York City, increasing the board membership from 9 to 10.

A. E. Bourassa

Alfred E. Bourassa was appointed to the position of merchandising coordinator for CBS-Hytron, Danvers, Mass. Before his present appointment Mr. Bourassa was assistant manager of the advertising department.

Personnel Notes

. . . **Lloyd Dopkins** joined Granco Products, Long Island City, as vice president in charge of sales. He was formerly with the Crosley Division of Avco Manufacturing Corp.

. . . **H. S. Gwynne** was named manager of the Tube Industry Sales Section of the RCA Tube Division, Harrison, N. J. **C. W. Taylor** was appointed to the new position of manager, color kinescope marketing. Gwynne was formerly manager, market plans and analysis; Taylor was manager, tube parts and machinery sales.

. . . **John L. Woods**, comptroller of American Phenolic Corp., Cicero, Ill., was elected to the board of directors. **Fred G. Pace**, administrative assistant to the president, was named secretary.

. . . **Everett W. Olson**, director of communications for Webcor, Chicago, was appointed director of public relations and advertising.

. . . **Leslie F. Muter**, president of the Muter Co., Chicago, and a director of RETMA, was awarded the 1955 Medal of Honor by RETMA at its recent industry banquet in Chicago. END

technical Literature

SPEAKER ENCLOSURES

Advantages and disadvantages of the many types of enclosures for hi-fi loudspeakers are discussed in an 8-page brochure. Frequency response curves which may be expected from different cabinet types are reproduced to illustrate the characteristics of different enclosure designs. Information for the design and construction of bass-reflex enclosures and detailed drawings for the construction of a corner enclosure is also given.

Altec Lansing Corp., 9356 Santa Monica Blvd., Beverly Hills, Calif., or 161 6th Ave., New York 13, N. Y.

AMPLIFIER-SPEAKER

A 4-page brochure describes the *Ampex 620* speaker-amplifier and its uses with the *600* tape recorder.

Ampex Corp., 934 Charter St., Redwood City, Calif.

COLOR TV

Magnavox's *Service Training* Bulletin No. 2 *Colorimetry* represents the first in a series of training bulletins on color TV. It is expected that succeeding bulletins will be distributed at the rate of approximately one per month. These bulletins are designed to give a good working knowledge of the NTSC color system, and will cover the circuitry of Magnavox color receivers when such receivers are available.

Bulletin No. 2 describes light and the human eye, color mixing and color specification.

Magnavox Co., Factory Service Dept., Fort Wayne, Ind.

OUTPUT TRANSFORMERS

Acrosound's *Ultra-Linear Output Transformers* are described in a 16-page pamphlet, which gives technical information as well as schematics.

Acro Products Co., 369 Shurs Lane, Philadelphia 28, Pa.

ELECTRONIC COMPONENTS

Catalog 29 contains in 16 pages technical data and illustrations on electronic components. This 1955 catalog

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.

PHOTOGRAPHS

RADIO-ELECTRONICS can use good photographs of service benches, service shops, high-fidelity audio layouts, and any other interesting and original radio-electronic devices.

We will pay $6.00 each for good professional photos or equivalent, suitable for reproduction.

Full information on subject photographed will increase their acceptability.

The Editor, RADIO-ELECTRONICS
21 West Broadway, New York 7, N. Y.

includes specifications on the new Fastatch dual controls, Snap-Tite controls, 1,000-volt rated disc capacitors, P.E.C. kits, temperature-compensating tubular capacitors.

Centralab, Division of Globe-Union Inc., 900 E. Keefe Ave., Milwaukee 1, Wis. or any Centralab distributor.

TRANSFORMERS

Stancor's 24-page *Catalog S-101* contains a numerical index and price list. This illustrated catalog has information on transformers for TV, industrial and communication applications.

Chicago Standard Transformer Corp., Addison and Elston, Chicago 18, Ill.

EQUALIZERS

Catalog No. 12E (16 pages) illustrates, with response charts, equalizers and wave filters. It gives many applications of this type of equipment in sound and sound recording. Case studies with solutions are given. Attached to the outside cover is a simulated theatrical bill—*Sound Stage Slanguage for Cinema Equalizers*—which gives terms used by the trade for various Cinema items together with their catalog numbers.

Cinema distributors or Cinema Engineering Co., Division of Aerovox Corp., 1100 Chestnut St., Burbank, Calif.

RESISTORS

Bulletin T-1 gives data on construction, dimensions, machining technique, tolerances, resistance values, power and voltage ratings, temperature and voltage coefficients of IRC resistance strips and concentric disc resistors.

International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa.

MICROPHONES

An eight-page brochure, *Technical Information on Condenser Microphones*, details their basic operational theory, and, in chart form, typical characteristics of these microphones with comparisons to other types. Nine formulas and four charts are included.

Frank L. Capps & Co., 20 Addison Pl., Valley Stream, N. Y.

AUDIO EQUIPMENT

The new *Audio Master* catalog describes three-speed portable record players, transcription players combined with PA systems, combination slide film projectors and record players, etc.

