OVER 21 PAGES ON HIGH FIDELITY

RADIO & TELEVISION NEWS

JUNE
1956
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IN THIS ISSUE

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COVER PHOTO: Two-way radio is being used in countless ways, in this case a Kaar "Imp" is installed on an electric "Golf Pony." For details on the current status of two-way radio see page 35 and for more details on cover, refer to page 37. (Ektachrome by Peter J. Samerjan)

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Average Net Paid Circulation 229,357

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MEMBER INSTITUTE OF HIGH FIDELITY MANUFACTURERS, INC.

ZIFF-DAVIS PUBLISHING COMPANY

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WILLIAM B. ZIFF (1898-1953) FOUNDER
Editorial and Executive Offices
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VOLUME 55 • NUMBER 6

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MEN 7-55!

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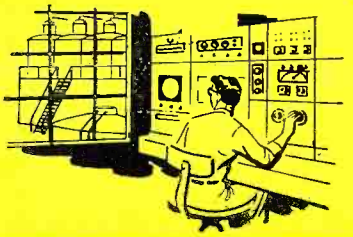
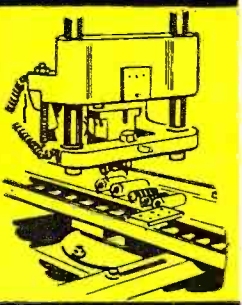


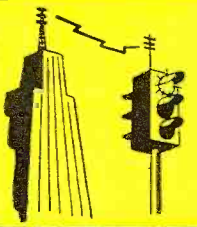
Industrial Processing



Making Electronic devices

Recording and billing

Anti-aircraft gun contro



Traffic control signals

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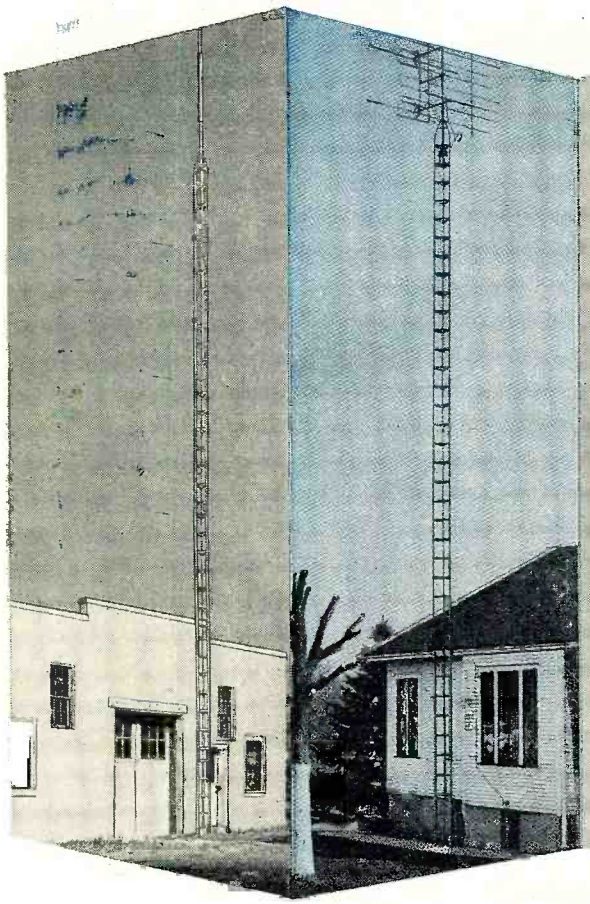

NO. 6 TOWER

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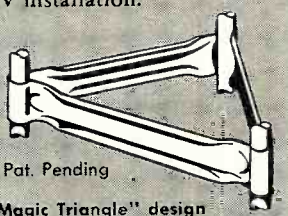

Pat. Pending

"Magic Triangle" design utilizes mass production machines —means sturdier towers, uniformity and lower costs!

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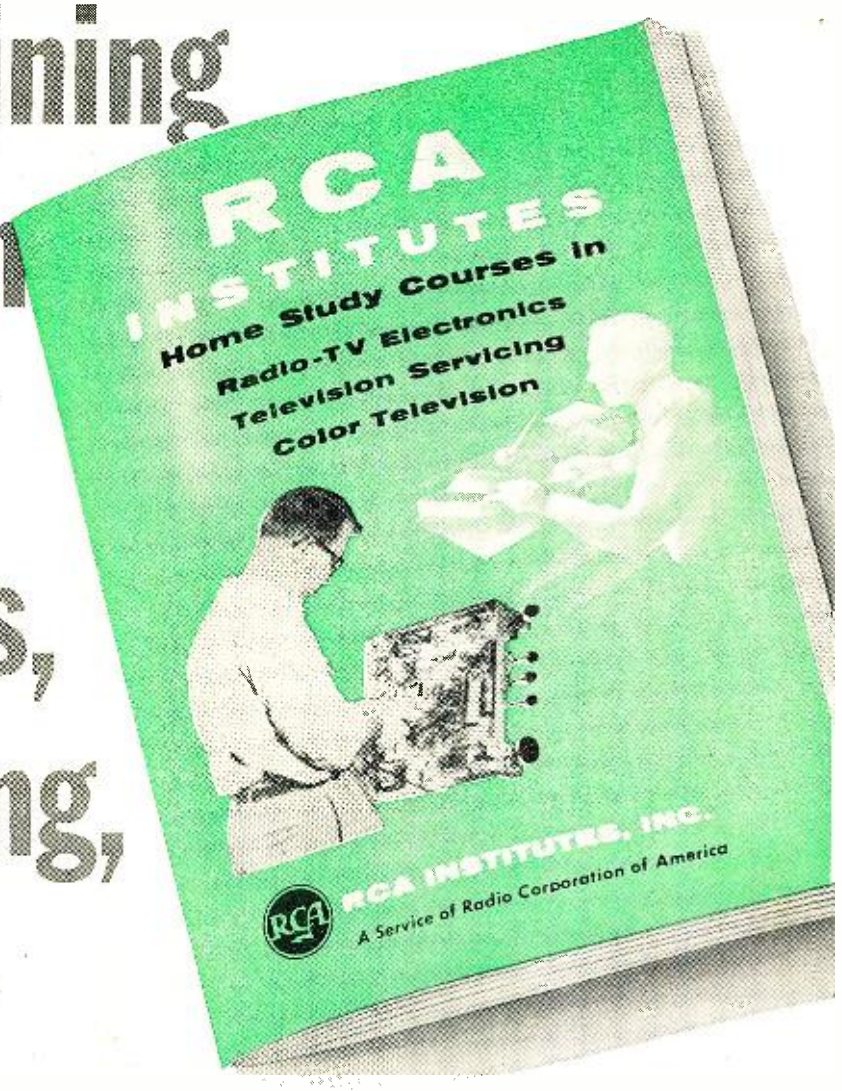

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For the RECORD

A STATEMENT OF POLICY

ONE of the country's leading manufacturers of high-fidelity components told us recently that he had long noted that RADIO & TELEVISION NEWS did not publish a monthly feature on hi-fi equipment on a "home tested" basis. He questioned the reliability and validity of such tests made under living room conditions and he expressed the hope that R & TV News would continue its policy of "reporting" new developments in audio equipment—rather than joining the ranks of several publishers who have literally "rubber stamped" all hi-fi products as being outstanding, lush, the best, you can't go wrong!, slick piece, ah—an extraordinary, sensational, etc., after so-called home tests.

He went on to say that, in many cases, new products tested and editorialized had appeared in the same issue of a magazine in which a new advertiser's ad appeared for the first time which illustrated and described the identical product. As a long established maker of hi-fi products and as a monthly advertiser in many periodicals, he felt that a "marriage" between advertising and editorial was obvious. He wouldn't complain, he said, if the tests of each product had been reported on a compatible and valid basis.

There are several reasons, we answered, why we have refused to place ourselves in such an untenable position. Having spent many years in the design of audio components and systems we have learned that the recording and the reproduction of high-fidelity sound is a complex subject embracing many methods and techniques. We know, for example, that the ultimate destination of transmitted (reproduced) audio energy impulses is the human ear.

Acoustics has its inductance, capacitance, and resistance. Practically all the elements found in electrical circuits are also found in acoustics. These acoustical elements affect the performance of any hi-fi system as far as our ears are concerned. This is why many rooms (especially small residential living rooms) tend to upset ideal acoustic elements and to degrade the performance of hi-fi systems.

Even in rooms ideally suited to hi-fi listening, an individual is not capable of accurately judging (for other people) the effects of reproduction *as others will judge in their own homes with their own ears.*

Such tests (especially in the case of loudspeaker systems) are, in our opinion, only capable of comparative performance when two or more are tested under identical conditions. The same can be done by the prospect for hi-fi at the dealer's sound room. A customer, after all, is the one to please and is the one who must "live" with his hi-fi. His choice must be based largely on the advertised specifications of equipment made by manufacturers known to be reputable, the recommendations of a reliable dealer, or the advice of technicians capable of evaluating audio system specifications.

The most precious of ingredients in the formula of a successful magazine must, above all else, include the faith of its readers as well as its advertisers. Both are essential to survival. The "mechanics" magazines, during the past few years, have had many makes and models of automobiles tested each month by their own reporters or free-lance writers. If car X handled poorly, the resulting published report would so state. If, by standards of good engineering practice, car X had a poorly designed windshield, this was also reported as a bad feature. Both *good* and *bad* features are always included in these reports. The point that we are attempting to stress is that these reports to readers do not attempt to hide the bad features of a product. This type of reporting is constructive and makes for keener competition and better products.

Most reports cover comparative specifications and features of automobiles in a certain price class. This is compatible and, in our opinion, a fair method of testing automobiles and reporting the results. The same technique could, at an almost identical level, serve to "guide" the hi-fi prospect in choosing his equipment.

A more practical technique, as far as reporting on hi-fi equipment is concerned, would be to rely on, and to publish reports from a totally independent laboratory equipped to accurately test the technical specifications of a product. The test procedure should be included. Bad features would then be obvious and would be reported. But even this technique is no "cure-all" for accurate reporting of hi-fi products (especially the loudspeaker) and its resulting influence on the buyer. And it would be a challenge to perfect a technique for evaluating the loudspeaker. The customers' ears are the important criterion.

We have been exploring the possibilities of employing a qualified independent laboratory for the testing of hi-fi products. If there is enough demand (and we would like to hear from those favorable to the idea), chances are good that we will publish such a monthly feature. . . . . O. R.

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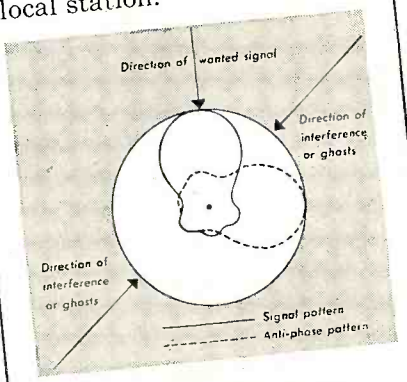

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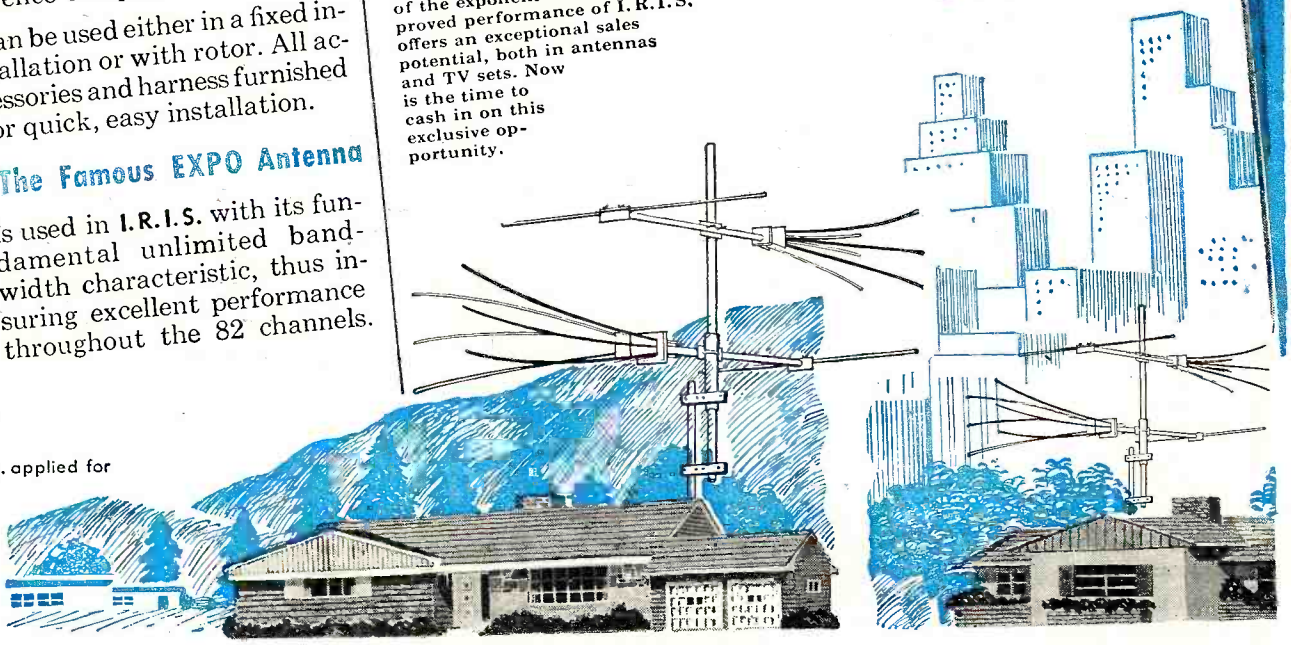

*Pat. applied for

Spot Radio News

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

By RADIO & TELEVISION NEWS' WASHINGTON EDITOR

THE BATTLE FOR THE ULTRA-HIGHS, a title bout in Washington with hundreds of contestants, that has been under the arc lights for months will, it appears, continue until the early summer.

The FCC has been pressured to add up the tallies and reach a decision; the Senate investigating committees have been scolded for their endless meetings that have thus far produced no results; and the networks have been blasted for their stranglehold on the whole broadcasting operation.

Many expert witnesses have appeared and offered logical suggestions to end the conflict, but with no effect on the authorities. At one session of the Senate Committee on Interstate and Foreign Commerce, E. W. Engstrom, executive vice-president of *RCA*, said that u.h.f. is certainly worth fighting for in the public interest.

Prefacing his testimony to the Senators, with the comment that neither he nor anyone has a complete answer to all of the questions which have been raised during the start-up period of u.h.f., and no one could offer a single plan or solution which will be fully effective, the manufacturer's spokesman added that one must consider and *act* upon *all* of the valid proposals.

When one takes into account the differences and limitations of the problem, he said, and uses good engineering judgment as to environmental conditions, and then studies the suggested programs, it will be found that u.h.f. stations can provide adequate and satisfactory signal service. But, it was stressed, one must understand TV performance at these high bands. He emphasized that we need the u.h.f. channels, in addition to the v.h.f. allocations for our still-growing black-and-white TV service and for the color service soon to become a mass medium, too.

In his proposal, Engstrom asked for authorization by the Commission of higher power; authorization for the use of directional antennas, boosters and translator-type stations; permission to de-intermix on a sufficiently broad basis to create a nucleus of predominantly u.h.f. service areas from which u.h.f. may grow and expand; encouragement for multiple ownership; and repeal by the Congress of the excise tax on all-channel color TV receivers.

"If the Congress exempts all-channel color sets from the excise tax," the technical executive said, "we would take appropriate steps to provide for the production of only all-channel color receivers as soon as practicable."

ONE OF THE MOST IMPORTANT TOOLS to be used in the launching of the earth satellite will be the electronic system known as radio telemetering. It will be used not only during all of the test phases, but during the actual launching attempts.

There will be twenty or more ground stations, spread out literally over a thousand miles; all will operate simultaneously and provide dual or overlapping coverage. Each station will be a vital link in the telemetering chain.

Radio means will also be used for tracking of the earth satellite itself and obtaining scientific data from it. The tracking will be required to handle three jobs for the satellite: To prove that it actually orbiting; to determine its precise orbit, and to measure what is happening within the satellite from the vantage point of a ground station.

In describing the immensity of the job of proving that the satellite is orbiting, one of the chief physicists on the project said that we should imagine a jet plane passing overhead at 60,000 feet, at the speed of sound, and suddenly a golf ball is ejected. The apparent size and speed of this golf ball will closely approximate the size and speed of a satellite that is three feet in diameter at a height of 300 miles. In the case of an actual satellite, the initial launching information such as time of launch, direction of launch, and the first and second stage tracking data, could localize the time of arrival of such a sphere over any given ground location to within six minutes and its position to within several hundred miles, during the initial orbit. The acquisition problem, it was said, is to locate the object under these conditions, and the tracking problem is to measure its angular position and angular rates with sufficient accuracy to alert non-acquiring tracking stations as to the time and position of expected passage of the object.

Both of these problems have been solved by a minitrack system of radio angle tracking developed by the Naval Research Lab. This system utilizes a transmitter of minimum size and

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weight within the satellite to send a beam of radio energy to receiving antennas at ground stations. By comparing the path length from the transmitter to one antenna with the length from the transmitter to a second antenna, it is possible to locate the satellite in its orbiting position. Similar measurements with another set of antennas help to fix the satellite accurately. In the actual ground station layouts, seven antennas will be used. Six pieces of data will be obtained in this manner, sent to a central computing facility within 20 minutes of receipt, and used there for determining the orbit of the satellite.

Reviewing the effectiveness of this system, the satellite expert said that it is not . . . "too unrealistic to predict that during the satellite event, the evening newspapers will publish on the front pages three boxes: one for the baseball scores, one for the horse-race results, and one for the evening times and angles at which the satellite can be picked up."

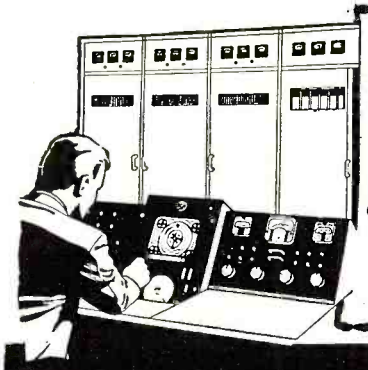
According to present plans, the minitrack transmitter will be a simple, minimum weight (three pounds or less) oscillator with a power output of between 10 and 50 milliwatts at an operating frequency of 108 megacycles. Two developments for this application are currently under consideration; one using subminiature low-filament tubes and the other using transistors. Reliability and general utility of the tube model has been found to be high, but it's considerably larger and heavier than the transistor unit. At present, it appears that one of the common battery types will be used for power supply. Solar batteries will be considered only after intensive tests to determine their reliability under the severe surface conditions that will be met by the satellite.

Telemetering of data from the satellite will also be accomplished through the minitrack system. A method of ground command turn-on has been worked out so that the telemetering will transmit only when the satellite is directly over a ground-recording station, in order to minimize battery requirements within the satellite.

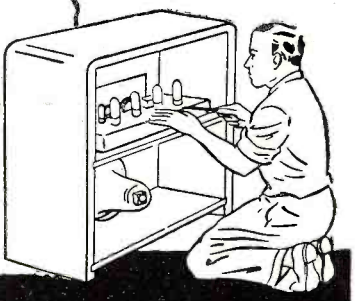
A PROTOTYPE MARINE WEATHER station that automatically reports local weather data by radio has been developed by the Bureau of Standards. The unit is incorporated in a buoy that can be anchored in remote locations and left unattended for periods up to six months. At regular intervals throughout the day, the station broadcasts in code, the air temperature, water temperature, barometric pressure, and wind speed and direction. Preliminary tests in Chesapeake Bay have disclosed that the station has a range in excess of 800 miles.

At present the gathering of comprehensive weather data from ocean areas outside of regular shipping lanes is haphazard and limited. Both military and civilian authorities would be better able

(*Continued on page* 97)



Where Will You Be in ELECTRONICS 6 Months from Today?



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CARL E. SMITH, Consulting Engineer, President
Desk RN-91, 4900 Euclid Bldg., Cleveland 3, Ohio

TELLS HOW—

Our Amazingly Effective JOB-FINDING SERVICE Helps CIRE Trainees Get Better Jobs

Here are a few recent examples of Job-Finding results!

ELECTRONICS TECHNICIAN

"I am now employed by the Collins Radio Company as a Lab Technician. (This job was listed in your bulletin). I have used the information gathered from your course in so many ways and I know that my training with CIRE helped me a great deal to obtain this job."

Charles D. Sindelar, Cedar Rapids, Iowa

AIRLINES

"I replied to the Job Opportunities you sent me and I am now a radio operator with American Airlines. You have my hearty recommendation for your training and your Job-Finding Service."

James A. Wright, Beltsville, Md.

INDUSTRIAL ELECTRONICS

"Upon my discharge from the Navy I used your Job-Finding Service and as a result I was employed by North American Aviation in electronic assembly (final checkout)."

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OURS IS THE ONLY HOME STUDY COURSE WHICH SUPPLIES FCC-TYPE EXAMINATIONS WITH ALL LESSONS AND FINAL TESTS.

Your FCC Ticket is recognized by employers as proof of your technical ability.

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Desk RN-91, 4900 Euclid Bldg., Cleveland 3, Ohio
(Address to Desk No. to avoid delay)

I want to know how I can get my FCC ticket in a minimum of time. Send me your FREE booklet, "How to Pass FCC License Examinations" (does not cover exams for Amateur License), as well as a sample FCC-type lesson and the amazing booklet, "Money-Making FCC License Information."

PLEASE PRINT CLEARLY

Name .....Age.....

Address .....

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

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Special tuition rates to members of the U. S. Armed Forces.
Electronic Training also available to Canadian Residents

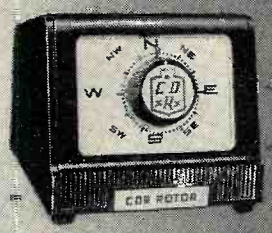
setting new selling records everywhere

C·D·R TV antenna ROTORS

the COMPLETE line
A Model for Every Need

AR-1

The completely AUTOMATIC rotor, powerful and dependable, with a modern design cabinet. Uses 4 wire cable.



AR-2

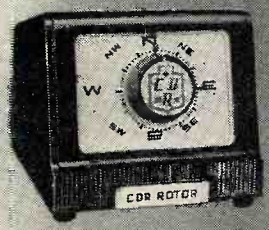
Completely AUTOMATIC rotor with thrust bearing. Handsome cabinet, uses 4 wire cable.

TR-4

The heavy-duty rotor complete with modern cabinet with METER control dial. Uses 4 wire cable.

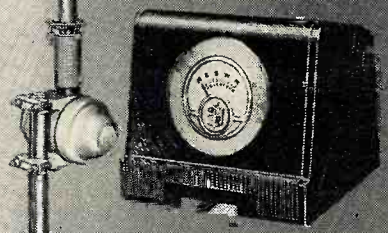
AR-22

Here is the completely AUTOMATIC version of the famous TR-2 with all the powerful features that made it so famous.



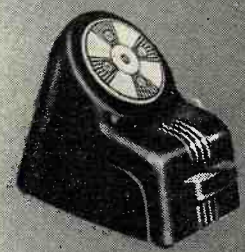
TR-11

The ideal budget all-purpose rotor with new, modern cabinet featuring meter control dial. Uses 4 wire cable.



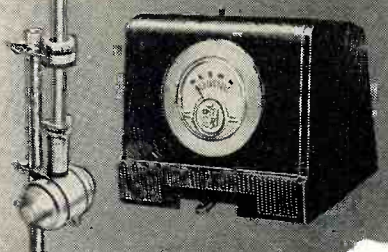
TR-2

The heavy-duty rotor with plastic cabinet featuring "compass control" illuminated perfect pattern dial. Uses 8 wire cable.



TR-12

A special combination value consisting of complete rotor with thrust bearing. Handsome modern cabinet with meter control dial, uses 4 wire cable.



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SOUTH PLAINFIELD, N. J.

THE **RADIART** CORP.
CLEVELAND 13, OHIO

NOW...get EVERYTHING YOU NEED to prepare to earn REAL MONEY in TELEVISION

...one of America's BRIGHTEST Opportunity Fields

Enjoy highly interesting work ...and a wonderfully promising future

America's great billion dollar Television field now offers you a chance of a lifetime to get started toward a good job or your own profitable business. With so many new TV stations coming on the air, Television is expected to grow as never before! Millions of TV sets must be produced, tested, installed and serviced. And Television is only *one branch* of this vast opportunity field of Electronics—for which D T I's amazingly effective training prepares you.

Right in your own home you may now get one of today's most interesting . . . PRACTICAL WAYS to prepare for your start in TELEVISION, including Radio and Electronics. No previous experience or advanced education are needed—because D T I brings you a 3-WAY COMBINATION method that speeds your understanding and progress. You (1) Learn from well illustrated lessons, you (2) Learn by Seeing from D T I's wonderfully effective home movies and (3) you Learn by Doing from electronic parts that provide the practical experience you need.

You get and KEEP the same type of basic electronic equipment used in our modern Chicago Training Laboratory. You get home training that includes the knowledge and experience gained from training thousands of students first hand. In other words, you get LABORATORY TYPE TRAINING . . . RIGHT IN YOUR OWN HOME. But why not get the whole exciting story. Mail coupon today.

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EMPLOYMENT SERVICE

Get an honest-to-goodness EMPLOYMENT SERVICE to help you get a good job after graduating — or assistance in starting your OWN TV-RADIO SALES & SERVICE BUSINESS.

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If you're subject to military service, the information we have for you should prove very helpful. Mail coupon today.

EARN AS YOU LEARN

After you get part of D T I's training, with equipment at home, you may then, in your spare time, begin to earn real money servicing Radio and TV sets.

"One of America's Foremost Electronics Training Centers"

MEMBER OF NATIONAL HOME STUDY COUNCIL

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FORMERLY
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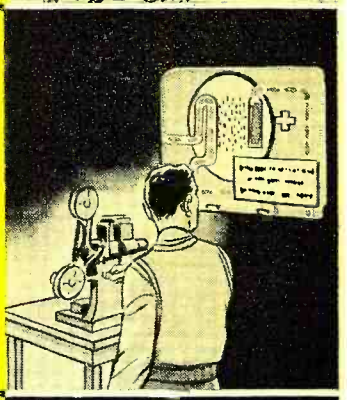
300 EXPERIMENTS

Build over 300 fascinating experiments from 16 BIG SHIPMENTS of Electronic-Radio parts which you KEEP. You build and operate Television circuits, Radio receiving circuits, a wireless microphone and many other major projects — all designed to provide outstanding practical experience at home.

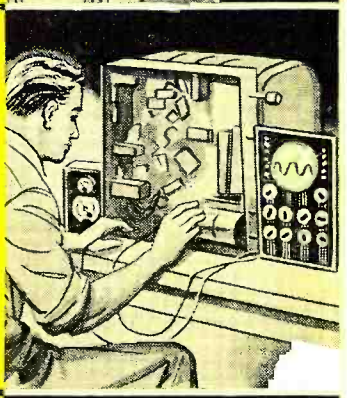
HOME MOVIES

Thanks to this exclusive D T I home training aid, many important Television-Radio fundamentals quickly become "movie clear." Now you can actually see electrons on the march and other "hidden actions" — a wonderful advantage that's almost like having a teacher in your home.



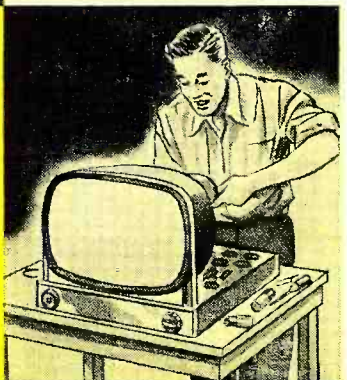
BUILD YOUR OWN TEST EQUIPMENT

As part of your home laboratory project you build and keep a quality 5-INCH oscilloscope and a **Vacuum tube Voltmeter.** You will find this equipment ideal for helping you earn in your spare time while a student — and later when working full time in the field.



BUILD AND KEEP A BIG 21" TV SET

For added practical experience, you build and keep this top quality 21 INCH TV Set that provides TV reception at its finest (D T I offers another home training but without the TV set.)



89 WAYS TO EARN MONEY IN TELEVISION RADIO ELECTRONICS

SEND FOR FACTS TODAY!

DeVry Technical Institute
4141 BELMONT AVE.
CHICAGO 41, ILLINOIS DEPT. RN-6-M

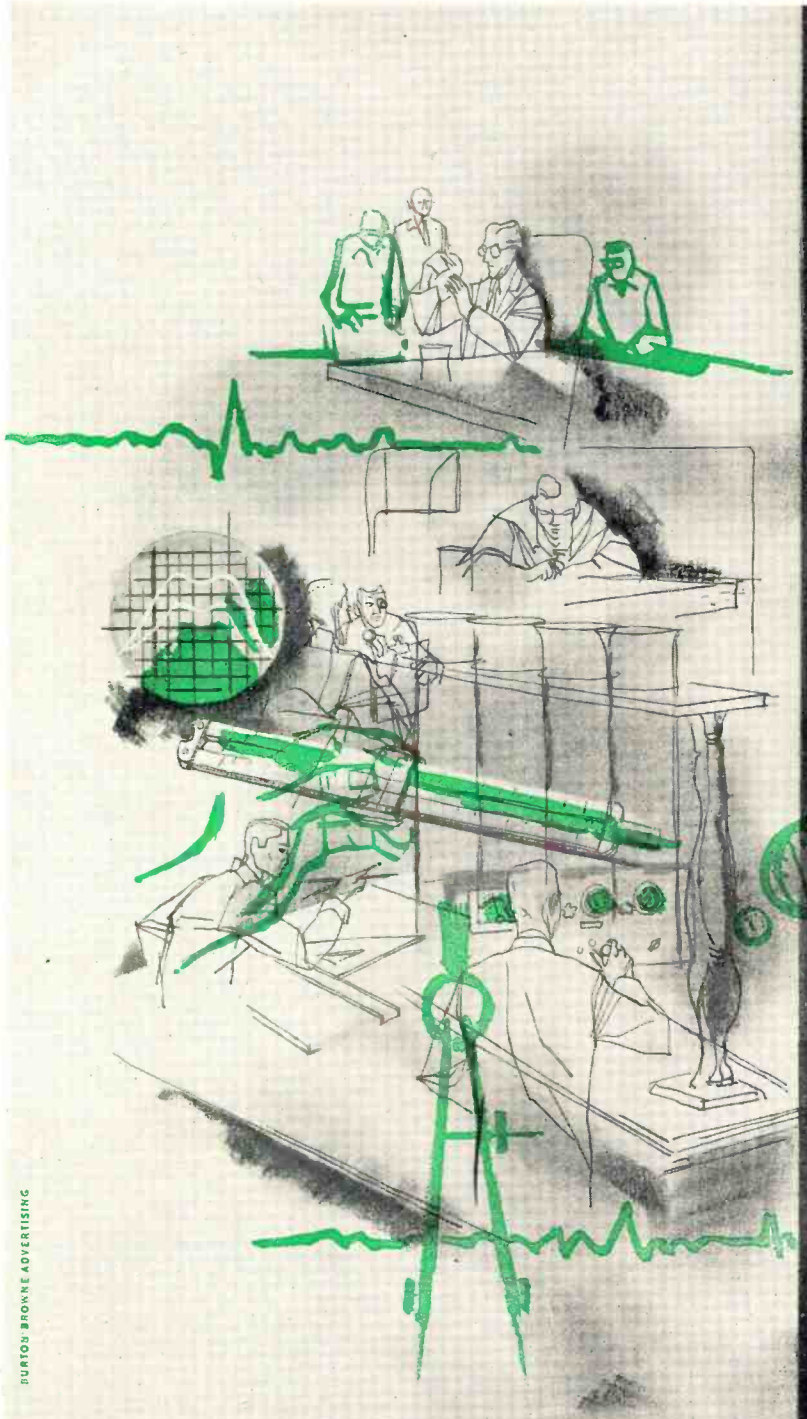
I would like your Opportunity Bulletin showing "89 Ways To Earn Money In Television-Radio-Electronics"; also, complete facts about the training opportunities made possible by your organization.

Name_____ Age_____
(PLEASE PRINT)

Street_____ Apt._____

City_____ Zone____ State_____

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



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TURRET STYLE TUNER

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Master Specialists in Tuned Circuits

WORLD'S LARGEST MANUFACTURER
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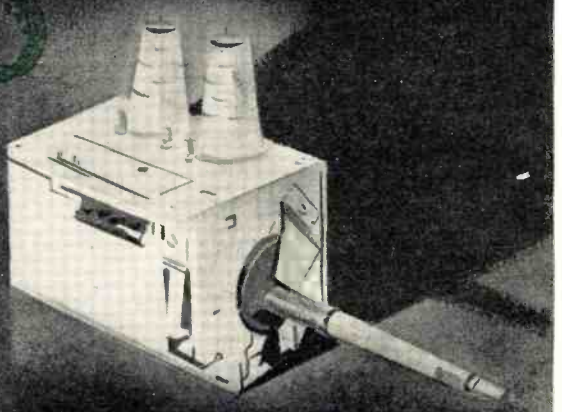


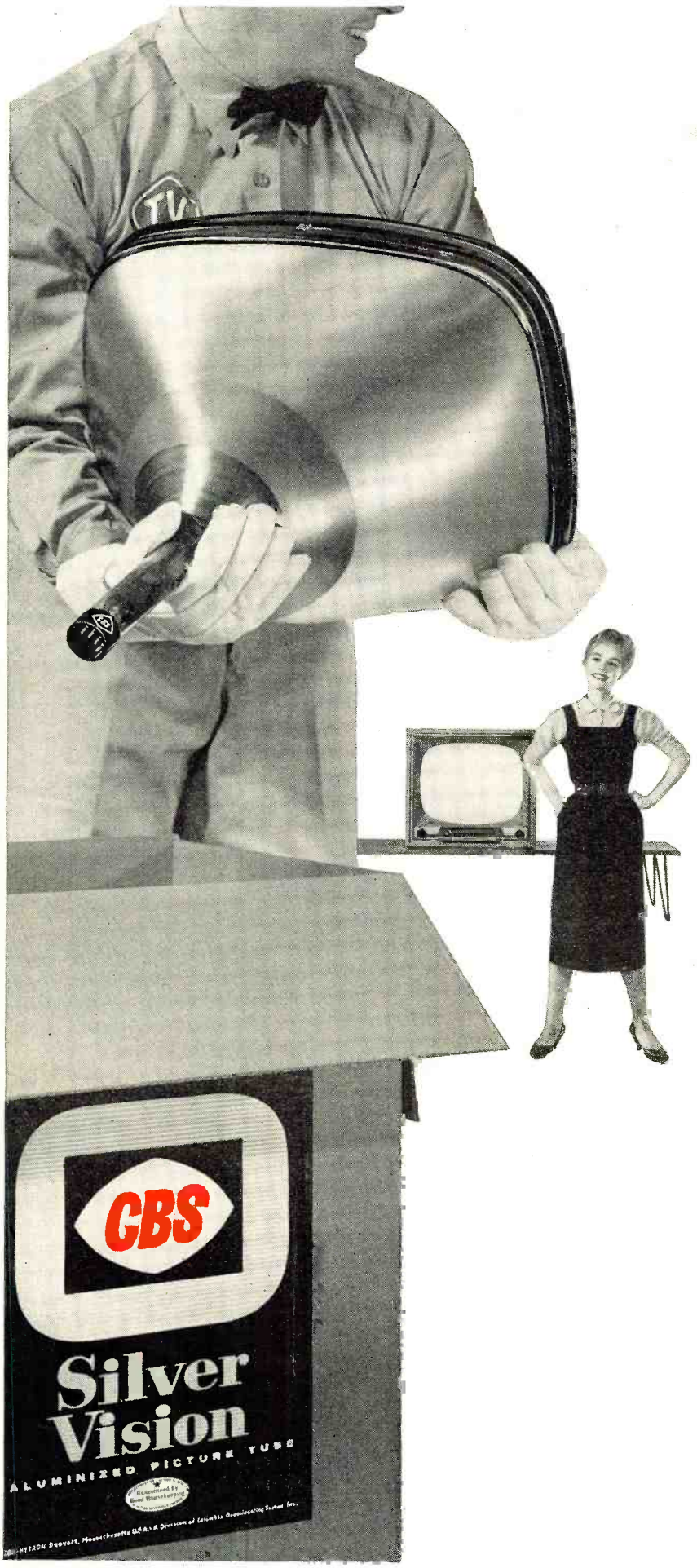
STANDARD TUNERS have been used in more than 19,000,000 TV receivers and designs contributed by STANDARD to the industry have been used for many millions more. STANDARD has not only a tremendous engineering department for production and development but also one of private industry's largest pure research engineering staffs for electronics. Only recently STANDARD at symposiums attended by all major TV manufacturers exposed the results of several intensive years of color TV research—results which will reduce by several years the time required for the development of practical color TV.

STANDARD PRODUCTS ARE WIDELY VARIED

for full story write or phone: Information Division, Standard Coil Products Co., Inc., Melrose Park, Illinois

Standard Coil Products Co., Inc. Chicago · Los Angeles · Bangor, Mich. · North Dighton, Mass · Toronto, Canada

Pioneers in Universal Replacement Tuners for TV · **Originators of Packaged Tuned Circuits**



It's easier to sell CBS

Silver Vision

the "High-Fidelity" Aluminized Tube

Your customer is aware that Hi-Fi does sound better . . . that it faithfully reproduces the original sound. And you can prove by demonstration that advanced-engineered CBS Silver Vision tubes can do for video what Hi-Fi does for audio.

You know Silver Vision's aluminization . . . silver-activated phosphors . . . and small-spot gun can accomplish this. But technical details do not interest the lady. She does appreciate Silver Vision's sparkling whites . . . deep blacks . . . and wide range of middle gray tones. She likes the way they can be blended to give her truly high-fidelity reproduction of the telecast picture.

Here's a tube whose performance sells it. And Garry Moore makes it still easier by convincing your women customers over the CBS Television Network: "There are no better tubes made than CBS tubes, the tubes with the Good Housekeeping Guaranty Seal." Sell the easy way, follow Garry's lead. Sell CBS Silver Vision . . . the "high-fidelity" aluminized picture tube.

Always show her the CBS carton with the Good Housekeeping Guaranty Seal.

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

PRODUCTION TECHNIQUES:

for the manufacturing of High Reliability Capacitors

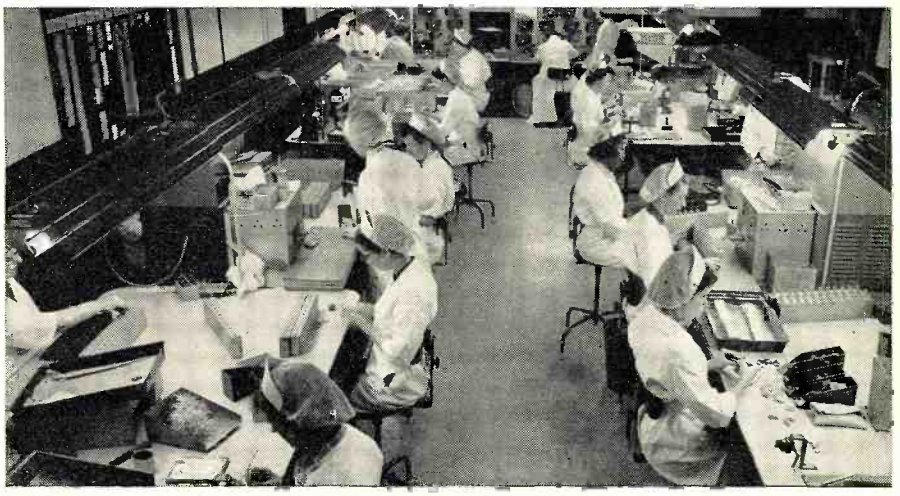
To produce capacitors free from any possibility of latent defects, for use in the most critical applications, the Sangamo Electric Company has recently intensified its high reliability program of fabrication and inspection methods.

Incoming materials are rigidly inspected to meet stringent high reliability standards and are stored in areas where temperature, humidity and dust are controlled at all times.

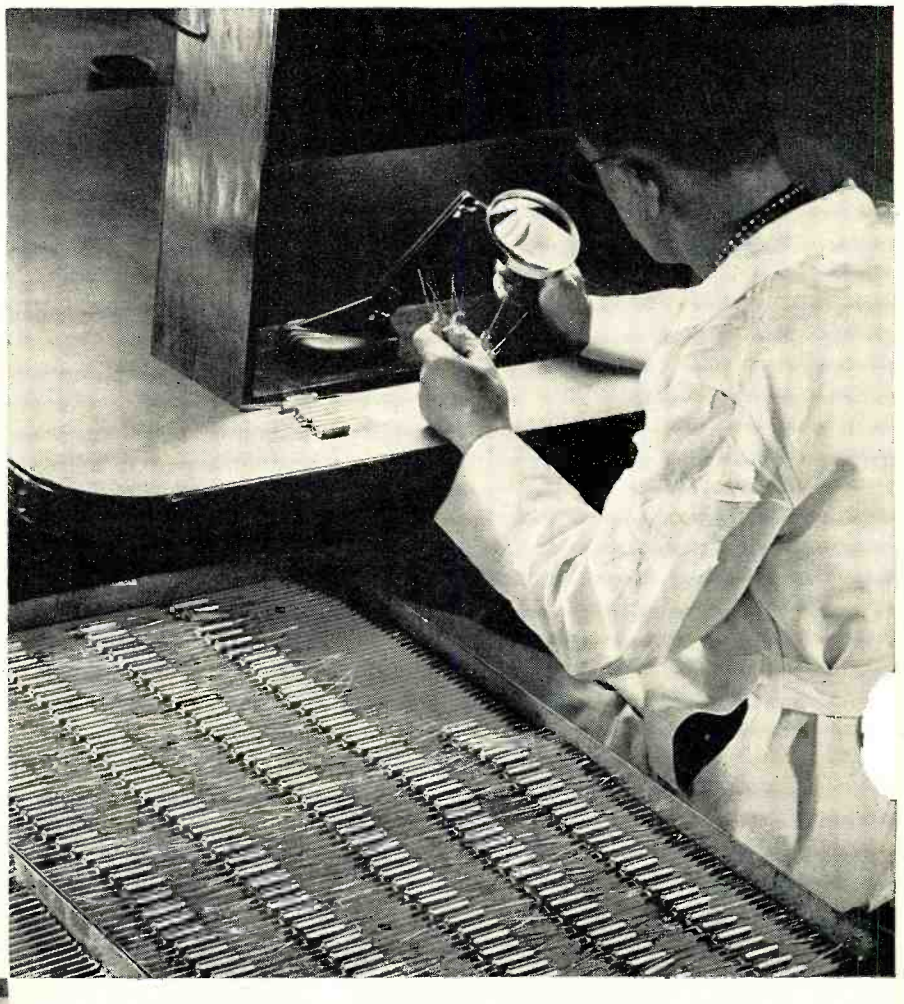
Complete production histories are kept on the basis of small capacitor lots. X-raying of individual units, heat tests, vibration tests, altitude tests, and total destruction tests of a given percentage of all finished units assure components with an extremely low AQL. Testing facilities and resultant performance characteristics are far in excess of military specifications. Specify these high reliability capacitors for your critical applications.

SANGAMO ELECTRIC COMPANY
MARION, ILLINOIS

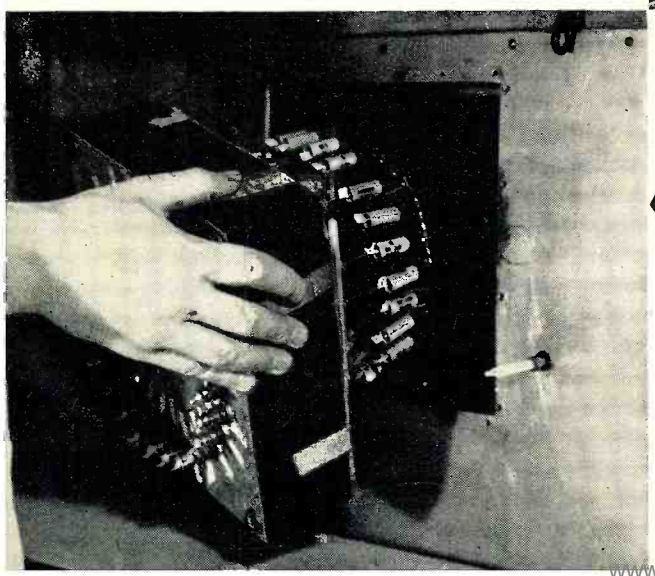
SC56-2



Separate facilities are maintained for the exclusive processing and manufacture of high reliability capacitors. Only specially trained, highly skilled operators, who wear special clothing to prevent any possible source contamination, work here.



Oil-filled capacitors are subject to vacuum under elevated temperatures, then are individually examined to insure complete hermetic seal.

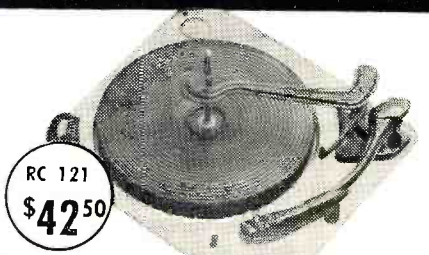


High temperature test ovens are used to check insulation resistance of Sangamo high reliability capacitors under sustained temperatures of 125° C.

This vibration testing machine brutally punishes Sangamo high reliability capacitors at accelerations up to 10 G's to determine their ability to resist vibration without damage to leads or [illegible]

Announcing 3 *great new* GARRARD

WORLD'S FINEST AUTO-MANUAL RECORD CHANGERS



Now...there's a GARRARD for every high fidelity system! It's worth the time to read the revolutionary features which lift these three new GARRARD Changers out of the commonplace into the extraordinary.

Here's why they are the world's finest!

1 PERFECTED TRUE-TURRET DRIVE "301 Professional" inspired. *Eliminates vibration-causing factors, plays your records at perfect, constant speed.* Operates directly off motor as a single turret, without belts.

2 OVERSIZED "SOFT-TREAD" IDLER WHEEL *gives you unfaltering speed without wows or flutter.* Traction is insured by a wide-arc of ¾" thick live rubber. SELF-NEUTRALIZING PULL-AWAY ball-bearing MOUNT keeps idler "true"...rumble-free.

