HOW TO TEST YOUR FM TUNER

RADIO & TV NEWS

NOVEMBER
1957
35 CENTS

World's Leading Electronics Magazine

A TELEPHONE OPERATED SWITCH
(See Page 51)

TELEMETRY IN FLIGHT TESTING

SINGLE-SIDEBAND RECEIVING ADAPTER

WHY LOW-EFFICIENCY SPEAKER SYSTEMS?

TV REMOTE CONTROLS FOR THE TECHNICIAN

INTERFERENCE-FREE AM RECEPTION

ERVICE TECHNIQUES FOR STANDARD COIL TUNERS

OAX LINE R. F. MONITOR

HEART RECORDING
(See Page 65)

A wonderful offer from the RAYTHEON RECEIVING TUBE DISTRIBUTORS who sponsor the RAYTHEON BONDED DEALER PROGRAM

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ELECTRONICS TECHNICIAN

AN INDEX to a BETTER JOB, A BRIGHTER FUTURE

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- Radar
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- Micro-Waves
- Communications
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Why you need every feature of these

NEW UNIVERSITY FOLDED-HORN ENCLOSURE KwiKits

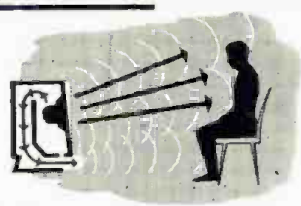
Because . . . in performance, mechanical design, construction and ease of assembly, these new KwiKits are unquestionably the *very finest* enclosure kits—at any price!

KEN-12 For 12" speakers & systems 15½"D x 21½"W x 29½"H — **$44.75** USER NET

KEN-15 For 12"/15" speakers & systems 18½"D x 29"W x 35½"H — **$59.50** USER NET

Adapter for mounting 12" speakers in KEN-15 — $1.50 User Net

ROOM-BALANCED PERFORMANCE



KwiKit acoustic design and tilted baffle combine direct speaker radiation and compensated rear horn loading in a way that blends bass, middle and treble ranges perfectly . . . for *uniform* response throughout the listening areas of a room.

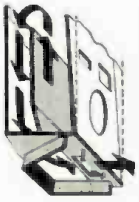
HEAVIER CONSTRUCTION

Heavy ¾" first grade, fully cured lumber for top, bottom, sides and back . . . *not* flimsy ½" wood commonly used in "kits." Bigger, sturdier — *as much as 30% heavier* than others in the same price class. Eliminates spurious resonances so detrimental to achieving richer, cleaner bass reproduction.

PRECISION MECHANICAL DESIGN

Exterior and interior elements, even the cleats, fit snugly within close tolerance "rabbeted" grooves. Gluing and screwing of each piece results in reliably air-tight, permanent joints. No nails used. No pencil markings necessary. Mitering and plenty of glue blocks and bracing for truly rigid construction.

PLACE ANYWHERE IN ROOM



Underside view shows how advanced design, self-contained folded horn extends to the *front* of the cabinet, projecting low frequencies out into the room . . . not back into a corner, splashed against the walls. Small slot in base is resistively controlled vent which equalizes woofer diaphragm excursions in compression chamber. KwiKits are therefore independent of room furnishings, shape or placement and can be used against a flat wall, in a corner . . . even up in the air!

FOOLPROOF ASSEMBLY

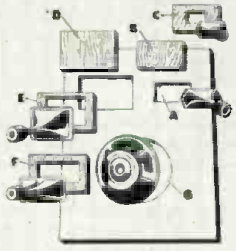
All pieces are pre-cut and pre-drilled . . . *engineered* to go together quickly. All you need is a screwdriver! Baffle board is pre-cut . . . blank plugs and adapters supplied for easy installation of additional components as your system expands.

Your KwiKit includes all required hardware, plastic wood, glue, sandpaper, Tuffiex insulation, easy-to-follow instructions *and* . . . special attention is given to packaging of KwiKits to insure safe, intact delivery to your door.

PROFESSIONAL RESULTS

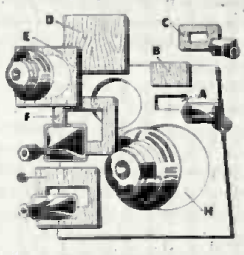
There's no end of decorative treatment you can give your KwiKit enclosure. Genuine Korina veneer is same as used in fine furniture, and provides a beautiful finish. Decorative front mouldings have been designed to complement and enhance your present decor. Exquisite, textured grille fabric is equally at home in settings of any period and is acoustically correct to prevent high frequency attenuation.

KWIKITS . . . THE PERFECT COMPLEMENT FOR P.S.E.*



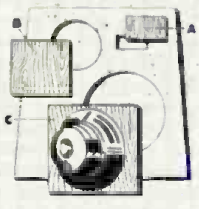
A—Hole cut out for HF-206.
B—Blank plug supplied when tweeter isn't used.
C—Adapter supplied cut out for UXT-5.
D—Blank plug supplied.
E—Adapter supplied cut out for 4409.
F—Adapter supplied cut out for H-600 horn.
G—Takes 312, UXC-123, Diffusicone-12, UXC-122, Diffaxials, 6200, 6201 wide-range speakers and C-12W woofer.

MODEL KEN-12
takes any 12" wide-range or woofer cone speaker and any tweeter or mid-range speakers.



A—Hole cut out for HF-206.
B—Blank plug supplied when tweeter isn't used.
C—Adapter supplied cut out for UXT-5.
D—Blank plug supplied.
E—Adapter supplied cut out for C-8W or Diffusicone-8.
F—Adapter supplied cut out for 4409.
G—Adapter supplied cut out for H-600 horn.
H—Takes 315-C, 6303, Diffusicone-15 Diffaxials, and C-15W, C-63W woofers.

MODEL KEN-15
takes any 15" wide-range or woofer cone speaker and any tweeter or mid-range speakers.



A and B—Blank plugs supplied.
C—Takes 312, UXC-123, Diffusicone-12, UXC-122 Diffaxials, 6200, 6201 wide-range speakers and C-12W woofer.

MODEL KEN-15
takes any 12" wide-range or woofer cone speaker when 12" adapter board (optional) is used.

*University's Progressive Speaker Expansion Plan

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PHILCO brings you extra picture tube business and extra dollars this Fall with a hard-selling, nation-wide advertising campaign. See your PHILCO DISTRIBUTOR. Cash in on this sales-making opportunity.

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For the RECORD

"PAY-AS-YOU-SEE" TELEVISION

PERIODICALLY over the past ten years, the subject of "pay-see" TV has made the headlines. On September 18th, the FCC requested present or proposed TV station owners to file formal requests for permission to conduct trial subscription TV on a limited basis for a period of three years but stressed that such applications won't be acted upon prior to March 1st of next year.

Whether or not the final decision will be in favor of one of the proposed methods is problematical. At the moment, most of the Commissioners are in favor of such experiments while other FCC members are questioning the validity of any results that might be obtained. This latter group feels that tests made in localized areas might not be indicative of national acceptance at a later date.

To test the validity of any of the systems and to determine public acceptance or non-acceptance would involve experiments in a majority of the key areas throughout the country. The cost of such a series of tests more or less precludes such an experiment.

Although the FCC gave its blessing to such experiments, before actual licenses could be issued the Commission would have to resolve its present impasse with Congress—no small matter as things stand now. Congress has indicated that, as far as it is concerned, "pay-as-you-see" television is doomed. Most congressmen have indicated that they would vote against any legislation granting free use of the airwaves to profit-making corporations whose revenue derives from the "sale" of the public's air to the public.

As in the past, there is still a controversy as to whether the FCC has complete jurisdiction over such decisions or whether Congress has the final word. With both sides claiming this right, the matter may soon face a showdown. Irrespective of which argument prevails, "pay-as-you-see" television involving the transmission of signals through the air seems to have a hard road ahead of it.

There is, however, an alternative method of transmission—one not subject to control by either the FCC or Congress at the present time—that offers some possibilities of success. This is closed-circuit (wired) TV. This is "pay-as-you-see" television in a different form and at the present time is undergoing tests in Bartlesville, Oklahoma under the aegis of *Video Independent Theaters, Inc.* and dubbed "Telemovie System." Installed by *Jerrold Electronics Corporation* of Philadelphia as the first of its "Cable Theatres," the new set-up is a closed-circuit coaxial system whereby residents of the Oklahoma oil center can receive first-run movies in their own living rooms. The initial offering was the recently released *Warner Brothers'* "Pajama Game."

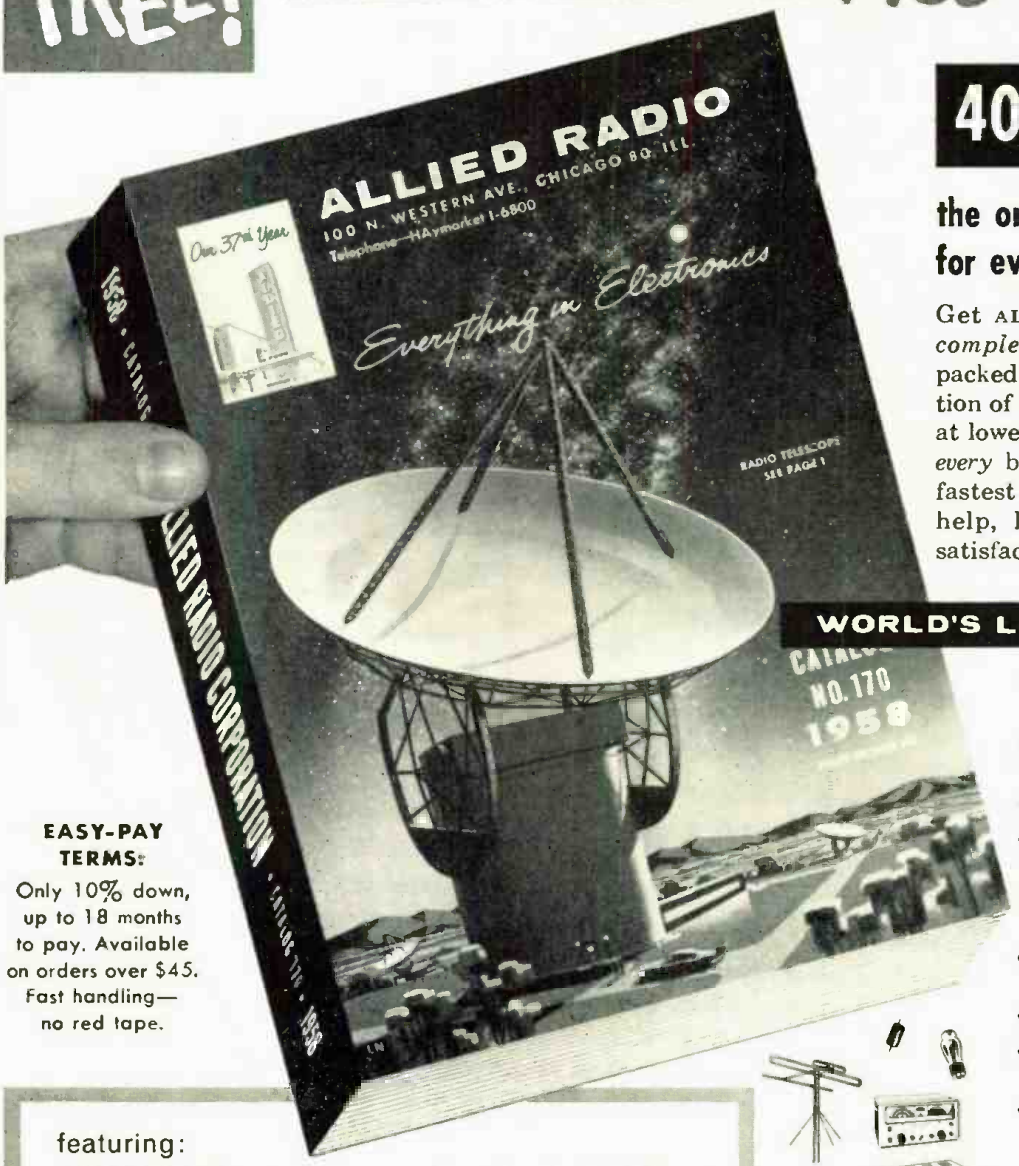
Subscribers pay a flat monthly fee of $9.50 and approximately 500 of the estimated 8000 television homes in Bartlesville have signed up for the first month's service. The operators estimate that at least a fourth of the TV homes, or 2000 subscribers, will be required before the system pays off.

Another planned installation which has made many headlines is in connection with the N. Y. Giant baseball club moving to San Francisco. A part of the agreement was that San Francisco will be wired for "pay-as-you-see" TV. Permission has already been granted by the local council for such an installation. Whether or not San Francisco will eventually have "pay-as-you-see" TV is hard to say at the moment. Many involved in the final decision feel that the cost of installation far exceeds the potential revenue that would make it a profitable enterprise.

All-in-all, wired TV seems to have some potential of success. With the exception of local regulations there are no Federal restrictions or controls that would cause bottlenecks or confusion at the present time. This is only a temporary situation. It is hard to believe that the FCC or Congress will continue to give it a free hand once it gets rolling. As long as it is a public service and comes under the heading of communications, transmissions, etc., the FCC claims it has the legal authority to put restricting rulings on all phases of the operation of any of these systems. If there is any doubt that the FCC does not have this control, rest assured Congress will give it to them.

Whether or not "pay-as-you-see" TV will benefit the public as a whole remains to be seen. If it means that movies, plays, major sporting events, etc. that would not *otherwise be available* to televiewers could be screened in the home, such systems would have a good chance of succeeding. If, however, such a service would result in the withdrawal of the better free TV programs from the air and their transferral to the closed-circuit lines, then the "fat would be in the fire." Another point—will the public pay $9.50 a month? It will be an interesting experiment to watch! . . . . W. S.

FREE! ALLIED'S 1958 CATALOG



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new dynamic tests produce high E.L.A.*

Sylvania damper tubes scored an **Earned Life Average* of 99.54% in a recent test of types in the 6AX4GT family. This means greater service reliability for you with an absolute minimum of trouble resulting from arcing, heater-cathode shorts and heater burnouts. It's the result of a new heater-cathode design introduced by Sylvania to meet your service needs.

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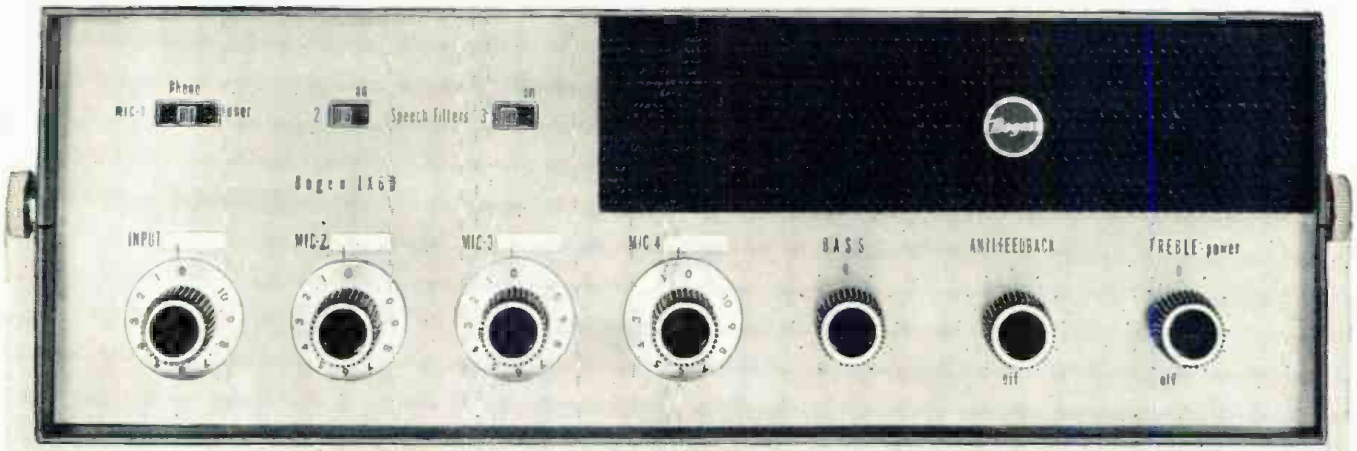

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Deluxe LX30 30-Watt Amplifier

4 Microphone Inputs (panel switch converts one microphone channel for phono or tuner); Built-In Remote Gain-Control Circuit; Exclusive Anti-Feedback Control; Speech Filters; Separate Bass and Treble Tone Controls.

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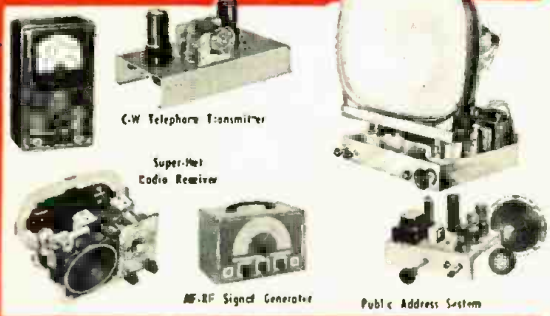

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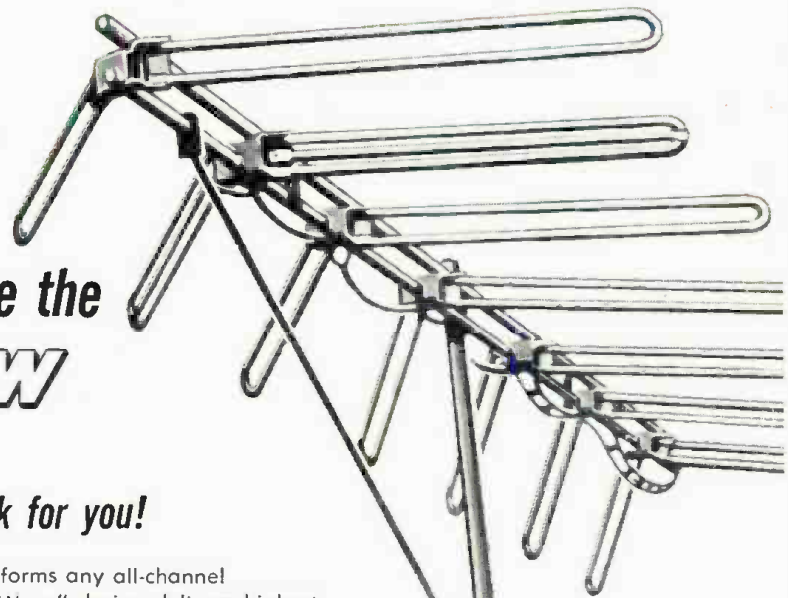
...because you don't feature the CHANNEL MASTER® T-W



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5-element
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Put these extra selling advantages to work for you!

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Stronger CONSTRUCTION! Super-strong in every detail of construction: Twin-Boom— the only antenna with 2 full length crossarms; 2 Super-Nests — the most powerful grip that ever held an antenna to the mast; Line-Lok — absorbs all transmission line tension; 7/16" dia. elements.

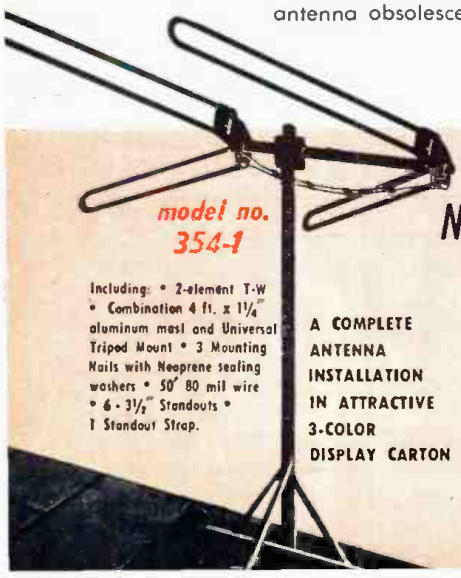
Bigger NATIONAL ADVERTISING! More than 75,000,000 advertising messages in America's leading national magazines. Now saturation coverage with big-space ads blanketing 173 prime outdoor antenna markets.

LIVE LEADS galore! Tens of thousands have already responded to Channel Master's Free "Antenna Check-Up Kit" offer — **repeated** in new national ads. Based on experience, 50% — and more — of these leads are converted into actual sales.

Local CO-OP ADVERTISING! The most liberal advertising allowance in the industry — so you can run your own local promotions. Channel Master dealers have the widest array of mats, radio and TV spots, and display materials.

Promoting ANTENNA REPLACEMENTS!
Channel Master's national advertising hammers home the theme of antenna obsolescence — opening new markets for you!

Call your Channel Master distributor now!



model no. 354-1

Including: • 2-element T-W • Combination 4 ft. x 1¼" aluminum mast and Universal Tripod Mount • 3 Mounting Nails with Neoprene sealing washers • 50' 80 mil wire • 6 - 3½" Standouts • 1 Standout Strap.

A COMPLETE ANTENNA INSTALLATION IN ATTRACTIVE 3-COLOR DISPLAY CARTON

NEW "INSTALL-IT-YOURSELF" ANTENNA KIT
featuring new 2 ELEMENT T-W ANTENNA

Designed for top performance in suburban and metropolitan areas. Powerful "Traveling Wave" principle provides the 2-element T-W with better all around performance than a stacked conical.

***Promotionally Priced at* $29.95 list**

CHANNEL MASTER CORP.
ELLENVILLE, N. Y.

WORLD'S LARGEST MANUFACTURER OF TV ANTENNAS AND ACCESSORIES

New Transcription-Type Tone Arm Makes *Collaro* World's First True High Fidelity Changer

The Turntable That Changes Records

From Collaro, Ltd., world's largest manufacturer of record playing equipment—comes the most significant development in the field in years—the new transcription-type tone arm.

This arm, exclusive with Collaro, literally changes the conventional record changer into a brand new instrument — a TRANSCRIPTION CHANGER — with features of the finest professional equipment.

The arm is a one-piece, spring-damped, counter-balanced unit which will take any standard high fidelity cartridge. It is free of any audio spectrum resonances. It permits the last record to be played with the same low stylus pressure as the first. Between the top and bottom of a stack of records there is a difference of less than a gram in tracking pressure as compared with 4 to 8 grams on conventional changers. Vertical and horizontal friction are reduced to the lowest possible level. These qualities, found only in the Collaro Transcription Changer, insure better performance and longer life for records and styli.

In its superb performance, the new Collaro Continental, Model TC-540, meets the rigid requirements for high fidelity equipment. Here, for the first time in a changer is professional quality at a record changer price. The Continental is $46.50. Other Collaro changers are priced from $37.50 up. (Prices slightly higher west of the Mississippi.)

In addition to the new tone arm, the Collaro Continental features include: 4 speeds, manual switch for turntable operation; wow and flutter specifications — 0.25% RMS at 33⅓ RPM — superior to any changer in the world; automatic intermix; automatic shut-off after last record; heavy duty 4-pole, shaded pole induction motor; heavy rim-weighted balanced turntable; muting switch and pop-click filter for elimination of extraneous noises; jam proof machinery; pre-wiring for easy installation; attractive two-tone color scheme to fit any decor; tropicalization to operate under adverse weather and humidity conditions; easy mounting on pre-cut board or base; custom testing at the factory for wow, flutter, stylus pressure and correct set down position.

FREE: Colorful new catalog describes complete Collaro line. Includes helpful guide on building record collection.

ROCKBAR Corporation

WRITE TO
ROCKBAR CORPORATION
Dept. R-011
650 Halstead, Mamaroneck, N.Y.

Rockbar is the American sales agent for Collaro and other fine companies.

Spot Radio News

★ **Presenting latest information on the Radio Industry.**

By RADIO & TV NEWS
WASHINGTON EDITOR

SCORES OF VITAL radio and TV bills were left in the till when Congress adjourned some weeks ago.

Shelved until the New Year was the controversial $7.00 excise tax credit measure that would be applied on TV sets which receive all of the channels.

Also tabled was Senator Mundt's bill which would make Inauguration Day a national holiday so . . . "that the whole nation could turn out every four years to see the Presidential inauguration ceremonies . . ." on TV.

Several bills prohibiting broadcasts of racing and lottery information were also put aside.

Representative O'Hara's bill prohibiting the use of any but Standard Time throughout the country was also put in mothballs: also Congressman Hale's proposal to exempt hotels from having to pay royalties for radio and TV programs and phonograph records received in rooms was neatly tied up and packed away.

Other bills that were not finalized were Senator Thurmond's pay-see TV item prohibiting charges for viewing TV in homes, and Senator Magnuson's request for an appropriation of up to a million dollars for each state for educational TV.

FOR MANY YEARS the only accurate method of evaluating a pilot's performance was to have an instructor watch his actions from a second seat in the plane. The Air Research and Development Command has developed an observation method—a telemetry system—which now allows personnel on the ground to view the action in airborne single-seat jet interceptor aircraft; in essence, the new approach allows one to "look over the pilot's shoulder."

In this application of telemetry the picture on the pilot's radar scope is radioed to the ground. This is accomplished by a series of high-frequency radio signals. The signals received on the ground reproduce what is seen on the pilot's radar scope; thus both the pilot and ground personnel have essentially the same picture.

ARDC scientists have found that their new telemetry system duplicates, with extreme accuracy and fidelity, the actual radar scope picture.

Installation of the newly developed telemetry system in interceptor aircraft will result in better training for all-weather interceptor pilots. By means of telemetry, the pilot's instructor will be able, through voice communication, to instruct the student from the ground. In addition, the ground reproduction of the pilot's radar scope face will aid the instructor in measuring the student pilot's performance, thereby providing a medium for improving the training of all-weather interceptor pilots.

For details on the use of telemetry in the design and flight-testing of aircraft, see the feature story on page 37.

NEW TELEVISION STATION GRANTS

An additional listing of new construction permits and changes that have been made in station call letters. List continued next month.

STATE	CITY	CALL	CHANNEL	FREQUENCY	POWER*
Mississippi	Biloxi	——	13	210-216	3
"	Gulfport	——	56	722-728	21.47
Nebraska	Hay Spring	——	4	66-72	100
"	North Platte	——	2	54-60	2.8
South Carolina	Charleston	——	4	66-72	58
Texas	Amarillo	——	7	174-180	46
"	Monahans	——	9	186-192	27.5
Washington	Kennewick	——	25	536-542	8.22

* ERP = (effective radiated power, kw.)

PAY-SEE TV was soundly scored by the American Veterans of World War II during their recent annual convention in Boston.

In a strongly worded resolution on toll-TV, representatives of AMVETS asked the FCC to return the issue to Congress and, in addition, requested that Congress table all legislation which would change the fundamental system of broadcasting in this country.

According to Dominick L. Strada, national commander of AMVETS, pay-TV could . . . "black out many of the free programs now seen by veterans at hospitals. We have no enforceable or legal assurances from the promoters of pay television that the free shows they now see could be continued without charge."

Continuing, the spokesman for the veterans said that . . . "Once pay TV is initiated, the major advertisers who now pay for the free TV entertainment given the American public will withdraw their support . . . since they will be unable to successfully advertise their products to large number of people in the better evening hours. . . ."

Without advertising revenue, the resolution said, public service shows, news, programs of the Armed Forces, government, veteran, and public affairs meetings would disappear.

A PLANE FOR FLIGHT CHECKING airways aids in Spain is now being equipped by the CAA in Washington.

The plane, a C-47 which the Spanish government bought in this country, will be equipped with about $100,000 worth of electronic and recording equipment for its work in the "Protection of Flight" section of the Spanish Ministry of Air. The project is being financed by the International Cooperation Administration as part of U. S. aid to Spain.

Equipment being installed is similar to that used in standard CAA flight check planes, with additional equipment necessitated by the facilities in use abroad.

THREE SPECIAL CONSOLES to calibrate radio-frequency voltmeters for science and industry have been developed by the Bureau of Standards experts and installed in the calibration center in Boulder, Colorado.

With these new voltmeters, it will be possible to calibrate for any practical voltage level starting with .2 volt at discrete frequencies of 30, 100, 300, and 1000 kc, and 5, 10, 30, 100, 300, 400, 500, and 700 mc.

Salient feature of the system is the application of the AT voltmeter, the most stable radio-frequency voltage reference standard known to date (See "Stable Radio-Frequency Voltmeters" in the *NBS Technical News Bulletin* for February, 1956). This voltmeter can reproduce calibration data to ±1 per-cent or better over a period of one year or longer. To make good use of such a standard, sources of error in

(*Continued on page* 120)

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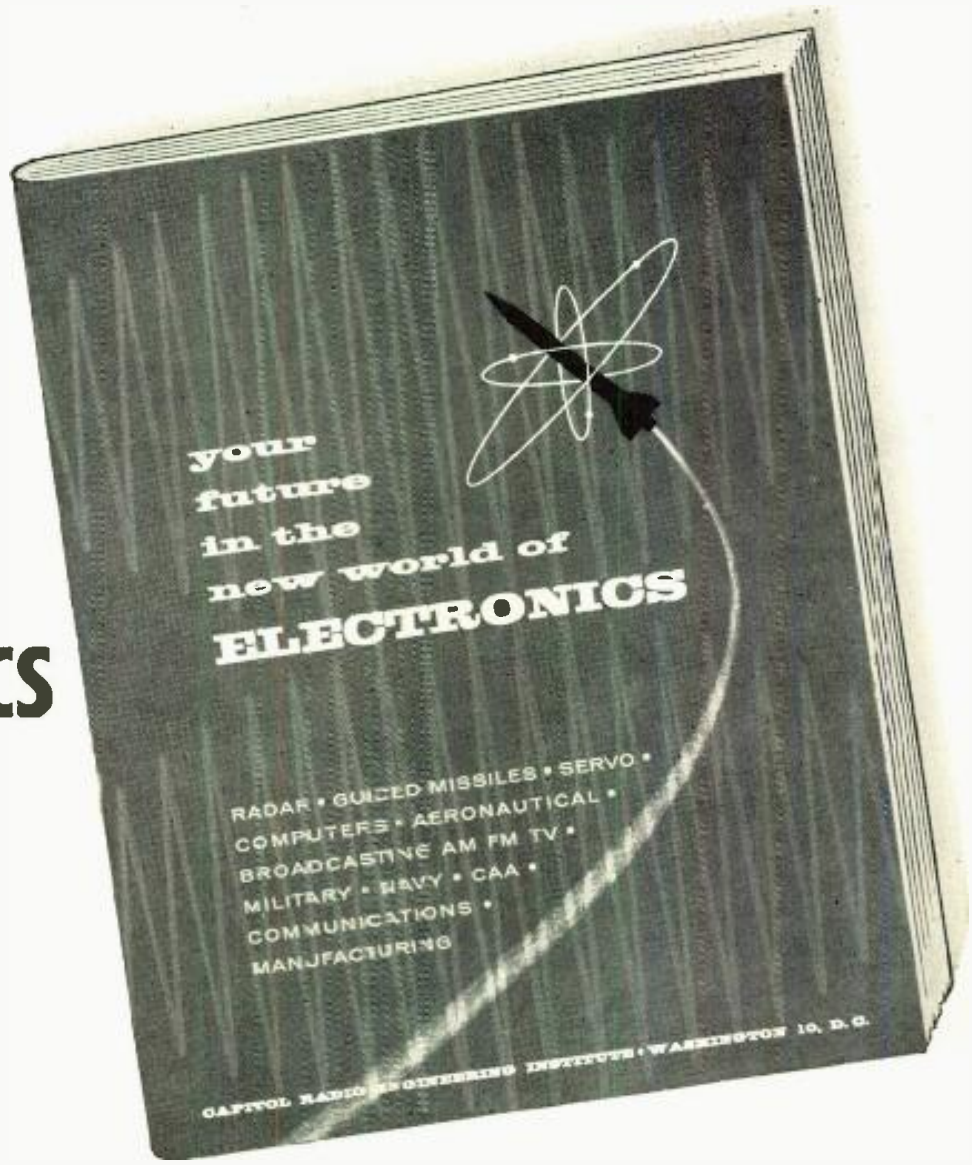

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CHECK: ☐ Home Study ☐ Residence School ☐ Korean Veteran

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Gyro-like Roto-Drive gives new Thorens TD-124 absolute speed uniformity. Heavier than 16-inch turntables, yet it starts, stops in less than 2/3 turn!

How to get the heaviest possible turntable for smooth, absolutely quiet operation without sacrificing fast starts and stops.

That's the problem Thorens engineers faced when they set out to build the best four-speed, 12-inch, hi-fi turntable money can buy. You'll be amazed at the simplicity of their solution.

The new TD-124 really has two turntables in one: (1) a heavy 10-lb. rim-concentrated, cast-iron flywheel (outweighs 16" aluminum turntables) (2) a light aluminum cover, or turntable proper. An exclusive, Thorens-originated clutch couples or decouples the light aluminum table to the heavy flywheel for instant starts and stops. What's more, the Thorens double turntable system gives you the weight of a cast-iron table (3 times as heavy as aluminum) without danger of attracting any pickup magnet. And with this unique construction, your pickup gets magnetic shielding from motor or transformer hum fields by the iron turntable.

Ask your hi-fi dealer to show you the Thorens TD-124. Better yet, arrange to hear one of those critical, slow piano records on the TD-124. If you don't know who your dealer is, write Thorens Company, Dept. R117, New Hyde Park, N. Y. 7.9

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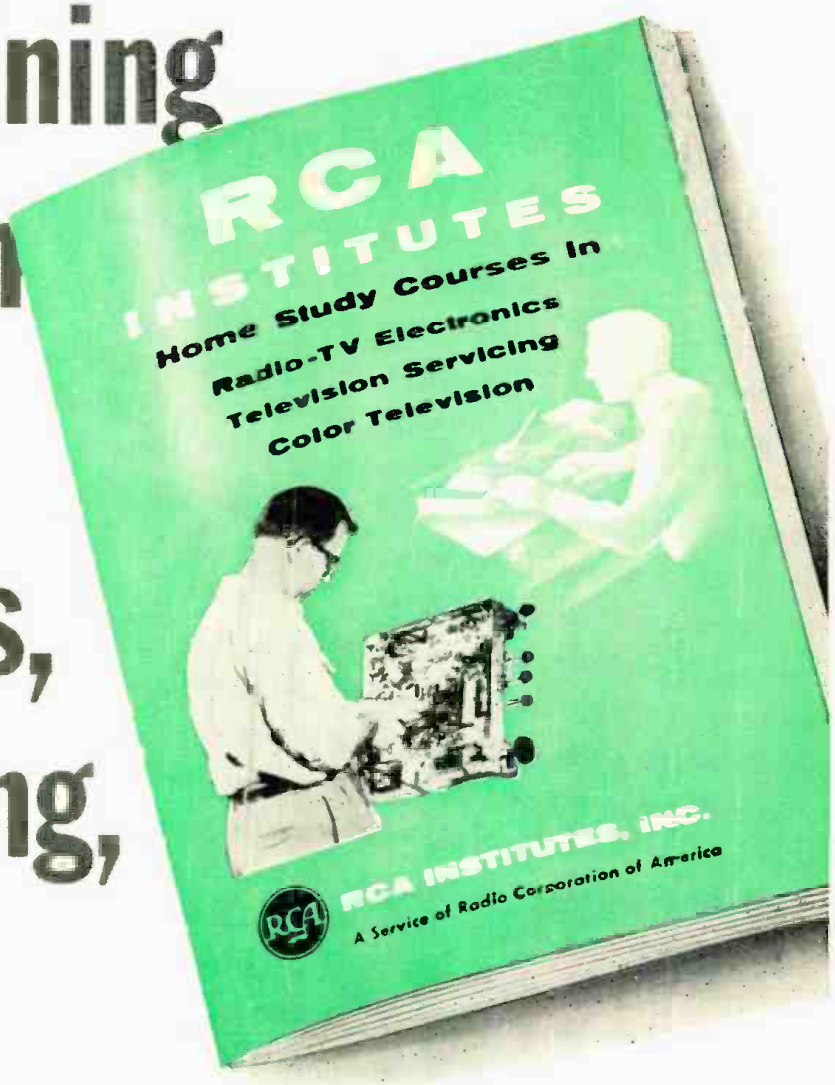

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what could be more exciting to a high fidelity enthusiast?

new GLASER-STEERS GS Seventy Seven*

the fully automatic record changer with turntable quality performance

At last — what every audiophile has been waiting for — the convenience of a fully automatic record changer with the performance quality of a transcription turntable.

The new GS-77 provides a quality of performance unsurpassed by turntables up to double the price. Flutter and wow are virtually non-existent. Rumble has, for all practical purposes, been eliminated. And as for automatic conveniences — it is, without doubt, the most advanced record changer of our time.

There is more originality in the GS-77 than in all other changers combined! See for yourself.

'SPEEDMINDER'* ... the amazing GS-77 feature that automatically selects correct turntable speed, and gives you record and stylus protection no other changer can equal.

You simply set the indicator to ***'SPEEDMINDER'*** and automation takes over . . .

- with the standard groove stylus in play position, the changer automatically plays at 78 rpm.
- with the microgroove stylus in position, the changer automatically intermixes and plays 33 and 45 rpm records without regard to speed, size, or sequence.

TURNTABLE PAUSES during change cycles and doesn't resume motion until next record has come into play position and stylus is in lead-in groove. Eliminates record surface wear caused by grinding action of record dropping on moving disc—a common draw-back in other changers. And the change cycle lasts only 5 seconds — fastest in the field.

* Trademark

***Every feature† spells**—Greater Convenience and Better Performance* — The ARM is shock suspended and damped, effecting complete acoustical isolation from deck plate and motor and practically eliminating resonance. An accessible vernier control adjusts stylus pressure to match any cartridge requirements. Once adjusted, the variation of stylus pressure between the first and tenth record on the table does not exceed 1 gram. Transcription arm convenience includes: finger lift for manual play, as well as indicator to facilitate location of stylus in groove. The MOTOR is 4-pole induction, dynamically balanced, hum shielded and shock mounted — all to assure accurate, constant speed, and smooth operation.

The IDLER and other rotating parts are precisely centered and mounted on low friction bearings. Idler automatically disengages in 'off' position. Prevents flat spots and wow. MUTING SWITCH and R/C filter network squelch all annoying sounds.

The GS-77 is absolutely jam-proof — built for years of trouble-free performance. A single knob controls all automatic and manual operations. The changer is pre-wired for easy installation, and is dimensioned to replace most changers.

less cartridge and base — ONLY **$59.50**

Styling of the new GS-77 is gracefully simple — enhanced by its ebony and brushed gold finish and oyster white turntable mat. For a thrilling experience — see it — hear it at your high fidelity dealer. Descriptive literature available on request. Dept. RTN-11.

† Patents Pending

GLASER-STEERS CORP. 20 Main Street, Belleville 9, N. J.
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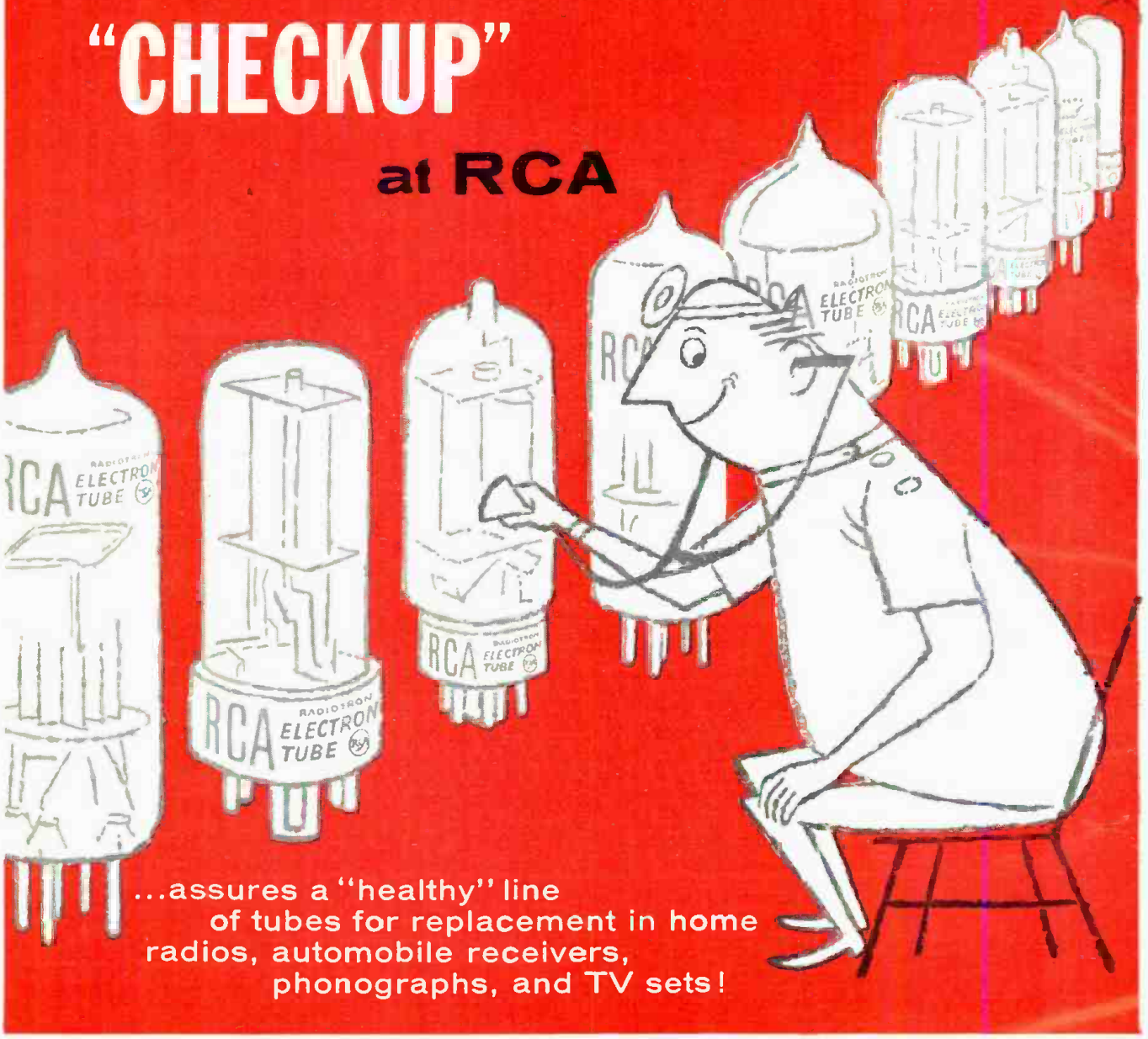

...assures a "healthy" line of tubes for replacement in home radios, automobile receivers, phonographs, and TV sets!

Fast service, efficient service—*without time-taking callbacks due to early hour tube failures*—are the vitamins, minerals, proteins and plasma of the healthy service business. "Out-of-the-carton" and "right-into-the-set" is the service dealer's dream. And RCA's rigid program of production-line testing and warehouse sampling converts it to reality.

Tests for shorts, heater-cathode leakage, and transconductance help weed-out the weaklings—assure superior-quality tubes. And where low noise and low microphonics are essential to top performance, certain tubes undergo visual and acoustic tests. Before RCA tubes are put into the famous red-and-black RCA carton they are tested all over again at the warehouse for "solid" shorts "flicker" shorts, and continuity. Add to this RCA's quality monitor: *microscopic inspection* of welds, seals, stems, and electrodes of all popular-types and new-type receiving tubes used in black-and-white and color-TV sets, and automobile receivers...and you have powerful reasons why RCA tubes are preferred by manufacturers of electronic equipment and by you who service it. So, never ask your distributor for "tubes" alone. Always specify: RCA TUBES!

Your "Profit Builders" Catalog

...now available from your RCA TUBE DISTRIBUTOR... lists and describes the many promotional, business, service, and technical aids RCA offers to service dealers. Get your copy and start building more profits right away.

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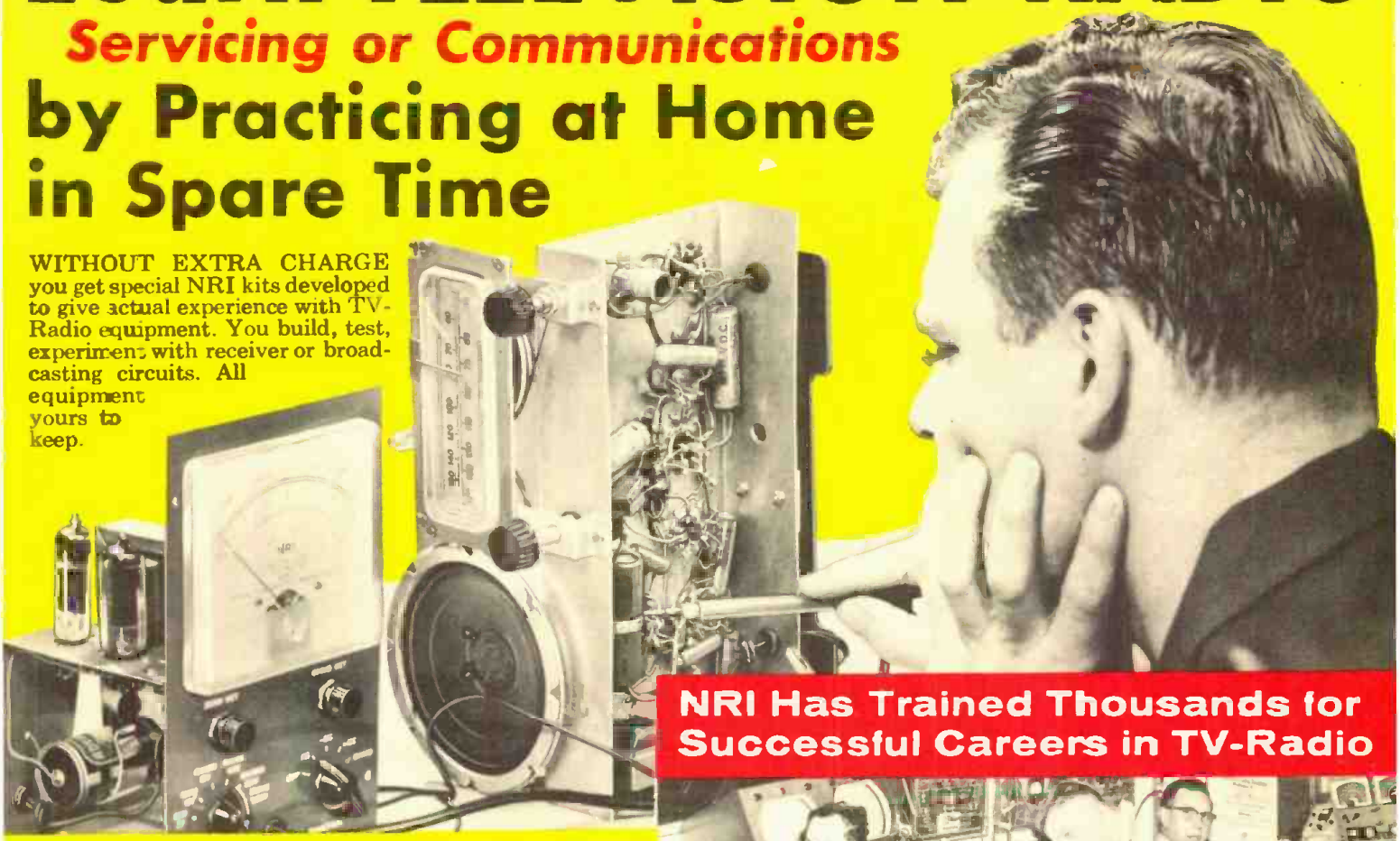

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"I am now Studio Engineer at Television Station KATV. Before enrolling for the NRI Course, I was held back by limitation of a sixth grade education." BILLY SANCHEZ, Pine Bluff, Ark.

Has All the Work He Can Do
"Since finishing NRI Course I have repaired more than 2,000 TV and Radio sets a year. NRI training certainly proved to be a good foundation." H. R. GORDON, Milledgeville, Ga.

Has Good Part Time Business
"Quite easly in my training I started servicing sets. Now have completely equipped shop. My NRI training is the backbone of my progress." E. A. BREDA, Tacoma, Wash.

Have the High Pay, Prestige, Good Future of a Skilled TV-Radio Technician

People *look up to* and depend on the Technician, more than ever before. Offices, plants, homes everywhere are obliged to buy his knowledge and services. His opportunities are great and are increasing. Become a TV-Radio Technician. At home, and in your spare time, *you* can learn to do this interesting, satisfying work—qualify for important pay. To ambitious men everywhere *here* in the fast growing Television-Radio field is rich promise of fascinating jobs, satisfaction and prestige as well as increasing personal prosperity.

Increased Opportunities in Growing Field

A steady stream of new Electronic products is increasing the job and promotion opportunities for Television-Radio Technicians. Right now, a solid, proven field of opportunity for good pay is servicing the tens of millions of Television and Radio sets now in use. The hundreds of TV and Radio Stations on the air offer interesting jobs for Operators and Technicians.

More Money Soon—Make $10 to $15 a Week Extra Fixing Sets in Spare Time

NRI students find it easy and profitable to start fixing sets for friends and neighbors a few months after enrolling. Picking up $10, $15 and more a week gives substantial extra spending money. Many who start in spare time soon build full time TV-Radio sales and service businesses.

Act Now—See What NRI Can Do for You

NRI has devoted over 40 years to developing simplified practical training methods. You train at home. Get practical experience, learn-by-doing. Address: NATIONAL RADIO INSTITUTE, Washington 16, D. C.

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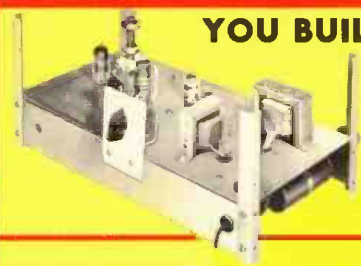
YOU BUILD AC-DC Superhet Receiver

NRI Servicing Course includes all needed parts. By introducing defects you get actual servicing experience practicing with this modern receiver. Learn-by-doing.



YOU BUILD Signal Generator

You build this Signal Generator. Learn how to compensate high frequency amplifiers, practice aligning typical I.F. amplifiers in receiver circuits. Make tests, conduct experiments.

YOU BUILD Broadcasting Transmitter

As part of NRI Communications Course you build this low power Transmitter, learn commercial broadcasting operators' methods, procedures. Train for your FCC Commercial Operator's License.

YOU BUILD Vacuum Tube Voltmeter

Use it to earn extra cash fixing neighbors' sets; bring to life theory you learn from NRI's easy-to-understand texts.

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Be a Television-Radio Technician

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J. E. Smith, Founder

Train at Home the NRI Way Famous for Over 40 Years

NRI is America's oldest and largest home study Television-Radio school. The more than 40 years' experience training men for success, the outstanding record and reputation of this school—benefits you in many ways. NRI methods are tested, proven. Successful graduates are everywhere, from coast to coast, in small towns and big cities. You train in your own home, keep your present job while learning. Many successful NRI men did not finish high school. Let us send you an actual lesson, judge for yourself how easy it is to learn.

No Experience Necessary—NRI Sends Many Kits for Practical Experience

You don't have to know anything about electricity or Radio to understand and succeed with NRI Courses. Clearly written, well-illustrated NRI lessons teach TV-Radio-Electronic principles. You get NRI kits for actual experience. All equipment is yours to keep. You learn-by-doing. Mailing the postage-free card may be one of the most important acts of your life. Do it now. Reasonable tuition. Low monthly payments available. Address: **NATIONAL RADIO INSTITUTE, Washington 16, D. C.**

NRI Graduates Do Important Work

Now Quality Control Chief
"Had no other training in Radio before enrolling, obtained job working on TV amplifiers before finishing course. Now Quality Control Chief." T. R. Favaloro, Norwich, N. Y.

NRI Course Easy to Understand
"I opened my own shop before receiving my diploma. I have had to hire extra help. I am independent in my own business." D. P. Cressey, Stockton, Cal.

Works on Color-TV
"NRI changed my whole life. If I had not taken the course, probably would still be a fireman, struggling along. Now Control Supervisor at WRCA-TV." J. F. Meline, NewYork, N Y.