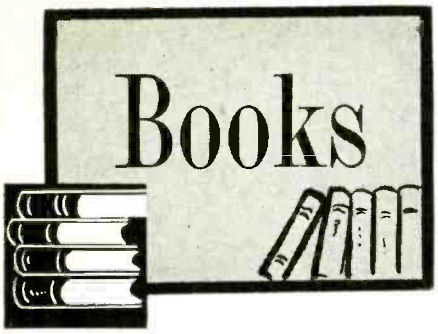
Audio Master Corp., 17 E. 45 St., New York 17, N. Y.

PRINTED CIRCUITRY

An eight-page illustrated booklet on *Printed Circuitry* describes in detail its applications and advantages in various electrical products and equipment, as well as technical information to aid design or planning of such circuitry. Different types of base materials, laminate characteristics, circuit designs, preparation of master drawings, soldering techniques and pricing variables are discussed.

Cornell-Dubilier Electric Corp., South Plainfield, N. J.

END



28 USES FOR JUNCTION TRANSISTORS. Sylvania Electric Products, Inc., 1100 Main St., Buffalo 9, N.Y. 6 x 9 inches, 47 pages. 25c.

Transistor prices are now within reach of all experimenters, and many will want to try their hand at building practical and useful circuits. This manual offers them a good start. It describes amplifiers, oscillators and control devices as tested in Sylvania laboratories. All diagrams are clearly marked with component values and operating data.

In addition to voltage and power audio amplifiers (including a 5-watter), the circuits include a phase inverter, multivibrator, r.f. relay, photoelectric counter and many others. The last chapter shows a selective null detector and several electronic meter circuits. The latest Sylvania high-power transistors are listed and rated for handy reference.—*IQ*

HI-FI MANUAL, by Donald Carl Hoefler. Fawcett Books, Dept. 232, Greenwich, Conn. 6½ x 9¼ inches, 144 pages. 75c.

This manual describes in turn each link in a hi-fi chain to help the reader choose his own equipment. Hundreds of photographs and diagrams are included. The text is informal, nontechnical, interesting, complete.

The book begins logically with a few pages on characteristics of the human ear, the nature of musical sounds and the requirements of a hi-fi system. A short history of records, radio and FM follows. Separate chapters discuss records, turntables, tone controls, tuners, speakers, enclosures, and how to assemble the various components. Questions—when to change styli, why three speeds, FM *vs.* AM, how to pick a turntable, how to install a tuner—are answered. A special chapter on tape recording shows how to operate, edit and handle a mike.

A hi-fi directory lists manufacturers, dealers and publications.—*IQ*

HI-FI HANDBOOK, by William J. Kendall. Thomas Y. Crowell Co., 432 4th Ave., New York 16, N.Y. 5½ x 8½ inches, 164 pages. $2.95.

Scratch an audiophile (you can use a sapphire needle, but diamond is preferable) and you will find a rugged individualist, a determined character, a nonsplitter of phrases. This is just as well, since the end product of any audio system is a matter of personal judgment. You may not agree with everything that William J. Kendall writes, but his forthright avoidance of weasel words on a rather touchy topic is endearing in itself.

Primarily directed to a nontechnical audience, this book is a valuable primer for service technicians, surrounded by ailing TV sets who wish to maintain a grip on the entire field of electronics. Every section of a hi-fi system is fully explained, from the pickup through the preamp and amplifier to the speaker setup. Well written, informative, but subject to debate.—*MC*

FILTER DESIGN DATA FOR COMMUNICATION ENGINEERS, by J. H. Mole. John Wiley & Sons, 440 4th Ave., New York, N. Y. 6½ x 10 inches, 252 pages. $7.50.

This work simplifies the extremely difficult problems of analyzing and designing filters by supplementing theoretical principles with form charts, formulas and tables prepared or selected to reduce greatly the labor of calculation. A college-level knowledge of filter and transmission-line theory is assumed.

TABLES OF CIRCULAR AND HYPERBOLIC SINES AND COSINES FOR RADIAN ARGUMENTS (National Bureau of Standards Applied Mathematics Series 36—reissue of Mathematical Table 3). Government Printing Office, Washington 25, D.C. 8 x 10½ inches, 407 pages. $3.

These tables of circular and hyperbolic sines and cosines are used by engineers and scientists using or interested in pure and applied mathematics.

PROCEEDINGS OF THE NATIONAL ELECTRONICS CONFERENCE (Volume X). National Electronics Conference, Inc., 84 E. Randolph St., Chicago, Ill. 6½ x 9¼ inches, 808 pages, plus indexes. $5.

A part of the permanent record of technical material presented before the conference, this volume contains 86 technical papers and three addresses presented during the 1954 session.

DEVELOPMENT OF THE GUIDED MISSILE, by Kenneth W. Gatland. Philosophical Library, Inc., 15 E. 40th St., New York 16, N. Y. 5¾ x 8¾ inches, 292 pages. $4.75.

This is the second edition of a book presenting factually all available contemporary information on the development of the rocket as a guided offensive and defensive weapon and for such peaceful applications as research aids for studying the upper atmosphere and outer space.

TELEVISION TUBE LOCATION GUIDE (TGL-5), prepared and published by Howard W. Sams & Co., 2201 E. 46th St., Indianapolis 5, Ind. 5¾ x 8½ inches, 232 pages. $2.