3 LOW-INERTIA, SIDE-ACTION FINGER-TIP SWITCHES *give you greater convenience, safety.* Make positive settings instantly from side with right or left index finger or thumb. Avoid damage to stylus or records.

4 GENUINE RUBBER TURNTABLE TRACTION MAT—With exclusive raised outside tread, *adapts itself to contours of your records.* Lint-free, washable. HEAVY STEEL PRECISION TURNTABLE. Full inch high. Eliminates magnetic hum by strengthening motor shielding. Flywheel action.

5 SILENT, FREE-WHEELING, BALL-BEARING TURNTABLE MOUNT — *Meticulously engineered to increase listening pleasure by preventing wow, friction and noise.* Sintered bronze bearings expertly burnished, revolve freely, smoothly in Garrard non-metallic cage, no metal-to-metal contact.

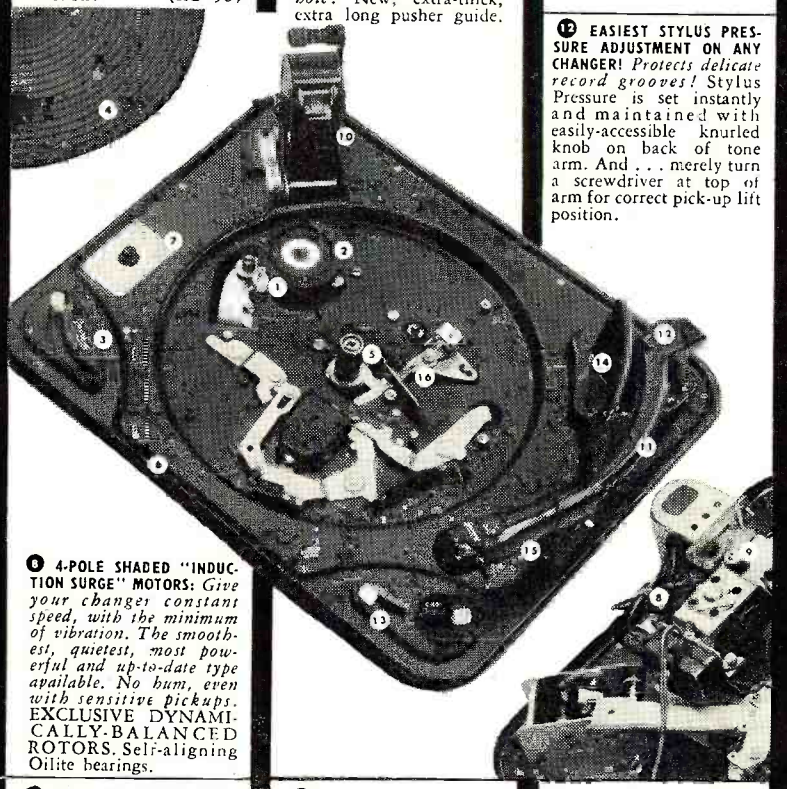
6 STEEL "MONO-BUILT" UNIT PLATE *keeps your changer "in line."* A husky, rigid support for entire mechanism. EXCLUSIVE "SNAP MOUNT" SPRINGS permit you to mount changer instantly. May be leveled from the top with a screwdriver.

7 VARIABLE SPEED CONTROL — *"Tunes your changer" to the pitch or key of a musical instrument.* Permits continuously variable + or — adjustment of each speed through all-electrical rheostat—no friction. (RC 98)

8 4-POLE SHADED "INDUCTION SURGE" MOTORS: *Give your changer constant speed, with the minimum of vibration. The smoothest, quietest, most powerful and up-to-date type available. No hum, even with sensitive pickups.* EXCLUSIVE DYNAMICALLY-BALANCED ROTORS. Self-aligning Oilite bearings.

9 4 — LIVE-RUBBER CONIPOISE MOTOR MOUNTS: Floating power! *Filter out even the slightest vibrations.* Motor is completely isolated and damped from rest of unit by exclusive tension-compression shock absorbers.

10 ADVANCED GARRARD PUSHER PLATFORM — Foolproof! After 20 years, *still the only device that insures you positive, gentle handling of all records, any diameter, any thickness, any condition center hole!* New, extra-thick, extra long pusher guide.



REINFORCED, AUTOMATIC MUTING SWITCH: *Your listening pleasure undisturbed by extraneous noises!* Eliminates sound through speaker during record-change cycle. Service-free performance—new heavyduty design.

11 EXCLUSIVE! TRUE-TANGENT TONE ARM OF ALUMINUM As used in costly separate pickup arms! *Plays better,* by eliminating resonance, providing greater rigidity, low mass and lightness.

12 EASIEST STYLUS PRESSURE ADJUSTMENT ON ANY CHANGER! *Protects delicate record grooves!* Stylus Pressure is set instantly and maintained with easily-accessible knurled knob on back of tone arm. And . . . merely turn a screwdriver at top of arm for correct pick-up lift position.

COMPLETE U-L APPROVED WIRING — *Changer comes ready for Plug-In!* Full 5 ft. U-L approved electrical line cord, and pick-up cable supplied, terminating in standard jack. Plugs into any system of high fidelity components . . . no soldering or special tools.

13 FULL MANUAL POSITION —*Finger-tip control adds to your automatic changer the versatility of a single-play.* Touch the switch—tone arm is freed for manual play. Returns to rest at end of record . . . no noise or stylus damage.

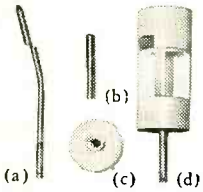
14 AUTOMATIC STOP—after last record. *Adds convenience and safety!* Soft polyethylene Safety Feeler (RC 88 and RC 98) cannot damage record edges.

15 INTERCHANGEABLE PLUG-IN HEADS *accommodate your personal choice of high fidelity pickups.* Fit all cartridges — magnetic, crystal or ceramic; turnover, twist, or simple plug-in types.

16 EXCLUSIVE SENSI-MATIC TRIP MECHANISM *gives you sure operation even with tone arm set at lowest tracking pressures. Quiet, safe, gentle to records.* EXCLUSIVE SHUT-OFF BRAKE instantly stops free turntable revolutions.

NEW-TYPE SHIELDED CONDENSER-RESISTOR NETWORK—*Eliminates startling "plop" noise heard through your speaker* when ordinary changers shut off at end of last record. A refinement pioneered by Garrard.

SERVICE AND REPLACEMENT PARTS—Purchase any Garrard changer with complete confidence! Garrard holds its pre-eminent position in the American market by the finest service and parts facilities available in the Industry—the guarantee and facilities of the B.I.C. Group.



INTERCHANGEABLE SPINDLES — Insert easily, remove instantly. *Greatest record protection.*

STANDARD SPINDLE EQUIPMENT (RC 88 and RC 98) (a) Garrard one-piece spindle. No moving parts to nick or enlarge center holes, (b) Manual "single play" spindle, (c) Manual 45 rpm adaptor.

SPECIAL AUTOMATIC 45 RPM SPINDLES —Supplied (RC 98) Optional (RC 88, RC 121) (d)

SIMPLI-MIX OPERATION: *In RC 121, you load records of any standard diameter* (12", 10", 7"—or mixed, bottom to top, in this order) *on fixed spindle at one time.* Put overarm in position. Changer then operates automatically, with tone arm dropping in correct positions.

GARRARD—A quality-endorsed product of the B. I. C. group

MAIL THIS COUPON for useful, illustrated B. I. C. High Fidelity Plan Book.

British Industries Corp., Dept. GF-46
Port Washington, N. Y.
Please send B. I. C. High Fidelity Plan Book.

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Address_____

City_____ Zone____ State_____

TEST 5 TUBES in 4 SECONDS EACH...ACCURATELY!

WITH THE NEW ADVANCED ENGINEERED

precise MODEL 116

Gm. & Em. ULTRAFAST TUBE & TRANSISTOR TESTER

COMPLETELY **NEW!**

PRECISE MODEL 116K in kit form..... **$69.95**

PRECISE MODEL 116W factory wired **$119.95**

Servicemen know the Precise Model 111 (the winner in an independent survey) easily rates "the finest tube tester in the field" at any price, BUT FOR AN ON THE JOB QUICK-TEST . . . the fastest, most accurate is the PRECISE Model 116. What's more you test tubes the foolproof method inherent in the famous Precise Model 111.

Did you ever wish you could plug in 5 of the same type tubes at once and check each one individually by rotating a switch? YOU CAN WITH THE PRECISE MODEL 116—Plug in 5 IF tubes and let them heat up at once and then check each one separately by rotating the TUBE BANK switch. ACTUALLY CHECK 5 TUBES IN 20 SECONDS, 4 SECONDS PER TUBE.

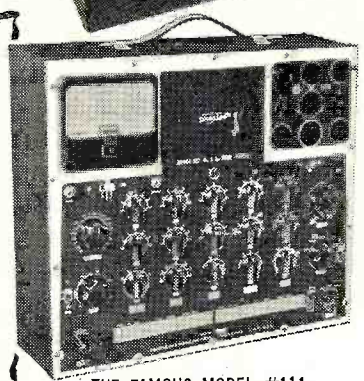
The Precise Model 111 taught the lesson that IF amplifier tubes (like the 6BC5 or 6AU6) should be tested for Gm (mutual transconductance) while the power amplifiers (like the 6L6) should be tested for Em (emission)—that's ULTRAFAST Model 116 test! It checks each section of each tube separately . . . by rotating the FUNCTION SWITCH . . . each triode of a dual triode is checked individually . . . each diode and the triode of a duo-diode-triode is separately tested and not lumped as in other testers . . . and a pentode is tested as a pentode—not a diode. TRANSISTORS, SHORTS, GAS, LIFE, Em, Gm etcetera can be tested with the PRECISE Model 116.

You can inexpensively extend the Precise Model 116 to test filament current, etc. The Model 116 gives an accurate, ultra-fast (3 basic knobs for testing) check of television tubes!

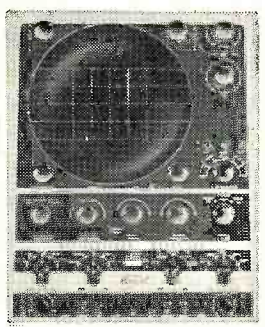
No Surplus—An etched panel—beautiful Moleskin covered wood carrying case and cover and specially simplified instructions makes the PRECISE MODEL 116 THE FINEST FAST-CHECK TUBE TESTER AND DOLLAR EARNING TRAVELING COMPANION A TV SERVICEMAN EVER HAD.

Not yet at your distributor. Order NOW to insure early delivery.

SEE YOUR LOCAL DISTRIBUTOR FOR PROOF OF WHAT WE OFFER — OR WRITE US FOR DOCUMENTARY RESULTS OF AN INDEPENDENT SCIENTIFIC SURVEY.

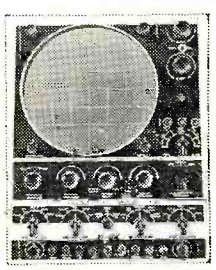


THE FAMOUS MODEL #111
111K **$79.95**
111W $139.95
INCL. CARRYING CASE & COVER

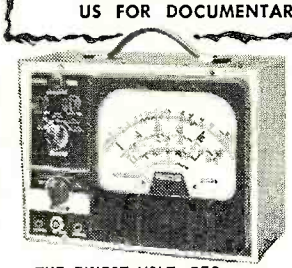


THE FIRST LOW PRICED 7" COLOR SCOPE
300K **$99.95**
300W $199.95

LOW PRICED 5" SCOPE
315K $49.95
315W $84.95

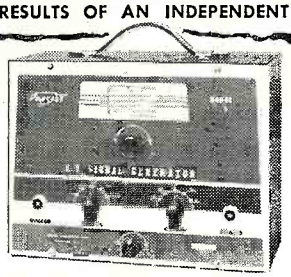


THE FIRST AND ONLY 8½" COLOR SCOPE
308K **$129.50**
308W $229.50

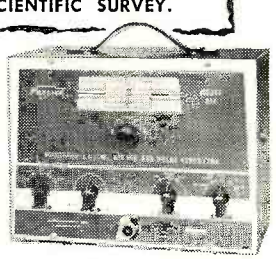


THE FINEST VOLT, REG, 7" VTVM KIT
9071K $35.95
9071W $49.95

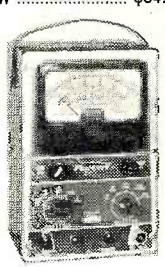
WRITE FOR CATALOG RN 6-6



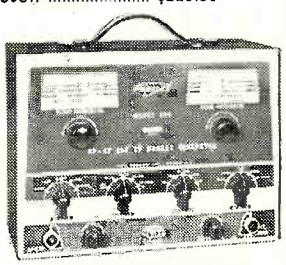
LOW PRICED RF SIGNAL GENERATOR "BEST BUY" IN GEN. FIELD
610K $23.95
610KA pre-assembled head..... $28.95
610W $39.95



UNIV. AF, SINE, SQ, & PULSE GEN.
635K $33.50
635W $52.50



LOWEST PRICED WIRED 4½" VTVM
909K $25.98
909W **$37.50**



RF—AF—BAR GENERATOR with pre-assembled* head
630K $33.95
630KA* $38.95
630W $53.95

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OAK RIDGE NATIONAL LABORATORY
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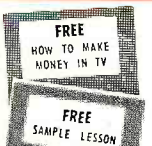

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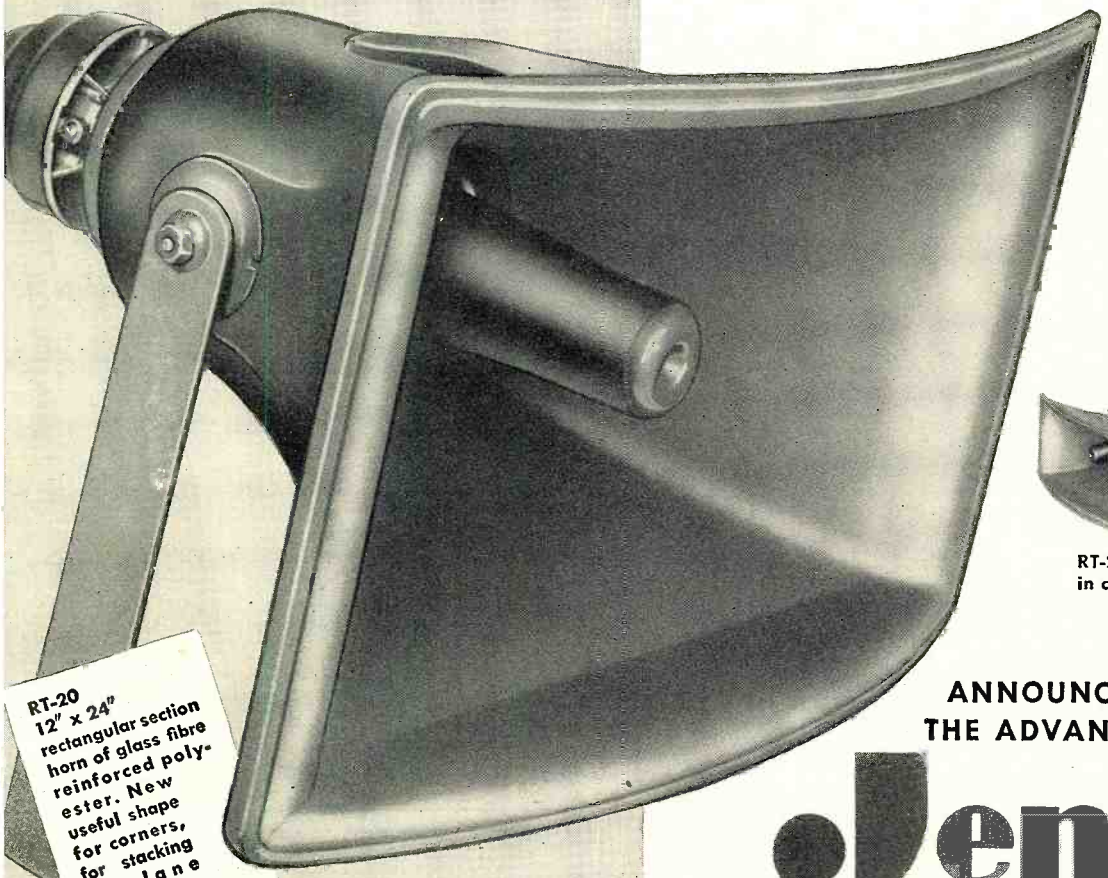

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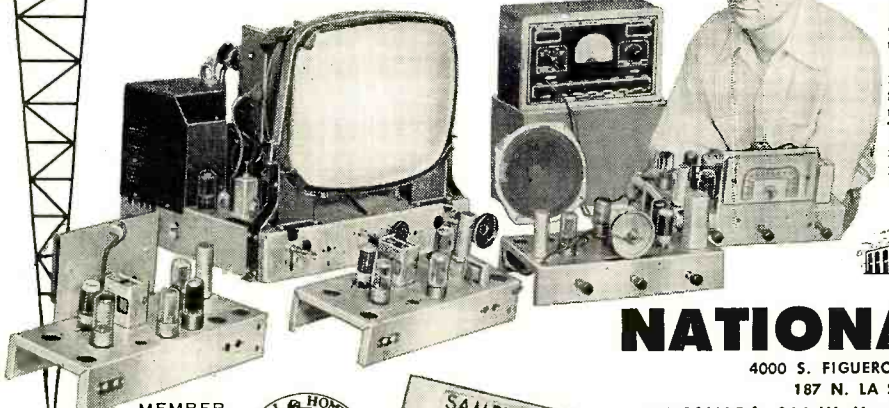

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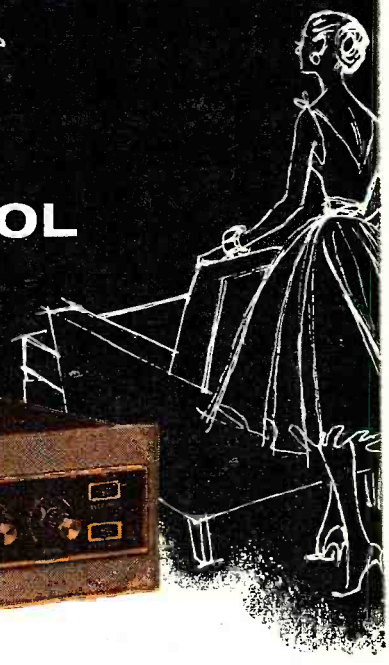

Model A20CL Music Control Center and 20-watt Power Amplifier. Features unique, exclusive "Presence" control. Response 20-20,000 cps. ±1.0 db at rated 20 watts, 40 watts peak. Controls include Playing Selector, Loudness, Bass, Treble, Volume and Power, Phono-Selector. Power Amplifier utilizes Circlotron Circuit and Variable Damping Control. Low-boy style. **Net, $124.50**

Model A15CL Music Control Center and 15-watt Power Amplifier. Similar to Model A20CL above except Power Output 15 watts rated, 30 watts peak. Controls include Power, Bass, Treble, Volume, Playing Selector and Phono-Selector. **Net, $99.50**

Model PC1 Music Control Center. Serves as control for line amplifiers. Has self-contained, shielded, low-noise power supply. Features exclusive E-V "Presence" control. Other controls include Playing Selector, Loudness, Bass, Treble, Volume, Power and Phono-Selector. **Net, $99.50**

Model PC2 Music Control Center. Serves as control for line amplifiers. Controls include Playing Selector, Bass, Treble, Phono-Selector, Volume and Power. Self-contained, shielded, low-noise power supply. **Net, $67.00**

Model A15 Circlotron Amplifier. Power output: 15 watts rated, 30 watts on peak. Response: ± .5 db 20-50,000 cps. **Net, $69.50**

Model A20 Circlotron Amplifier. Power Output: 20 watts rated, 40 watts on peak. Response: ± .5 db 20-60,000 cps. **Net, $85.00**

Model A30 Circlotron Amplifier. Power Output: 30 watts rated, 60 watts on peak. Response: ± .5 db 20-75,000 cps. **Net, $108.00**

Model A50 Circlotron Amplifier. Power Output: 50 watts rated, 100 watts on peak. Response: ± .5 db 20-75,000 cps. **Net, $169.00**

Model A100 Circlotron Amplifier. Power Output: 100 watts rated, 200 watts on peak. Response: ± .5 db 20-50,000 cps. **Net, $261.00**

Prices slightly higher west of the Rockies.

Featuring the new, vital PRESENCE CONTROL

With the thrilling new PRESENCE CONTROL, you take the leader's baton and conduct the orchestra to suit your own listening pleasure in the ELECTRO-VOICE MUSIC CONTROL CENTER. Balances vocals to orchestra and room acoustics for true high fidelity. Just like the network and recording studios, the PRESENCE CONTROL gives mid-range program equalization never before available in home systems. Low-boy styling is skillfully blended with mocha, satin brown, and brushed brass trim for a beautiful appearance that matches blonde or mahogany cabinets.

With ELECTRO-VOICE CIRCLOTRON AMPLIFIERS, you come closer than ever to perfection in high-fidelity reproduction. The famous Circlotron Circuit provides unity coupling between output tubes; eliminates switching transients and removes DC from output transformer. The exclusive Variable Damping Control greatly reduces loudspeaker low-frequency distortion and voice-coil override. Permits matching amplifier, speaker and enclosure to room...for the closest approach to reality of reproduction.

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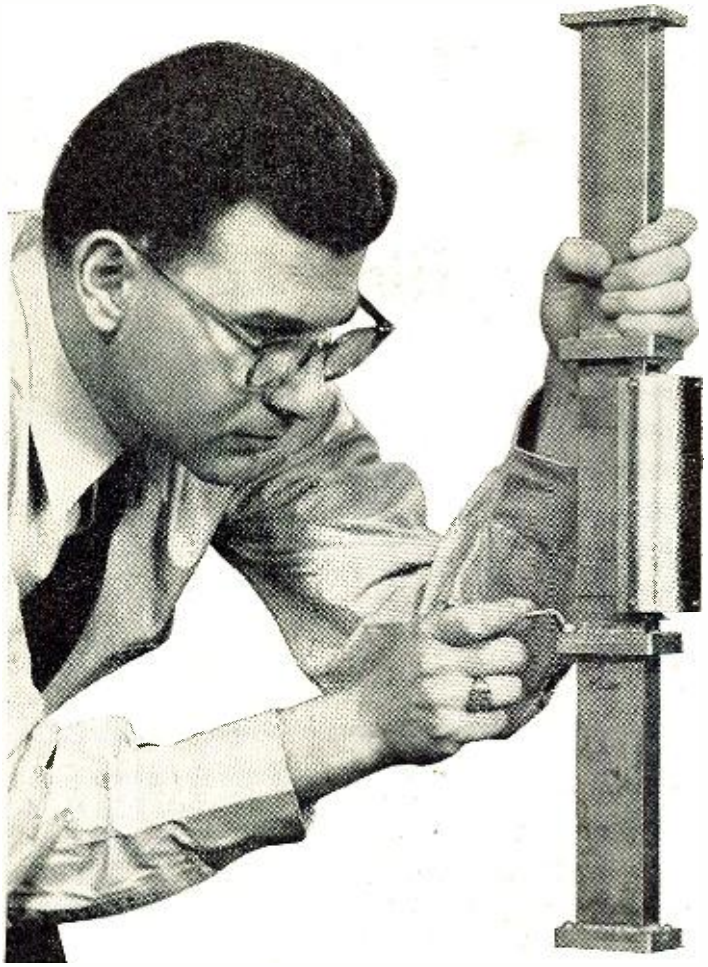


RADIO'S ONE-WAY STREET

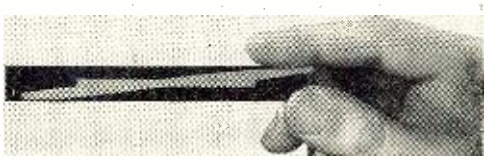
Dr. S. Weisbaum assembles an isolator which he developed for use in a new microwave system. Dr. Weisbaum is a Ph.D. in microwave spectroscopy from New York University. He is one of many young men at Bell Laboratories applying the insight of the physicist to develop new systems of communication.

New radio relay systems for telephone and television now in the making will employ an ingenious device invented by Bell scientists. The device, known as an "isolator," senses which way microwaves are traveling through a waveguide, and stops those going the wrong way.

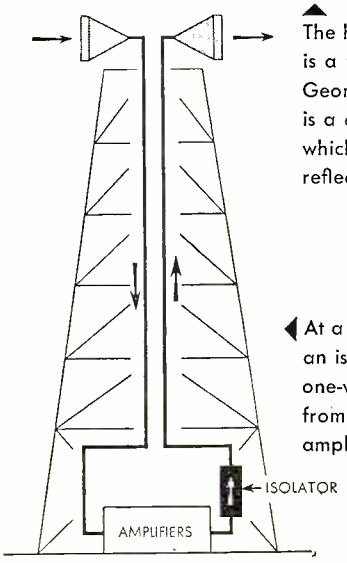
In the new systems a klystron wave generator sends signals through a waveguide to the antenna. The klystron must be shielded from waves reflected back along the waveguide by the antenna. The isolator stops reflections, yet allows the transmitted signals to go through clear and strong.

This isolator is a slab of ferrite which is mounted inside the waveguide, and is kept magnetized by a permanent magnet strapped to the outside. The magnetized ferrite pushes aside outgoing waves, while unwanted reflected waves are drawn into the ferrite and dissipated. This "field displacement" action results from the interplay between microwaves and a ferrite's spinning electrons. Bell physicists discovered this action during their fundamental studies of ferrites.

This is another example of how Bell Telephone Laboratories research works to improve American telephony and telecommunications throughout the world.



▲ The heart of the isolator is a ferrite slab. Geometric pattern is a carbon layer which dissipates reflected signals.



◀ At a radio relay station an isolator assures one-way transmission from the output of the amplifier to the antenna.

BELL TELEPHONE LABORATORIES

WORLD CENTER OF COMMUNICATIONS RESEARCH AND DEVELOPMENT

Within the Industry

ACOUSTICAL SOCIETY OF AMERICA will play host to the Second International Congress on Acoustics which will be sponsored by the International Commission on Acoustics of the I.U.P.A.P. under UNESCO.

The meet will be held in Cambridge, Mass., June 17th through 23rd. Registration headquarters and some of the technical sessions will be located at MIT's new Kresge Auditorium while other sessions and events will be held at Harvard University's Sanders Theatre.

Full details on the program as well as reservation information is available from John A. Kessler, secretary, Second ICA Congress, Acoustics Laboratory, Massachusetts Institute of Technology, Cambridge 39, Mass.

* * *

T. R. HAYS, formerly district sales manager for equipment sales for *RCA's* Tube Division, has been promoted to the post of general sales manager of the Semiconductor Division of the firm. He will make his headquarters in Harrison, New Jersey.

Mr. Hays joined *RCA* in 1937 after his graduation from the University of Ohio. During World War II, he served as a radar specialist, first in Europe and then with the Bureau of Ships in Washington. After leaving the armed services in 1945, he returned to *RCA,* where he has since held various posts in the equipment sales department.

* * *

GENERAL CEMENT MFG. COMPANY of Rockford, Illinois, has been acquired by **TEXTRON AMERICAN, INC.** and will be operated as a division of the parent company . . . **INTERNATIONAL RESISTANCE COMPANY** of Philadelphia has merged with three of its wholly-owned subsidiary companies on the West Coast which will henceforth be known as the **HYCOR DIVISION** of the parent firm. All three facilities have been transferred to a new plant at 12970 Bradley Ave., Sylmar, California . . . **ARTHUR D. LITTLE, INC.,** an industrial research consulting company of Cambridge, Mass., has acquired **THE MINER LABORATORIES** of Chicago . . . **GARY WELLS COMPANY** has been established at 149 Broadway, New York 6, New York, for the purpose of acting as importers of selected electronic devices and parts . . . **ELGIN NATIONAL WATCH COMPANY** has set up a new Micronics Division which will cater to the needs of other manufacturers for miniaturized precision parts . . . **SEMIMETALS, INC.** has been established for the manufacture of germanium and silicon components. Offices are at 15 East 48th Street in New York while the plant is located at 130-11 90th Ave., Richmond Hill, New York . . . **CLEVITE CORPORATION** has changed the name of its **HARRIS PRODUCTS COMPANY** subsidiary, to **CLEVITE HARRIS PRODUCTS, INC. . . . PERLMUTH ELECTRONIC ASSOCIATES** is the new name of the sales rep firm of **PERLMUTH-COLMAN & ASSOCIATES** of Los Angeles . . . **MAGNAVISION ELECTRONICS CORPORATION** has been established at 544 South Avenue, Garwood, N. J., to manufacture television replacement tubes . . . **AUTOMATIC POWER, INC.** has been organized in Houston, Texas, to manufacture packaged power units for unattended operation at remote locations. The address is 205 Hutcheson Street . . . **U.S. HOFFMAN MACHINERY CORP.** has entered the atomic energy field with the acquisition of a majority interest in **ANTON ELECTRONIC LABORATORIES, INC.** The Brooklyn firm will be operated as an independent subsidiary.

* * *

LOUIS L. ACKERMAN has been appointed vice-president in charge of purchasing at *CBS-Columbia.* He has served as director of purchases for the past three years.

He brings to his new post at the company headquarters in Long Island City, New York, a career in purchasing that dates from 1935. He has been associated with *Capehart-Farnsworth* and *Arvin Industries.*

* * *

RADIO CORPORATION OF AMERICA has established an advanced development laboratory at Needham, Mass., dedicated to the field of ferrites. The lab is housed in a one-story brick building comprising 20,000 square feet of space . . . **CAL-BEST ELECTRONICS COMPANY** is building a new research laboratory and office structure at Exposition and Vineyard in Los Angeles. Completion is scheduled for July of this year . . . **HYCOR DIVISION** is now occupying a modern, air-conditioned building at 12970 Bradley Ave., Sylmar 1, California . . . **PRECISION TECHNOLOGY, INC.** has opened a new engineering laboratory and production facility in Livermore, California . . . A new 120,000 square foot tube warehouse is being built by **WESTINGHOUSE** to supplement its existing plant facilities in Elmira, New York . . . **GENERAL DY-**

MOST ACCEPTABLE

FROM DELCO RADIO

come the transformers with high acceptability. You trust them... so do your customers!

Universal vibrator transformers, produced through the combined electronic skills of Delco Radio and General Motors, meet the requirements of nearly every model of auto radio. Each is designed for easy installation and complete customer satisfaction. Laminated core inserts are stamped out of low-loss silicon steel and heat treated to maintain correct magnetic properties. Coils are precision-wound on special machines. All models have ample leads. Your UMS-Delco Electronic Parts Distributor can supply you with all models. Call him today. Remember, the Delco Wonder Bar Radio is being nationally advertised in leading consumer publications . . . so you are tuned in on a constantly increasing service.

Uncased Models 6055, 6065, 6067 do not include filter network

Cased Models 6060, 6064 and 6066 are made with "A" line filter network consisting of an "A" choke and .5 mfd. capacitor. Easy-mount drilling template, plus three self-tapping screws are included for your convenience.

DELCO

WONDER BAR

RADIO

DIVISION OF GENERAL MOTORS, KOKOMO, INDIANA

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A GENERAL MOTORS PRODUCT — A UNITED MOTORS LINE

Distributed by Delco Electronics Parts Distributors

A complete line of original equipment service parts from the

WORLD LEADER IN AUTO RADIO

NAMICS CORPORATION has leased approximately 300 acres of land from the City of San Diego as a site for the construction of laboratory facilities for its **GENERAL ATOMIC DIVISION** . . . **UNITED CATALOG PUBLISHERS, INC.** of New York has established a West Coast sales office at 9015 Wilshire Blvd., Beverly Hills, California. Charles H. Mitchell is in charge . . . **SHURE BROTHERS INC.** has moved to 222 Hartrey Ave., Evanston, Illinois . . . **RMC ASSOCIATES** has acquired a new building at 236 East 75th Street, New York City which will double the representative firm's present space . . . A new California branch of **FEDERAL TELECOMMUNICATION LABORATORIES** has been established at Bledsoe Street and San Fernando Road, Los Angeles . . . A flight laboratory for the air and ground testing of airborne electronic equipment and systems has been established by **RADIO CORPORATION OF AMERICA** at New Castle County Airport, New Castle, Delaware . . . The Plastics Division of **GENERAL AMERICAN TRANSPORTATION CORPORATION** has established a research and development laboratory at 300 E. 51st Street, East Chicago, Indiana, just adjacent to its present plant . . . **WARWICK MANUFACTURING CORPORATION** is building a new engineering and administrative office building at Lehigh and Touhy Avenues in Chicago which will be ready for occupancy by mid-July. The new 65,000 square foot building is modern in design and air-conditioned throughout.

* * *

ARTHUR L. FOSTER has been appointed advertising manager of the special products division of *Stromberg-Carlson* of Rochester.

In his new post Mr. Foster will have charge of advertising the company's sound and intercom systems, high-fidelity equipment, electronic carillons, and other special products. He has been with the firm for about two years and prior to that served with the U. S. Navy in the Mediterranean area.

* * *

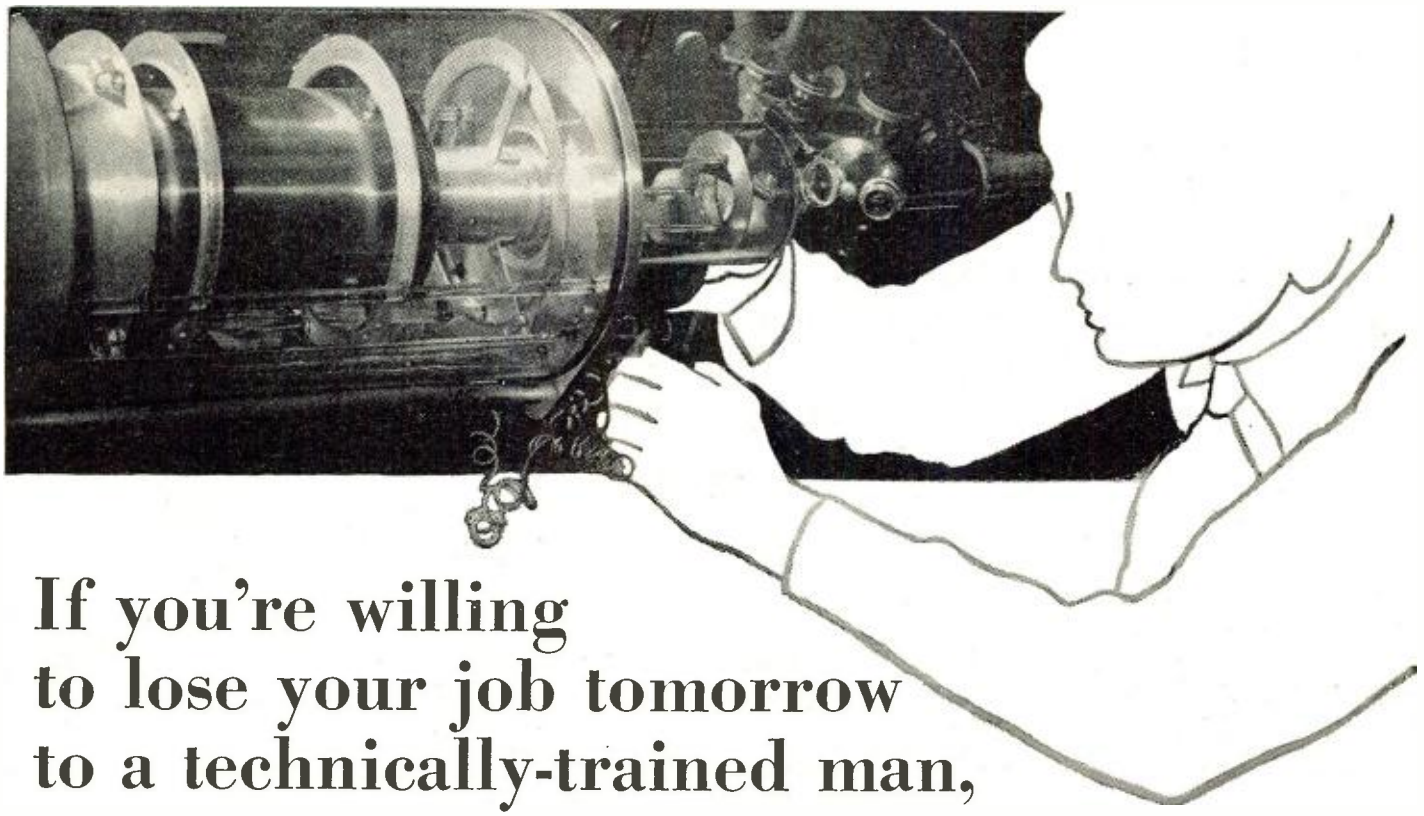
PAUL V. GALVIN, president of *Motorola Inc.* and a director of the RETMA for 22 years, will receive the association's 1956 Medal of Honor during its convention June 12-14 in Chicago.

Mr. Galvin was nominated by the Annual Awards Committee, headed by Leslie F. Muter, who cited his long leadership in Association activities and called particular attention to his work in behalf of the industry during World War II. Mr. Galvin was president of RETMA from 1942 through 1944 and has served as chairman of most major committees during his long leadership in industry affairs.

* * *

DR. CLINTON R. HANNA, associate director of the *Westinghouse Research Laboratories,* Pittsburgh, has been

(*Continued on page* 138)



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

turn the page, mister

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

The "how" is CREI training in radio-television-electronics. You don't have to be a college graduate. You *do* have to be willing to study—at home. You can do it while holding down a full-time job. Thousands have. However, you must have some prior electronic experience, either in military service, professional employment, experimenting, or ham operating. Since 1927 CREI has provided alert young men with the technical knowledge that leads to more responsibility, more job security, more money. More than a quarter century of experience qualifies CREI to train you.

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

How good is CREI training? Here are a few ways to judge. Ask an electronics engineer, if you know one. Ask a high-school or college physics teacher. Ask a radio station engineer. Check up on our professional reputation: CREI home study courses are accredited by the Engineers' Council for Professional Development; CREI is an approved member of the National Council of Technical Schools. Ask personnel managers how they regard a man with a CREI "ticket." Look at this partial listing of organizations *that choose CREI* to train their own personnel: All American Cables & Radio, Inc.; Canadian Aviation Electronics, Ltd.; Canadian Broadcasting Corporation; Columbia Broadcasting System; Hoffman Radio Corp.; Matchlett Labs.; Glenn L. Martin Co.; Magnavox Co.; Pan American Airways, Atlantic Division; Radio Corporation of America; United Air Lines. Finally, ask a CREI graduate to tell you about our Placement Bureau, which currently has on file more requests for trained men than we can fill.

What's the next step? The logical one is to get more information than we can cram into one page. The coupon below, properly filled out, will bring you a fact-packed booklet called "Your Future in the New World of Electronics." It includes outlines of courses offered, a resume of career opportunities, full details about the school, and tuition details. It's free.

Note: CREI also offers Residence School instruction, day or evening, in Washington, D.C. New classes start frequently. If you are a veteran discharged after June 27, 1950, let the new GI Bill help you obtain resident instruction. Check the coupon for more data.

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

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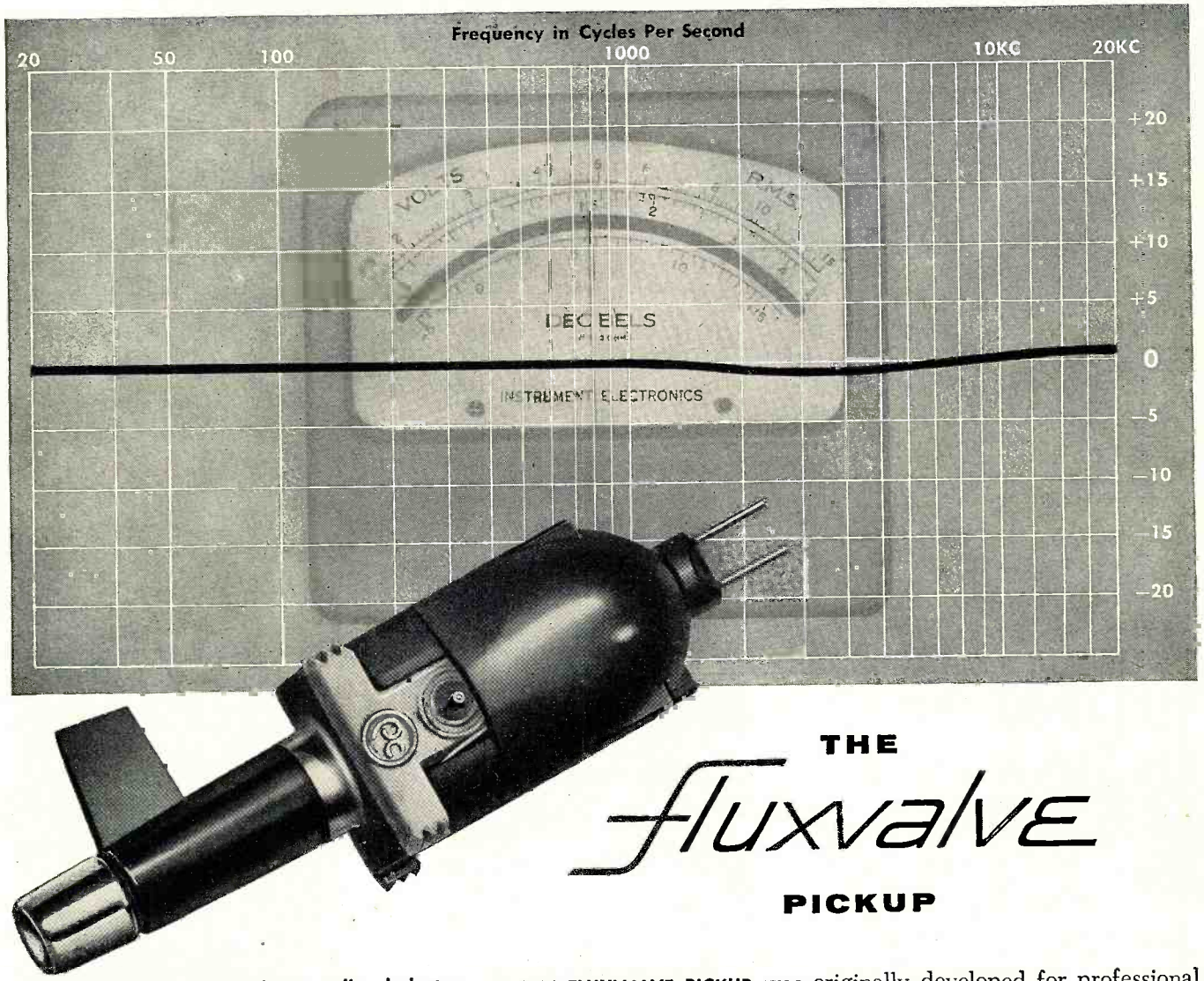

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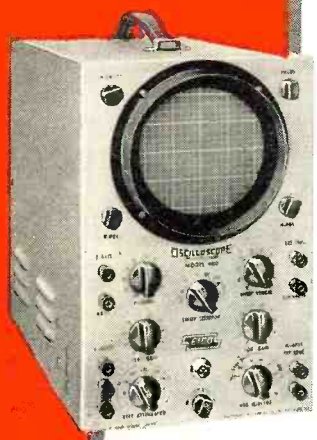

The FINEST professional 5 mc wide-band scope value. Ideal for research, h-f & complex waves, plus Color & Monochrome TV servicing. Flat from DC to 3.58 mc ±1 db (color burst freq.), flat DC to 4.5 mc +1, −3 db. Vert. sens. 25 rms mv/in. Vert. Z 3 megs. Has the following outstanding features not found in scopes up to several times its price, kit or wired:

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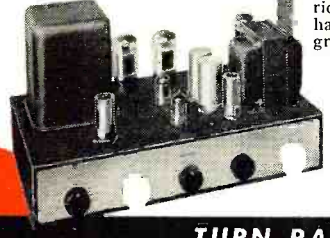

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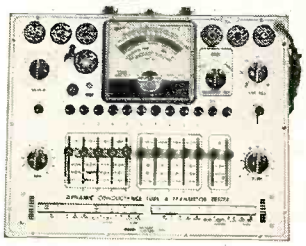

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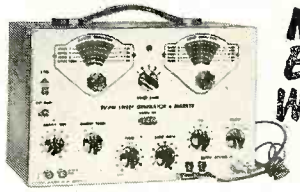

N E W

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• tests 600 mil series string type tubes
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Multi-range ac/dc voltmeter, ammeter, ohmmeter, wattmeter, leakage checker for home & auto repairs.

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• fast check all flybacks & yokes in or out of set.
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Range 500 kc—228 mc on fund. Cont. sweep width control, 0—30 mc.
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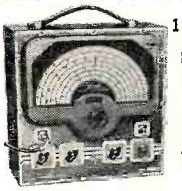

1% accuracy on all 7 ranges. Range 75 kc—150 mc. Volt reg.
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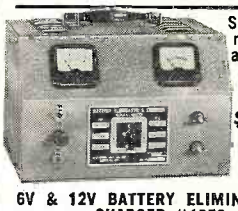
DELUXE RF SIGNAL GENERATOR #315



Sep. volt-meter & ammeter
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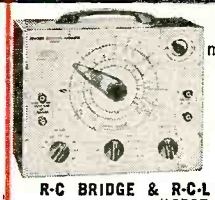

Reads 0.5 ohms—500 megs, 10 mmfd—5000 mfd; power factor.
KIT $19.95
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R-C BRIDGE & R-C-L COMPARATOR #950B

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HI-FI PREAMPLIFIER #HF-6
KIT $24.95 Wired $37.95. With Power Supply: KIT $29.95. Wired $44.95
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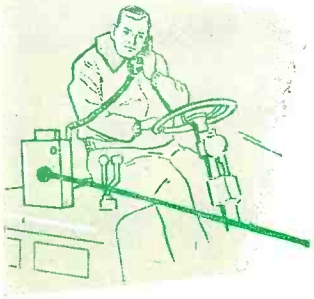


Person to Person Communications

Agent on Southern Pacific's "Lark" places phone call over the train's radiotelephone.

By **LEO G. SANDS**

Recent developments point the way toward personal communication in the future.

IMAGINE walking down the street or riding in an elevator or subway train when suddenly a bell rings inside your coat pocket. This signal lets you know that someone is trying to reach you. Stopping at the nearest pay telephone station, you call your home or office to get the message.