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Practical CBS Transistor Home-Study Course

Learn all about transistors by using them

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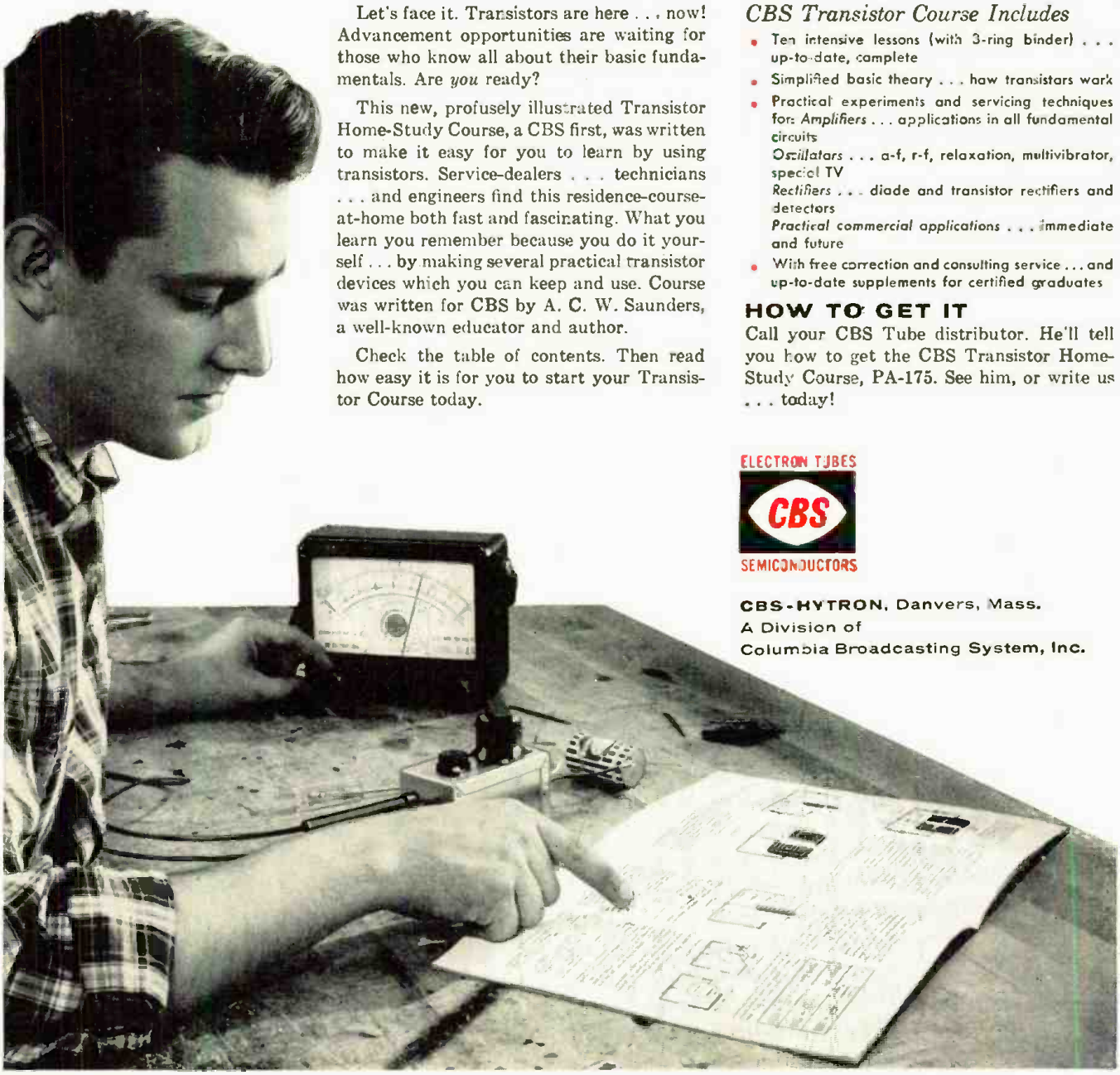

Let's face it. Transistors are here . . . now! Advancement opportunities are waiting for those who know all about their basic fundamentals. Are *you* ready?

This new, profusely illustrated Transistor Home-Study Course, a CBS first, was written to make it easy for you to learn by using transistors. Service-dealers . . . technicians . . . and engineers find this residence-course-at-home both fast and fascinating. What you learn you remember because you do it yourself . . . by making several practical transistor devices which you can keep and use. Course was written for CBS by A. C. W. Saunders, a well-known educator and author.

Check the table of contents. Then read how easy it is for you to start your Transistor Course today.

CBS Transistor Course Includes

- Ten intensive lessons (with 3-ring binder) . . . up-to-date, complete
- Simplified basic theory . . . how transistors work
- Practical experiments and servicing techniques for: *Amplifiers* . . . applications in all fundamental circuits
  Oscillators . . . a-f, r-f, relaxation, multivibrator, special TV
  Rectifiers . . . diode and transistor rectifiers and detectors
  Practical commercial applications . . . immediate and future
- With free correction and consulting service . . . and up-to-date supplements for certified graduates

HOW TO GET IT

Call your CBS Tube distributor. He'll tell you how to get the CBS Transistor Home-Study Course, PA-175. See him, or write us . . . today!

ELECTRON TUBES
CBS
SEMICONDUCTORS

CBS-HYTRON, Danvers, Mass.
A Division of
Columbia Broadcasting System, Inc.

Within the Industry

ARTHUR F. BALDENSPERGER, JR., has been appointed to the newly created position of management development coordinator, sales, for *CBS-Hytron,* a division of *Columbia Broadcasting System, Inc.*

According to the company, this move was made necessary by the expansion of the department. Mr. Baldensperger's background is said to amply qualify him to coordinate the sales training and management development activities of the firm's replacement, original equipment, and internal sales activities.

He is an alumnus of Dartmouth and New York State University and was formerly associated with *Sylvania Electric Products.*

* * *

DR. IRVING LANGMUIR, world famous scientist, died at Falmouth, Mass. recently at the age of 76.

The Nobel-prize winning scientist, often regarded as one of the scientific geniuses of modern times, was on the staff of the *General Electric* research laboratory from 1909 until his retirement in 1950.

During his long career with the firm, his researches were estimated to have saved the American public nearly one billion dollars per year in electric light bills, helped establish modern radio and television broadcasting, helped safeguard the lives of soldiers in battle, and, more recently, provided man with a key to possible control of the weather.

For his accomplishments, Dr. Langmuir received the world's top-ranking scientific awards, including the Nobel Prize in chemistry, granted to him in 1932.

* * *

REGINALD G. SCHULER has been named general engineering manager of *Brush Electronics Company,* a division of *Clevite Corporation.*

For the past two years he has served as director of engineering of the *Badger Meter Manufacturing Company.* Previously, he was for seven years research director of the *Victor Adding Machine Company* and before that was chief of the research department of the *Teletype Corporation.*

A recipient of B.S. and E.E. degrees from Armour Institute of Technology, Mr. Schuler is a member of the Institute of Radio Engineers, the Western Society of Engineers, and the Physics Club of Chicago.

In his new post, he will be fully responsible for the direction of the company's product engineering program.

* * *

INDUSTRO TRANSISTOR CORPORATION announces the completion of its initial transistor manufacturing facility located at 87-31 Britton Avenue, Elmhurst, N. Y. . . . **REK-O-KUT COMPANY, INC.,** is now located at 38-19 108th Street, Corona, N. Y. . . . The carrier-microwave department of **WESTINGHOUSE ELECTRIC CORPORATION** has expanded its facilities in Halethorpe, Md., by constructing a new, modern office building adjacent to the manufacturing plant . . . **MINNEAPOLIS-HONEYWELL REGULATOR COMPANY** has announced the leasing of a new $300.-000.00 plant in Fall River, Mass., for production of a new line of electronic industrial controls. The new plant is to be a manufacturing unit of the industrial division . . . **STACKPOLE CARBON COMPANY** has opened a large scale magnet production facility in a new 37,000 square foot plant in Kane, Pennsylvania . . . **JFD ELECTRONICS CORP.** is presently fabricating its own aluminum tubing in a new 10,000 square foot mill . . . **ELECTRONIC ENGINEERING COMPANY OF CALIFORNIA** has purchased 530,000 square feet of land in Santa Ana, Calif., for the expansion of its own facilities and for the construction of a new plant for its subsidiary, **THE ENGINEERED ELECTRONICS COMPANY** . . . An acre and a half is being added to the main plant of **DUKANE CORPORATION** . . . **MAGNECORD DIVISION** of **MIDWESTERN INSTRUMENTS, INC.** is being moved from Chicago to Tulsa, Okla. . . . The components division of **INTERNATIONAL TELEPHONE AND TELEGRAPH CORP.** is launching a new manufacturing operation in Palo Alto, Calif. The new plant is at 815 South San Antonio Road and contains approximately 8000 square feet of manufacturing space with a two-story office structure attached.

* * *

SALES MANAGERS' CLUB, Eastern Group, has been incorporated as Producers of Associated Components for Electronics, Inc., with a membership composed of electronic parts and equipment manufacturers located east of the Mississippi River.

The new organization continues as co-sponsor of the annual Electronic Parts Distributors' Show in Chicago. Its offices are located at 261 Broad-

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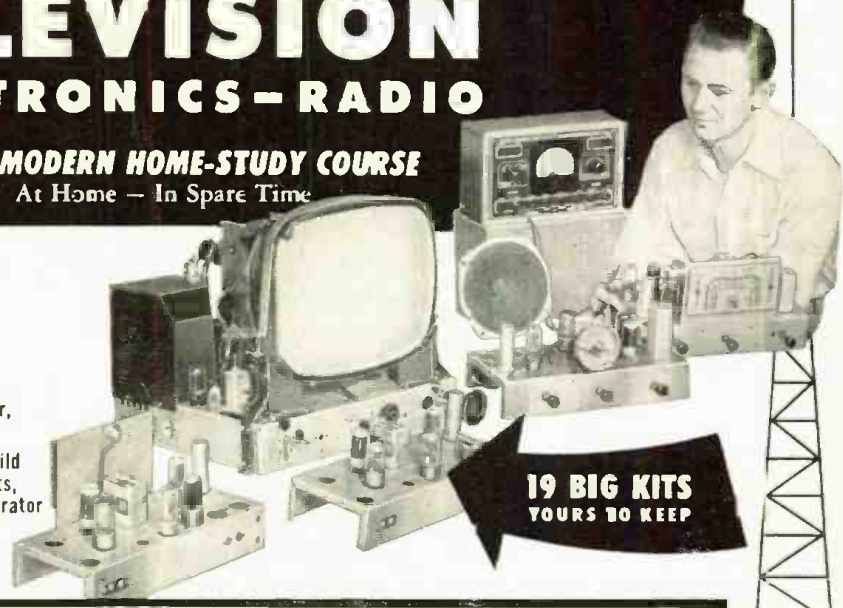

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- A Valuable Professional Multitester

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2. RADIO, FM AND AM
3. INDUSTRIAL ELECTRONICS
4. SOUND RECORDING AND HI FIDELITY
5. PREPARATION FOR FCC LICENSE
6. AUTOMATION
7. RADAR AND MICRO WAVES
8. COMMUNICATIONS

YOU ARE NEEDED IN THE TELEVISION-ELECTRONICS-RADIO INDUSTRY! You can build a secure future for yourself if you get into Electronics NOW! Today's shortage of trained technicians creates tremendous opportunities. National Schools Shop-Method trained technicians are in constant and growing demand for high-pay jobs in Broadcasting and Communications, Electronic Research, Servicing and Repair, and many other branches.

Let National Schools, a Resident Technical School for over 50 years train you for today's unlimited opportunities in electronics! Our Shop Method trains you to be a MASTER-TECHNICIAN. Completely up to date, developed by experienced instructors and engineers, your Telerama Course will teach you all phases of the industry quickly, clearly and correctly. You can master the most modern projects, such as Color TV, printed circuits — even prepare for FCC License without taking a special course. You can handle sales, servicing, manufacturing, or make good money in your own business. SEND FOR FACTS TODAY!

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If you wish to take your training in our Resident School at Los Angeles, the world's TV capital, start NOW in our big, modern Shops, Labs and Radio-TV Studios. Here you work with latest Electronic equipment—professionally installed—finest, most complete facilities offered by any school. Expert, friendly instructors. Personal attention. Graduate Employment Service. Help in finding home near school—and part time job while you learn. Check box in coupon for full information.

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way, New York City, with David Susser, executive vice-president, in charge of coordinating administrative and committee activities.

Sidney Harman, *Harman-Kardon, Inc.*, is president of the association. Other officers are: Leonard Carduner, *British Industries Corp.*, first vice-president; Edward Rothenstein, *Arco Electronics, Inc.*, second vice-president; and W. Walter Jablon, *Mark Simpson Manufacturing Co.*, secretary-treasurer.

The board of directors includes: Sam Baraf. *United Transformer Corp.*; Robert Ferree, *International Resistance Corp.*; Charles Golenpaul, *Aerovox Corp.*; Edward Finkel, *JFD Manufacturing Co.*; Joseph Kerner, *Blonder-Tongue Labs., Inc.*; Jerome Kirschbaum, *Precision Apparatus Co.*; Howard B. Saltzman, *Alpha Wire Corp.*; and George Silber, *Rek-O-Kut.*

The new organization's purposes are to promote the interests of manufacturers of parts and equipment for the electronic and allied industries; to foster trade in the manufactured products of these industries; to disseminate all useful information concerning the industry; and to promote better business relationships, more efficient operations, and better service for distributors, suppliers, and ultimate consumers of the electronics and allied industries.

Meetings of the membership have been scheduled for the fourth Wednesday of each month and will feature prominent speakers on specific ideas of prime interest to the organization.

In addition to the officers and directors, fourteen standing committees will develop the activities of the organization.

* * *

RICHARD DEUTSCH has been appointed chief sales engineer of *Channel Master Corp.*

In this capacity he will be in charge of the company's sales and field engineering department, which conducts dealer and distributor meetings and new product seminars throughout the country. The department is also responsible for answering the large volume of technical correspondence resulting from consumer and trade advertising.

Mr. Deutsch joined the firm's mechanical engineering department in 1953. Two years later he transferred to the sales department as a sales engineer.

* * *

RIXON ELECTRONICS, INC., Silver Spring, Maryland, has become an independent company, with James L. Hollis as the new president. It was formerly a subsidiary of **PAGE COMMUNICATIONS ENGINEERS, INC.**, Washington, D. C. . . . **VITRO CORPORATION OF AMERICA** has concluded negotiations to acquire all the business and facilities

(*Continued on page* 113)

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. . . easily . . . and quickly

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Name and Address	License	Time
Prentice Harrison, Lewes, Delaware	1st	27 weeks
John H. Johnson, Boise City, Okla.	1st	20 weeks
Herbert W. Clay, Phoenix, Ariz.	2nd	22 weeks
William F. Masterson, Key West, Fla.	2nd	24 weeks
Thomas J. Bingham, Finley, N. Dak.	2nd	9 weeks

(Names and addresses of trainees in your area sent on request)

Cleveland Institute training results in job offers like these:

Radio Operators & Technicians

American Airlines has openings for radio operators and radio mechanics. Operators start at $334.53 per month. Radio mechanic's salary up to $1.99 per hour. Periodic increases with opportunity for advancement. Many company benefits.

Electronic Technicians

Convair Electronics Department: Radio and Radar Mechanics. Electronics Technicians, and Junior Engineers are wanted for a special program on fire control development and installation. Beginning rate: $365 and up.

And our trainees get good jobs

Salary Increased

"I recently secured a position as Test Engineer with Melpar, Inc. A substantial salary increase was involved. My Cleveland Institute training played a major role in qualifying me for this position."

Boyd Daugherty
105 Goodwin Ct., Apt. C
Falls Church, Va.

Eastern Airlines

In a year and a half, he received his first class FCC License. He is continuing his training with Cleveland Institute. His goal is much higher than his present position with Eastern Airlines, so he is adding technical "know-how" to his practical experience.

Bob Thompson
2935 Ironwood Drive
Nashville 14, Tennessee

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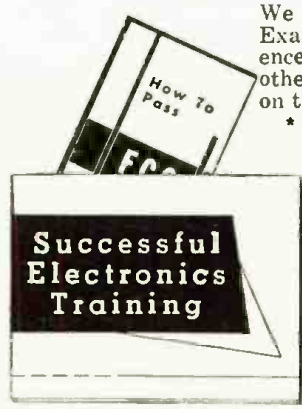
Desk RN-11, 4900 Euclid Bldg., Cleveland 3, Ohio



We can train you to pass your License Exams if you've had any practical experience—amateur, military, radio servicing, or other. Our proven plan can help put you on the road to success.

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- ☐ Amateur Radio
- ☐ Broadcasting
- ☐ Home Experimenting
- ☐ Telephone Company
- ☐ Other

In what kind of work are you now engaged? _____

In what branch of Electronics are you interested? _____

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SPEAKER COMPONENTS

designed for the most natural . . .
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ALTEC LANSING speaker components exemplify the ALTEC tradition to give the most faithful reproduction of sound obtainable through the most natural means.

ALL of these ALTEC high frequency horns are of the sectoral, exponential type which provides a clear, mathematically calculated flow path to direct the sound waves into the proper distribution pattern without interfering with their natural propagation in the air. These sectoral horns provide efficient distribution control at all frequencies, unlike diffusion and other types which have wide distribution at the lower frequencies and become extremely directional and inefficient in the higher ranges.

These sectoral horns and their associated driving elements represent the only true method for obtaining high efficiency, full dynamic range, smooth frequency response and wide, regular distribution of high frequency sounds.

Have the pleasure of listening to a two-way speaker system of ALTEC LANSING speaker components at your dealer's. If your ear is in tune, you'll take ALTEC home.

511B

HORN

This new ALTEC high frequency horn is the finest available for home use. When used with the ALTEC 802D high frequency driver the 511B gives amazingly smooth response throughout the range from 500 to 22,000 cycles, one-half octave above the range of the human ear. The ALTEC 803 bass speaker, either singled or paired, is recommended as a bass component for use with this horn. The 500D dividing network is needed to complete this system.

PRICE: $36.00

811B

HORN

This superb ALTEC horn is identical in design concept and quality with the 511B but is smaller and has a frequency range from 800 to 22,000 cycles. The 811B with the 802D driver can be used with the ALTEC 803A bass speaker or with the 415A Biflex to extend this wide range speaker to a full 22,000 cycle system.

PRICE: $27.00

802D

HIGH FREQUENCY DRIVER

Designed specifically for use with the 511B and 811B horns for smooth 500 to 22,000 cycle high frequency reproduction.

Power: 30 watts; Range: 500–22,000 cycles; Impedance: 16 ohms; Magnet Weight: 1.3 lbs

PRICE: $57.00

3000B

HIGH FREQUENCY SPEAKER AND NETWORK

This newly developed high frequency speaker and horn used with the 3000B network is the ideal unit to extend the range of the ALTEC 412A and 415A Biflexes or of any efficient 12" or 15" cone speaker to a full 22,000 cycles. The dividing network separates high and low frequencies at 3000 cycles, crossing over at a smooth 12 db per octave curve.

Speaker—Power: 20 watts; Impedance: 8 ohms; Range: 3,000–22,000 cycles

PRICE: $39.00

Network—Impedance: 8 ohms; HF Attenuation: 10 db continuously variable; Crossover: 3000 cycles

PRICE: $21.00

500D

DIVIDING NETWORK

For use with the 802D h.f. driver and 511B horn. Has smooth 12 db per octave slope and detented high frequency shelving control designed for external mounting with 4 steps of 1½ decibels each for precise adjustment to individual rooms.

Impedance: 16 ohms; HF attenuation: 6 db, 1½ db steps; Crossover: 500 cycles

PRICE: $54.00

803A

BASS SPEAKER

The 803A is used as the bass component in many of ALTEC's larger theatre speaker systems. Since it is intended for use with the 802D high frequency driver and either the 511B or 811B horn its efficient frequency range is limited to 30–1600 cycles. This 1600 cycle upper range assures a smooth crossover at any frequency up to 800 cycles. As a result the 803A has a bass performance far superior to that of loudspeakers designed to operate over a wider frequency spectrum.

Power: 30 watts; Impedance: 16 ohms; Range: 30–1600 cycles; Magnet Weight: 2.4 lbs

PRICE: $60.00

800E

DIVIDING NETWORK

Has the same characteristics as the 500D but with 800 cycle crossover for use with the 811B horn and 802D h.f. driver.

Impedance: 16 ohms; HF Attenuation: 6 db, 1½ db steps; Crossover: 800 cycles

PRICE: $42.00

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Ad #T2-11

NEW! 12-WATT Williamson-type HIGH FIDELITY INTEGRATED AMPLIFIER HF12

with Preamplifier, Equalizer & Control Section

KIT $34.95 WIRED $57.95

Compact, beautifully packaged & styled. Provides complete "front-end" facilities and true high fidelity performance. Direct tape head & magnetic phono inputs with NARTB (tape) & RIAA (phono) feedback equalizations. 6-tube circuit, dual triode for variable turnover bass & treble feedback-type tone controls. **Output Power:** 12 w cont., 25 w pk. **IM Dist.** (60 & 6000 cps @ 4:1): 1.5% @ 12 w 0.55% @ 6 w; 0.3% @ 4 w. **Freq. Resp.:** 1 w: ±0.5 db 12 cps – 50 kc; 12 w ±0.5 db 25 cps – 20 kc. **Harmonic Dist: 20 cps** 2% @ 4.2 w; ½% @ 2.5 w; **30 cps:** 2% @ 11 w; ½% @ 6.3 w; **40 cps:** 1% @ 12 w; ½% @ 9.3 w; **2000 cps:** ½% @ 12 w; **10 kc:** 1% @ 10 w; ½% @ 6 w. **Transient Resp:** excellent square wave reproduction (4 usec rise-time); negligible ringing, rapid settling on 10 kc square wave. **Inverse Feedback: 20 db. Stability Margin: 12 db. Damping Factor:** above 8, 20 cps – 15 kc. **Speaker Connections:** 4, 8, 16 ohms. **Tone Control Range:** @ 10 kc, ±13 db; @ 50 cps, ±16 db. **Tubes:** 2-ECC83/12AX7, 1-ECC82/12AU7, 2-EL84, 1-EZ81. **Size:** HWD: 3⅜" x 12" x 8¼". 13 lbs. Mounts in and out of cabinet.

NEW! 50-WATT Ultra-Linear HIGH FIDELITY POWER AMPLIFIER

HF50 KIT $57.95 WIRED $87.95

Like the HF60 shown below, the **HF50** features virtually absolute stability, flawless transient response under either resistive or reactive (speaker) load, & no bounce or flutter under pulsed conditions. **Extremely high quality output transformer** with extensively interleaved windings, 4, 8, & 16 ohm speaker connections, grain-oriented steel, & fully potted in seamless steel case. Otherwise identical to HF60. **Output Power:** 50 w cont., 100 w pk. **IM Distortion** (60 & 6000 cps @ 4:1): below 1% at 50 w; 0.5% @ 35 w. **Harmonic Dist.:** below 0.5% between 20 cps & 20 kc within 1 db of rated power. **Freq. Resp. at** 1 w: ±0.5 db 6 cps –60 kc; ±0.1 db 15 cps –30 kc at any level from 1 mw to rated power; no peaking or raggedness outside audio range. **All other specs identical to HF60 below.** Matching Cover **E-2 $4.50.**

NEW! 50-WATT Ultra-Linear HIGH-FIDELITY INTEGRATED POWER AMPLIFIER HF52

with Preamplifier, Equalizer & Control Section

KIT $69.95 WIRED $109.95

Combines a power amplifier section essentially identical to the **HF50** power amplifier with a preamp-equalizer control section similar to HF20 below. Provision for use with electronic crossover network & additional amplifier(s). See HF50 for response & distortion specs; HF60 for square wave response, rise-time inverse feedback, stability margin, damping factor, speaker connections; HF20 for preamplifier, equalizer & control section description. Hum & noise 60 db below rated output on magnetic phono input (8 mv input for rated output), & 75 db below rated output on high level inputs (0.6 v input for rated output). Matching Cover **E-1 $4.50.**

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NEW

HIGH FIDELITY PREAMPLIFIER

#HF61A KIT $24.95, WIRED $37.95

With Power Supply: #HF61 KIT $29.95, WIRED $44.95

Will not add distortion or detract from the wide-band or transient response of the finest power amplifiers at any control settings. High quality feedback circuitry throughout plus the most complete control & switching facilities. Heavy-gauge solid brushed brass panel, concentric controls, one-piece brown enamel steel cabinet for lasting attractive appearance. **Feedback-type, sharp cut-off (12 db/octave) scratch & rumble filters. Low-distortion feedback equalization:** 5 most common recording curves for LPs & 78s including RIAA. **Low-distortion feedback tone controls:** provide large boost or cut in bass or treble with mid-freqs & volume unaffected. **Centralab printed-circuit Senior "Compentrol" loudness control with concentric level control. 4 hi-level switched inputs** (tuner, tv, tape, aux.) & **3 low-level inputs** (separate front panel **low-level input selector** permits concurrent use of changer & turntable). **Proper pick-up loading & attenuation** provided for all quality cartridges. **Hum bal. control.** DC superimposed on filament supply. 4 convenience outlets. **Extremely flat wideband freq. resp.:** ±1 db 3-100,000 cps; ±0.3 db 12-50,000 cps. **Extremely sensitive. Negligible hum, noise, harmonic or IM distortion. Size:** 4-7/8" x 12-5/16" x 4-7/8". 8 lbs.

NEW

60-WATT Ultra-Linear HIGH FIDELITY POWER AMPLIFIER #HF60 with ACRO TO-330 OUTPUT TRANSFORMER

KIT $72.95 WIRED $99.95

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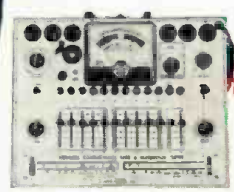

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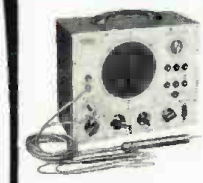

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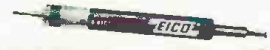

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Telemetry in Flight Testing

By
CHARLES M. DOWNS
Aeronautical Test
Convair (San Diego)

The Convair F-102A all-weather supersonic jet interceptor. Telemetering played an important part in the exhaustive flight testing of this aircraft at Edwards Air Force Base before the F-102A's became operational with Air Defense Command squadrons.

Part 1 of a two-part series on principles and applications of telemetering as used in developmental aircraft testing.

IN THE past few years a new application of electronics has "come of age." Telemetering (meaning to measure from a distance or to transmit a measurement) which has been used for the last ten years in missiles and rockets is now extensively used in flight testing military and commercial aircraft. With the advent of supersonic aircraft there was a need for a measuring system that would operate automatically with accuracy and precision without distracting the pilot of the aircraft in any way. Various airborne recording devices had the accuracy required but took up too much space, were too heavy, or were too restricted in the type of data they could record.

As an example, one type of recording oscillograph used as an airborne recorder weighs 70 pounds, records 26 functions and has a frequency range of from d.c. to about 500 cycles. With additional equipment (linear amplifiers) the frequency range is extended to 3000 cycles. A telemetering system weighing half as much can record many more functions with a response on some subcarrier bands (see Table 1) of from d.c. to speech frequencies. Safety functions such as temperature, pressure, and acceleration can be instantly and continuously monitored on the ground during flight. If safe limits are exceeded, the pilot can be notified for corrective action.

When an aircraft crashes into the ground at 500 miles per hour, there is little left from which to determine the cause of the crash. Lives have been saved because records, safe on the ground, revealed the cause of system or structural failure in telemetered aircraft. Data from airborne recorders would have been lost.

Since recording oscillographs are an important part of the receiving station, it should be pointed out that telemetering has not replaced the oscillograph as a flight test recorder; it has only moved the oscillograph down on the ground where its full capabilities can be utilized.

An oscillograph uses small mirrors mounted in galvanometer movements to reflect beams of light onto a moving strip of photosensitive paper. Thus the waveform of the current fed to the coil of the galvanometer is photographed as a continuous graph. Paper speed is variable from about 0.5 to 100 inches per second. One of the factors which limits the upper frequency response of an airborne oscillograph is paper speed. Due to the short supply of paper that can be carried aloft, the speed must be kept low if more than a few minutes of flight are to be recorded. This problem is overcome when the recorder is located in the ground station. Telemetered data stored on magnetic tape can be played back as many times as desired and oscillograph records may be made at any paper speed. Here it should be pointed out that oscillograph records are usually employed to determine which parts of the flight should be selected for further data reduction.

Theory of Operation

The theory of operation of an FM/PM telemetry system should be easily understood by anyone familiar with audio circuits. Several audio oscillators, operating at different frequencies, are frequency modulated by their associated pickups. The frequency-modulated audio signals are used to phase modulate a radio transmitter operating in the range of 215 to 235 megacycles. The r.f. signal is, in turn, picked up by a receiving station where the audio output of a receiver is passed through bandpass filters which separate the subcarrier oscillators (the audio oscillators in the aircraft) from the complex audio signal. The output of each bandpass filter is then fed into an audio discriminator which produces a varying d.c. voltage corresponding to the frequency shift of the subcarrier oscillator. The current in the discriminator output signal is the electrical equivalent of the original modulating signal obtained from the pickup in the aircraft. The discriminator output is then fed into electro-mechanical recorders such as recording oscillographs and pen recorders. Tape recorders, at the same time, record the audio output of the receivers so that in case of failure of one of the discriminators or electro-mechanical recorders, the data will not be lost. The tape playback can be fed directly into automatic data reduction computers if additional data reduction is required.

Airborne Components

Let us now consider various components of a system and their functions. Pickups and subcarrier oscillators (SCO's) fall into three basic types: voltage-, resistance-, and inductance-controlled. Of these three, the voltage-controlled oscillator is probably the most widely used. A diagram of a simple voltage-controlled system is shown in Fig. 1. Excitation voltage (in this case d.c.) is applied across a precision

BAND	CENTER FREQUENCY (cps)	LOWER LIMIT (cps)	UPPER LIMIT (cps)	FREQUENCY RESPONSE (cps)
1	400	370	430	6.0
2	560	518	602	8.4
3	730	675	785	11
4	960	888	1032	14
5	1300	1200	1389	20
6	1700	1572	1828	25
7	2300	2127	2473	35
8	3000	2775	3225	45
9	3900	3607	4193	59
10	5400	4995	5805	81
11	7350	6799	7901	110
12	10.500	9712	11.288	160
13	14.500	13.412	15.588	220
14	22.000	20.350	23.650	330
15	30.000	27.750	32.250	450
16	40.000	37.000	43.000	600
17	52.500	48.560	56.440	790
18	70.000	64.750	75.250	1050

Wide-band (±15% of center frequency) operation may be used on 22 kc. through 70 kc. if adjacent bands are omitted.

Table 1. The various subcarrier bands that are employed in telemetering systems.

potentiometer. The shaft of the potentiometer is linked to an angular motion such as the rudder of an aircraft. The signal voltage from the arm of the pot is fed through shielded wire to the SCO. In one type of voltage-controlled SCO the input signal is fed to a reactance modulator combined with a Hartley oscillator. In another type, a free-running multivibrator is frequency modulated by using the signal voltage to bias the grid of one half of the oscillator. The frequency stability of either of these types under steady-state input conditions is excellent.

The frequency deviation of a voltage-controlled SCO is an inverse function of signal polarity shift. In other words, when the signal is made more positive, the output frequency decreases. Two voltage ranges are generally used: 0 to 5 volts and ±2.5 volts. Since very sharp bandpass filters (down 60 db a few cycles past the bandpass limit) are used in the receiving station, SCO bandwidth limits and therefore input voltage limits must be carefully observed. Band limits (deviation limits) are determined as follows. There are 18 SCO frequencies established by the Department of Defense's Research and Development Board (RDB) now in use. (See Table 1.) Each SCO is allowed to deviate 7.5% of its center frequency each side of center frequency. As an example, given a 2.3 kc. SCO with a voltage range of 0 to 5 volts, the output frequency at 2.5 volts would be 2300 cps or f_c. At 5 volts the frequency would be 2127 cps or f_1. With 0 volt applied, the frequency would become 2473 cps or f_h. To provide a "fudge factor" and to reduce noise, many systems are operated at 80% bandwidth. Bandwidth now becomes 80% of 7.5% of f_c.

Special 15% units are available which are used when wide-band operation is desired.

So far, we have considered only a d.c. modulating signal. Although a.c. can be used to modulate voltage-controlled oscillators, another factor must be considered: that of the highest a.c. frequency that can be applied. Naturally, it would be impossible to impress 2000-cycle modulation on a 2300-cycle SCO. Generally, it may be said that up to and including the 14.5 kc. band, maximum modulating frequency should not be more than 1.5% of f_c. Above 14.5 kc., 3% is the maximum. These limits are conservative and can be exceeded but a point will be reached where severe intermodulation will occur. It should be remembered, however, that it is the instantaneous value of an a.c. modulating signal and not the frequency of the signal that causes the SCO to deviate.

Voltage-controlled oscillators are used to measure control surface positions, gas and liquid pressures, vibration, acceleration, or any function which can be made to produce varying d.c. or a.c. voltage. A 70 kc. voltage-controlled SCO can be modulated by the pilot's microphone to provide one-way communication from the aircraft to ground. This can be used to record the pilot's comments which, for security reasons, cannot be transmitted over the aircraft's normal communications system.

The second basic type of SCO is the resistance-controlled oscillator which changes frequency when a resistance change occurs in one or more arms of an a.c.-excited Wheatstone bridge. A basic resistance-controlled oscillator system is shown in Fig. 2. Bridge unbalance causes phase shift to occur in a phase-sensitive amplifier-oscillator loop. Sensitivity is determined by the number of active arms. Strain-sensitive bridges, precision potentiometers, and other variable resistance transducers are employed with resistance-controlled oscillators.

A troublesome drawback is present in resistance-controlled systems. The shunt capacitance of the shield wire used between the pickup and oscillator causes the response curve of the oscillator to become slightly parabolic. (See Fig. 3.) This can be reduced, however, by shunting the bridge at the SCO with another capacitance to balance the unwanted capacitance of the shielded wire.

The third widely used type of SCO is the inductance-controlled oscillator. Mechanical motion is transferred to a Mumetal slug which is suspended in the field of a coil. The slug is oil- or air-damped, depending on the frequency response desired. The coil comprises the inductance of a Hartley *LC* oscillator. Thus the frequency of the oscillator is modulated by the mechanical motion. The pickup is not usually mounted more than a few feet from the oscillator because the shunt capacitance of the shielded wire can lower the frequency of the oscillator to a point where it is out of the particular band being used, or can actually prevent the SCO from oscillating. This is overcome by mounting the pickup near the oscillator and running tubing (in the case of a pressure measurement) from the oscillator-pickup location to the measurement point. In the case of an acceleration measurement, the accelerometer can be mounted with the oscillator at the point where acceleration is to be measured.

Many special types of pickups are on the market which are designed to do a specific job such as the measurement of airspeed, altitude, fuel flow, and fuel quantity. Some of these contain their own SCO's while others convert hard-to-measure functions into easily handled voltage, inductance, or resistance changes.

The Radio Transmitter

After the audio output of the SCO's in a system (most systems use from ten to twelve SCO's) have been mixed through voltage dividers into a common audio bus, the combined or "complex audio" signal is applied to the modulator input of a crystal-controlled, phase-modulated transmitter.

For those unfamiliar with the main difference between a phase-modulation and a frequency-modulation system, it might be well to point it out. The end result in either case is the same; the frequency of the transmitter becomes a function of the modulation impressed on that transmitter. However, that result is achieved by different methods. An FM transmitter is actually amplitude modulated. That is, the frequency change of the transmitter is a function of the amplitude of the modulating signal. A signal of 10,000 cps would cause the same frequency shift as a signal of 1000 cps if their amplitudes were equal. The rate at which the frequency of the transmitter is varying, however, is dependent on the frequency of the modulating signal that is used.

In a phase-modulated transmitter, the amount of frequency deviation of the transmitter is a function of both amplitude and frequency of the modulating signal. Given a modulator with flat frequency response, and a ten SCO system with equal levels for all ten SCO's, the deviation of the transmitter caused by each SCO would be proportional to the frequency of the SCO. However, the frequency response of the modulator tube and circuit is

far from flat. The modulator tends to attenuate the level of the higher frequency SCO's. The result of these two opposing response curves (the increasing deviation of the transmitter with an increase in modulation frequency, and the attenuation of the higher frequency SCO's by the modulator tube) is a decrease in deviation response with an increase in frequency. It is therefore necessary to pre-emphasize the higher frequency SCO's in order to obtain the correct modulation index for a given transmitter.

The transmitter is a compact frequency multiplier with about 2.5 watts output. When used to telemeter vehicles or objects which are fairly close to the receiving station (1 to 3 miles) the power output of the transmitter alone is enough to deliver satisfactory signal strength; but when used in missiles and aircraft, additional power amplifiers are required. Telemetering power amplifiers usually contain 1 or 2 tubes (4X150A and 832B are commonly used types) and produce from 15 to 100 watts output, depending on tube type and plate supply voltage.

Antenna Systems

Antenna systems are more of a problem than usual when mounted on supersonic aircraft. In addition to exhibiting a satisfactory radiation pattern, the antenna must produce a minimum of drag and turbulence. For this reason flush antennas such as notch exciters, slot antennas, and quarter-wave dipoles imbedded in non-metallic material are used extensively. The airspeed measuring system on flight test aircraft usually consists of a short tapered tube, an inch or two in diameter, extending from the center of the nose of the aircraft. If insulated, the airspeed boom can serve as a quarter wave "spike" antenna. Blade antennas, in the form of an airfoil, can be mounted on the bottom of the aircraft where maximum r.f. propagation is effected. A quarter wavelength at the frequencies in use is about 9 to 11 inches which facilitates compact antenna design.

One system uses one antenna mounted in each wingtip to prevent signal dropout during rolls and sharp banks. Duplexers are in use which permit two transmitters of different frequencies to be loaded into a single antenna; three duplexers may be used to load four transmitters into one antenna system.

Design Considerations

Telemetering systems are manufactured in "building block" form. Due to the individual requirements of any one flight research program, it would be hard to build a "package deal" to be installed in all types of aircraft. Therefore, it is up to the engineers and technicians working with the equipment to use their ingenuity in selecting the components for their system. With these things in mind, a few design considerations will be discussed here.

Every system has its drawbacks and telemetry is no exception. Possibly the greatest problem encountered in a measurement system is noise. Types of noise existent in a telemetering system can be placed in two general classes: intermodulation and random or transient noise. Intermodulation can be caused by applying a complex wave to a non-linear impedance. Appearing as beats between the component frequencies of the complex signal, it produces frequencies which are not present in the original complex wave. Beat frequencies are always present in a complex audio bus (the combined output of the several subcarriers in a telemetering system) but the levels of the beats are down 30 db or so in relation to the subcarriers. If two subcarrier levels are allowed to increase to a high enough level, the beat between them will attain a high enough level to seriously affect the other subcarriers in the system. Intermodulation can be reduced or eliminated by the use of impedance matching devices, extra isolation, and carefully balanced subcarrier levels.

Random and transient noise should if possible, be eliminated at its source. Relays switching reactive loads can produce a transient which can be picked up fifty feet away. A large capacitor or neon lamp placed across the contacts of the relay can suppress much of the noise. Ground loops can be avoided by grounding the shielding at one point only and as close to the SCO as possible. Noise which amplitude modulates the SCO envelope is reduced by the limiters in the receiving station radio receivers. However, noise which frequency modulates the SCO must be eliminated at its source if the frequency response of the SCO is to be utilized. In the case of a d.c. or low-frequency a.c. measurement, the recording device can be damped so that its upper frequency limit falls below the noise frequency. Low-pass filters in the discriminator output circuit are also useful in noise reduction but again the high-frequency response of the subcarrier is limited.

(*Concluded next month*)

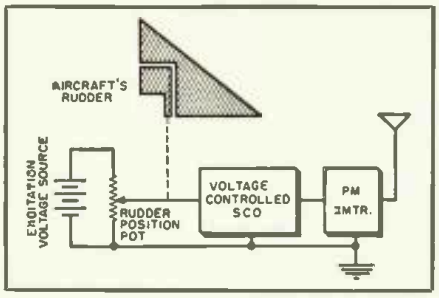


Fig. 1. Block diagram of a simple voltage controlled subcarrier oscillator system.

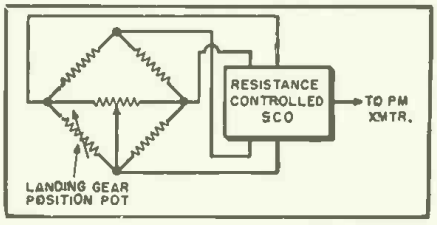


Fig. 2. Resistance controlled SCO system.

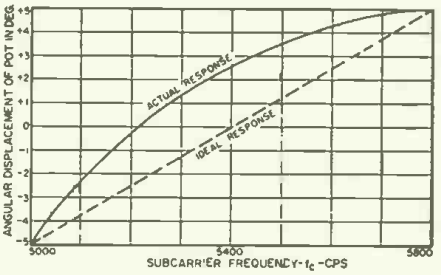
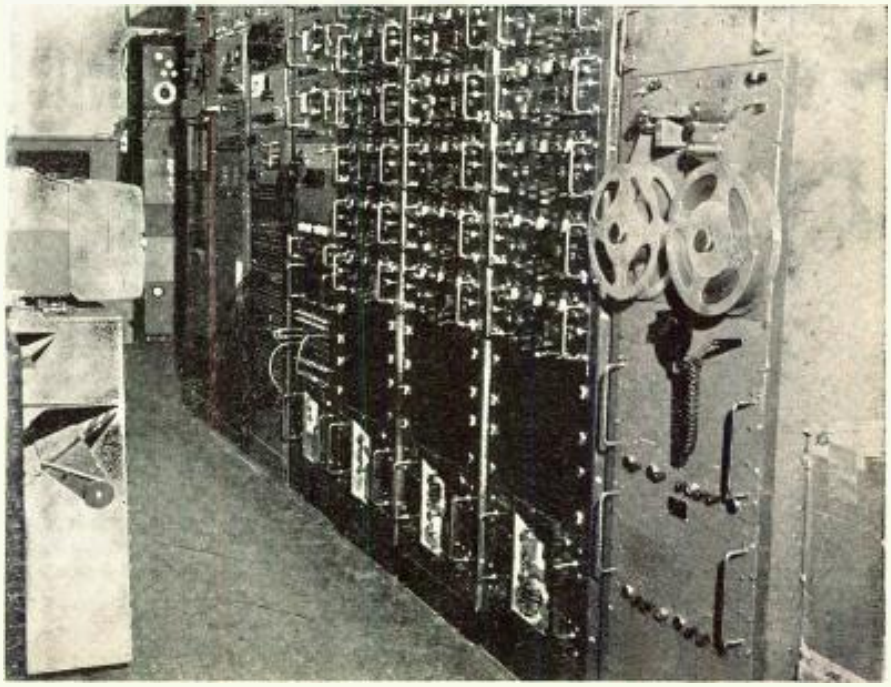
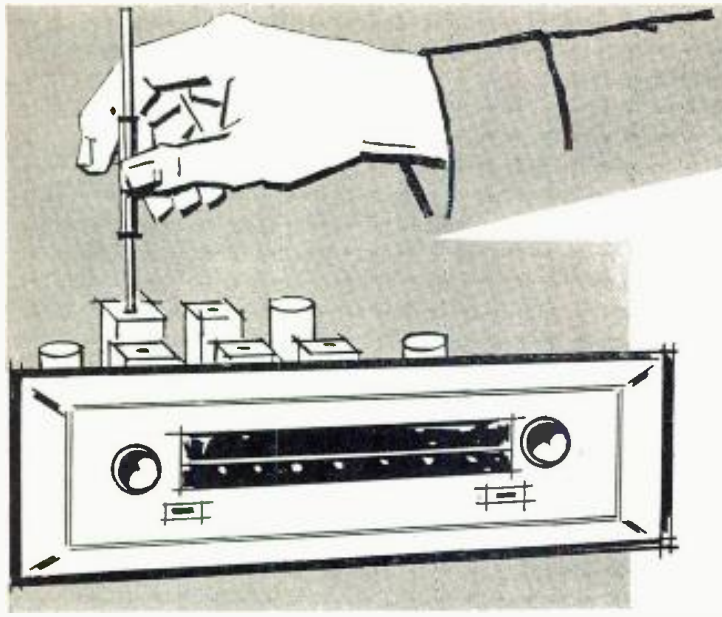


Fig. 3. Resistance controlled SCO response.

Convair's receiving station at Edwards AFB flight test facility. In right foreground is playback unit for airborne tape. The next three racks contain subcarrier discriminators. Left racks contain receivers, test gear, and patch boards.





Testing FM Tuners at Home

By **JULIAN D. HIRSCH**
Audio Consultant

Check and maintain your tuner's performance without the use of elaborate test equipment.

FM TUNER performance specifications may describe the tuner in terms of its quieting sensitivity, bandwidth, frequency stability, and distortion. Accurate determination of these performance factors requires considerable expensive laboratory equipment and is usually beyond the scope of the audiophile or radio technician.

The alignment and adjustment of an FM tuner may be performed with relatively inexpensive service instruments such as a signal generator, audio analyzer, v.t.v.m., and oscilloscope. Many users of FM tuners have one or more of these test instruments available and should be able to perform much of the adjustment and maintenance on their receivers at home.

However, the vast majority of users have no test equipment at their disposal. Without at least a v.t.v.m., it is next to impossible to check the performance of a tuner or to align it for optimum performance. However, a number of modern FM tuners have sufficient built-in metering, either in the form of signal and tuning meters or as "magic eye" tubes, so that considerable maintenance may be performed on them without additional test equipment. The eye, in effect, constitutes a built-in vacuum-tube voltmeter.

This article will describe some of the tests and procedures which may be followed at home in order to check and maintain the performance of an FM tuner without recourse to expensive laboratory-type test equipment. For some of these tests, one or two simple service instruments will be required. These may be purchased ready built, may be constructed from kits, or may be borrowed from a friend who is fortunate enough to have them available.

Sensitivity Measurement

The sensitivity of an FM tuner is normally expressed as "X microvolts for 30 db quieting." This is defined as the minimum signal for which a 30 db increase in output is obtained when modulation percentage is changed from zero to 30%. Most tuners are advertised as having a sensitivity ranging from 1 to 10 microvolts. In most cases the actual sensitivity is not of great interest to the user. He merely wants to be able to receive his local FM stations with low background noise and distortion-free audio reproduction. The quieting sensitivity of an FM tuner is dependent, among other things, on the alignment of the i.f. transformers, the tracking and alignment of the r.f. and converter stages, and the transconductance of the tubes used in the r.f. and i.f. stages. It is normal for tubes to deteriorate with use and frequently the adjustment of the i.f. transformers will change with the passage of time, under conditions of variable temperature and humidity. These deteriorations usually occur very gradually and may not be noticed in day-to-day listening. The usual result is an eventual dissatisfaction with the receiver's performance without being able to pin-point the source of the trouble.

Fortunately, it is very simple to determine whether a receiver has lost some of its original performance if a system of periodic checking is instituted from the beginning. When the tuner is first put into service, and if it seems to be operating satisfactorily, the signal strengths of several local stations should be noted. If the tuner has a signal strength meter, as many do, this may be used as a direct indicator of signal strength. If only a zero-center tuning meter, or no meter at all, is provided, it will be necessary to measure the limiter grid bias with a v.t.v.m. See Fig. 1. On tuners employing limiting followed by a Foster-Seeley discriminator, the limiter grid circuit is easily identified. If the receiver uses more than one stage of limiting, the measurement should be made at the grid of the first limiter.

If a ratio detector is used, without limiting, the output voltage of the detector is usually used for a.g.c. and may be used as a measure of signal strength. See Fig. 2 for a typical circuit employing a ratio detector. In either case a negative voltage will be read, whose magnitude increases with signal strength. This voltage is indicative both of the signal strength and the gain of the preceding r.f. and i.f. stages. If strong local stations are selected as reference signals, it may be expected that their strengths will not vary greatly with time. Sometimes one station may vary widely in strength due to transmitter or antenna difficulties or changes. However, using several check signals will permit easy detection of such an occurrence.

Assuming that the signal strengths of the check stations remain constant, any reduction in meter reading at a subsequent time indicates a deterioration in performance of the tuner. Since some meter circuits are sensitive to line voltage changes, it is a good idea to check line voltage if there is a sudden drop in meter readings. The loss of performance may be easily separated into that due to weak tubes and that due to mis-alignment. The alignment may be checked without use of additional instruments, using a strong local station as a test signal. Disable the a.f.c. either by switching it off or by grounding the

a.f.c. line. See Fig. 3. Tune in the station for maximum meter reading at the limiter or ratio detector. Using an insulated aligning tool, carefully adjust the top and bottom alignment screws on each i.f. transformer, starting from the one preceding the limiter and working toward the mixer stage. Only very slight adjustments should be made, to avoid seriously mis-aligning the tuner. If the alignment is correct, the meter reading will decrease in each case. Retune the transformer for the original maximum reading before proceeding to the next stage. If one or more transformers are found to give substantially higher meter readings when their settings are changed, it may be assumed that they were improperly aligned.

If this procedure does not result in an increased meter reading, it is probable that one or more of the tubes is weak. It is a good idea to have a spare for each type of tube used in the tuner, which may be substituted in the receiver until the defective tube is found. If the receiver has been in use a long time, it is likely that several weak tubes will be found.

This method of aligning an FM tuner, while not as good as the usual methods employing instruments, is likely to be quite satisfactory in most cases. If a service type signal generator is available, a more precise alignment may be accomplished. Fig. 4A shows the setup for the i.f. alignment of an FM tuner. The signal generator, set at 10.7 mc., is fed to the mixer grid. The i.f. transformers are peaked as described previously. Fig. 4B shows an alternate method which may be used when a signal generator covering the 88-108 mc. FM band is available. In this case, the signal is fed directly into the antenna terminals of the receiver through a resistance network which provides the proper driving impedance. The receiver in this case must be tuned to the generator frequency, which should be set at a point where no station is being received.

The alignment of the r.f. and mixer stages may be adjusted when the signal is introduced in this manner, but the details of this adjustment will vary somewhat with the particular receiver involved. Such r.f. alignment is not recommended for the relatively non-technical audiophile except for adjustment of the oscillator trimmer to calibrate the dial. Fortunately, the r.f. stages of an FM set are relatively broad and usually there is little loss of sensitivity from mis-alignment of these stages.

Detector Alignment

It is fairly common to find that the detector of an FM tuner is not aligned precisely on the center of the i.f. passband. This frequently causes distortion or high background noise level. If the receiver is equipped with a zero-center tuning meter or "magic eye" tube the alignment of the detector may be easily checked. The zero reading of the meter or the corresponding appearance of the eye tube should occur at the same frequency for which the limiter or detector output meter reads a maximum. If it is necessary to detune from this maximum in order to center the tuning indicator, the detector is not properly aligned. The simplest way to correct this condition is to carefully tune the receiver for maximum voltage at the limiter grid (or maximum signal strength meter indication) and adjust the secondary tuning of the discriminator transformer for zero d.c. volts at the discriminator output or a center reading on a zero-center tuning meter or eye tube. The easiest way to adjust the primary tuning of the discriminator transformer is to listen to a station or a modulated FM signal generator, properly tuned in, and adjust the primary tuning of the transformer for maximum audio output.

The alignment techniques just described are, of course, crude by comparison to the usual methods employing sweep signal generators and oscilloscopes. However, they are capable of giving, for all practical purposes, the same order of performance and have the advantage that they may be applied without technical training or elaborate equipment.

In general, final alignment of a ratio detector requires the use of a sweep generator and oscilloscope. A v.t.v.m. can be used for approximate alignment of a ratio detector by observing the variation of d.c. voltage at the detector output (measured at the point marked "*X*" in Fig. 2) as the receiver is tuned through a signal. The voltage should swing equally far on both sides of the center reading. This assumes that the i.f. stages are properly aligned and that the center frequency corresponds to the maximum meter reading on the a.g.c. line. If the voltage swings on both sides of center are unequal, adjust the secondary of the ratio detector transformer for symmetry. The primary is adjusted for maximum output, as with the discriminator.

H.F. Oscillator Alignment

After extended periods of use, or sometimes even when new, the dial calibration of an FM receiver will be found to be in error, either at one end of the dial or possibly at all points. Assuming that no mechanical slippage of the dial pointer has occurred, the cause of this calibration error is an incorrect adjustment of the oscillator tracking. The usual procedure for alignment of a tuner requires that the inductance of the oscillator coil be adjusted at the low-frequency end of the tuning range and the small trimmer capacitor shunting the tuning capacitor be adjusted at the upper end of the range. It is sometimes a risky business for a novice to start squeezing or stretching coil turns on the local oscillator tuning coil and thus is not recommended unless the calibration error is great. In this case, it is a job best performed by a competent service technician.

A minor calibration error in the middle or upper end of the band can be easily corrected by setting the dial to the known frequency of a local station and carefully adjusting the oscillator trimmer capacitor until the station is tuned in correctly. Consult the schematic and instruction manual for the particular receiver to determine the location of this capacitor. In the absence of other information, the oscillator trimmer may be easily located since signals will be strongly detuned when the hand is brought near it.