This latest addition to the Photofact series of tube-location guides covers 1953 and 1954 TV receivers, showing the type, location and function of tubes and the type and location of fuses. A convenient supplement to service data.

OPERATION TV, by Stephen A. Madas. Vantage Press, Inc., 120 W. 31st St., New York, N. Y., 5¾ x 8¾ inches, 81 pages. $2.50.

An easy-to-understand book that answers the TV set owner's questions about reception and shows him how to improve the set's performance and save money on service calls by adjusting the set's service controls properly.

PICTURE BOOK OF TV TROUBLES (Volume 3—Video I.F. and Video Amplifier Circuits), by John Rider Laboratories Staff. John F. Rider Publisher, Inc., 480 Canal St., New York 13, N. Y. 5½ x 8½ inches, 90 pages. $1.80.

A handy guide to troubles in the video i.f. and video amplifier circuits. Keyed oscilloscope and picture-tube patterns illustrate the effects of opens, shorts, misalignment and changes in component values in eight standard circuits.

BASIC ELECTRICITY and BASIC ELECTRONICS, two series of five books each, by Van Valkenburgh, Nooger and Neville, Inc. John F. Rider Publisher, Inc., 480 Canal St., New York 13, N. Y. 6 x 9 inches, 579 pages in electricity series; 518 in electronics series. $2 per volume, $9 for each 5-volume set.

Designed primarily to give basic instruction to Navy students, regardless of previous education, these books follow a pictorial style in which half the subject matter is illustrations. These are largely prominent drawings, executed with a pedagogical rather than an esthetic objective. Usually starkly simple, they get their ideas across.

The text has not been held to the same fundamental quality and is often more advanced than the illustrations. In many cases there is not sufficient text to explain the subject. The chief value of the books is therefore as supplementary material, especially to the home student who often finds verbal explanations difficult, and to the instructor who can make use of graphic aids.—*FS*

END

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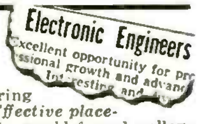

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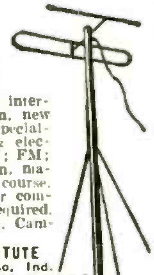

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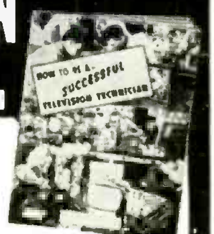

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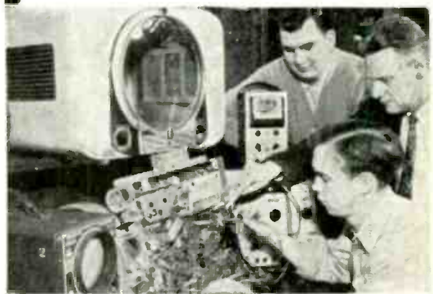

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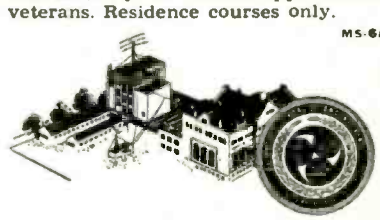

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RADIO SCHOOL DIRECTORY PAGE 119

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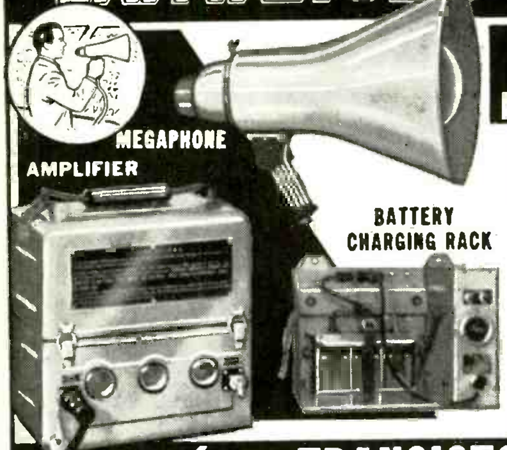