This is "personal" communication. It is not here in this form but it is not far away. It is practical and will be available when a suitable transistorized subminiature v.h.f. or u.h.f. receiver and a microminiature decoder are developed. One telephone official predicted that in the future everyone will be assigned a personal telephone number which will remain his or hers for life.

The ultimate will be a vest-pocket-size radiotelephone which will permit the extension of telephone service to all persons irrespective of where they are. This is no more fantastic than being called by the porter from your chair on the "Royal Blue" to answer the trainboard radiotelephone. It is being done every day on many name trains.

RCA has already developed a pocket-size transistorized v.h.f. two-way radio unit. Although currently being produced exclusively for the armed forces, its civilian counterpart can be anticipated.

So that more than just a few people in each urban area can be served, the personal pocket telephone will have to wait for the development of inexpensive techniques for dividing the radio spectrum so that thousands of messages can be transmitted simultaneously without mutual interference.

Radio Paging

There is today a reasonable substitute for the pocket telephone in the form of radio paging. In many cities, independent communications common-carrier companies operate base stations for radio paging which transmit on either 35.58 mc. or 43.58 mc., the two channels assigned to this service. These AM voice signals are picked up by subscribers who carry tiny pocket radio receivers or have their cars equipped with special fixed-tuned mobile v.h.f. receivers.

Typical of these tiny pocket receivers is the one made by *West Coast Electronics Company* which weighs only 6 ounces. Self-contained batteries which last up to 6 months in normal intermittent service furnish power for the simple two-tube superregenerative circuit. To conserve battery life, the receiver is inoperative until a small button is pressed. To listen, a subscriber holds the receiver to his ear, presses the button, and listens to sounds emanating from the miniature built-in speaker.

The base station transmits the names or code numbers of subscribers for whom there are messages, usually from a continuous tape recording. When a subscriber responds from a convenient telephone, his name is erased from the tape.

Mobile Telephone Service

Of course, you can get a telephone installed in your car which will permit you to call almost any other telephone in the world. However, the *Bell Telephone* companies and the few independents which provide mobile telephone service can serve only a few subscribers in each locality and then on a party-line basis because of the limited number of available radio channels.

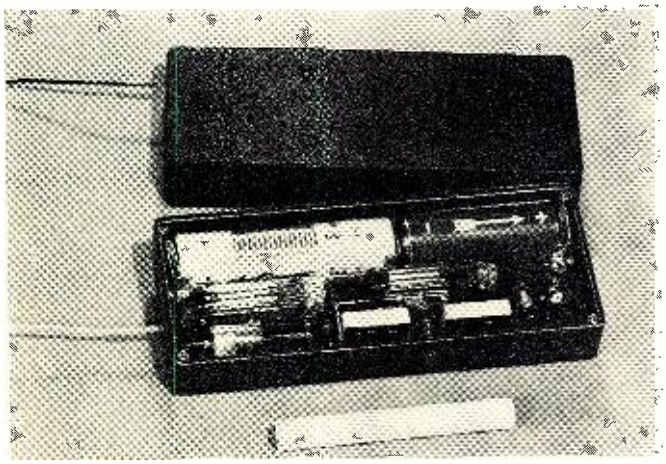
In San Francisco, for example, the *Pacific Telephone and Telegraph Company* has only two radio channels in the 152-162 mc. band in this type of service, two in Oakland across the bay, and a fifth channel in Sacramento, less than 100 miles away, for serving an area with a population of about four million. In addition, highway mobile telephone facilities in the 25-50

The newly-developed RCA ultraminiature FM transceiver which operates on frequencies between 45 and 50 mc. and utilizes 12 transistors. It weighs 15 oz. Range is ¼ mile.

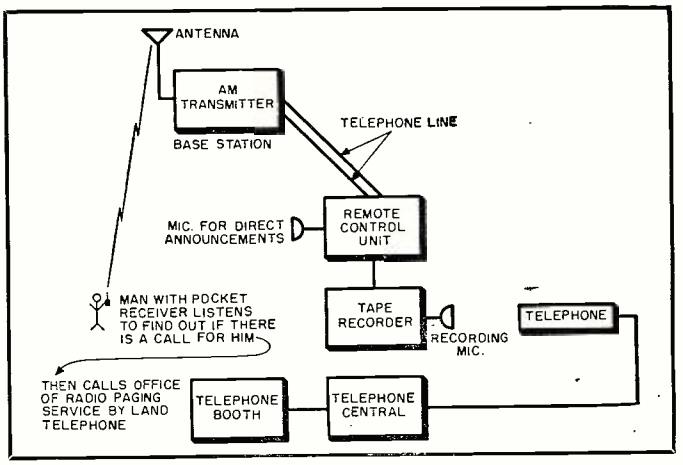
Frequencies allocated to the mobile radio services, excluding amateur radio bands.

27.5	to	28.0	mc.*
29.7	to	50.0	mc.
152.0	to	162.0	mc.
162.0	to	174.0	mc.
450.0	to	460.0	mc.
460.0	to	470.0	mc.**

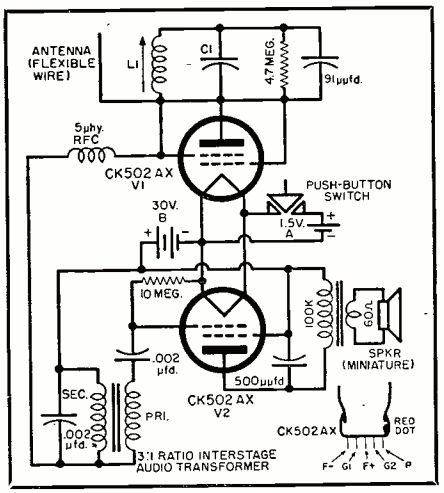
* Government agencies only
** Citizens Radio Service



The West Coast Electronics Co.'s personal pocket receiver as used in radio paging systems. This tiny receiver weighs only 6 ounces, employs a superregenerative circuit and uses subminiature tubes. It can receive paging calls 50 miles away.



Block diagram of a radio paging system setup The customer receives his coded call on his pocket receiver (shown in photo at left) and then contacts the paging service by phone to get the message. His radio equipment is not used for transmission.



Schematic of West Coast Electronics Co.'s radio paging pocket receiver for 35.58 or 43.58 mc. Tuning depends on the value of C_1 and adjustment of the slug in coil L_1.

mc. band are operated with base stations in Oakland, San Jose, and Sacramento to give blanket coverage of central California.

Approximately 100 independent common-carriers render radio dispatching service in this country. They relay messages to subscriber vehicles equipped with two-way radio units owned by the subscriber or leased from the common carrier.

Mobile Radio Industry

Mobile radio is the term generally used to describe radio communications between persons at fixed points and aboard vehicles as well as between persons on board different vehicles. However, *mobile radio* includes communications with persons carrying personal radio units whether on horseback or in a conveyance. Thus pocket paging receivers, "walkie-talkies," and "breakie-backies" are considered mobile radio. In this article, mobile radio refers to commercial applications but not to amateur mobile operation.

The idea of mobile radio is not new. The 1895 edition of a book edited by J. B. McClure entitled "Edison and His Inventions" describes a train-to-fixed-point telegraph communication system. This was probably the first *mobile radio* system. True, it was not radio in the form as we know it today, but it did operate without direct wire connections, it was electrical and did depend upon the presence of a modulated magnetic field.

Today, there are well over 250,000 mobile units in operation in the United States. Some 90,000 mobile units have been authorized for use in taxicabs alone. More than $100,000,000 has been invested in mobile radio. Yet, this is only the beginning.

Law enforcement agencies were among the first to utilize mobile radio. Today, electric utilities, taxicab operators, bus lines, truckers, railroads, contractors, pipe line operators, oil exploration crews, foresters, housewives, and some radio and TV technicians use mobile radio. It is a vital tool which saves time and money.

Paradoxically, the telephone companies which provide mobile radio telephone service and lease mobile radio systems to private users, also operate the nation's largest fleet of trucks, but do not use two-way radio themselves in their own operations. Likewise, the giant nationwide fleet of the *RCA Service Company,* which services mobile radio equipment as well as TV sets, is not yet fully radio-equipped.

Like the cobbler's children who have no shoes, thousands of radio and TV technicians who could make use of two-way radio, do not. These are the people who know how the equipment works, can do their own installation and repairs, and "can get it wholesale."

Until the Citizens Radio Service was established, the use of private mobile radio systems was restricted to certain specified types of organizations whose use of two-way radio was in the public interest. For example, a petroleum exploration firm could use radio but a retail distributor of petroleum products in an urban area could not obtain a license.

Today, any citizen may apply for a license in the Citizens Radio Service. This means that a radio and TV technician, a diaper laundry, a baker, and even a housewife can operate a private radio communications system.

Industrial Radio

Destined to be the biggest market for mobile radio is industry. The FCC

Directory of manufacturers producing two-way radio equipment of various types.

Bendix Radio Division
8633 Loch Raven Blvd., Baltimore 4, Md.

Cleveland Electronics, Inc.
6611 Euclid Ave., Cleveland, Ohio

Communications Company, Inc.
300 Greco Avenue, Coral Gables, Florida

Communications Engineering Co.
900 Dragon Street, Dallas, Texas

Connecticut Telephone & Electric Corp.
70 Britannia Street, Meriden, Conn.

Robert Dollar Company
50 Drumm Street, San Francisco, Calif.

Allen B. Du Mont Laboratories, Inc.
1500 Main Avenue, Clifton, N. J.

Federal Telephone & Radio Company
119 Eighth Street, Passaic, N. J.

General Electric Company
Electronics Park, Syracuse, N. Y.

Industrial Radio Corp.
428 N. Parkside Ave., Chicago, Ill.

Kaar Engineering Corp.
2995 Middlefield Road, Palo Alto, Calif.

Motorola Communications & Electronics, Inc.
900 N. Kilbourn Ave., Chicago 50, Illinois

Pye Corporation of America
270 Park Avenue, New York 17, N. Y.

Radio Corporation of America
Communications Equip. Marketing Dept.
Building 15-2, Camden 2, N. J.

Royalcall
11462 Euclid Ave., Cleveland, Ohio

Stewart Warner Corp.
1300 N. Kostner Ave., Chicago, Ill.

Vocaline Co. of America, Inc.
Old Saybrook, Conn.

West Coast Electronics Company
5873 W. Jefferson Blvd., Los Angeles, Calif.

The mobile radio antenna installed 435 ft. above the street at Pacific Telephone and Telegraph's main building in San Francisco. Anne Flick doesn't mind the "long drop."

COVER STORY

THE "last word" in golfing convenience is this electric "Golf Pony" by McCulloch Motors Corp. of Los Angeles equipped with the Kaar "Imp" two-way radio. Designed specifically for the low-power industrial service, the radio operates in the 152-162 mc. band and can be powered either by a 6 or 12 volt battery or from 117 volts a.c. The golf cart is powered by four 6-volt heavy-duty batteries which are good for 54 holes before recharging. The cart is a 4-wheeled type which will carry one golfer and one or two bags easily and safely. It is built on a lightweight automotive type chassis with automotive steering and completely enclosed differential gear drive. It has automatic brakes of the disc type. Operation of the car is controlled by a lever on the left side which handles all functions.

has separated various types of industries into different categories which include petroleum, power, forest products, motion picture, relay press, special industrial, and low-power industrial radio services. Manufacturing industries are licensed in the special industrial radio service, the low-power industrial radio service, or the Citizens Radio Service, depending upon the nature of the enterprise and communications requirements.

To make it possible for more industries to use mobile radio on the few available channels without excessive mutual interference, the FCC established the low-power industrial radio service in which transmitter antenna height is limited and transmitter power input (to the final) must be kept under 3 watts. It is intended that communicating range be confined to a single general plant area rather than extended to vehicles operating on public streets and highways.

In the low-power industrial radio service, a person or company engaged in a commercial activity or an industrial enterprise may be eligible for licensing provided citizenship requirements are met. Educational and philanthropic institutions are also eligible as are state and local governments when the radio facility is used primarily for purposes not directly related to public safety.

Most equipment manufacturers now offer mobile units for the low-power industrial radio service. They are generally modified versions of higher power sets. An example of a mobile unit designed exclusively for this service is the "Imp," an unusually compact transmitter-receiver unit manufactured by *Kaar Engineering Corporation*. The "Imp" can be used either as a base station or mobile unit and can be operated directly from a 6 or 12 volt battery or 117 volt a.c. line without modification.

Frequency Scarcity

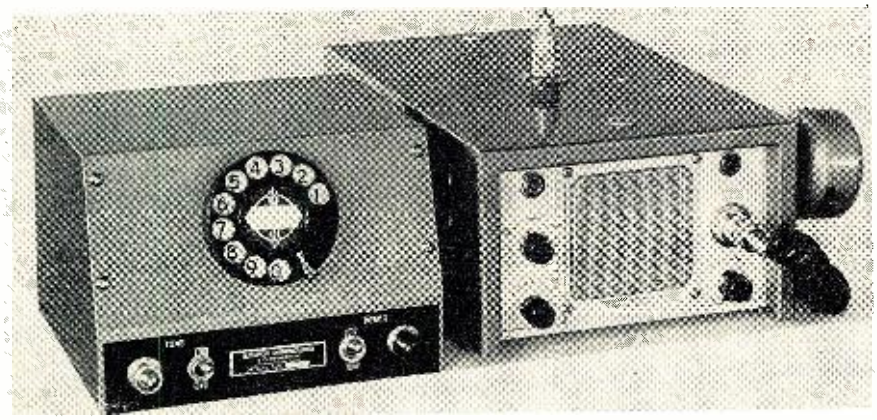
A problem of deep concern to equipment manufacturers and prospective users alike is the availability of radio channels—or rather, the lack of enough of them to meet the demand. There is only so much space in the radio spectrum for which practical equipment has been developed. This space has been divided into channels which have been allocated to specific services. Now that the economic advantages of mobile radio are apparent, there are many more potential users than channels. The telephone companies in particular are beseeching the FCC for wide blocks of radio spectrum space so they can take care of the present and anticipated future demand for mobile telephone services.

Engineers are talking about dividing the radio spectrum into narrower channels. The *Pacific Telephone and Telegraph Company* has installed an experimental split-channel system in Los

← Vibrator-type inverter allows operation of mobile units with a.c. power supply where only 24 volts d.c. is available. (Cornell-Dubilier.)

↓ Compact single-package mobile unit which contains transmitter, receiver, and power supply. Equipment by Du Mont.

↓ Under-dash type mobile unit using drawer construction which permits easy access for servicing. This unit is made by Communications Co., Inc. of Coral Gables.



Kaar Engineering's low-power industrial radio unit with "Secode" selective calling dial code sender attached. The "Imp" radio plugs into ordinary a.c. outlet and requires only 48 watts of power. Selective calling is optional.

The mobile radio unit on this fork-lift truck is energized by a separate 6-volt storage battery. The 36-volt battery which furnishes power for the truck is not connected to the radio system. Both batteries are charged simultaneously when the truck is not in use. Milton O'Donnell, general manager of the Johnson & Johnson plant in Menlo Park, California, demonstrates this Motorola two-way communications unit.

Angeles. *Motorola* has operated a split-channel system in Arizona for a number of years.

Under the present FCC operating rules for the 152-162 mc. band, center frequencies are spaced 60 kc. apart. In split-channel operation, channels are only 30 kc. apart.

Most mobile radio systems employ FM with frequency deviation limited to 15 kc. on each side of the center frequency. However, many transmitters using modern narrow-band equipment in the 25-50 mc. band deviate less than half that amount. A new British mobile unit made by *Pye* requires only 25 kc. of band space including the required guard band.

To permit split-channel operation, receivers must be more selective and transmitter spurious emissions must be kept at a minimum. Manufacturers are keeping in step with this requirement. *Motorola* uses a plug-in tuned circuit called a *PermaKay* filter, available for present adjacent channel service or future split-channel applications. *Bendix* provides a kit which permits narrowing the passband. *Sierra Electronic Corp.* manufactures low-pass filters for transmitters which sift out harmonics. *Electronic Products Corp.* has a staggered crystal filter which might be developed into a future mobile radio i.f. bandpass system.

Selective Calling

Then there is another solution. It does not provide more individual talking channels but it does provide privacy for "party-line" or channel-sharing licensees. This is "selective calling" for which equipment has been available for a long time but which was plagued by operational difficulties. Recent equipment developments have resulted in several types of reliable selective calling systems which are available at reasonable cost.

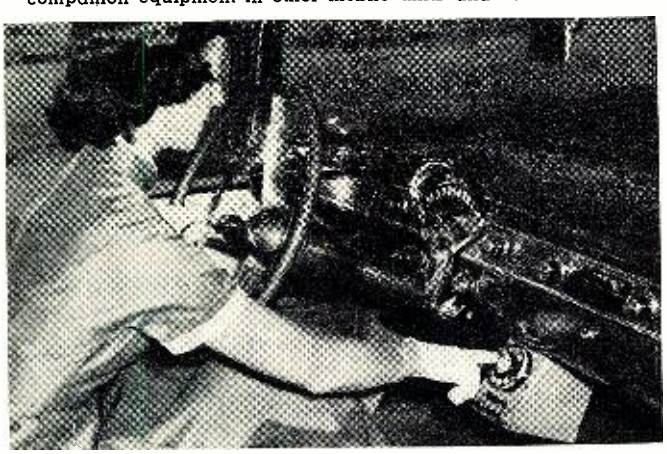
There are two basic types—tone-gated systems and dial-pulse systems. Tone-gated systems utilize push-buttons and respond fast. One tone or a combination of tones is transmitted which unlocks circuits within one selected receiver or a group of receivers in a fleet set to respond to this particular tone signal. The unlocking process may turn "on" a loudspeaker, sound a horn, ring a bell, turn on a light, etc. *RCA, Motorola, G-E,* and *Federal* manufacture tone-gated selective calling systems for use with their own brands of mobile radio equipment.

A dial-pulse system which can be added to any make of mobile radio equipment has been developed by *Electrical Communications, Inc.* This add-on apparatus is supplied by some radio equipment manufacturers as an optional accessory and when sold direct by its own manufacturer, it is known as the "Secode Selective Calling System." A compact dial pulse sender unit is attached to the audio input of the base station transmitter. Each of the radio-equipped vehicles in the fleet is provided with a simple electro-mechanical decoder unit which can be preset to respond to any of over 10,000 possible code combinations.

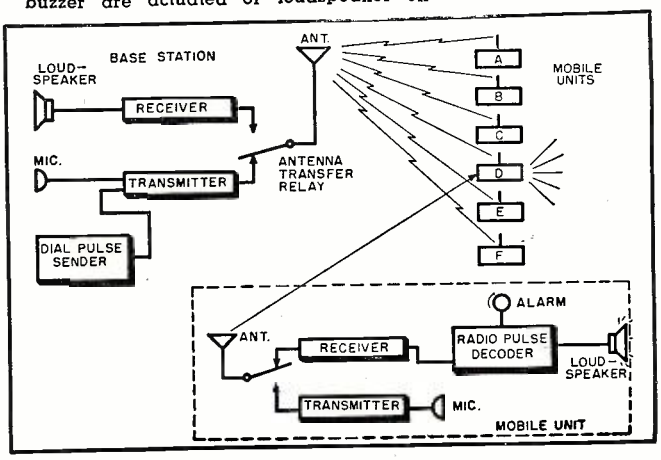
The base station operator may dial each car individually, in groups, or all equipped with dial pulse senders to at once. Mobile units, too, may be permit drivers to dial other mobile units, base stations, or to turn on pumps, shut off lights, etc., remotely by radio. In a new installation in the planning stage, drivers will be able to

(*Continued on page* 141)

Dialing other mobile units and base stations, as well as the remote control of machines and lights, can be effected by providing a dial pulse sender in the radio-equipped vehicle and companion equipment in other mobile units and base stations.



Selective calling provides privacy of communication. Mobile units A,B,C,E, and F are locked out so they cannot receive when mobile unit D is dialed. In mobile unit D, a lamp and buzzer are actuated or loudspeaker on unit is turned on.



Transmission Lines

By **ROBERT B. GARY**

This table will help you select the right wire or cable for test leads, transmission lines, and other uses.

WHETHER a short piece of coaxial cable is needed as a shielded test lead for an oscilloscope, or 10 miles of transmission line is to be selected for a community TV system, the electrical characteristics of the various commercially available cables are important criteria. The table presented here lists all of the most frequently-used coaxial cables and TV twin-leads and gives their electrical characteristics.

The wires and cables in the table are listed by "RG" numbers since these represent the only standard designations available for a great variety of manufacturer type numbers. Some of the types are variations of a standard type; for example, one variation may have a special outer insulation effective at low temperatures, or a metal outer sleeve or "armor." In many instances the letter "A" or "B" follows the type number and indicates that either a different type outer jacket or some other minor variation exists.

The type numbers listed represent the basic, up-to-date cables manufactured by most of the major cable suppliers.

Note that the characteristic impedances do not always fall into the standard 50 or 75 ohms expected from most diagrams. In general, such values as 48 or 53 ohms are close enough to 50 ohms to be considered such.

The outer diameter of a cable is important because it will determine such mechanical details as cable clamps, connector types, and feedthrough holes. The electrical data includes the effective capacity in micromicrofarads per foot, an important consideration in cables feeding either pulse networks or tuned circuits. The cable for an oscilloscope probe, for example, should have minimum capacity. If the nominal scope input capacity is 30 $\mu\mu$fd. without the cable and a 6-foot length of RG 58/U is added, this increases the effective input capacity to more than 200 $\mu\mu$fd., which may be sufficient to distort the leading edge of a short duration pulse.

Attenuation per 100 feet is stated in decibels for the most important frequencies. While attenuation in transmission lines becomes critical usually only in long distance systems such as in community TV installations, even shorter lengths require some consideration. Consider the lead-in from a 30-foot tower-mounted antenna array

(*Continued on page* 154)

TYPE RG . . . /U	IMP. OHMS	CAP. $\mu\mu$fd. PER FT.	OUTER DIAM. (inches)	ATTENUATION/100 FEET 1 mc.	10 mc.	100 mc.	400 mc.	1000 mc.	REMARKS
5	52.5	28.5	.332	.21	.77	2.9	6.5	11.5	Small, double braid
5A	50	29	.328	.16	.66	2.4	5.25	8.8	Small, low loss
6	76	20	.332	.21	.78	2.9	6.5	11.2	I.F. & video
8	52	29.5	.405	.16	.55	2.0	4.5	8.5	General purpose
9	51	30	.420	.12	.47	1.9	4.4	8.5	General purpose
9A	51	30	.420	.16	.59	2.3	5.2	8.6	Stable attenuation
11	75	20.5	.405	.18	.62	2.2	4.7	8.2	Community TV
13	74	20.5	.420	.18	.62	2.2	4.7	8.2	I.F.
14	52	29.5	.545	.10	.38	1.5	3.5	6.0	R.F. power
16	52	29.5	.630	.....	.....	.....	.....	.....	R.F. power
17	52	29.5	.870	.06	.24	.95	2.4	4.4	R.F. power
19	52	29.5	1.120	.04	.17	.68	1.28	3.5	Low-loss r.f.
21	53	29	.332	1.4	4.4	14.0	29.0	46.0	Attenuating cable
22	95	16	.405	.41	1.3	4.3	8.8	.....	Twin conductors
22A	95	16	.420	.42	1.3	4.0	8.5	12.5	Twin conductors
23	125	12	.65x.945	.....	.4	1.7	.....	.....	Twin conductors (balanced)
25	48	50	.565	.....	.....	.....	.....	.....	Pulse
26	48	50	.525	.....	.....	.....	.....	.....	Pulse
27	48	50	.675	.....	.....	.....	.....	.....	Pulse
28	48	50	.805	.....	.....	.....	.....	.....	Pulse
33	51	30	.470	.....	.....	.....	.....	.....	Pulse
34	71	21.5	.625	.065	.29	1.3	3.3	6.0	Flexible, medium
35	71	21.5	.945	.064	.22	.85	2.3	4.2	Low-loss video
36	69	22	1.180	.....	.....	.....	.....	.....	
41	67.5	27	.425	.....	.....	.....	.....	.....	Special twist
54A	58	26.5	.250	.18	.74	3.1	6.7	11.5	Flexible, small
55	53.5	28.5	.206	.36	1.3	4.8	10.4	17.0	Flexible, small
56	.....	.....	.535	.....	.....	.....	.....	.....	Pulse
57	95	17	.625	.18	.71	3.0	7.3	13.0	Twin conductors
58	53.5	28.5	.195	.38	1.4	5.2	11.2	20.0	General purpose
58A	50	29	.195	.42	1.6	6.2	14.0	24.0	Test leads
59	73	21	.242	.30	1.1	3.8	8.5	14.0	TV lead-in
60	50	.....	.425	.....	.....	.....	.....	.....	Pulse cable
61	500	.....	.....	.....	.....	.....	.....	.....	Special 500-ohm twin-lead
62	93	13.5	.242	.25	.83	2.7	5.6	9.0	Low capacity, small
63	125	10	.405	.19	.61	2.0	4.0	6.3	Low capacity
64	48	50	.495	.....	.....	.....	.....	.....	Pulse
65	950	44	.405	.....	.....	.....	.....	.....	Coaxial delay line
71	93	13.5	.250	.25	.83	2.7	5.6	9.0	Low capacity, small
72	150	.....	.630	.....	.....	.....	.....	.....	Not stock items
73	25	.....	.275	.....	.....	.....	.....	.....	
77	48	50	.415	.....	.....	.....	.....	.....	Pulse
78	48	50	.385	.....	.....	.....	.....	.....	Pulse
83	35	44	.405	.23	.80	2.8	5.8	9.6	Semi-flexible
87A	50	29.5	.425	.13	.52	2.0	4.4	7.6	Teflon dielectric
88	48	50	.490	.....	.....	.....	.....	.....	Pulse
89	125	10	.632	.19	.61	2.0	4.0	6.3	Low capacity
101	75	.....	.588	.....	.....	.....	.....	.....	
102	140	.....	1.088	.....	.....	.....	.....	.....	
108	76	25	.230	.....	.....	.....	.....	.....	Twin conductors
114	185	6.5	.405	.....	.....	.....	.....	.....	Extra flexible
117	50	29	.730	.05	.20	.85	2.0	3.6	Teflon & Fiberglas
119	50	29	.465	.....	.....	.....	.....	.....	Teflon & Fiberglas
122	50	29	.160	.40	1.70	7.0	16.5	29	
125	150	7.8	.600	.....	.....	.....	.....	.....	Extra flexible
126	50	29	.275	3.20	9.0	25.0	47	72	Teflon & Fiberglas
130	95	17	.625	.....	.....	.....	.....	.....	Twin conductors
131	95	17	.710	.....	.....	.....	.....	.....	Twin conductors
133	95	16.2	.405	.....	.....	.....	.....	.....	
140	73	21	.241	.33	1.03	3.3	6.9	11.7	Teflon & Fiberglas
141	50	29	.195	.35	1.12	3.8	8.0	13.8	Teflon & Fiberglas
142	50	29	.206	.35	1.12	3.8	8.0	13.8	Teflon & Fiberglas
143	50	29	.332	.24	.77	2.5	5.3	9.0	Teflon & Fiberglas
144	72	21	.405	.16	.53	1.8	3.9	7.0	Teflon & Fiberglas
174	50	30	.10	.....	.....	.....	19.0	.....	Miniature coaxial
Federal K-111	300	4.2	.48x.29	.....	1.2	3.4	6.6	.....	Shielded twin-lead
	300	.....	.405x.065	.....	.....	1.22	2.85	.....	7/#28 conductors
	300	.....	.37x.35	.....	.....	1.28	3.0	.....	7/#28 conductors
	300	.....	.37	.....	.....	1.15	2.6	.....	7/#28 conductors

Construction of a Wrist Radio

By
HARRY H. FRENCH
SCEL, Fort Monmouth, N. J.

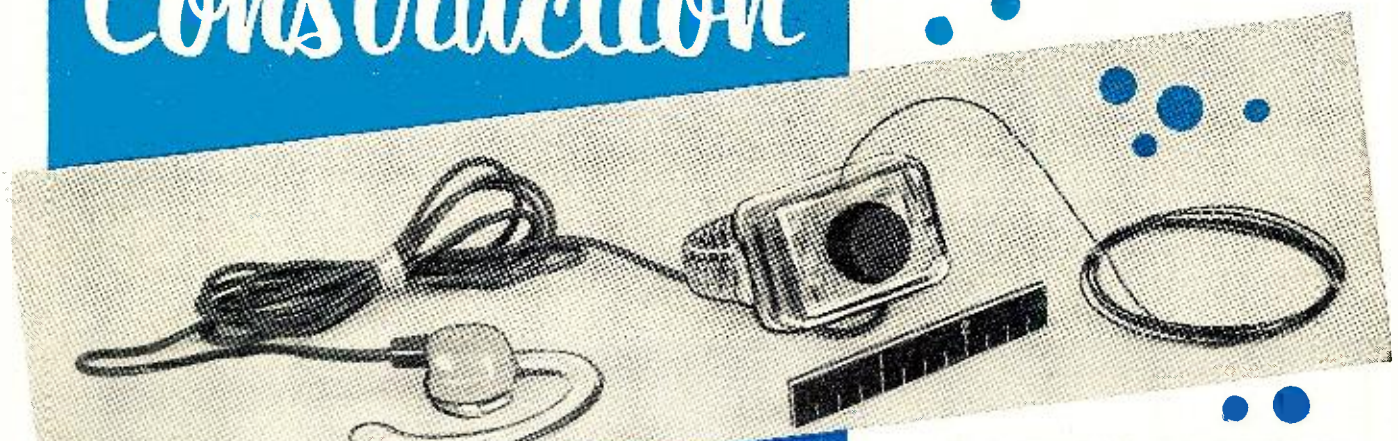


Fig. 1. Over-all view of the "wrist-watch" radio receiver. It can be mounted on a standard watchband, uses a hearing-aid type earphone, and coat-sleeve antenna.

"Build-it-yourself" version of a Signal Corps miniature experimental radio receiver.

MANY newspapers and periodicals have carried stories on the unique "Dick Tracy" wrist radio designed and fabricated at the Signal Corps Engineering Laboratories, (SCEL) Fort Monmouth, New Jersey. This unit was initiated solely as a demonstration of the miniaturization possibilities inherent in combining transistors with the basic SCEL-developed "Auto-Sembly" (printed wiring) constructional technique. This article presents the salient features of this unique receiver, as well as detailed procedures for constructing a similar unit, modified slightly to facilitate assembly in the average home workshop. Fig. 1.

The tiny transistorized receiver is self-contained in a small Plexiglas case shaped to fit the wrist and secured to the wrist with a watch strap. A hearing-aid type earphone is worn in the ear and a cord joining the earpiece to the receiver is concealed in the sleeve of the listener's coat. A short antenna is also concealed in the sleeve. A small push-to-listen switch is installed in the case to conserve the life of the miniature 6.5 volt mercury battery which consists of five RM-400-R mercury cells (1.3 volts each) and measures ½" x ⅝". Battery drain is 20 milliwatts and a single miniature battery will provide 10 hours of continuous reception.

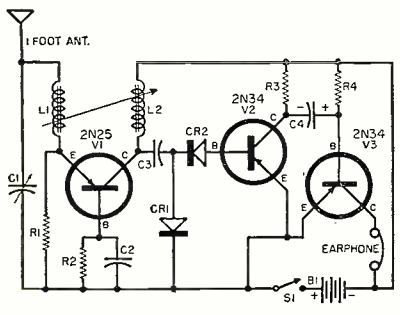
A small variable capacitor tunes the receiver from 1000-1600 kc. The regenerative stage uses a point-contact transistor (Type 1729 or 2N25) and the regeneration is controlled by variable inductive coupling. Two *p-n-p* transistors (TA153 or 2N34) are used as audio amplifiers and two bead diodes are also used (1764 or 1N84), one as a detector and one as a d.c. return.

The printed circuit wiring was formed on the copper-clad base material by a photographic process. The unit was "Auto-Sembled" with all connections soldered in a single dip of the card on the surface of a solder pot. The Plexiglas case enclosing the unit was blown to shape using simple molds, compressed air, and heat.

The wrist radio stimulated a great deal of interest among many people who expressed a desire to duplicate the unit. Unfortunately, not all of the components used, as well as professional processing equipment, are available to the average home craftsman. With this thought in mind, the following constructional details are given for a similar unit which can be fabricated in the average home workshop using conventional components and no professional processing equipment. It should be understood that the methods outlined and the modification of components are not all acceptable in military practice. However, they are simple techniques which should prove effective in producing a functional wrist radio in the home workshop.

Conversion of the schematic diagram Fig. 2 to prefabricated wiring is the first step in the construction of the wrist radio. The printed wiring pattern shown in Fig. 3 may be duplicated

Fig. 2. Complete schematic of receiver. Use of printed circuitry makes for compactness.



R1—4700 ohm, ½ w. res.
R2—900 ohm, ½ w. res.
R3—2200 ohm, ½ w. res.
R4—120,000 ohm, ½ w. res.
C1—8-50 μμfd. var. capacitor (Erie Type 557 trimmer modified, see text)
C2—.01 μfd., 150 v. ceramic capacitor
C3—150 μμfd. silver mica capacitor
C4—4 μfd., 60 v. tantalytic capacitor (Fansteel Metallurgical Corp., North Chicago, Ill.) Any small unit of proper rating may be used, such as the 4 μfd., 25 v. unit of International Electronic Industries, Box 1312, Nashville, Tenn.
L1, L2—500 μhy. coil with "Q" of 160. 240 t. of 6/44 litz wire universal wound on 3/16" length of ⅛" dia. "Ferric Q" or "J" body (Coil Winders Inc., New York Avenue, Westbury, Long Island, N. Y. or Maxwell Coil Co., 381 Empire Blvd., Brooklyn 25, N. Y.)
CR1, CR2—1N84 or 1764 crystal diode (Hughes 126, 127, 128; CBS-Hytron 126, 128; or Transitron 126, 128 may be used)
S1—Push-button switch (see text)
B1—6.5 volt mercury battery (Mallory SR 0600 or five Mallory RM-400-R cells)
V1—"p-n-p" point contact transistor, Type 2N25 or 1729 (Transistor Products Type 2D or RCA 2N33 may be used)
V2, V3—"p-n-p" transistor (2N34 or TA153)
1—2000 ohm hearing-aid type earphone (Telex)

by cutting masking tape to the size of the various lines and wedges and sticking the tape on the copper surface of the laminate, Fig. 3. The tape in the form of circuitry will protect the copper beneath it during the etching process. The pattern may also be drawn on the copper surface with machinist's Dykem Blue which will resist the ferric-chloride etchant.

When the pattern has been duplicated on the copper surface with masking tape or Dykem ink, the card is placed in a glass or enamel tray and a 50% solution of ferric chloride and water is added. The unprotected surfaces of the copper will be etched away as the tray is rocked. After etching, the pattern is washed in water and the masking tape or Dykem Blue is removed. The pattern may be trimmed to size and the component mounting holes drilled.

Figs. 4 and 6 illustrate the placement of the components on the printed circuit card. Small holes (#60 drill) are drilled through the circuitry and card, and are spaced to accommodate the various component leads. It is advisable to drill from the circuitry side of the card to prevent delamination of the pattern. The component leads are fed through the holes, bent over on the printed wiring, trimmed and soldered.

A small variable capacitor (8-50 $\mu\mu$fd.) is required for station selection. A ceramic trimmer (*Erie* type 557) may be modified to fit into the assembly. The trimmer is disassembled and the 1/16" case top replaces the phenolic. The discarded phenolic may be used as a template for cutting the holes in the case cover, Fig. 7. The variable capacitor is mounted on the outside of the receiver case with its terminations extending through to the inside. The terminations are joined to the printed circuitry by small flexible leads. A Bakelite knob is recessed to fit over the rotor portion of the trimmer and is held in position with set screws. Fig. 5. Small spring clips are fashioned from beryllium copper 1/64" x 1/8" x 1/2" and are riveted and soldered to the pattern to provide snap-in connections for the battery. Fig. 8.

Fabrication of the radio case is the next assembly step. The case is formed from 1/16" clear Plexiglas. A hot wire is used to bend the Plexiglas in the case making operation. Fig. 10. A piece of wood 6" x 1" x 1" is used as the base of the bending instrument. A saw slot is run down the center length of the base to provide a well for a length of resistance wire. Screws or nails mounted at the edges of the base are used as anchor terminals for the resistance wire, and a small coil spring keeps the wire taut. Just enough voltage is applied to the resistance wire to make it glow. The Plexiglas is placed over the recessed hot wire and is heated without coming in direct contact with the wire.

After heating the Plexiglas for a few seconds it may be bent to any desired angle. Plexiglas may be cut in a man-

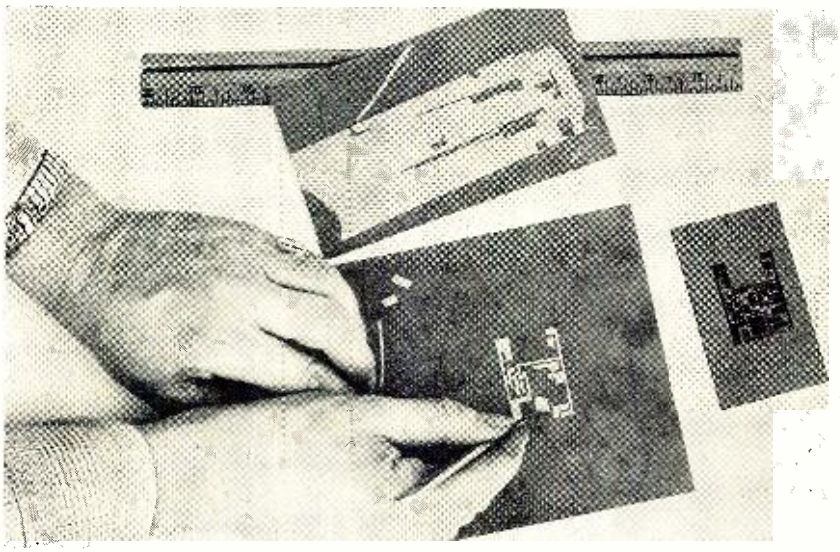
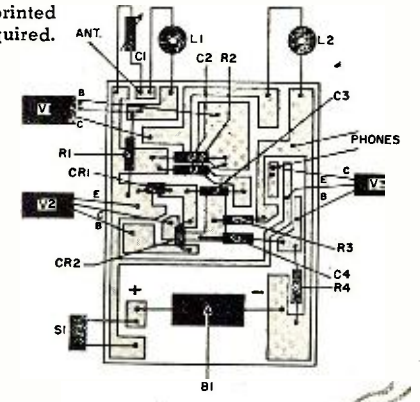


Fig. 3. Preparing the printed circuit board. Technique can be followed at home.

Fig. 4. Placement of parts on the printed circuit board. Special care is required.



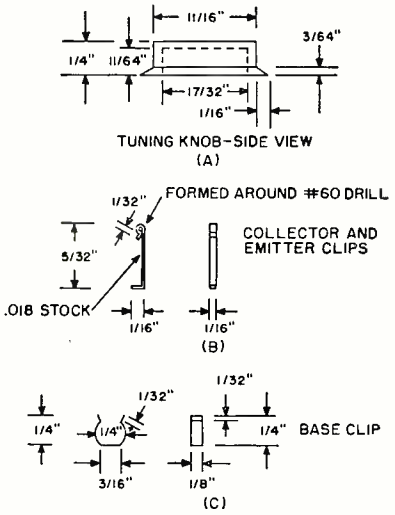


Fig. 5. Details for constructing some of the mechanical parts required in radio.

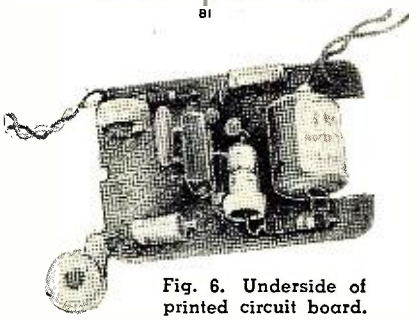
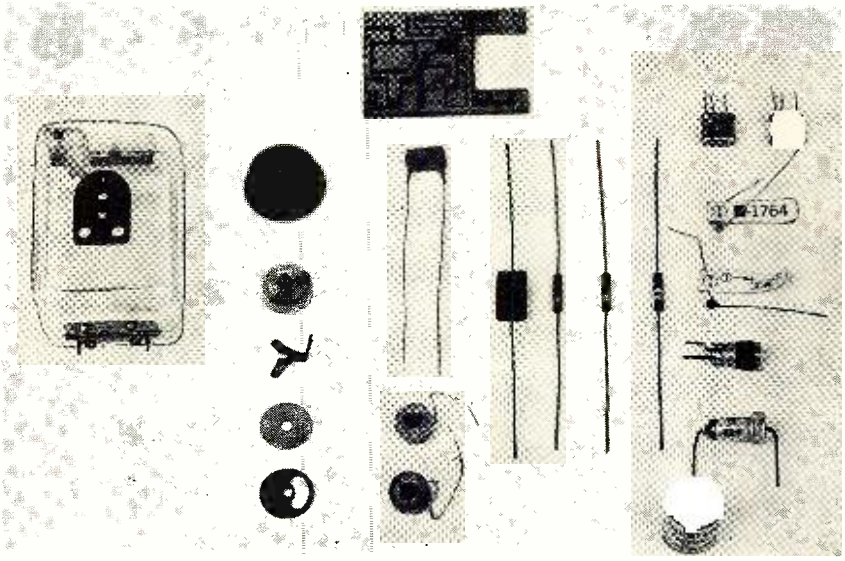


Fig. 6. Underside of printed circuit board.

Fig. 7. The various component parts required to construct the wrist-watch radio.



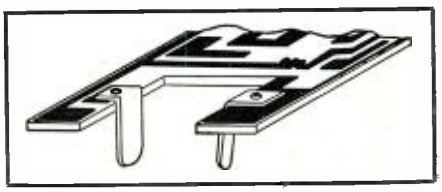


Fig. 8. Details for making the battery clips to be mounted on circuit board.

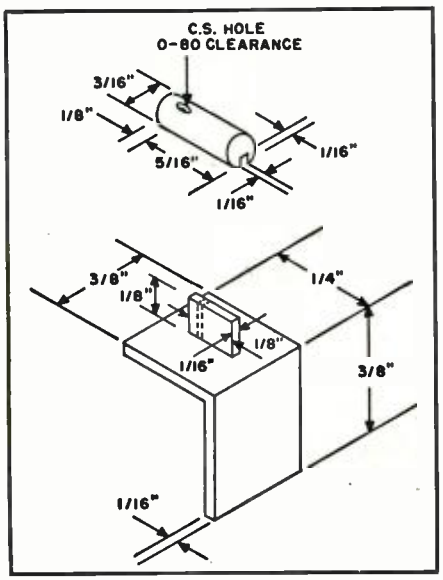


Fig. 9. Details on coupling slide assembly.

ner similar to glass. Using a straightedge, score the Plexiglas with a sharp scribe. Place the Plexiglas on the workbench with the scribed line at the edge of the bench. Hold the Plexiglas firmly and apply a fast downward pressure to the portion of Plexiglas extending over the edge. The Plexiglas will break along the scored line.

In making the case, a strip of Plexiglas is bent to form the bottom and two ends. If angular bends are not desired, the bottom of the case may be shaped to the contour of the wrist by heating the Plexiglas in an oven until it is pliable and then shaping it over a wooden or metal form. Fig. 10. Side pieces are cut and cemented to the bent portion using methylene chloride as the bonding agent. The sides are then filed to match the contour of the case. The top edges are now sanded even and a top cover is cemented to the case and is then filed even with the sides. The case is now a closed box. The case cover is formed by cutting off a section of the box. This cut is made about ½" from the top surface using a small thin hacksaw blade. The cut edges of the cover and bottom are smoothed with a file or sandpaper block. A small hinge may be fashioned from Plexiglas or metal and fastened to the case ends. If metal hinges are used, they may be fastened to the case with screws or brads used as rivets. Two small pieces of Plexiglas 1/16" x ¼" x ½" may be slotted and fastened to each side of the case for attaching a watch strap.

As mentioned earlier in this article, the tuning capacitor is mounted on the cover. The push-to-listen switch is mounted on one side of the tuning capacitor and the variable coupling control is on the other side.

Variation of coupling will increase or decrease the regeneration and, in general, act as a volume control. Lack of regeneration, irrespective of coupling, would indicate that the coils are bucking each other, requiring reversal of the connections of one coil.

The coupling slide may be made of Plexiglas 1/16" x ⅜" x ⅝". Fig. 9. The Plexiglas is bent at a right angle, forming sides ¼" and ⅜". A 1/16" x ¼" x ⅛" piece of Plexiglas is cemented to the center of the smaller side at a right angle to the bend to form a runner 1/16" wide. The coupling adjustment slide bar is formed from a piece of lucite rod 3/16" in diameter, 5/16" long, which is grooved down its length to form a 1/16" x 1/16" recess. A clearance hole for a 0-80 flathead screw is drilled through the slide bar into the recess, ⅛" from an end. This hole is then countersunk opposite the recess. A similar hole is drilled in the center of the ¼" side of the coupling slide ⅛" from the edge. A slot ¾" long is cut in the top of the case cover ⅛" from the edge and ¼" from the end to receive the runner. The runner is inserted from the inside of the cover and the slide bar is positioned on the protruding edge, being made secure with an 0-80 nut and a 7/16" 0-80 flathead screw. The coupling coil is cemented to the ⅜" surface of the slide which is now filed to conform to the shape of the coil.

The push-to-listen switch is made of two pieces of beryllium copper .010 x ⅛" x ½". Holes are drilled 1/16" from an end of each piece to clear 0-80 screws. The holes to mount each piece of the switch are drilled in the case cover 3/16" from the sides and 3/16" from the end. A 3/32" hole is drilled in the cover midway between the arm mounting holes. A mushroom shaped push-button is formed from a piece of phenolic or lucite rod. The shaft of the button is 3/16" long and 1/16" in diameter. The crown is ⅛" in diameter and 1/32" thick. In assembling the switch, the push-button is inserted into the 3/32" hole with the crown resting on the inner surface of the case cover. One of the beryllium arms is placed on the mushroom and is fastened to the case with a ¼" 0-80 screw and nut. The remaining beryllium arm is placed on top of the first arm and is similarly fastened to the case. This arm is now adjusted by bending it away from the other arm. When the push-button is pressed the two arms are forced together and establish contact. These contact arms are joined to the etched circuit by thin flexible wires.