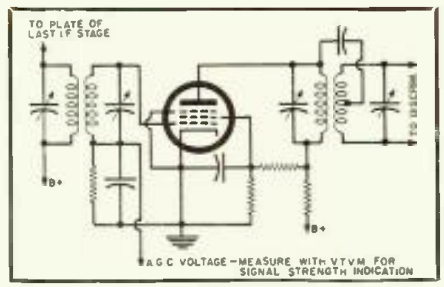


Fig. 1. Typical tuner limiter circuit.

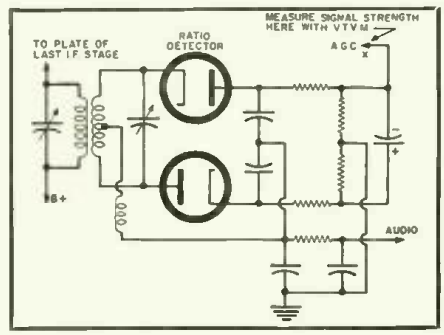


Fig. 2. Typical ratio detector circuit.

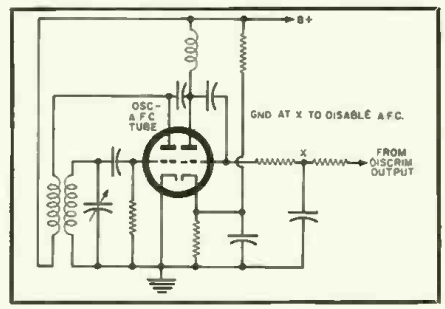
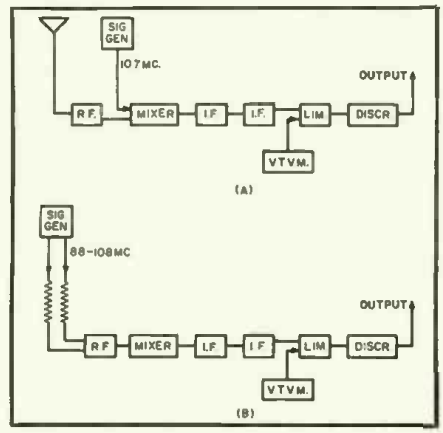


Fig. 3. Common oscillator-a.f.c. circuit.

Frequency Stability

Few things are more annoying than having to re-tune an FM receiver every

Fig. 4. I.f. and front end alignment setups.



15 minutes or half hour due to a continuous frequency drift in the local oscillator. Many older sets suffered from this fault but it is fortunately uncommon in the more modern receivers.

The incorporation of automatic frequency control (a.f.c.) in most receivers has helped the situation considerably, but a.f.c. can only mask the effects of drift and is, in itself, no guarantee of long-term stability. The correct solution is temperature stabilization of the oscillator, which renders a.f.c. unnecessary or, at best, a convenience in tuning.

If a receiver has excessive drift during warm-up, there is little that can be done about it by the user on a relatively non-technical level. Establishing the existence of drift is simple, however. With a.f.c. switched off, turn on the receiver and tune in a strong station as soon as it warms up. Use the receiver's tuning meter or an external v.t.v.m. as a tuning indicator. In many receivers there will be some drift in the first ten minutes of operation, but this should not cause high distortion or signal loss. After ten minutes, retune the set, if necessary, and continue to observe the tuning indicator. Any appreciable drift after this point is definitely undesirable.

Another form of drift which has received less publicity than warm-up drift is that due to line voltage variation. In many locations, line voltage fluctuations are considerable during the evening hours and many tuners exhibit rather large drifts with changes in line voltage. Actual measurement of this effect requires equipment beyond the scope of the ordinary user, but its detection is simple. Supply power to the tuner through a length of inexpensive rubber-covered wire having a cube tap at one end, such as is frequently used as an extension cord. When the set has fully stabilized temperature-wise, tune in a station carefully. Plug an electric iron, broiler, or other high wattage appliance into the same cube tap supplying the tuner. This will usually drop the line voltage from 5 to 10 volts. Most tuners will show a noticeable drift under these conditions. The important thing to note is whether the station is detuned to the point of distortion or requires retuning to make the signal useable. Of course, this test, as with all drift measurements, should be done with a.f.c. disabled.

Distortion

Distortion may be introduced in an FM tuner in two ways. Audio distortion occurs in the audio stages following the detector. Most tuners have little or no audio amplification and the signal levels are such that audio distortion is usually not significant. Most audible distortion comes from the detection process. Mis-alignment is a common cause of distortion. Assuming the receiver is properly aligned, the most likely causes of distortion are insufficient bandwidth in the detector or in the i.f. amplifier.

A fully modulated FM signal deviates 75 kc. each side of its center frequency. The discriminator must be linear over at least a 150 kc. bandwidth to give distortionless output from such a signal. Also, the i.f. bandwidth must be at least 150 kc. or the outermost components of the FM transmitted spectrum will be reduced in amplitude by the time they reach the detector. Discriminator performance is based on the signal having a constant amplitude and loss or reduction of the frequencies at the edges of the transmitted band will cause distortion exactly the same as inadequate discriminator bandwidth.

The effects of i.f. or detector bandwidth limitations cannot be measured without expensive test equipment, but they can easily be detected at home. If the receiver is well designed, a signal strong enough to "quiet" the receiver to a 30 db signal-to-noise ratio will sound clean and undistorted even though some background noise may be audible. If the receiver has insufficient i.f. bandwidth, a weak signal will sound distorted. If no weak signals are available, replace the antenna with a short wire to reduce the strength of a local station. If distortion becomes audible while the signal-to-noise ratio is still good, this is an indication of too much i.f. selectivity.

The reason for this can be seen in Fig. 5. The i.f. selectivity curve in Fig. 5A is typical of those found in low-priced FM tuners. A weak signal, not modulated very heavily, will be received without distortion, but as the frequency deviation becomes larger, the signal falls below the limiting level and distorts. A signal must be strong enough so that its outermost components limit fully if distortion is to be avoided. This condition is shown by the upper curve in Fig. 5A.

Fig. 5B shows the i.f. response of the more expensive FM tuners. The "flat top" means that any signal strong enough to reach the limiting level will be received with little distortion.

If the discriminator bandwidth is too narrow, loud passages will sound distorted on strong stations as well as weak ones. On most receivers, the discriminator bandwidth is at least as great as the i.f. bandwidth so this is not too great a problem. If the discriminator and i.f. both have 150 kc. bandwidth, tuning is critical and a slight drift will cause distortion. Many better tuners now employ wide-band discriminators, several megacycles wide, which make tuning fairly non-critical.

Hum

Hum in an FM tuner can be introduced by frequency modulation of the local oscillator, usually by heater-cathode leakage in the oscillator tube or in the discriminator stage, for the same reason. If the receiver has an audio section, it may arise here as well.

A quick check is to remove the discriminator tube. If hum persists, it is in the audio section; if it disappears it is due to the earlier stages. The next step is to remove the limiter stage, or stages. Any hum remaining probably arises in the discriminator stage. If it disappears, the local oscillator is the most likely cause. Local oscillator hum only appears when a station is tuned in and is not present in the absence of a signal. The receiver hiss may mask hum when no station is received, but an oscilloscope across the audio output will disclose its presence.

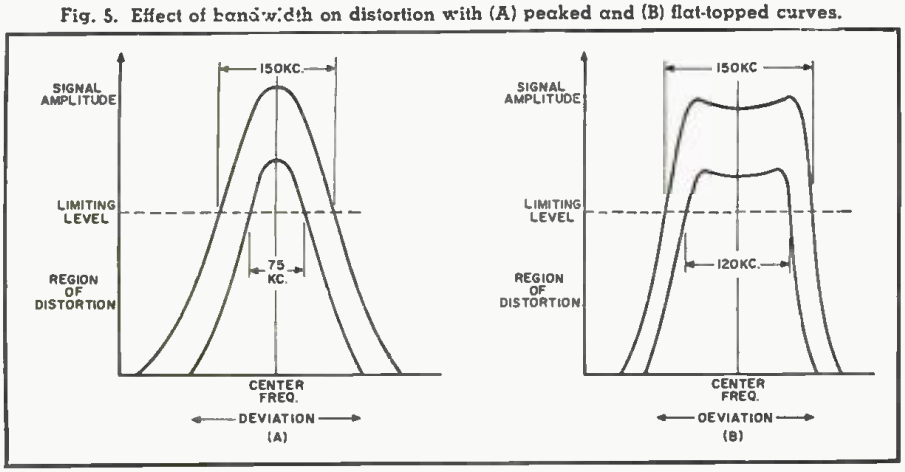
It is worth remembering that many FM stations have appreciable amounts of hum in their audio systems. This will be indistinguishable from hum modulation of the receiver local oscillator. If hum is heard on some stations but not on others, the receiver is probably not to blame. If it is present on all stations, it is most likely the fault of the receiver.

The only practical treatment of hum arising from heater-cathode leakage in a receiver tube is replacement of the tube. Many receivers now use germanium diodes in the discriminator stage, which eliminates that possible source of trouble.

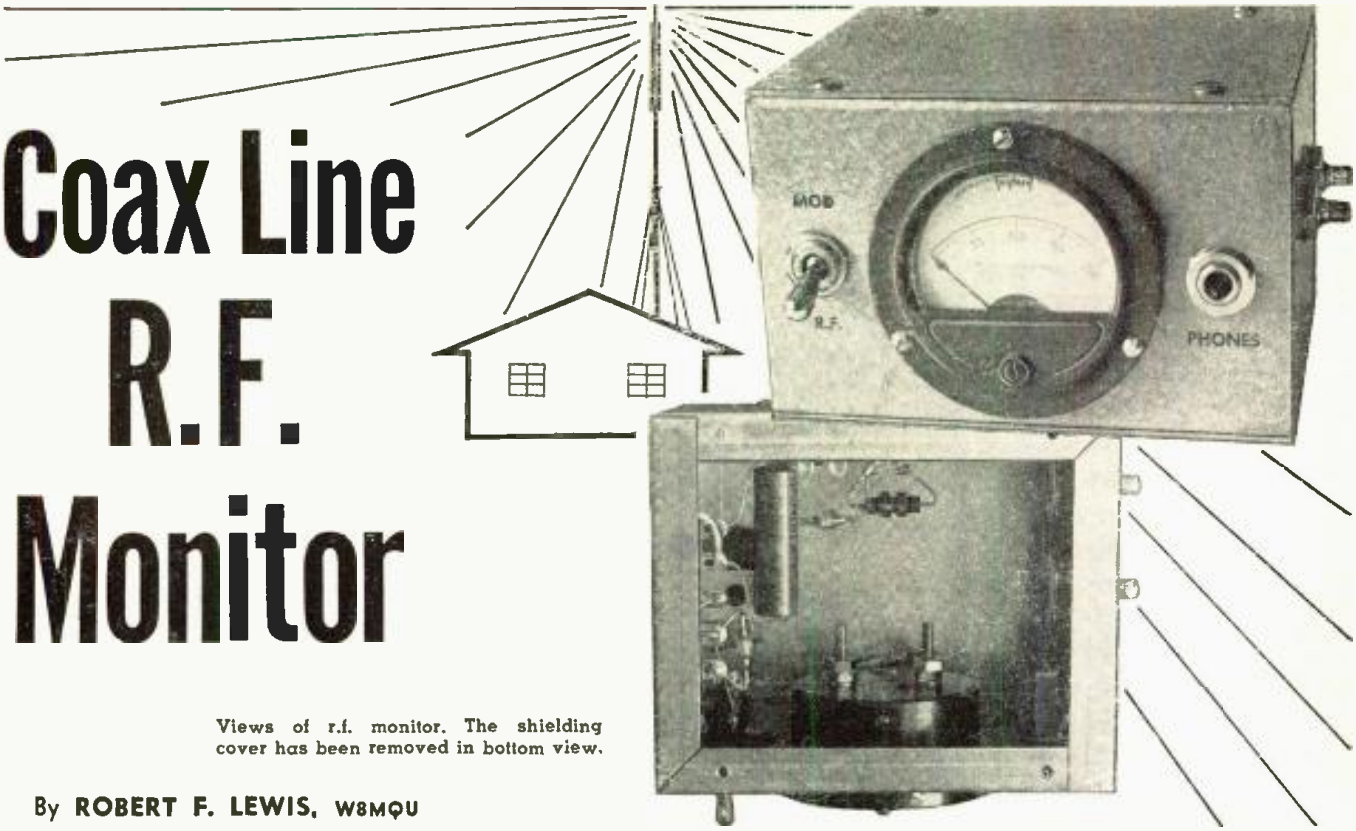
It is possible for the user of an FM tuner to make simple home checks of its performance, which will permit him to detect deterioration in its operation without the use of elaborate test instruments. Many simple tests and alignment procedures can be performed with no instruments other than the tuning indicators usually supplied with FM tuners. Practically all other service and test functions can be performed with simple, inexpensive equipment.

-30-

Fig. 5. Effect of bandwidth on distortion with (A) peaked and (B) flat-topped curves.



Coax Line R.F. Monitor



Views of r.f. monitor. The shielding cover has been removed in bottom view.

By **ROBERT F. LEWIS, W8MQU**

Output meter for ham shack measures relative power, modulation percentage, and monitors the modulation.

MOST amateur radio operators, these days, are fairly well supplied with instruments for measuring the various operating characteristics of their equipment. Practically any ham can determine, with reasonable accuracy, his operating frequency or final amplifier power input. Very few stations, on the other hand, have any facilities at all for determining the quantity or quality of r.f. output into the transmission line or antenna system.

In an attempt to help fill this gap, an r.f. output meter was developed which provides for the monitoring of: (1) relative carrier output power; (2) amplitude modulation percentage; and (3) aural monitoring of modulation. In view of the almost universal use of coaxial output circuits the instrument was designed to be inserted into a coaxial line without upsetting the characteristics of the line.

The circuit of the monitor is very simple. No external power source is required and the total cash outlay for component parts should not exceed ten or fifteen dollars, depending on the cost of the microammeter.

Briefly the monitor functions as follows: Resistors R_1 and R_2 form a voltage divider network across the coaxial line. That portion of the r.f. line voltage which appears between the junction of the two resistors and ground is rectified by CR_1, a 1N34 germanium diode. The rectified current passes through an r.f. filter composed of RFC_1 and C_1, through calibrating resistors R_3 and R_4, and then through M_1 (when S_1 is in the "R.F." position). The audio component of the signal passes through C_3 and T_1 and is rectified by CR_2. The rectified current is indicated on M_1 when S_1 is in the "MOD." position. Thus it is possible to read either the relative r.f. carrier level or modulation percentage of a signal by merely throwing S_1 to one position or the other. Output for aural monitoring is available at J_3. Interstage transformer T_1 is connected in a stepdown arrangement to provide a better match between the low-impedance load and the high-impedance primary circuit.

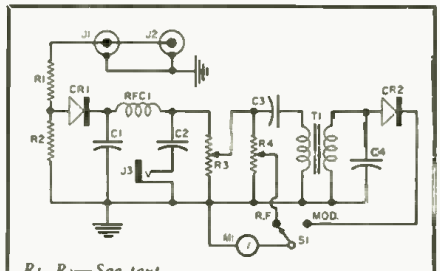
The resistance values of R_1 and R_2 are not given in the parts list as they must be determined for each individual case. The total network resistance (R_1 plus R_2) should be roughly one-hundred times the nominal line impedance, that is, between 5000 and 7500 ohms. It can be readily seen at this point that the monitor will draw a very insignificant amount of power from the transmission line, probably not more than one per-cent. The ratio of R_1 to R_2 should be chosen so that between 5 and 10 volts of unmodulated r.f. will appear across R_2. Much more than this may damage the germanium diode, CR_1, especially with amplitude modulation. The total power-dissipation rating of R_1 plus R_2 should be one per-cent, or more, of the expected transmitter power output. Both resistors should be of the non-inductive carbon type.

All other component values remain as indicated in the parts list irrespective of transmitter power rating. It should be noted, however, that calibrating resistors R_3 and R_4 were chosen for use with a 0-200 microampere meter. In the event that a meter of different range is used, it would be advisable to change the values of R_3 and R_4. Thus if M_1 were to have a range of 0-100 microamperes, then the values of R_3 and R_4 should be doubled. The use of a meter of greater than 1 milliampere range is not recommended.

The construction of the instrument can assume many variations. However, several points should be observed. First, the unit should be built in a

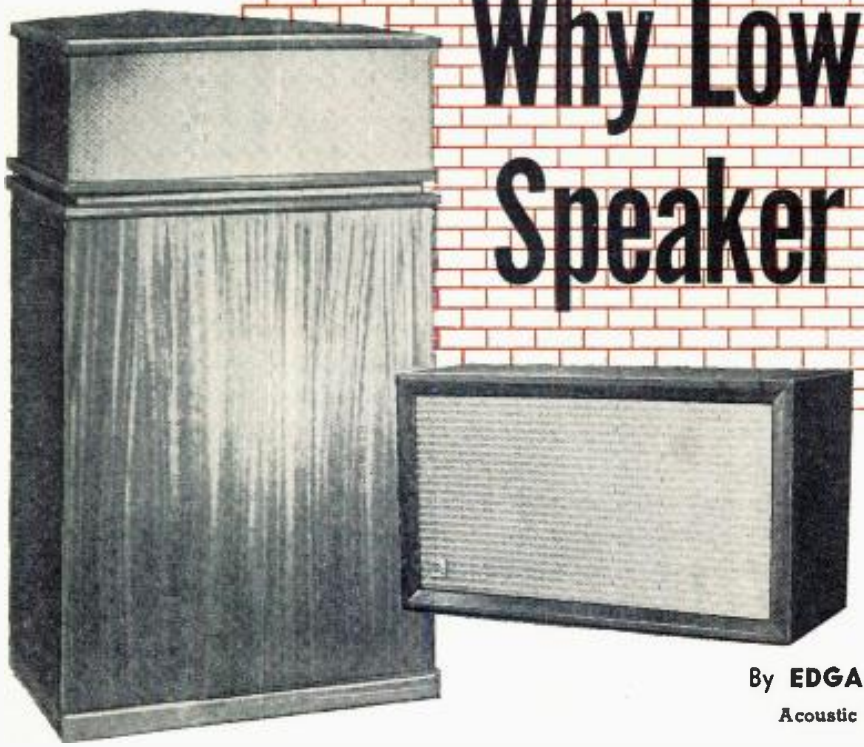
(*Continued on page* 108)

Schematic and parts list of r.f. monitor.



R_1, R_2—See text
R_3, R_4—50,000 ohm pot
C_1, C_3—.001 µfd. disc ceramic capacitor
C_2—.01 µfd. ceramic capacitor
C_4—.1 µfd., 400 v. capacitor
RFC_1—100 µhy. r.f. choke
M_1—0-200 µa. meter
T_1—Interstage trans. 3:1 ratio, connected stepdown (Merit A-2910 or equiv.)
S_1—S.p.d.t. toggle switch
J_1, J_2—Coax. connector (Amphenol 83-1-R)
J_3—Open-circuit jack
CR_1, CR_2—1N34 germanium diode

Why Low-Efficiency Speaker Systems?



Two extremes in speaker system design—the Klipschorn, considered as having the highest over-all efficiency, and the Acoustic Research AR-1, which is rated as having the lowest over-all output efficiency.

By **EDGAR VILLCHUR**
Acoustic Research, Inc.

A leading proponent of the low-efficiency loudspeaker system discusses its characteristics and gives his reasons for the use of this type of system.

THERE has been a lot of recent interest in loudspeaker efficiency, particularly with regard to its side effects. It has been claimed, for example, that high efficiency is a necessary earmark of good transient response, or that only low-efficiency speakers are capable of musical quality. Neither claim is accurate, and some of the "old wives' tales" about this particular subject need clearing up.

First, let us examine the factors that actually determine the electro-acoustic efficiency — the relationship between acoustic power output and electrical power input—of a speaker. These are: (1) strength of the magnetic field, (2) amount of copper or other material in the gap, (3) mass and friction of the moving system, and (4) nature of the coupling between the voice-coil and the air which it drives.

These factors are not constant at all frequencies. Mid-range efficiency may be quite different from efficiency at the frequency extremes; for example, the speaker which has the lowest over-all efficiency of any on the high-fidelity market is rated[1] as one of the most efficient, if not *the* most efficient, in the frequency range below 30 cycles. Apparently it is necessary to dig a little deeper.

Strength of Magnetic Field

For a given magnetic structure, the size and strength of the magnet can be taken as an index of the magnetic flux in the gap. Yet a "replacement" type speaker, with an *Alnico* V magnet of 6.8 oz., may have much higher mid-range efficiency than a quality speaker whose magnet, made of the same material, weighs five times as much. The amount of magnetic flux is thus only a relative figure, without absolute significance unless all of the other factors are held constant.

Amount of Copper in Gap

One of the reasons why the strength of the magnetic field is not an absolute index of efficiency is that the relative amount of working copper (or other conducting material) in the gap may vary from speaker to speaker.

If we design the voice-coil with a view to keeping bass harmonic distortion as low as possible, we must allow the winding to overhang the gap, so that even with large excursions the entire length of the gap is filled with copper. Unless the voice-coil is longer than the gap, each large excursion will remove some of the turns from the controlling field, and reduce the force generated by the signal; with voice-coil "overhang" the same number of turns is always immersed in the field, as shown in Fig. 1A. Here is a case where we must choose between efficiency on the one hand and reduced bass distortion on the other.

Fig. 2 is a comparison of performance, with regard to distortion, between a standard low-efficiency AR-1 speaker system (one-inch long voice-coil suspended in a half-inch long gap) and a non-production model of the same speaker, whose voice-coil length was purposely made the same as that of the gap. In the improperly designed, higher efficiency model *all* of the copper works to drive the speaker at mid-range frequencies, while in the standard model half of the signal voltage appears across non-active sections of the voice-coil. Ignoring fringing of the magnetic field, the sacrifice in mid-range efficiency would be by a factor of four, since power varies as the square of the voltage.

Mass and Friction

It is easy to understand intuitively that the heavier the vibrating cone and voice-coil and the greater the friction that must be overcome, the more electrical power will be required to set the speaker into motion at a given sound level. It might seem that the speaker designer should simply try for as light and frictionless a moving system as possible.

But here again there are complicating factors. When we go to light cones we must accept more violent cone flexure or "breakup," a phenomenon directly associated with harmonic distortion and with dips and peaks in the frequency response curve. Furthermore it is often desirable to deliberately introduce friction into the

speaker's moving system, in the form of a viscous damping substance at the cone rim suspensions. This suppresses edge reflections and the attendant standing waves set up in the cone.

An additional element in avoiding too light a cone has to do with over-damping, which will be considered in more detail a little later.

Speaker-Air Coupling

The factors that have been discussed so far involve the speaker mechanism itself, exclusive of its enclosure. These factors indicate the reasons that, at the present state of the art, *all* loudspeakers in themselves are grossly inefficient. Probably the best that can be hoped for, from a loudspeaker in a simple baffle, is a general efficiency on the order of 10%. A more typical figure is 5%, and current low-efficiency units boast efficiencies of one or two per-cent. At best, we must throw away 90 per-cent of our amplifier power before we convert it into sound; at worst, 99% or more.

This should not be a surprising situation to those familiar with the electronic field. It is an accepted fact in circuit design, for example, that narrow-band, resonant circuits can be designed with high gain, while wide-band circuits must limp along with low gain. A TV amplifier stage, with 4 megacycle bandpass, is not expected to provide the gain of a comparable audio stage. The analogy is not exact, but it will serve. If a loudspeaker had only to reproduce a narrow band of frequencies, we would not have to spend so much electrical power on it.

We now come to the most important single element that influences speaker efficiency, and the crux of the problem. The type of coupling between the speaker and the air (once the cone area is fixed), as determined by the speaker enclosure, not only has a direct and important bearing on the efficiency figure, but also influences the kind of design that can be used in the speaker mechanism itself. It tells the speaker designer whether he should be building a speaker whose mid-range efficiency (before enclosure) is in the one to three per-cent category, or in the seven to ten per-cent bracket. The enclosure thus counts twice with regard to efficiency.

In spite of the many apparent varieties of speaker enclosures available on the market, there are only three basic types: the direct-radiator (infinite baffle, acoustic suspension, etc.), the resonant (bass-reflex, acoustical labyrinth, etc.) type, and the horn. The resonant enclosure and the horn have one characteristic in common: the cone is coupled to an increased volume of air at low frequencies, compared to that which it would engage directly, and a given bass sound level is associated with smaller cone excursions. This means (1) voice-coil overhang requirements are reduced, and (2) the problem of over-damping, which would attenuate the bass in the region of speaker resonance, is likewise reduced, due to compensation of the enclosure. Both of these results enable the speaker designer to work for maximum mid-range efficiency. And since horn loading also increases the efficiency directly, it is possible to end up with a transducer whose conversion losses are relatively small. Horn efficiencies as high as 50% have been claimed.

If we were to take a speaker mechanism designed for maximum over-all efficiency and mount it as a direct-radiator, we would be likely to get very disappointing results. The speaker would not be capable, either electrically or mechanically, of undergoing the large excursions required in the bass, and it would also be over-damped. The bass range would be attenuated and harmonic distortion at low frequencies would be high.

On the other hand, a speaker designed for use as a direct-radiator would have the necessary overhang of voice-coil winding, and freedom from over-damping, and would fall in the low-efficiency range. The direct-radiator baffling system counts twice here, too, this time against efficiency; once in directing the speaker designer to choose features that must sap efficiency, and again in giving up any aid in coupling the cone to the air, other than that of direct contact. One may wonder, then, why anyone would deliberately choose a direct-radiator over a horn or resonant system, with the former's inherent sacrifice in electro-acoustic efficiency.

The author believes that each of the design approaches just referred to are valid, and that successful results can be achieved with any of them. Since the author's own experience has yielded the most success with the low-efficiency, direct-radiator approach, its case will be outlined here.

The benefits sought by such an approach, in return for the sacrifice of efficiency, are decreased bass harmonic distortion (in spite of the increased voice-coil travel), better uniformity of frequency response (and the attendant improvement in transient response), and a more extended range of frequency response at the bass end.

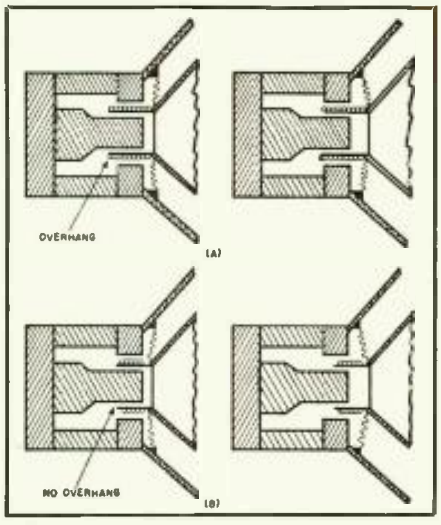
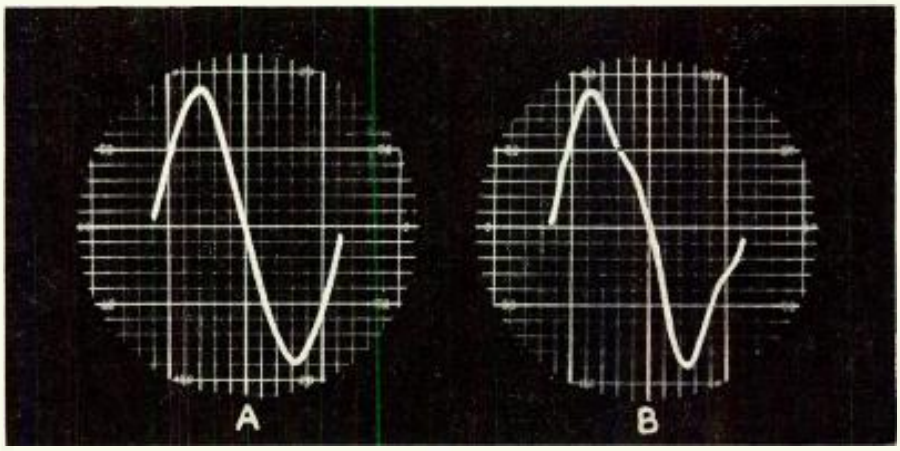


Fig. 1. A large voice-coil overhang keeps the number of turns in the gap constant, even on large cone excursions, but it results in a loss of efficiency.

A speaker is a resonant mechanical device, whether we like it or not, and much of the effort of the designer must be directed toward taming this resonance. The use of a horn, bass-reflex, or resonant-column enclosure adds greatly to the problem. Acoustical resonances, which produce response peaks and dips, and boomy, hollow sound, are very nasty and difficult to deal with, usually far more difficult than the primary resonance of the speaker itself. It is not theoretically impossible to tame acoustical resonance—bass-reflex ports can be damped, horns can be made with large enough mouth diameters to discourage

(*Continued on page* 140)

Fig. 2. (A) Acoustic output at 30 cycles, 39 watts to rated impedance, of a standard AR-1 speaker having a ½-inch voice-coil overhang. Output of the amplifier was adjusted for ½-inch cone excursions. (B) Acoustic output, at the same input frequency, of a special speaker system, identical to the AR-1 except for lack of voice-coil overhang. Only 23 watts were required for the same peak sound level at the microphone. (The actual 30-cycle level is less than that represented by the height of the waveform, because of the harmonic content.) A DuMont type 302 Polaroid oscilloscope camera and a type 401 oscilloscope were used for waveforms.



Service Techniques for Standard Coil Tuners

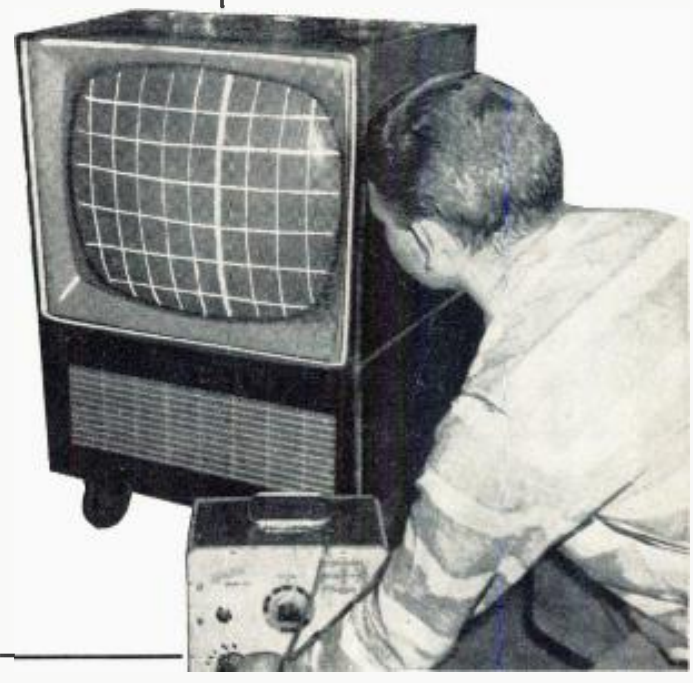


Fig. 1. A technician uses a pattern generator to check tuner sensitivity.

By **CHARLES GARRETT**

Procedures for handling electrical and mechanical difficulties on these widely employed front ends.

THE STANDARD COIL tuner is standard equipment in many of the more popular television receivers, both past and present models. Although it is not a difficult tuner to service, several special techniques, aids, and tools can speed up needed repairs, make its servicing more convenient, and help to insure maximum performance from each unit.

The basic mechanical design of this type of channel selector can be seen in Fig. 2. Each channel has an individual strip on which are mounted an antenna coil and r.f. coil for that channel. Also, in line with each antenna-r.f. strip, is another strip for that channel on which are mounted the mixer and oscillator coils for the channel. Each set of strips is designed and tuned for just one channel to obtain maximum gain and bandpass. Some later models have each channel's coils integrated into one extra-long strip instead of two strips. The contact points on the strips for the channel being viewed touch finger-springs which connect each strip's coils to the tubes and other circuitry in the tuner. All these channel strips are mounted on a drum or turret which rotates to select the various channels individually and independently.

All channel strips, other than those for the channel being viewed, are disconnected and could be removed without having any appreciable effect on the reception of that channel. This permits an interesting technique to be employed in the servicing of these tuners. Also, since any adjustment made on one channel's r.f. or oscillator strips has no effect on any other channel, this simplifies oscillator adjustments.

Cleaning and Maintenance

The most common servicing need of *Standard Coil* tuners is for the removal of tarnish that forms on the channel-strip contacts and on the finger-springs. Most technicians are familiar with the symptoms: fluctuating and intermittent performance of the channel selector. To the set owner it acts as if the detent fails to click in correctly or that, as he is likely to put it into words, "something is loose or shorted."

Tarnish on contacts can easily be removed without removing the drum from its tuner housing simply by applying a commercial tuner-contact cleaner fluid to a clean cloth and wiping each strip's contacts (Fig. 2) as the drum is rotated. Files, sandpaper, and emery cloth should not be used for this purpose as they can easily wear through the relatively soft finish on the contacts. It is not necessary to remove the drum, either, with the resultant difficulties often encountered in re-installing it, in order to clean the finger-springs or to check and adjust their tension.

Instead of removing the drum or turret, remove two or three adjacent sets of channel strips and rotate the drum so that the resultant empty spaces are under the finger-springs, as shown in Fig. 3. This gives the technician a clear view and sufficient working area to clean and adjust the finger-springs. A pencil with its eraser dipped into contact cleaner is a convenient tool for this purpose. Before re-installing the strips on the drum, check the tension of the finger-springs. Their tension is correct when they rub firmly against the plastic of the channel strips as the drum is rotated. Proper tension keeps the strip contacts clean for a longer time.

Repair Techniques

Although the *Standard Coil* tuner is not a difficult one to service, it does offer some obstacles, especially to voltage and component testing while it is assembled and in operation. Even with its side panel removed, many of the tube-socket terminals cannot be reached with test prods and many components are inaccessible unless the drum is removed. But, with the drum removed, the tuner cannot operate and therefore cannot be thoroughly tested under operating conditions.

Adapter test sockets are sometimes suggested as a partial solution to this difficulty by allowing socket voltages to be measured from the top of the tuner chassis with the tubes functioning. The technician will, however, have to take into account the fact that the inherent capacitance and inductance in these test sockets has considerable effect on the tuner's performance as well as on the tube-socket voltages—

particularly those in the oscillator and mixer circuits.

There is a more accurate way to test socket voltages and, at the same time, gain access to the circuitry on the underside of the tuner chassis. Remove most or all of the channel strips with the exception of the one channel being used. In this way (see Fig. 4) access to the tube sockets and circuit components is obtained.

Mechanical Repairs

The plastic cam on the rear of the fine-tuning shaft can develop slippage, thus making the fine-tuning control inoperative. The set owner usually brings about this condition by forcing the fine-tuning knob to turn the shaft farther than it is intended to go (usually due to an incorrectly set individual-channel oscillator adjustment) and by rough handling in general. No repair or replacement is generally called for unless the plastic cam refuses to rotate when the shaft is rotated.

When fine tuning is inoperative for this reason, remove and inspect the fine-tuning shaft and its attached cam, as shown in Fig. 5. Inspect the area around the flange that the shaft forms about the hole in the cam. Look for signs of chipping of the plastic. Where the flange is only loose or the chipping is moderate, reseating the flange should correct the slippage. Place the shaft upright on a hard surface with the plastic cam uppermost. Then gently indent the flange into the cam with a small steel chisel or a screwdriver, as shown in Fig. 5. This will correct slippage if the cam or flange, or both, are not too badly worn.

Many cases of intermittent tuner operation can be traced to one or more of the topside tuning screws (Fig. 6) having worked loose. When the washer-like conical nuts that hold these trimmer-capacitor assemblies in place become loose, they provide a poor ground for these screws. Actually, each screw is one terminal of its trimmer capacitor. These trimmers and conical nuts should be inspected for this condition when an elusive intermittent condition exists; if one is found to be loose, the conical nut should be turned down tight, then soldered in place to the tuner chassis.

Alignment and Sensitivity

Seldom is it necessary to completely re-align a *Standard Coil* tuner unless the adjustments were tampered with or unless extensive parts replacements were made in the signal-handling circuits. In either case, the set manufacturer's alignment data—data that may vary for his particular set or model or for the various models of *Standard Coil* tuners that are encountered—should be closely followed.

Most technicians are quite familiar with the individual-channel oscillator adjustment. It simply involves, in most cases, removing the channel-selector and fine-tuning knobs; inserting a non-metallic alignment tool or one with a non-metallic tip into the hole provided for it in the front of the tuner; and adjusting the powdered-iron tuning core in and out for the best picture and sound on the channel being received. These individual-channel adjustments have no effect on any other channel.

The problem sometimes encountered in this procedure is the loss of the tuning core caused by its accidentally being turned too far so that it slides to the rear of the coil form and disables that channel. Normally removal of the chassis of the disabled channel strip would be required to reposition the core. However, with the various tools now on the market, designed for retrieving these tuning cores from the front of the cabinet, dismantling a receiver is no longer necessary.

Receiver sensitivity, or its ability to produce a usable, snow-free picture from a relatively weak signal, is dependent on the tuner. Snow or background and shot-effect noise can be overcome by a TV signal of sufficient strength to cause the receiver's a.g.c. action to reduce the gain of the r.f. tube—a source of most background and shot-effect noise. This is of course true for all brands and types of tuners. The picture will be snow-free as long as the antenna is delivering a sufficient amount of signal and this signal is properly handled and amplified by the tuner.

Consequently, a defect in the antenna system or in the receiver's tuner can reduce this signal and produce receiver snow. In borderline and fringe areas and in some difficult locations, a certain amount of picture snow is commonplace. In these locations, the technician cannot assume receiver snow to be an indication of a defect. However, if either tuner or antenna system is defective, doubt can exist as to which. The readings of a field-strength meter are of little value in these cases, since there is usually no way of telling what the "normal" signal is for that particular location. The use of a portable linearity or cross-hatch generator with r.f. output can be of assistance.

Fig. 4. All strips removed except one pair in use, for access to circuitry.

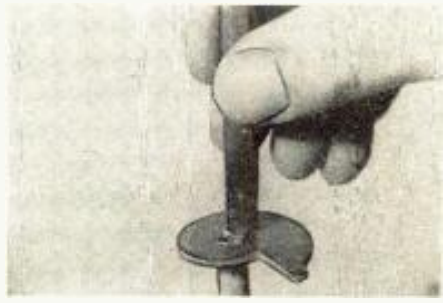


Fig. 5. Procedure for re-seating a plastic fine-tuning cam on its shaft.

The idea is to use the r.f. output of this generator to test, by comparative r.f. attenuator settings obtained from normal receivers, the minimum perceptibility or sensitivity level and the snow-free level of the receiver under test. The technician can then judge whether the snow (or excessive snow) is caused by a defect in the set or in the antenna system.

Comparative attenuator settings are obtained from two normally operating TV sets, one with a pentode tuner using r.f. tubes such as the 6AG5, 6BC5, or 6CB6, the other with a cascode tuner using a 6BK7, 6BQ7, 6BZ7, 6BS8 or the like. First connect the pattern generator to the antenna terminals of a set with a pentode tuner; tune the generator to the frequency of the channel being used; and adjust the generator output attenuator until the cross-hatch pattern on the screen is barely perceptible, as shown in Fig. 7. Mark or record the setting for a pentode tuner on the generator

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Fig. 2. A cloth moistened with contact cleaner fluid is used to remove tarnish.

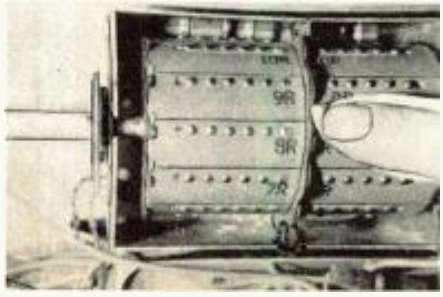


Fig. 3. Tuner drum with three sets of strips removed to expose finger springs.

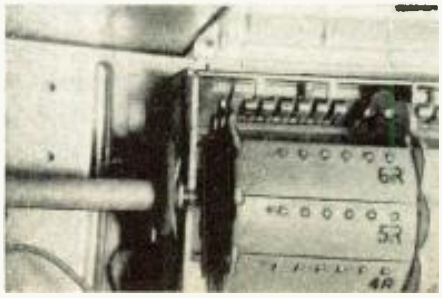
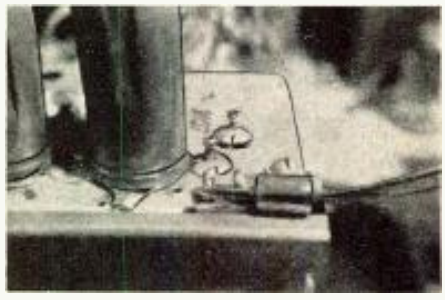


Fig. 6. The conical nut on the trimmer screw at the right has worked loose.



Practical Color TV for the Technician

By **KEN KLEIDON**
National Color TV Manager
Hycon Electronics

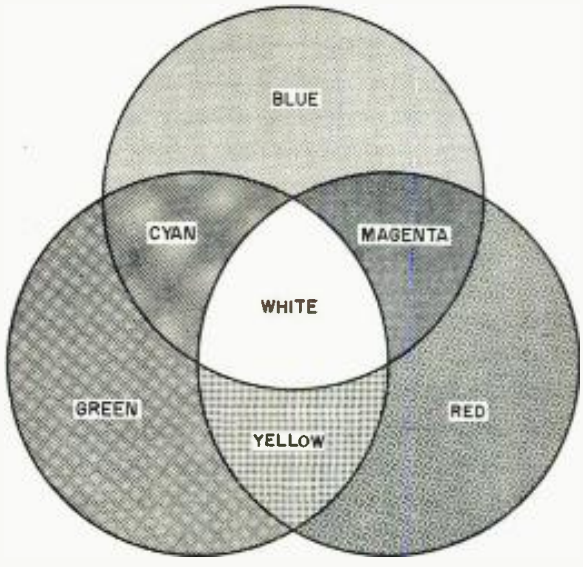


Fig. 1. The color combinations that result when the lights from a red, a green, and a blue lamp are thrown on a screen so that their beams overlap.

Part 4. The three-gun color picture tube and how it handles signals to make many colors of three.

THE PICTURE tube in a color receiver performs the final act in the reproduction of the televised scene as it converts the electrical signal impulses into the necessary color and light variations. As presently used, these tubes are of the three-gun type. While other types are still mentioned as possible, no commercial receiver manufactured to this date has used any but a three-gun tube and no set has been announced specifically for future production that uses any other. Thus, any understanding of color reception must include a study of this device.

In many ways, it is easier to look upon this tube as three separate ones built into a single envelope. Each gun has its own cathode, control grid, screen grid, and focus electrode. In fact, it may even be said that each gun has its own phosphor screen (although this screen has been broken up into dots of phosphor that appear side by side with dots of other phosphors).

Each of the three separate picture tubes integrated into a color CRT can independently function as would a monochrome picture tube. We could, for example, hook up a color picture tube so that only its red gun was in use. It would then produce a monochrome picture entirely in shades of red. The only difference between any of these three guns and any other is the color of the phosphor each is intended to activate. Each of the guns is designed to activate either red, green, or blue phosphors, and each of these colors is considered a primary color. That is, by various combinations of any two or all three of these primaries, white and all other colors can be produced.

Since there is only a single faceplate in the single tube envelope on which all three screens can be placed, the screens are broken up in an interesting manner. Minute dots of red, green, and blue phosphors are scattered all over the faceplate to fill its surface, but they are not put down in a random manner. They are precisely deposited in a repetitious, triangular relationship, as illustrated to the right in Fig. 2.

Inside the color CRT is the aperture mask, an element not found in conventional monochrome picture tubes. It is located between the neck of the tube and the faceplate, but much nearer to the latter. In fact, looking at this mask from the neck end of the tube, we would say that it covers the entire faceplate, whose contour and shape it follows.

The aperture mask, or shadow mask, is full of minute, regularly spaced holes, and there is one hole in the mask for each group of three phosphor dots on the faceplate. The three separate guns are mounted roughly parallel in the neck of the tube, and all aimed so that their beams converge in the plane of the aperture mask. In this way, as shown in Fig. 2, they will pass through the holes in the mask together, then separate so that each goes on to strike its own phosphor dot. In fact, if we could get inside each of the aimed electron guns separately and sight through holes in the aperture mask, the view we would see from each gun would be only of the phosphor dots belonging to it, as shown in Fig. 3. The view from the blue gun through the aperture mask is shown at (A), with the views from the green and red guns being shown at (B) and (C) respectively.

This phenomenon helps to explain the reason for using an aperture mask in the first place. Since it would be difficult to design a gun in which all the emitted electrons would be accurately aimed only at those phosphor dots of the right color, the mask acts as a control device. Only those electrons that are being propelled in the proper direction will get through the openings and activate phosphors. Any that are off target, that is, heading for a phosphor dot of the wrong color—will be blocked by the mask. Thus the mask is said to maintain color purity.

Once we have our three colors carefully separated, we go about mixing or adding them under controlled conditions to achieve desired results. The concept of color *addition* and the color combinations that result from it seem strange to many people, since most of us are used to blending colors by the mixing of pigments, which is a form of color *subtraction* and produces results that are quite different.

To begin with, physicists have established the fact that white light is actually a combination of lights of all colors mixed in a given proportion. This can be demonstrated by shining a white light on one face of a glass prism and permitting the light that leaves through another face of the prism to be projected on a flat, clear surface. The resulting light appears, not as white, but as a rainbow. Conversely, we can take colored lights and mix them in appropriate proportions to produce white light.

To illustrate this latter principle, which is used in the three-gun picture tube, we can use three matched slide projectors (or any other three matched sources of white light), a viewing screen, and three color filters. The filters used are red, green, and blue—to correspond to the shades of red, green, and blue phosphors found in the color CRT and considered to be the primary colors for television. Each of the projectors or lamps is fitted with one of the three transparent filters. The

circular spots of light are then projected onto the viewing screen.

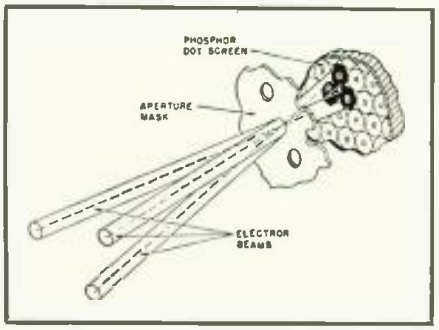
If the colored lights are projected to different points of the screen, we will see separate spots of red, green, and blue light. If the lamps are positioned so that they tend to converge and all three overlap, as in Fig. 1, we can see the results of the addition of colored lights. In the center, where all three colors overlap, we will see white light. If the filters are properly matched and light output of the three projectors or lamps is properly balanced, a pure white can be seen; if not, balancing out the line voltage fed to each of the lamps may achieve this condition. Where only blue and green overlap, cyan, a blue-green shade, will be seen. Where only blue and red overlap, magenta, a purplish shade, will be visible. Where red and green overlap, yellow will appear.

A great number of other colors can be produced by individually varying the brightness of each of these three primaries. This may be done by varying the line voltage input to each lamp. For example, the yellow wedge of light is shown to result from the addition of red and green. If brightness of the green lamp is reduced, the yellow segment begins to appear orange. Since we can infinitely vary the combinations of brightness settings for the three lamps, we can produce infinite color combinations. The three guns of the color picture tube function like the three projectors.

Actually, the phosphors excited by the three guns never overlap and blend together. Since the phosphor dots are so fine and so closely spaced, however, the human eye cannot resolve them except at the closest distance, and they appear to blend together. Their separate character can be confirmed by placing a magnifying glass in front of the screen of a color TV receiver to view the dots. Where yellow is seen on the screen from viewing distance, individually excited red and green dots can be seen under magnification; where magenta appears, individual red and blue dots will be revealed.

Three new types of adjustment arise with reference to the color CRT using three guns; they pertain to purity, convergence, and balance. These are important because they are performed at the time of installation of the color receiver and in many cases after the need for servicing the set has arisen.

Fig. 2. Beams from the three guns must converge in passing through the openings in the aperture mask.



Purity adjustments involve positioning the deflection yoke, adjustment of a purity magnet which is located on the neck of the picture tube, and adjustment of field equalizing magnets located around the perimeter of the face of the picture tube. The goal in manipulating all or any of these is to ensure that the electron beam of any of the three electron guns will strike phosphor dots only of its own color over the entire surface of the screen. The components typically associated with the picture tube are shown in Fig. 4.

Convergence adjustments are necessary because the electron beam does not always travel over the same distance from the point where it leaves its gun to the point where it strikes the screen. This is true because the screen of the tube does not follow a conspicuously curved shape that is made to correspond with the arc through which the three electron beams swing. Fig. 5, for example, shows the limits of deflection through which the three beams are swung in broken lines. Also shown in broken lines is the arc described by these beams.

Since this arc does not correspond to the shape of the somewhat flatter aperture mask and phosphor dot screen, the point at which the three beams converge in going through the apertures of the mask will not always be the same during deflection. At the center of the screen, they must converge at a point nearer to the guns than they converge at the outer edges of the screen.

Although there is no intention to delineate the convergence adjustment procedures here in detail, it is worth pointing out that signals for varying the beam length, derived from and in step with the deflection circuits, are fed to special convergence coils around the neck of the tube to vary the converging point of the three beams as they scan to match the distance to the aperture mask at any given moment.

It will obviously be an unreasonable production requirement to expect that all three guns of the picture tube be entirely identical in all respects, although the degree to which they approach this condition is important. Since some variation among these guns is inevitable, each electron gun is provided with balancing adjustments to facilitate the matter of matching all three to each other externally. These consist of individual screen and brightness controls for each gun. With these, the light output from each phosphor can be balanced against the output of the other two guns so that they all exist together in the proper proportion to produce white or other colors, as determined by incoming signal. This balancing arrangement is not too unlike the procedure, mentioned earlier, of adjusting line voltage input to the three projection lamps.

This greatly simplified explanation of some of the things that happen in the color picture tube will be of most value to the service technician if he remembers that he is fundamentally dealing with three monochrome picture tubes

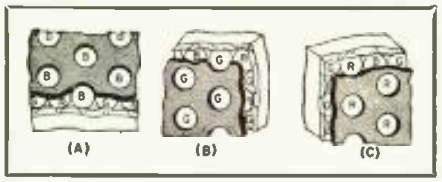


Fig. 3. Views through the aperture mask from (A) the blue, (B) the green, and (C) the red guns of the color CRT.

that have been placed in the same envelope. It may even happen, in fact, that he will have to deal with defectiveness in one of these three entities that does not directly involve the other. It will then help to remember that he can "turn off" any one or two of these three, for example, to isolate defects involving one gun or one of the channels associated with it.

This separate nature of the three guns, of course, comes into play only when the picture tube is being considered analytically—that is, from the point of view of troubleshooting or adjustment—and the technician is quite likely to be lulled away from this character of the CRT because the nature of his job is more often to manipulate these three tubes so that they act as one!

(To be continued)

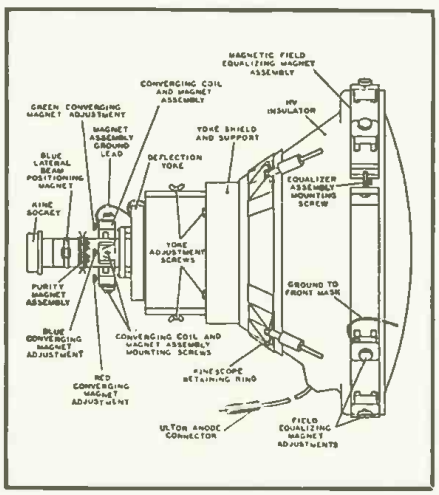
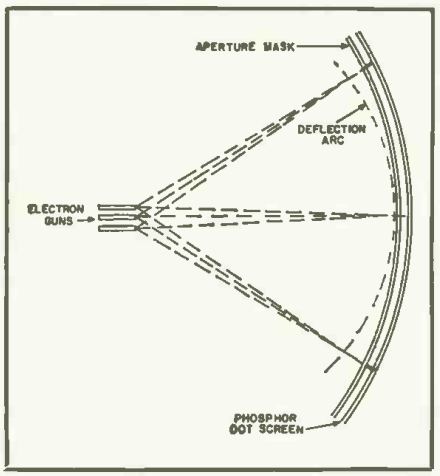


Fig. 4. A mounted tri-gun color CRT with some of its associated components.

Fig. 5. Paths of beams from the three guns must converge at the shadow mask.



Electronic Service in Northern Mexico

Fig. 1. A radio shop in Guaymas, Mexico, advertises quick service on transmitters, receivers, and phonographs.

By

RONALD L. IVES

Repair rather than replacement and other notable shifts in emphasis arise from economic factors.