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AR-101	Input	100,000	3,000 CT	.5	3600	60	1"x¾"x¾"
AR-102	Input	100,000	1,500 CT	.5	3600	40	1"x¾"x¾"
AR-103	Driver	20,000	2,000 CT	1.	400	50	1"x¾"x¾"
AR-104	Driver	20,000	1,000	.0	400	50	¾"x⅝"x⅝"
AR-105	Driver	20,000	400	1.	600	30	1"x¾"x¾"
AR-106	Driver	16,000	4,000	1.	620	350	¾"x⅝"x⅝"
AR-107	Driver	15,000	200	1.5	1000	20	1"x¾"x¾"
AR-108	Driver	10,000	3,000 CT	.0	200	100	¾"x⅝"x⅝"
AR-109	Driver	10,000	2,000 CT	.0	500	50	¾"x⅝"x⅝"
AR-110	Output	10,000	25	2.	600	2.5	¾"x⅝"x⅝"
AR-111	Output	5,000	100	1.	600	10	¾"x⅝"x⅝"
AR-112	Output	3,500	200	1.	120	25	1"x¾"x¾"
AR-113*	Driver	3,000 CT	1,000	9.	100	60	¾"x⅝"x⅝"
AR-114	Output	2,500	11	10.	50	.1	¾"x⅝"x⅝"
AR-115	Input	2,000 CT	8,000 CT	.0	150	660	1"x¾"x¾"
AR-116	Output	2,000	200	4.	120	20	1"x¾"x¾"
AR-117	Output	500 CT	30	.0	20	1.5	¾"x⅝"x⅝"
AR-118	Output	500 CT	16	.0	20	1.5	¾"x⅝"x⅝"
AR-119	Output	500 CT	3.2	.0	20	.3	¾"x⅝"x⅝"
AR-120*	Output	400 CT	11	1.	20	.9	¾"x⅝"x⅝"
AR-121*	Output	300 CT	3.2	.0	20	.25	¾"x⅝"x⅝"
AR-122*	Output	250 CT	3.2	.0	11	.3	1"x¾"x¾"
AR-123	Input	200	2,000 CT	2.	11	50	1"x¾"x¾"
AR-124*	Output	200 CT	16	.0	20	1.3	¾"x⅝"x⅝"
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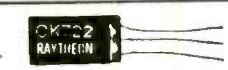

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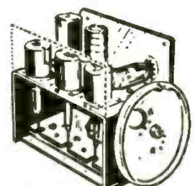

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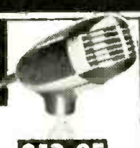

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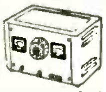

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T28V12ACC	12 Amp (1% Ripple)	$145
T28V24A†	0-28 VDC at 24 Amp	$135
T28V24ACC†	24 Amp (1% Ripple)	$195
T28V50A†	0-28 VDC at 50 Amp	$260
T28V50ACC†	50 Amp (1% Ripple)	$370
T28V100A†	0-28 VDC at 100 Amp	$469

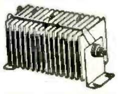
New! Basic Supplies, 115 VAC In

B115P5A	115 WDVC at 5 Amp	$90.00
B115P10A	115 VDC at 10 Amp	190.00
B230P5A	230 WVDC at 5 Amp	188.00
B230P10A†	230 VDC at 10 Amp	283.00

Less Meters. † 115 or 230 VAC and 3 Phase

NEW "TABTRON" SELENIUM BRIDGE RECTIFIERS

Dated



ONE YEAR GUARANTEE We mfg. Power Rectifiers to your specs. From 1 Amp up to and above 1000 Amps. Following list. Full Wave Bridge.

Curr. Cont.	18/14 Volts	36/28 Volts	54/42 Volts	130/100 Volts
1AMP	1.35	2.35	3.75	7.45
2AMP	2.00	2.75	5.35	9.15
3AMP	2.95	4.15	5.85	12.75
4AMP	3.50	6.45	11.35	21.75
6AMP	4.00	7.75	12.85	29.75
10AMP	5.90	11.45	19.50	41.35
12AMP	7.25	14.35	22.10	44.25
20AMP	13.05	25.05	37.25	78.50
24AMP	14.25	28.75	44.50	81.00
30AMP	17.95	34.35	56.50	109.00
36AMP	22.45	42.35	65.00	134.00
50AMP	29.50	54.35	97.35	174.00

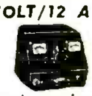
New Rectifier Xfmrs

Primary 115V 60 Cyc
5 Amp† ......$8.65; 2/$15.75
12 Amp† $16.65; 2/29.95
24 Amp* $35.75; 2/69.95
50 Amps* ......$59.00; 2/$112
100 Amp* ......$108.00; 2/$210
18 Volt, 2 Amps......$1.98
Secondary (Dual†) 18-15-9-0:0-9-15-18 Volts
†Wndgs in Series at ratings shown; Parallel 2xAmps. Voltage ½ max.* Dual Pri 115 & 220V 60 cy; Tapped 36VCT

New Rectifier Chokes

CR1A10/1AMP/0.1HY/1.4R/3# $3.95
CR1E11/2AMP/0.1HY/.67R/3# $5.95
CR7H12/5AMP/.07HY/.6R/10# $7.95
CR1L13/12AMP/.01HY/.1R/12# $14.95
CR4N14/24A/.004HY/.025R/20# $29.95

NEW VARIABLE 6 & 12 VOLT/12 A DC Power Supply



Battery Eliminator, Charger, Model RR, Plater, Aircraft, Marine or any DC Req. Extra Hvy Dty Selenium Rectifier 2 METERS V&A Desg'nd for cont. service & up to 20 amps intermittent overload. Model T612V12AC..........Special $32.00

New 110-115 VDC Power Supplies

for Fans, Shavers, Motors, Bells, Drills, Solenoids, Business Machines, Battery Chgrs, Machine Tools & Signal Systems. up to 50w......$4.95; up to 100w......$7.95 up to 250w....$12.95; up to 350w....$14.95 up to 800w..$28.95; up to 1100w..$32.95

NEW VARIABLE VOLTAGE XFMRS

Superior—Gr—Staco—Utc

0-132V 1.25A ....$ 7.99
0-135V 3A..............11.99
Cased 0-135V 7.5A..........21.95
Uncased 0-135V 7.5A..........17.25
Cased 0-270V 3A..........24.95
Uncased 0-270V 3A..........18.95
Cased 0-135V 15A..........41.98
Cased 0-270V 9A..........41.98
Six or more 10% Disc

ALL NEW DUAL VOLTAGE PHONO CARTRIDGE

$1.70 ea LOTS OF 6

Replaces 127 Popular Make & Type Cartridges

95% OF ALL 78 RPM'S

Externally mounted condenser slips off for output of 4½ Volts. With condenser in place, voltage at output terminals is 2 volts. Freq. response 6000 cy. A terrific Deal for Servicemen. Write for Replacement Chart. Singly $1.80 ea.