Dimensions of the case have not been specified, as it is possible to make this unit smaller than shown. Therefore, it is advisable to build the case around the unit, after the printed circuit card size has been established. Fig. 6 illustrates the unit with the coils on the surface of the printed circuit board and the 1729 or 2N25 transistor attached to the circuitry side of the board. One coil is cemented to the board and the other is cemented to the Plexiglas coupling assembly. *Duco* cement is used for this purpose.

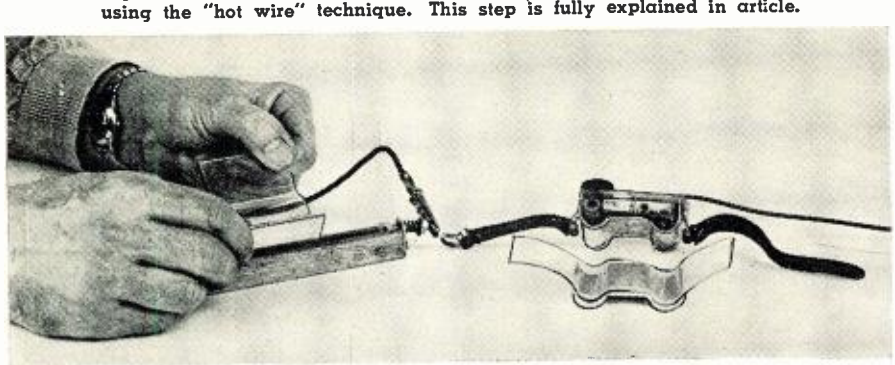
The leads of the *Telex* (2000 ohm) earpiece are brought through a small hole drilled in the side of the case and are soldered directly to the etched pattern. A small hole is provided for the antenna, which is soldered to one terminal of the tuning capacitor. In high signal areas, little or no antenna is required.

The transistor and bead diode leads are brought through the circuit board and are soldered to the etched pattern. As each lead is soldered, it should be held with longnose pliers close to the transistor body to absorb the heat travelling up the lead and prevent damage to the transistors and diodes.

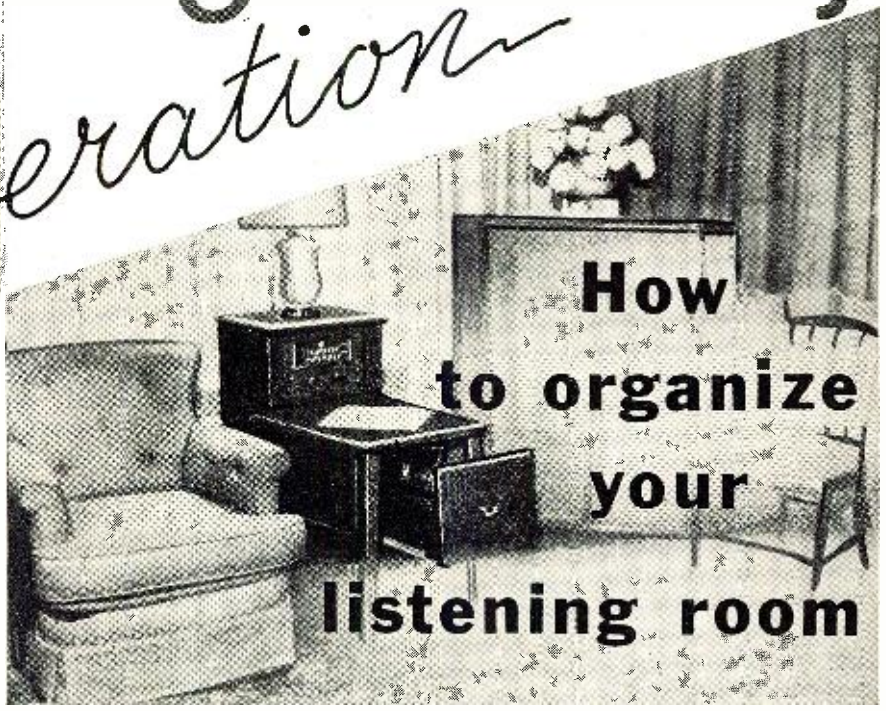
The 1729 or 2N25 transistor does not have flying leads and is fastened to the pattern by means of small clips made of beryllium copper. Fig. 5. A "C" shaped clip is riveted and soldered to the card and clamps the body of the transistor (base connection). Two narrow crook-shaped clips (1/16" beryllium copper .018) snap over the collector and emitter leads and are terminated in the etched pattern.

The assembled receiver has reasonably sharp selectivity and a sensitivity of 50 microvolts. In strong signal areas it is possible, with the addition of an output transformer and loudspeaker, to comfortably fill a large room with sound. When the receiver is held near the body, both the tuning and regeneration are affected by body capacitance. The regeneration should be optimized for each tuning adjustment. —30—

Fig. 10. How the "cabinet" for the receiver can be fabricated of Plexiglas using the "hot wire" technique. This step is fully explained in article.



Realistic High Fidelity Reverberation



By
H. A. HARTLEY

Part 3. Reverberation is an important factor in obtaining good sound reproduction. Here are simple tests you can make in your own listening room and methods for correcting faulty acoustics.

YOU now know how sound waves behave, you have been introduced to room resonances, reverberation, standing waves, and absorption coefficients. You realize that something should be done about the room in which you will listen to your radio, your records, and your tape. You may even, as I, have gone to the libraries and read book after book to find the answer, and come away, as I did, knowing no more about it, than when you went in. The treatment of large auditoriums has been studied intensively, but what is the good of consulting tables and examining curves if they start off with a smallest room of 10,000 cubic feet? You and I have to make do with something very much nearer 1000 cubic feet, and then it is cluttered up with all sorts of domestic bric-a-brac. What is worse, if we design a perfect auditorium then we are faced with the fact that our speakers are not perfect, and some of them are a very long way from being even near perfect. It seems sensible to arrange matters in the room to compensate some of the shortcomings of the speaker that is going to be used in it.

Well, we have to make a start somewhere, so let's start with reverberation. If the reverberation period is too long then good reproduction is impossible, so have this reduced to not more than 1½ seconds; I prefer it to be not more than 1 second, otherwise the "attack" of the reproduction is spoiled, to my ears.

If the floor is covered with a fitted carpet, so much the better. If not, and bare wood or linoleum forms an appreciable part of the floor, this added to bare walls and ceiling will result in too long a reverberation period. The clapped hands test can be used, or a very good instantaneous sound source is the old schoolboy trick of inflating a paper bag and bursting it between the hands. Have all the normal furnishings in the room, have the average number of people in the room who will be listening with you; let them sit in the chairs as they would normally do. Have a helper with a stopwatch and a keen pair of ears.

Explode the paper bag, your helper starting the watch at that instant. When the echoing sound has died away to negligible proportions the watch is stopped. Repeat this measurement with other helpers and other ears, in fact for as long as your supply of paper bags holds out, then take the average of all the figures, thus averaging out errors too. If the time for the sound to die away is greater than 1½ seconds (I still advise 1 second), more absorbing material must be used in the room, this being quite independent of the type of speaker, type of housing, or location of the speaker in its housing; it is a fundamental property of the room itself. If your room is sparsely furnished, or very modern, with reflective furniture and decorations, you may have to use acoustic tiles, which can conveniently be placed on the ceiling and one wall. If the period is not greatly in excess of 1½ to 2 seconds you may get away with heavier drapes and curtains. But before you do anything else, get that period down to 1 to 1½ seconds.

Now comes the far more tedious business of dealing with reflections and irregularities in the distributed sound. It is the plan of this series to deal with the whole subject of high fidelity from the end to the beginning. I could, therefore, assume you have no speaker at the moment, but you have got a speaker, and you may not want to scrap it. I must, therefore, make some break in the forward progression of the story, on the assumption that, at any rate for the time being, you will use the speaker you now possess. Let us, therefore, consider that speaker.

Its audio response is displayed by a frequency response curve. This curve will assume different shapes according

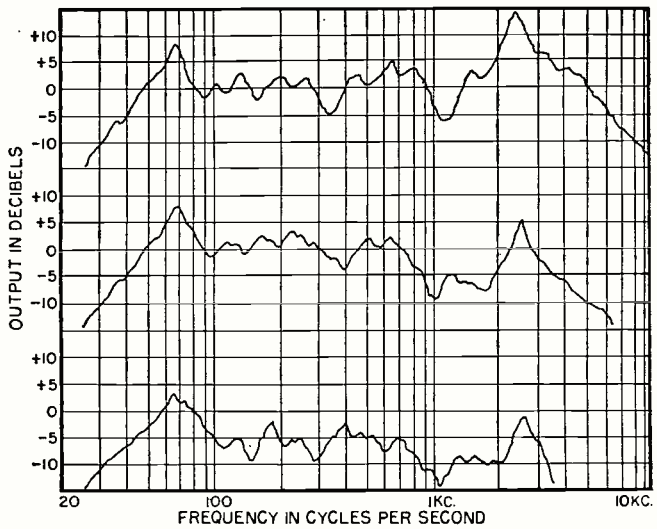


Fig. 7. Response curve of a speaker (top to bottom) on the axis and at 30 and 60 degrees off the axis. See text.

to the situation of the calibrating microphone on or off the axis. If a series of readings is taken on the axis, at 15 degrees off the axis on either side, at 30 degrees off the axis, and so on at 15 degree intervals, a series of polar curves can be plotted to show the sound distribution over the front hemisphere. Fig. 7 shows a series of response curves on and off the axis of a typical but hypothetical speaker; Fig. 8 shows polar curves for the same speaker. Obviously the radii of Fig. 8 are a sort of ground-floor plan of the "vertical" curves of Fig. 7, so the whole response of a speaker could be shown by a solid model, whose shape is determined by a long series of response curves taken at intervals of a few degrees; the curves of Fig. 8 are contours of this solid model taken at specific intervals.

These response characteristics of speakers are measured either in the open air or in anechoic chambers so that the surroundings do not influence the readings; yet the speaker will not be so used in real life. It will be obvious that whereas the frequency response determines the nature of the emitted sound, the room itself will decide what happens afterwards, since reflection is differential, both as to direction, determined by the angle at which the sound waves strike the walls and ceiling, and to magnitude, determined by the frequency absorption characteristics of the reflecting surfaces.

It would be possible to find out what happens to each frequency by feeding the amplifier with the output of an audio oscillator and listening for standing waves, as explained in an earlier part, but this, unfortunately, doesn't help very much with complex waves having several simultaneous frequencies, the sort of waves that make up musical sounds. A lifetime might be spent finding the standing waves for all frequencies and adjusting reflectors to eliminate them, and still the final result would be only an approximation. Can we find an approximation some other and simpler way? The method I suggest now has not, to my knowledge, ever been made public before.

Another characteristic of a speaker is its impedance curve. In free air, and on an infinite baffle of negligible interference, the ordinary dynamic speaker has an impedance curve something like that of the curve of Fig. 9A. The peak at the bass end of the frequency scale is caused by the natural resonant frequency of the cone-coil assembly and its associated suspension. Speakers having paper cones with molded corrugated surrounds resonate somewhere between 35 and 80 cps, but this resonant frequency is also added to by the resonant frequency of the suspension washer at the apex of the cone, the device which holds the voice-coil central in the gap. If the resonant frequency of the cone surround coincides with that of the spider washer, the impedance curve will have a very pronounced peak indeed, but usually the spider washer resonates at a higher frequency than the cone surround, owing to its smaller physical dimensions. The curve would then have two peaks, but the amplitude of the lower will be masked by that of the higher simply because if the speaker is unable to reproduce a frequency lower than that of the spider washer, the cone surround peak will not show on the curve.

In case this is not quite clear, I should explain that the output of the speaker, particularly at low frequencies, depends on the electrical input to it. This is determined by the freedom of movement of the cone-coil assembly. As long as the limit of movement has not been reached either in the outer surround or the spider washer, a sine-wave input to the speaker will produce a pure tone output. When the input is so great that the cone movement limit has been reached, what emerges from the speaker is not a pure tone of the same frequency as the input signal but a mixture of harmonics of the fundamental frequency; no fundamental (because the cone can't move enough), a very large proportion of second and third harmonics, and some higher harmonics. In other words, the speaker distorts because it is working beyond its power-handling capacity. Therefore, to measure the impedance of the speaker at any frequency it must not be made to move beyond a proportion of the limit of freedom of movement; under these conditions only is it possible to observe, in impedance measurements, the effects of the cone surround and spider resonances.

The peak at the treble end is due to the inductance of the voice-coil, apart from certain other subtle mechanical causes; for a given inductance the impedance must increase with frequency, but the increase only becomes appreciable at frequencies over 1000 cps; below this the mechanical design of the speaker is more important. The curve of Fig. 9A, then, shows how the impedance varies with frequency, but it is a smoothed curve. If the curve is taken very carefully indeed it will be more like the curve of Fig. 9B, for such phenomena as noding of the cone, radial "break-up" of the cone, even resonances in the metallic structure of the speaker chassis, will be revealed by irregularities in the curve. If the curve is taken again with the speaker in a cabinet of some sort, instead of being mounted on a rigid infinite baffle, the curve will be of a vastly different shape.

The reason for this is that the speaker will only have output *when it is doing work.* The output of an automobile motor is measured on a brake-horsepower test; that is, its power output is measured in terms of the work required to stop it. If you race your car engine in neutral it isn't doing any work, and has no output to speak of. Similarly, a speaker working into a vacuum hasn't work to do, so it has no output. The impedance curve is therefore a picture of the work the speaker has to do, and at the highest points the speaker has the greatest output. Any speaker with a fairly high

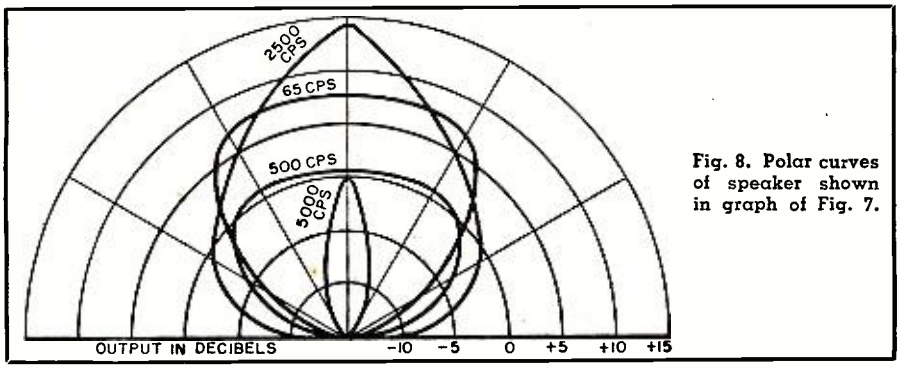


Fig. 8. Polar curves of speaker shown in graph of Fig. 7.

bass resonant frequency, say 60 to 80 cps, has a very audible bass thump of one note, and the treble resonance is noticeable as a shrieky edge to the music. If the speaker is working into a horn it has a higher efficiency because it is better loaded—instead of dissipating its energy in all directions it is concentrated in a column of air, and the output is also more linear and the impedance curve flatter. We can, therefore, associate speaker efficiency and capacity for work with its impedance curve. I suggest that this simply-determined characteristic can be used as an index of what is happening outside the speaker. I have used the method with great success.

The method is really very simple; it involves setting up a circuit to determine the impedance at all frequencies, and then making adjustments to the room furnishings and arrangements to reduce individual peaks. Of course, it is necessary to get a datum, which involves taking an impedance curve of the speaker *in its housing* in the open air. Then with this curve before you, you have a basis from which you can compare the performance of the speaker in the room. The open air curve may not strike you as being very good, in which case you would make adjustments in the room to absorb or reflect the sound on a trial-and-error basis to flatten the curve. If the original curve looks pretty good, you would take care to see that it is not made worse by the room. Even a simple adjustment like moving the speaker about the room will make an appreciable difference in the impedance curve. In this way you may find where it will work best, and where it works best you may be sure is the place where it sounds best. Don't forget that your human "guinea pigs" must be there when you are taking your measurements.

There are three different methods of taking impedance curves easily. For all three an audio oscillator is required, but the rest of the equipment varies. Fig. 10A shows how to measure the current through the speaker and the voltage dropped across it; this requires an a.c. ammeter and an a.c. voltmeter. The impedance at any frequency Z is simply E/I, where E is the voltage reading on the voltmeter across the voice-coil and I is the current in amperes through it. In taking the measurements, advance the oscillator in steps of 10 cycles from, say, 30 to 100 cps, then in steps of 100 cycles up to 1000 cps and thereafter steps of 1000 cycles up to the limit. Note particularly the exact frequency at which the voltage rises and the current falls momentarily, which marks resonant peaks.

Since a.c. ammeters are not always easy to come by, another method using two voltmeters is described. This is shown in Fig. 10B. The method is simply to compare the voltage drop across two resistances in series. Select R to be exactly the same as the d.c. resistance of the voice-coil of the speaker. With d.c. passing through the voice-coil and R in series, the voltage drop across each will be equal. Now apply an a.c. source, your audio oscillator. R must be a non-inductive resistor, otherwise its impedance will change with frequency, and if you use a molded composition resistor, be sure that it will dissipate enough watts. Now apply various frequencies as indicated previously, when the impedance of the speaker can be calculated from the simple formula:

$$Z_S = R(E_S/E_R)$$

Both these methods have the disadvantage that a certain amount of observing meters and simple calculating has to be done. A more elegant and much simpler way is to use an oscilloscope, which has the further advantage that for continuous observation you don't have to observe two separate meters. The hookup is shown in Fig. 10C. Here again R is a non-inductive resistor having the same resistance as the d.c. resistance of the voice-coil. For setting up purposes you will require two non-inductive resistors of the same value as the voice-coil d.c. resistance, since the oscilloscope must be set on a.c. Connect a resistor across each pair of plate terminals, apply a signal from the oscillator and adjust the sensitivity controls of the oscilloscope internal amplifiers so that the trace is a straight line at 45 degrees inclination. If the trace is adjusted so that it passes through a convenient point on the lower left-hand corner of the graticule, then the graticule can be used as a scale in the subsequent measurements.

Now replace the resistor across the vertical plates by the speaker. When the speaker acts as a pure resistance the trace will remain a straight line, but when the inductive and capacitative components take effect the straight line will become a narrow ellipse. It is the major axis of the ellipse in which you are interested.

As the frequency from the oscillator varies and as the ratio between the volts across the speaker and the volts across R varies, so the trace will move from the 45 degree position, and the relative magnitudes of the two voltages can be measured by counting graticule divisions. This is not absolutely necessary if you are mainly concerned in making the impedance constant. What is useful in this method is that divergence from the normal 45 degree position can be checked against adjustments of the room furnishings. For example, putting your hand in front of the speaker is enough to cause a shift. The effect of putting a diffusing slot in front of the speaker can be instantly observed. Modifications to the housing can be checked instantly.

You will never get the impedance curve flat, but the methods just detailed will indicate the effect of the adjustments you make to your listening room. It may all sound very tedious, and I am prepared to admit that it can be a trial to one's patience, but if your desire is honest-to-goodness high fidelity, then the room must be right. When all is said and done it only has to be done once (unless, of course, you change your speaker and its housing) but that is the way to do it. Get the background right and all that you do afterwards can be planned with some degree of certainty. If you don't, then you are inevitably working in the dark, and all the twisting of control knobs on the most elaborate preamplifier will not get matters right.

(To be continued)

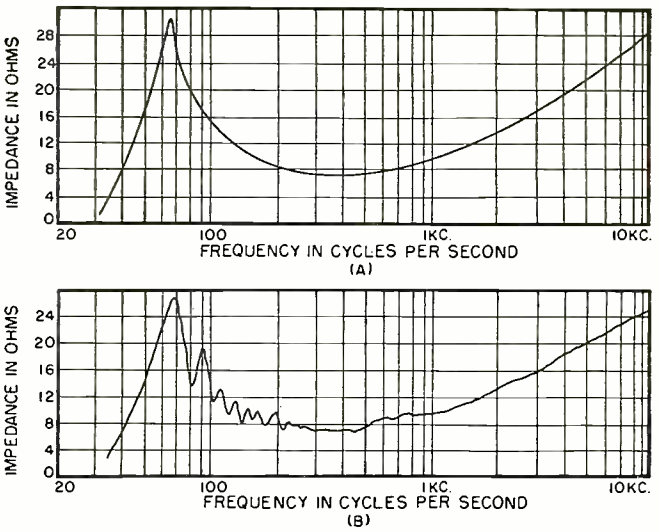


Fig. 9. Impedance curves of a typical speaker: (A) The customary smoothed curve showing bass resonant impedance peak and impedance rising with frequency; (B) Actual impedance curve showing major and minor bass resonant peaks and irregularities due to cone distortion and the chassis resonances. See text.

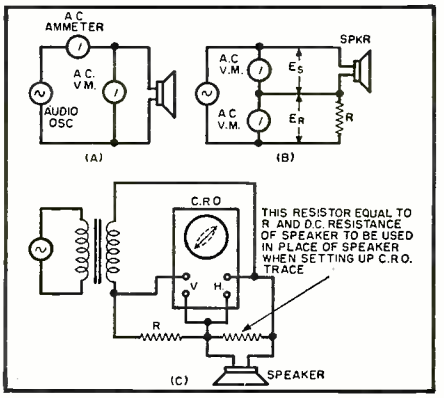


Fig. 10. Three methods of taking impedance curves of speakers. (A) Simple ammeter-voltmeter method. (B) Comparison with a standard resistor using two voltmeters, and (C) Oscilloscope method of direct comparison of resistor and speaker impedance.

TV TUNERS

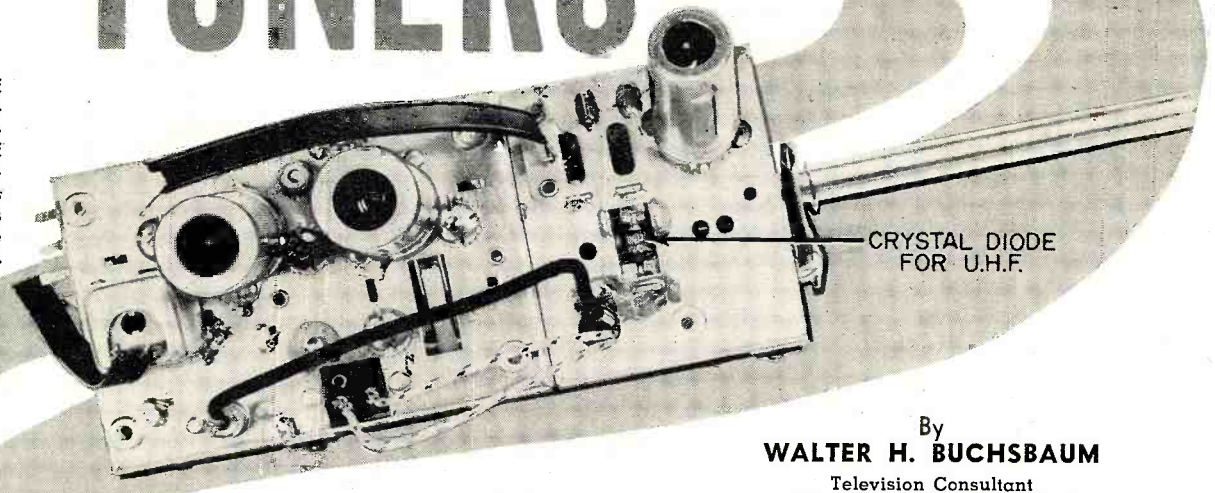


Fig. 1. Top view of an 82-channel Standard Coil tuner showing the location of the u.h.f. mixer crystal diode. Sometimes replacement of this crystal will reduce the noise on u.h.f.

By
WALTER H. BUCHSBAUM
Television Consultant
RADIO & TELEVISION NEWS

Noise and Gain Problems

How is the performance of TV tuners measured and how much improvement can be expected from them? Here also is information on improving TV reception in weak areas.

MUCH has been written in recent years about improving fringe area reception and many new developments have increased TV receiver sensitivity, reduced "snow," and in general resulted in better pictures in weak signal areas. There is, however, a limit of possible improvement. This limit is determined both by theory and practical considerations and applies to all types of receivers using broadband reception. This article will attempt to clarify this limit which may be called the "noise-gain barrier," and indicate how to determine if this barrier is reached in a particular instance.

The most common unit of measurement for both gain and noise in receiver practices is the decibel. It should be understood clearly that this is only a ratio between two values and that, assuming constant impedances, the values are generally that of voltage.

When gain is indicated in db, it is usually voltage gain that is referred to. A typical TV receiver, for example, may have an i.f. gain of 60 db. This means that the over-all amplification of signals within the flat portion of the frequency response band of the i.f. circuits is 1000 times. Because of the action of the a.g.c. system this gain will vary with signal input.

When considering gain figures, it is important to know where this gain is measured and into what impedance. For example, it would be incorrect for purposes of determining voltage gain to connect a 50-ohm generator directly to the grid of a tube and measure the output across the tuned plate circuit with a high impedance crystal probe. In such a case only power gain is measured, not voltage gain.

Probably the most misunderstood parameter in TV sets is the noise figure. By definition, the noise figure in decibels represents the ratio of the theoretical noise generated by a resistor equivalent to the input circuit to the actual noise due to the input circuit. Since noise is a random function, noise power is considered and therefore, the noise figure is a power ratio. Noise figure is usually measured by first noting the detected output of a receiver without any signal applied. Then a noise generator is applied to the input and the noise power is increased until the detector shows two times the no-signal power output. The noise figure in db can then be read off directly at the noise generator. To avoid errors due to detector nonlinearity, a 3 db attenuator pad may be connected into the i.f. section during the application of the noise generator.

From the preceding it becomes apparent that noise figure is not a function of receiver location, antenna, or transmission line, except in cases of severe impedance mismatch. Noise figure is a characteristic of the tuner input circuit, although the rest of the amplifier chain contributes slightly. For this reason, tuners are specially designed to provide the minimum noise figure. An ideal tuner would have zero db noise figure, meaning that only the theoretical minimum noise is generated.

In actual TV receivers there are different types of tuner circuits in use. The cascode or the new neutralized-triode tuners provide rather low noise figures. Tuners with pentode r.f. amplifiers usually have a higher noise figure because of their higher impedance. In most tuners the noise figure is lowest for the low channels and gets really poor in the u.h.f. region where no r.f. stages are used. For cascode and other triode-type tuners the minimum noise figure is usually about 3 to 5 db and goes up to 8 db on channel 13. Pentode tuners have noise figures ranging from 8 to 14 db and, at u.h.f., noise figures of 18 to 26 db are not unusual.

It should be kept in mind that this noise figure is important only on weak signals, when the locally generated (within the receiver) noise is at least one third as strong as the received signal. In a strong signal area the set's noise figure is insignificant.

The term signal-to-noise ratio describes the relative amplitude of the signal and the noise expressed as a voltage ratio and usually observed at the video detector or at one of the i.f. stages. Signal-to-noise ratio often takes into consideration not only the locally generated noise, but also the atmospheric or static noise received together with the signal. For this reason the signal-to-noise ratio is far more indicative of a reception problem than the noise figure or the receiver gain.

The appearance of noise at the video detector is shown in Fig. 2. Most TV engineers consider pictures having a

signal-to-noise ratio of 3 to 1 as viewable, but such a picture will definitely appear "snowy." Good, clear reception is obtained when a 10 to 1 signal-to-noise ratio is present.

An indication of the over-all gain of a receiver is its "sensitivity." The standard definition of sensitivity is the number of microvolts input signal at the antenna terminals which will produce a 22-volt signal at the kinescope. 22 volts is the minimum signal which produces cut-off at the screen of most picture tubes. Fig. 5 shows an instance of insufficient sensitivity with less than cut-off voltage at the picture tube.

The original "630" TV receivers had a sensitivity of 50 microvolts, meaning that an input signal of 50 microvolts would result in a 22-volt peak signal at the CRT. This gives a viewable picture.

Typical Tuner Problems

If in a particular weak signal area the picture is very "snowy" and no amount of antenna raising or orienting will improve it, the service technician needs to know if he should try a more powerful antenna array, if he can do anything with the receiver, if a booster would help, or if the situation is plain hopeless.

The first step is to see if the receiver has full gain. Usually, in such circumstances, noise will be visible on the screen when there is no station signal received. This noise should appear as both black and bright white dots. If only a pale sort of "snow" is visible, more receiver gain might be useful and this can often be obtained by replacing tubes in the i.f., video, and r.f. sections of the receiver or in retuning the i.f. and/or r.f. Precise gain measurements at low signal levels must usually be made in a shielded room, and require test equipment not usually found in service shops.

To check if improved noise figure would noticeably improve the apparent signal-to-noise ratio it is often simplest to substitute a receiver with a cascode or other triode-type tuner. Using a cascode preamplifier may also solve the problem.

If it is established that none of the preceding steps will improve the picture substantially, improving the antenna installation or relocating the antenna may improve reception.

Another problem that sometimes occurs is that two sets operating in the same neighborhood and from identical antennas produce pictures with different amounts of "snow." Often the poorly operating set uses old 300-ohm twin-lead whose impedance has changed considerably due to weather, sun, or moisture. In general, tubular transmission line is preferable in all really weak signal areas.

If the antennas and transmission lines of both sets are approximately equal, interchanging the sets will definitely establish the difference in performance. Keep in mind that even the best triode tuner will not perform properly if the tubes are weak or if the tuned circuits are not aligned for optimum performance. The noise figure of a cascode or neutralized-triode circuit will depend not only on the bandpass alignment but also on the adjustment of the neutralizing circuit.

Fig. 3 is a simplified diagram of the basic cascode input circuit which is the criterion of noise figure performance. The newly announced neutralized-triode tuner contains similar circuitry, but will not be found in many receivers until the latter part of 1956.

The use of triode amplifiers at v.h.f. is usually restricted to the grounded-grid circuit because of the effect of the internal plate-to-grid capacitance. If a tuned network is used in the grid and plate circuit, the plate-to-grid capacitance will, at v.h.f., provide enough feedback to convert the amplifier into an oscillator. The equivalent circuit of a triode amplifier is shown in Fig. 4A with C_c representing the plate-to-grid capacitance.

If an inductance, L_c, is connected between the grid and plate and tuned to be exactly equal in impedance to C_c (as in Fig. 4B), then the effect of this capacitance is neutralized. The neutralizing effect of L_c is usually sufficient for a fairly wide frequency band, such as channels 2 to 6.

The gain of a neutralized-triode tuner ranges up to 20 db, which is less than that of a cascode tuner; noise figures are essentially the same. The major saving in the neutralized triode circuit is realized through the elimination of an additional tube section and its associated components.

In the case of u.h.f. reception, the noise figure can often be improved by replacing the crystal mixer. Fig. 1 shows the location of this crystal in the *Standard Coil* 82-channel tuner. Here, the crystal can simply be plugged in. Be sure to try several crystal diodes and touch up the r.f. input network tuning for each one. Noticeable improvements in signal-to-noise ratio are often possible just by changing the mixer crystal.

The most difficult installations are those in which no type of receiver, regardless of adjustment, noise figure, or sensitivity, can bring in a viewable picture. In order to minimize noise due to the transmission line itself and also to improve the over-all noise figure, a special cascode-type antenna preamplifier may be warranted. This provides the optimum possible condition and, in conjunction with a good antenna and receiver probably will reach the limit of the "noise-gain barrier." —30—

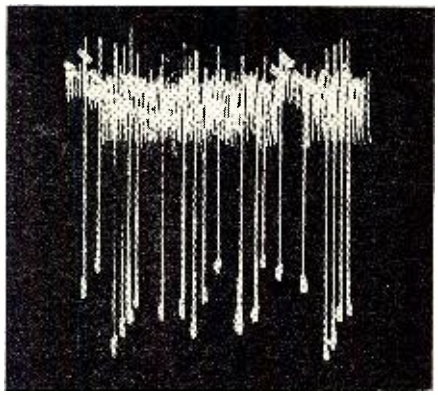


Fig. 2. Noise as it appears at the video detector of a TV set, seen on a scope.

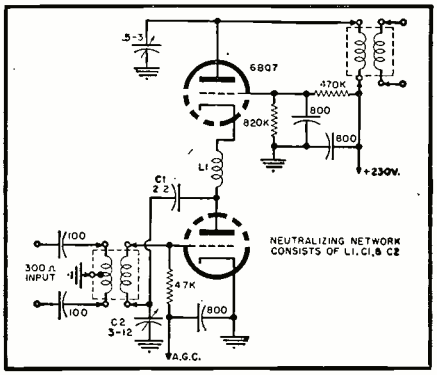


Fig. 3. Simplified schematic diagram of the input circuit of a typical cascode TV tuner. This tuner features low noise.

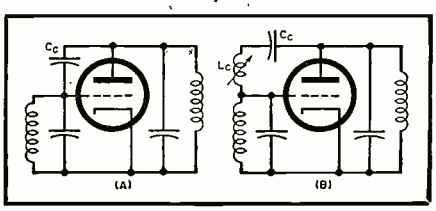


Fig. 4. Simplified circuits of an unneutralized triode amplifier (A) and a neutralized version (B) for a v.h.f. tuner.

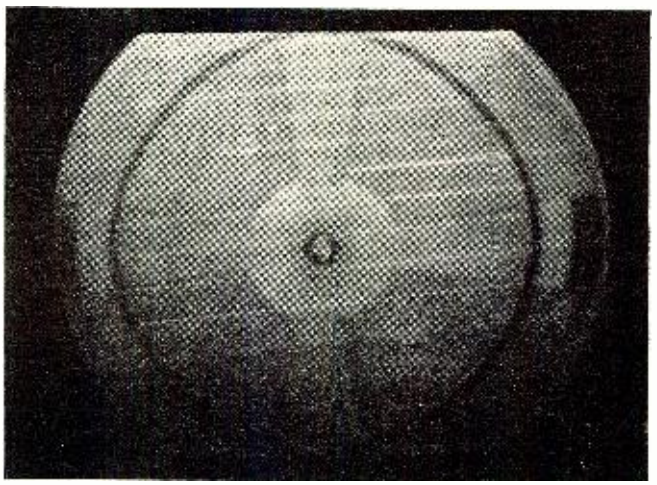


Fig. 5. Low-contrast picture due to insufficient sensitivity of the TV receiver. Note the prominence of the retrace lines.

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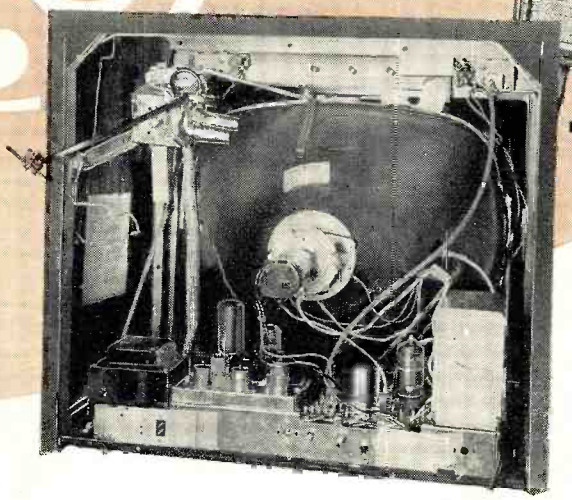
TEST POINTS

By **JACK NAJORK**
District Service Representative
General Electric Co.



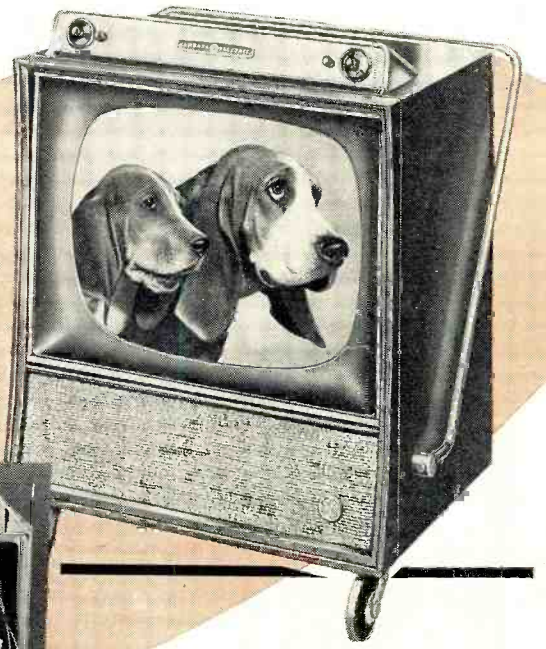


Fig. 1. Front and rear views of one model of the "ST" series G-E television receivers. Note the position of the tuner at the top.

Use of the test points will help spot most of the troubles that can occur in this new line of TV sets.

THE 1956 "ST" series of *General Electric* television receivers again use the dip-solder method of construction which makes available to the service technician many above-chassis test points. Included in this series are models 21C133, 21C134 "Hospitality" consoles; 21C135, 21C136, 21C140 standard consoles; and 21C141, 21C142 clock consoles.

All of these models feature "top-tuning," shown in Fig. 1, which places the r.f. tuner and other operating controls above the chassis. On some models the tuner is mounted on the picture-tube support bracket; in other models it is mounted on a bracket secured to the top of the cabinet as shown in Fig. 2. All models use one-unit construction in which the picture tube and chassis are mounted together on a removable plywood mounting board. This mounting board has cut-outs under the chassis so that when the unit is removed from the cabinet, most of the under-chassis wiring is exposed.

Although it is not apparent at first glance, all "ST" models are designed so that the safety glass can be easily and quickly removed from the front for picture-tube cleaning. This is done as follows:

1. Remove screws located along bottom of front rail. (See Fig. 2.)
2. Pull out bottom glass channel and glass. The mask and side rails will come out, leaving tube face exposed.
3. After cleaning, replace mask, safety glass, and glass rails, in that order. Replace rail securing screws.

Test Point Locations

The test point diagram, Fig. 3, shows the physical location of the most useful above-chassis test points, indicated by the Roman numerals I to IX. In addition to these designated points, many additional test points are available directly at the projecting tube-socket solder joints. Top-chassis shielding is used over the video i.f. and video amplifier stages for improved interference rejection, hence these tube-socket joints are not exposed. It is a simple matter, however, to remove this shield plate and when this is done, all tube-socket connections can be reached from the top of the chassis except for the tuner tubes, the 5U4GA/B rectifier, and the 6BL7 vertical stage.

Table 1 lists the voltages and waveforms normally found at the test points along with suggested test procedures.

The "ST" chassis employ a 13-position cascode tuner with 6BQ7A r.f. amplifier and 6X8 oscillator-converter. Test point I, which is in the mixer grid circuit, is useful mainly as a quick v.t.v.m. check point to determine if the oscillator section of the 6X8 is functioning. This point is isolated from the 6X8 mixer grid by a 15,000-ohm resistor, so no external isolation is needed and the d.c. v.t.v.m. probe can be connected directly to this point. A second use for this test point is signal insertion for alignment of the video i.f. stages.

The 13th position of the tuner is used for u.h.f. reception, the local oscillator being disabled and the tuner circuits functioning as a 40-mc. amplifier in conjunction with a single-conversion u.h.f. converter which uses a 6AF4A local oscillator and 1N82A diode mixer.

The three-stage, 40-mc. video i.f. amplifier uses two 6AU6's and one 6CB6. Excellent adjacent-channel attenuation is achieved by the use of two 47.25-mc. traps. The first trap is at the input to the i.f. amplifier strip while the second trap is coupled to the bifilar transformer linking the first and second stages. Test point II is connected to the video i.f. a.g.c. line which controls the gain of the first and second i.f. amplifiers.

A germanium diode is employed as the second detector, followed by the pentode section of a 6AU8 used as a video amplifier. 4.5-mc. intercarrier audio is picked off at the output of the video amplifier through a double-tuned trap circuit, and is fed to the audio circuits which consist of a 6AU6 audio i.f. amplifier, 6T8 ratio detector-first audio, and 6AS5 audio output.

Composite sync is also picked off at the plate circuit of the video amplifier and fed to a 6BY6 combination clipper and noise canceller. The triode section of the 6AU8 is used in a novel

(*Continued on page* 85)

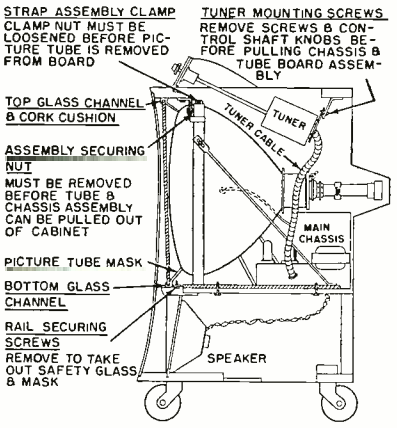
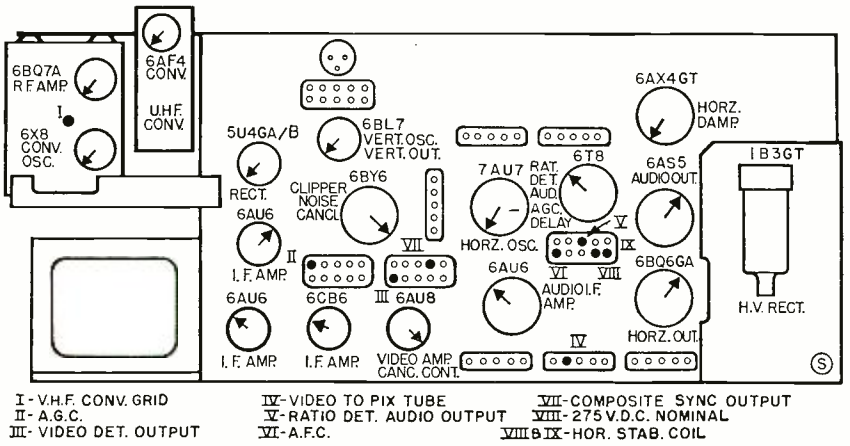


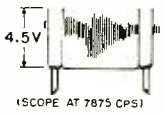
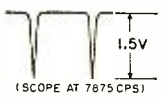
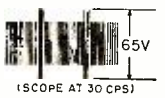
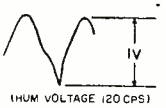
Fig. 2. Side view of a "Hospitality" model, new G-E TV set on wheels, showing the location of the major parts. The safety glass on this and the other G-E sets of this series is removable; note the instructions.

Fig. 3. Top view of a G-E series "ST" chassis showing the location of test points.



I - V.H.F. CONV. GRID
II - A.G.C.
III - VIDEO DET. OUTPUT
IV - VIDEO TO PIX TUBE
V - RATIO DET. AUDIO OUTPUT
VI - A.F.C.
VII - COMPOSITE SYNC OUTPUT
VIII - 275 V.D.C. NOMINAL
VIII & IX - HOR. STAB. COIL

Table 1. Procedure for servicing "ST" series G-E TV chassis using the nine regular test points provided.

TEST POINT	VOLTAGE READING NORMAL SIGNAL	SCOPE WAVEFORM	TEST PROCEDURE
I—Converter grid. (This point is a small metal tab. Do not confuse with screen feed-through connection near 6X8 tube socket.)	Use v.t.v.m. Always negative. Varies with channel, averages —1.5 volts.		Check on oscillator section of 6X8. Zero volts indicates no oscillation. Positive voltage could be caused by gassy tube or internal component failure in tuner.
II—Video i.f. a.g.c.	Use v.t.v.m. Always negative. Varies with signal level from —.6 to —5 volts.		Check a.g.c. action by noting voltage reading with antenna connected and disconnected. Reading should become more negative with increasing signal strength. Positive voltage at this point can be caused by gassy or shorted i.f. tube or i.f. strip component failure. No change in reading with varying signal strength can be caused by leaky or shorted a.g.c. line bypass capacitors.
III—Video detector	Always negative. Varies with signal level.		Signal continuity test between antenna terminals and detector. Correct indication here shows tuner and video i.f. amplifier stages OK.
IV—Video amplifier output	Always positive. Varies with brightness control setting from 40 to 120 volts.		Check 6AU8 video amplifier gain and drive by reading peak-to-peak voltage at this point with picture control full on. This reading divided by peak-to-peak reading obtained at TP III equals 6AU8 stage gain, normally around 12.
V—Ratio detector output			Check audio system by touching this point with finger or screwdriver. No output from loudspeaker means trouble in either 6T8 audio driver or 6AS5 audio output stage.
VI—Horizontal a.f.c. voltage			Use this test point to short out horizontal a.f.c. voltage while setting up horizontal stabilizer circuit.
VII—Clipper output	+50 volts		Check cleanliness of sync pulse by connecting scope to this point. The 65-volt reading shown is obtained with the vertical oscillator tube removed. If clean pulse cannot be obtained try new 6BY6, 6AU8.
VIII—Main "B+"	+275 volts		Low voltage here, evidenced by reduced pix size and brightness, generally caused by weak 5U4GA/B or low capacity input filter C_{400A}, 60 μfd. Open or low capacity output filter C_{400B}, 100 μfd., will have little effect on voltage reading but will cause hum in pix and poor sync. Scope will show much more than one volt peak-to-peak in this case.
IX—Horizontal oscillator	+275 volts		No "B+" voltage at this point indicates an open stabilizer coil which will result in no oscillations and no raster.

Repairing Printed

By **W. H. KLIPPEL** and **E. J. LORENZ**

Clear explanation of the different types of printed wiring and printed circuits and how to repair them.

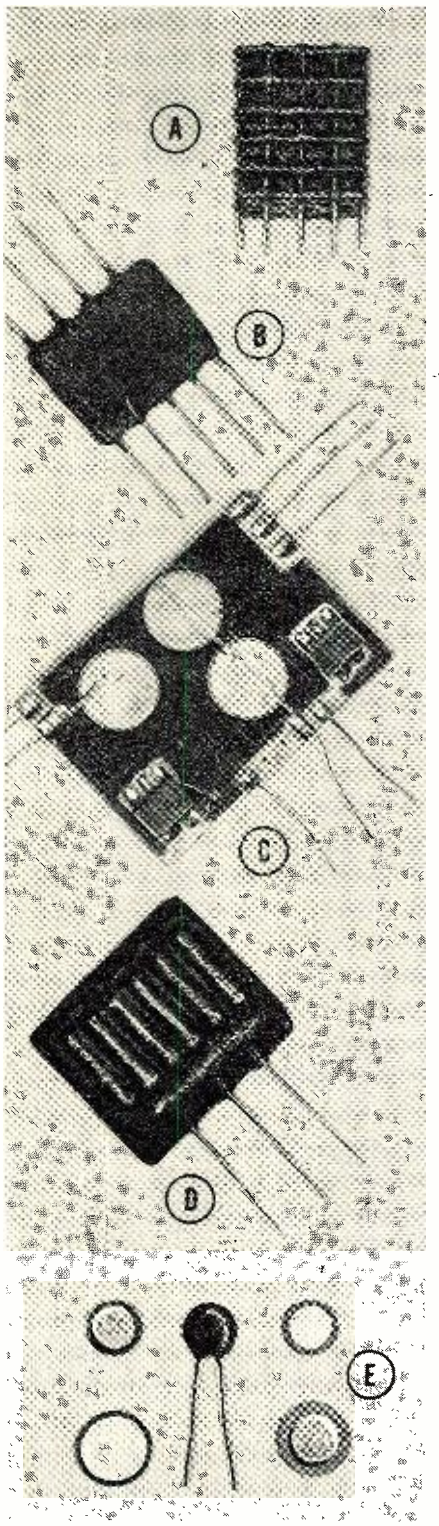


Fig. 1. Three different types of printed circuits are shown here: (A) is a module, (B) is a type using flat components such as shown in (C) and (E), and (D) is a type using small cylindrical component parts.