THE use of radio equipment has expanded enormously in northern Mexico during the past two decades to the point where almost every community, no matter how small or how isolated, has a radio link with some central administrative point. In addition, every resident of Mexico who has a relatively simple and inexpensive receiver is able to receive at least one program in Spanish. In many areas, programs are also available in the local Indian dialects. Over the greater part of Mexico, a multiplicity of broadcast programs is available.

Plans are now underway to extend the Mexican television network so that the republic will have complete video coverage. Radio, radar, and sonar equipment is becoming standard on Mexican vessels and the extensive Mexican airline system has adequate radio communications gear which operates very effectively.

Broadcast programs in Mexico are much like those in the United States and range in quality from the superlatively presented operas and symphonies from Mexico City to commercial programs which originate from the local stations. Singing commercials are as prevalent in Mexico as in the United States—many of them advertising familiar U. S. products with the same jingles and tunes used here.

With this great expansion of radio communication, both point-to-point and broadcast, has come an enormous increase in the work load of the radio service technicians who commonly repair not only broadcast receivers but local communication and shipboard equipment as well as complicated appliances. Radio servicing in Mexico is a profession, as it is in the United States, which provides an excellent income for the competent man. Shortages of skilled technicians in Mexico are quite serious and are complicated by the parallel demand for such personnel in the United States. An ambitious Mexican is likely to learn English at night school and then migrate to the United States where he has a good chance at higher wages.

The training program for technicians is at present inadequate although there are excellent technical schools in such urban centers as Mexico City and Monterrey. Some technicians learn radio by working for established servicemen. An appreciable number are largely self-taught, using rather good Spanish instruction books, most of them published in Argentina. Quite a few successful proprietors gained their technical knowledge by serving in the U. S. armed forces during World War II and in the Korean conflict.

Radio shops in Mexico look much like those in the United States, as can be seen from Fig. 1. Equipment in the better shops is quite adequate for the type of work handled. An inspection of test equipment in several shops disclosed that it was in good working order despite obvious long-time use. Adequate hand tools were found in most shops, although many of the tools had a slightly unfamiliar appearance since they were made in Germany, Sweden, Switzerland, or Japan. Mexico's growing small-tools industry cannot as yet fill all of its domestic needs.

Because labor is cheap relative to parts, most of which must be imported, radio servicing in Mexico involves much more actual *repairing* and much less *parts changing* than is customary north of the border. Coils, power transformers, and even i.f. transformers are often rewound; open wirewound resistors are skillfully patched, and bent plates of damaged variable capacitors are laboriously straightened. For the same economic reasons, receivers are repaired and patched up long after they would have reached the "throw-away" point in the United States.

There is an extensive Mexican market in second-hand receivers, both "as is" and skillfully rebuilt, and, in many communities, second-hand but usable components, stripped from hopelessly worn-out receivers, find a

(*Continued on page* 156)

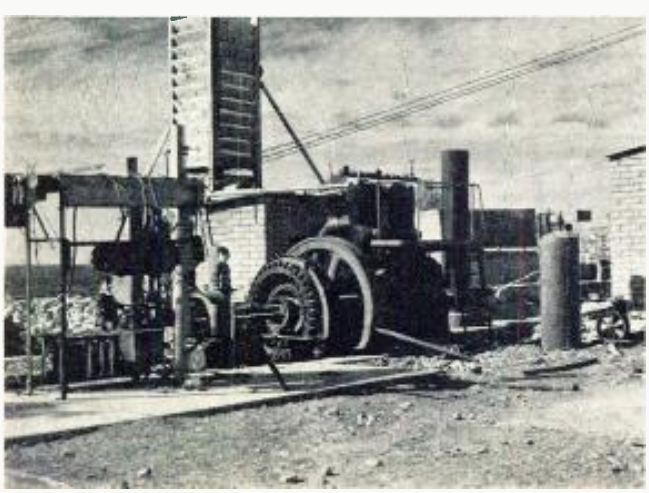


Fig. 2. Typical of others of its kind, this small-town generating plant supplies all of the power used locally. At the time the photograph was taken, the plant was shut down for repairs. This is not an infrequent occurrence.

Do it by Telephone with a Phone Operated Switch

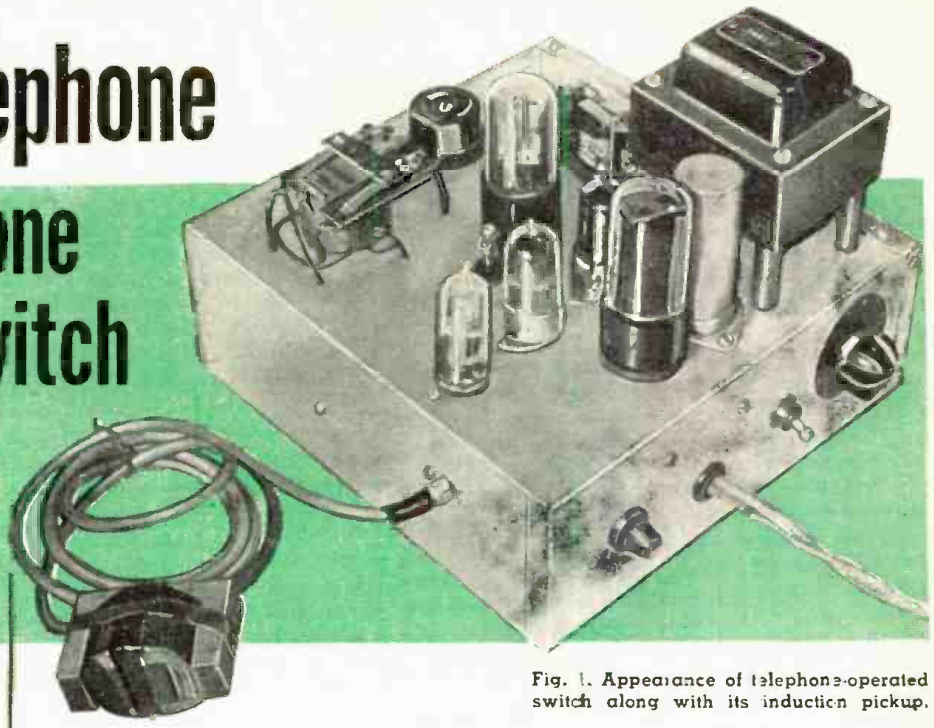


Fig. 1. Appearance of telephone-operated switch along with its induction pickup.

By TRACY DIERS
Staff Engineer, WNYE, New York, N. Y.

Use your phone to operate your electrical appliances from a distance. No connection to instrument required.

ALL of us, at one time or another, have been placed in a situation in which we wished we had the ability to turn some electrical device on or off when miles away from home. Perhaps it was some simple desire such as wanting to turn the air conditioner on before returning home or maybe that car battery was on charge and it became necessary to shut it off after a certain length of time. While it is true that automatic timers will turn things on or off they don't have the intelligence to allow for a change that may occur later, either in the mind of the owner or in surrounding conditions.

Take the case of that air conditioner you are planning for next summer. You may decide to go to the show on a warm evening, perhaps in town or at some distance from home. Connecting the air conditioner to a timer will cause it to go on even if the weather has cooled down while you were enjoying the show and perhaps you may have met some friends and decided to stay out longer. The result is that the air conditioner will be running possibly several hours and wasting power. The long arm of electronics makes it possible to reach into your home many miles away and turn on the air conditioner when you decide it's time to turn it on. Then when you return, cool, dry air will greet you with a minimum of wasted power.

The only requirement you need to perform this miracle is a telephone in your home. The fact that you have those two wires entering your home makes it possible to enjoy easier living.

The possibilities are limited only by the fact that you must be able to reach your number by *dial system* since a manual system involves a telephone operator. This limitation will be explained shortly.

Circuit Description

The device, Fig. 1, about to be described needs no electrical connections to the telephone lines. An inductive pickup coil is placed close to your telephone and this coil is activated by the magnetic field which is produced when the telephone bell rings.

The dialing code is simple, all you do is dial your number and let the bell ring *once only*. When the bell rings, the telephone is surrounded by a magnetic field which is picked up by the inductive pickup coil and fed to V_1, a 12AT7 audio amplifier. (See Fig. 3.) This is designed to amplify very low frequencies such as the alternating current which rings the telephone bell.

The amplified a.c. voltage is passed through C_4 to the 12AX7 tube (V_2) which is hooked up as a diode rectifier. This gives a d.c. voltage which is applied to capacitors C_6 and C_7. Notice that C_7 will have a slower rate of charge than C_6 because of the circuit arrangement. When the telephone bell rings once, C_6 immediately charges but C_7 takes only a partial charge. This charge on C_6 is negative and is present on the control grid of V_{3B}. The plate current of V_{3B} is cut off and the armature of relay RL_1 then opens and this applies the line voltage to the thermal delay relay RL_2. However RL_2 will not close for ten seconds at the end of which time it completes the circuit to the power relay, RL_3 which closes and turns the equipment on or off.

Now about this time someone always asks the question, "What happens if someone should call me on the telephone?" This is how the device can separate calls and determine when it should act and when it should do nothing. Should someone else call your number the first bell will start the cycle of operations but anyone trying to get you will naturally let the bell ring more than once. The instant a second bell comes through the device will reject the call in this way:

Remember capacitor C_7 in the description of operations given previously? It had received a partial charge as a result of that first bell. The second and third bells will charge it still further *but* the charge it receives is of opposite polarity to the charge on C_6. Thus it overpowers the negative charge which C_6 has put on the control grid of V_{3B} and now plate current flows again, RL_1 pulls its armature in and RL_2 no longer receives current. Since this happens in less than ten seconds, RL_2 never closes and thus the final power relay never closes. After a period of two minutes the circuits are ready to start all over again.

Construction

There are no problems in construction. See Fig. 2. Any layout may be used but try to keep wires carrying a.c. away from the grid leads of V_{3B}.

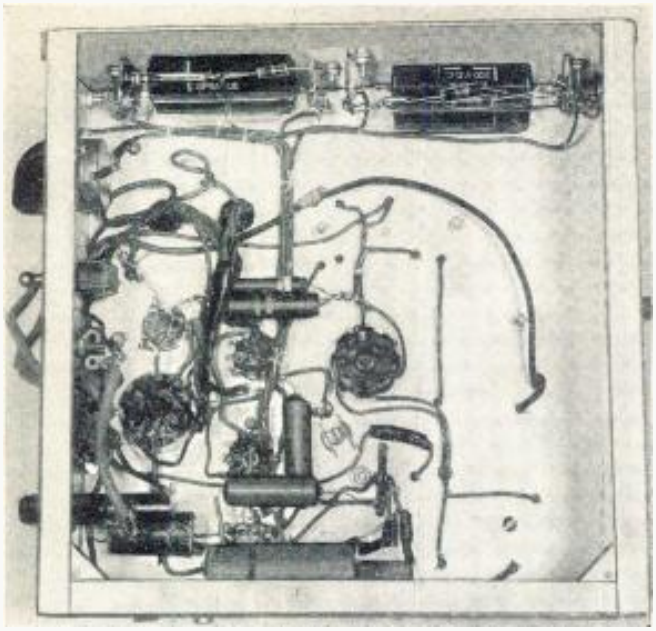


Fig. 2. There are no unusual difficulties in wiring the unit. Be sure that capacitors C_6 and C_7, shown here as two pair of paralleled 1-μfd. units at the top edge of the chassis, are well insulated from the metal chassis to avoid leakage-to-ground problems. Any logical parts placement would be satisfactory for the unit shown here.

Use good quality components, especially for capacitors C_6 and C_7. If these are inferior, they will leak charge on humid days. They should be of the plastic-sealed type and designed for 600 volts. Use a large chassis for ease in wiring and good ventilation since the finished job may run for days at a time.

The pickup coil is made out of a modified high inductance choke. Any choke having an inductance of 100 henrys or over will work well. The choke used in this unit is 120 hy., 5 ma. and is made by *UTC* under the number R22. Another suitable choke would be the *Thordarson* 20C50. A mike-to-grid transformer is also suitable. Use only the secondary connections. Whichever coil you use it will be necessary to open the core. Most chokes or transformers are made in such manner that one side of the laminations can be taken off thus leaving the coil surrounded by the pole pieces. See Fig. 4. This treatment will increase the voltage pickup capabilities of the coil.

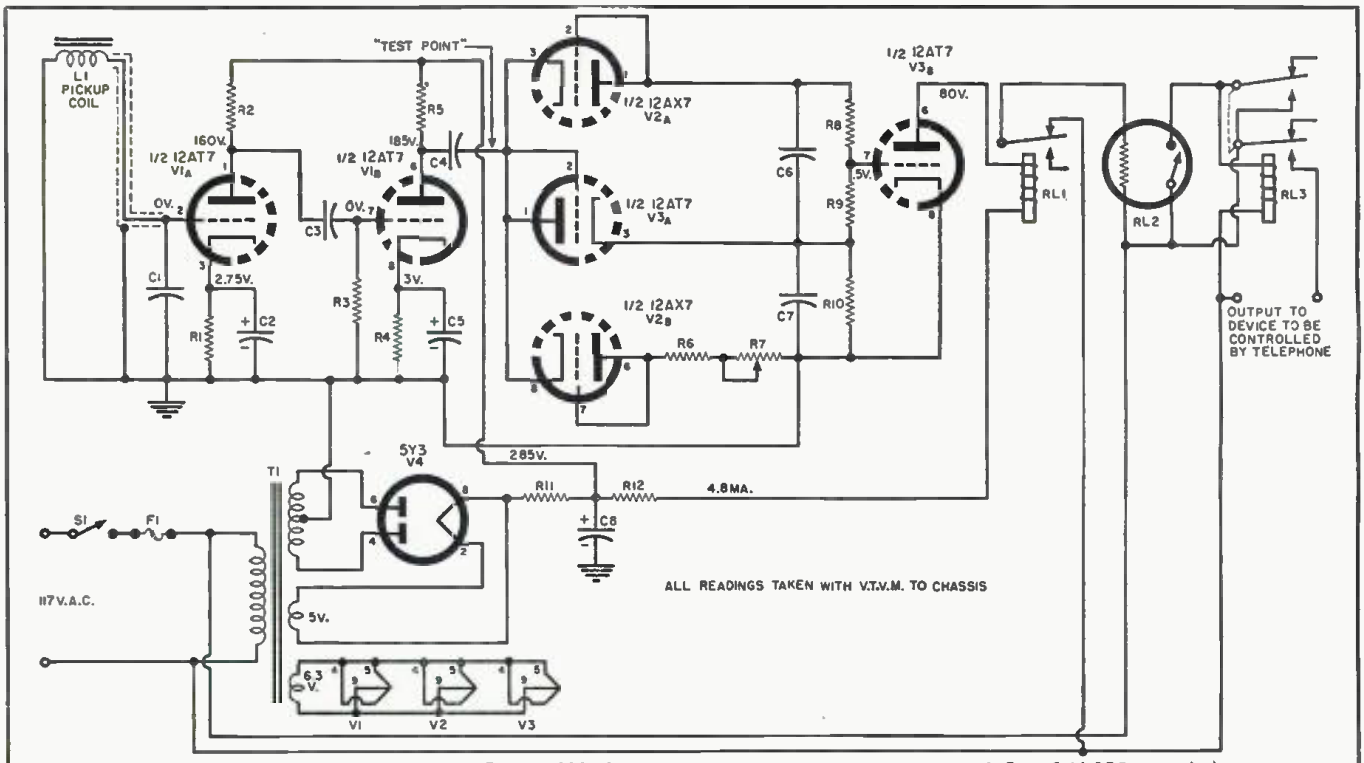
Preliminary Tests

After you have finished preparation of the pickup coil, you may proceed with the first test on the main unit. Plug in all tubes and turn the power on. In a few seconds RL_1 should pull its armature in. With your v.t.v.m. take readings at the tube sockets. These readings should come close to the ones shown in the diagram of Fig. 3. If the project passes its d.c. voltage test, then you may proceed with the adjustment and installation tests. The first step is to find the best spot on your telephone to position the pickup.

Fig. 5 shows the best spot for one type of telephone; this may vary in other types of phones. Also there still are a few real "oldies" in various parts of the country and Canada. These ancient phones have the bell ringing coils in a metal box attached to the wall. The box acts as a fairly good shield, hence pick up of the triggering signal is difficult from the outside.

To locate the best spot, proceed this way: Remove the thermal delay relay,

Fig. 3. Complete schematic diagram and parts listing for the phone-operated switch.



R_1—2500 ohm, ½ w. res.
R_2—100,000 ohm, ½ w. res.
R_3—220,000 ohm, ½ w. res.
R_4—2200 ohm, ½ w. res.
R_5—68,000 ohm, ½ w. res.
R_6—470,000 ohm, ½ w. res.
R_7—2 megohm pot
R_8—4.7 megohm, ½ w. res.
R_9—3 megohm, ½ w. res.
R_{10}—10 megohm, ½ w. res.
R_{11}—11,000 ohm, 5 w. res.
R_{12}—25,000 ohm, 5 w. res.
C_1—.5 μfd., 200 v. capacitor
C_2, C_5—10 μfd., 25 v. elec. capacitor
C_3, C_4—.05 μfd., 400 v. capacitor
C_6, C_7—2 μfd., 600 v. capacitor (see text)
C_8—20 μfd., 600 v. elec. capacitor
T_1—Power trans. 380-0-380 v. @ 40 ma.; 6.3 v. @ 2 amps.; 5 v. @ 2 amps.
RL_1—Plate circuit relay, 10,000 ohm coil (Potter & Brumfield LB5 or equiv.)
RL_2—10 sec. thermal delay relay (Amperite 115N010)
RL_3—D.p.d.t. power relay
L_1—Pickup coil (see text)
S_1—S.p.s.t. switch
F_1—3 amp fuse
V_1, V_3—12AT7 tube
V_2—12AX7 tube
V_4—5Y3 tube

Fig. 4. In order to increase the pickup sensitivity of the choke it is necessary to take one side of the core off as shown. Most laminated cores will come apart quite easily.

Fig. 5. In recent model telephones the pickup choke will work well in the area shown here or on the side. For telephones with metal housing the best spot is under the phone.

V_2, and V_3. Set your v.t.v.m. for a.c. readings and connect it to the "test point" and chassis. Now have a friend call you on the telephone. While the bell is ringing move the pickup coil around until you find a spot which will produce 100 to 120 volts at the test point. The amplifier must develop this voltage, if it doesn't, test the audio amplifier separately as described later. When you are receiving the proper voltage at the test point, you may proceed with the adjustment of the unit.

Place V_2 and V_3 in their sockets and put the pickup coil on the phone. Your associate should now telephone you allowing your bell to ring only once. Almost instantly the armature of RL_1 should open and should stay open for 13 to 18 seconds. Then it should suddenly pull in as plate current once again flows in V_{3B}. If the armature of RL_1 stays open too long then change the setting of the pot, R_7. Less resistance will decrease the time between opening and closing. If the relay armature pulls in too soon then advance the pot to increase resistance. Allow at least a minute between tests because capacitors C_6 and C_7 must reach discharge.

Also, *and this is very important,* do not dial an outgoing call while your pickup coil is on the phone since the dial pulses will cause capacitors C_6 and C_7 to start charging. Remove the pickup coil to a distance at least two feet from the phone when dialing or lifting the receiver during this test period.

The best method is to have your associate dial your number about once every two minutes, allowing the bell to ring only once. After four or five trials you will arrive at the proper setting for R_7. When RL_1 armature opens instantly with one bell and stays open for 13 to 18 seconds, then pulls in; you are ready for the final test.

Now have your associate dial your number and let the bell ring twice. The first bell should open the relay armature and the second bell should pull it in almost immediately. If the second bell does not cause rapid pull-in of the armature then turn R_7 in the direction of lower resistance. A change of at least 20,000 or 30,000 ohms is necessary.

If your unit is working satisfactorily it will meet the test in which one bell opens the armature of RL_1 and the second bell closes it.

Now put the thermal relay tube in its socket. While the RL_1 armature is in its "pull-in" position the thermal relay will not function.

Final Testing

Your unit is ready now for its final test. As soon as the first bell rings, the RL_1 armature will fall out. Immediately the thermal delay relay starts to heat up and tick off the seconds. If no second bell comes along. RL_2 completes its timing process of ten seconds and finally it closes—then the power relay RL_3 snaps shut and stays closed thus turning on whatever device is plugged into the output terminals.

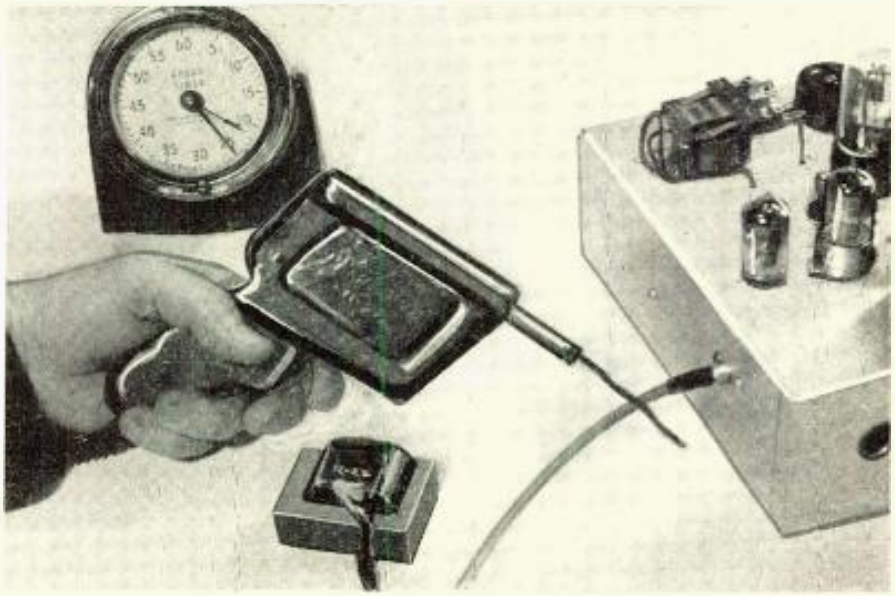
However if the bell rings more than once, RL_1 will pull its armature in and thus remove heater current from RL_2. Because of this, RL_3 won't close.

When you leave home put the pickup coil on the phone and turn on the power to the unit. Plug in whatever must be turned on. Be sure that the power relay you are using can handle the required wattage.

When you are ready to call on the unit to perform, simply go to a dial telephone and dial your number, let the bell ring once and hang up. As you know, bell ringing is automatic and your call may come through on the end of a ringing cycle. This is a rare occurrence. To be absolutely certain that your device will function, especially if it is important, let the bell ring once, hang up and do it again two minutes later. If you should hear a busy signal when you call be sure you allow at least two minutes before placing your call. The bell ringing sound you hear when you dial is not necessarily *your* bell which is ringing—it is a sound provided by the central exchange but you may use it as a guide to timing anyhow. In other words, act as though it were your bell, it will still work. In practically all

(*Continued on page* 122)

Fig. 6. The solder gun or any a.c. power transformer may be employed in place of the telephone bell for initial adjustments and operation check of the unit.



Interference-Free AM Reception

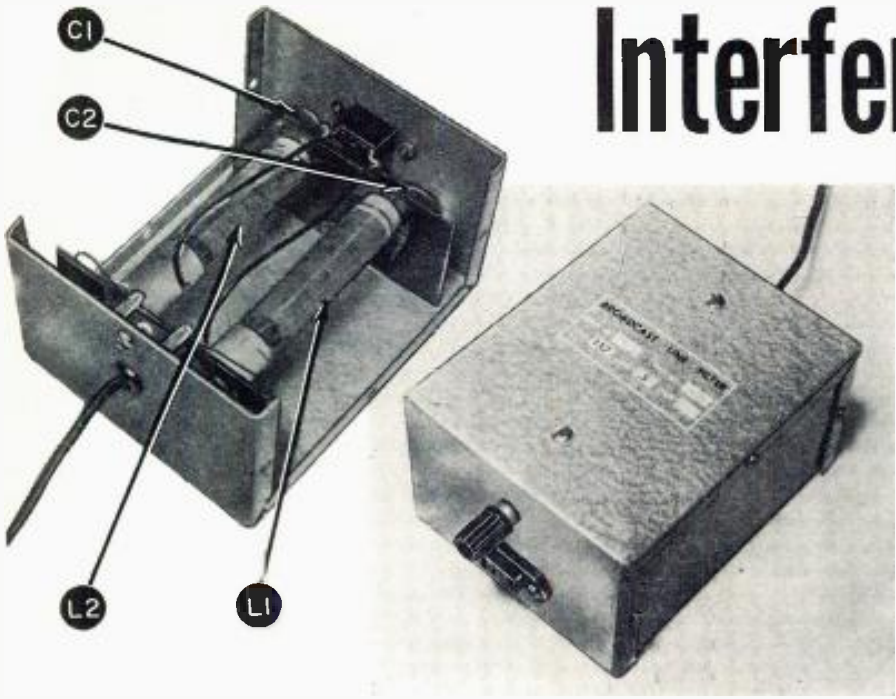


Fig. 1. An effective interference filter broadly tuned in the broadcast band.

By
FRANK H. TOOKER

Howls and other noises caused by TV sets and other appliances often ruin broadcast-band listening. Remedial steps include an effective tuned filter.

IN THESE DAYS of television sets and a host of household appliances in almost every human abode, enjoyable listening from an ordinary AM broadcast-band receiver often becomes well-nigh impossible—especially when the broadcast station is forty to sixty miles away and the devices in question are within twenty to forty feet.

Where several TV sets are operating and are relatively near the broadcast receiver (twenty to forty feet), the yowling and snarling set up in the broadcast receiver by the TV sets' sweep circuits is sufficient to smother all reception on the low-frequency portion of the AM band and to create considerable havoc all the way up to the high end. Some makes and models of TV sets are worse offenders than others, and some sets are apparently in need of new parts and/or adjustments—for quite a few can be heard at distances that are obviously in infringement of FCC regulations. There must be thousands of these scattered throughout the country.

Possibly the best solution to this problem is strictly enforced federal regulations to put an end to all forms of interference—not just from poor TV receivers, irrespective of age, but from all other serious interference creators: vacuum cleaners, electric razors, hand power drills, and a host of others. We are also in need of popularly priced broadcast-band receivers that are better able to reject the interference—for it has been the author's experience that, by far, the greater part of the noise due to TV sets and household appliances at distances of twenty feet or more comes in *via* the power line. In the meantime—while waiting for regulations and better receivers—considerable improvement can often be effected in present broadcast sets even though they may be of the most basic a.c.-d.c. variety.

It has been said that the best place to get rid of interference is at its source. To this could well be added, "provided someone calls upon you to clean up the interference for him and is willing to pay for the job." When it comes right down to cases, persons who are interested in getting rid of interference that doesn't bother them directly are quite rare. Most householders who own offending appliances are reluctant, to put it mildly, about *paying* to "improve reception on my neighbor's radio." Yet the easiest thing in the world is to "clean up" a particular interference-plagued home, only to find that most of the havoc was—and still is—coming from next door, or across the street or from both of these points at the same time!

Even where neighbors tend to be cooperative about having their equipment worked on to reduce their role as offenders, there may be too many of them to deal with practically, one at a time, on an individual basis. While this is theoretically the best procedure, a single solution is to be preferred to many separate solutions.

The a.c.-d.c. type of broadcast receiver does an excellent job of picking up unwanted signal from the power lines. It takes a pretty good line filter to make these sets behave. If one isn't careful, it's easy to spend more on a filter than would be necessary for the power transformer the set might have had in the first place. Merely connecting a capacitor, even a very large one, across the power line usually has little or no beneficial effect, principally because, while one side of the line may be grounded for 60-cycle a.c., both sides are almost invariably several hundred ohms above ground at radio frequencies. Thus, maximum rejection of interference can be obtained only when both sides of the line are filtered and bypassed to a local ground with a good, low-impedance connection.

The filter shown in Fig. 1 and in the schematic of Fig. 2 has been designed to be particularly effective at broadcast frequencies. Its excellent rejection characteristics are due to the fact that the two coils, L_1 and L_2, are made to

(*Continued on page* 158)

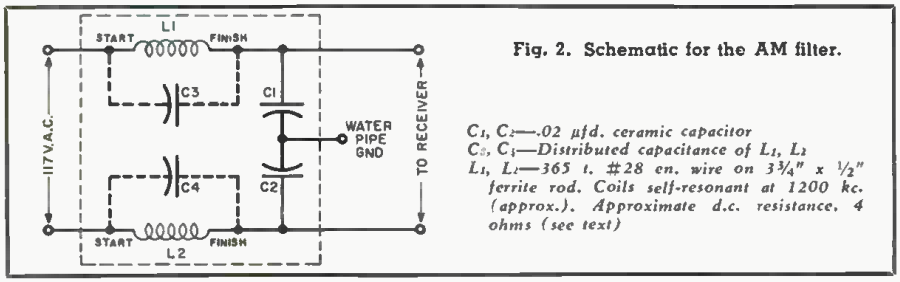
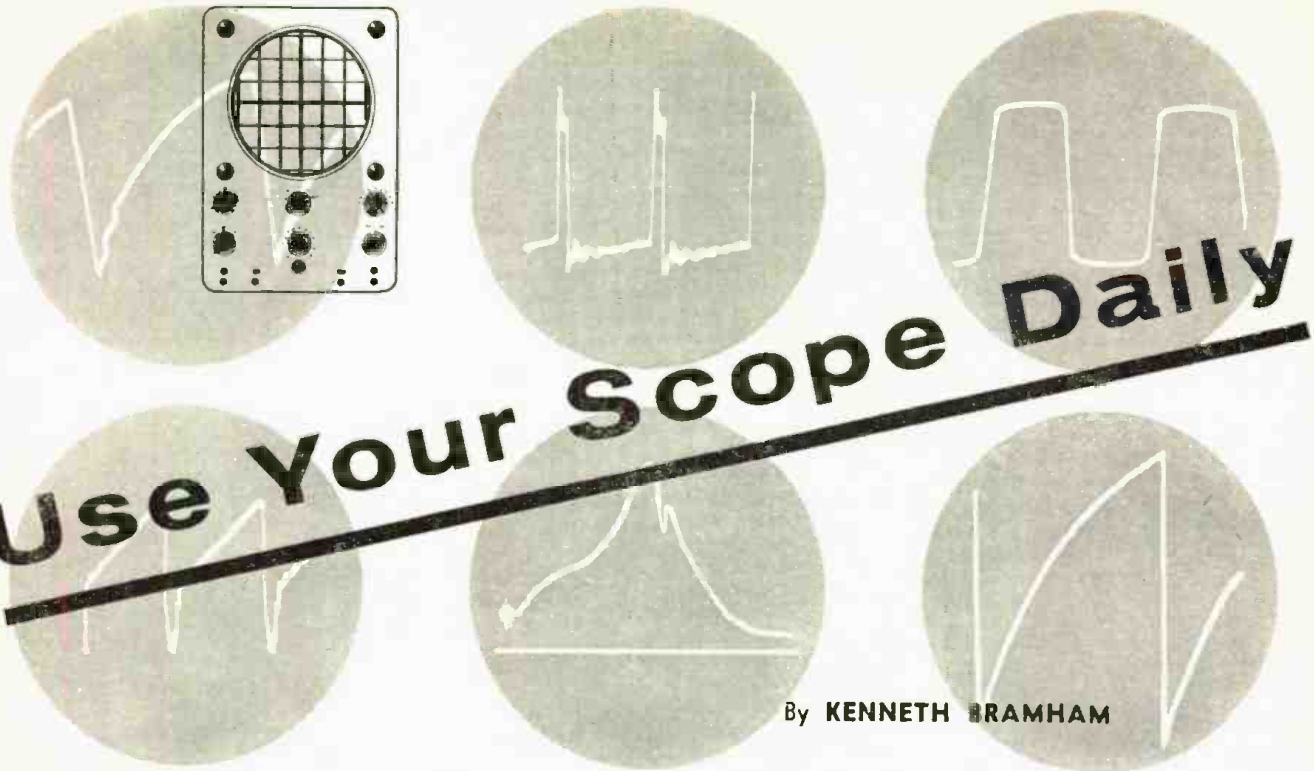


Fig. 2. Schematic for the AM filter.

C_1, C_2—.02 μfd. ceramic capacitor
C_3, C_4—Distributed capacitance of L_1, L_2
L_1, L_2—365 t. #28 en. wire on 3¾" x ½" ferrite rod. Coils self-resonant at 1200 kc. (approx.). Approximate d.c. resistance, 4 ohms (see text)



Use Your Scope Daily

By KENNETH BRAMHAM

Familiarity breeds efficiency. Try these regular applications to keep your scope technique sharp.

THE OSCILLOSCOPE, now a normal part of the radio-TV service shop, represents a sizable investment, often being the most expensive piece of equipment on the bench. Nevertheless, how many technicians get full value for this investment? Often the attitude is, "I don't use it very often, but I just cannot be without it." A more profitable attitude would be, "I have to have a scope and I am going to get every possible use from it."

A scope which gathers dust waiting for an alignment job or a tough sync fault is better discarded completely. When it eventually has to be used, more time will be wasted by the technician who is not familiar with it than can be saved by its use. Many of the results produced will be unreliable or misleading and the outcome may be an unsatisfactory job.

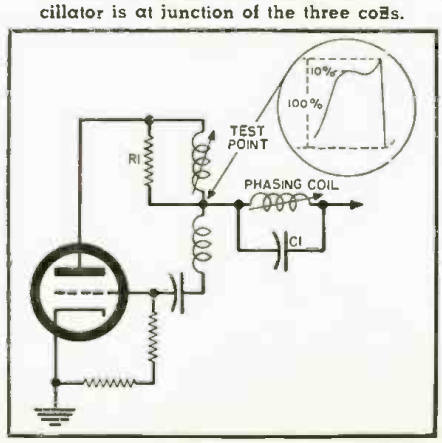
The only reliable combination of technician and equipment is the one of constant use. This does not mean that every set going through the shop must be completely aligned merely to keep the technician in practice; it does mean that there are other uses for a scope which will improve bench efficiency while making the instrument as familiar to the technician as his v.t.v.m. and cutters.

There are cases where a scope is allowed to go into disuse simply because it is not adequate for the job. In this case the solution is to replace it or modify it until it is adequate.

Perhaps the most useful way in which a scope can be kept in constant use is to develop a checking routine for all completed bench jobs. This will not only familiarize the operator with the equipment but also with the test points in the circuits on which he works. There will, eventually, be less need to consult a schematic; finding a test point will become automatic. Waveforms displayed on the scope will become more familiar until the question of whether or not a pattern is correct can be answered automatically. This is perhaps the biggest problem in TV bench service and only solid familiarity with correct waveforms will make an incorrect shape obvious. Routine checking of completed sets will also reveal minor defects which may have been overlooked, bringing about an improvement in service quality and a lower percentage of "repeats."

"Synchroguide" waveforms should head any routine check-list. Horizontal sync may seem perfect under shop conditions, but checking and adjusting the "Synchroguide" phasing coil will ensure that it is still good when returned to the less favorable conditions in the customer's home. The "Synchroguide" test point and correct waveform is shown in Fig. 1. Adjustment of the phasing coil should place the sine wave about 10% down from the peak. An adjustment which is too high will result in a "Christmas-tree" or "mode-hopping" effect on the screen. Unstable sync and poor noise immunity will result from too low an adjustment.

Fig. 1. Test point for a pulse-width oscillator is at junction of the three coils.



(EDITOR'S NOTE: *The bulk of existing service literature on pulse-width or "Synchroguide" circuit adjustment recommends equal amplitude for the rounded sine-wave portion and the pulse peak. The author is one of a growing group which has found that better long-term stability is obtained from the adjustment he recommends. This view is reflected in the manufacturers' service data on some of the newer sets using this circuit.*)

"B" supplies may be checked with the scope for incorrect filtering. While the scope oscillator is still set for the *horizontal* sweep frequency (after the "Synchroguide" check), the probe should be applied to the final filter capacitor of the power supply. If this capacitor is functioning normally, no waveform will be noted. An open capacitor or one of low value may not show as 60-cycle interference or "pull" in the raster, but may cause 15,750-cycle feedback through "B+," which may show up as a sync or a.g.c. fault. The test point for this check is shown

(*Continued on page* 186)

A New Look at Positive Current Feedback

By
H. D. ZINK
and
L. R. SANFORD

Tests show that positive current feedback improves hi-fi systems which already have good loudspeakers providing the correct feedback circuit is employed.

THE use of current feedback to provide improved bass response in a high-fidelity speaker system has caused a lot of discussion pro and con. It has been argued that it cannot greatly improve speaker damping because the mechanical parts of the speaker are not coupled closely enough to the electrical parts.[1] It has also been argued that it might help on an inadequate speaker system but that it was worse than useless on a truly high-fidelity speaker.[2] On the other side, curves have been presented which give dramatic proof of the improved damping obtained with a particular kind of current feedback,[3] but few details are given about the speaker system used and, therefore, no adequate conclusions can be drawn. This difference of opinion is understandable since the most desirable mode of loudspeaker operation for the best listening is not agreed upon even by experts in the field. The only way an individual can determine for himself the merits of such feedback is by the use of his ears.

Listening tests in commercial demonstration rooms are not necessarily conclusive for two reasons; (1) many of the current feedback circuits are so arranged that a common ground between the amplifier input and a speaker lead destroys the feedback network and common grounds are frequently used in demonstration rooms, (2) many amplifiers provide only for negative current feedback which can only decrease the damping on a speaker and thereby accentuate its undesirable characteristics. Therefore, opinions formed by a brief listening test in a demonstration room may not be valid about current feedback.

The question in the minds of the authors was whether positive current feedback (that which *increases* speaker damping) could add anything to a truly high-fidelity system which already had good speakers. The results of tests showed the answer to be conclusively *yes*, if the correct kind of feedback circuit were used. However, the feedback configuration most suitable was different from those heretofore used and for best results different speaker enclosures required somewhat different configurations.

What is actually accomplished with current feedback can be best understood by forgetting the ideas of damping, negative impedance, etc. for the moment and concentrating only on the frequency response. Anyone who has heard an audio oscillator through any speaker system has probably observed that while the response may be poor below a certain frequency, frequencies much lower than this can usually be reproduced if the power to the speaker at these frequencies is increased relative to the higher frequencies. Often, when this is done, appreciable harmonic distortion is present and the speaker cone rattles. Usually for music system use, if the bass output from the speaker is increased by conventional bass-boosting techniques, then such distortions are objectionable. In the optimum use of positive current feedback these objections to low-frequency boosting are overcome by using a rising bass characteristic as part of the feedback network. This compensates for the loss of low-frequency acoustic output without the harmful effect noted, since the positive current feedback keeps the speaker cone under control and, thereby, significantly reduces the distortion which would otherwise result. In some cases, the frequency below which no acoustic output at all is obtained is actually lowered.

The term, positive current feedback, is disturbing to some because, as is well known, positive feedback increases the distortion of an amplifier to which it is applied. This is true in this application also, but it must be noted that the net feedback applied to the amplifier is never positive but simply less negative in the region where the positive current feedback is effective. See Fig. 1. The slight increase in distortion, which results from the decrease in the amount of negative feedback applied in the bass region, is more than offset by the decrease in speaker distortion in the same region. In the high-frequency region, where amplifier distortion is more disturbing, no positive feedback is applied and the amplifier characteristics remain unchanged. The important point to note is that positive current feedback applied to the amplifier is effectively negative feedback as far as the speaker cone is concerned. This point is not obvious, so the following experiment will be described to suggest why this is actually the case.

Arrange a speaker, battery, multirange ammeter, and a switch as shown in Fig. 2. With the switch on the "A" contacts so that the battery is out of the circuit, push the speaker cone in the minus direction and note the direction of the current generated by the movement of the voice coil through the speaker field. Assume this current flows in the direction of the arrow *I*. Now connect the battery through the "B" contacts so that the current which it causes to flow is also in the direction of the arrow, and note the direction in which the speaker cone moves. It is found that the speaker cone moves in the plus direction, that is, in the opposite direction from which it was moved in the first case. The current which acts *on* the speaker results in a plus motion of the cone whereas a *minus* motion of the cone produces the *same* direction of current when the cone reacts on the circuit. This means that when the cone oscillates after a driving signal has ceased, the current generated by the erroneous motion can be fed back through the amplifier to produce a driving current which will be in the same direction as the error current and that this current will drive the cone in the opposite direction. The net effect will be that the cone moves very little after the original driving force ceases. It can thus be seen that in order for the forces on the cone to cancel out (negative feedback) the error signal must be fed back without a change of phase (positive feedback).

When these facts are realized, the correct application of positive current feedback to any speaker system then becomes merely a matter of cut and try until the right boost characteristic is found. Since no electrical measurements can indicate the total effect,

the final results must be reached by listening tests. The correct results are achieved when the speaker has a deeper bass than it has ever reproduced before without any trace of boominess. A very good test is when low-level, low-frequency bass notes, such as the light tap of a tympani, bass drum, or soft organ pedal, are clearly evident without being boomy or muffled. An excellent demonstration of the effect of positive current feedback was given when the low-frequency response of a *Klipschorn* was extended from 27 cps to below 20 cps with a clean fundamental response. The difference in reproduction of a complex 16 cps organ tone before and after was quite impressive and easily noticed even by the untrained ear.

The block diagram of the current feedback network used by the authors is shown in Fig. 3A. The essential difference between this circuit and similar ones used on commercial amplifiers is that no provision is made for negative current feedback, and an *LC* circuit is used in the frequency discriminating section of the feedback network instead of a single capacitor. *It is necessary to use an LC circuit because the single capacitor gives too much bass boost in a region where no boost is needed when used with some speaker systems* (especially the *Klipschorn* and "Rebel" series). This results in an unpleasant over-accentuated bass sound and is probably the reason some have rejected the use of current feedback with high-quality speakers.

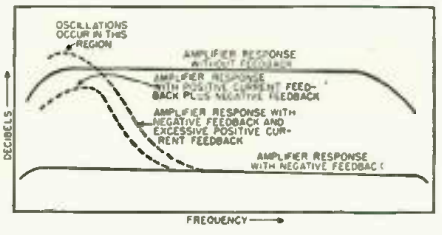
The 25-ohm potentiometer shunted across the 1-ohm resistor provides a means of varying the feedback from zero to full positive. Its use, except for comparison purposes, is questionable since usually full positive feedback is the most desirable condition. It could be omitted with no harmful effects in which case the 240-ohm resistor is tied to the ungrounded end of the 1-ohm resistor.

The amount of feedback and therefore the degree of bass boost may be varied in several ways aside from the use of the potentiometer. The principal way is by changing the value of the 1-ohm resistor. It will be noted that a dividing network is formed between the speaker impedance and the current feedback resistor, such that if the speaker is high impedance (16 ohms) less feedback voltage will be developed across the resistor than if the speaker impedance is low (4 ohms). That is, for a given resistor more bass boost would be obtained when feeding a 4-ohm speaker than when feeding a 16-ohm speaker. The 1-ohm resistor has been found satisfactory when used with a speaker system having a net impedance of 4 ohms and, therefore, in some instances a 4-ohm resistor might be desirable for a 16-ohm speaker system.

The amount of feedback and, therefore, the amount of boost can also be changed by changing the *"Q"* of the circuit elements used in the feedback network. The values called for usually require electrolytic capacitors and if these units are leaky or are used singly instead of in series pairs back-to-back, then less feedback will be obtained than would be expected. If the inductor used is variable, its *"Q"* will vary as it is tuned and this will also change the feedback. It should be noted that since the resistance in series with the speaker absorbs power it represents a loss in peak output, therefore, it is desirable to keep it as small as possible while still obtaining the required feedback voltage. Since high *"Q"* elements in the feedback network represent more voltage feedback than do low *"Q"* ones, they are to be preferred unless they give a boost characteristic that rises too sharply. This is an unlikely occurrence. It should be noted that the characteristics of the network, when not connected in the feedback loop, are not a good indication of the over-all amplifier response when the network is in the loop since a *"Q"* multiplication effect is obtained and the amplifier response is sharper than the network response.

To determine the constants of the *LC* network shown in Fig. 3A, procure an audio oscillator or frequency test record whose range is slightly lower than the lowest range of interest and listen to the performance of the speaker system using a conventional negative feedback amplifier. Note: (1) the frequency at which the bass response just begins to roll off and (2) the frequency at which no more acoustic output is obtained irrespective of how much power is used to drive the speaker. An *LC* network having a low-pass or bandpass filter configuration is then designed so that the upper turnover frequency occurs slightly above the frequency at which the response starts to roll off and the peak response occurs slightly below the frequency at which no output is normally heard. (The hypothetical termination resistance necessary for calculating the filter sections can be assumed to be about 600 ohms since it has been found experimentally that this value gives networks that are satisfactory.) This network will serve as a starting point and by varying the parameters while listening to the system using an audio oscillator or tone record the best sounding arrangement can be determined. For those not technically able to perform such calculations, the networks to be discussed will give moderately good results on any speaker system and will serve as a starting point for more experimentation. It is not advisable to use music for the first tests since low-frequency tones occur rather infrequently and are of rather short duration so it is difficult to notice the effect of circuit changes.

Fig. 1. Effect of positive current feedback on the frequency response of amplifier.



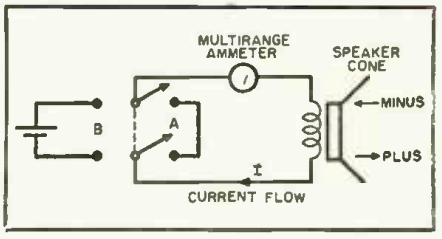


Fig. 2. Experimental setup that is used to determine how positive feedback works.

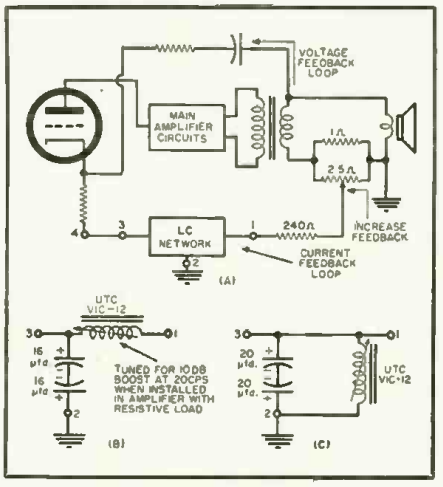


Fig. 3. (A) Location of positive current feedback network. (B) shows Klipschorn network. (C) shows Rebel 4 LC network.

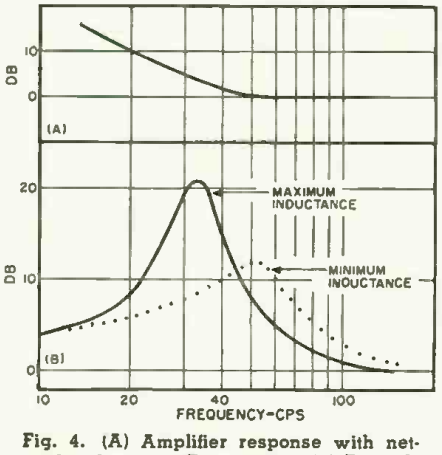


Fig. 4. (A) Amplifier response with networks shown in Fig. 3B and (B) Fig. 3C.

The specific *LC* circuit configuration used with a *Klipschorn* is shown in Fig. 3B. This type of enclosure normally falls off below 27 cps so the feedback network is designed to become effective in this region and to provide 10 db of boost at 20 cps as measured across a resistive load. The response curve of the amplifier, when this circuit is used, is shown in Fig. 4A. It must be remembered that this curve was taken with a 16-ohm resistive load substituted for the speaker and does not necessarily represent the actual boost curve obtained with the speaker connected. In this case, suf-

(*Continued on page* 137)

TV Remote Controls for the Technician

Fig. 1. RCA's hand-held "Magic Brain."

By
WALTER H. BUCHSBAUM
Television Consultant
RADIO & TV NEWS

Wired or wireless, partial or complete, hand-held or chairside—they all need occasional service.

IN THE PAST few years, the trend towards remote controls for TV receivers has increased steadily. Almost all manufacturers now offer some kind of remote-control feature either as part of the set or as an extra accessory. Many older receivers have been modified for remote control as well and, by now, the service technician has occasion to work on such a control.

Basically there are three different types of remote control units. One, like the *Zenith* "Space Command" or the *Hoffman* "Beamrider," uses no wires between the control and the receiver. The second variety, cable-connected, controls the receiver by means of relays and a tuning motor while the third type contains a separate remote tuner, i.f. strip, audio section and various controls as well.

The complexity of the various systems depends largely on how many functions are controlled remotely. It is interesting to note that, with few exceptions, all current TV models have some provision for remote control and, in the majority of sets, this is done by cable-connected units of the motor-relay type.

Fig. 2. The Packard-Bell separate control box houses an auxiliary loudspeaker.

Frequent Trouble Spots

Every service technician has had instances where the only thing wrong with a TV set was the lack of a.c. power, frequently because the plug was out of its receptacle or the line cord broken. Similarly, a great many service calls where the complaint is that only the remote control operation is defective will be due to such simple defects. The cable itself, as well as the connectors should be checked carefully first. Almost all sets have a switch at the rear for selecting remote-control operation. Forgetting to turn that switch or accidental change to the "direct" setting will naturally cause apparent failure of the remote control.

Troubleshooting of the ultrasonic "Space Command" system is somewhat different from the wired systems and was described in more detail in the October 1956 issue of this publication. Basically the most likely troubles in the *Zenith* system are found in the section which makes up the ultrasonic receiver, frequency discriminator, and control circuitry. The remote unit is a tuning-fork type of ultrasonic generator containing no tubes. Unless mechanical troubles occur, this part rarely needs servicing. In the *Hoffman* "Beamrider" the most likely defect is a weak transmitter battery or defective tubes in either transmitter or receiver.

Having examined the condition of the cable and connectors, a few ohmmeter tests are usually sufficient to spot the defective part. Those remote units which contain a separate tuner, i.f., and audio circuits are, of course, subject to difficulties just like these sections in the receiver, but the most likely defects in any remote-control unit are open or shorted leads in the cable or connectors. The second most likely trouble spot is the switch or potentiometer which does the remote tuning. A poor contact or broken lead at either end can upset the control action. Fortunately the location of this type of defect is indicated by the malfunction of a particular section. If, for instance, the tuner never tunes to Channel 6 on remote, the corresponding contact, wire, or connector is probably defective. If all controls work except the volume control, the defect obviously is in the connections to that control. When the on-off switch does not work on remote and the connections have been checked, the fault might be in a relay, where used, which either may not be actuated or else may have defective contacts. Such defects are not too difficult to find and repair.

Simple Remote Controls

From the servicing point of view, the simplest controls are those having only a switch for tuning channels, possibly also a remote off-on volume and fine-tuning control. These are not much different from the now popular "automatic" tuning systems which use *Microswitches* to actuate the tuner motor or stepping solenoid. A few words might be said here about the different systems of rotating the tuner

shaft. Some motor units drive the shaft of the tuner through a gear train and operate by starting and stopping the motor either through a relay, detent switch, or selector switch arrangement. The latter circuit is used in the *RCA* remote-tuning unit shown in the photograph of Fig. 1 and the schematic of Fig. 4. Wafer switches corresponding to those used in the remote selector are mounted on the tuner shaft in the set and so connected that the motor keeps going until the rotation of the shaft turns the switch to the point that the current to the motor is shut off.

A much simpler system is used by *Emerson*, and this is shown in the circuit of Fig. 5. Channel selection is accomplished by a single switch which powers the tuning motor through the motor relay. As the tuner shaft turns, it actuates a detent switch which interrupts the motor relay power and thus stops the motor. This means that the viewer presses the channel selector button once for each tuner step, while in the *RCA* system the desired channel is selected directly and the motor continues to operate until that channel is reached. *Packard-Bell* and some other manufacturers offer both types of tuning, one as a standard remote feature and the other as optional full remote control.

Although the *Philco* "Top Touch Tuning" and its remote control are also of the single-step type, the method for moving the tuner shaft is different. A rotary solenoid is used here to actuate a spring-loaded lever which turns the tuner shaft. Anyone familiar with telephone central selector switches or the *Automatic Electric Company's* Model 44 automatic step switch, will recognize the *Philco* system as very similar. The top tuning feature consists of a *Microswitch* in parallel with a similar switch at the remote control. Fig. 6 shows the circuit of the *Philco* system without showing the motor itself.

More Complex Systems

The *Packard-Bell* unit shown in the photograph of Fig. 2 contains not merely channel tuning, on-off, and volume controls but also has its own remote loudspeaker. The circuit diagram of Fig. 7 shows how this unit is connected and also indicates how fine tuning is accomplished. As in most units, this is done by varying the voltage on the local oscillator tube and thus changing its frequency to a small degree.