COMPONENT KITS

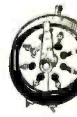
Resistors 100 Asst'd .95 ea.........6/.85 ea.
Tube Sockets 20 Asst'd .85 ea.......6/.75 ea.
Ceramicon Cond. 25 Asst'd.........6/.75 ea.
Vit WW Res. 15 Asst'd ....6/$1.25 ea.
Knobs 10 Asst'd .98 ea..............6/.89 ea.

NEW OIL CONDENSERS

1.3 MFD/2400WVDC.... .89 @ 6/$3
1.5 MFD/3000WVDC $1.69 @ ;4/$5
25 MFD/1000WVDC $6 @ ; 2/$10
26 MFD/1000WVDC $7 @ ; 2/$12
48 MFD/1000WVDC $10 @ ;2/$15
0.25MFD/1200WVDC 30c; 20/$3
Write for Complete Listing & Qty. Price

Write for "TABOGRAM" Bargain Sheet

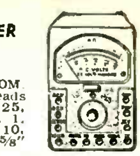
RHEOSTAT BUY



15 Ohm 25W....$1.10; 10/$7
50 Ohm 25W....$1.10; 10/$7
75 Ohm 25W..$1.98; 10/$14
125 Ohm 25W....$1.10; 10/$7
250 Ohm 25W....$1.10; 10/$6
500 Ohm 25W....$1.10; 10/$7
1200 Ohm 225W..$2.98; 2/$5
5000 Ohm 25W $1.25; 10/$9
Write for Quantity Prices

ONCE AGAIN BY DEMAND

Pocket AC-DC MULTITESTER "TAB" 27C



$9.45 Lots of 3

Hi-accuracy Precision VOM 1000 Ohms per V. Reads AC & DC Volts 0, 5, 25, 250, 1000 V. DCMA; 0, 1, 10, 100 MA. Ohms 0, 10, 100 K. Size 1¼" D. 4⅝" L. 3¼" W. Test Leads
Singly $9.95 (plus 40c ship in U.S.A.)

NEW SONIC SOUND GENERATOR 115VAC INPUT

Agitates! Cleans Washes • Mixes

"TAB" SPECIAL **$19.95**

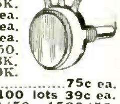
Write for Complete Details

★ TEST EQUIPMENT ★

EMC 208 Tube Tester................$21.95
EMC 206 Mutual Cond. Tube Tester $83.50 Reg. ....Special $67.50
HICKOK 600A Mutual Cond. Tube Tester $164 Reg.........Special $150.00
TRIPLETT 630 VOM $38.71 Reg...$36
SIMPSON 260 VOM $38.17 Reg.....$36

$ $ Prices Slashed $ $

AB "J" POTENTIOMETERS



Short Shaft ⅛", 150, 200, 500, 3K, 5K, 10K, 15K, 25K, 30K, 50K Ohms............60c ea.
12 or more ass'td..........50c ea.
Lots of 100......Special 30c ea.
W/Shaft ¼" & up, 5, 50, 150, 200, 1K, 1500, 2K, 2500, 3K, 10K, 25K, 30K, 50K, 70K, 100K, 750K, 10 megohms..............75c ea.
12 or more ass'td 60c ea; 100 lots 39c ea.
Dual ⅜" Shaft & up, 150/50, 1500/50, 1500/500, 2x25K, 25K/450, 25K/5K, 35K/5K, 50K/5K, 2x500K, 2x1 meg, 2x10 meg. Triple 5K/1K/1 meg, 3x750K ohms $1.00 ea; 12 or more ass'td 75c ea; 100 lots...50c ea.

"TAB" DO-IT-YOURSELF TOOLS

HI Quality Power Saws

Cummins 6⅜" Maxsaw (90° cut 2⅛" 45° cut dress 2x4) "TAB" Bargain Buy @ $39.95
THOR 5" Power Saw (90°+45° cut) Special $22.50

Thor Electric Speed Drills

200 J ¼" Electric Speed Drill w/Jacobs chuck, 2400 RPM/115 VAC only $14.25
400J ½" Electric Speed Drill w/geared chuck, 425 RPM/115 VAC $29.95

Chrome Vanadium Speed Drills

60 pc Set #1 to 60 C.V.....................$5.95
29 pc Set 1/16" to ½" by 64th.......$7.98
13 pc Set 1/16" to ¼" with Index....$1.98
Drill Index HUOT for 60 pc Set..........$1.49

Esico Soldering Irons 115 VAC-DC

60W ¼" Tip......$1.91
100W ⅜" Tip......$2.51
130W ½" Tip......$3.17
100W† ⅜" Tip....$5.29
300W† ⅞" Tip....$8.18
†Industrial Constant Use 120 VAC-DC

Thor Bench Speed Grinder

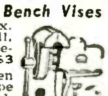
Model 117—3450 RPM, 115 VAC motor; 2 wheels 4½"x⅜"x⅜"; (1-60 grit, 1-120 grit) Self-aligning. Oilless 1 pc. Aluminum Body. Precision mfg. Special only $12.39.