PRINTED circuits are appearing with increasing frequency in many commercial radio and television sets. It is important that the service technician understand the basic principles involved and also learn new methods of repair and servicing. This article will describe the various methods used in manufacturing these circuits and will outline proper repair and service techniques.

The printed circuits shown in Figs. 1B and 1C consist of a ceramic plate on which are printed conductor lines. These conductor lines are usually of a silver composition, fired onto the ceramic. Resistors are deposited in place by silk screening a graphite or a carbon mixture onto the plate. They measure approximately 1/10 of an inch in width and ¼ to ⅜ inch in length and have a wattage rating of from ¼ to ½ watt.

Capacitors used in the circuit are of the ceramic disc type shown in Fig. 1E. They are plain ceramic blanks with silver fired on both sides. These capacitors are soldered onto the silver pattern on the ceramic plate using a special solder. The top of the capacitor is connected to the proper terminal by a small strip of metal.

After connecting wires have been soldered in place, the unit is dipped in a mixture which provides a protective coating against moisture and mechanical damage. The finished unit is compact and simple to install in a radio or TV circuit. The printed circuit described has been in use for the past several years and presents no problem in servicing; the unit being treated in the same manner as an individual resistor or capacitor.

The unit shown in Fig. 1D is made by the *Erie Resistor Corporation,* and consists of cylindrical resistors and/or capacitors mounted in clips which have been fastened to a printed-wiring plate. This type of construction enables each component to be checked before insertion in the circuit panel. After the individual components are mounted, the panel is dipped into a protective coating. The entire assembly is then handled as an individual component. This type of assembly does not lend itself readily to repair, it must be replaced completely if any particular part goes bad. Replacement is easy, however.

The third type of printed-circuit package which the service technician will encounter in the near future is the modular design shown in Fig. 1A. This unit was conceived by the National Bureau of Standards and consists of ceramic wafers, upon which are placed components such as tape resistors, disc capacitors, and conventional components as required. The wafers are spaced about 5/32″ apart and are connected together as the circuit requires by stiff vertical wires. The wires extend below the bottom wafer for mounting purposes. This assembly may contain a tube or transistor socket and comprises a working circuit by itself or in conjunction with other units.

Should a defect be encountered in a module, the entire printed circuit is replaced. It is not feasible or possible for the service technician to replace a resistor or capacitor. To discover just what is under the protective coating, the unit may be soaked in a strong solution of sodium hydroxide or lye and the coating removed by light scraping.

Within the past few years another form of printed circuitry, more specifically known as etched wiring or printed wiring, depending upon the method of manufacture, has been injected into the manufacture of electronic equipment. In either case, this new medium is generally a pattern of wiring which is used to connect terminal points of conventional components such as resistors, capacitors, chokes, transformers, etc. It may also include circuits which are made up of inductances and certain

Wiring

forms of capacitors. (Fig. 2.) Since this is the type of printed circuit with which the service technician will come into contact most frequently, the manufacture and servicing will be dealt with in detail.

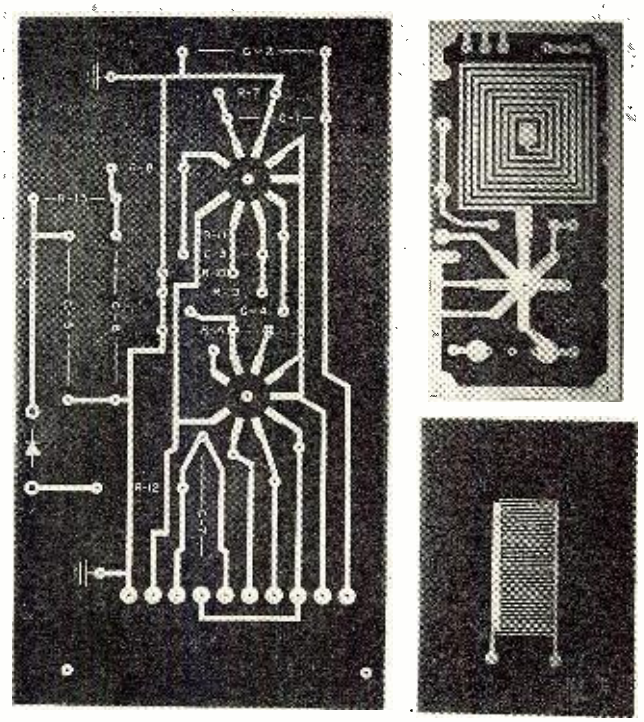


Fig. 2. Various examples of printed wiring. On the left is a board containing the wiring for three complete stages. This wiring is etched. Top right is a printed inductor, bottom right, a capacitor.

Printed Wiring

The etched-circuit method is a means of obtaining a circuit pattern on an insulating base by employing known etching techniques. (See Fig. 3.) An insulating base material, generally of phenolic-impregnated paper or cloth, has a sheet of .0014" thick copper foil bonded to either one or both sides. The desired circuit pattern is placed on the copper surface, using a material which will resist the etching acids. This is done by standard silk screening techniques, offset press methods, or by various photographic methods. After the "resist" pattern is applied, the unprotected copper is etched away by a variety of acids. After the background copper is etched away, the resist is removed and the bare copper pattern remains. The pattern may be either plain copper or plated with solder, silver, gold, or other metals for corrosion protection and in some instances for ease of soldering.

About five years ago radio chassis and loop antennas were made using a die-stamping process. This process uses a fixed pattern die for stamping the desired circuit onto a phenolic base material. First a sheet of tinned copper approximately .005" thick is coated on one side with an adhesive. The adhesive-coated side is placed against the base material and inserted into a heated die press. The die cuts the foil into the desired pattern and presses the edges of the conductors into the base material. The heat in the press also sets the adhesive, resulting in a chemically and mechanically secure pattern.

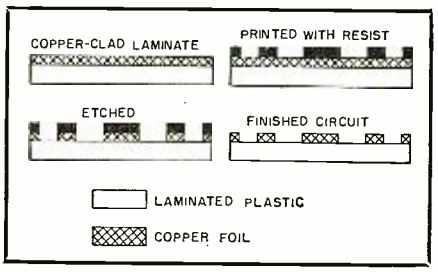
The additive method of making printed wiring consists of applying a chemically deposited conductive film on a pre-punched base of phenolic paper laminate. A background pattern is silk screened over the chemically deposited film, leaving the desired conductor lines exposed. Copper is plated onto these lines, after which the silk screen paint and conductive film in the background pattern are removed by solvents, leaving a copper conductor pattern on the insulated base. This method of manufacture produces what is known as "plated-through holes", since the conductive film is chemically deposited inside of the holes, and subsequent plating is also deposited on the walls of the holes. Variations of this process are presently used by *General Electric* and *Motorola* in the manufacture of home radio sets.

Another method of placing the conductor pattern on the base material consists of silk screening a conductive ink or paint in the desired pattern. The ink or paint is made conductive by the use of powdered silver, copper, or other metals in a suitable binder. This provides a very inexpensive and rapid means of producing printed wiring.

Solder Flux

Before going into details on the servicing of various types of printed circuitry and printed wiring, it should be pointed out that the type of soldering flux used is of prime importance. Outside of a pure water-white, rosin-alcohol mixture, there is no known commercial flux which is completely noncorrosive and nonconductive. Under certain conditions, water-white rosin is a perfect flux. Unfortunately, these conditions of cleanliness and correct temperature are not always present. Therefore, various activators are used, in conjunction with pure rosin, to make fluxes which will produce satisfactory results over a wide range of conditions. When fluxes which contain these activators are used for printed-wiring work, they must be completely cleaned off the assembly after soldering. It is true that they may not be corrosive, but they do lessen the insulation resistance between adjacent conductors. In conventional wiring, this problem is not as serious as with printed wiring.

Fig. 3. The technique for manufacturing etched wiring, from laminate to circuit.



With printed wiring, there is, in effect, a two-dimensional wiring pattern and the insulation resistance of the base board is relied upon to furnish the required insulation between components. Under ideal conditions of a perfectly clean board and humidity under 30%, the resistance between two pattern lands may be upward of 50,000 megohms. This same pattern, with flux bridging the two lands, may have a resistance of but a few megohms when humidity and temperature enter the picture. Several megohms, or even several hundred megohms may seem insignificant in general work, but can wreak havoc in certain electronic circuits. It is essential that no flux be present on the printed-wiring card after solder repairs are made. Needless to say, acid-core flux should never be used. Paste fluxes should also be avoided because of their acid content.

When circuit cards or boards are commercially produced the manufacturer inserts the components, after which the spots to be soldered are individually fluxed or the flux is applied to the entire surface that comes in contact with the dip soldering pot. The board is then floated on a bath of molten solder ranging in temperature from about 400° F to 500° F for from 2 to 10 seconds. The flux is then removed in a series of rinse baths. Some-

(*Continued on page* 136)

Typical examples of commercially-available SSB bandpass filters. From left to right: 20 kc. filter by Barker & Williamson, Inc.; a 50 kc. filter made by Burnell & Co., and a 455 kc. mechanical filter made by Collins Radio Company.

Commercial Aspects of Single-Sideband

Part 2. A discussion of single-sideband generation using either of two current systems: filter or phase-shifting.

By
JACK N. BROWN
Engr., Barker & Williamson

IN THE first article of this series we dealt briefly with the theoretical system gains of a single-sideband *versus* an AM system, the economic considerations involved in converting an AM system to single-sideband, as well as some of the less extensive technical considerations of single-sideband such as frequency stability requirements and the choice of single-sideband generation systems. In this article the author proposes to delve deeper into the method of single-sideband generation by the two currently available systems.

The Filter System

The filter system of generation was the first one that was technically available for use when single-sideband was under consideration. Since it was shown theoretically that sidebands do exist about an amplitude-modulated carrier, it then became a problem for the engineer to design satisfactory filters which could, by brute force, separate one sideband of an AM signal from its adjacent sideband. If we consider that speech frequencies on the order of 300 to 3000 cycles are necessary for satisfactory communication-type speech systems, the filter problem then is to separate the sideband signals lying either side of the carrier.

To the design engineer this means that the sideband filter must be able to discriminate between signals that are a minimum of 600 cycles apart. For many years this filter requirement could be met only by filters in the high audio or low radio frequency spectrum. Until relatively recent years all sideband filter generation was at or below 100 kc. Filters of the *LC* variety were in common use in the region of 15 to 60 kc. and quartz crystal lattice filters were used in the region of 50 to 100 kc. These very satisfactorily divorced the two sidebands of the double-sideband suppressed-carrier signal that had to be generated first. See Fig. 1 for a block diagram of a typical filter-type single-sideband transmitter. In recent years improved techniques in filters have made possible the manufacture of filters at higher frequencies than previously considered feasible. It is now possible to build magnetostriction or mechanical filters up to the region of approximately 500 kc. The construction of crystal lattice filters up into the region of a few megacycles is more practicable. The block diagram of Fig. 1 uses what might be a typical filter in the low radio frequency spectrum of approximately 400 kc. The speech signal is fed into the microphone and amplified in the speech amplifier and thence goes into the balanced modulator. The low-frequency carrier oscillator at 400 kc. also feeds an r.f. signal into the balanced modulator. The balancing action of this modulator stage successfully eliminates the carrier signal at its output yet under application of speech signals at the microphone, a double-sideband suppressed-carrier signal is present at the output of the balanced modulator. The sidebands thus generated lie symmetrically either side of the 400 kc. r.f. carrier frequency. The identical sideband signals are then fed into the sideband filter, the filter discriminates between the sideband signals in that it passes the sideband signals lying to the low-frequency side of 400 kc. and attenuates the sideband lying just to the high-frequency side of the 400 kc. carrier frequency. At the output of the sideband filter we have a carrierless single-sideband signal whose suppressed-carrier frequency is 400 kc. and whose intelligence is contained in the 3 kc. spectrum just below 400 kc. The lower audio speech frequencies will lie closest to the 400 kc. carrier frequency while the higher audio frequencies are correspondingly farther away (to the low side) from the 400 kc. carrier frequency.

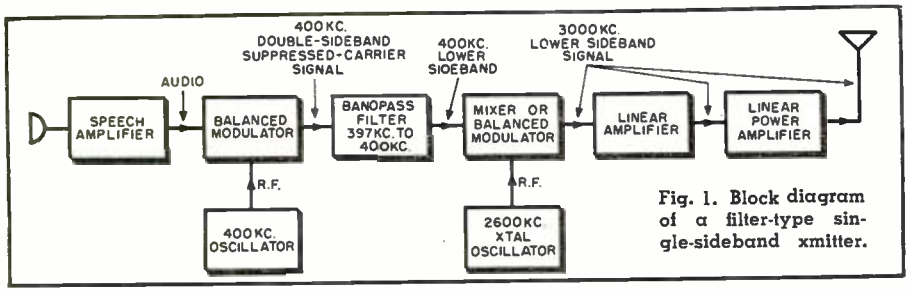


Fig. 1. Block diagram of a filter-type single-sideband xmitter.

Our problem now is to translate the single-sideband signal existing at approximately 400 kc. up to a usable operating frequency of, for example, 3 mc. The single-sideband signal is then fed into a mixer or balanced modulator stage into which is also fed an r.f. voltage from a crystal controlled or stable v.f.o. source which is exactly 400 kc. removed from the desired output frequency. If operation is desired on 3 mc., for example, the oscillator frequency must be either 2600 kc. or 3400 kc. If the 2600 kc. oscillator frequency is used and the 400 kc. lower sideband is heterodyned with this oscillator frequency, a lower sideband

signal with a suppressed carrier frequency of 3 mc. will exist at the output of the high-frequency balanced modulator.

If the 3400 kc. oscillator frequency was chosen and the 400 kc. single-sideband signal arithmetically subtracted, the result at 3 mc. would be an upper sideband signal. A pencil, a piece of paper, and a couple of minutes will demonstrate the reason for this. Use actual numbers for the sideband frequency existing for a 2000 cycle audio tone and a suppressed carrier frequency of 400 kc. This simple mathematical manipulation is left to the reader. If the high-frequency mixer is actually a balanced modulator, the oscillator frequency at either 2600 or 3400 kc. can be balanced out. The tuned circuits following the high-frequency balanced modulator must successfully discriminate between the sum-mixture of the sideband and oscillator frequency and the difference-mixture of the same sideband and same oscillator frequency. If the 2600 kc. oscillator frequency was chosen, the tuned circuits following the balanced modulator must pass the 3000 kc. lower sideband signal as well as attenuate the *upper sideband* signal existing at 2600 — 400 or 2200 kc. In this part of the spectrum two or three tuned circuits will accomplish this successfully. However, if operation in the higher frequency part of the spectrum is contemplated, more tuned circuits or a different heterodyning system must be used. It is often necessary to use multiple steps in heterodyning a low-frequency generated single-sideband signal up to some usable high frequency part of the spectrum, say 20 mc., for example.

It can be seen that we now have existing at a desired operating frequency a single-sideband, either upper or lower, as the operator desires. The problem now is to amplify this single-sideband signal to a high enough level to permit radiation by the antenna system. The amplifier stage or stages following the last heterodyning stage must be some class of linear amplifier. Linear amplifiers will be discussed in detail later in this article.

The Phasing System

Generation of a single-sideband signal by the phase-shift method has been possible only in recent years. It has only been since 1946 that it has been feasible to construct wide-band audio-frequency phase-shift networks. The successful phase-shift generation of an SSB signal places very strict requirements on certain critical parts of the sideband generator. See Fig. 2. It can be seen in Fig. 2 that two different types of phase-shift network are necessary. The audio-frequency voltages picked up by the microphone are amplified in the speech amplifier and appear in the input to the audio-frequency phase-shift network. This network must meet two very stringent requirements. Throughout the audio-frequency range used (usually 300 to 3000 cps) this network must yield two output audio voltages which are identical in amplitude and frequency but which must differ by exactly 90° in phase relationship. See Fig. 3 for a schematic of a typical audio network. The departure from exact equality of the two output voltages or exact quadrature relationship in phase will cause a deterioration of this generated SSB signal. The v.f.o. or crystal-oscillator signal is fed into a radio-frequency phase-shift network which must fulfill exactly the same conditions as that of the audio phase-shift network. The r.f. network must give two equal output voltages whose phase relationship is exactly quadrature, that is, they must be exactly 90° apart. Since the radio frequency involved is a single frequency, the problem of constructing a practical r.f. phase-shift network to work on a fixed frequency is comparatively simple. A simple combination of *R, L,* and *C* can do this quite nicely. See Fig. 4. However, if operated on any frequency other than that for which the r.f. network was designed and adjusted a deterioration of the single-sideband signal will result. The block diagram shown in Fig. 2 is for a "fundamental phasing generator." By this is meant that the single-sideband signal is generated at the frequency of the desired transmitter output. Thus it can be seen that for each frequency of operation a different r.f. phase-shift network must be used. The dual output of the audio phase-shift network feeds into two separate balanced modulators labeled "A" and "B." The two separate r.f. output voltages from the radio-frequency phase-shift network likewise feed into the previously mentioned "A" and "B" balanced modulators. The r.f. and audio-frequency signals combine in each to produce at the individual balanced modulator output a double-sideband suppressed-carrier signal. Thus at the output of balanced modulator "A" there appears a double-sideband suppressed-carrier signal with carrier frequency of 3000 kc., likewise, at balanced modulator "B" another double-sideband suppressed-carrier signal appears also of 3000 kc., suppressed-carrier frequency. These two double-sideband signals are identical in every respect except that the instantaneous phase-shift relationship of one sideband in each balanced modulator output is exactly 180° opposed. At the output of the two balanced modulators "A" and "B" the two sidebands that are out-of-phase will cancel while the other remaining sideband signals will add and re-inforce each other at the output of the balanced modulators. Thus by careful manipulation of the phase relationships of sideband signals involved it is possible to successfully attenuate one sideband of an AM signal. With the fundamental frequency SSB generating system if operation on other than the alignment frequency is desired careful realignment of the r.f. phase-shift network is necessary to operate satisfactorily on the new frequency. It has generally been found satisfactory to design a radio-frequency phase-shift network that yields a constant r.f. 90° phase-shift between the two output r.f. voltages for varying frequency input but the two amplitudes of the individual outputs vary in direct proportion to the operating frequency. If a certain design tolerance is permitted in the variation of operating frequency so as not to degenerate the quality of the single-sideband signal, a certain frequency variation about the design center frequency may be used. If we restrict the change in operating frequency to ±2½% of the operating design center frequency it will be found that (all other phase-shift and amplitude relations in the single-sideband generator being perfect) the unwanted single-sideband suppression will be degraded to a value of 37 db. This value of 37 db is generally considered acceptable. However, it must be remembered that all other phase-shift and amplitude regulations must be perfect in order to get 37 db sideband attenuation. In general, this will not be the case and further degradation of the sideband suppression will result. For a commercial-type service where operation only on certain fixed frequencies is contemplated, the fundamental phasing type single-sideband

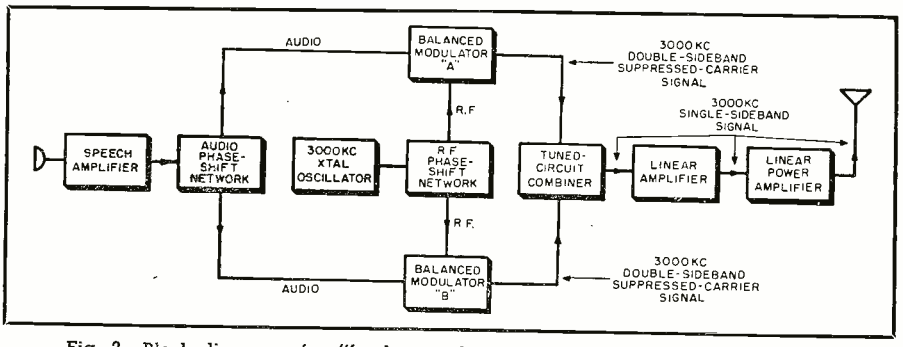


Fig. 2. Block diagram of a "fundamental phasing" single-sideband transmitter.

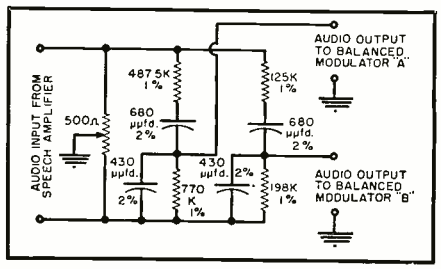


Fig. 3. B & W's audio phase-shift network.

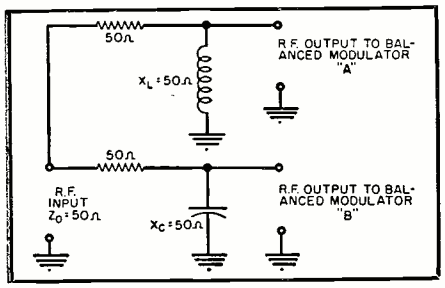


Fig. 4. Radio-frequency phase-shift network.

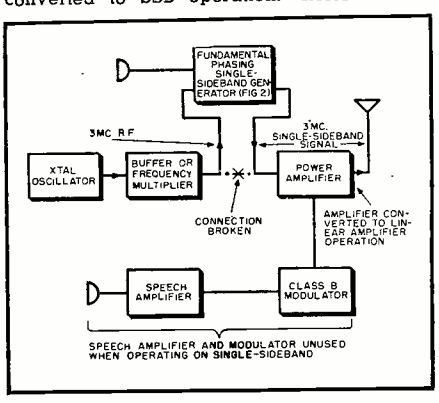
generator would appear to have some merit. Since it is possible to build very stable components, the r.f. phase-shift remains relatively constant with time and temperature variations. It would appear that this would be a most economical method to use. Where a number of fixed frequency channels are required in commercial service the individual channel r.f. phase-shift networks could be made part of the channel selector switch which would normally change the frequency control system of the basic transmitter. It is also possible to build precision audio phase-shift networks to hold an angular accuracy to considerably less than 1°. The fundamental phasing sideband generation system would appear to be a "natural" for converting an existing AM transmitter to single-sideband type transmission. See Fig. 5.

The normal frequency control components and stages of the AM transmitter in question are used to furnish the r.f. signal indicated in the block labeled "xtal. oscillator" in Fig. 2. The r.f. from the exciter stages would be fed into the r.f. phase-shift network and thence into the two "A" and "B" balanced modulators. It would appear uneconomical to make general use of the audio-frequency equipment in an existing AM transmitter since only one or two stages of audio amplification are necesary to drive the precision audio phase-shift network also illustrated in Fig. 2. The output of the dual balanced modulators after a stage or two of linear amplification in the external single-sideband generator would then feed the single-sideband signal back into the grid circuit of the existing AM transmitter. It would be necessary to make appropriate changes in the AM transmitter final amplifier to insure that it would operate as some form of linear amplifier rather than in its former class C operation. This would necessitate re-adjusting the operating bias on the control grid of the final amplifier to a value that would permit operation of the tube as a class A, class AB_1, class AB_2, or class B linear amplifier. The tube characteristic should be consulted for proper operating bias. If the transmitter output tube is a tetrode the screen voltage applied must be stabilized by using voltage regulation either of the vacuum-tube or gaseous-tube type. The converted AM transmitter will perform satisfactorily as a single-sideband transmitter. The normal AM speech amplifier and class B modulator stages will be unused and appropriate measures can be taken to disable them to conserve power drain on the transmitter power supplies. One manufacturer[1] markets such a unit for converting amateur transmitters to SSB if they fulfill certain minimum requirements. Admittedly this is for the restricted range of the amateur bands, however, it would appear that the same techniques would be quite usable for the commercial services where a given number of fixed-frequency channels are used. This should be a very good interim method of obtaining single-sideband without the pain of discarding existing AM equipment.

Linear Amplification

In the preceding discussion brief mention was made of linear amplifiers. This is a subject which, in itself, could occupy many thousands of words and yet not be satisfactorily covered. It is not the intention of the author to delve deeply into the general subject of linear amplifiers. A linear amplifier is one whose output is an amplified replica of the grid input signal. The most commonly encountered linear amplifiers are the ordinary class A amplifiers in an audio system or the r.f. amplifiers employed as r.f. stages in the front end of a receiver or the high level modulator stages used in currently-operated AM equipment. The linear amplifiers used in single-sideband amplification work on the same principle except that in all cases tuned circuits or r.f. coupling devices are used as interstage and output coupling units. Since a single-sideband signal once generated is made up of amplitude variations, any amplification of the signal following generation must be of a linear nature to faithfully reproduce all of the amplitude variations involved. If linear amplification is not attained spurious adjacent channel signals are generated in the amplifier circuits themselves creating unnecessary adjacent channel interference to other services and contributing nothing as far as the intelligence transmitted by the offending station. The most common causes of non-linear distortion in amplification are: 1. Improper adjustment of operating bias on the grid of a linear amplifier; 2. Improper plate loading of the linear amplifier, and 3. Too large a driving signal causing saturation of the operating characteristics.

Fig. 5. How an AM transmitter can be converted to SSB operation. Refer to text.



Any one or all of these factors will cause serious distortion products which will cause adjacent channel interference. Several articles have appeared[2,3,4] in recent technical literature which outlined the requirements and certain techniques to be used in linear amplification.

Various Systems

From the preceding discussion it can be seen that the fundamental phasing generating system is not feasible for general coverage of the high-frequency range. If general or continuous coverage of the 2 to 30 mc. high-frequency range is necessary it would appear most reasonable to make use of heterodyning techniques in order to cover the spectrum properly. This involves generating the single-sideband signal by either the filter or the phasing system at some fixed frequency and by either single or multiple heterodyning steps to cover the high-frequency communication spectrum. Heterodyning a fixed-frequency, single-sideband signal to any other part of the radio-frequency spectrum cannot be done without careful consideration of the frequencies involved, the selectivity of the tuned circuits following the heterodyning stage, and the possible combinations of the heterodyning frequencies. Spurious mixture outputs are the result of heterodyning of the harmonics of the two signals being fed into the mixer or balanced modulator stage. It is possible to have present at or near the desired output frequency a spurious signal either c.w. in nature, or a single-sideband signal of either upper or lower sideband. Very careful consideration must be given to this matter in the initial design of any single-sideband equipment. It can be seen that the one big advantage of the fundamental frequency generating system, using the phasing technique, is that no spurious mixture products are encountered since the single-sideband signal is generated at the fundamental output frequency. The design engineer must then decide which system is most applicable to the particular problem with which he is concerned. If the heterodyning system is to be used it is suggested that the design engineer consult the spurious mixture product charts published by Badessa[5] and Eberhardt.[6] These two articles will give the design engineer some very handy tools for designing the heterodyning system to be used. The author can not overemphasize the importance of the design characteristics that must be considered in a heterodyne system.

Problems of the Design Engineer

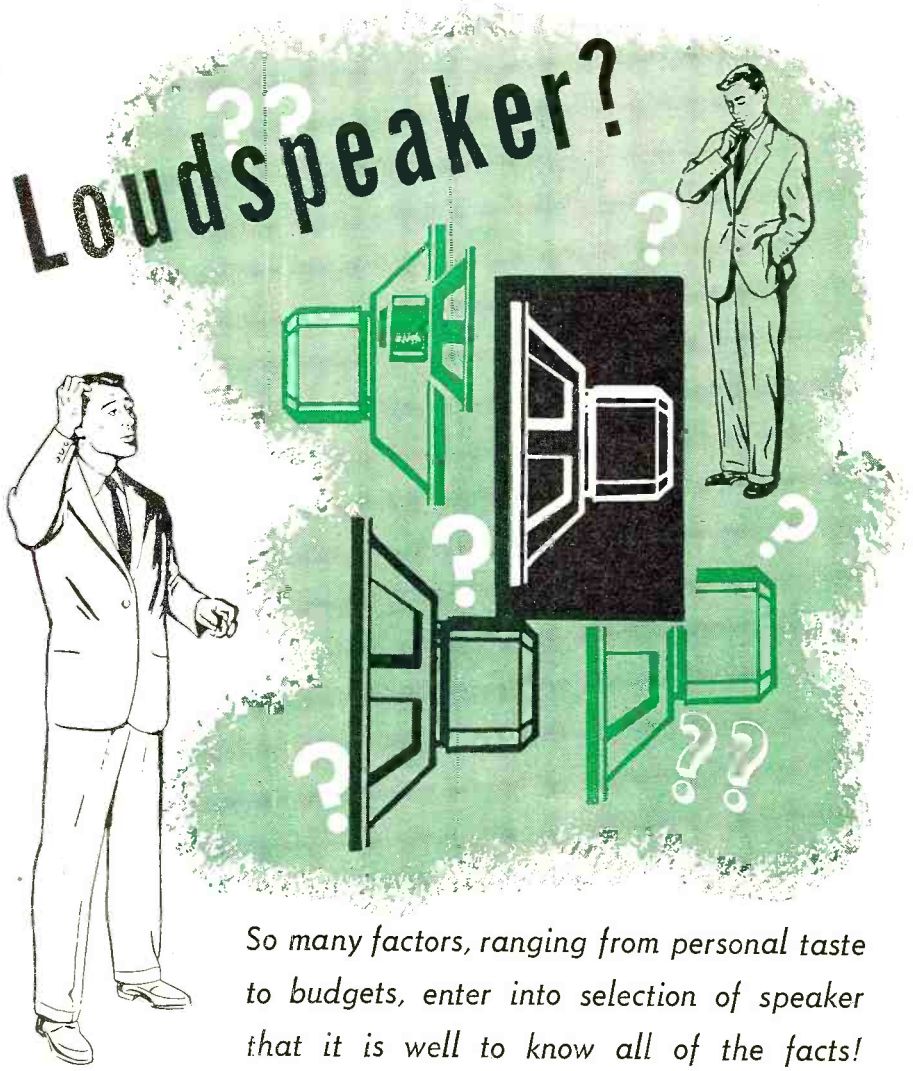
The single-sideband equipment design engineer is faced with varying and somewhat difficult problems involving, in general, the following:

(1) Frequency stability. This would appear to be one of the most difficult

(*Continued on page* 104)

By N. H. CROWHURST

Buying a Loudspeaker?



So many factors, ranging from personal taste to budgets, enter into selection of speaker that it is well to know all of the facts!

RECENTLY two of us went to listen to a variety of loudspeakers. We were both sitting back relaxing in the easy chairs provided, enjoying the music and trying to be critical of the different loudspeakers we were hearing. I was just coming to the conclusion that this particular loudspeaker was about the best reproduction I had ever heard, when my friend leaped from his chair with the remark, "How on earth can you listen to this thing?"

To his ears apparently this speaker was introducing a spurious sound that he found quite annoying. When he described it to me, I found I couldn't even hear it. We exchanged places to check whether it might be a freak of listening position, but I still couldn't hear it. A little later, when listening to another loudspeaker, he was apparently getting wonderful satisfaction, while I was being annoyed by an intense edginess that almost amounted to a whistle, somewhere up at the high end. My friend couldn't hear this.

This experience just goes to show the difference in individual ears and the fact that among loudspeakers, one man's meat is definitely another man's poison. It so happens that this example can easily be explained: my own hearing goes on out to about 17,500 cycles, whereas my friend's stops stone dead just above 12,000. On the other hand, my friend, who happens to be a motor mechanic, has an ear trained to hearing very minute sounds that to most ears are completely masked by much louder ones.

The reason why this difference in choice shows up so noticeably in the selection of loudspeakers is that, good as these units are compared to their predecessors, they are still the weakest link in the modern reproducing chain. Although our modern loudspeakers are much nearer to perfection in reproduction than their earlier counterparts, they still fall short of perfection in such a variety of ways that this individual preference shows up because of the difference between individual ears.

But telling you this will not help you to select the best loudspeaker for your listening—it merely shows you that you cannot rely on someone else's judgment. You want to buy a loudspeaker that will give *you* the greatest listening pleasure, covering a variety of program material. Without some guide to tell you what to listen for, it is extremely difficult to make a selection. You are apt to find yourself listening somewhat aimlessly to different loudspeaker units in succession.

So we shall explain the things to listen critically for in different loudspeaker units, as a guide to what will give you satisfaction when you take home the unit of your choice. Having covered the different things to listen for, we will briefly consider the different kinds of unit available and the trends they exhibit in performance. Finally, do you have in mind a single channel or a stereophonic system? This will have some effect on your choice too.

In a loudspeaker specification its performance is given in terms of frequency response, either by giving a complete response curve, or by giving a statement of its response range and its maximum deviation from an average level throughout this range, for example, ±4 db from 50 to 10,000 cycles. Frequently a maximum power handling capacity is stated and very occasionally one meets a specification of distortion, either harmonic or intermodulation.

Quite frankly, as we have already stated, there are so many things that can deviate, and individual ears differ so much, that there is no simple way to determine just what such a specification will mean *to your listening pleasure,* however well it is specified.

This doesn't mean that technical specifications on the performance of a loudspeaker are useless. These technical specifications have provided the basis for progress in loudspeaker design, because without them it would be impossible to tell how closely individual units approach perfection in reproduction, and so it would also be impossible to tell whether certain changes in design or construction effected any improvement towards that goal. So, to the manufacturer, the use of these specifications has been a great aid in producing the wide range of extremely good units that are now available on the market.

But from this point it rests with the individual listener's ears to determine which of the ranges available gives him the greatest satisfaction and listening pleasure.

What to Listen For

To make your choice you should listen to a variety of program material reproduced over any loudspeaker

unit or system that you wish to judge, and listen carefully for its performance as regards: coloration, cleanness of bass response, cleanness of high-frequency response, integration of sound, muddiness due to intermodulation or other forms of distortion, and transient distortion.

Perhaps in giving this list we have overlooked one fairly obvious thing—that the unit should be free from rattles or buzzes. Even today, one sometimes finds a loudspeaker unit with a grille or gauze which rattles or buzzes when some particular frequency in the spectrum is played.

Coloration: This means the over-emphasis of a certain tone or tones in the frequency spectrum due to resonance in the loudspeaker. If the loudspeaker response is published (and if also it happens to be a true response) coloration will show up in the form of upward bumps in the response as shown in Fig. 1A. The irregularity in response causing noticeable coloration is the upward kind of peak. A downward irregularity or dip is much less noticeable. This is because the accentuation of any individual frequency, compared with other frequencies in the same region, makes that particular tone stand out above its neighbors whenever it is played. It can also over-accentuate that harmonic when a lower tone, having this particular tone as one of its harmonics, is played.

The thing to listen for is whether any particular tone or tones seem to stand out more than they should every time they are played, compared with the rest of the program material.

Very occasionally such coloration occurs in an original recording, due perhaps to coloration in the studio, or to some particular freak of microphone placement. But in modern high-quality recordings this rarely occurs. If you want to be quite sure that it is not a characteristic of the particular recorded material, listen to a variety of program material to see whether it occurs consistently. If it only occurs on one particular disc, but is completely absent from other recordings, then it is evidently a characteristic of the particular recording and not of the loudspeaker.

Listening conditions: Another factor to bear in mind, when listening for coloration, is the fact that the listening room can contribute coloration to the reproduction. This is due to the fact that the dimensions of any room tend to set up specific standing-wave patterns, the dominant frequencies of which are characteristic of the room. At these frequencies the dimensions of the room combine through these standing waves to over-emphasize the intensity at certain points in the room.

There is a simple means of checking whether coloration is due to room acoustics or to the loudspeaker. Just move around a little while listening to the program material. If the coloration is due to the loudspeaker, or maybe even to the program material itself, moving around will not remove it. On the other hand, if it is due to room acoustics the coloration effect will vary considerably as you move from point to point.

Your own listening room at home may also exhibit coloration but it will most probably emphasize frequencies different from those that may be characteristic of the demonstration room.

Different loudspeakers will also sound differently in different rooms because of the various modifying effects individual room colorations have on the loudspeaker responses.

To be more precise, every loudspeaker possesses *some* coloration, manufacturers' claims notwithstanding. In listening for coloration, what we're trying to do is find whether this individual unit possesses coloration sufficient to be annoying. As room acoustics can further emphasize coloration already present in the loudspeaker, it is possible (and often happens) that a loudspeaker sounds well in one room and not so well in another, while another loudspeaker would reverse the order.

Unfortunately there is no reliable way to predict this kind of thing. Probably greatest satisfaction can be obtained by making arrangements, if possible, for having the loudspeaker tried out in your own listening room before finally committing yourself to buy. A few showrooms are specializing in this kind of service, and it is well worth it.

Clean bass: This is the next specific thing on the list that you should listen for. Just what do we mean by clean bass? There are two things we should pay attention to in listening to the low-frequency response of a loudspeaker: (1) that it should be free from noticeable resonances and (2) that it should not exhibit what the specification attributes to IM distortion.

The easiest way to check for freedom from a marked low-frequency resonance is to play program material that has some good low-frequency score in it, either organ music in which there is pronounced bass during the program, or else orchestral music in which the string bass has a strong part. The thing to listen for is whether one note in the bass gets emphasized more than another.

If the loudspeaker is free from any bass resonance, each of the low-frequency notes will have its own character, good and clear, and there will be no over-emphasis of any particular note.

The effects of IM distortion can best be detected by listening to other frequencies, higher in the band, at the same time the low frequencies are being played. For this purpose an organ record is particularly useful. When the bass tones come out good and loud, listen carefully to see whether the higher frequencies stay crystal clear or whether they go somewhat dithery. This is a good way of detecting whether the loudspeaker produces intermodulation on the lower tones.

Clean highs: What do we mean by clean highs? This is similar to the specifications for clean bass. The response should be free from any marked resonance. Many loudspeaker units, in an attempt to achieve something that will appeal to the high-fidelity market, employ a resonance at the high-frequency end to stress the extreme "highs," in the region above about 8000 to 10,000 cycles. This certainly gives the impression that something is there in the high frequencies, but it is not realistic reproduction.

Manufacturers are very fond of advertising this high-frequency accentuation as "brilliance." If you listen critically you will notice that all the

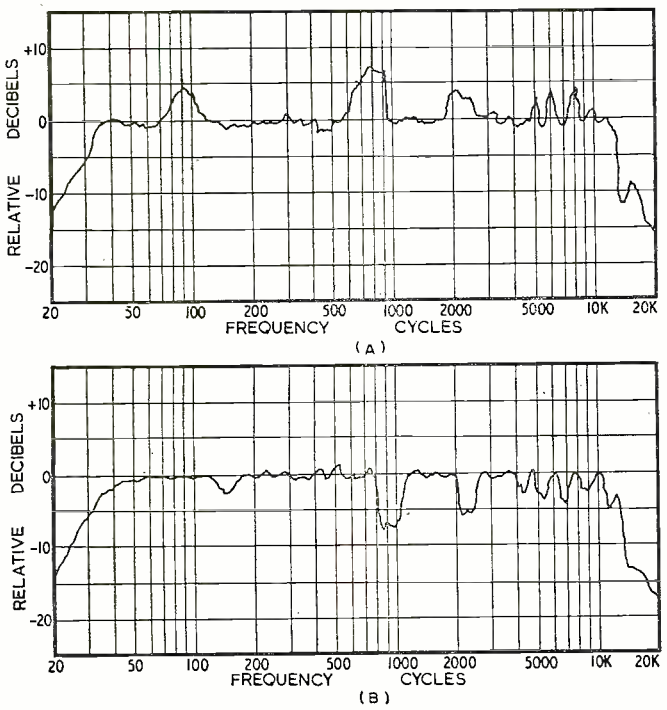


Fig. 1. Typical loudspeaker frequency response curves to illustrate how coloration occurs. Each response shows a similar deviation from average response, but response at (A) predominating in upward irregularities, will be more noticeably colored than the response at (B) which predominates in downward type irregularities.

frequencies in this region seem to ring, or perhaps I should say whistle, on the same tone. Even surface noise from the record seems to hiss at you in this same tone. Don't be carried away by the sound of the "wonderful highs you never heard before." Be critical.

Make sure that you are getting true reproduction of the high frequencies and not an over-emphasis of one particular tone that will annoy you in course of time. Notice particularly if playing of the triangle or washboard, or any other instrument that introduces a quantity of "highs," all happens to sound like someone rattling a piece of aluminum foil. This is the kind of effect that coloration of the highs produces. Good high-frequency response enables the individual character of different instruments to be clearly brought out without this confusing effect.

Another feature to which some attach considerable importance in the reproduction of high frequencies is their dispersion. High frequencies tend to get radiated in a very directional manner. To improve this, so the quality is less dependent on where you sit in relation to the loudspeaker, some manufacturers fit devices, such as dispersers or acoustic lenses, to "spread" the highs, as they come out. In the writer's opinion, while it is good to get this feature, it is more important to have "clean" highs, and to have them well integrated (see next heading). The over-all performance should be weighed with this in mind.

Integrated sound: We have now been analytical about the reproduction of frequencies throughout the entire audio band. We have carefully listened to the low frequencies to make sure that we have clean bass. We've listened to the middle of the range to make sure there is no IM distortion from the bass, or coloration throughout the middle range, and also to the high frequencies to make sure these are clean. We now need to make sure that the whole program sound is properly integrated—because many loudspeaker systems give wonderful reproduction of all the component frequencies in the spectrum, and yet somehow the total sound doesn't seem to be integrated correctly.

By this we mean that the various frequencies in the spectrum do not seem to belong to one another in space. We are apt to get the impression that low frequencies come from one place and high frequencies from another. For example, a loudspeaker with good integration of sound should reproduce equally well solo voices or instruments *and* large area sources of sound such as full orchestra or organ.

A loudspeaker that may have extremely high fidelity, in the sense of uniform reproduction of all frequencies, can still sound quite unnatural. The voice of a solo singer may seem to be divided up so that the "body" of it seems to come from one place, while perhaps the "s" sounds come from somewhere on the side.

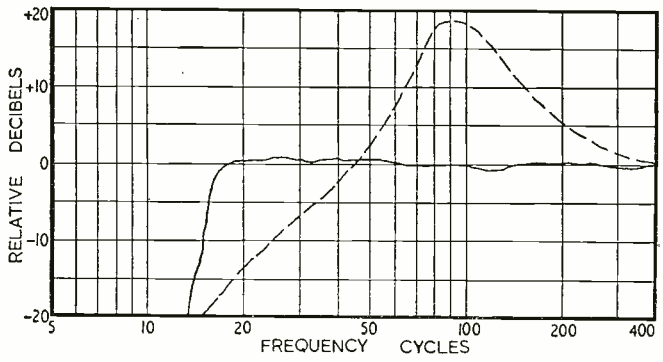


Fig. 2. Showing method a conventional enclosure uses to obtain the bass response. The dotted curve represents the response of driving unit without enclosure: the solid curve is over-all response with the enclosure.

To check for good integration of sound, listen to the loudspeaker reproducing the kind of program material that includes the intimate kind of singing voice for the solo presentation, and also a good full orchestra for realistic wide area sources of presentation.

Not too many of the loudspeakers on the market can successfully handle both kinds of material equally well. It is rather a tough requirement, it is true, but there are some loudspeakers which give extremely good results in this direction, because attention has been paid to this matter of integrating the sounds.

Listen high and low: As well as listening to the different areas in the frequency response, and checking that the sound is well integrated, remember that our ears do not perform the same at different levels. In particular is this true relative to the effect known as masking, whereby a quiet sound gets obscured by a louder sound of a different frequency.

Generally speaking, making the sound louder increases the masking effect, and this is one means that some demonstrators have of hiding the fact that a loudspeaker produces intermodulation distortion.

The intermodulation products are at a much lower level than the desired program material. If the *program* is reproduced at an intermediate level, the quieter intermodulation products may be audible through it, but by turning the volume up so the program level is loud, the intermodulation products, although also somewhat louder, will not be audible due to the increased masking effects in our ears at this level.

Under some circumstances this effect may work in the reverse way, particularly as intermodulation tends to be more pronounced at higher levels than lower levels.

So the best way to prove this is to listen to the system played quietly, intermediately, and loudly. Notice carefully all the points we have already discussed at these different levels. If the performance sounds good at all levels, you really have a good loudspeaker.

Transients: This is just one more point that is not taken care of by the careful listening that we have already discussed. Good reproduction of all program material must include good clean handling of transients. What this means can best be illustrated by considering the difference between organ tones and those of a piano or the string section of an orchestra playing pizzicato.

A loudspeaker, consisting virtually of a number of organ pipes driven by moving coil transducers, could sound extremely realistic on organ reproduction. But try to imagine what it would sound like reproducing a plucked string. The effect would be quite unrealistic—unless you like your string players squeezed into organ pipes!

The ability, or otherwise, of a loudspeaker to reproduce transients is usually concerned more with the design of its enclosure than with the design of the driving element. It is to some extent concerned also with the design of the diaphragm or cone. But, if the loudspeaker gives good reproduction of the entire frequency range without any serious coloration, the driving unit will probably give good reproduction of the transients. However, this is not true of all the various enclosure systems on the market.

Probably the best kind of program as a test for this is the string section of an orchestra playing pizzicato. See if you can really hear those strings being plucked good and clear in this kind of recording. Another test that is a good indication of transient performance is the reproduction of piano music. Unfortunately, however, the distortion that shows up on reproduced piano music is more often due to a kind of transient distortion that occurs either in the recording unit or in the pickup on the playback. Probably the pizzicato string test is the most decisive one for testing loudspeaker performance on transients.

Kind of Unit and Trend

Having discussed the different things to listen for, we will now go briefly through the different kinds of units available and enumerate their usual good points and failings so as to have a specific guide to the features to listen for in each.