A variation of this system is found in later *Emerson* models, where a separate crystal diode is connected across the oscillator plate circuit and the current through that diode is varied remotely to control frequency. The *RCA* circuit uses a neon tube (see Fig. 4) and current variation through it. These methods have less effect on oscillator output and therefore less effect on receiver sensitivity in weak signal areas.

The *RCA* "Magic Brain" system is designed primarily for installation on all receivers using the KCS-96 and 97 chassis but can be adapted for use

Fig. 3. This Hoffman control unit, a wireless type, is a transmitter that activates a receiver at the TV set.

with any receiver back to the KCS-66. From the circuit of Fig. 4, it appears that three separate assemblies make up the "Magic Brain" kit. One, shown in Fig. 1, is the remote-control head, which contains the channel selector, fine tuning, volume, and contrast controls. The second unit comprises the tuning motor mounted on a master bracket which mounts directly to the tuner chassis. A shaft coupling for the tuning shaft contains the required selector switches, all wired. The third chassis contains a 24-volt transformer and three relays. *RCA* also furnishes

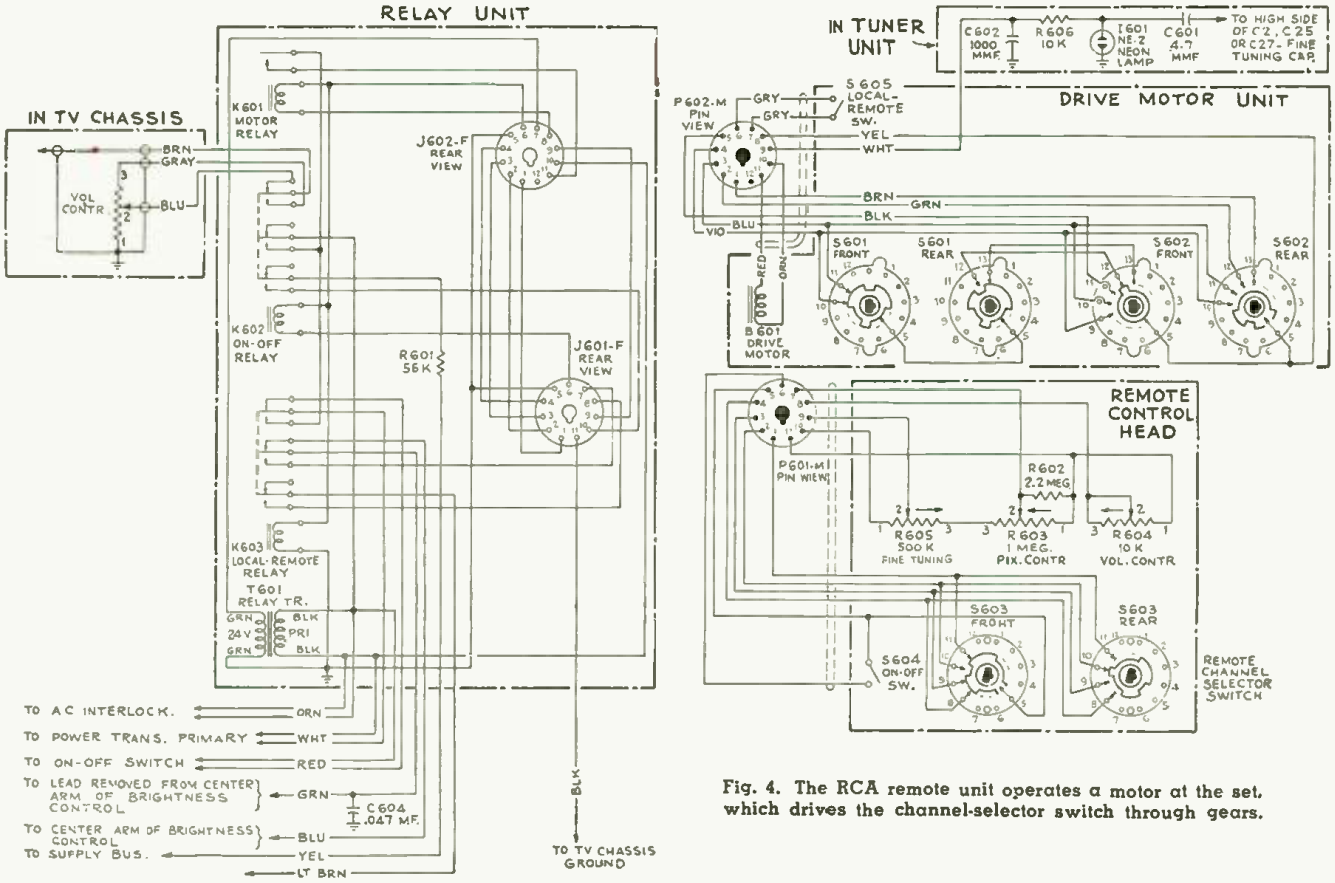


Fig. 4. The RCA remote unit operates a motor at the set, which drives the channel-selector switch through gears.

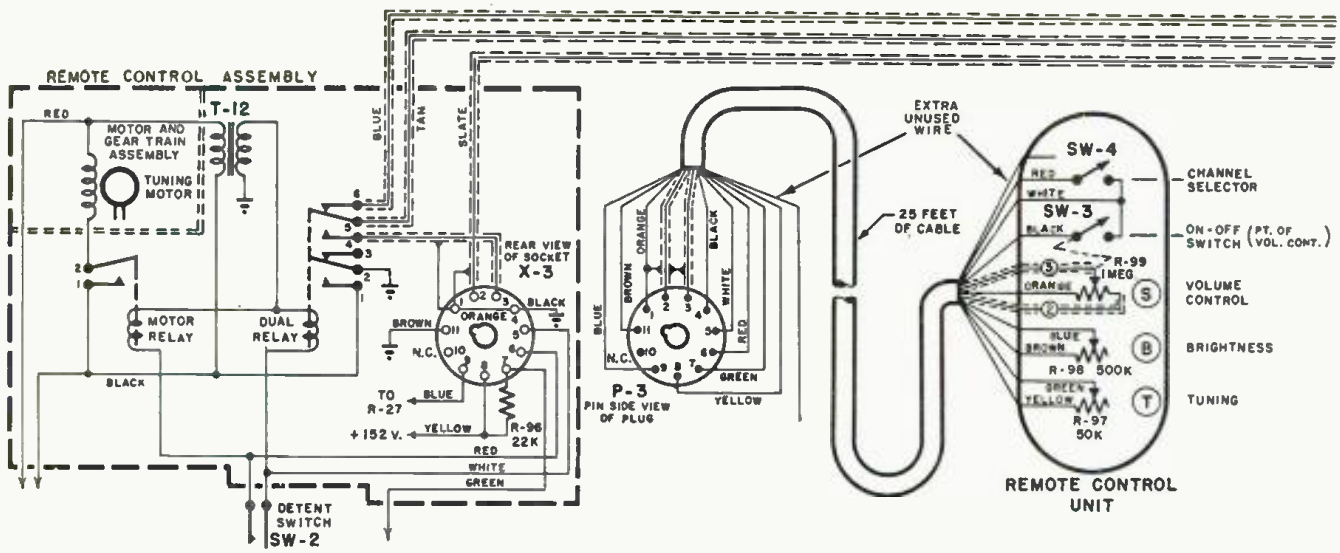


Fig. 5. The tuning motor, through its relay, moves one channel at a time in this Emerson remote station selector.

brackets, resistors, hardware and a neon lamp together with detailed instructions for connection to any of the previously mentioned *RCA* chassis. In most installations some wiring changes must be made, making this job a suitable one only for the experienced service technician.

As mentioned in the beginning, the *Zenith* "Space Command" unit makes use of an ultrasonic tuning-fork generator, the sound of which is received by a microphone at the set, amplified, and passed through filters. This permits the use of different frequencies for different command functions, but also requires a number of relays and control circuits.

Another wireless remote-control unit is the *Hoffman Electronics Co.* "Beam-rider" system which, however, only switches channels. As shown in the photograph of Fig. 3, it is a small, self-contained unit. Its circuit, shown in Fig. 8, consists of a single-stage, crystal-controlled oscillator operating at 26.25 mc. To select a station, the "on" switch on the transmitter is depressed, actuating the quick-heating battery-type tube and transmitting a c.w. signal. The companion receiver has two tubes (four sections), and is a superregenerative type with a biased control tube operating a relay. Since this system is intended for use with *Hoffman's* "Dyna Touch" TV receivers, the relay simply shorts out the *Microswitch* which otherwise actuates the tuning motor.

In troubleshooting the *Hoffman* unit, primary emphasis will have to be placed on the life of the battery and tube in the transmitter. Since the batteries are used only intermittently, they should last a reasonably long time. Nonetheless, their failure will be a thing to watch for. Another thing to look out for is the dislocation or mistuning of the receiver antenna. This latter is usually located at the rear of the TV set, and will be adjusted at the initial installation. Moving the set or overzealous dusting and cleaning in back of the set often results in either outright damage or some dislocation, causing the over-all sensitivity to drop. Otherwise the receiver may require troubleshooting just as any superregenerative set would. The transmitter is best checked through the receiver.

Somewhat more elaborate is the *Motorola* system which is used in conjunction with chassis TS-539. The major components of this system, shown in Fig. 10, are a small, transistorized transmitter operating at 2.6 mc. and a three-tube remote receiver and control circuit. The receiver is a two-stage TRF circuit with a crystal-diode detector, a.v.c., and a relay-control stage. This remote system connects directly to the automatic tuning circuit which, as mentioned previously in connection with the *Philco* system, is *Microswitch* controlled. *Motorola* has an additional feature: by adjustment of indexing rods and tabs, the tuner is set up so that unused channels are skipped. This means that a cam-driven *Microswitch* is shunted across the tuning switch to actuate the motor while the shaft skips unused channels. An a.c. shaded-pole motor drives a system of reduction gears which turn the tuner shaft as well as the associated cams, switches, etc. During the tuning operation, a set of cam-driven contacts also shorts out the sound and picture to avoid blasting.

Another remote-control system is the type in which a portion of the receiver is separated and mounted in a small unit, suitable for chairside operation. Typical of this is the *Tech Master* "Duo Master" shown in Fig. 9. It is similar in many respects to the "Fleetwood" Model 800 made by *Conrac, Inc.* Both units contain a TV tuner, i.f. section, sound detector, and sound-output stage driving a local speaker. Each has a self-contained power supply. To drive the TV set, the detected video signal is passed through a cathode follower and then fed to the remote picture-tube chassis by coaxial cable. Provision is also made to furnish sound to a remote speaker. The *Tech Master* system also has an audio jack for simultaneous tape recording or hi-fi connection. The troubleshooting of these units should not present any difficulties, since most circuits are identical to those found in conventional TV sets. The cathode followers are rather simple and require

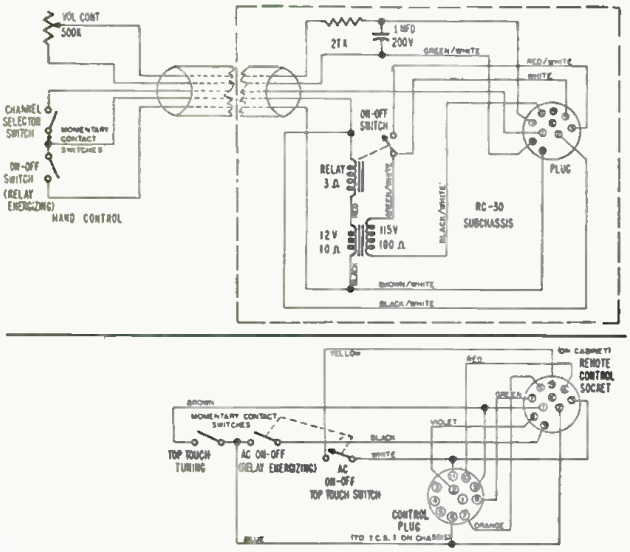


Fig. 6. How the remote unit (top) connects to the main receiver circuit (bottom) in the system used by Philco. Remote operation is tied in with "Top Touch Tuning" featured by Philco.

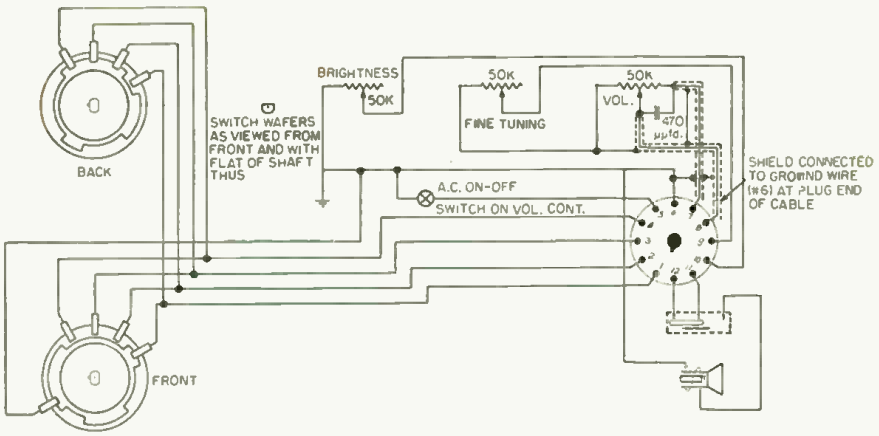


Fig. 7. The Packard-Bell remote unit contains its own integral loudspeaker, as well as a fine-tuning control that varies the oscillator plate voltage.

no alignment or adjustment; the cable connections are as subject to defects as those of other remote-control units.

Special Components

Most of the circuits used in remote controls are not too complex electronically and can be traced out by resistance or voltage measurements. What makes servicing of remote control units different from regular TV receiver work is the defects which occur in the electro-mechanical components, such as the switches, relays, and motors.

While most readers are familiar with rotary selector switches, they may not have really looked at the construction of a typical wafer. Double-sided wafer switches especially can contain hard-to-find defects. A typical problem is to replace a defective switch wafer with an exact duplicate. Unless all connections are checked for proper function in several positions of the shaft, it is possible to reverse the orientation of the switch. Bent finger springs, loose rotor blades, and cracked wafers are other troubles to look for.

Relays are often considered a field in themselves, their design and application requiring considerable mechanical and electrical knowledge. The types of relays used in remote-control units are not too complex but, in order to function properly, they must be adjusted with care. Basically these relays operate by applying the magnetic force generated by the current in the relay coil to overcome the spring tension which keeps the armature from the pole piece. If the spring is too tight, then the current will not have sufficient force to pull or to hold the armature against the pole.

It may happen that the current can attract the armature but, after the first impact, the latter bounces off and the spring pulls it away again. Chattering can also be caused by insufficient current or insufficient magnetic force due, occasionally, to a shorted turn in the relay coil. When the spring is too loose, residual magnetism may, after a while, prevent the relay from opening after the current is removed.

The contacts of a relay are even more subject to trouble than the armature and relay coil. Arcing can take place if the contacts do not close tightly or do not open sufficiently wide. Arcing could destroy the contact points in time, but usually this defect becomes apparent as a failure to actuate the motor fully or failure to stop completely. Arcing and relay chatter are usually audible, and the technician can thus locate this type of defect without trouble.

To repair relay contacts, a small ignition file or a double piece of emery cloth is inserted between the points to clean off the pitted area. Contacts are mounted on springs; these springs can usually be bent slightly to adjust the contact spacing. On some relays, the contact springs are backed up by a more solid steel leaf which can be bent to regulate the maximum travel of the spring. Relay adjustment, which can be quite tricky, requires more patience than electronic knowledge.

The motors used to turn the tuner shaft in most TV sets are simple, single-phase, a.c. motors. They are mass produced and have hardly any adjustable or replaceable parts. If a motor fails, the most likely reason is a broken lead or mechanical failure in the gear train. Defective connections can be found with the ohmmeter and mechanical failure in the gear train becomes apparent when the gears are manipulated by hand. Lubrication data and any possible adjustments of the motor drive mechanism are included in the manufacturer's service data and these should be followed.

One of the effects that motor tuning has on the wearing characteristics of TV tuners is that contacts will tend to become corroded somewhat sooner than on manually operated sets. The reason is that most motor-turned tuner shafts always turn in the same direction. If the tuner is set for Channel 7 and Channel 5 is desired, it will have to turn through Channels 8, 9, 10 etc., while in manual operation it would be turned only through Channel 6. This means not only more frequent contact actuation but also that the contacts are always wiped in one direction and some of the self-cleaning action is lost. However, the remainder of the tuner, especially the shaft bearings, will wear well since the motor action is more uniform than in manual tuning. -30-

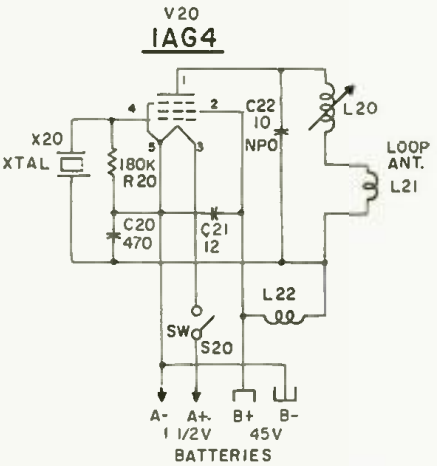


Fig. 8. Heart of the Hoffman system is this single-stage, battery-operated oscillator, controlled by a crystal.

Fig. 9. A good portion of the receiver signal circuits is included in the remote-control box of the TechMaster unit.

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Fig. 10. The major components of the Motorola remote-control system. Included is a transistorized transmitter unit.

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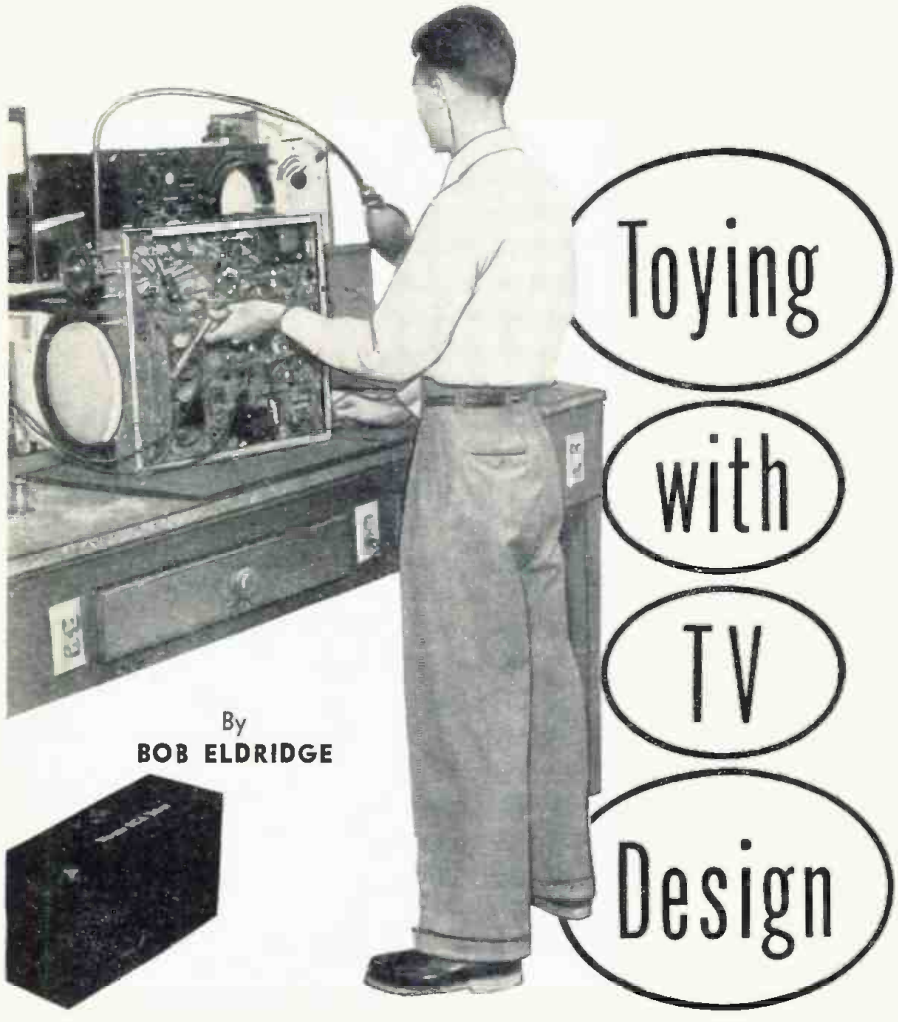


Toying with TV Design

By **BOB ELDRIDGE**

It's all right to make circuit changes if you know what you're doing and why the changes are needed.

FEW THINGS are more likely to throw a TV design engineer into a fit than the practice of meddling with his brain-child, on the part of the service technician, in an effort to improve performance. So, before we commit ourselves along just those lines, let's begin with a word of caution.

We are dead against indiscriminate changes in component values or other circuit modifications in a TV receiver if they can be avoided. When such changes are finally made, there should be full awareness on the part of the technician of what is happening in the set as a result of the modification and of exactly why the change had to be made.

After all, when a new set comes off the production line, it has to be capable of operating reasonably well under a wide variety of signal levels and other differences in reception from one locale to another. This means that a certain degree of compromise is present in the design of any receiver. Furthermore, accumulated errors in component values—even though the individual deviations of particular components may be well within tolerance—sometimes add up to a total deviation that results in performance that is less than acceptable. In such cases, as long as we use knowledge and discretion, it is possible to "custom-tailor" certain constants in a set so that an otherwise unhappy customer is satisfied.

Incorrect A.G.C. Balance

To illustrate the desirability of being able to "customize" a chassis for a particular purpose, let us take as an example an actual case which arose recently. The set had been in use for about nine months when a tube failure occurred in the sync section. After the tube had been replaced the set worked normally, but the customer complained that the snow level behind the two strongest signals was now higher than before. Two subsequent callbacks by different technicians failed to convince the owner that the set was operating exactly as it had before. (We all know this situation only too well, of course!)

It so happens that this make of set had rather high i.f. gain with very efficient gated a.g.c., and a slight noise level is usually visible in the background of the strongest signal. The customer, not having noticed it before, was sure it had never been there until the unfortunate technician replaced the sync clipper. Changing the value of one resistor, to put a little more bias on the i.f. strip and a little less on the tuner, did the trick perfectly (and incidentally left the customer not only happy but triumphant: "You see, young man, there *was* something wrong.").

A simplified diagram of the a.g.c. line is shown in Fig. 1. Before you read farther, have a look at this diagram. Which resistor would you have changed to alter the balance of the two bias lines?

Let us examine briefly the operation of the circuit shown. Each time the a.g.c. tube conducts, current flows through the series resistor network, R_1, R_2, and R_3, which form a voltage divider. We can consider point A as being the source of our common negative bias for both tuner and i.f. strip. With a strong signal being received, the voltage at this point will be on the order of 30 or 40 volts negative. The i.f. bias is taken from the junction of R_2 and R_3, and, the ratio of these two resistors being 10:1, the actual bias applied to the grids of the first and second i.f. tubes will be about one eleventh of that present at point A.

The tuner bias is taken off through R_3 and an opposing positive voltage, derived from a source of "B+" through R_4 is also applied to the a.g.c. input line to the tuner. The value of R_4 is such that the net result of the two bucking voltages is a negative value for a normal signal. The a.g.c. input to the tuner is clamped to ground by a diode, to insure that the r.f. amplifier bias can never go positive. (Positive bias would result in excessive conduction in the r.f. amplifier, with resultant damage to the tube). If the bias goes momentarily positive, the diode conducts, short-circuiting the line to ground and restoring the voltage to zero. When the voltage is negative, the diode is, of course, inoperative.

So much for the operation of the circuit. There is one thing more to consider. If, by some means, we reduce the bias on the tuner, this will automatically produce an *increase* in bias on the i.f. tubes. This is because, by increasing the gain of the tuner, we pass a stronger signal through to the video amplifier. The a.g.c. tube responds by conducting more heavily and thereby increases the over-all bias produced at point A (Fig. 1). Conversely, by increasing the bias on the i.f. tubes only, a.g.c. action will produce less bias than was available before at the tuner.

To return to our problem of the set with slight snow behind a strong signal, increasing R_3 to 39,000 ohms achieved the desired balance of gain between i.f. and tuner. Note that lowering the value of R_2 would have the same effect, because it is the *ratio* between the two arms of the divider that we have to change.

An attempt could also have been made to handle the problem directly at the tuner line: a reduction in value of R_1 would have provided more positive bucking voltage, which would have reduced negative bias to the r.f. amplifier where it is taken off between R_1 and R_2. However, as Fig. 2 shows, R_1 and R_2 also form a voltage divider with a potential difference of 175 volts across them in the original circuit, if we disregard the relationship to ground momentarily. Reducing resistance in the divider would have reduced the potential difference across the entire divider, with the result that the negative 35 volts from which i.f. a.g.c. voltage is derived would also have been reduced. This would have made the entire receiver more sensitive. Since plenty of signal was available from the antenna to which the set in question was connected, it was decided that this would not be advisable. The deterioration in over-all a.g.c. action might have resulted in annoying overload conditions on some strong signals.

Leaving aside for the moment our pretensions to redesigning the TV set on the bench, it is obvious that the technician who knows just which values affect which function in a circuit such as the one just discussed, is better able to service a set in which one of the components has changed in value due to normal aging or failure. Every tube jockey soon learns that a snowy picture probably means lack of gain in the front end, but it is not so obvious that *excessive* gain in the i.f. stages could be pushing up the tuner bias and causing the lowered tuner output.

Poor A.G.C. Compensation

In a multi-channel area with one or more very powerful local signals it sometimes happens that a set will over-compensate in the a.g.c. circuit, causing washed out contrast on the stronger signals. Of course, the opposite effect sometimes occurs, with too much contrast on the stronger signals. Fig. 3, a typical keyed a.g.c. stage shows the component to play with to correct either of these effects. R_1, shown in the diagram as 180,000 ohms, is a useful regulating device to set the keying level of the a.g.c. tube; that is to say, the signal level at which it will begin to conduct, and, at the other end of the grid curve, the signal level above which further increase ceases to create greater conduction. Notice, however, that the grid-cathode bias on the tube is more or less established by the voltage drop across R_2 in the plate circuit of the video amplifier. It is important that this resistor be checked before attempting any changes in grid-cathode relationships in the a.g.c. stage. In passing, it should also be noted that, if it is desired to achieve more gain in the video amplifier at the expense of some bandwidth, R_3 should be raised slightly, rather than R_2 lest a.g.c. action be upset.

Rather than rely on visual observation of the picture in estimating whether or not the a.g.c. is fully effective, it is a better idea to hook the scope probe to the output of the video detector or grid of the video amplifier. The signal-waveform display at this point should remain at a reasonably constant level irrespective of the channel being received. This method enables a reliable check to be made, and reduces the chance of being fooled by unusually low contrast due to low modulation level (as when films are used) on an otherwise strong carrier. If a v.t.v.m. is used instead of a scope, bear in mind that d.c. across the diode load is dependent on average signal information level, so the character of the picture must be taken into account when comparing the voltage developed on different channels.

Stacked "B+" Systems

Fig. 4 is a simplified schematic of a typical set using the cathode of the audio output tube as a source of "B+" for several stages of the receiver. When we consider that, in this particular case, the 140-volt line feeds not only the i.f. strip but also the mixer, audio i.f., screen of the video amplifier, and both sync stages, it is obvious that, if the 140-volt line is low, it will have a serious effect on the performance of the whole set.

In this method of operation, the self-bias resistor of the audio output tube is effectively made up of the resistance of all these other stages in parallel. Each separate stage passes relatively little plate current, so a change in the operation of one of them will not have much effect on the voltage produced at the audio-output cathode.

However, if we leave the resistance in the cathode path of this tube constant, we can conveniently change the plate-current flow by varying the grid-cathode bias, so this is the obvious way to regulate the 140-volt line to the correct level. We must, of course, stay within the bias limits of the audio tube itself in respect to its function as an amplifier. The cathode being elevated above ground, the grid must have a somewhat similar potential. Referring again to Fig. 4, we see that R_1 and R_2 form a potential divider which is used to establish the bias. Changing the value of either arm of

(*Continued on page* 126)

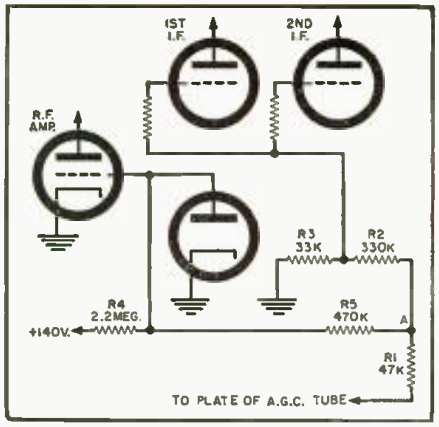


Fig. 1. Voltage dividers and bucking voltages often establish the delicate balance between r.f. and i.f. a.g.c.

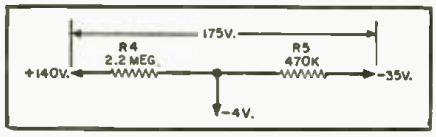


Fig. 2. Detail of part of a.g.c. divider shows total potential difference.

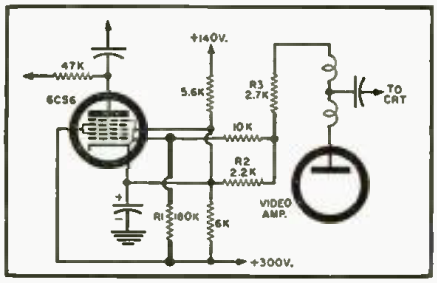
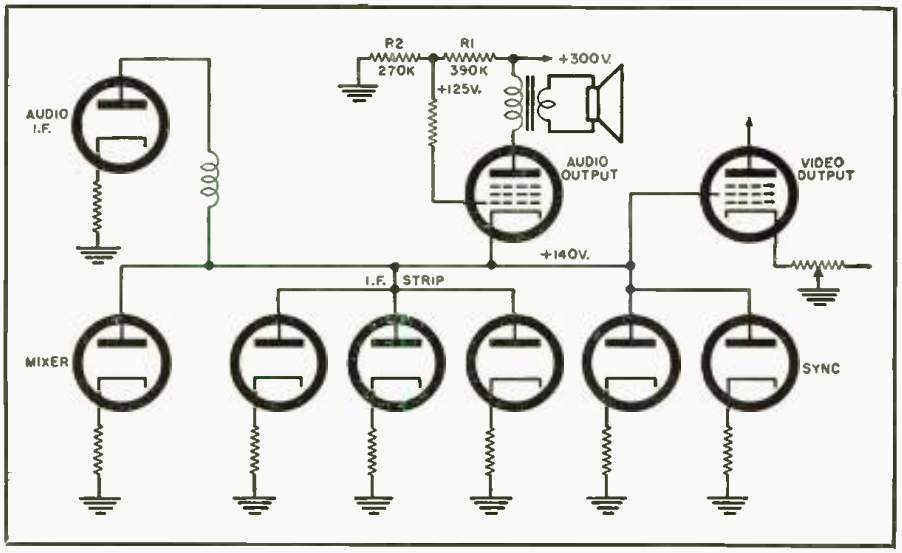


Fig. 3. The keying level in this typical keyed a.g.c. stage is set by R_1.

Fig. 4. A representative circuit using a "stacked B+" supply, wherein low "B+" voltages are derived from the cathode of the audio output amplifier.



Tape Recorder Quiz

By HERMAN BURSTEIN

How many of these answers do you know relating to tape recording principles and practices?

THE role of the tape recorder in high-fidelity systems is one of fast-growing importance, particularly since the machines available at moderate prices are steadily improving. The individual who wants maximum performance from his unit must approach it with at least a basic technical understanding. The following "true-or-false quiz" is designed to check and possibly augment your knowledge of tape recorder operation and practices.

1. The NARTB standard provides a specific equalization characteristic for playback of tapes.

TRUE. This standard characteristic is in the nature of a playback bass-boost curve. After the stipulated playback characteristic is provided, NARTB then states that record equalization should be adjusted to effect relatively flat record-playback frequency response, that is, within NARTB limits. It should further be pointed out that NARTB playback equalization requires treble boost to be incorporated to the extent that playback head losses cause treble response to fall below NARTB requirements. The amount of such playback head losses can be estimated on the basis of nominal gap width or can be found by playing a standard test tape.

2. A record head with a very narrow gap provides better high-frequency response than one with a relatively wide gap.

FALSE. Within a relatively wide practical range, the gap width of the record head is unimportant. When a.c. bias is used, as is almost always the case today, recording takes place at the trailing edge of the gap, and the requirement here is that the gap edge be as linear and sharply defined as possible.

3. A playback head with a very narrow gap provides better high-frequency response than one with a relatively wide gap.

TRUE. In playback, when the width of the gap becomes more than half of the recorded wavelength, very severe losses begin to take place. High frequencies are represented on the tape by short recorded wavelengths, so that high-frequency response is inversely related to gap width. For high-fidelity performance at 7.5 ips, a gap of .00025" or less is required, although at 15 ips equally good results can be had with a .0005" gap.

4. A low-impedance head is desirable for record and a high-impedance one for playback.

TRUE. A low impedance winding minimizes the amount of voltage that must be developed by the record amplifier and by the oscillator in order to drive the required audio and bias currents through the record head. On the other hand, a high impedance winding is desirable for the playback head in order to generate as much playback signal as is practical and thereby maximize the signal-to-noise ratio. Here is one of the reasons that a machine with separate record and playback heads can yield better results than one which utilizes the same head for record and playback.

5. If a constant amount of signal is to be recorded on the tape at all audio frequencies then a constant amount of voltage must be applied to the record head at these frequencies.

FALSE, on two counts:

a. Since the record head is an inductive device, its impedance rises with frequency, so that for a given applied voltage the current through the head declines. What is required is *constant current* through the head in order to apply equal magnetic flux at all frequencies to the tape.

b. Even though constant magnetic flux is *applied* to the tape, this does not result in equal amounts of flux *recorded* on the tape. This is so because, due to bias current and the phenomenon of self-demagnetization, there are very substantial losses in the amount of recorded flux at high frequencies—as much as roughly 35 db at 15,000 cycles when recording at a speed of 7.5 ips.

6. Some tape recorders, particularly professional ones, operating at 7.5 ips record a flat signal on the tape.

FALSE. This would be a difficult attainment in the present state of the art. A professional tape recorder, which ordinarily uses NARTB equalization or a close equivalent, permits the recorded signal (flux) to be 3 db down at 3180 cycles and to decline thereafter at a rate approaching 6 db-per-octave. This is so because of the heavy record losses described in the answer to statement 5, which cannot be fully compensated by practicable amounts of record treble boost. Other tape recorders permit the decline in recorded signal to commence at frequencies lower than 3180 cycles. This decline is compensated in playback inasmuch as the playback head, being an inductive device, has an output that tends to rise at the rate of 6 db-per-octave over most of the audio range. It should be added that even in the case of 15 ips tape recorders it is not feasible to record a flat signal on the tape, although this is done by some 30 ips machines.

7. Harmonic distortion of 3% at average levels is acceptable in tape recording, and for this reason the rated signal-to-noise ratio of a number of high-quality machines is based upon an output level corresponding to 3%.

FALSE. 3% harmonic distortion is acceptable only on *peaks*, which are characteristically of short duration and therefore much less offensive to the ear (when they contain this much

distortion) than if they were sustained. The signal-to-noise ratio of a tape recorder is based upon *peak* output level. The amount of IM distortion corresponding to 3% harmonic distortion is quite large, on the order of 10 to 20%. At average signal levels this much IM would of course be incompatible with high-fidelity requirements.

8. *Azimuth alignment is a more critical process in the case of full-track heads than half-track ones.*

TRUE. A given degree of misalignment produces considerably greater high-frequency losses in the case of a full-track head.

9. *Optimum bias current maximizes high-frequency response.*

FALSE. Although high-frequency response can be greatly extended by keeping bias current relatively low, this practice results in appreciable distortion. Optimum bias is that which produces the most satisfactory combination of low distortion and wide frequency range. Since lower distortion can also be had by reducing the record level, optimum bias implicitly takes into consideration the requirements with respect to signal-to-noise ratio.

10. *Distortion continues to decrease as bias current is increased.*

FALSE. In the practical operating range, an increase in bias current ordinarily results in less distortion. However, a minimum point is reached beyond which a rise in bias serves to increase distortion. When recording at 7.5 ips, it is rather unlikely that excessive bias would be used because before then the high-frequency response would have been reduced to an inordinate degree. On the other hand, when recording at 15 ips, it is possible for bias to be beyond the point of minimum distortion and at the same time allow adequate treble response.

11. *Distortion and frequency response characteristics may vary significantly from one kind of tape to another.*

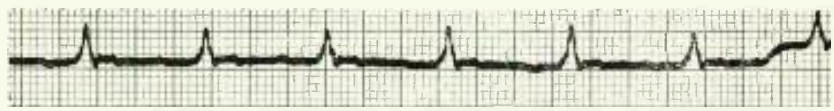
TRUE. There may be as much as 6 db or more difference in response at 15,000 cycles for the same bias current. For a given output level, there may be an appreciable difference in minimum distortion obtained by varying the bias.

12. *If a tape is recorded half-track on a machine that moves the tape from left to right, this tape can be played back successfully on another machine with right-to-left motion.*

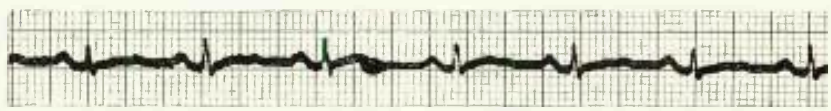
TRUE. The conventional arrangement is that recording takes place on the upper half (track) of the tape for left-to-right motion, and on the lower half for right-to-left. Thus if the upper track were recorded on a left-to-right machine, when the tape is reversed on a right-to-left transport this recorded track becomes the lower one and is therefore the one which is played back. -30-

COVER STORY

Heart Recording



New hope for cardiacs is offered with the development of special and highly sensitive electronic diagnostic tools.



WITHIN recent years considerable progress has been made in the application of acoustic methods to medical problems. This month's cover photograph shows the Altec Lansing 21MA contact medical microphone and M-16 microphone system being used in conjunction with an Ampex 600 tape recorder for the instruction of medical students.

Using this equipment, heart sounds can now be recorded so that an accurate, permanent record of the sound is available for teaching, diagnostic, and prognostic interpretation. About four years ago a public health grant was made available which resulted in the building up of a tape library which included normal heart sounds, heart action under the effects of drugs, hearts with various heart diseases and congenital abnormalities, and sounds resulting from wounds which penetrated the heart or circulatory system. The use of these tapes in medical schools is so effective that medical students are advanced two years ahead of classes not using this technique.

Another advantage of heart recording is that it permits filing of the tape for future reference so that the sounds can be directly compared with those of earlier examinations. This method allows no uncertainty as to memory or depreciation of hearing on the part of the physician.

Still another feature is the ability of a physician to record heart abnormalities and have them evaluated by a specialist at a later date. Today there are several types of heart diseases which can be greatly benefited or cured by skilled intervention. By this simple expedient of recording the heart sounds, the patient can benefit from the diagnosis of specialists throughout the country.

The reason why these recordings can be made today results from improved microphones which reproduce heart sounds more faithfully than had been possible with the conventional acoustic stethoscope. The acoustical stethoscope consists, in general, of a fiber or metallic diaphragm clamped on its edge and mounted in a small enclosure. The tone of each heart sound depends on the diameter and thickness of the diaphragm, the material of which it is made, the size of the cavity back of the diaphragm, and the loss in the rubber tubing leading up to the ear. Usually these diaphragms are resonant at 200 cps.

As contrasted to this, a small condenser microphone, such as the Altec 21MA, uses a diaphragm having a natural resonance far higher than any heart sound and its output is a more exact reproduction of the chest sound. Electrical amplification without distortion permits the recording and reproduction through headphones or loudspeakers.

Basically, heart sounds extend from a very low frequency, such as 1 cps, up to 1000 cps. The sounds from 1 to 100 cps may be classified as "ballisto" sound or having to do with the stopping and starting of the column of blood in the circulatory system. The frequency range of 100 to 1000 cps is thought to be the range of sound produced by the motion of the blood through the valves in the heart. It is these frequencies which are considered most important for clinical stethoscope diagnosis. The condenser microphone faithfully reproduces these many variations in pitch and character so they can be accurately identified.

There is a growing tendency to use the microphone in the operating room to continuously monitor the patient's heart sounds so that the anesthetist will know at all than use the intermittent method with an times how the patient is responding, rather acoustical stethoscope. The microphone can also be used to run a rate recorder so that in the recovery room, one nurse can tell at a glance the condition of each patient. (Photo by Peter J. Samerjan)

A NEW TRANSISTORIZED Voltmeter

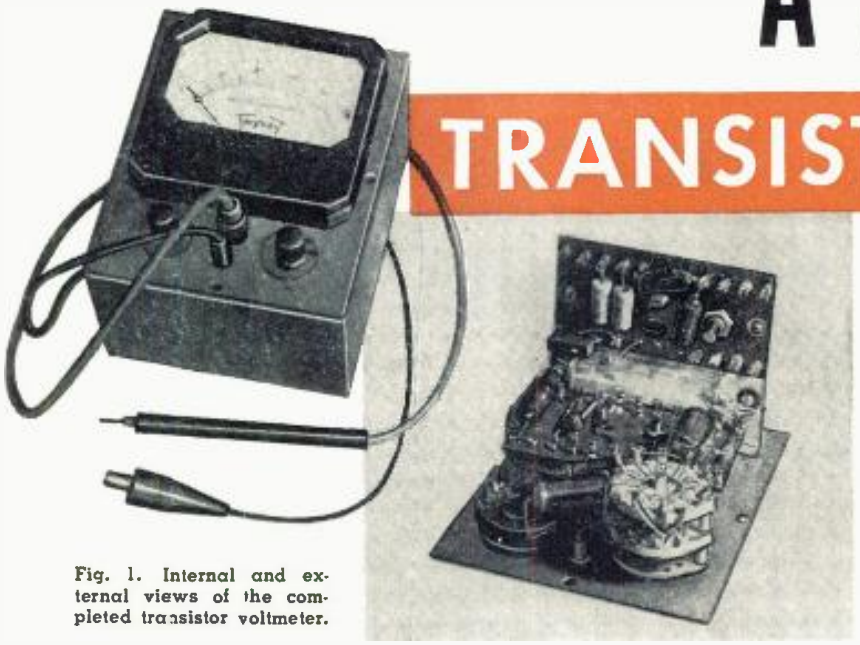


Fig. 1. Internal and external views of the completed transistor voltmeter.

By
HERBERT MALAMUD

A reliable and relatively inexpensive unit with 100,000 ohms-per-volt sensitivity is realized.

TRANSISTORS had scarcely become commercially available when they were put to use to increase the sensitivity of conventional current-drawing meters. Some of the techniques involved and a suggested design for a practical transistorized voltmeter will be presented here. Before considering the finalized meter, however, it will be helpful to review briefly some traditional meter circuits out of which it developed.

A standard voltmeter consists of a meter movement plus a choice of multiplying resistors to be placed in series with it to increase the value of the voltage necessary to drive the rated current through the meter for full-scale deflection. Fig. 3 shows a representative arrangement of this type. If the resistance of the meter movement is R and the current I is required to drive the meter to full-scale deflection, then the four voltage ranges for the switch positions shown will be IR, $10IR$, $100IR$, and $1000IR$.

A typical movement of high quality may have a full-scale current rating (I) of 100 microamperes and a resistance (R) of 5000 ohms. Then, in a circuit configuration like that of Fig. 3, it would have ranges of 0.5 volt, 5 volts, 50 volts, and 500 volts.

A vacuum-tube voltmeter is a voltage-driven device. A voltage to be measured is applied to a tube grid, where it draws a current so small that it is negligible for most purposes. The meter itself loads down the output of the tube, and draws the current necessary for its deflection without affecting the circuit being measured. A system of this type, diagrammed in Fig. 2, presents the same load to the circuit being measured, irrespective of the voltage scale in use. Typical values in common use have R about 1000 ohms, with scales ranging from perhaps 1 volt to 5000 volts full scale. (For simplicity, voltage scales are shown in steps of 10, although practical meters usually employ one or more intermediate values to make it easier to keep readings somewhere near the middle of the scale.)

Fig. 2. Typical vacuum-tube voltmeter circuit, showing meter loading plates of tubes while constant high impedance at the grid loads circuit under test.

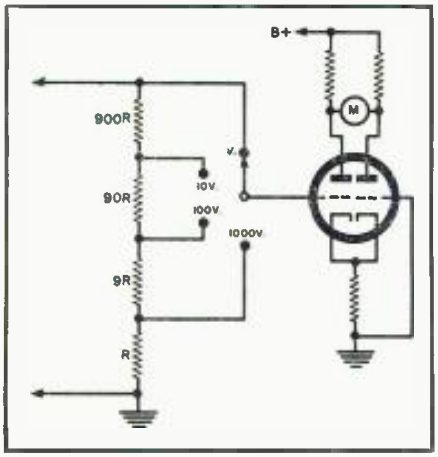
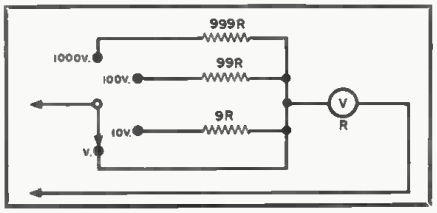


Fig. 3. A basic voltmeter circuit, using series multiplier resistors.



The transistor, a current-sensitive and current-amplifying device, can be used to increase the sensitivity of a meter movement. Its acceptance in this application can be attributed to the fact that a relatively inexpensive 200-microampere meter can be used, with transistors, to make a voltmeter of about 100,000 ohms-per-volt sensitivity. A comparable 10-microampere meter movement would cost several times as much as the common 200-microampere unit that could be used with transistors, and it would be much more fragile.

The circuit commonly used, shown in Fig. 4, is essentially a bridge, where the emitter-collector circuit of the transistor is one arm, balanced by the zero-set potentiometer. When an input current is supplied through the base-emitter circuit, the collector current changes. From the point of view of the meter, it is as though the impedance of one arm of the bridge changed. This unbalance permits the meter to draw current and give a reading.

There is good reason for using a bridge: the current through the collector circuit of the transistor is *not* zero when the base current is zero. The collector current, of course, must not be allowed through the meter, and it may be balanced out in the bridge circuit.

The major drawback to transistor voltmeters of this type is the fact that this zero-signal collector current (I_{co}) is not constant, but varies with temperature. A typical variation may be as much as 50% change in I_{co} for a temperature change from 20° to 40° centigrade. A less serious problem is the fact that current amplification itself depends on temperature—less serious because the change in amplification is on

the order of 5% for the temperature change noted. Note that 20°centigrade is 68° Fahrenheit and 40° centigrade is 104° Fahrenheit. Considering that voltmeters are usually used indoors, this range thus roughly encompasses the variation to be expected in practice from winter to summer weather.

Unless something is done to compensate for it, this instability of the transistor's characterisics can make a meter using it hopelessly unreliable for any sort of accuracy. Since, in effect, it might be said that the transistor's resistance is varying with temperature, one approach tried is that of using a temperature-dependent resistor whose characteristic is roughly inverse to that of the transistor. However, another approach occurred to the author: Why not balance out the erratic behavior of one transistor with another matched transistor? If the two were of the same type, then the zero-signal collector current (I_{co}) should vary in step for both and, if they were balanced in a bridge with a meter, the latter should keep its zero setting.

To avoid the need for two power supplies (since each transistor should be supplied with exactly the same voltage), a bit of juggling of the bridge was needed. The circuit evolved is shown in Fig. 5.

The experimental meter built according to this circuit kept its zero well, over a period of months, with no adjustment. However, small improvements were still considered possible. For one thing, the transistor characteristics are not best in the region at and near the zero base-signal point. For another, the second transistor was wasted as far as its amplification properties were concerned, as it was used exclusively to balance out zero signal.

The next step was to take advantage of its amplification properties by feeding in the signal between the two transistor bases. This seemed to mean that one of the transistors would have its base made negative, while the other was made positive. However, this was avoided by biasing both bases with a positive current greater than the maximum signal to be applied and letting the signal simply increase one and reduce the other base current. This, of course, requires a second battery, but it was judged to be worthwhile in this application, shown in Fig 6. The bridge now balances out not only I_{co} but also collector current due to the bias signal. The second or bias battery has one other purpose. By supplying current through a resistor whose value is much greater than that of the base circuit, it acts to stabilize the transistor circuit somewhat as does a self-biased tube circuit.

The final circuit built is shown in Fig. 7. Provision has been made for an a.c. as well as d.c. voltmeter which should be flat in response down to about 10 cycles. By using precision resistors for R_5 and R_6, a balancing potentiometer in the collector circuit is avoided.

If this potentiometer is desired, use a value of 1000 ohms, put it between R_5 and R_6, and set it to zero the meter reading with points A and B shorted by a jumper. This potentiometer can then be more or less permanently fixed by a drop of cement or shellac where the shaft enters its body. It should not require frequent adjustment.

We use two capacitors at C_1 and C_2 to avoid the need for a 1-μfd., 1000-volt unit, which would be quite bulky and expensive compared to an extra set of switch positions on S_1. The high value is needed on the low-voltage scale, since the scale resistor is only 100,000 ohms. The resistor for the 1000-volt scale is 100 megohms, and a .001-μfd., 1600-volt TV high-voltage capacitor is satisfactory. The 100-megohm resistor is either a high-voltage high-value unit especially made not to break down, or it can be assembled by putting four 22-megohm

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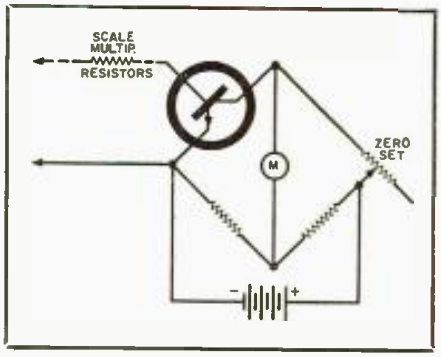


Fig. 4. Emitter-collector circuit of the transistor is one arm of a bridge circuit across which is meter movement.

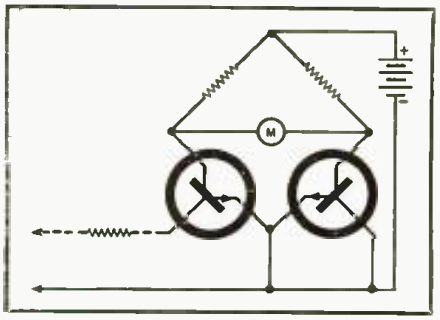


Fig. 5. With two transistors in this configuration, the instability of one cancels the instability of the other.

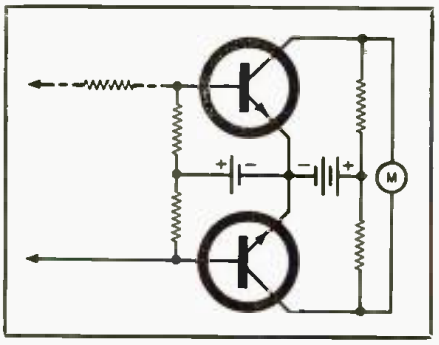
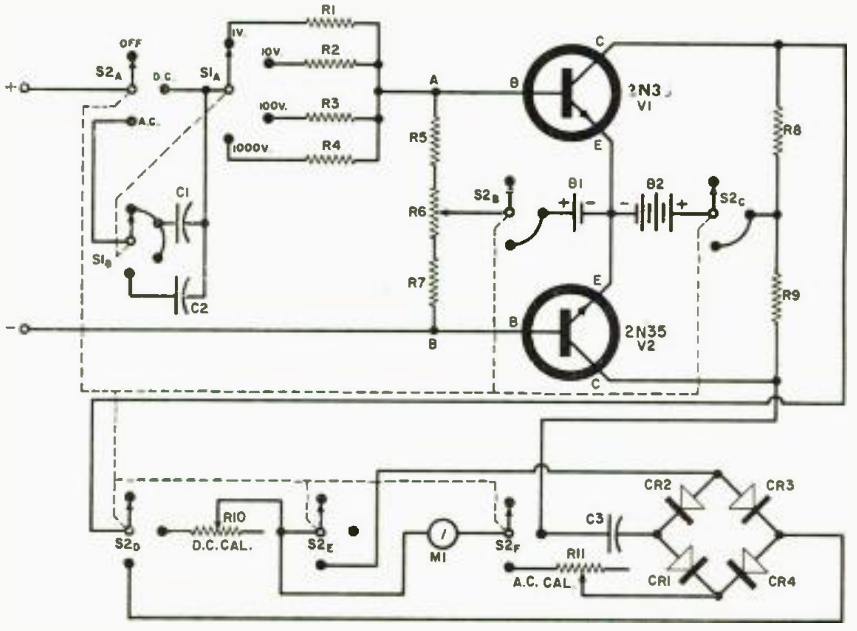


Fig. 6. Final evolution of the bridge.