Servicemen! Radio, TV, Refrig Kit

Time Saver Master Kit 17 pc includes every nut & screw driver used in Radio, Refrigerator & TV repair. Kit contains Hvy duty handle. Ratchet & extension drive, (2) Phillips & (3) screwdriver long blades, (8) Nut drivers ¼" to 9/16" (Deeply recessed for long chassis screws), Hi Quality Tempered Steel, Case, Gtd to SATISFY, Special.........................$5.98 ea; 3 for $17

Swiss "Quickie" Wrench, 10 way. Fits 95% all sizes Sq & Hex Head nuts & bolts ¼" to 9/16". Gtd. Rustproof, Brkproof (Prepaid USA) ....98c, 6/$5
Swedish Hand Saw, 24 to 30" long, Crosscut Finest Sandvick Steel..................$3.98

Wilton Quality Utility Bench Vises



V107-2½" jaw width, max. open 2¼" Straightline Pull, Acme Thread Spindle & Malleable iron casting $3
V106-3" jaw width max, open 3" w/swivel Base, Steel pipe jaws & wire cut-off tool, Rugged $5.75
Write For New "Thor" Tool Catalog

• 1st Quality • No Electrical or Mechanical Rejects

TUBES!! *FULL RETMA WARRANTY*

• Individually Boxed • Hickock Mu Tested •

WE WHOLESALE TO SERVICEMEN, DEALERS & INDUSTRY

0A2	.74	2E5	.92	6B8	.64	6SN7	.59	12BE6	.62
0A3	.98	2V3	2.90	6BA6	.48	6SQ7	.56	12BH7	.99
0B2	.74	2X2A	1.15	6BC5	.75	6SR7	.60	12C8	.62
0B3	1.19	3A4	.48	6BD6	.74	6SS7	.89	12H6	.48
0C3	.88	3B4	2.70	6BE6	.54	6SU7	4.20	12J5	.48
0D3	.78	3B7	.56	6BG6	1.58	6T7	1.27	12K8	.78
0Z4	.50	3D6	.46	6BH6	.62	6T8	.82	12SC7	.78
1A5GT	.64	3Q5	.68	6BJ6	.68	6U5	.99	12SF7	.78
1A7GT	.96	3S4	.46	6BK7A	1.11	6U7	.64	12SH7	.62
1AD4	3.95	3V4	.79	6BL7	1.19	6V6GT	.56	12SJ7	.54
1AE4	3.75	4BZ7	1.55	6BN6	1.19	6W4	.38	12SK7	.62
1AH4	1.07	5AX4	1.22	6BQ6	.98	6X4	.42	12SL7	.62
1AX2	1.25	5AZ4	.54	6C4	.46	6X5	.46	12SN7	.81
1B3	.79	5R4GYW	1.56	6C5	.68	6Z7	2.11	12SQ7	.54
1C6	.49	5T4	1.48	6C6	.56	7A4	.78	12SR7	.46
1D8GT	.89	5U4	.54	6C8	.82	7A5	.74	12Z3	.89
1E5	.69	5V4	1.28	6CB6	1.58	7A7	.79	14A7	.89
1E7	.49	5X4G	.78	6CD6	1.58	7A8	.68	14AF7	.95
1G4GT	.69	5Y3	.42	6D6	.84	7AD7	1.41	19BG6	1.98
1G5	.69	5Y4	.62	6D8	.81	7B4	.81	19T8	1.49
1G6GT	.49	6A3	1.29	6E5	1.09	7B6	.72	19V8	1.96
1H4G	.49	6A5	2.98	6F5	.91	7B8	.82	24A	.92
1H5GT	.72	6A6	.81	6F6	.76	7C4	.68	25A6	1.79
1H6	.69	6A7	1.09	6F8	.86	7C7	.54	25BQ6	1.30
1J6G	.79	6A8GT	1.09	6G6	.92	7E6	.54	25L6	.46
1L4	.48	6AB4	.62	6H6	.57	7E7	.72	25Y5	.84
1LA4	1.01	6AB7	.78	6J4	4.59	7F7	.82	25Z6	.60
1LB4	1.09	6AC5	1.19	6J5	.46	7F8	1.18	26	.79
1LC6	.89	6AC7	.68	6J6	.58	7H7	.72	28D7	1.29
1LD5	.98	6AF6	1.18	6J7	.72	7N7	.90	34	.69
1LE3	.99	6AG5	.71	6K6	.61	7S7	1.29	35/51	.60
1LH4	1.01	6AG7	1.14	6K7	.46	7V7	1.06	35A5	.71
1LN5	.78	6AH6	.88	6L5	1.09	7X6	.89	35B5	.54
1P5	.78	6AK5	.62	6L6	.98	7Y4	.64	35C5	.71
1Q5	1.19	6AK6	.74	6L7	.80	10	.49	35Y4	.68
1R4	.96	6AL5	.48	6N7	.80	12A6	.48	35Z3	.69
1R5	.58	6AL7	1.22	6P5	.99	12A8	.79	35Z4	.64
1S4	.88	6AQ5	.52	6Q7	.81	12AH7	.92	38	.58
1S5	.66	6AQ6	.54	6R8	7.44	12AL5	.54	39/44	.56
1T4	.68	6AR6	2.74	6S4	.99	12AT6	.46	45Z3	.66
1T5	.98	6AS6	2.22	6S7	1.30	12AT7	.82	49	1.29
1U4	.52	6AS7	3.48	6S8	.92	12AU6	.61	50A5	.72
1U5	.54	6AT6	.42	6SA7	.67	12AU7	.58	50C5	.54
1V2	.68	6AU6	.48	6SC7	.74	12AV6	.52	50L6	.60
1X2A	.88	6AV5	.84	6SF7	.74	12AW6	.84	71A	.74
2A4	2.37	6AV6	.48	6SG7	.62	12AX7	.78	75	.82
2A5	.78	6AX4	.81	6SH7	.46	12AY7	1.22	76	.68
2A6	1.49	6B4	1.12	6SJ7	.69	12BA6	.69	77	.68
2A7	.89	6B5	1.18	6SK7	.54	12BA7	.94	83V	1.22
2B7	.89	6B7	.91	6SL7	.62	12BD6	.65	117Z3	68