Single unit: The simplest kind of unit one can buy is the single 8" or 10" loudspeaker, with only one voice coil and a single straightforward diaphragm or cone. This kind of unit is good for integration of sound because there is only one vibrating element. All the sound must come from the same place.

The reason why the single units are

not more popular is because of their essentially restricted frequency band. To get good low-frequency response we need a large area, relatively heavy diaphragm that will move a lot of air. To get high-frequency response we need a small light diaphragm that can move extremely rapidly. The two requirements are conflicting. Consequently, a single unit has to be a compromise that will get as wide a frequency response as possible and one usually has to be satisfied with a range of, say, 50 to 10,000 cycles. Even in this range the response usually lacks the uniformity that can be attained with more expensive units. The elliptical cone is an asset from this viewpoint. But this does not satisfy the modern definition of high fidelity, and so multiple units come into the picture.

Another reason why multiple units are favored is because single units are also apt to suffer from intermodulation distortion, the kind that shows up when low frequencies are played and the higher frequencies are present at the same time.

Dual and triaxial units: This type of construction probably has the best chance of any, among the multi-unit variety, for achieving good integration of sound. The units for reproducing the low, middle, and high frequencies are all on the same axis and if the electrical crossover circuits for dividing the frequencies to the respective units, and also the physical placement of the units on the axis, have been properly taken care of, extremely good integration can be achieved with this kind of unit.

The use of a nice, large, fairly heavy diaphragm for reproducing the low frequencies, a small, light one for reproducing the middle and upper frequencies, and yet another one for the extreme highs, is a good safeguard against some forms of intermodulation distortion, by keeping the frequencies separate at the reproducer.

The thing to watch for is coloration at all frequencies; also check that the integration is really good; although it *should* be, some designs have not adequately taken care of this feature. A particularly prevalent weakness in this type is that the tweeter or high-frequency unit is resonated to one particular frequency as discussed in the section on "Clean Highs."

Multi-unit systems: In this category we have a variety of enclosures with loudspeakers all over the place and labyrinths twisted all around. For achieving uniformity of frequency response, these have a better chance than the dual or triaxial units, because each unit can be more accurately matched acoustically and the response more carefully tailored so that every frequency is reproduced uniformly. The big problem with these multi-unit loudspeakers is the integration of the sound, particularly for solo program material.

It is difficult to have the sound for the middle part of the range coming from one unit, located at one point in the cabinet, while the high frequencies come from another unit located somewhere else, and still give the impression that the person's voice is located in one spot. Difficult, but not necessarily impossible. Some units of this type give extremely pleasing reproduction, but the main thing to listen for is realism from the viewpoint of whether the sounds from individual instruments and solo voices are properly integrated.

Floppy bass: A number of units coming on the market recently have the particular advantage of being extremely compact for the low-frequency response they achieve. They adopt a new approach to low-frequency response. Until quite recently most loudspeaker units, even of the low frequency type, had a resonance, always above 50 cycles, and usually in the region of 100 to 110 cycles. Using this kind of driving unit as a basis for loudspeaker design, the problem has always been one of extending the response *below* the fundamental resonance of the driving unit. See Fig. 2. However this is tackled, it involves a minimum volume requirement in enclosure size, and results in a comparatively large unit.

The new method of attack consists of using a driver unit in which the suspension is extremely "floppy" so the natural resonance of the unit is down at a few cycles—well below the bottom end of the audio spectrum. This means that instead of having to make the enclosure extend the response downwards, it can actually be allowed to restrict the response upwards by damping down its natural resonance. See Fig. 3. This results in an extremely compact unit for the frequency response that it achieves.

The approach seems to be, theoretically and practically, quite sound. One thing that bothered the writer is whether the unit will be robust enough to stand up to a sudden shock through the system, that will tend to throw the voice coil clear out of the gap. But if the unit is always operated in its cabinet, the acoustic damping should take care of this. It is certainly inadvisable to try operating this kind of unit outside of its cabinet, as you're almost certain to wreck it.

The scheme seems to be good as regards the handling of the low-frequency end of the problem, and how the unit as a whole handles the middle and high frequency end of the problem must be decided by the various features already discussed.

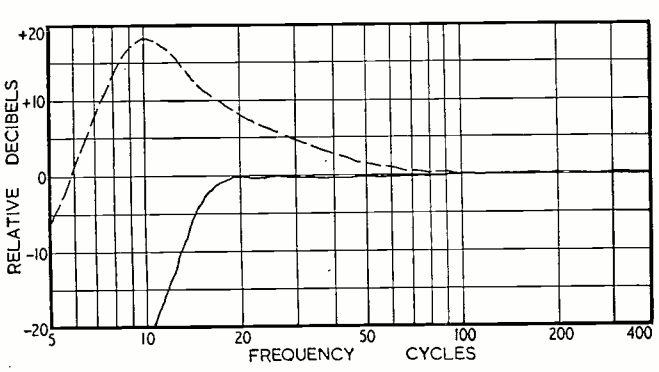


Fig. 3. Method of getting bass response used in newer "floppy bass" technique: the drive unit is resonated to a much lower frequency, represented by dotted curve; the enclosure, which is much smaller and simpler, pulls response down to that illustrated by the solid curve.

Electrostatic Loudspeakers

There are two kinds of electrostatic loudspeakers in vogue at the moment: (1) the electrostatic tweeter, and (2) the wider range electrostatic unit.

The electrostatic tweeter *can* give extremely good reproduction of the high frequencies, but unfortunately the way it has been used has not always exploited it to the best advantage. Due to the complete difference in nature between the impedance characteristics of a dynamic loudspeaker and the electrostatic loudspeaker, there are problems in matching the two units to the same amplifier.

To achieve results that are at least audible—but not exactly high fidelity —some manufacturers have employed a method of matching that has resulted in resonating the response applied to the electrostatic unit. This is not a basic fault in electrostatic units, but it does result in a very peaky high-frequency response as discussed earlier under the heading "Clean Highs." The electrostatic tweeter quite naturally gives good dispersion.

The wider range electrostatic unit that is only recently coming into vogue, with a crossover as low as, maybe, 800 cycles, if correctly matched to the amplifier with which it is used, by following the manufacturer's instructions, can give extremely uniform frequency response over the range it covers. It does, in fact, provide a very good solution to the problem of reproducing frequencies of 800 cycles (or wherever the crossover is) on up, but, thus far at least, we still have to use a dynamic loudspeaker for the low-frequency end, below this crossover point.

The thing to look for in utilizing such a combination is whether there is good integration of the sound above and below this crossover, due to the fact that we are using different kinds of transducers for the two parts of the spectrum. Properly used, this combination can give extremely good results that seem to be quite favorable compared with any of the other types available.

Horns and Enclosures

This is an extremely complicated part of the subject and there is a wide

(*Continued on page* 112)

A Simple Linearity Pattern Generator

Fig. 1. Heathkit Model LP-1 linearity pattern generator, producing vertical and horizontal bars as well as cross-hatch and white dots.

By
J. FRANK BRUMBAUGH
Project Engineer
Heath Company

Description and theory of operation of a recent pattern generator for color and black-and-white.

THE advent of color television has prompted the design and manufacture of many new test instruments of which the linearity pattern generator is perhaps the most versatile. This article describes one of recent design.

The *Heath* Model LP-1 linearity pattern generator (shown in Fig. 1) is a compact and highly versatile instrument, designed to enable the television service technician to rapidly and accurately adjust linearity, size, and focus on both monochrome and color television receivers, and to make color convergence adjustments on all types of color TV receivers. In addition, it allows positioning of yoke and ion trap, and provides for a rough qualitative test of the audio circuits of the receiver.

Completely self-contained and a.c. operated, it covers channels 2 through 13. White bar patterns are generated to form a choice of 6 to 12 vertical bars, 4 to 7 horizontal bars, or a white cross-hatch or grid pattern. A white dot pattern is also made available for color convergence adjustments. No external synchronization is required.

The instrument feeds audio, video, and sync signals to the television receiver through the antenna terminals. A shielded output cable is provided, and an r.f. gain control establishes the signal level impressed across the antenna terminals. Individual control of horizontal and vertical bars enables the service technician to maintain the correct 4:3 aspect ratio when using cross-hatch or dot presentations, and make synchronization easier. Advancing the volume control on the television receiver allows the audio components of the modulation to be heard, thus serving as a rough test of the audio demodulation and amplifying circuits in the receiver.

Theory of Operation

An a.c. operated power supply, comprising a power transformer and 6X4 rectifier, supplies pulsating d.c. to the filter. Filtered d.c. is decoupled by a 100-ohm resistor and a .02 μfd. capacitor to prevent oscillation of the voltage regulator tube, and is stabilized at approximately +150 volts by the 0A2. Regulated plate voltage is supplied to both 6J6's and the 12AT7.

The first 6J6 in Fig. 2 is a cross-coupled, astable multivibrator generating pulses which form vertical bars on the television screen, the number of which is controlled by the "Vertical" potentiometer in the grid circuit. Output from this stage is coupled through the function switch into the cathode of the left half of the 12AT7.

The second 6J6 is a cross-coupled, astable multivibrator generating pulses which form horizontal bars on the television screen. The number of horizontal bars is controlled by the "Horizontal" potentiometer in the grid circuit. Output from this stage is also coupled through the switch into the

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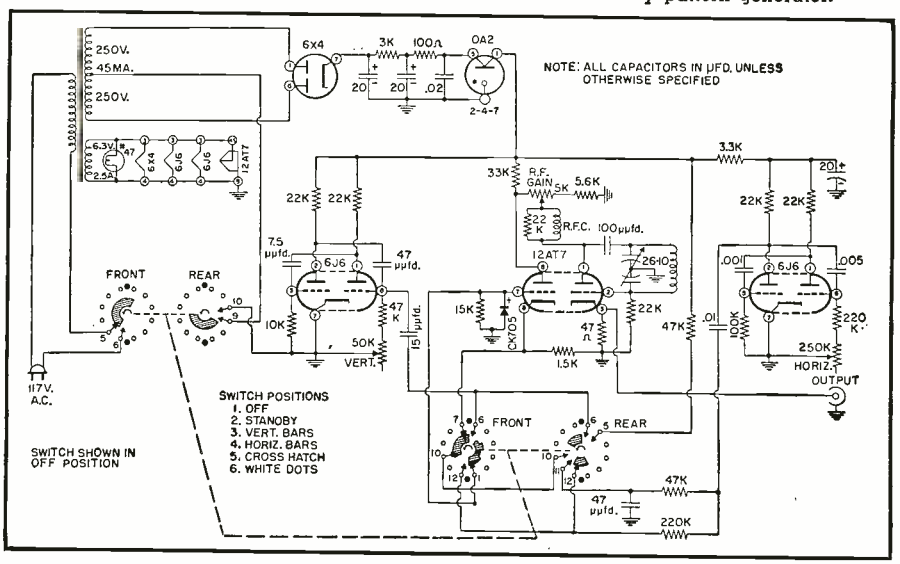
Fig. 2. Complete schematic diagram of the Heathkit linearity pattern generator.



By BERT WHYTE

A FEW months ago, a very interesting and significant hi-fi sound demonstration was presented in San Francisco. Picture this scene if you can . . . you are sitting in a great concert hall and the San Francisco Symphony is about to perform the Overture to the "Marriage of Figaro" by Mozart . . . conductor Enrique Jorda raises his baton, gives the downbeat and the first bars of the familiar music reaches you. As you listen, you note the precision of the first violins, they are all bowing together in near perfect unison; observing the woodwind section you focus your attention on the flutist and the pure sound of his instrument cames to you from the middle of the orchestra where he is sitting. Your eyes and ears move back to the right where several contrabassists are busily sawing away at their ponderous instruments. As the score develops, you are aware of the constant activity of the instrumentalists.

Now we are about two-thirds of the way through the work and at the beginning of a crescendo, suddenly you can't believe your eyes! The musicians have stopped playing and have laid down their instruments, but the *music continues to its triumphant conclusion!* You are as bewildered as everyone around you, when three floodlights illuminate three huge theater-type speakers placed at equal intervals across the back of the stage, and another flood shines down upon the familiar heads, reels, and tape of an *Ampex* tape machine and you realize you have been hearing a *three-channel stereophonic recording* of the work that has just been "played"!

A moment later a narrator assured everyone that this is in fact, the truth . . . that right from the very beginning of the Overture the musicians were merely pantomiming their playing in concert with the tape which had previously been recorded! "Oh come now," says Mr. Audio-doubter, . . . "do you mean to say the realism was so great that everyone was fooled? You must have had some inkling that the reproduction didn't sound 'quite right' and that it had a mechanical quality."

Now friends, this situation actually existed at that demonstration, and in subsequent numbers, other stereophonic trickery was shown. Now whether the same sense of realism was perceived after the audience knew there was stereophonic reproducing equipment on the stage, I don't know. However it is well known that there is an interrelationship between the eyes and the ears when both senses are used simultaneously as in listening and looking at a live concert. The eyes and the ears can easily deceive you. With the musicians going through their motions in perfect synchronization with the stereotape, if there were differences, the mind was not psychologically prepared to accept these differences.

With three-channel stereo the highest pinnacle of the audio art to date and with the demonstration under absolutely ideal conditions, the difference between live and recorded was of a very small order at any rate and the mind of the individual listener, having pre-conditioned itself to the fact that it was going to hear live music, accepted what it heard and saw without question. To further the deception so that even the most astute music lover or knowledgeable hi-fi fan in the audience would find nothing amiss, very special machines and recording techniques were utilized. The *Ampex* machines were special three-channel Model 300 units, modified to use half-inch wide tape, instead of the one-quarter-inch standard width. This eliminates what was one of the problems with the original one-quarter-inch three-channel machine, the deterioration of the signal-to-noise ratio. With less than 45 db signal-to-noise ratio in the standard machine, at high levels some sharp-eared hi-fi fan would have heard the tape hiss, and even in a pre-conditioned state, he would ultimately realize that he was not hearing live music.

The half-inch wide tape allows each of the three channels a much wider area with subsequent improvement of the signal-to-noise ratio. The tapes made before the performance had to resort to special microphone techniques. No omnidirectional pickup here . . . all recording had to be very close-up and as non-reverberent as possible, otherwise you run into double acoustics, in other words, in a normal recording session you want some of the hall reverb in your recording to lend "liveness" to the sound. If that had been done at this demonstration, it would have spoiled the illusion desired since you would be playing back the recording in the same hall and you would have produced double reverberation.

The speakers used were the Cinemascope type developed by *Ampex* in conjunction with *Jim Lansing* and have extremely broad coverage. With their exceptionally high efficiency, it was found that 30 watts of power was sufficient to cover the audience of over 3000 people. Now the crux of this whole thing is this, among those 3000 people were many hi-fi fans who no doubt were vastly impressed, to say nothing of the many people who had never heard real hi-fi sound let alone three-channel stereo! Undoubtedly many of these people, affluent or otherwise, will want to know if there is anything available that will give them this three-channel sound in their homes. The answer of course, is yes, *but* you must be prepared to pay roughly 2900 dollars for a standard *Ampex* three-channel machine, and set up three amplifiers and three speakers as well. Assuming some oil millionaire indulges himself in one of these rigs, do you know what will be available to him on three-channel recorded tape? Just *one* reel of some organ music. There may be one or two others somewhere but I have no knowledge of anything outside this one commercially-made tape.

I'm a lucky guy. I'm one of the few people who have had a three-channel *Ampex* stereo machine in his home. And *Ampex* supplied me with not one but four or five different tapes. I lived with that machine and it was one of the biggest thrills I've ever had in audio, but even the fabulous sound of three-channel stereo begins to pall a little when you hear the same music continuously The lesson to be learned from this demonstration is this . . . stereo whether two or three channels is here to stay. The public is impressed and the public likes it and will buy it if a way can be found to get the cost of the equipment down to an approachable level. The *Ampex* 612 was, of course, a big step in the right direction and if the production rate and availability of two-channel stereotapes can be stepped up, they will enjoy a brisk market. But going one step further, why not take the final plunge and try to produce a marketable three-channel system. Two-channel stereo is great, but nonetheless there are many people who have difficulty in perceiving its depth and directional qualities. With a three-channel unit the fact that you have something *different,* something that sounds incredibly alive and *natural* is immediately apparent even to the most untrained ear. It is well known that a two-channel stereo system using very modest amplifiers and speakers, will sound better than some of the most expensive and elaborate monaural systems. With three-channel stereo you can literally, "get away with murder" in the matter of speakers and amplifiers and even with units no better than are found in today's inexpensive tape recorders! Knowing a bit about the economics of producing tape recorders, I say that the logical step up to three channels is neither technically difficult nor financially unfeasible.

The big problem to overcome is the matter of the recorded tape. But that was the problem of two-channel recorded tape and it has been largely overcome and the situation will be well in hand by the end of this year. Many people, some of them placed very high in the music and audio fields, feel that monaural tape is now merely a transitional thing, and that stereo will be the medium used for music on recorded tapes. I'm inclined to agree, but why stop there? Why not start beating the drums for three-channel stereo, which believe it or not, I feel has a larger sales potential than anything in the field of home music entertainment. The fact that three-channel sound is so startlingly better than conventional sound, leaves open avenues for some smart manufacturer to produce a complete packaged system at a price the public can afford. I sincerely feel that three-channel stereo is in much the same position as was television some years back. It's new, it's different, it's good and, like television, I think there are plenty of people who would be willing to pay the initially higher costs for the privilege of hearing it before it reaches the price level of the masses. As to the music . . . well you just see how fast the big record companies will produce three-channel stereo, when they smell a new market.

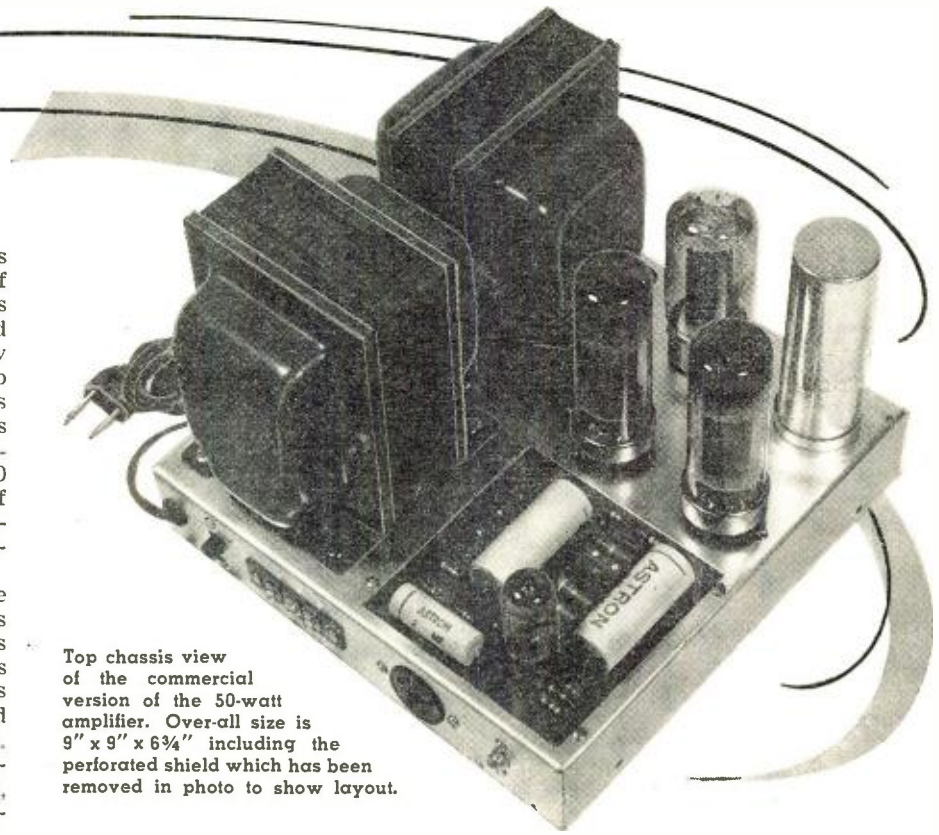
As a matter of fact there is an even easier way of getting the necessary music. I don't have to tell you about the success of the various record clubs . . . it's an accomplished fact and they are growing bigger all the time. If one of the big ones, like the "Record of the Month Club" were really on the ball, they would get themselves three-channel tape recorders and record everything they do in the stereo medium as well as on monaural tape and offer the resultant tapes on their usual subscription plans. I'd join instantly and so would thousands of others.

(*Continued on page* 130)

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.

A 50-Watt Power Amplifier

By **DAVID HAFLER**
Dyna Company



Top chassis view of the commercial version of the 50-watt amplifier. Over-all size is 9" x 9" x 6¾" including the perforated shield which has been removed in photo to show layout.

A high-power amplifier, providing high-fidelity performance, that is well engineered and suitable for home construction.

IN THE last decade tremendous strides have been made in the art of amplifier design. Distortion figures of .1% at normal listening levels and less than 1% at rated output are now routine specifications in contrast to corresponding figures which ran as high as five times as much ten years ago. Even the least expensive amplifiers have response flat over the 20 cps to 20 kc. range and the cost of amplifiers with these excellent specifications has declined steadily in recent years.

There have been times when people have felt that the audio amplifier has reached the limit of design capabilities —but every time this complacency has appeared, new amplifier arrangements came along which *sounded* better and started a new cycle of design variants. Even though distortion has been lowered and frequency response extended, there has still been room for improvement in listening quality. The customary specifications for amplifiers do not correlate closely with audible performance. Low distortion and flat response are necessary for good performance, but they do not insure high quality. The factors which indicate good listenability have not all been identified, and many of them are not subject to evaluation by conventional measuring techniques. However, basic criteria for good sound are being established through extensive controlled listening experience and these criteria are basic to the new amplifier design to be described.

There are several important features in addition to distortion and frequency which have been identified as important in determining auditory quality. These warrant some discussion.

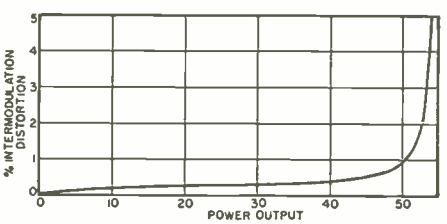
1. *Transient performance* is probably the amplifier characteristic which contributes most to listening quality (assuming low distortion and suitable frequency response). It is one of those hard-to-quantify qualities because a transient, by definition, is a non-repetitive waveform which can only be approximately represented by square waves and similar non-sinusoidal signals.

Good transient performance entails critical damping of the amplifier so that pulse-type signals do not cause oscillatory surges which appear at the output as spurious signals. It also requires extremely wide bandpass so that steep fronted signals of the square-wave type are not distorted. The response outside the audio band must be smooth and controlled so that there is no overshoot and ringing exhibited on a square-wave signal input, and phase shift in the audio band must be at a minimum.

These requirements are all interrelated to the stability characteristics of the amplifier under feedback conditions and with the regulation characteristics of the power supply. An amplifier which is on the verge of instability under conditions of speaker loading (which are more critical than resistive loading) cannot exhibit good transient performance since signals may excite low-frequency surges, high-frequency ringing, and possibly parasitic oscillations under high output conditions. In similar fashion, if power supply voltages shift under signal conditions, there is a change in operating conditions; and the performance with dynamic program sources is not the same as the performance under steady state conditions.

This is one explanation of the lack of correlation between listening quality and measured performance. The laboratory measurements are made with sine and square wave sources which do not duplicate the varying dynamics of musical sources. In addition, the laboratory test uses a fixed load impedance while the amplifier in a practical situation works into a load of variable impedance like a loudspeaker (which may be further complicated by the associated crossover network). Performance with transient waveforms, under varying load conditions, cannot be evaluated with steady-state test methods on a simple resistive load. The solution for the designer is to use all available design considerations which will increase stability and preserve operational characteristics under dynamic signal inputs with reactive loads. Then he must use his ears as the final test instrument.

Fig. 1. IM distortion versus power output.



2. After transient performance, the next important factor in the sound quality of an amplifier is *adequate power handling capacity.*[1,2] Although the total power requirement necessary for good reproduction is a controversial issue, the required power for *realistic* reproduction is in excess of

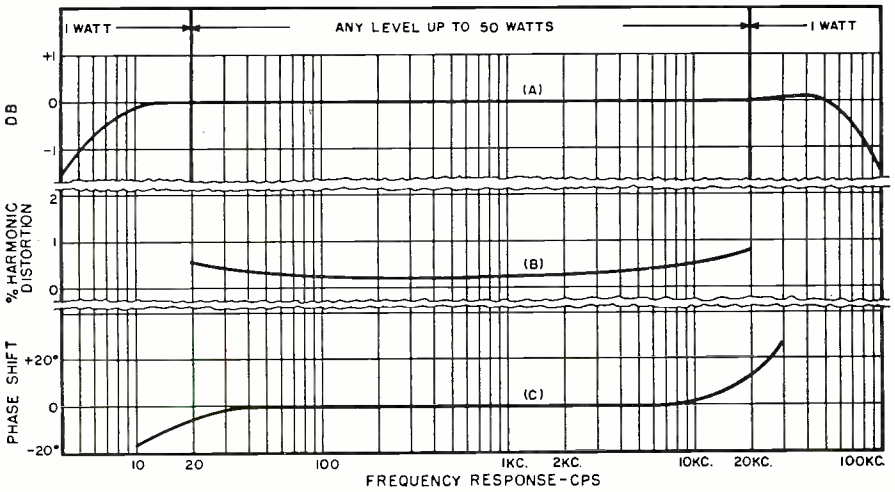


Fig. 2. (A) Frequency response of the amplifier at any level up to 50 watts. (B) The harmonic distortion at 50 watts vs frequency. (C) Phase shift vs frequency.

30 watts unless speakers of very high efficiency are used. This can be demonstrated by recording a piano and then playing back the tape at the same level as the original piano. Scope patterns show definite clipping with a 30-watt amplifier and medium efficiency speaker.

The reasons why more power is required than most people realize involve both psychological and electronic factors. For example, a fixed level of acoustic power sounds louder when issuing from a stereophonic source than from a single-channel source. Therefore, realism which parallels that of stereophonic reproduction requires at least twice as much power if the effect is to be simulated from a single-channel system. Electronic factors which bring about high power requirements are based on the wide increase in bandpass and dynamic range of present-day source material. To handle wide dynamics over a wide frequency band takes power. If "10 watts is enough" was correct 10 years ago, then 40 or 50 watts is required now since the loudness range of records has been increased at least 4 or 5 times.

As the frequency band has been extended, the power requirements are more severe. At frequency extremes, the impedance characteristics of loudspeaker systems change from their nominal values. This mismatches the amplifier and causes a downrating of power capabilities. On some speaker systems, a 50-watt amplifier may be limited to 5 or 10 watts at 30 cps even though it measures full power on a resistive load—this is another factor in the discrepancy between lab tests and listening tests.

3. Even when excellent transient performance and adequate power handling are available, a circuit may still not give the best sound because it is critical as to parts and layout and therefore has insufficient *reproducibility*. It is necessary to have *tolerance latitude* in the design so that any builder of the circuit will get the performance specified. It is not suitable to have an amplifier in which the desired performance can be obtained only by careful balancing and adjustment. In some designs, the movement of a lead can affect stability or hum. This is undesirable since the user has no warranty of continued high-quality performance. This problem received careful attention in the design of the circuit to be described since the amplifier is available commercially in kit form and many users do not have facilities for adjustments and corrections in the effort to get peak performance.

These considerations of *transient performance, adequate power handling,* and *reproducibility* of characteristics were the guiding factors in the design of the amplifier to be described. The attainment of these desiderata required an integration of components and circuitry of unique combination.

The Output Stage

The output stage consists of 6CA7/EL34's in push-pull, matched at 4300 ohms plate-to-plate with the *Dynaco* A-430 output transformer. With the operating conditions selected, this stage, *without feedback,* will put out 50 clean watts over the entire audio band and has frequency response plus or minus 2 db from 6 cps to over 100 kc. These characteristics are further improved by the proper use of negative feedback.

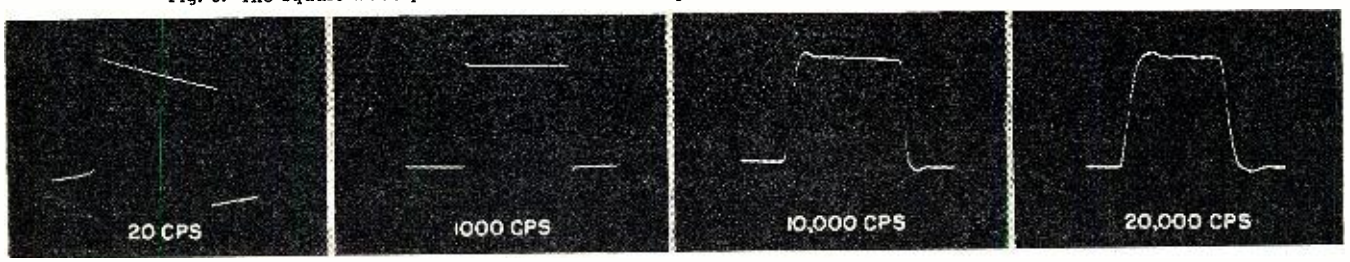
The 6CA7/EL34 is a linear tube which is designed for operation as a pentode. It has a suppressor grid which controls the space charge in the tube and provides a high order of linearity under reactive loading conditions. This type of performance is superior to that of beam tetrodes which tend to show increased distortion under speaker loading conditions. If screen loading is used with this tube, it will affect the space charge control; but if the proportion of screen loading is small, the beneficial aspects of the pentode design can be maintained. In this amplifier, the screen load is about 10%, which preserves the inherent linearity of the tubes. The combination of plate and screen impedances was empirically determined as that which gave optimum performance at both high and low levels under a wide range of load conditions.

The output stage is operated in class AB_1. Class AB_2 or class B operation would have been more efficient, but both of these conditions of operation have relatively high distortion at low levels, and they have such wide current swings that operational conditions shift with changing signal level. In order to maintain optimum transient performance, the essentially linear operating conditions should be adhered to rigorously throughout the entire signal cycle at all power levels. This entails good power supply regulation, and also involves the use of fixed bias. The bias is obtained from a supply of fairly low impedance so that it does not change at any signal level, and operation remains linear under dynamic conditions. If cathode bias were to be used, the operating point of the tubes would shift at higher levels and give a form of transient distortion.

The Phase Inverter

The output stage is driven directly from the phase inverter which is of the split load type. This drive, without an intervening stage, is accomplished readily with the tube used, the triode section of a 6AN8. This arrangement is an old tried and true one which has now been revitalized because of the efficacy of the new tube type which permits adequate voltage amplifica-

Fig. 3. The square-wave performance of the 50-watt power amplifier at various frequencies, as indicated.



tion (to be discussed later) and phase inversion in the same envelope.

The sole disadvantage of the split load, or cathodyne, type of inverter is that its balance fails at high frequencies. The high-frequency response from its cathode section is better than from its plate section since the cathode is at lower impedance than the plate and is less influenced by the following grid input capacitance. Unbalance at high frequencies results in some increase in distortion and also limits the amount of permissible feedback. This, in turn, lessens the margin of stability. Fortunately, however, a simple expedient can provide accurate correction of the unbalance so that the drives to the output tubes can be balanced out to ultrasonic frequencies.

The correction can be made by adding a small feedback capacitor on the side of the circuit energized from the cathode of the phase inverter. In the circuit used, a 390 $\mu\mu$fd. capacitor is connected from the screen of the output tube back to an earlier point. This capacitor introduces more feedback at the higher frequencies so that the circuit has less gain as frequency increases. This correction is most effective on the side of the circuit which has the most high-frequency response, and the net result is to balance the signals from the two sides of the phase inverter. Thus the basic deficiency of the split load inverter is rectified.

The Voltage Amplifier

The phase inverter is preceded by the other half of the 6AN8 tube which is used as a high-gain pentode voltage amplifier. This is direct coupled, *a la* Williamson, to the phase inverter, and the parameters are chosen to give minimum intermodulation distortion over the two stages. A gain of 200 can be readily obtained in the voltage amplifier stage even with the unbypassed cathode.

The use of the pentode tube introduces some subtle advantages. The input capacitance is very low so that there is little shunting capacitance to attenuate the high frequencies of input signals even from high source impedances. Also, under feedback conditions, the low Miller effect in the pentode makes the circuit uncritical as to input source. In triode stages, parasitic oscillations may be encountered when the input source has high capacitance such as that from a shielded input cable.

The high gain of the pentode tube eliminates the necessity for an additional stage. This, of course, simplifies the amplifier and makes a substantial improvement in stability characteristics since it is easier to take feedback over three stages than over four.

The Feedback Loop

Twenty decibels of feedback are incorporated in an over-all feedback loop which goes from output to input of the amplifier. The amplifier is sufficiently stable that it would take an additional 20 db of feedback before oscillation could be induced. This is a substantial margin of safety which makes a very important contribution to transient performance. The stability margin is obtained both through circuit design and through characteristics of the output transformer.

The margin of stability which exists at both low and high frequencies can be readily demonstrated. Touching the input grid of the amplifier sends a sharp pulse through the system. If the speaker cone is watched, it can be seen to move out, then back, and that is all. There is no tendency for it to "rock" back and forth—a form of hangover which blurs the sound of percussive signals. The corresponding high-frequency effect is revealed with square-wave testing. Many amplifiers exhibit a spike (overshoot) on the leading edge of the square wave followed by ripples (ringing) which are similar to low-frequency hangover. These conditions are aggravated by capacitive

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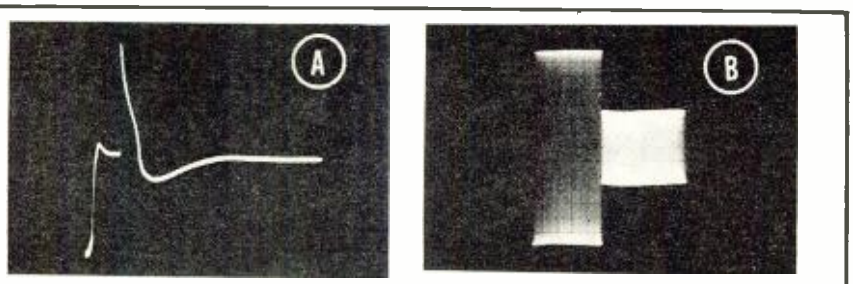
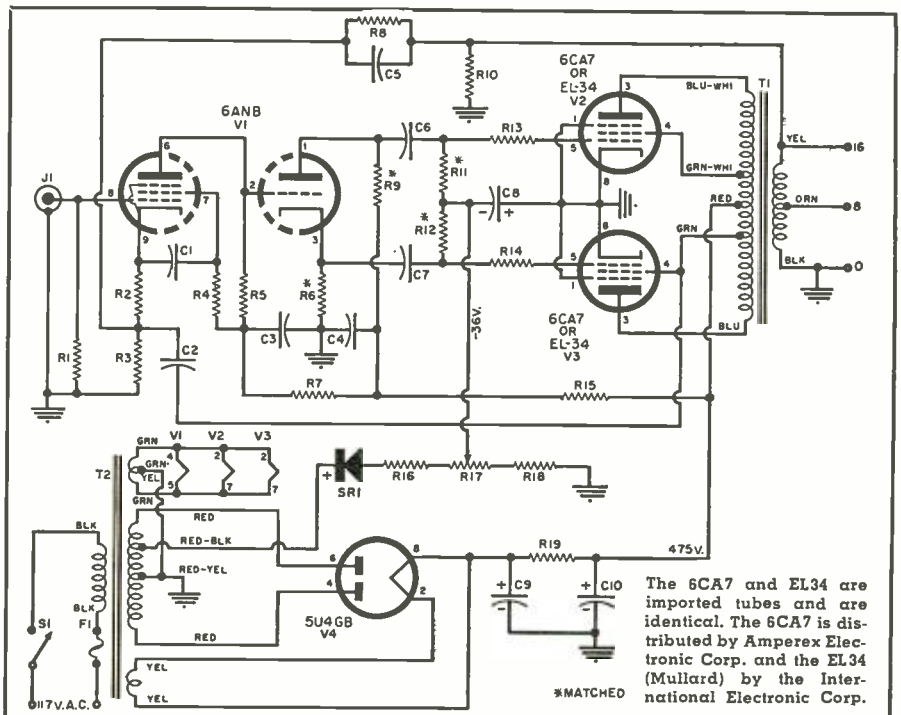


(A) Amplifier response to 1.5 volt d.c. pulse from battery. Initial portion of trace shows switching in of battery; second portion shows switching off. Both impulses are damped on first half cycle, even with this high level signal which drives the amplifier to full output. See text.

(B) Amplifier performance under changing signal levels is demonstrated here by switch from 40 to 6 watt levels. No bounce or surge is visible.

Fig. 4. The transient performance of the 50-watt power amplifier described in text.

Complete schematic of 50-watt amplifier. Parts are standard except for transformers.



The 6CA7 and EL34 are imported tubes and are identical. The 6CA7 is distributed by Amperex Electronic Corp. and the EL34 (Mullard) by the International Electronic Corp.

R1—470,000 ohm, ½ w. res.
R2—680 ohm, ½ w. res.
R3—47 ohm, ½ w. res.
R4—1.2 megohm, ½ w. res.
R5—270,000 ohm, ½ w. res.
R6, R9—47,000 ohm, 1 w. res. (matched)
R7—47,000 ohm, ½ w. res.
R8—1000 ohm, 1 w. res.
R10—680 ohm, 1 w. res.
R11, R12—100,000 ohm, ½ w. res. (matched)
R13, R14, R16—1000 ohm, ½ w. res.
R15—6800 ohm, 1 w. res.
R17—5000 ohm pot.
R18—10,000 ohm, ½ w. res.
R19—50 ohm, 10 w. wirewound res.
C1—.1 μfd., 400 v. capacitor
C2—390 μμfd., 1000 v. capacitor
C3, C4, C9, C10—20 μfd., 500 v. elec. capacitor
C5—750 μμfd. mica capacitor
C6, C7—.25 μfd., 600 v. capacitor
C8—100 μfd., 50 v. elec. capacitor
S1—S.p.s.t. switch
F1—5 amp. fuse
SR1—20 ma. selenium rectifier
J1—Phono jack
T1—Output trans. (Dynaco A-430, see text)
T2—Power trans. 440-50-0-440 v. @ 200 ma.; 6.3 v. @ 4 amps.; 5 v. @ 3 amps. (Dynaco P-782)
V1—6AN8 tube
V2, V3—6CA7/EL34 tube
V4—5U4GB tube

MARINE RADIO Installation and Tuning

By WARREN WIENER and ROGER REYNOLDS
Munston Manufacturing and Service, Inc.

This field has grown greatly and more service specialists are needed if they can make the grade.

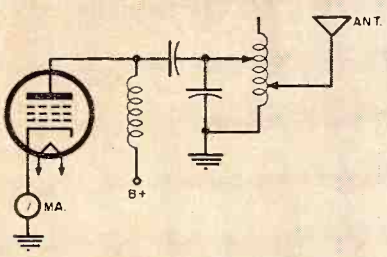
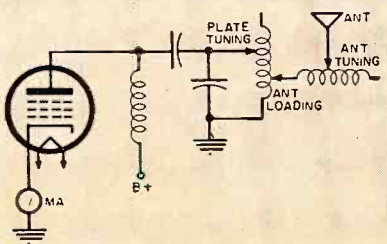


Fig. 1. Simplified diagram of the tank circuit of the final amplifier of a marine radiotelephone of 10 years ago.

Fig. 2. The tuning system shown here is an improvement over that shown in Fig. 1 since the antenna is tuned separately to appear as a low value resistive load.



THE tremendous increase in small boating since the end of World War II has caused the rise of an entire new industry. Every conceivable type of accessory and gadget is manufactured in large numbers and every effort is made to entice the boat owner to buy and install these items on his vessel.

The modern marine radiotelephone has come of age during this period. No longer in the gadget category, the marine radiotelephone is now a compact, efficient, and reliable piece of electronic equipment which is taken for granted by the experienced boatman.

The antenna system probably is not furnished as part of the radio equipment, but it plays a major role in the effectiveness of the radiotelephone. The radiation efficiency of antenna systems on small boats operating in the 2 to 3 mc. band is quite low, ranging from a few per-cent to a fraction thereof. The lead from the antenna to the transmitter should be of large cross section to reduce r.f. losses. The feed point should be at the base of the antenna so that all currents in the antenna system flow in the same direction.

Of equal importance is the lead from the equipment to ground. This lead cable should have a large cross section and be short as possible. If the vessel has a metal hull, the ground connection may be made directly to the hull or to a frame or bulkhead if it is a part of, or electrically bonded to, the hull. The ground can be made directly to the motor or cooling system, which affords the required metallic area in direct contact with the water.

On vessels with wooden hulls and without fresh water cooled inboard engines, the ground lead should be connected to a ground plate fastened to the outside of the hull below the waterline and having a total area of not less than 12 square feet. This requirement is part of the FCC rules effective November 1, 1954, to assure more efficient operation of the antenna employed. Sheets or strips of heavy gauge copper should be fastened to the hull or sides of the keel at less than four inch intervals with screws of Everdur bronze or Monel. A bronze through bolt should be located on the ground plate as directly below the radio as practical. This connection to the copper plate should be brazed or silver soldered for permanent connection. The through-the-hull connection should be bedded in compound to prevent leaks.

The ground plate is normally not painted. Regular copper or bronze antifouling bottom paints are not good insulators and can be applied without appreciable effect. The newer plastic-type bottom paints with good insulating properties should not be applied.

There are many misconceptions about electrolysis. A properly installed radiotelephone and ground plate is not a cause of electrolysis. In fact, it is possible to substantially reduce electrolysis by using a ground plate as a central bonding conductor. Electrolysis results from having two different metals (or two metals at different electrical potentials) in contact with an electrolyte such as salt water. The resulting reaction is nothing more than a form of electroplating.

The best insurance against electrolysis is a properly installed bonding system. This is accomplished by electri-

cally connecting all through-hull fittings together by a heavy wire or copper strap. The engines and ground plate are then connected into this network. When this is done, all metal parts in contact with the water are shorted together and are at the same electrical potential. An alternate solution is to insulate all metal parts from the ground plate. This would require the use of a rubber hose in a water intake, etc. The ground plate should then be left floating by insertion of a .01 μfd. mica transmitting capacitor in series with the ground-plate lead. This will prevent the flow of d.c. between plate and fixtures. The capacitor must be capable of handling the antenna current.

The antenna should be as high as possible. The correct length of the antenna in feet can be approximated by dividing 200 by the highest operating frequency in megacycles. The resulting antenna will be a Marconi type equal to, or less than, one-quarter wavelength at the highest operating frequency. When center-loaded, marine-type antennas are installed, normally 19 to 25 feet in height, the antenna by virtue of its designed use is resonant at approximately 2.8 mc. If this type antenna is placed on top of a 40-foot mast, normal on commercial fishing vessels, the center-loading coil inductance must be reduced by removing turns to compensate for the increased lead-in length.

Transmitter Adjustments

Transmitter adjustments must be made by the holder of at least a Second Class Radiotelephone Operator's License.

All marine radiotelephone transmitters for the 2 to 3 mc. marine band are crystal controlled. These transmitters are generally quite simple; the r.f. portion consisting of a crystal oscillator stage, possibly a buffer, and the final amplifier. Invariably, the oscillator and buffer stages are untuned, leaving only the amplifier tank circuit and the antenna tuning system to adjust.

Since most of the transmitters are multichannel affairs, a bandswitch usually selects a crystal, appropriate coil clips, and other tuning adjustments for each channel. On some sets, a common adjustment is used for two or more adjacent channels and compromise tuning is necessary.

Fig. 1 is the partial schematic diagram of a simple tuning system used about 10 years ago. The FCC will no longer grant a license for a set with this tuning system because of bad harmonic radiation. They will, however, renew a license for a set of this type. Operation is not allowed on 2738 kc.

Tuning this system is quite simple. First, remove the antenna tap on the tank coil or set it at the ground end. Then, move the plate clip over the coil until resonance occurs as indicated by a sharp drop in the current as read by the plate meter. Antenna coupling is now accomplished by tapping up on the tank coil for the desired loading, (proper loaded plate current at resonance, determined by dividing the power input rating by the plate voltage). This must be done slowly, starting at the ground end and moving upward a turn at a time. Since the antenna appears as a large capacity, it detunes the tank circuit, requiring readjustment of the plate coil clip for resonance. For long antennas, the antenna will load within 2 or 3 turns from the ground end. Short antennas will require more turns.

The circuit shown in Fig. 2 is representative of more recent marine radiotelephones. The antenna in this case is tuned to series resonance by the antenna tuning control. The antenna tuning inductance tunes out the apparent antenna capacity, so that the antenna looks like a low value resistive load at the antenna loading clip.

Tuning for this system is quite straightforward. Disconnect the antenna, and place the antenna loading tap 2 or 3 turns from the ground end of the plate coil. Move the plate coil tap to the turn which provides minimum plate current. Then, connect the antenna tuning clip across the tuning coil to obtain the maximum increase in plate current and maximum output on the antenna indicator, if used. The amount of output is now determined by the antenna loading clip; move it up for more output, down for less. Since these adjustments will have some effect on the tank circuit capacity, the plate clip should be moved a turn or two to re-establish resonance.

In some cases the previous system uses a separate coil for antenna loading as illustrated in Fig. 3. Fig. 4 illustrates improved versions of the latter, using link coupling for better harmonic attenuation. In some cases the plate tank capacitor may be variable as an aid in setting up the first channel for resonance. It should be adjusted on one channel and then considered as a fixed capacitor for the other channels. A few models also switch in a separate variable tank capacitor for each channel. This is a great aid in tuning as finer adjustments are possible.

The circuit shown in Fig. 4B provides harmonic attenuation of the second harmonic on the order of 50 to 60 db. However, capacitive coupling and link resonances prevent increasing attenuation at higher frequencies, and measurements indicate that harmonics from the 4th to 10th actually decrease in attenuation to about 40 db.

To further improve harmonic attenuation some radiotelephones use the pi network which, however, is cumbersome to adjust. Such a circuit is shown in Fig. 5. The capacity of C_1 and C_2 in series and the inductance of part of the tank coil must be adjusted to provide resonance. C_2 is normally a bank of fixed capacitors which determines the amount of antenna coupling. As the

(*Continued on page* 149)

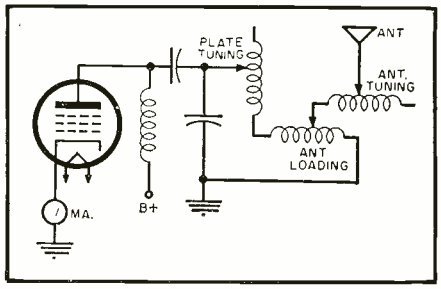


Fig. 3. This tuning system is a modification of the one shown in Fig. 2.