Fig. 7. Complete schematic of the transistorized 100,000-ohm-per-volt meter.



R_1—100,000 ohm, ½ w. res. ± 1%
R_2—1 megohm, ½ w. res. ± 1%
R_3—10 megohm, ½ w. res. ± 1%
R_4—100 megohm, ½ w. res. (see text)
R_5, R_7—39,000 ohm, 1 w. res.
R_6—50,000 ohm wirewound pot
R_8, R_9—2000 ohm, ½ w. res. ± 1%
R_{10}, R_{11}—20,000 ohm wirewound pot
C_1—1 μfd., 200 v. capacitor
C_2—.001 μfd., 1600 v. capacitor
C_3—2 μfd., 200 v. capacitor
S_1—D.p. 4-pos. switch
S_2—6-pole, 3-pos. switch
M_1—100 μa. meter
CR_1-CR_2-CR_3-CR_4—Bridge composed of four 1N34 rectifiers (meter rectifier may be substituted)
B_1, B_2—Mallory RM-1-R mercury cell (see text)
V_1, V_2—"n-p-n" junction transistor (Sylvania 2N35)

Build the "Transactivator"

← Over-all view of the transistor activator.

By **FRANK H. TOOKER**

An a.c.-operated transistor supply made for 24-hour-a-day use, switches to built-in battery during power failure.

HERE is a transistor activator (power supply) that is just about everything you have always wanted a transistor power source to be. Let's take a look at its features:

First of all, as the photos and the schematic diagram indicate, it is extremely simple and compact. It uses only a handful of miniature parts. Second, although it is fundamentally a.c.-operated, it keeps right on delivering current even though the plug is pulled out of the socket or a power line failure occurs! Third, there is less than ¼ of 1 per-cent ripple in its output (with new cells at B_1), yet it uses only a single half-wave rectifier, one electrolytic capacitor, and no iron-core filter choke. Fourth, it is voltage regulated. The output voltage is at all times very nearly equal to the battery voltage. Fifth, current drawn from the battery as a result of portable or power-line-failure operation is automatically replaced, insofar as is possible, by rejuvenation while the unit is operating on a.c.

The "Transactivator" is conservatively rated at 2.9 volts (±4%) and up to 10 milliamperes d.c. output.

How It Works

Most of the interesting and desirable features of this little power source are obtained through the functioning of the transistor, V_1, which is connected in the manner of an emitter follower (analogous to a cathode follower in a vacuum-tube setup). Because of this connection, the voltage across the output terminals tends to be a replica of the voltage across the battery, B_1, in the base circuit, *i.e.*, 3 volts d.c., and largely free from hum ripple. Thus, the transistor functions as a voltage regulator and as an electronic filter circuit.

When the "Transactivator" is operating from the a.c. line, all of the d.c. output is obtained from the a.c. source *via* the rectifier, CR_1, and electrolytic capacitor C_1. Most of the output current flows through the collector circuit of V_1. Only a small fraction flows through resistor R_2 to the output *via* the base. If the a.c. source is interrupted, however (as during a power-line failure), the transistor itself automatically switches over and draws all of the output current *via* the base, *i.e.*, from the battery. Since the transition from a.c. to battery is performed entirely within the transistor and, additionally, is involved with the discharge of capacitor C_1, switching occurs smoothly—without sudden current interruptions or surges. Thus, there are no switching transients. Even at the full rated output of 10 milliamperes, the only evidence that the a.c. circuit has been broken is a very slight lowering of the output current due to the base-to-emitter voltage drop in V_1.

When the a.c. connection is restored, the transistor automatically switches the output back to the rectifier and filter capacitor source of d.c. Since this operation is involved with the charging of C_1, switching in this direction also occurs smoothly.

The value of resistor R_2 has been chosen to make the current flowing through it greater than that needed to supply the fraction of the output demanded by V_1's base circuit. The excess current flows in a reverse direction through the battery and tends to rejuvenate the battery, thereby effectively prolonging its useful life. At 10 milliamperes d.c. output from the "Transactivator" the reactivating current through the battery is in the vicinity of 2 milliamperes. At 1 milliampere output the reactivating current is about 3½ milliamperes. Larger reactivating currents are not recommended, for two reasons: (1) larger currents may harm the battery instead of tending to reverse the chemical processes, and (2) decreasing the value of R_2 increases the percentage of hum ripple across the output terminals. With the specified value of R_2, and with two good dry cells at B_1, the measured ripple was below ¼ of 1 per-cent at 10 milliamperes d.c. output.

Switch S_1 is a d.p.d.t. component. One section (S_{1A}) breaks the primary circuit of the miniature step-down transformer, T_1, while the second section (S_{1B}) opens the battery circuit and grounds the base of V_1 to prevent the output voltage from rising to the value across C_1 when the unit is switched off. Simultaneously, R_2 becomes a bleeder to discharge C_1. The latter switching operation also prevents the discharge of the battery through the electrolytic capacitor and the back resistance of the rectifier at times when the "Transactivator" is not in use. Actually, the current flow here is small—on the or-

der of microamperes—but it could help to discharge the battery if the "Transactivator" is kept out of operation for long periods of time. When continuous operation is anticipated, S_1 may be eliminated, if desired. A small neon lamp is connected as a pilot light to indicate when the a.c. power is on.

Construction

The assembly of the author's "Transactivator" is shown in the photos. Layout is not at all critical, so any reasonable construction is permissible. This particular setup is intended for use on the experimental bench. Thus, it is assembled as a separate unit. However, in many cases, it will be found expedient to construct the unit as part of the equipment it is to operate.

In the construction used by the author a small interlocking metal box chassis was employed. Holes were first drilled in the front panel for the "on-off" slide switch, the neon indicator bulb, and the two output terminals. A rubber grommet was used in the indicator bulb hole to protect the bulb. Insulating washers were used for the output terminals to prevent them from being short-circuited to the metal panel. Holes were also drilled in the sides of the box for the passage of the line cord, which was protected by means of a grommet, and for the terminal strip, battery clips, and for the transformer.

After mounting the slide switch and terminals, the clips for the two penlite cells were mounted, as was the terminal strip for the wiring, and the small transistor audio input transformer that was used as a power transformer.

Both the 2N188A transistor and the 1N91 germanium junction rectifier are mounted by means of their own leads. Spaghetti should be used to prevent short-circuiting of the leads. Be sure not to use excessive heat from the soldering iron and do not apply the iron too close to the transistor itself otherwise the unit may be damaged. It is a good idea to hold the lead with a pair of long nose pliers while soldering so that the pliers are between the iron and the transistor. In this way, the pliers act as a heat absorber and prevent damage.

After the remaining components have been soldered into place, the transformer connections made, and the batteries put into their clips, the unit is ready to be plugged into the a.c. line and tried out.

Applications

A supply of this type finds wide application wherever low-power transistors are used and reliable operation up to 24 hours a day is called for—such as in fire alarms, burglar alarms, rain alarms, remote amplifiers, repeaters and indicators, data-taking and recording machines, etc. It could conceivably be built in as part of a small transistor radio receiver. In this case, the receiver would operate from the battery in portable use, and would switch automatically to a.c. operation when the power cord was plugged into an outlet. In such a relatively hum-sensitive application as this, additional filtering might possibly be needed in the bus to low level stages in some receiver circuits. Such filtering is almost always desirable anyway, however, even for 100% battery operation (to prevent objectionable regeneration or motorboating) so using the "Transactivator" circuit would add little or nothing to the cost in this area of the receiver.

R_1—100,000 ohm, ½ w. res.
R_2—2700 ohm, ½ w. res.
C_1—100 μfd., 15 v. elec. capacitor
PL_1—Type NE-2 neon lamp
S_1—D.p.d.t. slide switch
B_1—3-volt battery (two 1½ volt units in series)
T_1—Transistor audio input trans. (used as power trans., Argonne AR-144)
CR_1—1N91 junction rectifier (General Electric)
V_1—"p-n-p" transistor (General Electric 2N188A)

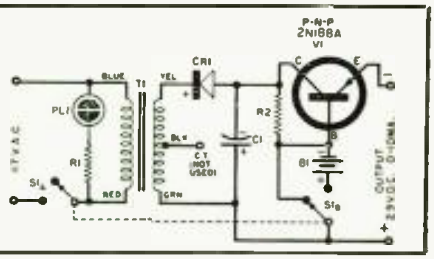


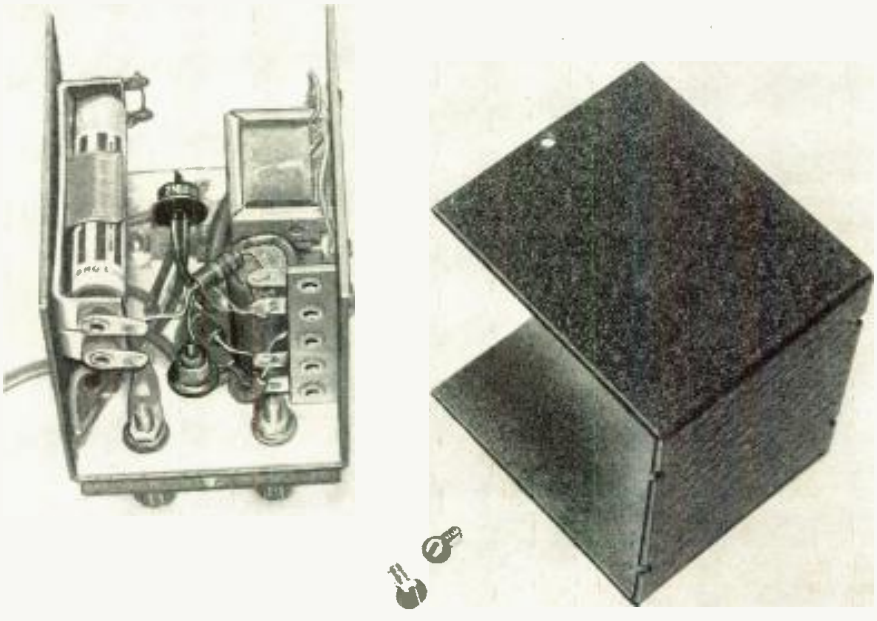
Fig. 1. Complete schematic diagram and parts list for the transistor circuit "activator". The single transistor operates as a voltage regulator and filter.

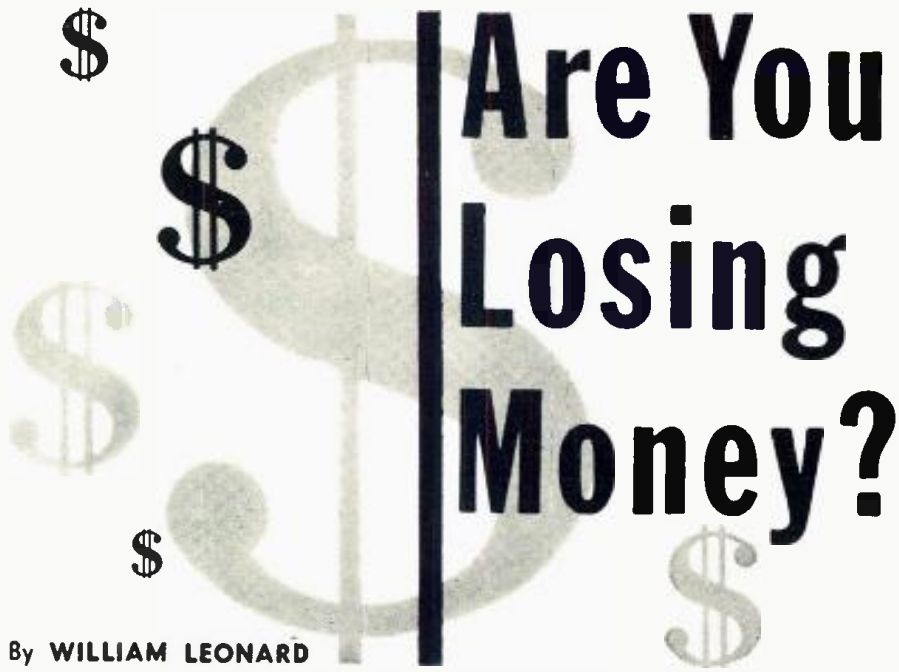
Although rejuvenation prolongs the life of a dry-cell battery, sometimes to a surprising degree, it does not guarantee that the battery will last forever. Thus, a check on the condition of the battery should be made occasionally. Either one of the two following methods is suggested. One method is a check on the voltage across the output terminals of the "Transactivator" when the unit is operating on battery and delivering power to its usual load. An abnormal *decrease* in output voltage indicates deterioration of the battery. This is undoubtedly the most reliable method. However, a second method—especially when the "Transactivator" is being used to power a sensitive amplifier—is a check on the hum ripple in the output when the unit is operating on a.c. and delivering its normal amount of current. An increase in ripple indicates an increase in the internal resistance of the battery which, in turn, indicates a need for battery replacement. Always interrupt the a.c. circuit before removing or replacing the battery, since without the cells in place and determining the voltage reference level, the output voltage may rise as high as the maximum across C_1.

An unusual *increase* in d.c. output voltage when the unit is operating on a.c. may also indicate a worn-out battery, or it may mean that the rejuvenating current is too high. When the "Transactivator" is to be in continuous use, 24 hours a day, every day, such as in powering a fire alarm—and a.c. power failures are rare, so battery operation is infrequently needed—it may be desirable to increase the value of R_2 to reduce the reactivating current to one milliampere or less. Reactivating current should be checked only when the supply is delivering current to its usual load.

Although transients are absent when switching occurs in the transistor, a momentary pulse does appear across the output terminals when S_1 is switched off. When the "Transactivator" is used to power a device containing voltage-sensitive transistors, make sure that device also contains an RC filter to absorb the pulse before S_1 is operated. —30—

Photo of the "Transactivator" with the cover removed. Note the transistor mounted beween the power transformer and the two penlite cells to the left.





Are You Losing Money?

By **WILLIAM LEONARD**

Unrealistic charges, subnormal income eat away the basic assets of thousands of service businesses.

SEVERAL years ago a bright, shining new service shop was opened in a medium-sized midwestern city by a hopeful service technician. He had handled home radio and TV service as a part-time activity for several years. Now he had cut his ties with a regular job and embarked on a long-planned career as a full-time service business operator.

Today this shop looks drab and uninviting. The paint is dull, weather-beaten, and forlorn. The windows, which once framed attractive displays, are cluttered with a motley array of promotional pieces that look as if they were thrown in place. The owner is weary and worried because he is constantly hard-pressed for money to pay his bills.

What happened to blight this dream of economic independence in a self-owned business? Why did this service shop deteriorate while the market rose steadily for the services it had to sell?

There is no simple, easy answer to the question of why promising service businesses slowly wither and die. Many things are involved. The personality and aggressiveness of the owner are very important; also his ingenuity and adaptability—his willingness to change to meet the needs of the times.

There is a definite pattern, however, that is woven into the history of most service businesses that fail. That pattern is the tendency to sell service for less money than it costs to give it. In the case mentioned at the beginning of this article, that man thought he could build a business by selling service calls at a dollar per call less than the average charged by successful shops operating in a similar way.

The most important factor in the management of an electronic service business is the constant recognition that the major product it handles is the sale of *time*. If the *time* of the owner and employee cannot be sold at a profit, the business will finally fail. It may, for a time, continue to operate by burying some of the service charges in padded tube and parts bills. But, sooner or later, devices like the self-service tube testers move in to take a big slice of the lucrative tube business away from service shops. The dealers are left with the tough job of getting an adequate return for their time on the tougher service jobs.

How much do you get for a service call?

The most recent survey of the costs of operating a service business indicates that it *costs* $5.14 to put a competent technician at the front door of a home prepared to give normal service to a TV set and up to 30 minutes of his time. This is a national average. It will vary fifty cents up or down depending on local conditions in different parts of the country. It is, however, an actual cost figure. The charge to the set owner should be ten percent more to provide the business with the income necessary to show a gross operating profit. This means that set owners should be paying about $5.75 for TV service calls that require up to thirty minutes to complete.

It should be pointed out that the national average of $5.14 per service call reflects the cost of operating in an efficient service business that pays its technicians competitive wages and normal fringe benefits. It is also based on the business having a sufficient volume of work to keep its technicians fully occupied in making field calls eight hours per day.

For many years the curse of the independent service industry has been the advertising of service at three dollars (or less) per call, while the known cost of operating was rising steadily from about four dollars and thirty-five cents per call to the current average above five dollars. Despite the fact that all other costs have been spiraling upward, price advertisers have stuck to the three dollar ceiling. Since no dealer can beat the factor of basic costs in the sale of *time*, it would appear that there has been a steady rise in the padding of parts bills or else the TV service industry has attracted thousands of philanthropists who are devoting their lives to giving the public service on its finest entertainment medium at less than cost.

Consumer studies have consistently shown that bait advertisers eventually fold up because of customer dissatisfaction *if* the majority of their competitors maintain normal prices and provide honest service. It is unfortunate, however, that a large number of misguided service dealers try to meet fire with fire by participating in the bait advertising racket. The end result is that the entire service market in the area is depressed while consumer dissatisfaction expands to include the entire independent service industry.

In every market, service dealers say bitterly, "I am not making a decent living from my present charges but I can't raise mine because my competitors won't raise theirs." If a dealer is not making a decent living on the basis of his present charges he is losing money operating his business. Certainly he is not able to lay aside any reserves to repaint his store or to replace the equipment that is deteriorating. This applies to any competitor in the same market who uses the same scale of service charges. The end result is that all businesses engaged in this blind battle of price are headed for the rocks of financial trouble.

Economists say that the spiral of living costs will continue to climb in the months ahead. A recent business forecast stated:

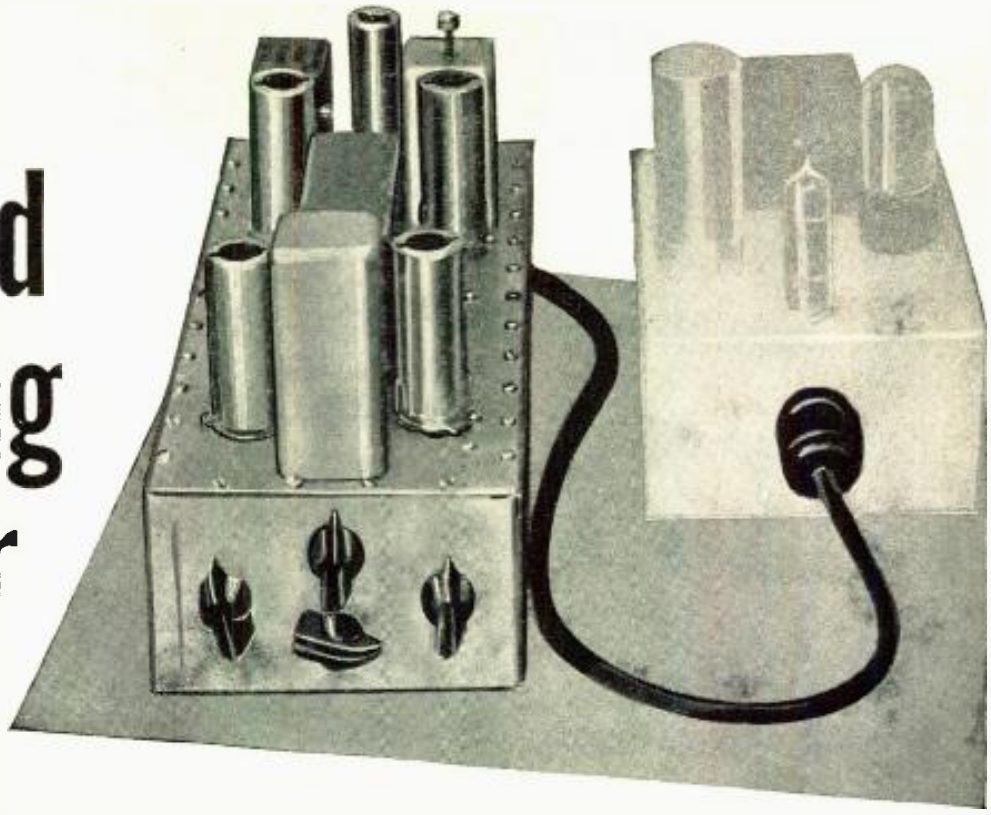
"The price you'll pay will be pushed up by higher material and freight costs, as well as higher wages. At wholesale, the stability of recent months will give way to increases averaging as much as 2% by year-end; from 3% to 6% for steel products; 2% to 4% for fuels; 5% to 8% for electrical appliances.

"Consumer prices, after a summer decline because of seasonal food dips, will jump 1.5% to 2% this fall. Cars, apparel, and services all will cost more."

Everything the service dealer uses in his business costs more than it did two or three years ago. His own living

(*Continued on page* 185)

Single-Sideband Receiving Adapter



Single-sideband adapter, shown at left, with power supply recommended by author.

By
HARRY D. HOOTON
W6TYH

Easy-to-build unit allows SSB reception on standard 450 kc. i.f. ham receiver without receiver changes.

MORE and more amateurs are becoming interested in single-sideband transmission and reception. It is only necessary to examine the circuitry of some of the very latest communications receivers and transmitters to realize that great strides have been made in single-sideband techniques within the past few years. It is quite likely that during the next few years, most amateur voice transmissions will be carried out on single-sideband.

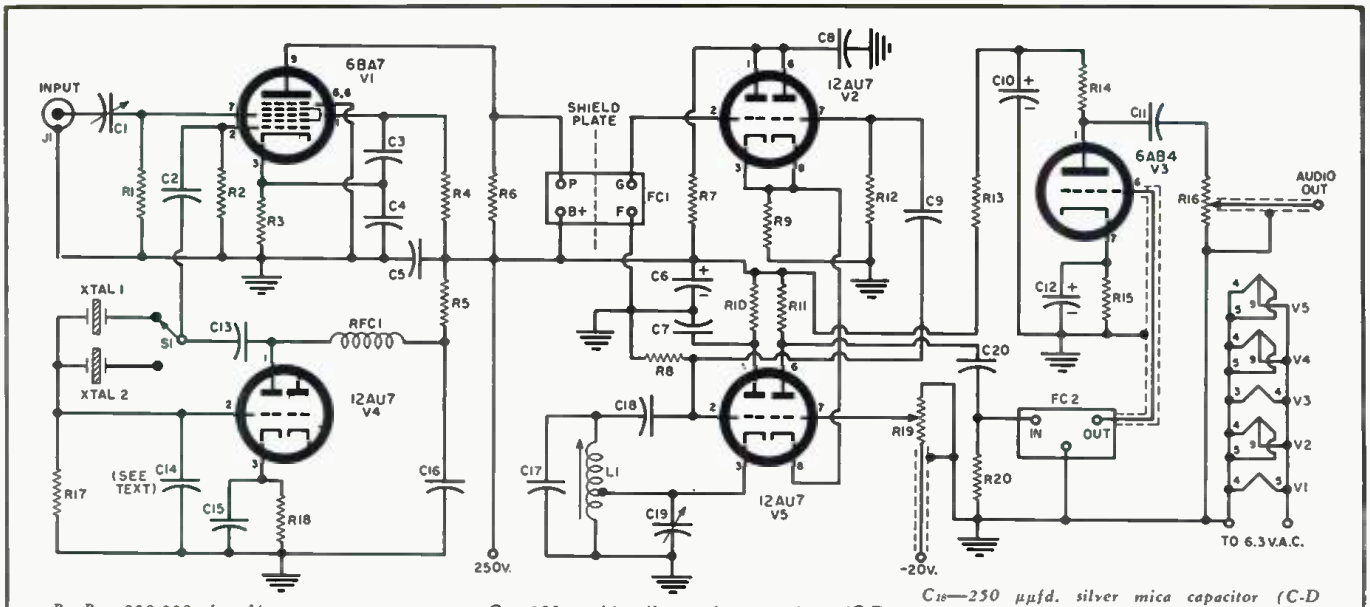
Unfortunately, for many amateurs, good commercial communications receivers, designed with the emphasis on single-sideband reception, are both complex and expensive. Some amateurs have attempted to revamp the circuits of their regular communications receivers in order to improve their performance on single-sideband. The results, in many cases, have been disappointing and the resale or trade-in value of the set has been considerably reduced.

The single-sideband adapter unit described here solves the single-sideband reception problem for the ham who already owns a good quality standard AM receiver having an intermediate frequency in the vicinity of 450 kc. The adapter unit will permit reception of single-sideband signals, on a standard receiver, with a clean-cut quality comparable to that of the best communications receiver on the market; no modifications of the receiver, either electrical or physical, are necessary. Either single-sideband or regular AM reception may be selected merely by throwing a switch. The unit is easy to build since there are no tricky adjustments or alignment involved. The reception of regular AM and c.w. signals will be improved because the effective bandwidth required is cut in half. This narrow bandpass also reduces noise. The intelligibility of weak DX signals is increased over regular AM reception. Best of all, the adapter can be built for $75.00 or less.

As shown in Fig. 1, the adapter unit uses five tubes. A type 6BA7 is used as a mixer to convert the receiver i.f. signal from around 450 kc. to 50 kc. where it can be filtered to remove one sideband. The oscillator tube, for the converter stage, is one-half of a 12AU7 which is controlled by either a 400 kc. or 500 kc. crystal, selectable from the front. The nominal 50 kc. output signal from the 6BA7 plate, which contains the transmitted carrier and two sidebands (assuming a regular AM signal), is applied to the input terminals of a toroidal sideband filter which passes the band of frequencies from 47 to 50 kc. but sharply attenuates the frequencies higher than 50 kc. The characteristic response of the filter, which is the heart of the adapter design, is shown in Fig. 2.

The receiver is normally tuned so that the AM carrier, or suppressed single-sideband carrier, is placed at the 50 kc. position, as indicated, approximately 20 db "down" on the high-frequency or steep side of the curve. The relative position of a double sideband (regular AM) signal is shown by the dotted line in Fig. 3. The solid line indicates the portion of the signal which is passed by the filter. It will be noticed that the "upper" or high-frequency sideband is sharply attenuated to 70 db or more and, for all practical purposes, is virtually removed. The output of the filter, with an applied AM signal, then consists of a reduced carrier and the spectrum of sideband frequencies which lie between 50 and 47 kc. In single-sideband terminology, the filter passes only the "lower sideband" and a reduced amplitude carrier and suppresses the "upper sideband." The bandpass of a filter is usually specified as the width of a band of frequencies passed between two points on the characteristic curve 6 db below the peak or maximum amplitude. The filter shown here has a bandpass of 3000 cycles or 3 kc. between the 6 db points. This figure has become more or less a standard for voice communications.

It must be remembered that the filter itself passes only the lower sideband. In order to select either an upper or a lower sideband, as desired, we must be able to "invert" or change the polarity or position of the two sidebands in the mixer plate circuit so that the desired sideband always appears to the



R1, R3—220,000 ohm, ½ w. res.
R2—27,000 ohm, ½ w. res.
R3—270 ohm, 1 w. res.
R5—27,000 ohm, 1 w. res.
R6—30,000 ohm, ½ w. res. ±5%
R7—4700 ohm, ½ w. res.
R8, R11, R17—100,000 ohm, ½ w. res.
R9—470 ohm. 1 w. res.
R10—5600 ohm, 1 w. res.
R11, R14—47,000 ohm, 1 w. res.
R13—10,000 ohm, 1 w. res.
R15—1000 ohm, 1 w. res.
R16—500,000 ohm audio taper pot
R18—800 ohm, 1 w. res.
R19—5000 ohm wirewound pot
R20—20,000 ohm, ½ w. res. ±5%
C1—4.5-25 μμfd. ceramic trimmer (Centralab 822-CN)
C2—100 μμfd. silver mica capacitor (C-D 22R5T1)
C3, C4, C5, C13—.01 μfd., 600 v. disc ceramic capacitor
C6—40 μfd., 450 v. elec. capacitor
C7, C8—.1 μfd., 600 v. molded paper capacitor
C9—47 μμfd. silver mica capacitor (C-D 22R5Q47)
C10—10 μfd., 450 v. elec. capacitor
C11, C20—.0033 μfd. silver mica capacitor (C-D 1R5D33)
C12—10 μfd., 25 v. elec. capacitor
C14—50 μμfd. mica capacitor (may require up to 200 μμfd. for some crystals)
C15—.02 μfd., 600 v. disc ceramic capacitor
C16—.05 μfd., 600 v. disc ceramic capacitor (paralleled .02 μfd. and .01 μfd.)
C17—Part of L1
C18—250 μμfd. silver mica capacitor (C-D 22R5T25)
C19—140 μμfd. variable tuning capacitor
RFC1—2.5 mhy. r.f. choke (Miller 4530)
L1—Osc. trans., 48-52 kc. (Miller 1898-BFO)
FC1—Single-sideband filter, 50 kc. (Burnell S-15000)*
FC2—Low-pass audio filter, 300-3000 cps (Burnell S-23197)*
Xtal. 1, Xtal. 2—FT-241-A surplus crystal (See text)
S1—S.p. 2-pos. miniature rotary switch, steatite insulation. (Centralab PA-2001)
J1—RCA-type phono jack
V1—6BA7 tube
V2, V4, V5—12AU7 tube
V3—6AB4 tube
**Available direct from Burnell & Co. Inc., Yonkers 2, N. Y.*

Fig. 1. Complete schematic diagram and parts list for the single-sideband adapter.

filter as a lower sideband. Fortunately, it is a characteristic of mixer-oscillator circuits that the relative positions of the two sidebands in the frequency spectrum are reversed when the oscillator frequency is changed above or below the signal frequency by an amount equal to the intermediate frequency. Thus, in this unit, the "signal" frequency is 450 kc. which is taken from the receiver i.f. circuit, and the two oscillator frequencies required for sideband inversion will be equal to 450 kc. plus 50 kc. and 450 kc. minus 50 kc. or 500 kc. and 400 kc. respectively.

The oscillator frequencies must be capable of being maintained exactly plus and minus 50 kc. with respect to the i.f. carrier position; otherwise, the carrier will not fall at exactly 50 kc. on the filter curve and the full benefits of sideband selection will not be realized. It is for this reason that the oscillator is crystal controlled. To select sidebands, it is only necessary to select either of the two crystal frequencies. The crystals used are surplus type FT-241-A units which can be purchased at low cost in most radio surplus stores or may be ordered by mail from the advertisers in this magazine. A listing of the proper crystal frequencies and channel numbers for several popular intermediate frequencies is given in Table 1.

The signal from the filter, which now consists of a carrier and one sideband, is applied to a "product" or "exalted carrier" demodulator. This type of demodulator does not "detect" or rectify the signal, in order to recover the audio intelligence, in the usual sense; the product demodulator is really a form of converter, where the 47-50 kc. signal is mixed with a 50 kc. oscillator, the "difference" frequency, in this case, being the original audio or modulation frequencies. The 50 kc. oscillator signal voltage amplitude is approximately 100 times that of the signal from the filter output and is therefore generally called an "exalted" carrier. The actual signal and oscillator voltage values at the demodulator are approximately 0.1 and 10 volts respectively.

The output from the demodulator is applied to the input of a low-pass audio filter, which limits the audio response to the frequencies between 300 and 3000 cycles. The low-pass filter serves the dual purpose of limiting the audio range in order to "clean up" the signal and also prevents the high amplitude 50 kc. "exalted" or "synthetic" carrier voltage from appearing at the input of the audio amplifier which would cause overloading and distortion.

The demodulator circuit uses two type 12AU7 tubes. Three of the triodes are used as cathode followers. The first is used as a cathode follower for the 47-50 kc. signal voltage; the second is used as a cathode follower for the 50 kc. injected carrier, and the third is used as the mixer for the oscillator and signal voltages. The fourth triode is used as the 50 kc. oscillator.

The first three triodes work into a common 470-ohm cathode resistor; the mixing process occurs in the third triode, which has its grid grounded for the signal voltages but contains an audio load resistor in its plate circuit. The bias on the mixer and the signal cathode follower is adjustable by means of a 5000-ohm potentiometer in the grid circuit of the third triode. This control, which is on the front panel, is ordinarily adjusted, with the 50 kc. oscillator turned off, to a point just below where AM signals are heard. This point should be marked for future reference. When the oscillator is turned on, the audio will be heard and the output will be proportional to the "product" of the applied signal and oscillator voltages. The signal-to-oscillator voltage ratio will be approximately correct when the bias control is adjusted as described. However, it may be desirable to vary this adjustment slightly under actual operating conditions in order to minimize distortion on over-modulated AM signals, interference from adjacent strong AM carriers, etc.

An audio preamplifier stage, using a 6AB4 triode, is included in the adapter circuit. In order to prevent overloading the first audio amplifier stage in the receiver, an adjustable audio level control is provided on the front of the

adapter unit. Either the level control or the regular receiver volume control may be used to control the audio gain.

It is important that the audio leads from the 12AU7 detector plate to the input of the low-pass filter, the lead from the filter output to the 6AB4 grid, and the leads from the 6AB4 plate to the level control and output jack be shielded and kept away from wires carrying 60-cycle a.c., such as the heater leads. The audio level at the 6AB4 grid is very low and any a.c. introduced into this circuit may appear in the output with a hum level equal to that of the audio signal. The audio lead from the adapter unit to the receiver must be shielded to prevent hum pickup and should not be over two or three feet in length. The input and output connections are made at the rear of the chassis by means of *RCA*-type phono jacks and plugs.

The arrangement of the various parts on the chassis is important and it is recommended that the layout shown in the photographs be followed closely. The two FT-241-A crystal sockets are mounted near the front so that the leads from the sockets to the crystal switch will be short. When in use, the crystals are normally covered by the aluminum shield can. The tube at the left front is the 12AU7 crystal-controlled oscillator. The crystal selector switch is controlled by the pointer knob at the left; the knob at the right is the frequency adjustment control for the 50 kc. oscillator. The knob at the top center is the bias adjustment control and the knob at the bottom center is the audio level control.

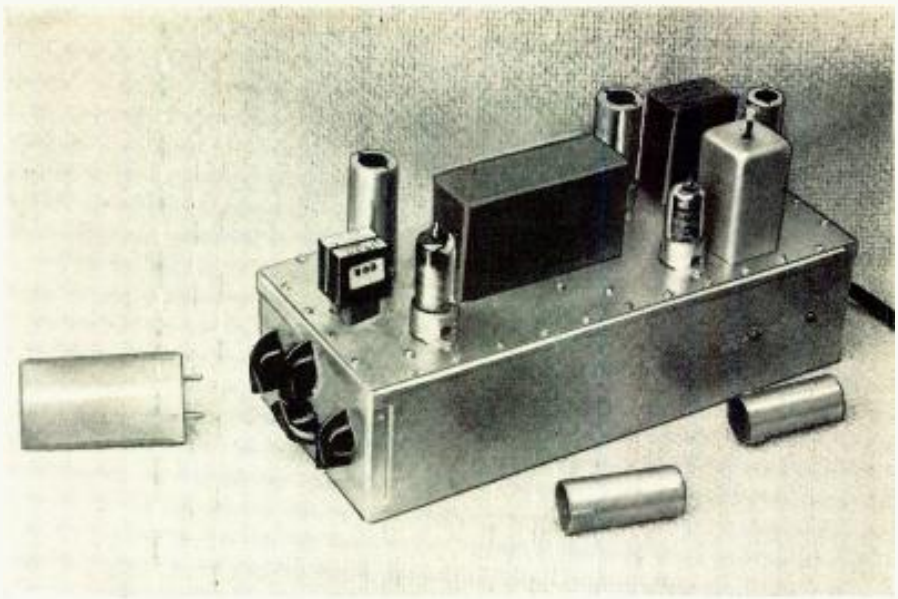
The 6BA7 mixer is at the right front of the chassis. The 50 kc. *Burnell* S-15000 single-sideband filter is mounted lengthwise on the chassis just behind the oscillator and mixer tubes. The two tubes at the rear of the 50 kc. filter are the 12AU7's used for the demodulator and 50 kc. oscillator. One triode section of the 12AU7 at the right is used as the oscillator; the shield can mounted just behind it contains the 50 kc. oscillator coil. The *Burnell* S-23197 low-pass audio filter is mounted at the left rear of the chassis and the 6AB4 audio preamplifier is mounted at the extreme rear and center.

The phono jack at the left, on the rear panel, is the 450 kc. i.f. input from the receiver; the jack at the right is the audio output from the adapter unit.

The center shield terminals of the five tube sockets are connected together with #12 tinned bus wire which is grounded to the chassis plate through the two long brass 6/32 machine screws shown in the bottom view. The shield plate between the input and output terminals of the filter is necessary in order to prevent undesired stray signal coupling which would destroy the bandpass characteristics. One terminal of each tube heater is connected to the common ground bus; the other common heater lead should be kept short and direct and as far from the audio leads as possible. The audio lead shielding is connected to the common ground bus rather than the metal plate.

The leads to the crystal sockets must be kept short. All bypass capacitors should have the shortest possible leads between the terminal to which they are connected and the common ground bus. A long capacitor lead may couple sufficient 50 kc. signal energy around the filter to distort its characteristics. In general, keep away from "beautiful" wiring arrangements and use the shortest possible point-to-point connections.

The construction job will be easier if the top plate is removed from the rails during the wiring process. After the wiring on the top plate is completed, it is placed in position on the side and end rails and secured by the screws provided. The potentiometers,



Over-all view of unit with crystals shield and two of the tube shields removed. Output and input phono jacks (not visible in photo) are on right end of chassis.

RECEIVER I.F.	SIDEBAND #1	SIDEBAND #2
450 kc.	400 kc. (21.6 mc.)	500 kc. (27.0 mc.)
455 kc.	405 kc. (21.9 mc.)	505 kc. (27.3 mc.)
460 kc.	410 kc. (22.1 mc.)	510 kc. (27.5 mc.)
465 kc.	415 kc. (22.4 mc.)	515 kc. (27.8 mc)
470 kc.	420 kc. (22.7 mc.)	520 kc. (28.0 mc.)

Note: Data applies to "two digit" crystals only. To obtain fundamental frequency, divide frequency (in mc.) by 54. The "three digit" crystals (channel number contains three figures) frequency (in mc.) must be divided by 72 to obtain the fundamental frequency. All crystals are FT-241-A type.

Table. 1. Relationship between the sideband, crystal, and receiver i.f. frequencies.

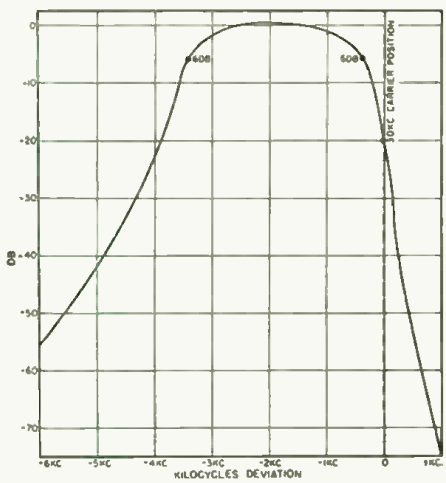
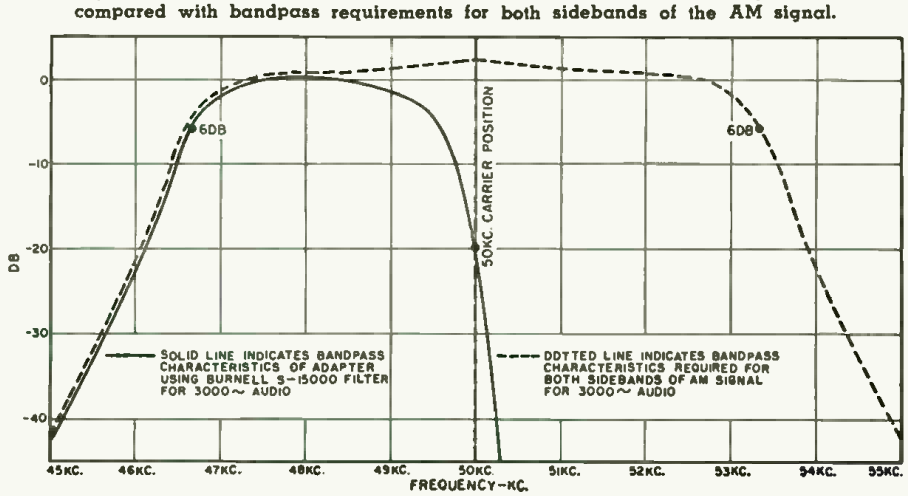


Fig. 2. Characteristics of the Burnell S-15000 single-sideband filter employed.

Fig. 3. Bandpass characteristics of adapter with S-15000 filter for 3000 cps audio compared with bandpass requirements for both sidebands of the AM signal.



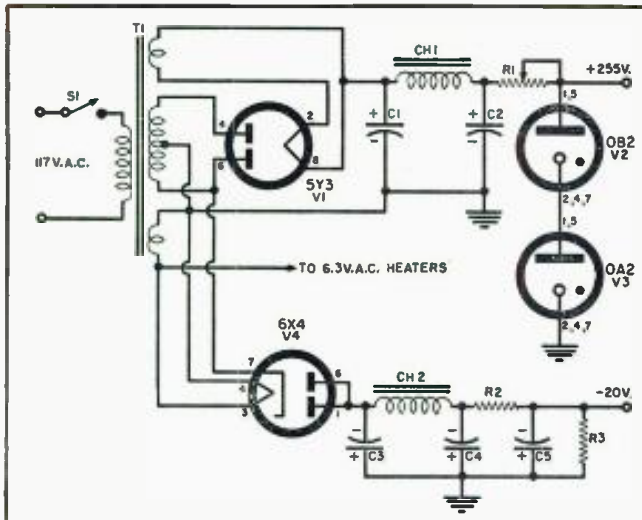


Fig. 4. Complete schematic diagram and parts list for the regulated power supply employed with the single-sideband adapter described here. The use of a supply that is separate from the receiver is recommended by author.

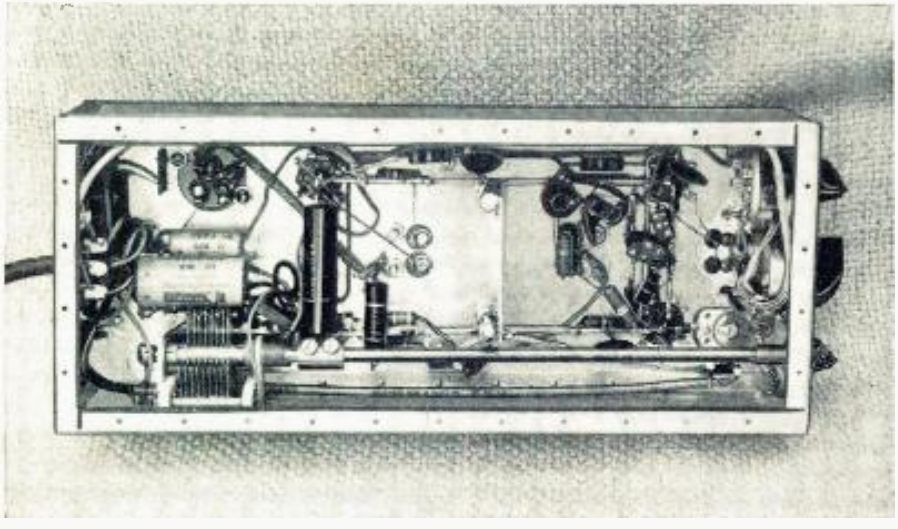
R_1—5000 ohm, 10 w. wirewound rheostat
R_2—15,000 ohm, 10 w. wirewound res.
R_3—5000 ohm, 2 w. res.
C_1-C_2—40/40 μfd., 450 v. elec. capacitor
C_3 C_4-C_5—40/40/40 μfd., 450 v. elec. capacitor
CH_1—10 hy., 75 ma. filter choke
CH_2—10 hy., 50 ma. filter choke
S_1—S.p.s.t. switch
T_1—Power trans. 250-0-250 v. @ 70 ma.; 5 v. @ 2 amps.; 6.3 v. @ 2.5 amps (Any unit which will provide at least 255 volts d.c. to capacitor input filter is suitable)
V_1—5Y3 tube
V_2—0B2/VR105 tube
V_3—0A2/VR150 tube
V_4—6X4 tube

the crystal switch, the variable tuning capacitor and the output and input jacks are wired into the circuit. The unit is now ready for operation.

The use of a power supply separate from that of the receiver is recommended. The small power unit shown in Fig. 4 supplies 255 volts at 50 ma. for the plates and screens, a bias voltage of −20 volts and the necessary 6.3 and 5.0 volt a.c. for the heaters. The voltage regulation shown on the schematic is not incorporated in the power unit shown in the photographs; however, it is desirable since it will eliminate adjustments of the 50 kc. oscillator frequency during changes of line voltage. The −20 volt supply must be well filtered and precautions taken to insure that a.c. is not coupled into the lead; this lead is shielded all the way up to the bias control potentiometer.

In this discussion we have referred to an i.f. signal of 450 kc. and oscillator frequencies of 400 and 500 kc. Many communications receivers use an i.f. of 455, 460, or 465 kc. In order to select the proper crystal frequencies, merely add and subtract 50 kc. from the intermediate frequency of your particular receiver. The i.f. is given in the instruction or service manual, usually on the schematic. It can be obtained by writing to the manufacturer or by reference to the appropriate service manuals which are carried by most radio parts stores. The FT-241-A crystals are marked in "channel" numbers. The 400 and 500 kc. units shown are marked "channel 16, 21.6 mc." and "channel 70, 27.0 mc." respectively. These crystals are known among hams as the "two digit" series, since the channel numbers consist of two digits. The two-digit crystals have a fundamental frequency equal to the *frequency marking in megacycles divided by 54*. Crystals with three digits in the channel number have a fundamental equal to the megacycle designation divided by 72. The two digit crystals are employed in this adapter.

Bottom view of the single-sideband adapter showing the clean-cut construction. Control knobs are to the right; output, input, and power connections are to left.



The easiest way to select the proper crystals for your particular application is to add and subtract 50 kc. from the i.f. to obtain the two fundamental frequencies. Then multiply each fundamental frequency (in megacycles) by 54 and the crystal frequency marking in megacycles will be obtained. Now, select a *two-digit* crystal with the proper megacycle marking and it will be correct. As an example, suppose the receiver i.f. is 455 kc. The fundamental frequencies of the crystals will be 455 − 50 or 405 kc., for one crystal, and 455 + 50 or 505 kc. for the other crystal. Converting kilocycles to megacycles, 405 kc. is equal to .405 mc. and 505 kc. is equal to .505 mc. To arrive at the crystal marked frequency, we multiply .405 x 54 and obtain 21.87 mc. (this crystal will be marked 21.9 mc.); the other crystal marking is determined by multiplying .505 x 54 which gives 27.27 mc. or, possibly an actual designation of 27.3 mc. The slight error at the fundamental is negligible and causes no noticeable effects when switching from one sideband to the other.

The i.f. signal should be taken from the receiver through a low-capacitance cable such as the shielded lead used between an automobile antenna and the receiver. *Do not use* coaxial line, such as RG-59/U, since the capacitance-per-foot value is too high and will result in both signal loss and detuning effects.

A small 10 μμfd. coupling capacitor should be soldered directly on the plate terminal of the last i.f. tube socket in the receiver. When connected in this manner, the capacitance of the shielded lead will be in series with 10 μμfd. across the primary winding of the i.f. transformer and the detuning effect will be negligible. The i.f. trimmer, however, should be repeaked after the connection is made. The easiest way to take the i.f. signal from the receiver and return the audio to it, is to install a phono jack for each circuit at the rear of the cabinet. If auto antenna cable is used to transfer the i.f. signal, the auto radio connectors will be more suitable than the phono jacks since these cables come complete with fittings. The audio cable may be any type of good quality shielded wire.

If the receiver does not already have a "radio-phono" switch, this would be a desirable feature since the type of reception may be changed from single-sideband to AM by merely throwing a single switch. Frequently, signals which are unreadable on AM. due to interference and other causes, may be copied on the adapter without difficulty.

Best results will be obtained with the adapter-receiver combination if a definite operating procedure is established. Practice on an AM signal, preferably a local broadcast station, until you become familiar with the tuning characteristics. When receiving AM, tune the receiver so that the carrier falls in the center of the receiver i.f. bandpass

(*Continued on page* 118)

By JOHN T. FRYE

CUSTOMER SAFETY

MAC was watching Barney put a small a.c.-d.c. receiver back in the cabinet. As the youth wrapped the line cord up in a neat little hank, Mac reached over and pulled lightly on the cardboard back. The loosely fitting Trimounts came out of their sockets and the back fell off.

"You intend to let it go out like that?" Mac asked quizzically.

"Sure, why not? The spring has gone out of those Trimounts and they will not hold much, but what's the difference? If we would take that back off and throw it clear away the set would operate cooler."

Mac closed his eyes as he said slowly, "Of course we never know exactly the circumstances under which a set such as this will be used in the customer's home, but I always try to think of a picture such as this: I see a little child standing barefoot on a damp basement floor running his chubby little hands over the set trying to get his fingers into where the music is coming from. Now do you see why it's important the back be held securely in place?"

"Yeah, I guess I do," Barney said with a flushed face as he squirted Duco cement into each of the Trimount sockets and pushed the spread Trimounts firmly into place. "This cardboard back, in such a case, would be all that would prevent the child's getting a severe burn or maybe even a bad shock."

"Right. The old days when the console radio was enthroned in the living room and was only approached with awe, respect, and caution are gone. Radio and TV sets are being carried around these days as they never were before and they are being used in every conceivable place from the garret to the side of the swimming pool. In view of all the handling sets get these days, it might be a good idea if we reviewed our service practices aimed at protecting the customer from possible injury or even death from his electronic equipment that we service. We've talked a lot about protecting ourselves from injury; now let's think about what we should do to make sure our customers don't get hurt.

"We know by the papers that occasionally someone is killed by a radio or TV set. I remember one case in which a radio toppled from a shelf into a bathtub and electrocuted the occupant. These occurrences are very, very rare considering the number of radio and TV sets in daily use under all kinds of circumstances; and this fact is a fine tribute to the safety precautions of the manufacturers.

"However, no matter how carefully sets are designed and tested at the factory, things can happen out in the field through age or abuse that may render them deadly. That is where we come in. If we are constantly on the alert to detect any potentially dangerous condition and remedy it, we can make sure the safety measures built into the equipment stay on guard for its entire life."

"You got any specific examples in mind?"

"Lots of them. Take, for example, the line cord, probably the most abused part of a radio or TV set. Let's inspect the insulation on every one of these cords as carefully as though we were depending on that insulation to restrain a couple of live cobras, for the analogy is not too far fetched. If the insulation shows any sign of deteriorating, such as hardening, cracking, or flaking, replace it. Do not depend on the customer's asking that the cord be replaced, for this will seldom happen. It is astonishing how people will continue to use an electrical appliance with a cord from which great chunks of insulation have disappeared.

"Be sure and examine with special care the points where the line cord enters the wall plug and where it passes through the chassis. These are the points of greatest normal wear and a breakdown at either place could easily lead to serious shock or maybe cause a fire."

"How about those a.c.-d.c. sets we get in to repair that are in badly broken cabinets or have no cabinets at all?"

"Either repair the cabinet so that it is safe or get a new cabinet. If the customer does not want to go to this expense after you have explained to him how dangerous such an unprotected chassis can be, refuse to service the set. We do not want to be a party to a possible tragedy for a few dollars."

"OK, but some of the wise boys are going to get pretty huffy about that."

"Let them. Usually our customers are always right, but we don't want any of them dead right."

"Once in a great while," Barney observed, "we come across a set in which the capacitor from one side of the line to the chassis is shorted out. When this happens, touching the chassis and the ground simultaneously could kill you. I wonder if it wouldn't be a good idea to make a routine check for resistance between both sides of the line cord and the chassis on every set before it leaves the shop. That way we'd catch these rare but potentially deadly cases."

"A fine idea!" Mac applauded. "When that capacitor does short-circuit, it usually means the heads of the bolts holding the chassis in the cabinet and those holding the antenna in place on the back of the chassis are, for all practical purposes, connected to one side of the line. If the wall plug is inserted one way, this means these exposed points carry the full line voltage with respect to the ground."