CIRCUIT BREAKERS

He'nmann Magn Bkrs. Amps; 3, 5, 7, 9, 10, 12, 30, 40, 80, 180. ea. $1.98; 12/ $20 50/$75
Sq D & CH Toggle Sw. Bkrs. Amps; 5, 10, 15, 20, 25 @ 98c;
Klixon Therma Push Button Bkrs. Amps; 5, 10, 15, 20, 25, 30..........89c; 10/$7.98

"TAB" *All Mdse. Sold ON MONEY BACK* **GUARANTEE**

PRECISION RESISTORS

W.E. — IRC — Wilkor
1% Accuracy Gtd.
SPECIAL 25c ea.
10 of One Value........**20c ea.**
100 of One Value.............................$15
10 Asst'd Values.............................$2.50
Write for Complete Listing

HI-FI SPEAKERS

Inbuilt network, 2 wires needed for HF & LF Response, Famous Hi Fi Speaker Mfgs. 15" Coaxical PM & 5" Tweeter 25 Watt/20-17500 cycles.
MODEL P25CO $19.50
12" Coaxical PM & 3½" Tweeter 12 Watt/45-15000 cy. Special $12.75; 3 for $35
8" Coaxical PM & 2½" Tw/8w/70-15Kc MODEL P8CO...................$7.98; 2 for $15
12" HI-FI PM 10w/35-14KC....$10; 2/$18
8" HI-FI PM 7w/45-14KC......$7.25; 2/$13

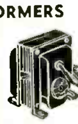
HI-FI Audio Components

Phono Cart. & N'dles Gtd.

RPX050* Dual .001&.003 $6.98
RPX052* Gold Treas*........19.98
RPX041* (S) .001.............. 5.25
RPX040* (S) .003............................. 5.25
RPX053* (DD) Gold Treas*.............$28.98
*GE Original Boxed, $, $, $, Back Gtd.
RPJ010 Dual (S) .001 & .003 (GE)....$1.98
RPJ012 Dual (D) .001&.003 "Tetrad" 18.99
RPJ013 Dual(DS).001&.003 "Tetrad" 10.99
RPJ003 or RPJ004 Sing D "Tetrad" 9.99
RPJ001 or RPJ005 Sing S (GE).......... 1.35
MG or 78 Single Sapphire Styli..........$1.15
MG and 78 Dual Sapphire $1.98; 4/ 7.50
MG or 78 Single Diamond "Tetrad".. 9.89
MG and 78 Dual Diamond "Tetrad"....20.89

4 MFD/1200 VDC or 10 MFD/600 VDC (or ass'td) Lots 12 $1.50 ea.; Singly. $1.79
HOOK UP WIRE. Ass'td 5 Colors. 100 ft p/roll; 500 ft $1.98 ea;..............6/$10
CLAMP LAMP, Adjustable, w/Bulb & Reflector $1.57 ea;...............................7/$10
WILLIAMSON AMPLIFIER KIT, Ultra linear 20 Watts. 10-70 KC/10W (+ −) 1 DB. Model TAB 20 $47.50. Wired to go...$61
866A KIT (2) 866A Tubes, Sockets, & Transformer...$4.98

230 TO 115V AUTOFORMERS



For 220-240 V/50-60 cy in. To 110-120 v or step-up.† w/ Cord, Plug & Receptacle.
TPA050/50W* $2.55
TPA075/75W* $3.65
TPA100/100W† $4.00
TPA200/200W† $5.75
TPA250/250W† $6.75
TPA300/300W† $7.25
TPA500/500W$8.25; TPA750/750W$11.75
Model TPA1000/1000W/1KW..........$16.95
Model TPA2000/2000W/2KW $34.00
$100 Order Take 10% Disc. *Less C, P&R