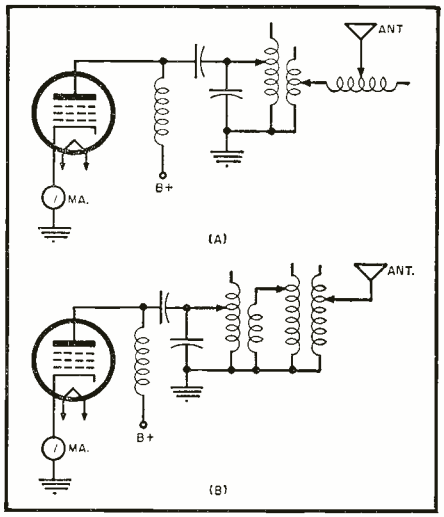


Fig. 4. The two final amplifier tuning circuits shown here use link coupling between the tank coil and the antenna tuning coil to reduce harmonic radiation.

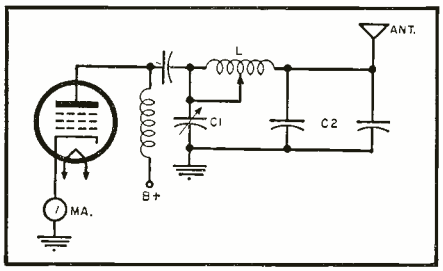


Fig. 5. The pi-type network used in this tuning system greatly reduces harmonic radiation, however, this circuit is cumbersome to tune. See text.

Table 1. Minimum transmitter power authorized by FCC for marine radiotelephones.

CLASS OF RADIO-FREQUENCY AMPLIFIER USED IN LAST STAGE OF TRANSMITTER	MINIMUM AUTHORIZED TRANSMITTER POWER IN WATTS (WHEN NO MODULATION IS PRESENT)
Class C—plate, or plate and screen-grid modulated	15
Class C—control, screen, or suppressor-grid modulated	30
Class C—cathode modulated	24
Other classes	Equivalent values as specified in the station authorization.

Recording from Tape to Tape with a Single Deck

By **JAMES A. McROBERTS**

Preserve your priceless recordings by making new tapes of the material. You can do it on your standard home machine.

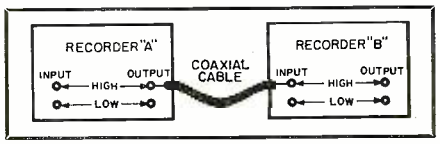


Fig. 1. Method for rerecording tape on two separate machines. Refer to article.

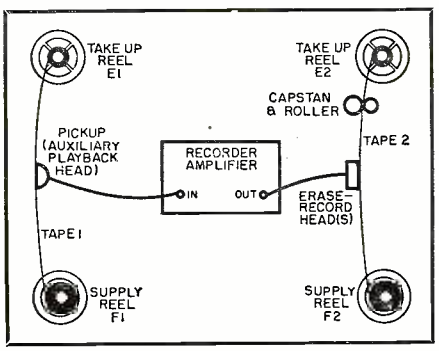


Fig. 2. Simplified diagram illustrating the basic idea of duplicating a magnetic tape utilizing a single recording machine equipped with auxiliary head. Details in text.

NUMEROUS occasions may arise making the duplication, or rerecording, of a magnetic tape desirable, or necessary, or both desirable and necessary. An irreplaceable tape, or perhaps a valuable tape becoming noisy due to wear, are common examples.

No particular problem exists if a second recorder is available having the same tape transport speed. Even the "same speed" requirement may be waived if the machine that records the tape will be used in playing it later. Of course, the recorder that picks up the old material must be similar in speed to the recording that it picks up. As Fig. 1 shows, the output of the "pickup" recorder "A" feeds the input of the "record" recorder "B" that does the job of making the new tape or rerecording. Naturally, the impedances of the two machines (output of "A" and the input of "B") must be nearly the same or an impedance matching network is needed. An additional machine may not be available, or perhaps the expense involved does not justify the purchase or rental of a second machine. This article will describe means whereby a single recorder may be used to make a duplicate recording.

To effect rerecording on a single machine, two problems must be solved. These are: 1. An additional tape must be transported at constant speed with supply reel braking and takeup facilities, and 2. The additional tape, the old tape from which a record is desired, must be pulled past a playback head to pick off its recorded signals.

The general idea is illustrated in Fig. 2, which outlines the problem. We will now consider, in detail, how the separate phases are solved.

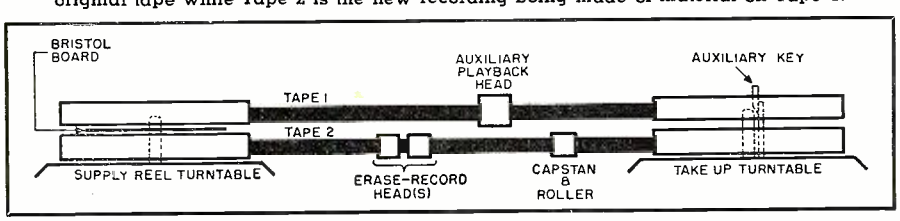
Dual Tape Transportation

If we set up a recorder and thread a tape through it in the customary manner for recording, then the capstan and its roller govern the linear speed at which the recorded tape is wound on the takeup reel. Therefore, if we place another reel on top of this takeup reel, and key it to the lowermost reel, the added upper reel will pull a tape on it at the same linear speed as the bottom reel pulls its tape on to itself and winds that tape up. Thus, if the reel (bottom record takeup reel, see Fig. 3) is of the same spool diameter as the reel on top of it (the playback takeup reel), then tape 1 (the top tape being played back for rerecording) will travel at the same speed linearly as the bottom tape (on which the rerecording is being performed) which latter tape is capstan controlled. Hence, the two tapes travel linearly at the same speed.

Fig. 3 shows also a form of a brake on the supply reel for the uppermost supply reel. This brake is a piece of rather rough cardboard laid on top of the lower reel after the "new" tape has been threaded. It provides some additional braking of the top reel over the bottom. A pressure pad brake could have been arranged against this reel's rim as an alternative measure. The paper "brake" plus the braking inherent in the machine (applied to the supply reel turntable) is quite sufficient for all practical purposes.

The old or master tape is threaded past an auxiliary pickup (playback) head—more later about it—onto the

Fig. 3. A horizontal plan of a dual tape transport mechanism. Tape 1 is the original tape while Tape 2 is the new recording being made of material on Tape 1.



takeup reel. See Figs. 2, 3, and 4. The takeup reel must turn at the same angular speed as the bottom takeup reel as previously mentioned. The spindle on all recorders will project far enough through the top of the bottom reel to position the top reel but will not force it to revolve. This revolution is forced by the insertion of a key in the key spaces on the standard reels. Two pieces (halves) of a toothpick form a good keying device as shown in Fig. 6. The problem of pulling tape 1 at the same speed as tape 2 is now solved completely.

The Auxiliary Head

As Fig. 3 shows, the top tape is pulled past an auxiliary playback head. This head is connected to the input of the recorder as indicated in Fig. 2. If the auxiliary head is properly chosen, no impedance matching will be required—simply plug into the high or the low impedance input to the recorder, usually the high impedance or microphone input. A matching network may be used if such is necessary.

In choosing the head, see that it has tape guides. If no guides are furnished as an integral part of the head, then they must be fashioned to hold the tape in position vertically against the head. Also, check to see that the head is either a lower track or an upper track head as the old recording(s) require.

In selecting the position for the auxiliary head, the warp must be considered. Fig. 5 illustrates correct and incorrect warping. Some types of heads do not require warping but do need pressure pads. Naturally, the pads are additional cost and trouble. If needed you must fit them in the same manner as for ordinary playback service. Preferably purchase a head that will tend to hold the tape tight against itself by the warp method.

The mountings for the head used in this particular machine were fashioned from small brackets procured at the local dime-store. The top of the machine's head cover provided a handy support, as is shown in the photo. All adjustments of the head except the azimuth adjustment could be obtained by the joints in the hardware. The azimuth adjustment was secured by the forming of the thin metal brackets—thin enough for bending but still sturdy enough so that excessive vibration would not be encountered. A wingnut is preferable to a plain nut where it can be used since it is easier to tighten or loosen.

The vertical adjustment of the head must be such that the tape will lie against it with normal tension applied; the tape guides will do very little work if this vertical adjustment is properly made. The head must be adjusted so that the tape will lie flat against the contour of the head, particularly the gap. The top of the tape should not exert more pressure against the head than the bottom of the tape; bouncing will result if this alignment

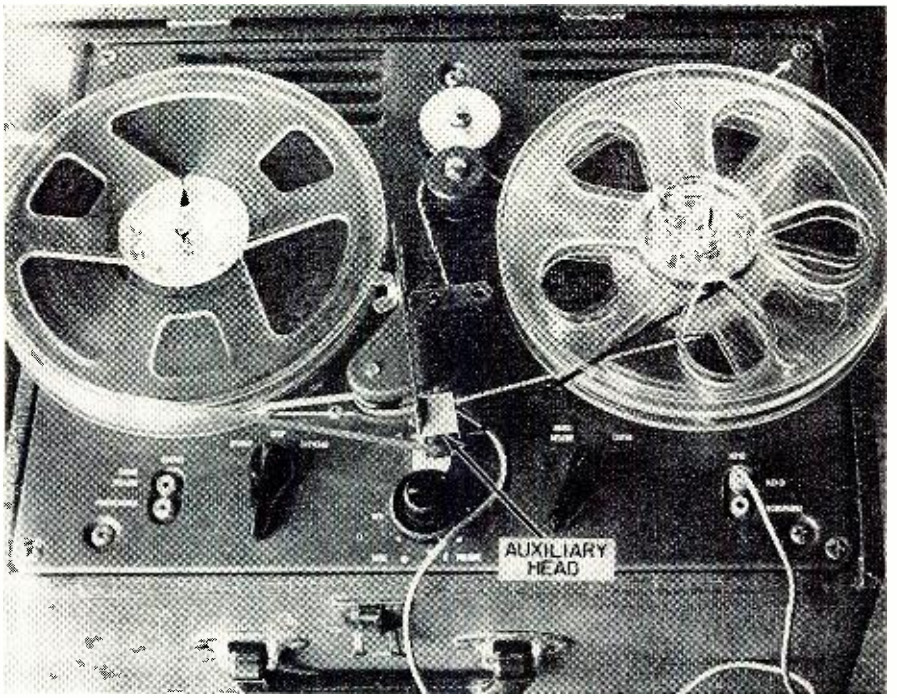


Fig. 4. Typical setup for rerecording with a single, standard tape recorder.

is not correct. A further adjustment is making the gap at right angles to the direction of travel of the tape. Loss of volume, the loss of high note volume particularly, will result if this setting is incorrect. Monitoring the output with headphones while adjusting the head will tell the correct adjustment—the greatest volume with all other things equal is the correct adjustment point.

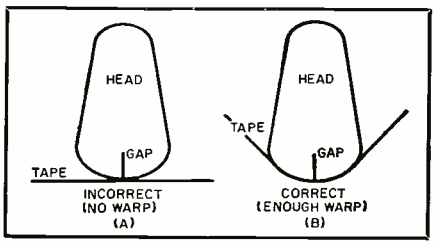


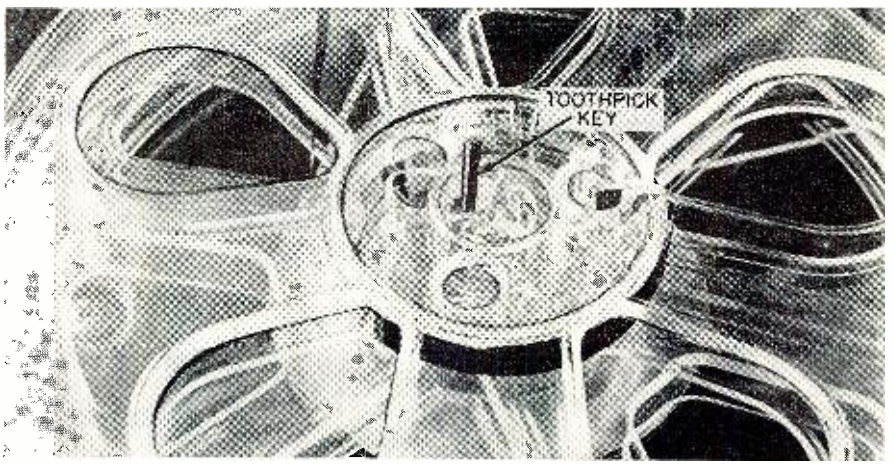
Fig. 5. The correct and incorrect warping of recording tape around playback head.

Now the sound is all electrical in the case of this type of recording. There is no guide post except the overload indicator, which may be rather crude. For this reason, the output should be monitored with a pair of headphones. Pay particular attention to the lower passages. The overload indicator will tell you if the higher or louder passages are too strong.

At the start of the recording, one hand should be placed on the record level control. The level may be too great or too little at the beginning and must be adjusted. If you do not prepare yourself, the reels may require rewinding and starting the process over again.

A standard test tape record has been rerecorded in such a manner with satisfactory results. No tonal differences could be observed between the original and the rerecording which indicated relatively constant speed. The quality will depend to an extent on the alignment of the head, which must be performed with care, as much care as the main heads of the machine. —30—

Fig. 6. Closeup showing the toothpick "key" on take-up reel. Refer to article.



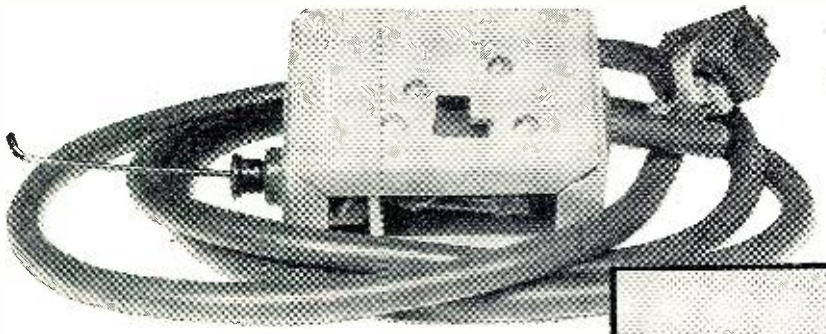
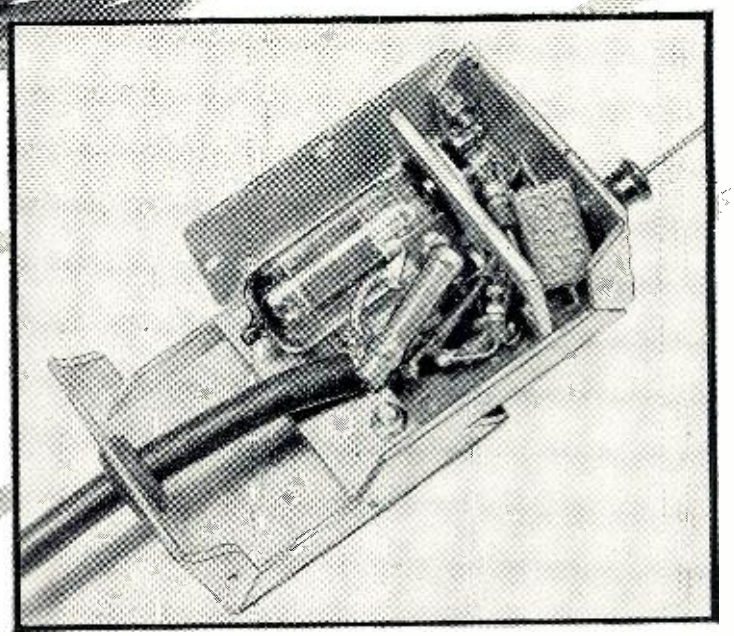


Fig. 1. Two views of the probe which presents an extremely high impedance to the circuit under test. The construction is fully described here.



A No-Load Signal Probe

By **EDWIN BOHR**

Would you like an input impedance of over 100 megohms for your meter or scope? This probe will do just that.

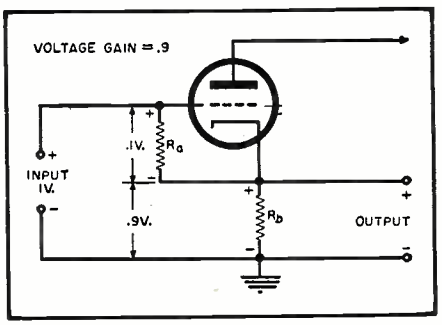


Fig. 2. Basic diagram of cathode follower probe circuit giving high input impedance.

WOULD you like to have an oscilloscope, a.c. vacuum-tube voltmeter, or signal tracer with an input impedance of more than 100 megohms? Or, perhaps you would like to pick up signals from wires without direct contact to the signal-carrying circuit. The "no-load" probe described here and shown in Fig. 1, which can be built for as little as three dollars, will do these jobs and many more.

All measuring instruments affect, at least to some degree, the circuits to which they are connected. This is especially true of high-impedance amplifying circuits. The ideal instrument would absorb no energy from the circuit under test. We can approach this ideal by making the impedance of the measuring instrument as high as possible. This means that the d.c. load resistance must be large and the shunt capacitance small.

The simple, one-tube circuit to be described meets all of these requirements.

For a better understanding of the probe and its applications, following is an explanation of how it is used with an oscilloscope.

The high input capacitance of an oscilloscope and its shielded cable can severely affect the frequency response and operation of the circuit it is measuring. An average oscilloscope with a five-foot shielded cable has a shunt capacitance of about 165 $\mu\mu$fd. (The oscilloscope has an input capacitance of about 40 $\mu\mu$fd. and the wire has 25 $\mu\mu$fd. per foot.) This much capacitance will adversely affect the response of the oscilloscope and the added capacitance can detune r.f. circuits to inoperation.

If a "no-load" probe is used with the scope, the total shunt capacitance can be held to 8 $\mu\mu$fd., permitting better response to fast rise-time wave shapes. Actually, the probe puts the first stage of the scope on the end of a

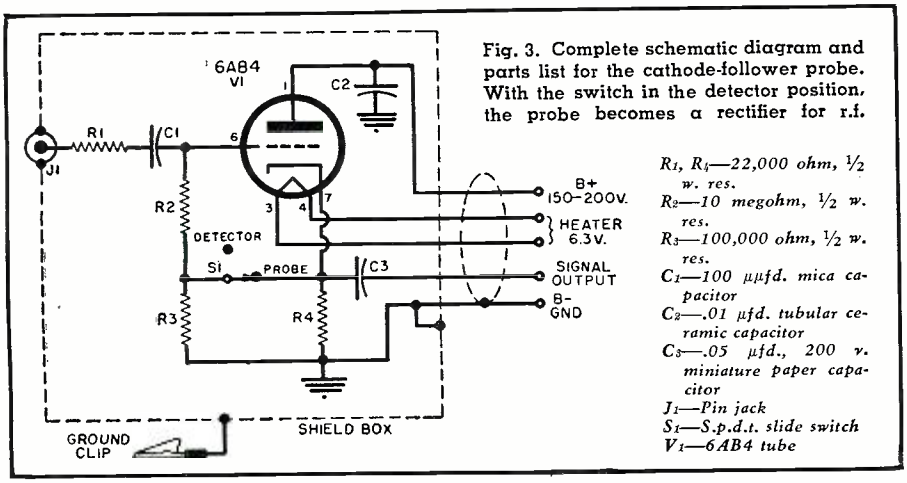
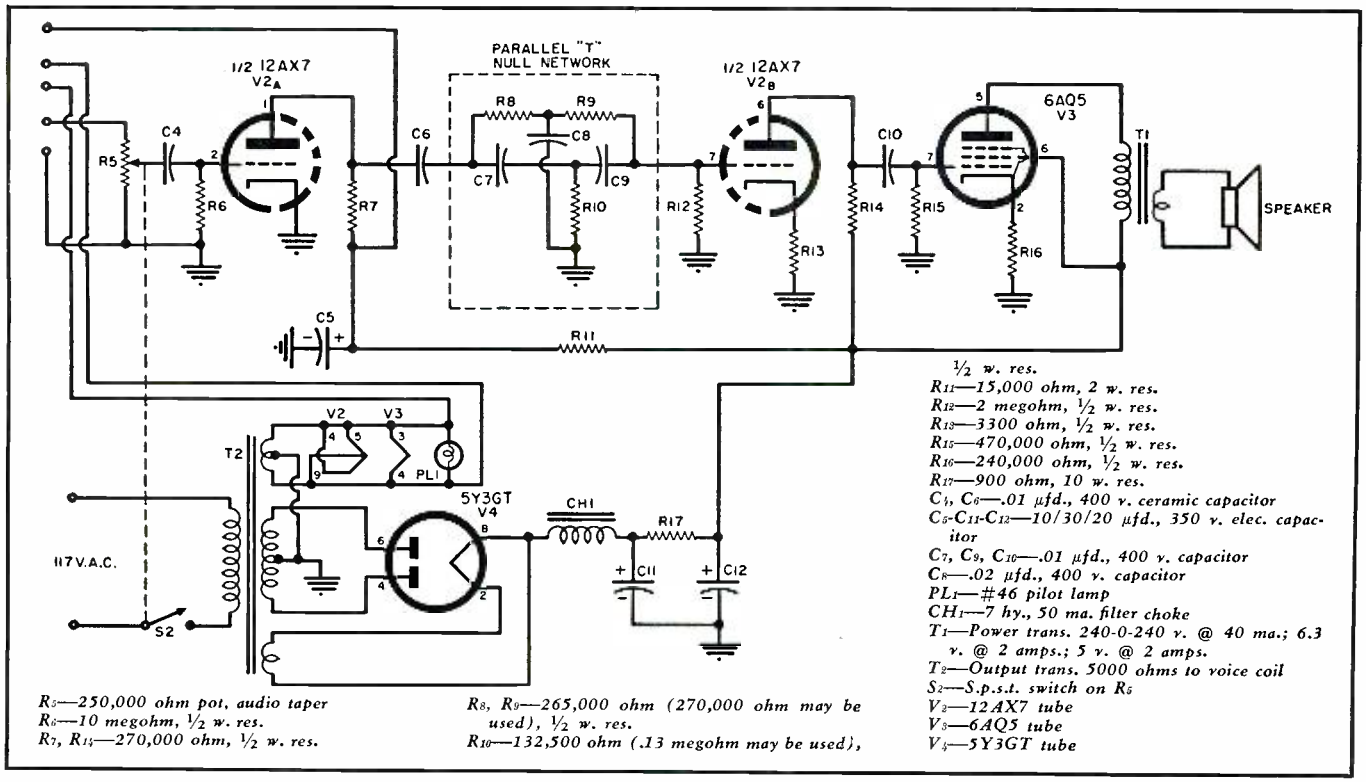


Fig. 3. Complete schematic diagram and parts list for the cathode-follower probe. With the switch in the detector position, the probe becomes a rectifier for r.f.

R_1, R_4—22,000 ohm, ½ w. res.
R_2—10 megohm, ½ w. res.
R_3—100,000 ohm, ½ w. res.
C_1—100 $\mu\mu$fd. mica capacitor
C_2—.01 μfd. tubular ceramic capacitor
C_3—.05 μfd., 200 v. miniature paper capacitor
J_1—Pin jack
S_1—S.p.d.t. slide switch
V_1—6AB4 tube



R₁—250,000 ohm pot, audio taper
R₂—10 megohm, ½ w. res.
R₇, R₁₃—270,000 ohm, ½ w. res.
R₈, R₉—265,000 ohm (270,000 ohm may be used), ½ w. res.
R₁₀—132,500 ohm (.13 megohm may be used), ½ w. res.
R₁₁—15,000 ohm, 2 w. res.
R₁₂—2 megohm, ½ w. res.
R₁₃—3300 ohm, ½ w. res.
R₁₅—470,000 ohm, ½ w. res.
R₁₆—240,000 ohm, ½ w. res.
R₁₇—900 ohm, 10 w. res.
C₁, C₆—.01 µfd., 400 v. ceramic capacitor
C₅-C₁₁-C₁₂—10/30/20 µfd., 350 v. elec. capacitor
C₇, C₉, C₁₀—.01 µfd., 400 v. capacitor
C₈—.02 µfd., 400 v. capacitor
PL₁—#46 pilot lamp
CH₁—7 hy., 50 ma. filter choke
T₁—Power trans. 240-0-240 v. @ 40 ma.; 6.3 v. @ 2 amps.; 5 v. @ 2 amps.
T₂—Output trans. 5000 ohms to voice coil
S₂—S.p.s.t. switch on R₁
V₂—12AX7 tube
V₃—6AQ5 tube
V₄—5Y3GT tube

Fig. 4. Audio amplifier for use with the probe for signal tracing. The varicus terminals on the left correspond to the leads from the probe. Note the parallel-"T" network, this severely attenuates 60-cycle hum picked up by the probe.

cable only inches from the circuit under test. Furthermore, the probe stage has a much higher impedance and better frequency response than found in the average oscilloscope.

Such a probe equips an oscilloscope to make all measurements from audio to video frequencies.

Probe Circuit

The secret of the probe's high impedance is a simple but ingenious cathode follower circuit that actually multiplies the input impedance to a point where only a very low coupling capacitance is sufficient for signal pickup. Even 100 $\mu\mu$fd. of coupling capacitance gives excellent response at 60 cycles. The low-frequency response is so flat and the impedance so high that it may be desirable to include a parallel-"T" circuit to attenuate hum pickup from nearby 117-volt a.c. wiring.

The circuit theory is easily understood. Fig. 2 is the simplified probe circuit; the complete circuit is shown in Fig. 3. In Fig. 2 the signal is shown applied between the grid of the probe tube and ground, while the output is taken from the cathode resistor, R_b, to ground. Notice that the grid resistor R_a is not returned directly to ground, but is in series with the output resistor R_b. A stage such as this is a current amplifier with a voltage gain of slightly less than one.

For the sake of illustration, assume the output voltage is .9 of the input signal. Suppose a one volt positive signal is impressed across the input terminals. Immediately, more cathode current will flow through R_b, making the cathode more positive. This cathode voltage change is in-phase with the signal input.

Notice that while one volt is placed across the input, the e.m.f. across the

(*Continued on page* 154)

Fig. 6. Top view of the amplifier showing the location of the tubes and other parts. The speaker normally is on top.

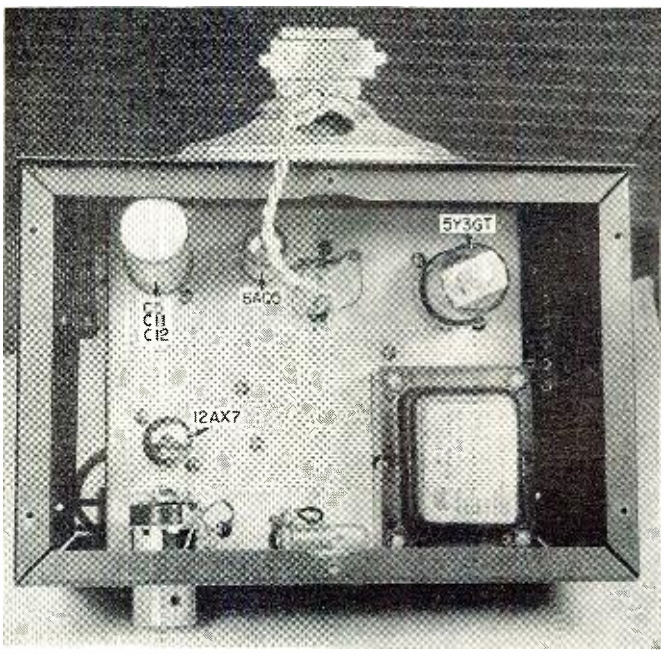
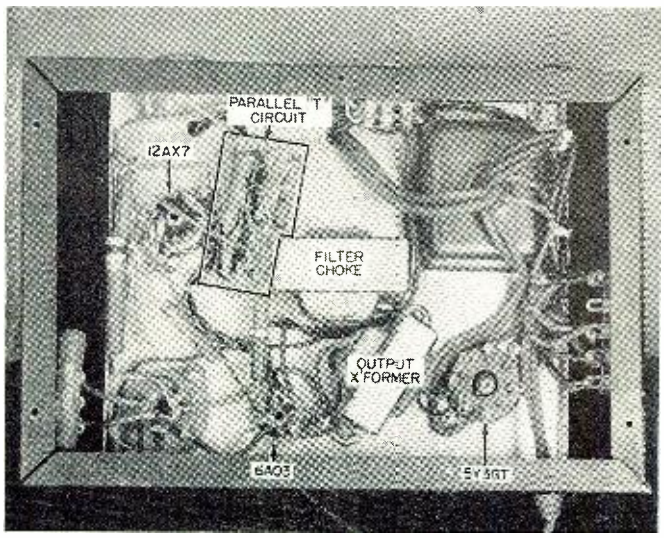


Fig. 5. Bottom view of the audio amplifier chassis designed for use with the probe for signal tracing and other uses.



Simplified Preamp

By **JAMES P. SAUERS**

Construction details on a "stripped down" preamp which is designed to be used with the G-E pickup and amplifiers of the "Williamson" type. It meets RIAA disc characteristics.

WHEN the home builder begins to assemble his audio system, he is faced with a bewildering number of choices for every component of his rig. It is safe to say that thousands have settled for the *G-E* variable reluctance pickup, and some version of a *Williamson* amplifier. Many different preamplifiers have been used with this combination and most of them give excellent results. However, the best are expensive; some of the better ones have features the user doesn't care for (or at least prefers not to pay for); and many of the simpler ones are not satisfactory, particularly with this combination of cartridge and amplifier. This last is due, in part, to the following reasons:

1. They have insufficient gain, since the output of the *G-E* cartridge is 10 to 15 millivolts, and 1.5 to 2 volts input is required to drive a *Williamson* to full output.

2. They do not have sufficient low frequency equalization; that is, the low frequency response falls off below 100 cycles.

3. When fixed equalization is provided, it is not likely to conform to the RIAA curve.

The goal set for this preamplifier was to do the job as simply as possible, but to maintain top quality. Since it was desired to use negative feedback to accomplish the bass boost required for the low-frequency equalization, more gain was necessary than could be obtained from two triode stages. To obtain this gain, two pentode stages were used. The advantages of negative feedback for bass boost are covered adequately elsewhere[1], but mainly, it provides the 18½ db rise at 30 cycles required by the RIAA curve while maintaining sufficient feedback to minimize distortion.

The high-frequency roll-off is accomplished at the grid of the first stage; the shunt capacitor, C_1, and resistor R_1, in combination with the inductance of the *G-E* cartridge (370 mhy.) gives a roll-off of 13.5 db at 10,000 cycles as required by the RIAA curve. Note that this is very close to the AES curve, and about halfway between the NARTB roll-off of 16 db, and the *London* of 10 db.

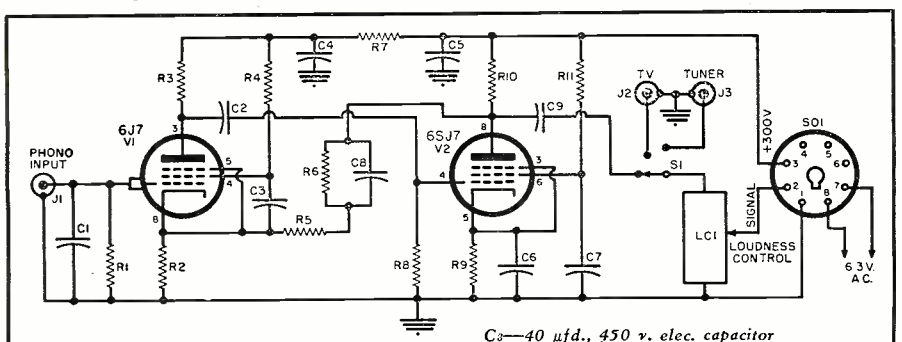
Since this preamplifier was to be used only with a *G-E*, no provision was necessary for other cartridges, where in any commercial product, they would have to be provided. Other cartridges with approximately the same inductance would have about the same roll-off with this preamplifier; the exact values could be determined either by calculation or by trial and error. If more or less gain is required, the gain of the two pentode stages can be varied to arrive at the desired level. For example, a *Pickering* has much less inductance, and two to three times the output, so the shunt resistor would be smaller, and the gain of the preamplifier could be reduced slightly. One incidental advantage of this method of obtaining the required roll-off is the low impedance input at the grid of the first stage, which aids in reducing hum and noise pickup at this point.

The low-frequency equalization is accomplished by negative feedback from the plate of V_2 to the cathode of V_1, *via* R_6, R_5, and C_8. With the gain available from the two pentodes, the rising characteristic can be carried down to 30 cycles and lower. Similar usage has been made in many other instances and switching arrangements to care for other turnover frequencies are included in these preamplifiers[2, 3].

Originally this preamplifier was built with tone controls, in addition to separate high-frequency roll-off and turnover switches, a selector switch, and, later, a loudness control and level controls were added. The decision to simplify the preamplifier was prompted by the realization that the tone controls were seldom used, and that the roll-off and turnover combinations were ending up on the same settings more and more often. Virtually all manufacturers are now using the RIAA recording characteristics, some for quite some time. In addition, since the RIAA curve is in the "middle of the road," many of the older recordings give acceptable sound even though recorded with different characteristics. If this weren't enough, add the fact that many of the older releases are being re-recorded, for better sound, for more judicious coupling, and with the RIAA curve.

(*Continued on page* 89)

Complete schematic of the simplified preamp for use with G-E cartridges.



R1—9400 ohm, ½ w. res.
R2—1800 ohm. 2 w. res.
R3, R10—500,000 ohm, 2 w. res.
R4, R8, R11—2 megohm, ½ w. res.
R5—50,000 ohm, ½ w. res.
R6—1.8 megohm, ½ w. res.
R7—5000 ohm, 5 w. res.
R9—3900 ohm, 2 w. res.
C1—.002 µfd., 200 v. capacitor
C2, C9—.1 µfd., 600 v. capacitor
C3—40 µfd., 450 v. elec. capacitor
C4-C5-C6-C7—20/20/20/20 µfd., 450 v. elec. capacitor
C8—.006 µfd., 400 v. capacitor
J1, J2, J3—Standard phono jack
SO1—Octal socket
LC1—Loudness control (Centralab "Compentrol" or equiv.)
S1—S.p. 3-pos. switch
V1—6J7 tube
V2—6SJ7 tube

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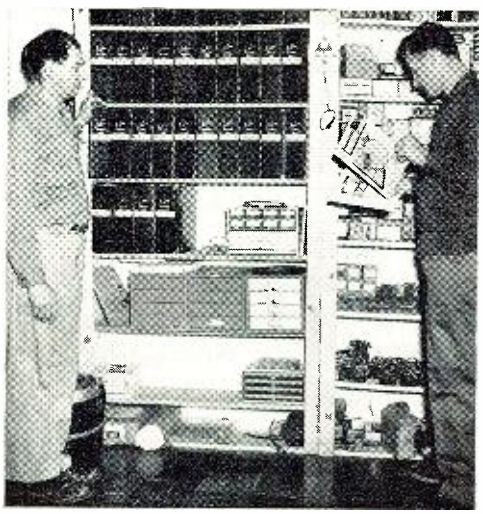
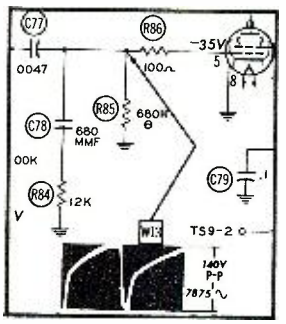
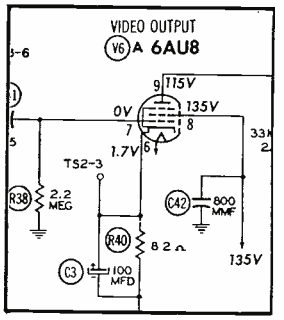


George Englert stands near the shop's complete PHOTOFACT Library. Charles Tanner refers to his handy Sams PHOTOFACT Index for the time-saving Folder covering his next bench job.

* 

* 

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New Tube Tester Data

LISTED here are the settings for the Philco models 7050, 7051, 7052, and 9100 tube testers for the new tubes which have been made available by the tube manufacturers since Philco issued its last roll charts for these testers. With this information you can now test these new tubes on your Philco tester. The Accessory Division of the Philco Corp. in Philadelphia, Pa., has new roll charts available.

PHILCO MODELS 7050 and 7051

Tube Type	Filament Control	Toggle Switches Short Test	Load Control	Toggle Switches Quality Test	Tube Section
3B2	4	bcknop	11	BCKNOPT	
4BC8	5	ABCDEF	4	ADEF	T1
			4	BCEF	T2
4BS8	5	ABCDEF	3	ADEF	T1
			3	BCEF	T2
4BZ8	5	ABCDEF	4	ADEF	T1
			4	BCEF	T2
5B8	5	AC BCDEF	4	ABCF	T
			4	ACDE	P
5BT8	5	AE DE BCEF	4	ABCEF	D1
			4	BCDEF	D2
			3		P
5V3	5	mABDEF	4	DM	D
			4	BM	D
6BC8	6	ABCDEF	4	ADEF	T1
			4	BCEF	T2
6BH8	6	ABCDEF	4	A	T
			4	B	P
6BS8	6	ABCDEF	3	ADEF	T1
			3	BCEF	T2
6BT8	6	AE DE BCEF	4	ABCEF	D1
			4	BCDEF	D2
			3		P
6BZ8	6	ABCDEF	4	ADEF	T1
			4	BCEF	T2
6CN7	4	hABCDEF	5	AEH	D1
			5	DEH	D2
			6	BH	T
6DN6	6	ACE	3	A	
6M3	Cannot be tested				
25C5	10	bnAEFG	5	BNR	

PHILCO MODELS 7052 and 9100

Tube Type	Fil.	R-G	Bias	Fil.	Fil.	G.	P.	Sc.	C.	Su.	Press	Gm	Notes
1B3*	1.1	78	0	J	R	0	0	0	0	0	P5	....	Cap = P
3B2	3.0	68	0	J	R	0	0	0	0	0	P5	....	Short on 3, Cap = P
4BC8	4.3	81	24	E	V	7	6	0	8	0	P4	2300	Triode No. 1
4BC8	4.3	81	24	E	V	2	1	0	3	0	P4	2300	Triode No. 2
4BS8	4.3	88	20	E	V	7	6	0	8	0	P4	4000	Triode No. 1
4BS8	4.3	88	20	E	V	2	1	0	3	0	P4	4000	Triode No. 2
4BZ8	4.3	88	18	E	V	7	6	0	8	9	P4	3000	Triode No. 1
4BZ8	4.3	88	18	E	V	2	1	0	3	9	P4	3000	Triode No. 2
5B8	5.0	83	29	E	V	2	3	0	1	0	P4	2400	Triode
5B8	5.0	87	10	E	V	6	9	8	7	0	P4	3200	Pentode
5BT8	5.0	75	0	E	V	0	1	0	3	0	P1	....	Diode No. 1
5BT8	5.0	75	0	E	V	0	2	0	3	0	P1	....	Diode No. 2
5BT8	5.0	87	11	E	V	8	6	7	9	0	P4	3100	Pentode
5V3	5.0	30	0	H	R	0	4	0	0	0	P3	....	Plate No. 1
5V3	5.0	30	0	H	R	0	6	0	0	0	P3	....	Plate No. 2
6BC8	6.3	81	24	E	V	7	6	0	8	0	P4	2300	Triode No. 1
6BC8	6.3	81	24	E	V	2	1	0	3	0	P4	2300	Triode No. 2
6BH8	6.3	81	30	E	V	2	3	0	1	0	P4	2400	Triode
6BH8	6.3	84	17	E	V	7	9	8	6	0	P4	2350	Pentode
6BS8	6.3	88	20	E	V	7	6	0	8	0	P4	4000	Triode No. 1
6BS8	6.3	88	20	E	V	2	1	0	3	0	P4	4000	Triode No. 2
6BT8	6.3	75	0	E	V	0	1	0	3	0	P1	....	Diode No. 1
6BT8	6.3	75	0	E	V	0	2	0	3	0	P1	....	Diode No. 2
6BT8	6.3	87	11	E	V	8	6	7	9	0	P4	3100	Pentode
6BZ8	6.3	88	18	E	V	7	6	0	8	9	P4	3000	Triode No. 1
6BZ8	6.3	88	18	E	V	2	1	0	3	9	P4	3000	Triode No. 2
6CN7	6.3	56	11	E	V	7	8	0	6	0	P4	960	Triode
6CN7	6.3	80	0	E	V	0	2	0	3	0	P1	....	Diode No. 1
6CN7	6.3	80	0	E	V	0	1	0	3	0	P1	....	Diode No. 2
6DN6	6.3	82	67	J	R	5	0	7	3	0	P4	2480	Cap = P
6M3	6.3	96	0	H	R	0	0	0	3	0	P5	....	Cap = P, Short on 3, Rev. meter.
25C5	25.0	91	0	J	R	2	7	6	3	0	P4	6000	

*Revised data

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O-10 LABORATORY TYPE OSCILLOSCOPE: The world's largest selling oscilloscope kit, and the most successful oscilloscope in history. Designed especially for color and black-and-white TV service work. Its 5 megacycle bandwidth and new 500 Kc sweep generator readily qualify it for laboratory applications. Features easy-to-assemble etched metal circuit board construction.

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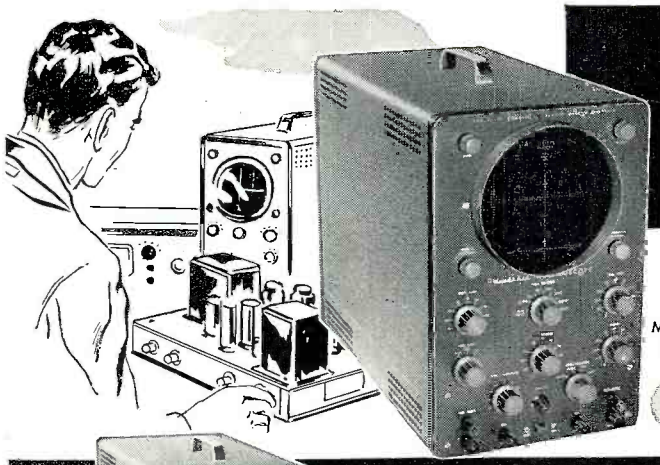

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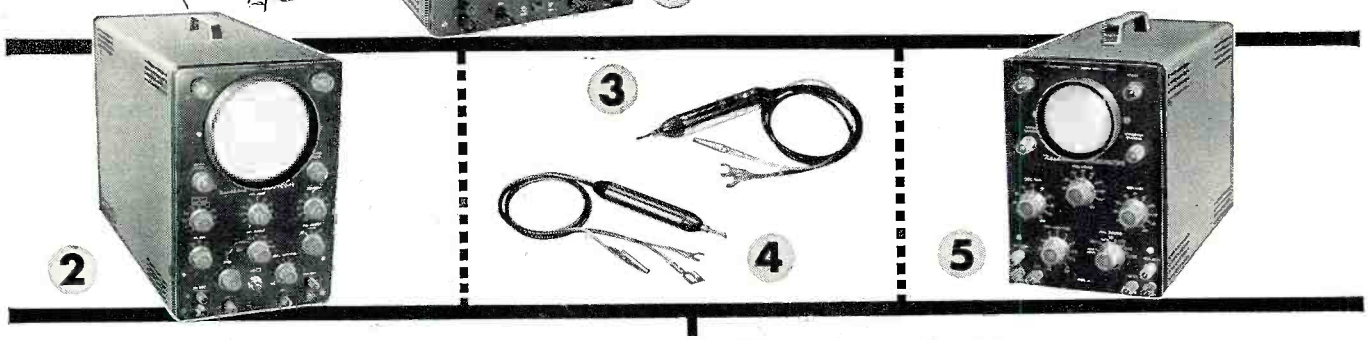

1 Heathkit ETCHED CIRCUIT COLOR-TV 5″ OSCILLOSCOPE KIT

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Features amplifier response to 5 Mc for color TV work, and employs the radically new sweep circuit to provide stable operation up to 500,000 cps. In addition, etched metal, pre-wired circuit boards cut assembly time almost in half, and permit a level of circuit stability never before achieved in an oscilloscope of this type.

Vertical amplifiers flat within +2 db −5 db from 2 cps to 5 Mc, down only 1½ db at 3.58 Mc. Vertical sensitivity is 0.025 volts, (rms) per inch at 1 Kc. 11 tube circuit employs a 5UP1 CRT.

Plastic molded capacitors used for coupling and bypass—preformed and cabled wiring harness provided.

Features built-in peak-to-peak calibrating source—retrace blanking amplifier—push-pull amplifiers and step-attenuated input.

MODEL O-10
$69.50
Shpg. Wt. 21 Lbs.

2 Heathkit ETCHED CIRCUIT 5″ OSCILLOSCOPE KIT

This is a general purpose oscilloscope for the more usual applications in the service shop or lab, yet is comparable to scopes costing many dollars more.

Features full size 5″ CRT (5BP1), built-in peak-to-peak voltage calibration—3 step input attenuator—phasing control—push-pull deflection amplifiers—and etched metal prewired circuit boards.

Vertical channel flat within ±3 db from 2 cps to 200 Kc, with 0.09 V. rms/inch, peak-to-peak sensitivity at 1 Kc. Sweep circuit from 20 cps to 100,000 cps. A scope you will be proud to own and use.

MODEL OM-1
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Scope investigation of circuits encountered in TV requires the use of special low capacity probe to prevent loss of gain, circuit loading, or distortion. This probe features a variable capacitor to provide correct instrument impedance matching. Also the ratio of attenuation can be controlled.

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Extend the usefulness of your Oscilloscope by observing modulation envelope of R.F. or I.F. carriers found in TV and radio receivers. Functions like AM detector to pass only modulation of signal and not signal itself. Applied voltage limits are 30 V. RMS and 500 V. DC.

NO. 337-C
$3.50
Shpg. Wt. 1 Lb.

5 Heathkit ETCHED CIRCUIT 3″ OSCILLOSCOPE KIT

This compact little oscilloscope measures only 9½″ H. x 6½″ W. x 11¾″ D., and weighs only 11 lbs! Easily employed for home service calls, for work in the field or is just the ticket for use in the ham shack or home workshop. Incorporates many of the features of the Model OM-1, but yet is smaller in physical size for portability.