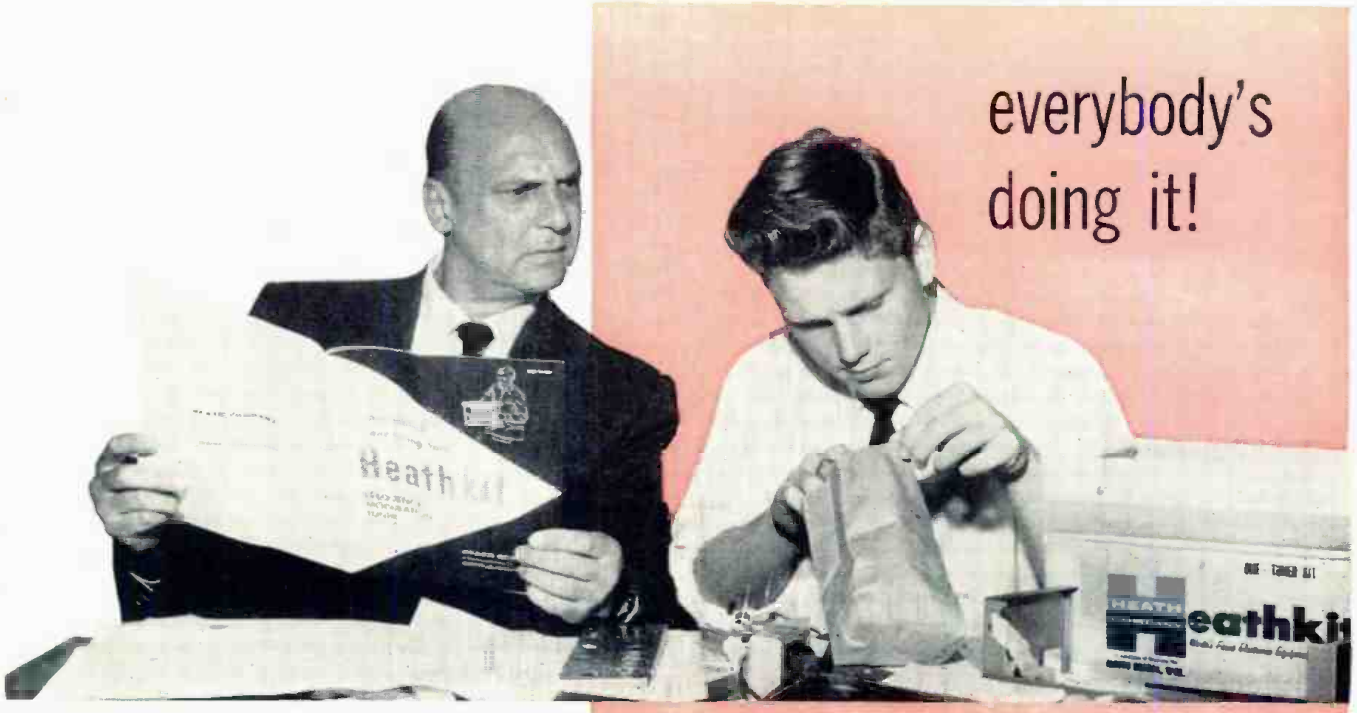
"With one of these sets a person will always feel a light shock when touching the chassis and ground even though the capacitor is perfectly all right," Barney pointed out. "A small amount of a.c. current passes through the capacitor and through the resistor, usually around a quarter of a megohm, that shunts it."

"That's right, and this fools a lot of people who use such equipment in basement playrooms or other places where the feet are in contact with the ground or cement floors. Quite often they want us to do something that will prevent their feeling this tingle. About all we can do is insulate exposed metal surfaces carrying this small current with tape or plastic spray, or suggest the floor around the apparatus be carpeted with rubber matting. Of course reversing the plug in the wall socket will often get rid of the condition. but this is not always the case.

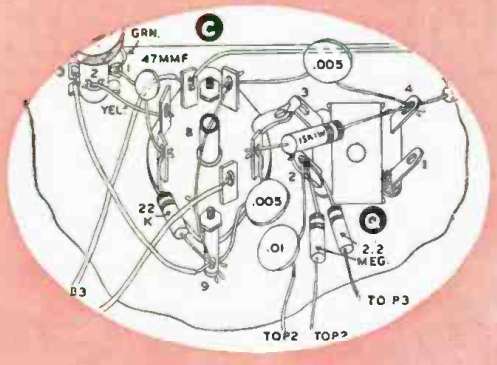
"Before leaving the subject, though, I want to make one important point: never, under any circumstances, dismiss a customer's complaint that he has received a shock from his equipment as being caused by a condition of this harmless nature. Investigate. Make sure nothing is wrong. Fail to do so and you may be sorry all your life."

"Will do," Barney said as he nodded his head vigorously. "Let me ask you another. Now and then when I am working on a TV set in a customer's home and employ a cheater cord so I

(*Continued on page* 117)



Motion picture and TV personality, Jackie Coogan, looks on with unbelieving interest as his 14-year-old son, Anthony, prepares to assemble his latest Heathkit, a hi-fi FM tuner. The Coogans have found out about the fun and savings of building their own electronic equipment the Heathkit way . . . so why don't you?



You'll get plenty of these detailed pictorial diagrams in your Heathkit construction manual to show where each and every wire and part is to be placed. Everything you do is spelled out in pictures so you can't go wrong. That's what makes it such fun!

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By DAYSTROM

...fun to build and a thrill to own!

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1. You get higher quality at lower cost by dealing direct, and by doing your own assembly.
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3. You benefit from the latest in engineering designs because of our concentration on kit-form equipment only.
4. You may depend on performance as advertised—backed by Heath's world-wide reputation for quality.
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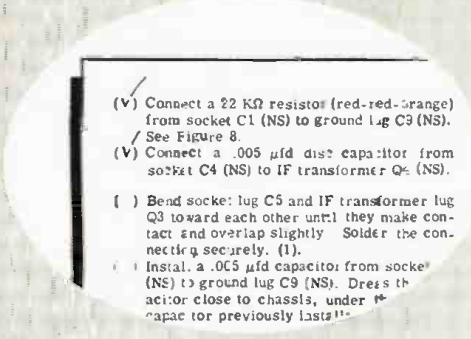

Read the step . . . perform the operation . . . and check it off—it's just that simple. These plainly-worded, easy-to-follow, steps are combined with pictorial diagrams to take you through every phase of assembly. Let our experience be your teacher!

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The Heath Time Payment Plan was designed for your convenience. Now, you can order the kits of your choice, and pay for them in small monthly installments. Write for full details.

HEATHKIT EXTRA PERFORMANCE 70-WATT AMPLIFIER KIT

For really high performance, with plenty of reserve power, the W-6M is a natural. The full 70-watts output will seldom, if ever, be required. However, this reserve insures distortion-less sound on power peaks. The W-6M will loaf along at normal listening levels and yet is always ready to extend itself when program material demands it, without the least amount of strain. The output circuit employs 6550 tubes with a special-design Peerless output transformer for maximum stability at all power levels. A quick-change plug selects 4, 8 and 16 ohms or 70-volt output and the correct feedback resistance. A variable damping control is also provided for optimum performance with any speaker system. Extremely good power supply regulation is possible through the use of a heavy-duty transformer along with silicon-diode rectifiers, which are noted for their very long life, and yet are smaller than a house fuse. Frequency response at 1 watt is ±1 db from 5 cps to 80 kc with controlled hf rolloff above 100 kc. At 70 watts output harmonic distortion is below 2%, 20 to 20,000 cps and IM distortion below 1%, 60 and 6,000 cps. Hum and noise 88 db below full output. In addition to high performance, its fine appearance makes it a pleasure to display in your living room. Proper layout of chassis insures ease of assembly by eliminating those cramped and difficult places to get at. Clear instructions—and top-quality components. Get started now and make this amplifier the heart of your hi-fi system. Shipped express only. Shpg. Wt. 50 lbs.

MODEL W-6M

$109.95

MODEL W-6: Consists of W-6M kit, plus WA-P2 preamplifier. Express only. Shpg. Wt. 59 lbs. $129.70

HEATHKIT HIGH FIDELITY FM TUNER KIT

This tuner can bring you a rich store of FM programming, your least expensive source of high fidelity material. It covers the complete FM band from 88 to 108 mc. Stabilized, temperature-compensated oscillator assures negligible drift after initial warmup. Features broadbanded circuits for full fidelity, and better than 10 uv sensitivity for 20 db of quieting, to pull in stations with clarity and full volume. Employs a high gain, cascode RF amplifier, and has AGC. A ratio detector provides high-efficiency demodulation without sacrificing hi-fi performance. IF and ratio transformers are prealigned, as is the front end tuning unit. Special alignment equipment is not necessary. Edge-lighted glass dial for easy tuning. Here is FM for your home at a price you can afford. Shpg. Wt. 8 lbs.

MODEL FM-3A

$25.95

(with cabinet)

HEATHKIT BROADBAND AM TUNER KIT

This AM tuner was designed especially for high fidelity applications. It incorporates a special detector using crystal diodes, and the IF circuits feature broad band-width, to insure low signal distortion. Audio response is ±1 db from 20 cps to 9 kc, with 5 db of preemphasis at 10 kc to compensate for station rolloff. Sensitivity and selectivity are excellent, and tuner covers complete broadcast band from 550 to 1600 kc. Quiet performance is assured by 6 db signal-to-noise ratio at 2.5 UV. Prealigned RF and IF coils eliminate the need for special alignment equipment. Incorporates AVC, two outputs, two antenna inputs, and built-in power supply. Edge-lighted glass slide-rule dial for easy tuning. Your "best buy" in an AM tuner. Shpg. Wt. 8 lbs.

MODEL BC-1A

$25.95

(with cabinet)

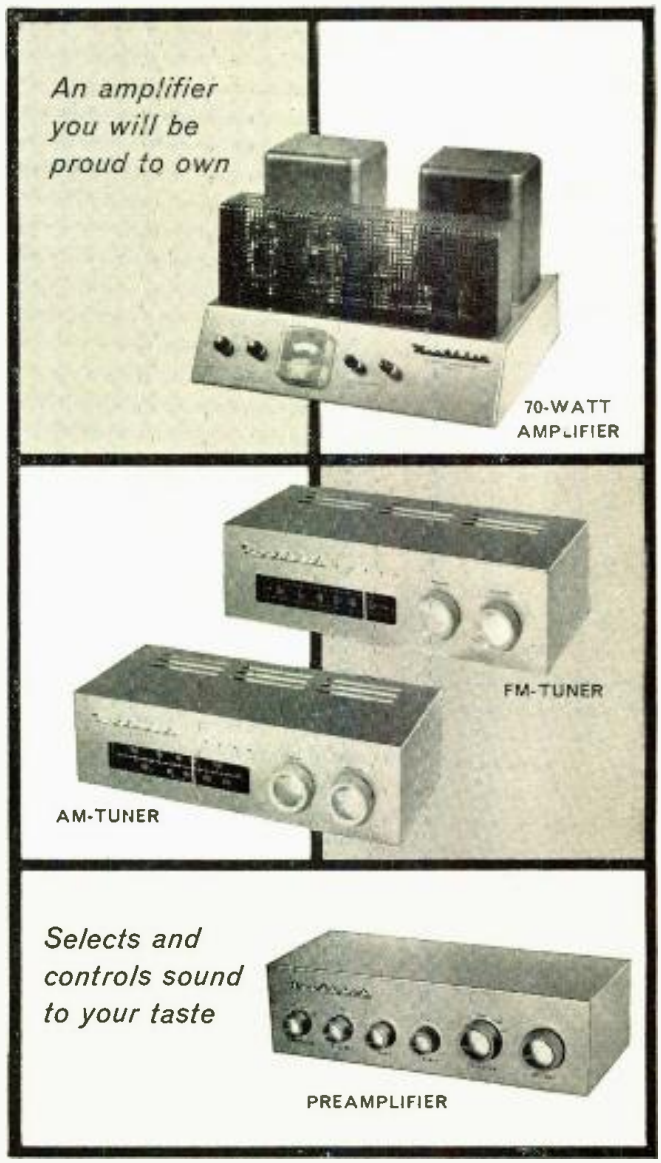
HEATHKIT MASTER CONTROL PREAMPLIFIER KIT

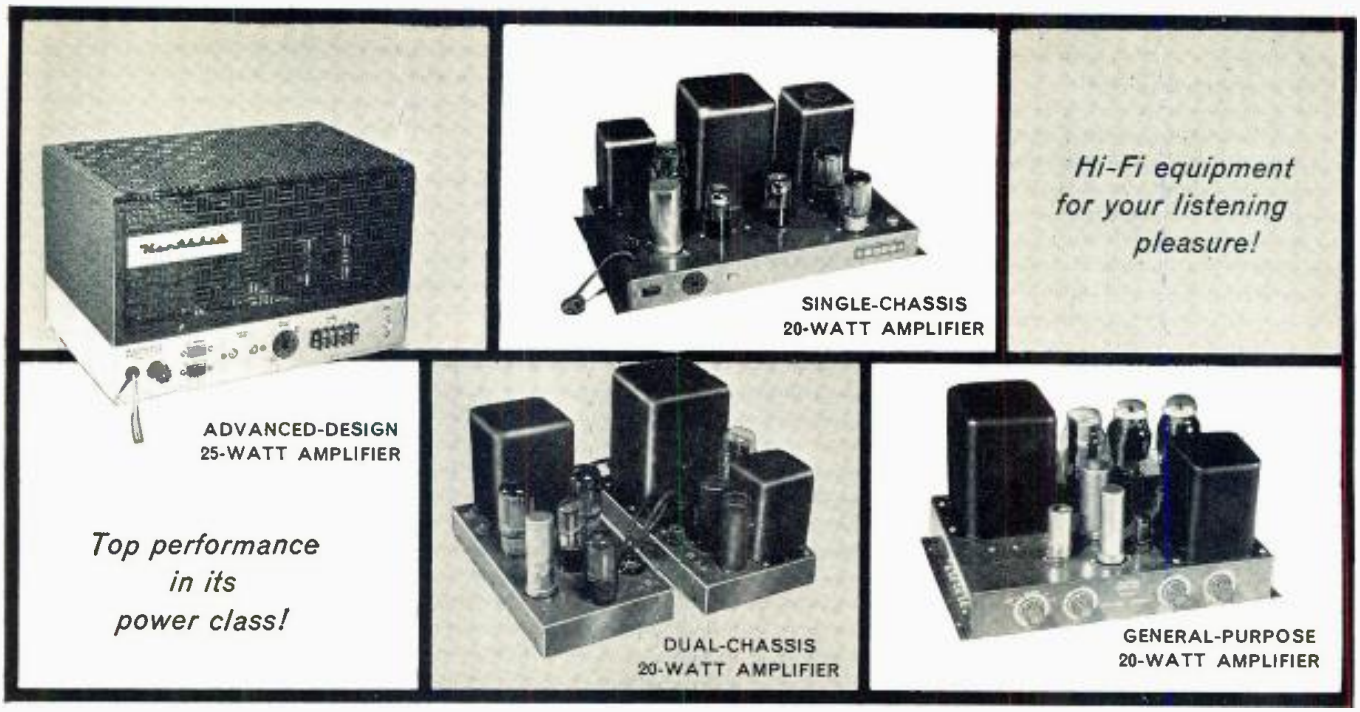
Designed for use with any of the Williamson-type amplifiers, the WA-P2 has five switch-selected inputs, each having its own level control to eliminate blasting or fading while switching through the various inputs, plus a tape recorder output. A hum control allows setting for minimum hum level. Frequency response is within ±1½ db from 15 to 35,000 cps. Equalization provided for LP, RIAA, AES, and early 78's. Separate bass and treble controls. Low impedance cathode follower output circuit. All components were specially selected for their high quality. Includes many features which will eventually be desired. Shpg. Wt. 7 lbs.

MODEL WA-P2

$19.75

(with cabinet)





HEATHKIT ADVANCED-DESIGN 25-WATT HIGH FIDELITY AMPLIFIER KIT

Designed especially to satisfy critical audio requirements, the W-5M incorporates the extra features needed to compliment the finest in program sources and speaker systems. Faithful sound reproduction is assured with a frequency response of ±1 db from 5 to 160,000 cps at 1 watt, and harmonic distortion is less than 1% at 25 watts, with IM distortion less than 1% at 20 watts. Hum and noise are a full 99 db below rated output, assuring quiet, hum-free operation. Output taps are 4, 8 and 16 ohms. Exclusive Heathkit features include the "tweeter saver", and the "bas-bal" balancing circuit, requiring only a voltmeter for indication. Years of reliable service are guaranteed through the use of conservatively rated, high quality components. KT66 tubes and Peerless output transformer are typical. Shipped express only. Shpg. Wt. 31 lbs.

MODEL W-5: Consists of W-5M kit above plus model WA-P2 preamplifier. Express only. Shpg. Wt. 38 lbs. $79.50

MODEL W-5M
$59.75

HEATHKIT DUAL-CHASSIS 20-WATT HIGH FIDELITY AMPLIFIER KIT

The model W3-AM is a Williamson-type amplifier built on two separate chassis. The power supply is on one chassis, and the amplifier stages are on the other chassis. Using two separate chassis provides additional flexibility in installation. Features include the famous acrosound model TO-300 "ultralinear" output transformer and 5881 tubes for broad frequency response, low distortion, and low hum level. The result is exceptionally fine overall tone quality. Frequency response is ±1 db from 6 cps to 150 kc at 1 watt. Harmonic distortion is less than 1% and IM distortion is less than 1.3% at 20 watts. Hum and noise are 88 db below 20 watts. Designed to match the speaker system of your choice, with taps for 4, 8 or 16 ohms impedance A very popular high fidelity unit employing top quality components throughout. Shipped express only. Shpg. Wt. 29 lbs.

MODEL W-3A: Consists of W-3AM kit above plus model WA-P2 preamplifier. Express only. Shpg. Wt. 37 lbs. $69.50

MODEL W-3AM
$49.75

HEATHKIT SINGLE-CHASSIS 20-WATT HIGH FIDELITY AMPLIFIER KIT

The model W4-AM Williamson-type amplifier will amaze you with its outstanding performance. A true Williamson circuit, featuring extended frequency response, low distortion, and low hum levels, this amplifier can provide you with many hours of listening enjoyment with only a minimum investment compared to other units on the market. 5881 tubes and a special Chicago-standard output transformer are employed to give you full fidelity at minimum cost. Frequency response extending from 10 cps to 100 kc within ±1 db at 1 watt assures you of full coverage of the audio range, and clean clear sound amplification takes place in circuits that hold harmonic distortion at 1.5% and IM distortion below 2.7% at full 20 watt output. Hum and noise are 95 db below full output. Taps on the output transformer are at 4, 8 or 16 ohms. Shipped express only. Shpg. Wt. 28 lbs.

MODEL W-4A: Consists of W-4AM kit above, plus model WA-P2 preamplifier. Express only. Shpg. Wt. 35 lbs. $59.50.

MODEL W4-AM
$39.75

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HEATHKIT GENERAL-PURPOSE 20-WATT HIGH FIDELITY AMPLIFIER KIT

The model A-9C will provide you with high quality sound at low cost. Features a built-in preamplifier with four separate inputs, and individual volume, bass and treble controls. Frequency response covers 20 to 20,000 cps within ±1 db. Total harmonic distortion is less than 1% at 3 db below rated output. Push-pull 6L6 tubes are used, with output transformer tapped at 4, 8, 16 and 500 ohms. A true hi-fi unit using high-quality components throughout, including heavy-duty "potted" transformers. Shpg. Wt. 23 lbs.

MODEL A-9C
$35.50

HEATHKIT "BASIC RANGE" HI-FI SPEAKER SYSTEM KIT

The extremely popular Heathkit model SS-1 Speaker System provides amazing high fidelity performance for its size. Features two high-quality Jensen speakers, an 8" mid-range woofer and compression-type tweeter with flared horn. Covers from 50 to 12,000 CPS within ±5 db, in a special-design ducted-port, bass reflex enclosure. Impedance is 16 ohms. Cabinet measures 11½" H x 23" W x 11¾" D. Constructed of veneer-surfaced plywood, ½" thick, suitable for light or dark finish. All wood parts are precut and predrilled for easy, quick assembly. Shpg. Wt. 30 lbs.

MODEL SS-1
$39.95

HEATHKIT "RANGE EXTENDING" HI-FI SPEAKER SYSTEM KIT

Extends the range of the SS-1 to ±5 db from 35 to 16,000 CPS. Uses 15" woofer and super-tweeter both by Jersen. Kit includes crossover circuit. Impedance is 16 ohms and power rating is 35 watts. Measures 29" H x 23" W x 17½" D. Constructed of veneer-surfaced plywood ¾" thick. Easy to build! Shpg. Wt. 80 lbs.

MODEL SS-1B
$99.95

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let you save up to ½ or more on all types of electronic equipment.

HEATHKIT SINE-SQUARE GENERATOR

The new AG-10 provides high quality, sine and square waves over a wide range, for countless applications. Some of these are; radio and TV repair work, checking scope performance, as a variable trigger source for telemetering and pulse work, and checking audio, video and hi-fi amplifier response. Frequency response is ±1.5 db from 20 CPS to 1 MC on both sine and square waves, with less than .25% sine wave distortion, 20 to 20,000 CPS. Sine wave output impedance 600 ohms, square wave output impedance 50 ohms, (except on 10v ranges). Square wave rise time less than .15 usec. Five-position band switch—continuously variable tuning—shielded oscillator circuit—separate step and variable output attenuators in ranges of 10, 1, and .1 volts for both sine and square wave, with extra range of .01 volt on sine wave. Both sine and square wave can be used at the same time without affecting either wave form. Power supply uses silicon-diode rectifiers. Shpg. Wt. 12 lbs.

MODEL AG-10
$49.95

HEATHKIT AUDIO ANALYZER KIT

The AA-1 is actually three instruments in one compact package. It combines the functions of an AC VTVM, an audio wattmeter, and an intermodulation analyzer. Input and output terminals are combined, and high and low frequency oscillators are built in. VTVM ranges are 0-.01, .03, .1, .3, 1, 3, 10, 30, 100 and 300 volts (RMS). Wattmeter ranges are .15 mw, 1.5 mw, 15 mw, 150 mw, 1.5 w, 15 w and 150 w. IM scales are 1%, 3%, 10%, 30% and 100%. Provides internal load resistors of 4, 8, 16 or 600 ohms. A tremendous dollar value. Shpg. Wt. 13 lbs.

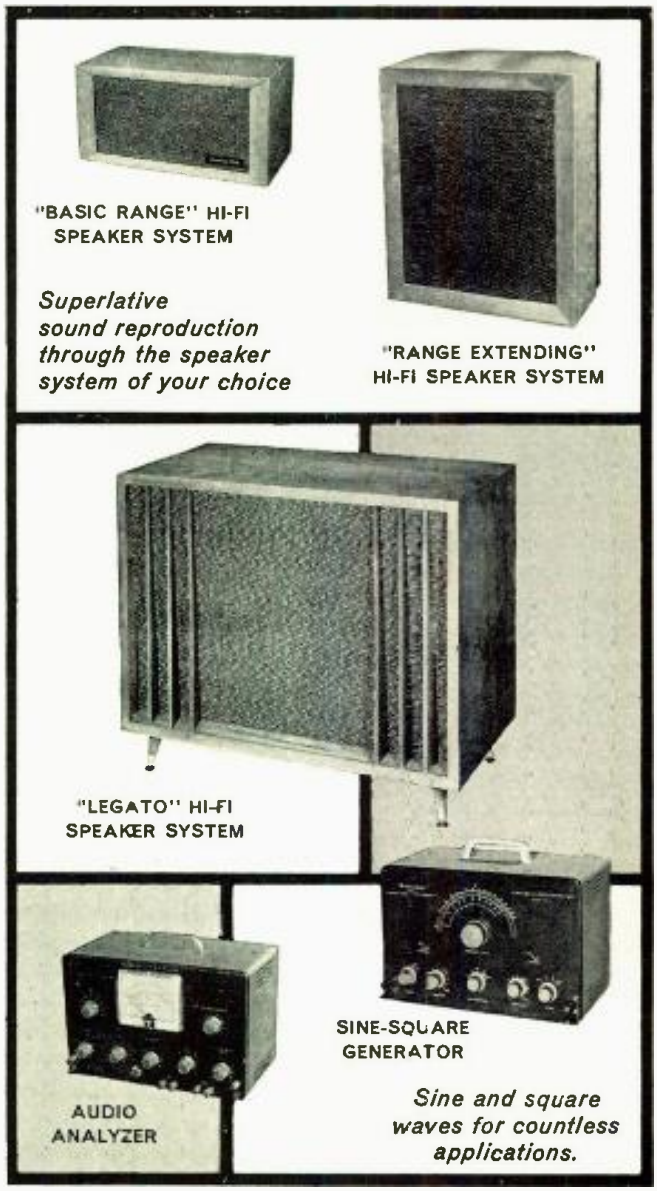
MODEL AA-1
$49.95

HEATHKIT "LEGATO" HIGH FIDELITY SPEAKER SYSTEM KIT

The quality of the Legato, in terms of the engineering that went into the initial design, and in terms of the materials used in its construction, is matched in only the most expensive speaker systems available today. The listening experience it provides approaches the ultimate in esthetic satisfaction. Two 15" theater-type Altec Lansing speakers cover 25 to 500 CPS, and an Altec Lansing high-frequency driver with sectoral horn covers 500 to 20,000 CPS. A precise amount of phase shift in the crossover network brings the high frequency channel into phase with the low frequency channel to eliminate peaks or valleys at the crossover point, by equalizing the acoustical centers of the speakers. The enclosure is a modified infinite baffle type, especially designed for these speakers. Cabinet is constructed of veneer-surfaced plywood, ¾" thick, precut and predrilled for easy assembly. Frequency response 25 to 20,000 CPS. Power rating, 50 watts program material. Impedance is 16 ohms. Cabinet dimensions 41" L x 22¼" D x 34" H.

Choice of two beautiful cabinets. Model HH-1-C in imported white birch for light finishes, and HH-1-CM in African mahogany for dark finishes. Shpg. Wt. 195 lbs.

MODEL HH-1-C
MODEL HH-1-CM
$325.00
EACH



HEATHKIT "GENERAL PURPOSE" 5" OSCILLOSCOPE KIT

The model OM-2 Oscilloscope is especially popular with part-time service technicians, students, and high fidelity enthusiasts. It features good vertical frequency response ±3 db from 4 cps to over 1.2 mc. A full five-inch crt. and sweep generator operation from 20 cps to over 150 kc. Stability is excellent and calibrated grid screen allows precise signal observation. Extra features include external or internal sweep and sync, 1-volt peak-to-peak calibrating reference, 3-position step-attenuated input, adjustable spot shape control, push-pull horizontal and vertical amplifiers, and modern etched-metal circuits. Easy to build and a pleasure to use. Ideal for use with other audio equipment for checking amplifiers. Shpg. Wt. 21 lbs.

MODEL OM-2

$42.50

HEATHKIT AUDIO WATTMETER KIT

The AW-1 Audio Wattmeter can be used in any application where audio power output is to be measured. Non-inductive LOAD resistors are built in for 4, 8, 16 or 600 ohms impedance. Five power ranges cover 0-5 mw, 50 mw, 500 mw, 5 w, and 50 w full scale. Five switch-selected db ranges cover −10 db to +30 db. All indications are read directly on a large 4½" 200 microampere meter. Frequency response is ±1 db from 10 cps to 250 kc. Precision type multiplier resistors used for high accuracy, and crystal diode bridge for wide-range frequency response. This meter is used in many recording studios and broadcast stations as a monitor as well as servicing. A fine meter to help supply the answers to your audio operating or power output problems. Shpg. Wt. 6 lbs.

MODEL AW-1

$29.50

HEATHKIT AUDIO SIGNAL GENERATOR KIT

The model AG-9A is "made to order" for high fidelity applications, and provides quick and accurate selection of low-distortion signals throughout the audio range. Three rotary switches select two significant figures and a multiplier to determine audio frequency. Incorporates step-type and a continuously variable output attenuator. Output indicated on large 4½" panel meter, calibrated in volts and db. Attenuator system operates in 10 db steps, corresponding to meter calibration, in ranges of 0-.003, .01, .03, .1, .3, 1,3 and 10 volts RMS. "Load" switch permits use of built-in 600-ohm load, or external load of different impedance. Output and frequency indicators accurate to within ±5%. Distortion less than .1 of 1% between 20 and 20,000 cps. Total range is 10 cps to 100 kc. Shpg. Wt. 8 lbs.

MODEL AG-9A

$34.50

HEATHKIT HARMONIC DISTORTION METER KIT

All sounds consist of dominant tones plus harmonics (overtones). These harmonics enrich the quality and brightness of the music. However, additional harmonics which originate in the audio equipment, represent distortion. Used with an audio signal generator, the HD-1 will accurately measure this harmonic distortion at any or all frequencies between 20 and 20,000 cps. Distortion is read directly on the panel meter in ranges of 0-1, 3, 10, 30 and 100% full scale. Voltage ranges of 0-1, 3, 10 and 30 volts are provided for the initial reference settings. Signal-to-noise ratio measurements are also permitted through the use of a separate meter scale calibrated in db. High quality components insure years of outstanding performance. Full instructions are provided. Shpg. Wt. 13 lbs.

MODEL HD-1

$49.50

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are well known for their high quality and reliability.

HEATHKIT AUDIO VTVM KIT

This new and improved AC Vacuum Tube Voltmeter is designed especially for audio measurements and low-level AC measurements in power supply filters, etc. Employs an entirely new circuit featuring a cascode amplifier with cathode-follower isolation between the input and the amplifier, and between the output stage and the preceding stages. It emphasizes stability, broad frequency response, and sensitivity. Frequency response is essentially flat from 10 cps to 200 kc. Input impedance is 1 megohm at 1000 cps. AC (RMS) voltage ranges are 0-.01, .03, .1, .3, 1, 3, 10, 30, 100 and 300 volts. Db ranges cover −52 db to +52 db. Features large 4½" 200 microampere meter, with increased damping in meter circuit for stability in low frequency tests. 1% precision resistors employed for maximum accuracy. Stable, reliable performance in all applications. Shpg. Wt. 5 lbs.

MODEL AV-3

$29.95

HEATHKIT COLOR BAR AND DOT GENERATOR

The CD-1 combines the two basic color service instruments, a Color Bar Generator and White Dot Generator in one versatile portable unit, which has crystal-controlled accuracy and stability (no external sync lead required). Produces white-dots, cross hatch, horizontal and vertical bars, 10 vertical color bars, and a new shading bar pattern for screen and background adjustments. Variable RF output on any channel from 2 to 6. Positive or negative video output, variable from 0 to 10 volts peak-to-peak. Crystal controlled sound carrier with off-on switch. Voltage regulated power supply using long-life silicon rectifiers. Gain knowledge of a new and profitable field by constructing this kit. Shpg. Wt. 12 lbs.

MODEL CD-1
$59.95

Heathkits...

By DAYSTROM

are guaranteed to meet or exceed advertised specifications

HEATHKIT TV ALIGNMENT GENERATOR KIT

This fine TV alignment generator offers stability and flexibility difficult to obtain even in instruments costing several times this low Heathkit price. It covers 3.6 mc to 220 mc in four bands. Sweep deviation is controllable from 0 to 42 mc. The all-electronic sweep circuit insures stability. Crystal marker and variable marker oscillators are built in. Crystal (included with kit) provides output at 4.5 mc and multiples thereof. Variable marker provides output from 19 to 60 mc on fundamentals and from 57 to 180 mc on harmonics. Effective two-way blanking to eliminate return trace. Phasing control. Kit is complete, including three output cables. Shpg. Wt. 16 lbs.

MODEL TS-4A
$49.50

HEATHKIT "EXTRA DUTY" 5" OSCILLOSCOPE KIT

This fine oscilloscope compares favorably to other scopes costing twice its price. It contains the extra performance so necessary for monochrome and color-TV servicing. Features push-pull horizontal and vertical output amplifiers, a 5UP1 CRT, built in peak-to-peak calibration source, a fully compensated 3-position step-type input attenuator, retrace blanking, phasing control, and provision for Z-axis modulation. Vertical amplifier frequency response is within +1.5 and −5 db from 3 CPS to 5 MC. Response at 3.58 MC down only 2.2 db. Sensitivity is 0.025 volts RMS/inch at 1 kc. Sweep generator covers 20 CPS to 500 kc in five steps, five times the usual sweep obtained in other scopes through the use of the patented Heath sweep circuit. Etched-metal circuit boards reduce assembly time and minimize errors in assembly, and more importantly, permit a level of circuit stability never before achieved in an oscilloscope of this type. Shpg. Wt. 21 lbs.

MODEL O-11
$69.50

HEATHKIT ELECTRONIC SWITCH KIT

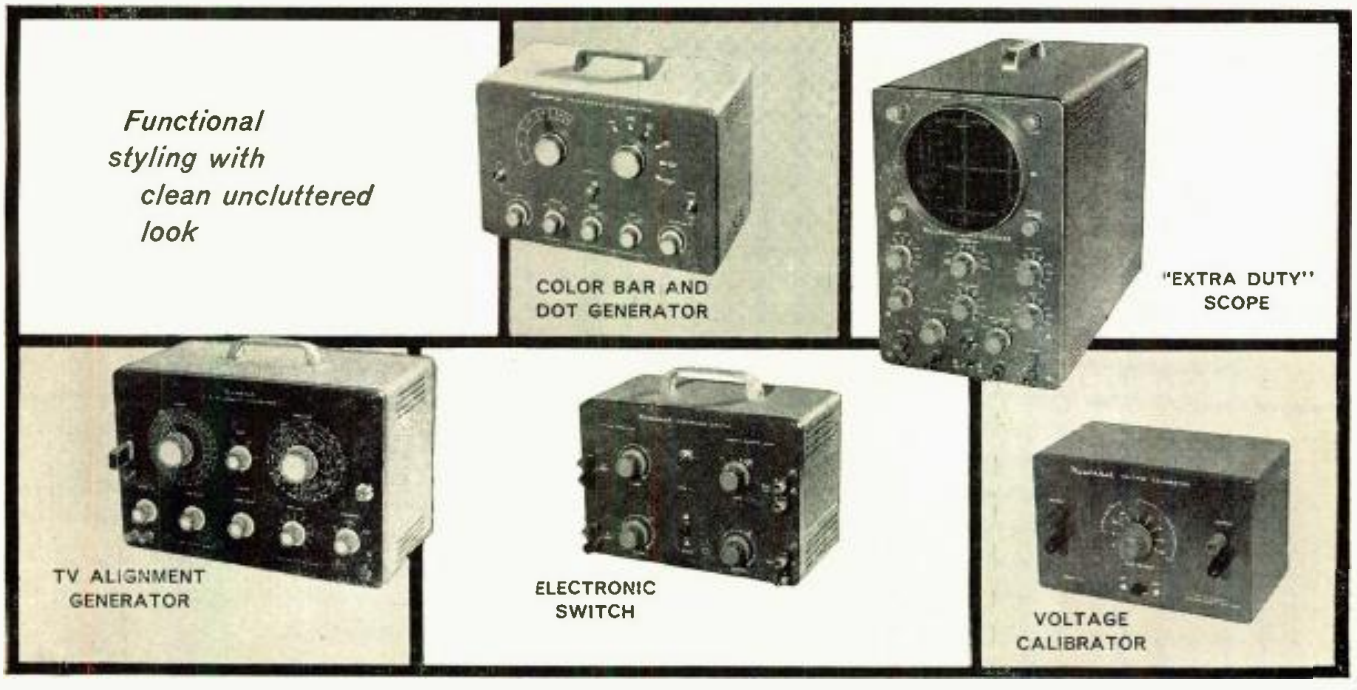
A valuable accessory for any oscilloscope owner. It allows simultaneous oscilloscope observation of two signals by producing both signals, alternately, at its output. Four switching rates. Provides gain for input signals. Frequency response ±1 db, 0 to 100 kc. A sync output is provided to control and stabilize scope sweep. Ideal for observing input and output of amplifiers simultaneously. Shpg. Wt. 8 lbs.

MODEL S-3
$21.95

HEATHKIT VOLTAGE CALIBRATOR KIT

This unit is an excellent companion for your oscilloscope. Used as a source of calibrating voltage, it produces near-perfect square wave signals of known amplitude. Precision 1% attenuator resistors insure accurate output amplitude, and multivibrator circuit guarantees good sharp square waves. Output frequency is approximately 1000 CPS. Fixed outputs selected by panel switches are; .03, 0.1, 0.3, 1.0, 3.0, 10, 30 and 100 volts peak-to-peak. Allows measurment of unknown signal amplitude by comparing it to the known output of the VC-3 on oscilloscope. Shpg. Wt. 4 lbs.

MODEL VC-3
$12.50



HEATH COMPANY *A Subsidiary of Daystrom, Inc.* **BENTON HARBOR 15, MICH.**

HEATHKIT TUBE CHECKER KIT

Eliminate guesswork, and save time in servicing or experimenting. The TC-2 tests tubes for shorted elements, open elements, filament continuity, and operating quality on the basis of total emission. It tests all tube types encountered in radio and TV service work. Sockets are provided for 4, 5, 6 and 7-pin, octal, and loctal tubes, 7 and 9 pin miniature tubes, 5 pin hytron miniatures, and pilot lamps. Tube condition indicated on 4½" meter with multicolor "good-bad" scale. Illuminated roll chart with all test data built in. Switch selection of 14 different filament voltages from .75 to 117 volts. Color-coded cable harness allows neat professional wiring and simplifies construction. Very easy to build, even for a beginner. Shpg. Wt. 12 lbs.

MODEL TC-2

$29.50

HEATHKIT HANDITESTER KIT

The small size and rugged construction of this tester makes it perfect for any portable application. The combination function-range switch simplifies operations. Measures AC or DC voltage at 0-10, 30, 300, 1000 and 5000 volts. Direct current ranges are 0-10 ma and 0-100 ma. Ohmmeter ranges are 0-3000 (30 ohm center scale) and 0-300,000 (3000 ohm center scale). Very popular with home experimenters, electricians, and appliance repairmen. Slips easily into your tool box, glove compartment, coat pocket, or desk drawer. Shpg. Wt. 3 lbs.

MODEL M-1

$14.50

HEATHKIT PICTURE TUBE CHECKER KIT

The CC-1 can be taken with you on service calls so that you can clearly demonstrate the quality of a customer's picture tube in his own home. Tubes can be tested without removing them from the receiver or cartons if desired. Checks cathode emission, beam current, shorted elements, and leakage between elements in electromagnetic picture tube types. Self-contained power supply, and large 4½" meter. CRT condition indicated on "good-bad" scale. Relative condition of tubes fluorescent coating is shown in "shadowgraph" test. Permanent test cable with CRT socket and anode connector. No tubes to burn out, designed to last a lifetime. Luggage-type portable case. Shpg. Wt. 10 lbs.

MODEL CC-1

$22.50

HEATHKIT ETCHED-CIRCUIT VTVM KIT

This multi-purpose VTVM is the world's largest selling instrument of its type—and is especially popular in laboratories, service shops, home workshops and schools. It employs a large 4½" panel meter, precision 1% resistors, etched metal circuit board, and many other "extras" to insure top quality and top performance. It's easy to build, and you may rely on its accuracy and dependability. The V7-A will measure AC (RMS) and DC voltages in ranges of 0-1.5, 5, 15, 50, 150, 500 and 1500. It measures peak-to-peak AC voltage in ranges of 0-4, 14, 40, 140, 400, 1400 and 4000. Resistance ranges provide multiplying factors of X 1, X 10, X 100, X 1000, X 10k, X 100k, and X 1 megohm. Center-scale resistance readings are 10, 100, 1000, 10k, 100k, 1 megohm and 10 megohms. A db scale is also provided. The precision and quality of this VTVM cannot be duplicated at this price. Shpg. Wt. 7 lbs.

MODEL V7-A

$24.50

Heathkits...

By DAYSTROM

let you fill your exact needs from a wide variety of instruments

HEATHKIT 20,000 OHMS/VOLT VOM KIT

This fine instrument provides a total of 25 meter ranges on its two-color scale. It employs a 50 ua 4½" meter, and features 1% precision multiplier resistors. Requires no external power. Ideal for portable applications. Sensitivity is 20,000 ohms-per-volt DC and 5000 ohms-per-volt AC. Measuring ranges are 0-1.5, 5, 50, 150, 500, 1500 and 5000 volts, AC and DC. Measures direct current in ranges of 0-150 ua, 15 ma, 150 ma, 500 ma and 15 a. Resistance multipliers are X 1, X 100 and X 10,000, with center-scale readings of 15, 1500 and 150,000 ohms. Covers −10 db to +65 db. Easy to build and fun to use. Attractive bakelite case with plastic carrying handle. Shpg. Wt. 6 lbs.

MODEL MM-1

$29.50

HEATHKIT RF SIGNAL GENERATOR KIT

Even a beginner can build this prealigned signal generator, designed especially for use in service work. Produces RF signals from 160 kc to 110 mc on fundamentals in five bands. Covers 110 mc to 220 mc on calibrated harmonics. Low impedance RF output in excess of 100,000 microvolts, is controllable with a step-type and continuously variable attenuator. Selection of unmodulated RF, modulated RF, or audio at 400 CPS. Ideal for fast and easy alignment of radio receivers, and finds application in FM and TV work as well. Thousands of these units are in use in service shops all over the country. Easy to build and a real time saver, even for the part-time service technician or hobbyist. Shpg. Wt. 8 lbs.

MODEL SG-8

$19.50

HEATHKIT LABORATORY RF GENERATOR KIT

Tackle all kinds of laboratory alignment jobs with confidence by employing the LG-1. It features voltage-regulated B+, double shielding of oscillator circuits, copper-plated chassis, variable modulation level, metered output, and many other "extras" for critical alignment work. Generates RF signals from 100 kc to 30 mc on fundamentals in five bands. Meter reads RF output in microvolts or modulation level in percentage. RF output available up to 100,000 microvolts, controlled by a fixed-step and a variable attenuator. Provision for external modulation where necessary. Buy and use this high-quality RF signal generator that may be depended upon for stability and accuracy. Shpg. Wt. 16 lbs.

MODEL LG-1

$48.95

HEATHKIT DIRECT-READING CAPACITY METER KIT

Here's a fast, simple capacity meter. A capacitor to be checked is merely connected to the terminals, the proper range selected, and the value read directly on the large 4½" panel meter calibrated in mmf and mfd. Ranges are 0 to 100 mmf, 1,000 mmf, .01 mfd, .1 mfd full scale. Not affected by hand capacity. Shpg. Wt. 7 lbs.

MODEL CM-1

$29.50

Heathkits...

By DAYSTROM

are educational
as well as functional

HEATHKIT "IN-CIRCUIT" CAPACI-TESTER KIT

With the CT-1 it is no longer necessary to disconnect one capacitor lead to check the part, you can check most capacitors for "open" or "short" right in the circuit. Fast and easy—to save your valuable time in the service shop or lab. Detects open capacitors from about 50 mmf up, so long as the capacitor is not shunted by excessively low resistance value. Will detect shorted capacitors up to 20 mfd (not shunted by less than 10 ohms). (Does not detect leakage.) Employs 60 cycles and 19 megacycle test frequencies. Electron beam "eye" tube used as indicator. Compact, easy-to-build, and inexpensive. Test leads included. Shpg. Wt. 5 lbs.

MODEL CT-1

$7.95

HEATHKIT CONDENSER CHECKER KIT

This handy instrument uses an electron beam "eye" tube as an indicator to measure capacity in ranges of .00001 to .005 mfd, .5 mfd, 50 mfd and 1000 mfd. Also measures resistance from 100 ohms to 5 megohms in two ranges. Checks paper, mica, ceramic and electrolytic capacitors. Selection of five polarizing voltages. Shpg. Wt. 7 lbs.

MODEL C-3

$19.50

HEATHKIT VISUAL-AURAL SIGNAL TRACER KIT

Although designed originally for radio receiver work, the T-3 finds application in FM and TV servicing as well. Features high-gain channel with demodulator probe, and low-gain channel with audio probe. Traces signals in all sections of radio receivers and in many sections of FM and TV receivers. Built-in speaker and electron beam eye tube indicate relative gain, etc. Also features built-in noise locator circuit. Provision for patching speaker and/or output transformer to external set. Shpg. Wt. 9 lbs.

MODEL T-3

$23.50

HEATH COMPANY *A Subsidiary of Daystrom, Inc.* **BENTON HARBOR 15, MICH.**

HEATHKIT IMPEDANCE BRIDGE KIT

The model IB-2A employs a Wheatstone Bridge, a Capacity Comparison Bridge, a Maxwell Bridge, and a Hay Bridge in one compact package. Measures resistance from 0.1 ohm to 10 megohms, capacitance from 100 mmf to 100 mfd, inductance from 0.1 mh to 100 h, dissipation factor (D) from 0.002 to 1, and storage factor (Q) from 0.1 to 1000. A 100-0-100 ua meter provides for null indications The decade resistors employed are of 1% tolerance for maximum accuracy. Completely self-contained. Has built in power supply, 1000-cycle generator, and vacuum-tube detector. Special two-section CRL dial insures convenient operation. Instruction manual has entirely new schematic that clarifies circuit functions in various switch positions. A true laboratory instrument, that will provide you with many years of fine performance. Shpg. Wt. 12 lbs.

MODEL IB-2A

$59.50

HEATHKIT "LOW RIPPLE" BATTERY ELIMINATOR KIT

This modern battery eliminator incorporates an extra low-ripple filter circuit so that it can be used to power all the newest transistor-type circuits requiring 0 to 12 volts DC, and the new "hybrid" automobile radios using both transistors and vacuum tubes. Its DC output, at either 6 or 12 volts, contains less than .3% AC ripple. Separate output terminals are provided for low-ripple or normal filtering. Supplies up to 15 amps on 6 volt range or up to 7 amps on 12 volt range. Output is variable from 0 to 8 or 0 to 16 volts. Two meters constantly monitor output voltage and current. Will also double as a battery charger. Shpg. Wt. 23 lbs.

MODEL BE-5

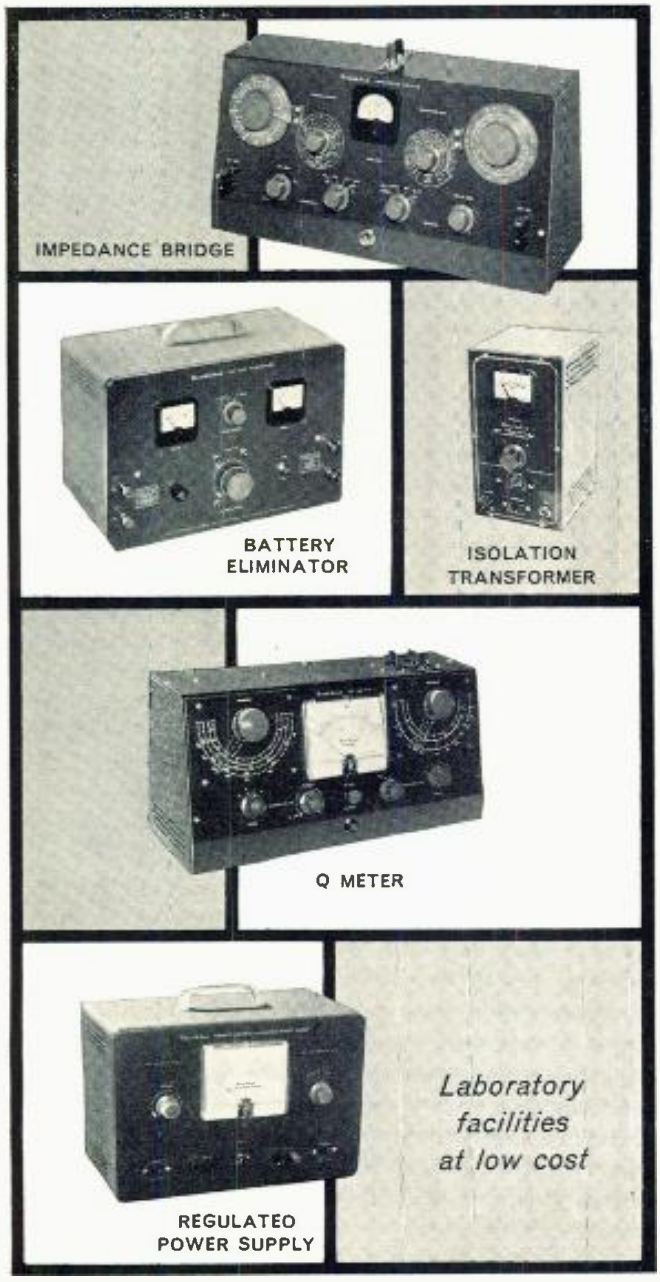
$39.95

HEATHKIT ISOLATION TRANSFORMER KIT

The model IT-1 is one of the handiest units for the service shop, home workshop or laboratory. Provides complete isolation from the power line. AC-DC sets may be plugged directly into the IT-1 without the chassis becoming "hot". Output voltage is variable from 90 volts to 130 volts allowing checks of equipment under adverse conditions such as low line voltage. Rated for 100 volt amperes continuously or 200 volt amperes intermittently. Panel meter monitors output voltage. Shpg. Wt. 9 lbs.

MODEL IT-1

$16.50



Heathkits...

By DAYSTROM

are designed with high-quality, name-brand components to insure long service life

HEATHKIT "Q" METER KIT

At this price the laboratory facilities of a Q Meter may be had by the average service technician or home experimenter. The Q Meter permits measurement of inductance from 1 microhenry to 10 milihenry, "Q" on a scale calibrated up to 250 full scale, with multipliers of 1 or 2, and capacitance from 40 mmf to 450 mmf ± 3 mmf. Built in oscillator permits testing components from 150 kc to 18 mc. Large 4½" panel meter is featured. Very handy for checking peaking coils, chokes, etc. Use to determine values of unknown condensers, both variable and fixed, compile data for coil winding purposes, or measure RF resistance. Also checks distributed capacity and Q of coils. No special equipment is required for calibration. A special test coil is furnished, along with easy-to-follow instructions. Shpg. Wt. 14 lbs.

MODEL QM-1

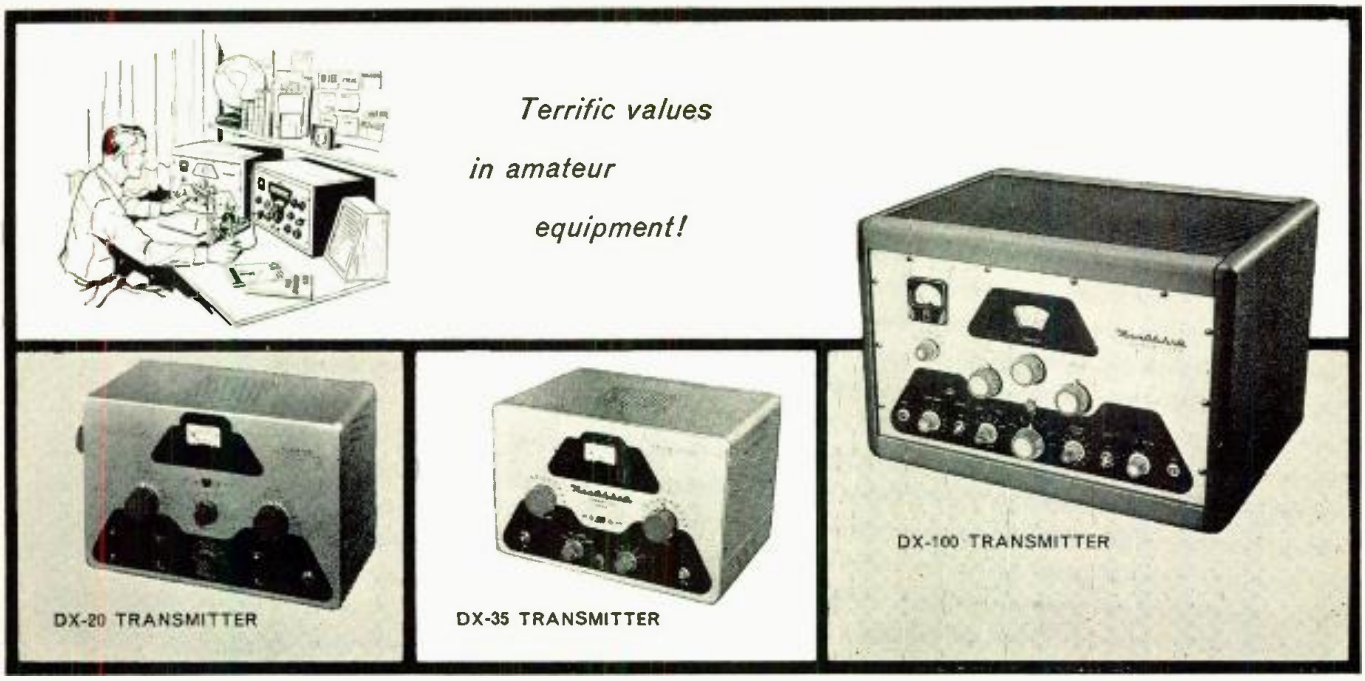
$44.50

HEATHKIT REGULATED POWER SUPPLY KIT

Here is a power supply that will provide DC plate voltage and AC filament voltage for all kinds of experimental circuits. The DC supply is regulated for stability, and yet the amount of DC output voltage available from the power supply can be controlled manually from 0 up to 500 volts. At 450 volts DC output, the power supply will provide up to 10 ma of current, and provide progressively higher current as the output voltage is lowered. Current rating is 130 ma at 200 volts output. In addition to furnishing B+ the power supply also provides 6.3 volts AC at up to 4 amperes for filaments. Both the B+ output and the filament output are isolated from ground. Ideal unit for use in laboratory, home workshop, ham shack, or service shop. A large 4½" meter on the front panel reads output voltage or output current, selectable with a panel switch. Shpg. Wt. 17 lbs.