TERRIFIC OFFER!! *Crystal Diode*

IN21 

"TAB" SPECIAL **25c each** 5 for $1.00 100 for $15

TV BARGAIN VALUES

Television Antennas

Fringmaster V Conical, Broad response. All Ch. $6.69
TV Conical Ant. All Channel Sturdy 10 Elements, cross bar & clamp $3.49; 3 for $9.49
Double V Ant. All Channel w/mtg clamps. Hvy duty $3.49
VHF Bow Tie & Reflector $1.95
Corner Array w/Bow Tie (UHF ch 14-83) Flicker free, Hi Gain............Special $6.49
Panoramic Broad Band "Yagi" VHF (Ch covered 2-6) $41 Reg............Only $19.95
Channels (7-13) $21 Reg.........Now $10.95

"TAB" Accessory Specials!!

300 Ohm Twinex 65 Mil Hvy duty, 100 ft @ $1.19; 1000 ft @.....................$10.25
RG59U 73 Ohm, 100 ft $5; 500 ft $22

NEW 106W/SEC PHOTOFLASH

AC & Dry Battery Kit

Includes condensers two/525 MFD/450V/Total 106W/Secds. Resistors capacitors, rectifier, flash tube in indicating flash gun, guide #40 Daylight Kodachrome, 120 on Ektachrome. Does not Incl Battery. AC ONLY..............................$35.98
Five (5) 90V (N60) Batteries @ $12.50
Flash Lamp Gun, Holder & 10" wide range Reflector $4.98; w/Lo or Hi volt Flash Trigger Coil lamp........................$12.98
525MFD/450V/53W'Scds Cond. new low leakage famous mfr.. DATED $8; 2/$15
16 MFD/2500VDC/60WS/OIL $6; 2/$10
16 MFD/1.8 to 2.8KV/60WS $5; 2/$8
CK5517 mini gas rectifier.................$2.88
600 VAC Selenium Rectifier................$4.25
1600VDC Selenium Rectifier..............$2.98
Electronic Flash Handbook ckt. data 50c

FOTOFLASH & STROBE LAMPS

"TAB" No.	Replaces	W-Sec. Max	Each
TLW	FA 104/FT118	150	$ 5.98
THI	AMGLO 5804X	100	10.98
23ST	GE FT 210	200	9.98
THVA	SYLV. 4330	200	9.98
V4X4	X400	200	10.98
TLX	DX & FA10Q	150	9.00
TDX	DXC/250-350	150	10.00
353GTQ	FT 503	2000	49.98

Trigger Coil for LO Volt Flash $1.47
Write for "TAB" Flash Tube Data 50c

HI-FI RECORDING TAPE

Finest, $, $, $, Back Gtd

PRECISION COATED & SLIT, Gtd Splice free. Quality Controlled. Plastic Base. Gtd Constant Output. Freq. 7½ IPS 40-15KC Oxide Wnd In 7½" reel; 1200 ft. per reel

Sold Singly **$1.80** Twelve Lot Special **$1.58 ea.**

POWER SUPPLY KIT, Incls. Transformer, Selenium Rectifier and Filter Condensers "TAB" Buy Only $2.25 ea.;...3 for $1.98 ea.
GTD VINYL ELECTRIC TAPE, Hi Volt ¾" x 30 ft. @ ....6 for $2.00
SOUND POWER HEADSET, Chest & Throat Mike U.S.N..................Per Pair $29.98
MICROSWITCH KIT, Assorted Types. Special 4 for $1.00:.......................20 for $4.00
PLANETARY DRIVE, 5:1 & 1:1, Bargain Buy Only.......................................$2.49 ea.

CIRCULAR SLIDE RULE

Equiv. 12" only 2⅛" radius, Laminated Mult. Div. Sqs. Cubes & Roots. Log & Dec. Scales. Data & Case 98c ea; 6/$5.00

NEW PRECISION POTENTIOMETERS

Helipot 1000 Ohm/0.5%/$6.49
Helipot 2000 Ohm/0.5%/$6.49
Helipot 5000 Ohm/0.5%/$6.49
Micropot 5000 Ohm/0.1%/10 Turns $6.49
Micropot 20000 Ohm/0.1%/10 Turn $6.49
Buy in Quantity 6 for $24

TRANSFORMERS

All 115 V 60 Cyc Input TV, & CR pwr Xmfr up to 20" tubes. Hi VOLTS to 20KV (w/quadrupler ckt.) ALL tubes. PL & FIL wndgs. 5000 VDC/5MA, 300 VDC/275 Ma Full-Wave, 6.4V/10.3A,5.4V/8A,2.5V/3A Hypersil Core, Oil Fill $4.98; 2 for $8.50; 6 for $22.00
2500V/20MA, 6.3V/.6A, 2.5V/1.75A for BC412 Scope Replmt.........................$7.98
900V/35MA 2X2.5V/2A, XCLENT 1800V DBLR TWO 2X2 FIL WNDGS..............$1.98
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