MODEL PS-3

$35.50



HEATHKIT DX-20 CW TRANSMITTER KIT

The Heathkit model DX-20 "straight-CW" transmitter features high efficiency at low cost. It uses a single 6DQ6A tube in the final amplifier stage for plate power input of 50 watts. A 6CL6 serves as crystal oscillator, with a 5U4GB rectifier. It is an ideal transmitter for the novice, as well as the advanced-class CW operator. Single-knob band switching is featured to cover 80, 40, 20, 15, 11 and 10 meters. Pi network output circuit matches various antenna impedances between 50 and 1000 ohms and reduces harmonic output. Top-quality parts are featured throughout, including "potted" transformers, etc., for long life. It has been given full "TVI" treatment. Access into the cabinet for crystal changing is provided by a removable metal pull-out plug on the left end of the cabinet. Very easy to build from the complete step-by-step instructions supplied, even if you have never built electronic equipment before. If you appreciate a good, clean signal on the CW bands, this is the transmitter for you! Shpg. Wt. 18 lbs.

MODEL DX-20
$35.95

Heathkits...

By DAYSTROM

are designed by licensed ham-engineers, especially for you

HEATHKIT DX-35 PHONE AND CW TRANSMITTER KIT

The DX-35 transmitter can be thought of as the "little brother" of the DX-100. It features both phone and CW operation on 80, 40, 20, 15, 11 and 10 meters. A single 6146 tube is used in the final amplifier stage to provide full 65 watt plate power input on CW, or controlled carrier modulation peaks up to 50 watts for phone operation. Modulator and power supplies are built right in and single knob band switching is combined with a pi network output circuit for complete operating convenience. The tight fitting cabinet presents a most attractive appearance, and is designed for complete shielding to minimize TVI. Back panel control provides convenient switch selection of three different crystals, reached through access door at rear of cabinet. A most remarkable power package for the price. Complete step-by-step instructions with pictorial diagrams to assure your success in assembly. Shpg. Wt. 24 lbs.

MODEL DX-35
$56.95

HEATHKIT DX-100 PHONE AND CW TRANSMITTER KIT

Listen to any ham band between 160 meters and 10 meters and note how many DX-100 transmitters you hear! The number of these fine rigs now on the air testifies to the enthusiasm with which it has been accepted by the amateur fraternity. No other transmitter in this power class combines high quality and real economy so effectively. The DX-100 features a built in VFO, modulator and power supplies, complete shielding to minimize TVI, and pi network output coupling to match impedances from approximately 50 to 600 ohms. Its RF output is in excess of 100 watts on phone and 120 watts on CW, for a clean strong signal on all the ham bands from 10 to 160 meters. Single-knob band switching and illuminated VFO dial and meter face add real operating convenience. RF output stage uses a pair of 6146 tubes in parallel, modulated by a pair of 1625's. High quality components are used throughout, such as "potted" transformers, silver-plated or solid coin silver switch terminals, aluminum heat-dissipating caps on the final tubes, copper plated chassis, etc. This transmitter was designed exclusively for easy step-by-step assembly. Shpg. Wt. 107 lbs.

MODEL DX-100
$189.50

FUNCTIONAL DESIGN . . .

The transmitters described on this page were designed for the ham, by hams who know what features are desirable and needed. This assures you of the best possible performance and convenience, and adds much to your enjoyment in the ham shack.

HEATH COMPANY *A Subsidiary of Daystrom, Inc.* **BENTON HARBOR 15, MICH.**

Automatically turns off transmitter and gives visual signal

"AUTOMATIC" CONELRAD ALARM

GRID DIP METER

"Q" MULTIPLIER

COMMUNICATIONS-TYPE RECEIVER

An ideal receiver for the beginning ham or short wave listener

HEATHKIT "AUTOMATIC" CONELRAD ALARM KIT

This conelrad alarm works with any radio receiver; AC-DC-transformer operated—or battery powered, so long as the receiver has AVC. Fully complies with FCC regulations for amateurs. When the monitored station goes off the air, the CA-1 automatically cuts the AC power to your transmitter, and lights a red indicator. A manual "reset" button reactivates the transmitter. Incorporates a heavy-duty six-ampere relay, a thyratron tube to activate the relay, and its own built-in power supply. A neon lamp shows that the alarm is working, by indicating the presence of B+ in the alarm circuit. Simple to install and connect. Your transmitter plugs into an AC receptacle on the CA-1, and a cable connects to the AVC circuit of a nearby receiver. A built-in sensitivity control allows adjustment to various AVC levels. Receiver volume control can be turned up or down, without affecting alarm operation. Build a Heathkit CA-1 in one evening and comply with FCC regulations now! Shpg. Wt. 4 lbs.

MODEL CA-1
$13.95

HEATHKIT "Q" MULTIPLIER KIT

The Heathkit Q Multiplier functions with any AM receiver having an IF frequency between 450 and 460 KC, that is not "AC-DC" type. It derives its power from the receiver, and needs only 6.3 volts AC at 300 ma (or 12 VAC at 150 ma) and 150 to 250 volts DC at 2 ma. Simple to connect with cable and plugs supplied. Adds additional selectivity for separating signals, or will reject one signal and eliminate heterodyne. A tremendous help on crowded phone and CW bands. Effective Q of 4000 for sharp "peak" or "null". Tunes any signal within IF band pass without changing the main receiver tuning dial. A convenient tuning knob on the front panel with vernier reduction between the tuning knob and the tuning capacitor gives added flexibility in operation. Uses a 12AX7 tube, and special high-Q shielded coils. Instructions for connecting to the receiver and operation are provided in the construction manual. A worthwhile addition to any communications, or broadcast receiver. It may also be used with a receiver which already has a crystal filter to obtain two simultaneous functions, such as peaking the desired signal with the crystal filter and nulling an adjacent signal with the Q Multiplier. Shpg. Wt. 3 lbs.

MODEL QF-1
$9.95

HEATHKIT GRID DIP METER KIT

A grid dip meter is basically an RF oscillator for determining the frequency of other oscillators, or of tuned circuits. Extremely useful in locating parasitics, neutralizing, identifying harmonics, coil winding, etc. Features continuous frequency coverage from 2 mc to 250 mc, with a complete set of prewound coils, and a 500 ua panel meter. Front panel has a sensitivity control for the meter, and a phone jack for listening to the "zero-beat." Will also double as an absorption-type wave meter. Shpg. Wt. 4 lbs.

MODEL GD-1B
$19.95

Low Frequency Coil Kit: Two extra plug-in coils to extend frequency coverage down to 350 kc. Shpg. Wt. 1 lb. No. 341-A. $3.00

HEATHKIT ALL-BAND COMMUNICATIONS-TYPE RECEIVER KIT

This communications-receiver covers 550 kc to 30 mc in four bands, and provides good sensitivity, selectivity, and fine image rejection. Ham bands are clearly marked on an illuminated dial scale. Features a transformer-type power supply—electrical band spread—antenna trimmer—headphone jack—automatic gain control and beat frequency oscillator. Accessory sockets are provided on the rear of the chassis for using the Heathkit model QF-1, Q Multiplier. Accessory socket is handy, also, for operating other devices that require plate and filament potentials. Will supply +250 VDC at 15 ma and 12.6 VAC at 300 ma. Ideal for the beginning ham or short wave listener. Shpg. Wt. 12 lbs.

MODEL AR-3
$29.95
(Less cabinet)

Cabinet: Fabric covered cabinet with aluminum panel as shown. Part no. 91-15A. Shpg. Wt. 5 lbs. $4.95.

Heathkits...

By DAYSTROM

are outstanding in performance and dollar value

HEATHKIT REFLECTED POWER METER KIT

The Heathkit reflected power meter, model AM-2, makes an excellent instrument for checking the match of the antenna transmission system, by measuring the forward and reflected power or standing wave ratio. The AM-2 is designed to handle a peak power of well over 1 kilowatt of energy and may be left in the antenna system feed line at all times. Band coverage is 160 meters through 2 meters. Input and output impedances for 50 or 75 ohm lines. No external power required for operation. Meter indicates percentage forward and reflected power, and standing wave ratio from 1:1 to 6:1. Another application for the AM-2 is matching impedances between exciters or R.F. sources and grounded grid amplifiers. Power losses between transmitter output and antenna tuner may be very easily computed by inserting the AM-2 in the line connecting the two. No insertion loss is introduced into the feeder system, due to the fact that the AM-2 is a portion of coaxial line in series with the feeder system and no internal connections are actually made to the line. Complete circuit description and operation instructions are provided in the manual. Cabinet size is 7-3/8" x 4-1/16" x 4-5/8". Can be conveniently located at operating position. Shpg. Wt. 3 lbs.

MODEL AM-2

$15.95

HEATHKIT VARIABLE FREQUENCY OSCILLATOR KIT

Enjoy the convenience and flexibility of VFO operation by obtaining the Heathkit model VF-1 Variable Frequency Oscillator. Covers 160-80-40-20-15-11 and 10 meters with three basic oscillator frequencies. Better than 10 volt average RF output on fundamentals. Plenty of output to drive most modern transmitters. It features voltage regulation for frequency stability. Dial is illuminated for easy reading. Vernier reduction is used between the main tuning knob and the tuning condenser. Requires a power source of only 250 volts DC at 15 to 20 miliamperes and 6.3 volts AC at 0.45 amperes. Extra features include copper-plated chassis, ceramic coil forms, extensive shielding, etc. High quality parts throughout. VFO operation allows you to move out from under interference and select a portion of the band you want to use without having to be tied down to only two or three frequencies through use of crystals. "Zero in" on the other fellow's signal and return his CQ on his own frequency! Crystals are not cheap, and it takes quite a number of them to give anything even approaching comprehensive coverage of all bands. Why hesitate? The model VF-1 with its low price and high quality will add more operating enjoyment to your ham activities. Shpg. Wt. 7 lbs.

MODEL VF-1

$19.50

Heathkits...

By DAYSTROM

are the answer for your electronics hobby.

HEATHKIT BALUN COIL KIT

The Heathkit Balun Coil Kit model B-1 is a convenient transmitter accessory, which has the capability of matching unbalanced coax lines, used on most modern transmitters, to balance lines of either 75 or 300 ohms impedance. Design of the bifilar wound balun coils will enable transmitters with unbalanced output to operate into balanced transmission line, such as used with dipoles, folded dipoles, or any balanced antenna system. The balun coil set can be used with transmitters and receivers without adjustment over the frequency range of 80 through 10 meters, and will easily handle power inputs up to 250 watts. Cabinet size is 9" square by 5" deep and it may be located any distance from the transmitter or from the antenna. Completely enclosed for outdoor installation. Shpg. Wt. 4 lbs.

MODEL B-1

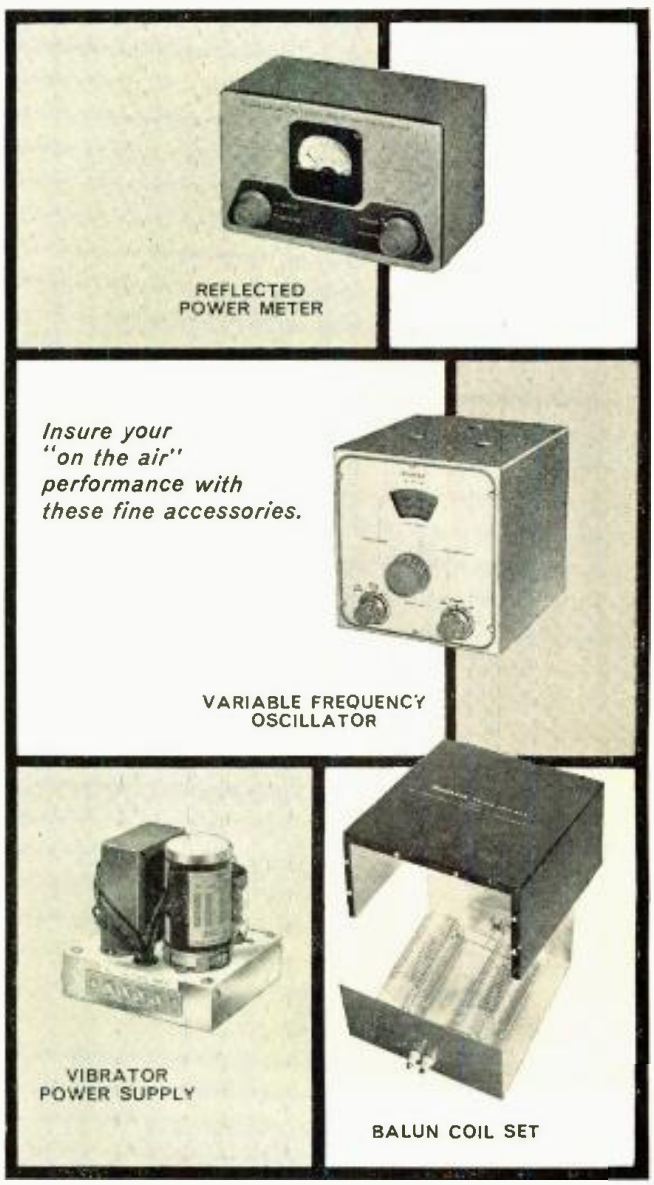
$8.95

HEATHKIT 6 OR 12 VOLT VIBRATOR POWER SUPPLY KITS

These little power supply kits are ideal for all portable applications with 6 volt or 12 volt batteries, when you are operating electronic equipment away from power lines. By replacing the power supplies of receivers, small public address systems, or even miniature transmitters with these units, they can be used with conventional 6 or 12 volt batteries. Use in boats, automobiles, light aircraft, or any field application. Each unit provides 260 volts DC output at up to 60 miliamperes. More than one power supply of the same model may be connected in parallel for increased current capacity at the same output voltage. Everything is provided in the kit, including a vibrator transformer, a vibrator, 6X4 or 12X4 rectifier, and the necessary buffer capacitor, hash filter, and output filter capacitor. Shpg. Wt. 4 lbs.

6 VOLT
MODEL VP-1-6
12 VOLT
MODEL VP-1-12

$7.95 Each



HEATH COMPANY *A Subsidiary of Daystrom, Inc.* **BENTON HARBOR 15, MICH.**

HEATHKIT ELECTRONIC IGNITION ANALYZER KIT

Previous electronic experience is not necessary to build this fine ignition analyzer. The construction manual supplied has complete step-by-step instructions plus large pictorial diagrams showing the exact placement and value of each component. All parts are clearly marked so that they are easily identified. The IA-1 is an ideal tool for engine mechanics, tune-up men, and auto hobbyists, since it traces the dynamic action of voltage in an ignition system on a cathode-ray tube screen. The wave form produced is affected by the condition of the coil, condenser, points, plugs, and ignition wiring, so it can be analyzed and used as a "sign-post" to ignition system performance. This analyzer will detect inequality of spark intensity, a poor spark plug, defective plug wiring, breaker-point bounce, an open condenser, and allow setting of dwell-time percentage for the points. An important feature of this instrument is its ability to check dynamic performance, with the engine in operation (400 to 5000 RPM). It will show the complete engine cycle, or only one complete cylinder. Can be used on all types of internal combustion engines where breaker-points are accessible. Use it on automobiles, boats, aircraft engines, etc. Shpg. Wt. 18 lbs.

MODEL IA-1
$59.95

HEATHKIT PROFESSIONAL RADIATION COUNTER KIT

This Heathkit professional-type radiation counter is simple to build successfully, even if you have never built a kit before. Complete step-by-step instructions are combined with giant-size pictorial diagrams for easy assembly. By "building it yourself" you can have a modern-design, professional radiation counter priced far below comparable units. Provides high sensitivity with ranges from 0-100, 600, 6000 and 60,000 counts-per-minute, and 0-.02, .1, 1 and 10 miliroentgens-per-hour. Employs 900-volt bismuth tube in beta/gamma sensitive probe. Probe and 8-foot expandable cable included in kit price, as is a radiation sample for calibration. Use it in medical laboratories, or as a prospecting tool, and for civil defense to detect radioactive fallout, or other unknown radiation levels. Features a selectable time constant. Meter calibrated in CPM or mR/hour in addition to "beep" or "click" from panel-mounted speaker. Prebuilt "packaged" high voltage power supply with reserve capacity above 900 volt level at which it is regulated. Merely changing regulator tube type would allow use of scintillation probe if desired. Employs five tubes (plus a transistor) to insure stable and reliable operation. Kit price includes batteries. Shpg. Wt. 8 lbs.

MODEL RC-1
$79.95

Heathkits...

By DAYSTROM

are supplied with comprehensive instructions that eliminate costly mistakes and save valuable time

HEATHKIT ENLARGER TIMER KIT

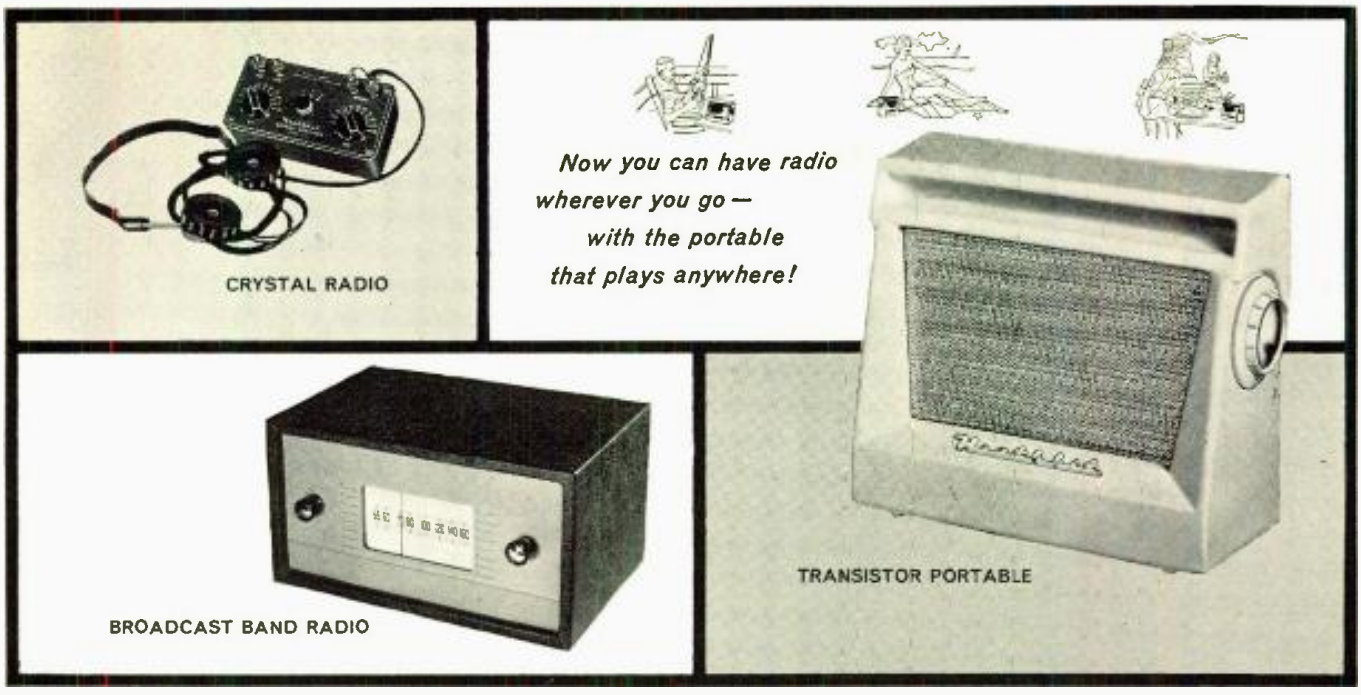
The ET-1 is an easy-to-build electronic device to be used by amateur or professional photographers in timing enlarger operations. The calibrated dial on the timer covers 0 to 1 minute, calibrated in 5-second gradations. The continuously variable control allows setting of the "on" cycle of your enlarger, which is plugged into a receptacle on the front panel of the ET-1. A "safe light" can also be plugged in so that it is automatically turned "on" when the enlarger is turned "off." Handles up to 350 watts with built-in relay. All-electronic timing cycle insures maximum accuracy. Timer does not have to be reset after each cycle, merely flip lever switch to print, to repeat time cycle. A control is provided for initial calibration. Housed in a compact plastic case that will resist attack of photographic chemicals. A fine addition to any dark room. Shpg. Wt. 3 lbs.

MODEL ET-1
$11.50

HEATHKIT BATTERY TESTER KIT

The BT-1 is a special battery testing device that actually "loads" the battery under test (draws current from it) while it is being tested. Weak batteries often test "good" with an ordinary voltmeter but the built-in load resistance of the BT-1 automatically draws enough current from the battery to reveal its true condition. Simple to operate with "good-weak-replace" scale. Tests all kinds of dry cell batteries within ranges of 0-15 volts and 0-180 volts. Slide switch provides for either 10 ma or 100 ma load, depending on whether you're testing an A or B battery. Not only determines when battery is completely exhausted, but makes it possible to anticipate failure by noting weak condition. Ideal for testing dry cell hearing aid, flashlight, portable radio, and model airplane batteries. Test batteries in a way your customers can understand and stimulate battery sales. Shpg. Wt. 2 lbs.

MODEL BT-1
$8.50



HEATHKIT CRYSTAL RADIO KIT

The Heathkit model CR-1 crystal radio is similar to the "crystal sets" of the early radio days except that it has been improved by the use of sealed germanium diodes and efficient "high-Q" coils. The sealed diodes eliminate the critical "cats whisker" adjustment, and the ferrite coils are much more efficient for greater signal strength. Housed in a compact plastic box, the CR-1 uses two tuned circuits, each with a variable tuning capacitor, to select the local station. It covers the broadcast band from 540 to 1600 kc. Requires no external power whatsoever. This receiver could prove valuable to emergency reception of civil defense signals should there be a power failure. The low kit price even includes headphones. Complete step-by-step instructions and large pictorial diagrams are supplied for easy assembly. The instruction manual also provides the builder with the basic fundamentals of signal reception so that he understands how the crystal receiver functions. An interesting and valuable "do-it-yourself" project for all ages. Shpg. Wt. 3 lbs.

MODEL CR-1
$7.95

Heathkits...

By DAYSTROM

are easy and fun to build, and they let you learn by "doing-it-yourself"

HEATHKIT TRANSISTOR PORTABLE RADIO KIT

Heath engineers set out to develop a "universal" AM radio, suitable for use anywhere. Their objective was a portable that would be as much "at home" inside as it is outside, and would feature top quality components for high performance and long service life. The model XR-1 is the result of these efforts. Six name-brand (Texas Instrument) transistors were selected for extra good sensitivity and selectivity. A 4" by 6" PM speaker with heavy magnet was chosen to insure fine tone quality. The power supply was designed to use six standard size "D" flashlight cells because they are readily available, inexpensive, and because they afford extremely long battery life (between 500 and 1000 hours). Costs you no more to operate from batteries than what you pay for operating a small table-model radio from the power line. An unbreakable molded plastic was selected for cabinet material because of its durability and striking beauty. Circuit is compact and efficient, yet components are not excessively crowded. Transformers are prealigned so it is ready for service as soon as construction is completed. Has built in rod-type antenna for reception in all locations. Cabinet dimensions are 9" L x 8" H x 3¾" D. Comes in holiday gray, with gold-anodized metal speaker grille. Compare this portable, feature by feature, to all others on the market, and you'll appreciate what a tremendous dollar value it represents! Shpg. Wt. 4 lbs.

MODEL XR-1
$34.95
(Less batteries)
(With cabinet)

HEATHKIT BROADCAST BAND RADIO KIT

This table-model broadcast radio is fun to build, and is a fine little receiver for your home. It covers the standard broadcast band from 550 to 1600 kc with good sensitivity and selectivity. The 5½" PM speaker provides surprisingly good tone quality. High-gain IF transformers, miniature tubes, and a rod-type built in antenna, assure good reception in all locations. The power supply is transformer operated, as opposed to many of the economy "AC-DC" types. It's easy to build from the step-by-step instructions, and the construction manual includes information on operational theory, for educational purposes. Your success is assured by completely detailed information which also explains resistor and capacitor color codes, soldering techniques, use of tools, etc. A signal generator is recommended for final alignment. Shpg. Wt. 10 lbs.

Cabinet: Fabric covered cabinet with aluminum panel as shown. Shpg. Wt. 5 lbs. Part no. 91-9A. $4.95.

MODEL BR-2
$18.95
(Less cabinet)

HEATH COMPANY *A Subsidiary of Daystrom, Inc.* **BENTON HARBOR 15, MICH.**

protects against possible explosion and fire from undetected fuel vapor

FUEL VAPOR DETECTOR

detects electrolysis currents which cause deterioration of underwater metal fittings on your boat

ELECTROLYSIS DETECTOR

indicates condition and charge of batteries for safe cruising

BATTERY CHARGE INDICATOR

R.F. POWER METER

HEATHKIT FUEL VAPOR DETECTOR KIT

Protect your boat and its passengers against fire or explosion from undetected fuel vapor by building and using one of these fine units. The Heathkit Fuel Vapor Detector indicates the presence of fumes on a three-color "safe-dangerous" meter scale and immediately shows if it is safe to start the engine. A pilot light on the front panel shows when the detector is operating, and it can be left on continuously, or just used intermittently. A panel control enables initial calibration of the detector when installed. Features a hermetically-sealed meter with chrome bezel, and a chrome-plated brass panel. It is very simple to build and install, even by one not having previous experience. Models FD-1-6 (6 volts DC) and FD-1-12 (12 volts DC) operate from your boat batteries. The kit is complete in every detail, even to the inclusion of a spare detector unit. Shpg. Wt. 4 lbs.

6 volt MODEL FD-1-6
12 volt MODEL FD-1-12
$35.95 EACH

HEATHKIT BATTERY CHARGE INDICATOR KIT

The Heathkit model CI-1 Marine Battery Charge Indicator has been designed especially for the boat owner, although it has found use in service stations, power stations, and radio stations where banks of batteries are kept in reserve for emergency power. It is intended to replace the hydrometer method of checking storage batteries, and to eliminate the necessity for working with acid in small, below-decks enclosures. Now it is possible to check as few as one, or as many as eight storage batteries, merely by turning the switch and watching the meter. A glance at the meter tells you instantly whether your batteries are sufficiently charged for safe cruising. Dimensions are 2-7/8"W x 5-11/16" H x 2" D. Operates on either 6 or 12 volt systems using lead-acid batteries, regardless of size. Simple installation can be accomplished by the boat owner in fifteen minutes. Shpg. Wt. 3 lbs.

MODEL CI-1
$16.95

HEATHKIT ELECTROLYSIS DETECTOR KIT

The Heathkit model ED-1 Electrolysis Detector indicates the extent of electrolysis currents between the boat's common ground and underwater fittings, except on boats having metal hulls. These currents, undetected, could cause gradual corrosion and deterioration of the propeller or other metal fittings below the water line. It is particularly helpful when installing electrical equipment of any kind, or to determine proper polarity when power is obtained from a shore supply. Easy-to-build, the model ED-1 consists of a hermetically-sealed, waterproof meter, special sensing plate, and sufficient wire to install, including the necessary hardware. Mounts on instrument panel where it can be easily seen. Requires no power for operation, and gives instant warning to guard your boat for a lifetime. Shpg. Wt. 2 lbs.

MODEL ED-1
$9.95

HEATHKIT RF POWER METER KIT

The Heathkit RF Power Meter Kit is designed to sample the RF field in the vicinity of your transmitter, whether it be marine, mobile, or fixed. Output meter is mere'y placed in some location close to the transmitter, to pick up RF radiation from the antenna. Requires no batteries, electricity, nor direct connection to the transmitter. It provides you with a continuing indication of transmitter operation. You can easily detect if power is dropping off by comparing present meter readings with past ones. Operates with any transmitter having output frequencies between 100 kc and 250 mc, regardless of power. Sensitivity is 0.3 volts RMS full scale, and a special control on the panel allows for further adjustment of the sensitivity. Meter is a 200 ua unit, mounted on a chrome-plated brass panel. The entire PM-1 measures only 3¾" W x 6¼" L x 2" D. An easy way to put your mind at ease concerning transmitter operation. Shpg. Wt. 2 lbs.

MODEL PM-1
$14.95

Heathkits...

By DAYSTROM

now offer you completely modern marine equipment with outstanding design features

HEATHKIT TRANSISTOR RADIO DIRECTION FINDER KIT

The Heathkit Transistor Radio Direction Finder model DF-1 is a self-contained, self-powered, 6-transistor super heterodyne broadcast radio receiver incorporating a directional loop antenna, indicating meter, and integral speaker. It is designed to serve primarily as an aid to navigation when out of sight of familiar landmarks. It can be used not only aboard yachts, fishing craft, tugs, and other vessels which navigate either out of sight of land or at night, but also for the hunter, hiker, camper, fisherman, aviator, etc. It is powered by a 9-volt battery. (A spare battery is also included with the kit). The frequency range covers the broadcast band from 540 to 1600 kc and will double as a portable radio. A directional high-Q ferrite antenna is incorporated which is rotated from the front panel to obtain a fix on a station and a 1 ma meter serves as the null and tuning indicator. The controls consist of: tuning, volume and power (on-off), sensitivity, heading indicator (compass rose) and bearing indicator (antenna index). Overall dimensions are 7½" W x 5⅞" H x 5⅜" D. Supplied with slip-in-place mounting brackets, which allow easy removal from ship bulkheads or other similar places. Shpg. Wt. 5 lbs.

MODEL DF-1

$49.95

(Available after November 15)

use it for a radio-compass or as a portable radio

TRANSISTOR RADIO DIRECTION FINDER

Heathkits...

By DAYSTROM

are sold only by direct mail, passing middleman profits on to you

Pioneer in "do-it-yourself" electronics

HOW CAN YOU MISS?

The Heath Company maintains a technical consultation service, should you experience some sort of difficulty in construction or operation. Although only a very small percentage of our customers ever have occasion to use this service (usually only beginners in electronics) it is still reassuring to know that technical help is available when needed. A service department is also available, should you wish a complete factory check of operation and alignment or repair. After you build your first Heathkit you'll realize how easy it is.

Free Catalog

Send for this informative booklet listing more than 100 "do-it-yourself" kits.

HEATH COMPANY *A Subsidiary of Daystrom, Inc.* **BENTON HARBOR 15, MICH.**

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Hi-Fi-Audio Product Review

STEREO-BINAURAL KITS

Arkay, 120 Cedar Street, New York, N. Y. has recently introduced a new stereo-binaural component line which is being offered in kit or wired form.

The line consists of the SA-25 25-watt stereo preamp-amplifier, the SP-6 dual-channel stereo preamp, and

the ST-11 stereo AM-FM tuner. The SA-25 features a dual-channel preamp which drives its own 25-watt linear Williamson amplifier in conjunction with any existing amplifier.

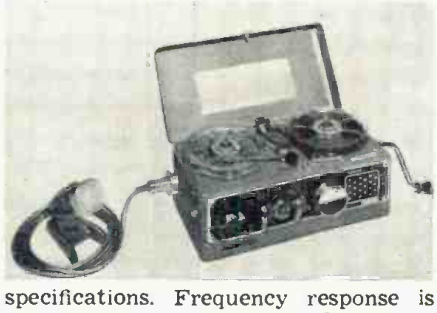
The SP-6 dual preamp has the same features as the Model SA-25, less the amplifier. The controls of both models include equalization for all records, tuner, NARTB tape heads, and auxiliary equipment. A two-position lo-cut and hi-fi filter enables the user to filter out undesirable frequencies at either end of the band. Frequency response of both models is 20-20,000 cps.

The ST-11 tuner offers the listener a choice of monaural or stereo operation. Plans are underway to offer a hi-fi stereo tape recorder in the near future.

BATTERY-OPERATED RECORDER

Electronic Applications, 50 East 35th St., New York, N. Y. is handling the U. S. distribution of a new Swiss-built battery-operated portable tape recorder, the "Nagra II CI."

The unit, which measures 12" x 6" x 4¾", is designed to record at standards conforming to broadcast and disc



specifications. Frequency response is guaranteed to be within ± 2 db from 50 to 10,000 cps. Signal-to-noise is better than 55 db on recording and better than 50 db on playback, both referred to total distortion under 3% over-all. At 7.5 ips, the unit will provide 15 minutes playing time on 5" reels and 22 minutes on 5" long-play tape.

The recorder is powered by two 67.5 volt and two 1.5 volt batteries. A spring motor powers the mechanism. A built-in speaker permits playback and monitoring operations.

Write the U. S. distributor for full specifications and prices.

TRIAD AUDIO TRANSFORMERS

Triad Transformer Corporation, 4055 Redwood Ave., Venice, Calif. has added four new units to its line of transformers for audio applications.

Two of the new units are output transformers, one is a line-to-grid input transformer, and the other a voice-coil-to-grid input type.

Complete specifications on these four units plus details on other transformers in the company's line are included in the firm's new general catalogue, TR-57, which is available from distributors or the manufacturer direct.

VARIABLE RELUCTANCE UNITS

The hi-fi component department of *General Electric Company,* Auburn, N. Y. has announced the availability

of a new line of seven moderately priced magnetic reluctance cartridges to be known as the "VR-II" series.

Providing a frequency response from 20 through 20,000 cps at a tracking pressure of four grams, these new cartridges have 33% less tracking pressure and 40% greater compliance than the company's RPX-type units.

The new units have a narrower body with a 27% weight reduction and a 10% lighter stylus. They also incorporate a new electrostatic shield. The shield is designed to eliminate electrostatic hum from such external electrical fields as fluorescent light fixtures and pops during playback from the buildup of electrostatic charges on the record.

The cartridges are being offered in four single-stylus types and three dual-stylus types, all with *G-E* "Clip-In-Tip" stylus assemblies. The styli

build with the best...

JBL signature loudspeakers!

The careful work you do in building your high fidelity sound system will be shown off to best advantage if you use precision-made JBL SIGNATURE Loudspeakers. These are the most efficient units to be found anywhere, made with the most exacting care, meticulous attention to detail. Remember, it takes no more effort on your part to build with the best.

MODEL D130
15" Extended Range Loudspeaker

The only 15" extended range speaker made with a 4" voice coil is the world-famous JBL Signature D130. The large voice coil stiffens the cone for crisp, clean bass; smooth, extended highs. Your basic speaker, the D130 works alone at first, later becomes a low frequency driver when you add a JBL Signature high frequency unit and dividing network to achieve the ultimate excellence of a JBL Signature two-way system.

MODEL D208
8" Extended Range Loudspeaker

A precision transducer in every sense of the word, the famed JBL Signature 8" D208 is made with the same care and precision as the larger units in the James B. Lansing Sound, Inc., line. If space and cost are major considerations, the D208, properly enclosed, provides the most lastingly satisfactory sound you can get. It is widely used in top quality systems where extension speakers are desired for areas other than the main listening room.

MODEL D123
12" Extended Range Loudspeaker

With outstanding "presence" and clear response throughout the entire audio spectrum, the D123 features an unusual shallow construction. Only 3½" deep, it is designed to mount flush with the wall between studding in any standard wall or partition. Frequently, the D123 is used in multiples in "infinite baffle" wall installations. In this case the JBL Signature 075 is a logical high frequency unit to add when you advance to a two-way system.

MODEL 075
High Frequency Unit

Another exclusive for James B. Lansing Sound, Inc., is the ring radiator in the JBL Signature 075 high frequency unit. A ring, rather than a diaphragm, radiates into the annular throat of an exponential horn. The result is high frequency reproduction of unmatched smoothness and clarity, absolutely free of resonances and strident peaks. The horn is beautifully machined from aluminum, the entire unit a gratifying, solid piece of fine craftsmanship. Designed for crossover at 2500 cycles with the JBL Signature N2500 Network.

MODEL 175DLH High Frequency Assembly

The acoustical lens is only available on JBL Signature high frequency units. The 14 element lens on the 175DLH disperses sound within the listening area over a 90° solid angle, smoothly, with equal intensity regardless of frequency. The acoustical lens is the greatest contribution to life-like high frequency reproduction in 20 years, and it was developed for use with high fidelity equipment by James B. Lansing Sound, Inc. In addition to the lens the 175DLH consists of a high precision driver with complex phasing plug and a machined aluminum exponential horn. Designed for crossover at 1200 cycles with the JBL Signature N1200 Network.

JBL Signature Two-way Systems Are Available As Kits

D8E KIT This two-way system is made up of units which have been acclaimed by impartial authorities as the finest available anywhere today. Included in the kit are the 150-4C Low Frequency Driver, N500H Network, 375 High Frequency Driver, 537-509 Horn-Lens Assembly. These are the same units—including the serpentine acoustical lens—which are used in The Hartsfield . . . units designed originally for installation in the most modern theaters in the world.

There are many more kits and loudspeakers in the JBL Signature line. Whatever your needs, you will find exactly the right unit or system in the complete JBL Signature catalog. Send for your free copy. A limited number of technical bulletins are also available. Please ask only for those in which you are vitally interested.

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James B. Lansing Sound, Inc.

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TECHNICAL BULLETINS ON:
☐ D130 ☐ D123 ☐ D208 ☐ 175DLH ☐ 075 ☐ 375 ☐ 150-4C

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City_____ Zone____ State_____

are diamond or sapphire, with some sapphires synthetic.

60-WATT AMPLIFIER

MusiCraft, 48 E. Oak Street, Chicago 11, Ill. is currently offering a basic power amplifier, the Model M-60, rated at 60 watts.

Frequency response of the new unit is ± .5 db from 20 to 20,000 cps and

± 1 db from 7 to 70,000 cps. The amplifier will handle 120 watt peaks. IM distortion is less than 1% at 60 watts measured with 60 and 7000 cps 4:1. Hum and noise level is 85 db below 60 watts output. There is a choice of damping factors of 15 or 30, selectable by means of a switch.

The unit comes completely assembled and tested. It is housed in a chrome plated chassis measuring 9" x 14" x 8".

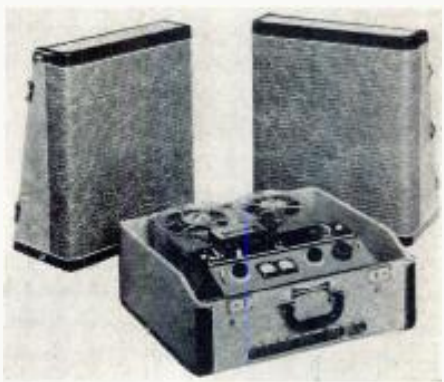
The output transformer is fully potted and varnish impregnated for moisture protection. Grain oriented laminations are used.

A data sheet on this special amplifier will be forwarded on request.

STEREOPHONIC RECORDER

The *Audio Electronics Division* of *Superscope, Inc.*, 780 Gower Street, Hollywood 38, Calif. is now offering a new stereo and monaural tape unit which records and plays back in both modes.

Known as the "Sterecorder," the new unit is housed in two carrying



cases. Available with the recording and playback unit are two separately enclosed *James B. Lansing* "Signature" twelve-inch speakers and two high-impedance dynamic microphones.

Although designed for professional use, the unit is simple to operate and practical for home or office applications. It features a hysteresis synchronous motor, two vu meters, cueing and editing facilities, and two self-

contained independent channels of pre-amplification and power amplification to insure precision recording and reproduction.

COLLARO CHANGERS FOR 1958

The Rockbar Corporation, 650 Halstead Ave., Mamaroneck, N. Y., U. S. sales representative for *Collaro, Ltd.,* has announced three new record changers for 1958, two of which incorporate a new transcription-type tone arm.

The tone arm feature is included in the Model TC-540 ("Continental") and Model TC-340 ("Conquest"). The third model, RC-440 ("Coronation") uses a standard plug-in arm and universal head shell which will accept all standard hi-fi cartridges.

The transcription-type tone arm is a one-piece, spring-damped, counter-balanced unit which will accept any standard high-fidelity cartridge. It is completely free from audio spectrum resonances.

All of the units incorporate four speeds and have four-pole shaded-pole

induction motors. All have manual switches and feature automatic shut-off after the last record is played.

LIGHTWEIGHT RECORDER

Telectrosonic Corporation, 35-16 37th St., Long Island City, N. Y. is now offering a new two-speed tape recorder with simple push-button speed change control that is easy to operate and compact and light enough for wide-range portability.

The Model 1960 measures 7¾" x 11" x 11⅝" and weighs less than 15 pounds. It is housed in a two-tone, luggage-type carrying case. At the 3.75 ips speed it will provide up to two hours of recording time. The 7.5 ips speed is designed for applications

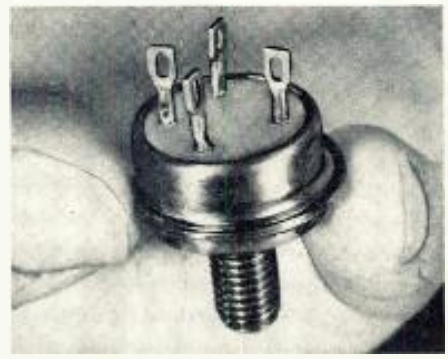
where greater fidelity is required. A single control for record and play makes the unit simple to operate. The

"on-off" knob serves as the volume control and for setting the proper recording level.

The recorder comes complete with a microphone, 1-hour reel of tape, and take-up reel. A patch cord for direct recording is available as an accessory.

POWER TETRODE TRANSISTOR

Minneapolis-Honeywell Regulator Company's Semiconductor Products



Division has unveiled a new power tetrode transistor which has been especially designed for applications in the audio field.

According to the company, the use of this new component in high-fidelity amplifiers will reduce the amount of circuitry required and lessen the chance of thermal runaway because of the inherent stability of the device. This new tetrode is designed to operate on a 28-volt system and can carry up to 10 amperes.

Limited quantities are currently available. Inquiries regarding deliveries and for information on specifications should be addressed to R. O. Anderson, transistor sales manager, in care of the division at 2753 Fourth Ave., S., Minneapolis 8, Minn.

"DYNAKIT" PREAMPLIFIER

Dyna Company, 617 North 41st St., Philadelphia 4, Pa. has incorporated several novel features in its new "Dynakit" preamplifier which has just been put on the market.

The unit which measures only 6" x 12" x 2⅝" includes a printed circuit board on which all components are premounted at the factory and dip-soldered, a built-in voltage-doubler

rectifier to supply d.c. for the filament circuits, a unitized switch assembly which contains 1% components for accurate record compensation, and similar unique features.

Utilizing a new type of all-feedback tone control with a true flat center setting plus wide control range of ± 20 db at 30 cps and ± 15 db at 15 kc., the tone control network in flat position offers no distortion on square waves over the range from 20 to 20,000 cps. Frequency response is ± .5 db, 60 to 60,000 cps, at any setting of the volume control.

Six inputs are furnished with one being an option of extra phono, tape head, or microphone. An A-B monitor switch will be of special interest to tape recordists.

The kit is offered in a choice of two colors. A solid brass escutcheon is furnished and an optional escutcheon can be obtained to simplify cabinet mounting of the unit. A complete brochure with performance and design information is available on request.

TAPE REPEATER

Soundcraft Inc., 3456 E. Jefferson Ave., Detroit 7, Mich. is now offering its new "Soundpac" tape repeater which utilizes the "Fidelipac" continuous-loop tape cartridge.

The new unit is designed to permit the user to record directly into the fully-enclosed endless-play tape cartridge. It is intended for p.a. merchandising, point-of-sale promotions, background music applications, educational

work, and home use. Tape cartridges may be as short as a few seconds and as long as two hours. Blank and various pre-recorded tapes are now available.

Three models of the new "Soundpac" are available. For full details write the manufacturer direct.

UNFINISHED HI-FI CABINETS

To meet the needs of audiophiles who want distinctive enclosures for their equipment yet prefer to finish them in custom colors, *Salmanson & Co., Inc.,* 1107 Broadway, New York 10, N. Y. has introduced three functional hi-fi cabinets for the do-it-yourself crowd.

Designed to house a record player, audio gear, and as many as 200 LP records in a sliding door cabinet, the units are of kiln-dried ponderosa pine. Panels are supplied to contain the record player and front-end audio components if desired. Optionally, the record storage compartment may be used to house a speaker system.

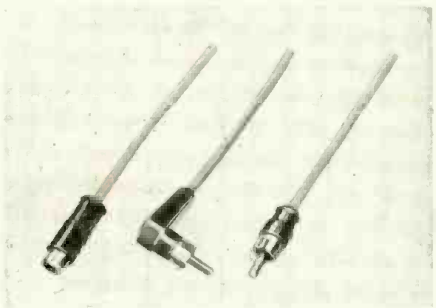
The units are shipped assembled, sanded smooth, ready for painting, staining, or varnishing. The three models now in the line include an "economy" version (No. 3001) which measures 16" x 35" x 24¾"; the "lift-top" model (No. 3002) which

measures 16" x 35" x 24¾" (both models have optional 5¼" legs); and the "deluxe" unit which sits on a solid base and measures 16" x 35" x 30". It is catalogued as the No. 3003.

A data sheet giving full specs on all models is available on request.

PHONO JACKS AND PLUGS

Switchcraft, Inc., 1328 N. Halsted St., Chicago 22, Ill. is now offering a new line of phono plugs and extension



jacks (with shielded handle) molded to cable. The plugs are available in both straight and right-angle types.

The new line will be available in standard cable assemblies of the type used in high-fidelity and audio equipment for interconnecting amplifiers, microphones, etc.

Full details on prices, specifications, and delivery are available from the manufacturer.

SYSTEMS FOR ELECTROSTATICS

KLH Research and Development Corporation, 30 Cross St., Cambridge 39, Mass. is now in production on three new loudspeaker systems covering the low and mid-frequency range and designed for use with the *Janszen* electrostatic tweeter.

Designated as Models One, Two, and Three, the new units feature low-frequency distortion through use of the acoustic suspension principle and an unusual degree of freedom from mid-range irregularities through use of specially designed and manufactured speaker cones.

NEW AMPEX STEREO UNITS

Ampex Audio Inc., 1020 Kifer Road, Sunnyvale, Calif. will have a full line of stereo units for the home on the

market this fall, including consoles, portables, and table models.

In the console versions the cabinets contain matched amplifier-speaker systems, a *Fisher* AM-FM tuner, a *Garrard* 4-speed record changer, tape recorder-stereo reproducer, and microphone for recording off-the-air or from other sound sources.

The portable and table models are housed in three separate cases, one containing the tape mechanism and the other two the amplifier-speaker systems. Both wood and luggage-type cases are offered in these models.

For full details on this new line, including information on the styles and cabinet finishes, write the manufacturer direct.

TUBES FOR FM TUNERS

The Electron Tube Division of *Radio Corporation of America,* Harrison, N. J. has introduced two new general-purpose high-mu twin triodes designed to be used as r.f. amplifiers and combined oscillator-mixers in FM tuners.

Designated as the 6DT8 and 12DT8, the triodes are identical except for their heater voltage and current. The two units of each type are effectively isolated from each other by an internal shield having a separate base-pin terminal. This shielding arrangement enables the designer to achieve substantial reduction of antenna radiation thus providing stable performance in high-frequency applications.

The two cathodes in each type have separate base-pin terminals to provide the equipment designer with greater flexibility in circuit connections.

KLIPSCH STEREO TAPES

Klipsch and Associates, Hope, Ark. has announced the release of the 7000-series of recorded tapes for 7.5 ips operation.

This new series are stacked-head stereo, 1200 feet on 7" reels, recorded at 7.5 ips. The first three releases at this new speed (prior recordings were at 15 ips) include an organ recital by John Eargle featuring a variety of classical works played on two *Aeolian-Skinner* pipe organs (one in Kilgore and the other in Longview, Texas); popular favorites played on the four-manual Wurlitzer at the Palace in Dallas by Weldon Flanagan; and The Joe Holland Quartet in a series of modern jazz numbers.

AUDIO CATALOGUES

PILOT BOOKLET

Pilot Radio Corporation, Long Island City 1, N. Y. has published a 16-page booklet written for the audio consumer.

Entitled "High Fidelity in the Home —A New Approach by *Pilot,*" the brochure contains a glossary of high-fidelity terms, describes the history and development of high-fidelity, and illustrates representative equipment.

Copies are available at no charge from the company direct or through its authorized dealers.

STEREOPHONIC SOUND

Ampex Audio Inc., 1020 Kifer Road, Sunnyvale, Calif. has recently published a 16-page, full color booklet which explains the nature of stereophonic sound and tells how it can be enjoyed in the home.

An illustrated article explains, in easily understood language, what is meant by stereo sound and how the firm's line of home music systems enables the music lover to enjoy such reproduction. The various models in the company's stereo line are shown by means of color photographs.

LAFAYETTE FLYERS

Lafayette Radio, 165-08 Liberty Ave., Jamaica 33, N. Y. is now offering copies of three 4-page flyers covering various items of equipment of interest to audiophiles.

Publication ST-70 covers a full line of speakers, enclosures, and complete systems; leaflet ST-62 pictures and describes various tone arms, audio systems for custom installation, and turntables. The third publication lists special offerings in speakers and changers, describes the firm's 70-watt amplifier and master audio control center, as well as miscellaneous audio components.

Write the company for any or all of these bulletins. —30—

Aerial view of RCA Victor's new radio and "Victrola" plant in Cambridge, Ohio. This 355,000 square-foot factory is said to be the world's largest facility for the production of "packaged high-fidelity units." The plant employs nearly 2000 persons and is capable of turning out 6000 instruments from its fifteen assembly lines during an eight-hour shift. The plant was dedicated September 11th.

Certified RECORD REVUE

By BERT WHYTE

THIS issue is produced before the new season's Hi-Fi Shows so I can't give you any report on them until a later issue. So not having much to say, I'll get on with the reviews and try to catch up on the flood of new material. Oh, I almost forgot to warn you that, contrary to some opinions, LP record prices are not due for any further reductions and, in fact, there is much talk of a price rise, because of increased costs, etc. Several labels have slyly pegged some records as "special" merchandise and have already upped the tariff one dollar over the existing $3.98 base. Thus it might behoove you to latch on to some of the records you've been planning to buy, "sometime," before you find your buying power sadly diminished. Don't say you haven't been warned!

IBERT

SUITE ELIZABETHAINE
Vienna Symphony Orchestra conducted by Henry Swoboda.

DIVERTISSEMENT
CAPRICCIO
Winterthur Symphony Orchestra conducted by Henry Swoboda. Westminster XWN18520. RIAA curve. Price $3.98.

This record was an early *Westminster* success which has now been re-mastered using the new RIAA equalization. The advances in cutting and pressing techniques have made a notable improvement in a record which, in its original issue, was much admired for its clean, crisp, well-balanced sound. The delightfully satirical "Divertissement" is the most familiar Ibert work on this disc and Swoboda affords it a light-handed, most engaging performance. The "Suite" and the "Capriccio" are not of the same level of inspiration which sired the "Divertissement," but are nonetheless interesting examples of the Ibert style.

HOROWITZ IN RECITAL
Vladimir Horowitz, pianist. Victor LM1957. RIAA curve. Price $3.98.

This is a rather odd collection of piano works ranging from a Haydn Sonata and a Brahms Intermezzo, to a Chopin Polonaise and Mazurka, the Schumann Variations on a Theme by Clara Wieck, a pair of Scriabin Sonatas and winding up with s'help me . . . the Horowitz piano transcription of Sousa's "Stars and Stripes Forever!" Melange it might be, but shining through it all is the artistry of Horowitz.

Here he gives a generous display of his prodigious technique and although quite awed by such *bravura* virtuosity, one is puzzled why this great pianist is so poorly served on records. His disc output is small and very circumscribed as to repertoire. One might add that the recorded sound is not all that it might be. On this disc, *Victor* fails to identify where the recitals were recorded, and mentions only that the Scriabin Sonatas were especially recorded for this album. This fact is audibly noticeable since the Scriabin works sound far cleaner and brighter than the other

The opinions expressed in this column are those of the reviewer and do not necessarily reflect the views or opinions of the editors or the publishers of this magazine.