Employing etched circuit boards, the Model OL-1 features vertical response within ± 3 db from 2 cps to 200 Kc. Vertical sensitivity is 0.25 V. RMS/inch peak-to-peak, and sweep generator operates from 20 cps to 100,000 cps. Provision for r.f. connection to deflection plates for modulation monitoring, and incorporates many features not expected at this price level. 8-tube circuit features a type 3GP1 Cathode Ray Tube.

MODEL OL-1
$29.50
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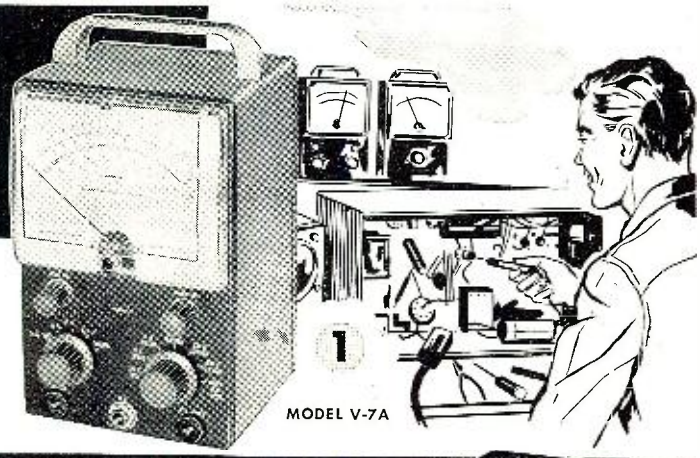

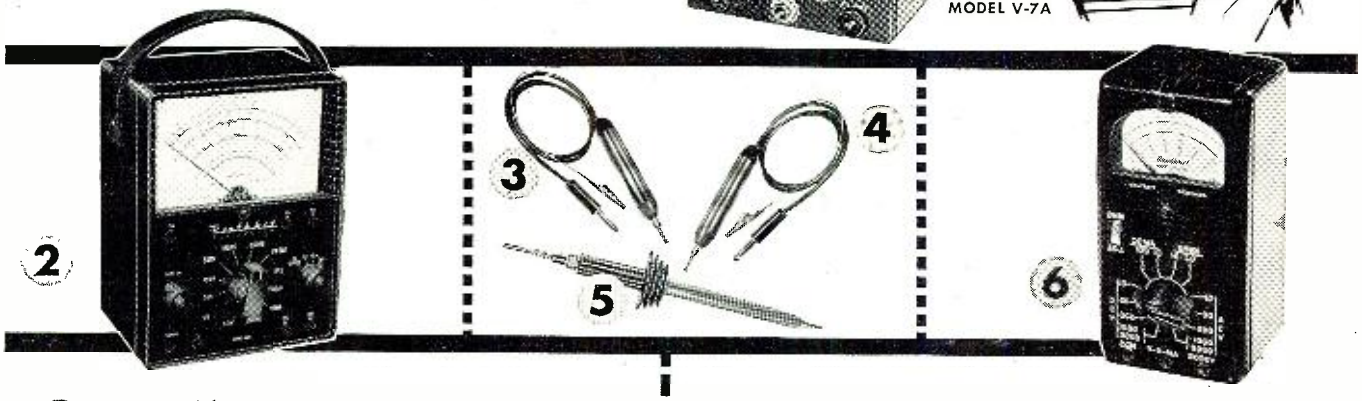

1 *Heathkit* ETCHED CIRCUIT VACUUM TUBE VOLTMETER KIT

Besides measuring AC (rms), DC and resistance, the modern-design V-7A incorporates peak-to-peak measurement for FM and television servicing.

AC (rms) and DC voltage ranges are 1.5, 5, 15, 50, 150, 500, and 1500. Peak-to-peak AC voltage ranges are 4, 14, 40, 140, 400, 1400, and 4000. Ohmmeter ranges are X1, X10, X100, X1000, X10K, X100K, and X1 megohm. Also a db scale is provided. A polarity reversing switch provided for DC measurements, and zero center operation within range of front panel controls. Employs a 200 μa meter for indication. Input impedance is 11 megohms.

Etched metal, pre-wired circuit board for fast, easy assembly and reliable operation is 50% thicker for more rugged physical construction. 1% precision resistors for utmost accuracy.

MODEL V-7A
$24.50
Shpg. Wt. 7 Lbs.

2 *Heathkit* 20,000 OHMS/VOLT MULTIMETER KIT

The MM-1 is a portable instrument for outside servicing, for field testing, or for quick portability in the service shop. Combines attractive physical appearance with functional design. 20,000 ohms/v. DC, and 5000 ohms/v. AC. AC and DC voltage ranges are 0-1.5, 5, 50, 150, 500, 1500 and 5000 volts. Direct current ranges are 0-150 μa., 15 ma., 150 ma., 500 ma., and 15 amperes. Resistance ranges are X1, X100, X10,000 providing center scale readings of 15, 1500 and 150,000 ohms. DB ranges cover −10 db to +65 db.

Features a 4½" 50 μa. meter. Provides polarity reversal on DC measurements. 1% precision resistors used in multiplier circuits. Not affected by RF fields.

MODEL MM-1
$29.50
Shpg. Wt. 6 Lbs.

3 *Heathkit* ETCHED CIRCUIT RF PROBE KIT

The Heathkit RF Probe used in conjunction with any 11 megohm VTVM will permit RF measurements up to 250 Mc with ± 10% accuracy. Uses etched circuits for increased circuit stability and ease of assembly.

NO. 309-C
$3.50
Shpg. Wt. 1 Lb.

4 *Heathkit* ETCHED CIRCUIT PEAK-TO-PEAK PROBE KIT

Now read peak-to-peak voltages on the DC scale of any 11 megohm VTVM with this new probe, employing etched circuit for stability and low loss. Readings made directly from VTVM scales, from 5 Kc to 5 Mc. Not required for Heathkit Model V-7A VTVM.

NO. 338-C
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5 *Heathkit* 30,000 VOLT D.C. HIGH VOLTAGE PROBE KIT

For TV service work or similar application for measurement of high DC voltage. Precision multiplier resistor mounted inside plastic probe. Multiplication factor of 100 on the ranges of Heathkit 11 megohm VTVM.

NO. 336
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6 *Heathkit* HANDITESTER KIT

The Model M-1 measures AC or DC voltage at 0-10, 30, 300, 1000, and 5000 volts. Measures direct current at 0-10 ma. and 0-100 ma. Provides ohmmeter ranges of 0-3000 (30 ohm center scale) and 0-300,000 ohms (3000 ohms center scale). Features a 400 μa. meter for sensitivity of 1000 ohms/volt. Because of its size, the M-1 is a very handy portable instrument that will fit in your coat pocket, tool box, glove compartment, or desk drawer. Makes a fine standby unit in the service shop when the main instruments are in use, or is ideal for the hobbyist or beginner. An unusual dollar value.

MODEL M-1
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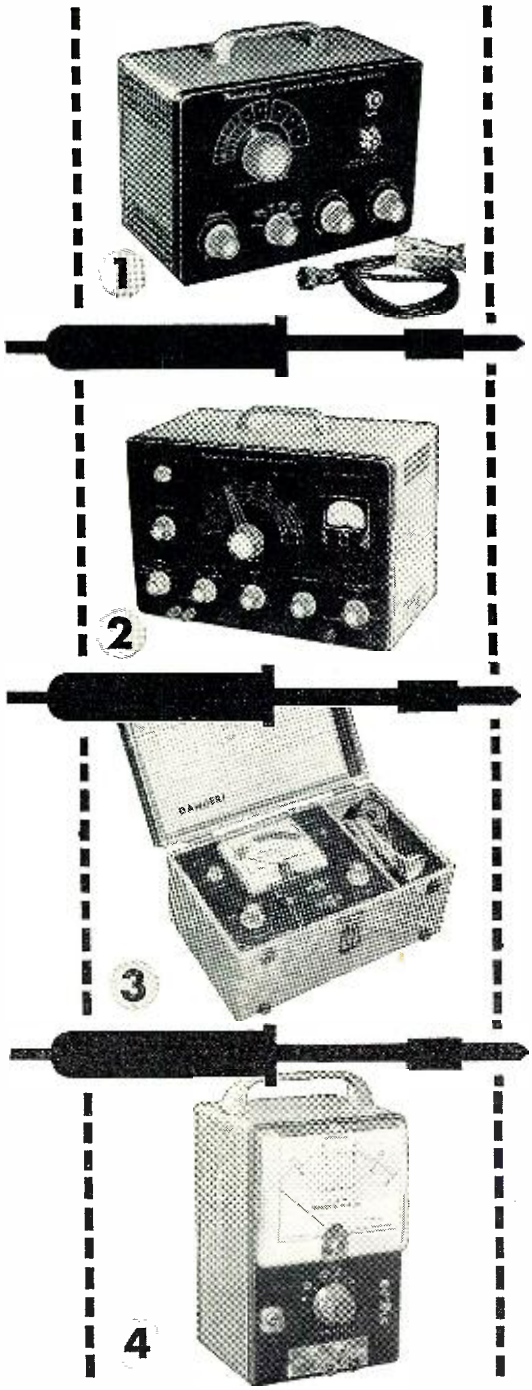
The Model TS-4 features a controllable inductor for all-electronic sweep, improved oscillator and automatic gain circuitry, high RF output, center sweep operation, and improved linearity. It sets a new high standard for sweep generator operation, and is absolutely essential for the up-to-date service shop doing FM, black-and-white TV, and color TV work.

Voltage regulation and effective AGC action insure flat output over a wide frequency range. Electronic sweep insures complete absence of mechanical vibration. Sweep deviation controllable from 0 up to 40 Mc, depending upon base frequency. Effective two-way blanking.

Fundamental output from 3.6 Mc to 220 Mc in 4 bands. Crystal marker provides markers at 4.5 Mc and multiples thereof. Crystal included with kit. Variable marker covers from 19 Mc to 60 Mc on fundamentals, and up to 180 Mc on harmonics. Provision for external marker.

MODEL TS-4
$49.50
Shpg. Wt. 16 Lbs.



1 Heathkit LINEARITY PATTERN
GENERATOR KIT

The new-design Model LP-1 produces vertical or horizontal bar patterns, a cross-hatch pattern, or white dots on the screen of the TV set under test. No internal connections required. Special clip is attached to the TV antenna terminals. Instant selection of the pattern desired for adjustment of vertical and horizontal linearity, picture size, aspect ratio, and focus. Dot pattern presentation is a *must* for color convergence adjustments on color TV sets.

Extended operating range covers all television channels from 2 to 13. Produces 6 to 12 vertical bars or 4 to 7 horizontal bars.

MODEL LP-1
$22.50
Shpg. Wt. 7 Lbs.

2 Heathkit LABORATORY
GENERATOR KIT

The Heathkit Model LG-1 Laboratory Generator is a high-accuracy signal source for applications where metered performance is essential It covers from 100 Kc to 30 Mc on fundamentals in 5 bands. Modulation is at 400 cycles, and modulation is variable from 0-50%. RF output from 100,000 μv. to 1 μv. 200 μa. meter reads the RF output in microvolts, or percentage of modulation. Fixed step and variable output attenuation provided.

Features voltage regulation, and double copper plated shielding for stability. Provision for external modulation. Coaxial output cable (50 ohms).

MODEL LG-1
$39.50
Shpg. Wt. 16 Lbs.

3 Heathkit CATHODE RAY
TUBE CHECKER KIT

This new-design instrument holds the key to rapid and complete picture tube testing, either in the set, on the work-bench, or in the carton. Tests for shorts, leakage, and emission. Features Shadowgraph test (a spot of light on the screen) to indicate whether the tube is capable of functioning.

The Model CC-1 tests all electromagnetic deflection picture tubes normally encountered in television servicing. Supplies all operating voltages to the tube under test, and indicates the condition of the tube on a large "GOOD-BAD" scale. Features spring loaded test switches for operator protection.

The CC-1 is housed in an attractive portable case and is light in weight – ideal for outside service calls.

MODEL CC-1
$22.50
Shpg. Wt. 10 Lbs.

4 Heathkit DIRECT READING
CAPACITY METER KIT

Not only is this instrument popular in the service shop, but it has found extensive application in industrial situations. Ideal for quality control work, production line checking, or for matching pairs.

Features direct reading linear scales from 100 mmf to .1 mfd full scale. Necessary only to connect a capacitor of unknown value to the insulated binding posts, select the correct range, and read the meter. The CM-1 is not susceptible to hand capacity, and has a residual capacity of less than 1 mmf.

MODEL CM-1
$29.50
Shpg. Wt. 7 Lbs.

HEATH COMPANY
A SUBSIDIARY OF DAYSTROM INC.

BENTON HARBOR 15, MICHIGAN

Heathkit SIGNAL GENERATOR KIT

MODEL SG-8 **$19.50**
Shpg. Wt. 8 Lbs.

This is one of the biggest signal generator bargains available today. The tried and proven Model SG-8 offers all of the outstanding features required for a basic service instrument. High quality components and outstanding performance.

The SG-8 covers 160 Kc to 110 Mc on fundamentals in 5 bands, and calibrated harmonics extend its usefulness up to 220 Mc. The output signal is modulated at 400 cps, and the RF output is in excess of 100,000 uv. Output controlled by both a continuously variable and a fixed step attenuator. Also, audio output may be obtained for amplifier testing. Don't let the low price deceive you. This is a professional type service instrument to fulfill the signal source requirements in the service lab.

1 Heathkit . . . IMPEDANCE BRIDGE KIT

The IB-2 features built-in adjustable phase shift oscillator and amplifier, and has panel provisions for external generator. Measures resistance, capacitance, inductance, dissipation factors of condensers, and storage factor of inductance.

D, Q, and DQ functions combined in one control. ½% resistors and ½% silver-mica capacitors especially selected for this instrument. A 100-0-100 microammeter provides null indications. Two-section CRL dial provides 10 separate "units" with an accuracy of .5%. Fractions of units read on variable control.

MODEL IB-2 **$59.50**
Shpg. Wt. 12 Lbs.

2 Heathkit "Q" METER KIT

The Heathkit Model QM-1 will measure the Q of inductances and the RF resistance and distributed capacity of coils. Employs a 4½" 50 microampere meter for direct indication. Will test at frequencies of 150 Kc to 18 Mc in 4 ranges. Measures capacity from 40 mmf to 450 mmf within ± 3 mmf. Indispensible for coil winding and determining unknown condenser values. A worthwhile addition to your laboratory at an outstandingly low price. Useful for checking wave traps, chokes, peaking coils, etc. Laboratory facilities are now available to the service shop and home lab.

MODEL QM-1 **$44.50**
Shpg. Wt. 14 Lbs.

3 Heathkit 6–12 VOLT BATTERY ELIMINATOR KIT

This modern battery eliminator will supply 6 or 12 volt output for ordinary automobile radios as well as 12 volts for the new models in the latest model cars. Output voltage is variable from 0-8 volts DC, or 0-16 volts DC. Will deliver up to 15 amperes at 6 volts, or up to 7 amperes at 12 volts. Two 10,000 microfarad filter capacitors insure smooth DC output. Two panel meters monitor output voltage and current. Will double as a battery charger. Definitely required for automobile radio service work.

MODEL BE-4 **$31.50**
Shpg. Wt. 17 Lbs.

4 Heathkit DECADE RESISTANCE KIT

Twenty 1% precision resistors provide resistance from 1 to 99,999 ohms in 1 ohm steps. Indispensible around service shop laboratory, ham shack, or home workshop. Well worth the extremely low Heathkit price.

MODEL DR-1 **$19.50**
Shpg. Wt. 4 Lbs.

5 Heathkit VIBRATOR TESTER KIT

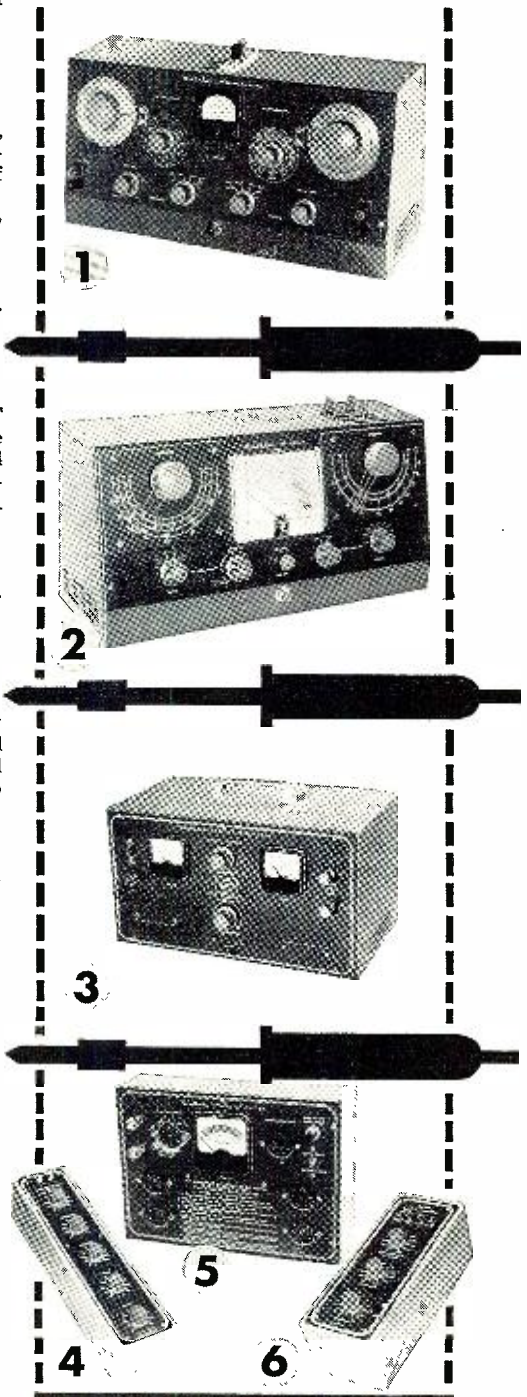
Tests vibrators for proper starting and indicates the quality of the output on a large "GOOD-BAD" scale. Checks both interrupter and self-rectifier types in 5 different sockets. Operates from any battery eliminator delivering variable voltage from 4 to 6 volts DC at 4 amps. Ideal companion to the Model BE-4.

MODEL VT-1 **$14.50**
Shpg. Wt. 6 Lbs.

6 Heathkit DECADE CONDENSER KIT

Provides capacity values from 100 mmf to 0.111 mfd in steps of 100 mmf. ± 1% precision silver-mica condensers used. High quality ceramic switches for reduced leakage. Polished birch cabinet. Extremely valuable in all electronic activity.

MODEL DC-1 **$16.50**
Shpg. Wt. 3 Lbs.



BENTON HARBOR 15, MICHIGAN

HEATH COMPANY
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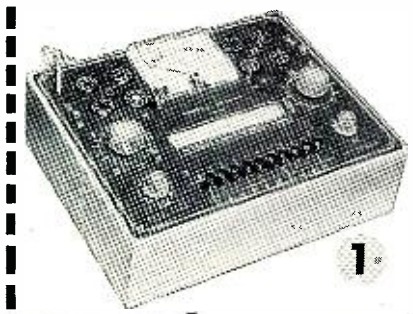
Heathkit TUBE CHECKER KIT

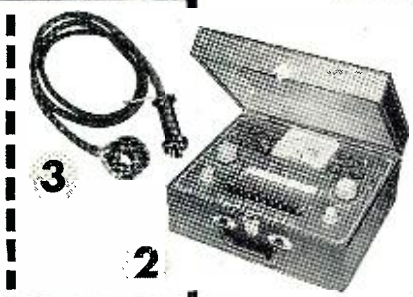


1 The Heathkit Model TC-2 is an emission type tube tester that represents a tremendous saving over the price of a comparable unit from any other source. At only $29.50, you can have a tube tester of your own, even if you are an experimenter, or only do part time service work. Extremely popular with radio servicemen, it uses a 4½" meter with 3-color meter face for simple "GOOD-BAD" indications that the customer can understand. Will test all tubes commonly encountered in radio and TV service work.

Ten 3-position lever switches for "open" or "short" tests on each tube element. Neon bulb indicates filament continuity or short between tube elements. Line adjust control provided. The roll chart is illuminated.

Sockets provided for 4, 5, 6, and 7-pin, octal, and loctal tubes, 7 and 9 pin miniature tubes, and the 5 pin Hytron tubes. Blank space provided for future socket addition. Tests tubes for opens, and shorts, and for quality on the basis of total emission. 14 different filament voltage values provided.

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



2 *Heathkit* **PORTABLE TUBE CHECKER KIT**

The Model TC-2P is identical to the Model TC-2 except that it is housed in a rugged carrying case. This strikingly attractive and practical two-tone case is finished in proxylin impregnated fabric. The cover is detachable, and the hardware is brass plated. This case imparts a real professional appearance to the instrument. Ideal for home service calls, or any portable application.

MODEL TC-2P
$34.50
Shpg. Wt. 15 Lbs.

3 *Heathkit* **TV PICTURE TUBE TEST ADAPTER**

The Heathkit TV picture tube test adapter is designed for use with the Model TC-2 Tube Checker. Test picture tubes for emission, shorts, and thereby determine tube quality. Consists of 12-pin TV tube socket, 4 ft. cable, octal connector, and necessary technical data. (Not a kit.)

MODEL 355
$4.50
Shpg. Wt. 1 Lb.

4 *Heathkit* . . .

CONDENSER CHECKER KIT

Use this Condenser Checker to quickly and accurately measure those unknown condenser and resistor values. All readings taken directly from the calibrated panel scales without any involved calculation. Capacity measurements in four ranges from .00001 to 1000 mfds. Checks paper, mica, ceramic and electrolytic condensers. A power factor control is available for accurate indication of electrolytic condenser efficiency. Leakage test switch—selection of five polarizing voltages, 25 volts to 450 volts DC to indicate condenser operating quality under actual load conditions. Spring-return test switch automatically discharges condenser under test and eliminates shock hazard to the operator.

Resistance measurements can be made in the range from 100 ohms to 5 megohms. Here again, all values are read directly on the calibrated scales. Increased sensitivity coupled with an electron beam null indicator increases overall instrument usefulness.

For safety of operation, the circuit is entirely transformer operated. An outstanding low kit price for this surprisingly accurate instrument.

MODEL C-3
$19.50
Shpg. Wt. 7 Lbs.

5 *Heathkit* VISUAL-AURAL

SIGNAL TRACER KIT

This signal tracer is extremely valuable in servicing AM, FM, and TV receivers, especially when it comes to isolating trouble to a particular stage of the circuit under test.

This visual-aural tracer features a high gain RF input channel to permit signal tracing from the receiver antenna input clear through all RF, IF, detector, and audio stages to the speaker. Separate low-gain channel provided for audio circuit exploration. Both visual and aural indication by means of a speaker or headphone, and electron beam "eye" tube as a level indicator. Also incorporates a noise locater circuit for DC noise checks, and a built-in calibrated wattmeter (30-500 watts). Panel terminals provided for "patching" output transformer or speaker into external circuit for test purposes. Designed especially for the radio and TV serviceman. Cabinet size: 9½" wide x 6½" high x 5" deep. A real test equipment bargain.

MODEL T-3
$23.50
Shpg. Wt. 9 Lbs.

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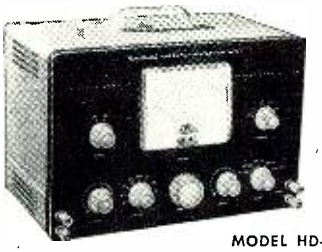
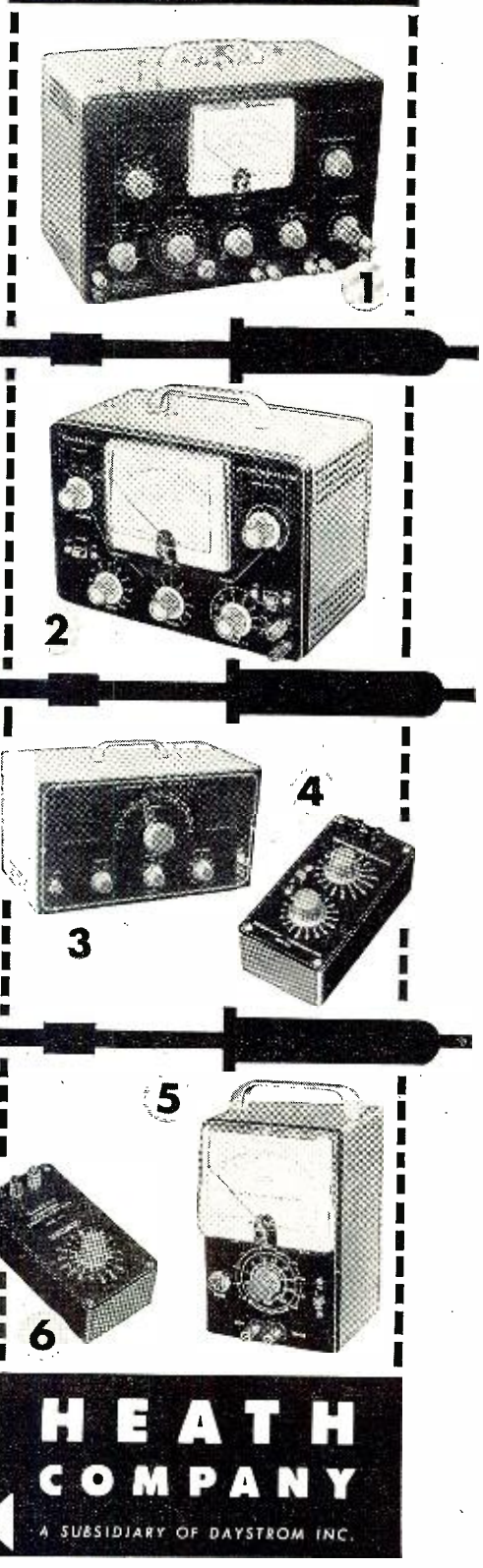


MODEL HD-1

Shpg. Wt. 13 Lbs. **$49.50**

Used with a sine wave generator, the Model HD-1 will check the harmonic distortion output of audio amplifiers under a variety of conditions. Reads distortion directly on the meter as a percentage of the input signal. Operates between 20 and 20,000 cps. High impedance VTVM circuit for initial reference settings and final distortion readings. Ranges are 0-1, 3, 10, and 30 volts full scale. 1% precision resistors. Distortion scales are 0-1, 3, 10, 30 and 100% full scale. Requires only .3 volt input for distortion test.

Heathkit HARMONIC DISTORTION METER KIT



1 Heathkit AUDIO ANALYZER KIT

This instrument consists of an audio wattmeter, an AC VTVM, and a complete IM analyzer, all in one compact unit.

Use the VTVM to measure noise, frequency response, output gain, power supply ripple, etc. Use the wattmeter for measurement of power output. Internal loads provided for 4, 8, 16, or 600 ohms. VTVM also calibrated for DBM units. High or low impedance IM measurements made with built-in 6KC and 60 cps generators. VTVM ranges are .01, to 300 volts in 10 steps. Wattmeter ranges are .15 mw. to 150 w. in 7 steps. IM scales are 1% to 100% in 5 steps.

MODEL AA-1 **$59.50** Shpg. Wt. 13 Lbs.

2 Heathkit AUDIO GENERATOR KIT

This new Heathkit Model features step-tuning from 10 cps to 100 Kc with three rotary switches that provide two significant figures and multiplier. Less than .1% distortion. Frequency accurate to within ± 5%.

Output monitored on a large 4½" meter that reads voltage or db. Both variable and step-type attenuation provided. Meter reads zero-to-maximum at each attenuator position. Output ranges (and therefore meter ranges) are 0-.003, .01, .03, .1, .3, 1, 3, 10 volts. Step-tuning provides rapid positive selection of the desired frequency, and allows accurate return to any given frequency.

MODEL AG-9 **$34.50** Shpg. Wt. 8 Lbs.

3 Heathkit AUDIO OSCILLATOR KIT

(SINE WAVE — SQUARE WAVE)

The Model AO-1 features sine wave or square wave coverage from 20-20,000 cps in 3 ranges. It is an instrument specifically designed to completely fulfill the needs of the serviceman and high fidelity enthusiast. Offers high level output across the entire frequency range, low distortion and low impedance output. Features a thermistor in the second amplifier stage to maintain essentially flat output through the entire frequency range. Produces an excellent sine wave for audio testing, or will produce good, clean, square waves with a rise time of only 2 microseconds.

MODEL AO-1 **$24.50** Shpg. Wt. 10 Lbs.

4 Heathkit RESISTANCE SUBSTITUTION BOX KIT...

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

MODEL RS-1 **$5.50** Shpg. Wt. 2 Lbs.

5 Heathkit AC VACUUM TUBE VOLTMETER KIT...

The Heathkit AC VTVM features high impedance, wide frequency range, very high sensitivity, and extremely wide voltage range. Will accurately measure a voltage as small as 1 mv. at high impedance. Excellent for sensitive AC measurements required by laboratories, audio enthusiasts and experimenters. Frequency response is substantially flat from 10 cps to 50 Kc. Ranges are .01, .03, .1, .3, 1, 3, 10, 30, 100, and 300 v. RMS. Total db range −52 to + 52 db. Input impedance 1 megohm at 1 Kc.

MODEL AV-2 **$29.50** Shpg. Wt. 5 Lbs.

6 Heathkit CONDENSER SUBSTITUTION BOX KIT...

Very popular companion to Heathkit RS-1. Individual selection of 18 RTMA standard condenser values from .0001 mfd to .22 mfd. Includes 18" flexible leads with alligator clips.

MODEL CS-1 **$5.50** Shpg. Wt. 2 Lbs.

HEATH COMPANY
A SUBSIDIARY OF DAYSTROM INC.

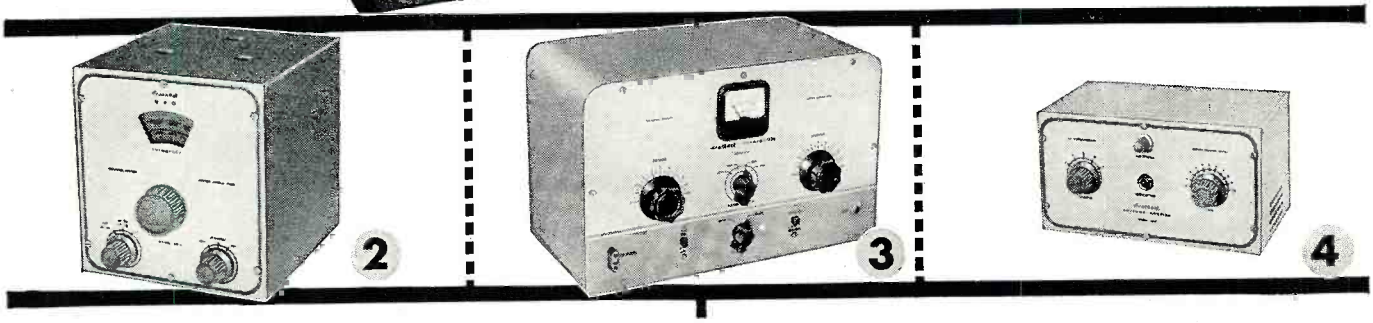
BENTON HARBOR 15, MICHIGAN

HEATHKIT HAM GEAR

for high quality at moderate cost

MODEL DX-100

DOLLAR VALUE: *You get more for your Heathkit dollar because your labor is used to build the kit instead of paying for someone else's. Also, the middleman's margin of profit is eliminated when you deal directly with the manufacturer.*



1 *Heathkit* DX-100 PHONE & CW TRANSMITTER KIT

The reception given this amateur transmitter has been tremendous. Reports from radio amateurs using the DX-100 are enthusiastic in praising its performance and the high quality of the components used in its assembly. Actual "on the air" results reflect the careful design that went into its development.

The DX-100 features a built-in VFO, modulator, and power supplies, and is completely bandswitching for phone or CW operation on 160, 80, 40, 20, 15, 11, and 10 meters. All parts necessary for construction are supplied in the kit, including tubes, cabinet, and detailed step-by-step instructions. Easy to build, and a genuine pleasure to operate.

Employs push-pull 1625's modulating parallel 6146's for RF output in excess of 100 watts on phone and 120 watts on CW. May be excited from the built-in VFO or from crystals (crystals not included with kit). Features five-point TVI suppression: (1) pi network interstage coupling to reduce harmonic transfer to the final stage; (2) pi network output coupling; (3) extensive shielding; (4) all incoming and outgoing circuits filtered; (5) inter-locking cabinet seams to eliminate radiation except through the coaxial output connector. Pi network output coupling will match 50 to 600 ohm non-reactive load. Illuminated VFO dial and meter face. Remote control socket provided.

The chassis is made of extra-strong #16 gauge copper-plated steel. It employs potted transformers, ceramic switch and variable capacitor insulation, solid silver loading switch terminals, and high-grade well-rated components throughout. Features a pre-formed wiring harness, and all coils are pre-wound.

High-gain speech amplifier for dynamic or crystal microphones, and restricted speech range for increased intelligence. Plenty of audio power reserve. Measures 20⅞" W. x 13¾" H. x 16" D. Schematic diagram and complete technical specifications on request.

MODEL DX-100
$189.50
Shpg. Wt. 120 Lbs.

Shipped Motor Freight Unless Otherwise Specified
$50.00 Deposit Required on C.O.D. Orders

2 *Heathkit* VFO KIT

The Model VF-1 covers 160-80-40-20-15-11 and 10 meters with three basic oscillator frequencies. Better than 10-volt average RF output on fundamentals. Features illuminated and pre-calibrated dial scale. Cable and plug provided to fit crystal socket of any modern transmitter.

Enjoy the convenience and flexibility of VFO operation at no more than the price of crystals. May be powered from plug on the Heathkit Model AT-1 transmitter, or supplied with power from most transmitters. Measures: 7" H. x 6½" W. x 7" D.

MODEL VF-1
$19.50
Shpg. Wt. 7 Lbs.

3 *Heathkit* CW AMATEUR TRANSMITTER KIT

The Model AT-1 is an ideal novice transmitter, and may be used to excite a higher power rig later on.

This CW transmitter is complete with its own power supply, and covers 80, 40, 20, 15, 11, and 10 meters. Features single-knob bandswitching, and panel meter indicates grid or plate current for the final amplifier. Designed for crystal operation or external VFO. Crystal not included in kit. Incorporates such features as key click filter, line filter, copper-plated chassis, pre-wound coils, 52 ohm coaxial output, and high quality components throughout. Instruction book simplifies assembly. Employs a 6AG7 oscillator, 6L6 final amplifier. Operates up to 35 watts plate power input.

MODEL AT-1
$29.50
Shpg. Wt. 15 Lbs.

4 *Heathkit* . . . ANTENNA COUPLER KIT

The Model AC-1 will properly match your low power transmitter to an end-fed long wire antenna. Also attenuates signals above 36 Mc, reducing TVI. 52 ohm coax. input→ power up to 75 watts—10 through 80 meters—tapped inductor and variable condenser—neon RF indicator—copper plated chassis and high quality components. Ideal for use with Heathkit AT-1 Transmitter.

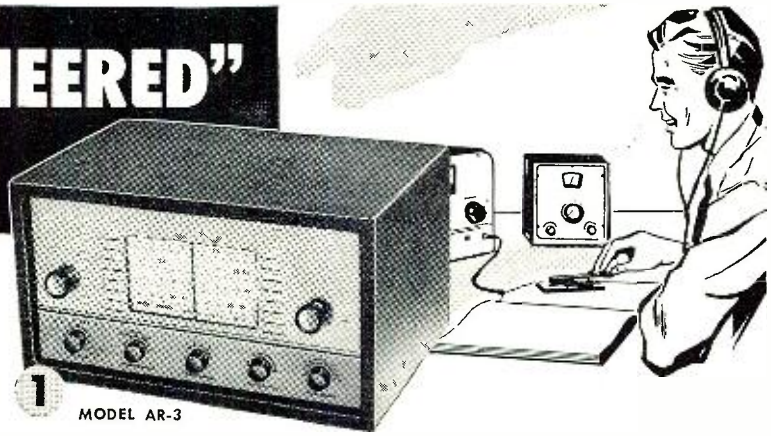
MODEL AC-1
$14.50
Shpg. Wt. 4 Lbs.

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

"AMATEUR-ENGINEERED"

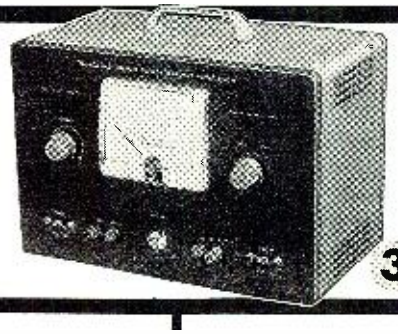
Equipment For The Ham

MODERN DESIGN: *You can be sure of getting all the latest and most desirable design features when you buy Heathkits. Advanced-design is a minimum standard for new Heathkit models.*



1 MODEL AR-3

2



3

4

5

1 *Heathkit* COMMUNICATIONS-TYPE ALL BAND RECEIVER KIT

The new Model AR-3 features improved IF and RF performance, along with better image rejection on all bands. Completely new chassis layout for easier assembly, even for the beginner

Covers 550 Kc to 30 Mc in four bands. Provides sharp tuning and good sensitivity over the entire range. Features a transformer-type power supply—electrical bandspread—separate RF and AF gain controls—antenna trimmer—noise limiter—AGC—BFO—headphone jacks—5½" PM speaker and illuminated tuning dial.

CABINET: Fabric covered cabinet with aluminum panel as shown. Part No. 91-shipping weight 5 lbs. $4.50.

MODEL AR-3
$27.95
Shpg. Wt. 12 Lbs.
(Less Cabinet)

2 *Heathkit* "Q" MULTIPLIER KIT

Here is the Heathkit Q Multiplier you hams have been asking for. A tremendous help on the phone and CW bands when the QRM is heavy. Provides an effective Q of approximately 4,000 for extremely sharp "peak" or "null." Use it to "peak" the desired signal or to "null" an undesired signal, or heterodyne. Tunes to any signal within the IF band-pass of your receiver. Also provides "broad peak" for conditions where extreme selectivity is not required.

Operates with any receiver having an IF frequency between 450 and 460 Kc. Will not function with AC-DC type receivers. Requires 6.3 volts AC at 300 ma. and 150 to 250 VDC at 2 ma. Derives operating power from your receiver. Uses a 12AX7 tube, and special High-Q shielded coils. Simple to connect with the cable and plugs supplied. Measures only 4-11/16"H.x7⅜"W.x4⅛"D. A really valuable addition to the receiving equipment in your ham shack.

MODEL QF-1
$9.95
Shpg. Wt. 3 Lbs.

3 *Heathkit* VARIABLE VOLTAGE REGULATED POWER SUPPY KIT

Provides well filtered DC output, variable from zero to 500 volts at no load and *regulated* for stability. Will supply up to 10 ma. at 450 VDC, and up to 130 ma. at 200 VDC. Voltage or current monitored on front panel meter. Also provides 6.3 VAC at 4A. for filament. Filament voltage isolated from B+, and both isolated from ground. Invaluable around the ham shack for supplying operating potentials to experimental circuits. Use in all types of research and development laboratories as a temporary power supply, and to determine design requirements for ultimate power supply.

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

4 *Heathkit* ANTENNA IMPEDANCE METER KIT

Use in conjunction with a signal source for measuring antenna impedance, line matching, adjustment of beam and mobile antennas, etc. Will double as a phone monitor or relative field strength indicator. 100 μa. meter employed. Covers the range from 0-600 ohms. An instrument of many uses for the amateur.

MODEL AM-1
$14.50
Shpg. Wt. 2 lb.

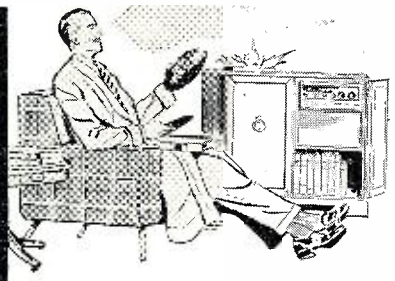
5 *Heathkit* GRID DIP METER KIT

This is an extremely valuable tool for accomplishing literally hundreds of jobs on all types of equipment. Covering from 2 Mc to 250 Mc, the GD-1B is compact and can be operated with one hand. Uses a 500 μa. meter for indication, with a sensitivity control and headphone jack. Includes prewound coils and rack. Indispensable instrument for hams, engineers, or servicemen.

MODEL GD-1B
$19.50
Shpg. Wt. 4 lbs.

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

Heathkits PROVIDE THE "CONSTRUCTIVE" APPROACH TO HIGH-FIDELITY



EASY TO BUILD: *The assembly instructions supplied with Heathkits are so complete and detailed that anyone can assemble the kits without difficulty. Plenty of pictorial diagrams and step-by-step instructions. Information on resistor color codes, soldering, use of tools, etc. Build-it-yourself with confidence!*

1

1 Heathkit ADVANCED-DESIGN HIGH FIDELITY AMPLIFIER KIT

The 25 Watt Model W-5 is one of the most outstanding high fidelity amplifiers available today—at any price. Incorporates the very latest design features to achieve true "presence" for the super-critical listener.

Features a new-design Peerless output transformer, and KT66 output tubes handle power peaks up to 42 watts. The unique "tweeter-saver" suppresses high frequency oscillation. A new type balancing circuit results in closer "dynamic" balance between output tubes. Features improved phase shift characteristics and frequency response, with reduced IM and harmonic distortion. Color styling harmonizes with the Heathkit WA-P2 Preamplifier and the FM-3 Tuner.

Frequency response—within ± 1 db from 5 cps to 160 Kc at 1 watt. Harmonic distortion only 1% at 25 watts, 20-20,000 cps. IM distortion only 1% at 20 watts, using 60 and 3,000 cps. Output impedance 4, 8, or 16 ohms. Hum and noise—99 db below rated output. Uses two 12AU7's, two KT66's and a 5R4GY.

KIT COMBINATIONS:

W-5M Amplifier Kit: Consists of main amplifier and power supply, all on one chassis. Complete with all necessary parts, tubes, and comprehensive manual. Shpg. Wt. 31 lbs. Express only. **$59.75**

W-5 Combination Amplifier Kit: Consists of W-5M Amplifier Kit listed above *plus* Heathkit Model WA-P2 Preamplifier Kit. Complete with all necessary parts, tubes, and construction manuals. Shpg. Wt. 38 lbs. Express only. **$79.50**

2

2 Heathkit DUAL-CHASSIS WILLIAMSON TYPE HIGH FIDELITY AMPLIFIER KIT

This is a very popular high fidelity amplifier kit that features dual-chassis type construction. The resulting physical dimensions offer an additional margin of flexibility in installation. It features the famous Acrosound TO-300 "ultra-linear" output transformer, and has a frequency response within ± 1 db from 6 cps to 150 Kc at 1 watt. Harmonic distortion only 1% at 21 watts. IM distortion at 20 watts only 1.3% at 60 and 3,000 cps. Rated power output is 20 watts. Output impedance 4, 8, or 16 ohms. Hum and noise—88 db below 20 watts. Uses two 6SN7's, two 5881's, and a 5V4G.

KIT COMBINATIONS:

W-3M: Consists of main amplifier and power supply for separate chassis construction. Includes all tubes and components necessary for assembly. Shpg. Wt. 29 lbs., Express only. **$49.75**

W-3: Consists of W-3M Kit listed above *plus* Heathkit Model WA-P2 Preamplifier described on opposite page. Shpg. Wt. 37 lbs., Express only. **$69.50**

3

3 Heathkit SINGLE-CHASSIS WILLIAMSON TYPE HIGH FIDELITY AMPLIFIER KIT

This is the lowest priced Williamson type amplifier ever offered in kit form, and yet it retains all the usual features of the Williamson type circuit. Main amplifier and power supply combined on one chassis, and uses a new-design Chicago output transformer. Frequency response—within ± 1 db from 10 cps to 100 Kc at 1 watt. Harmonic distortion only 1.5% at 20 watts. IM distortion at rated output, 2.7% at 60 and 3,000 cps. Rated power output is 20 watts. Output impedance 4, 8, or 16 ohms. Hum and noise—95 db below 20 watts. Uses two 6SN7's, two 5881's, and one 5V4G.

Instructions are so complete that the kit may be assembled successfully even by a beginner in electronics.

KIT COMBINATIONS:

W-4AM: Consists of main amplifier and power supply for single chassis construction. Includes all tubes and components necessary for assembly. Shpg. Wt. 28 lbs. Express only. **$39.75**

W-4A: Consists of W-4AM Kit listed above *plus* Heathkit Model WA-P2 Preamplifier described on opposite page. Shpg. Wt. 35 lbs. Express only. **$59.50**

HEATH COMPANY

A SUBSIDIARY OF DAYSTROM INC.

BENTON HARBOR 15, MICHIGAN

ATTRACTIVELY STYLED: *Heathkit high fidelity instruments are not only functional, but are most attractive in physical design. Such units as the preamplifier and the W-5 main amplifier are designed for beauty as well as performance. They blend with any room decor and are the kind of instruments you will be proud to own.*

enjoy....
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HEATHKITS

❶ *Heathkit* HIGH FIDELITY PREAMPLIFIER KIT

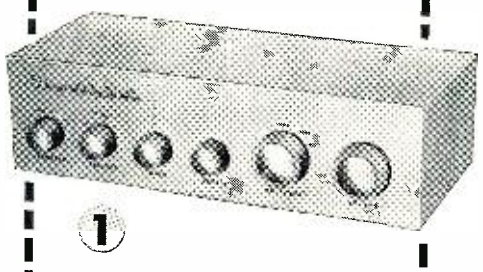
This outstanding preamplifier is designed specifically for use with the Heathkit Williamson type amplifiers. It completely fulfills the requirements for remote control, compensation and preamplification, and exceeds even the most rigorous specifications for high fidelity performance.

Features five separate switch-selected input channels (2 low level and 3 high level), each with its own input control. Full record equalization with four-position turnover control and four-position rolloff control.

Output jack for tape recorder – separate bass control with 18 db boost and 12 db cut at 50 cps. – treble control offering 15 db boost and 20 db cut at 15,000 cps – special hum control to insure minimum hum level – and many other desirable features. Overall frequency response (with controls set to "flat" position) is within 1 db from 25 cps to 30,000 cps. Will do justice to the finest available program sources. Beautiful satin-gold finish.

Power requirements from the Heathkit Williamson type high fidelity amplifier – 6.3 VAC at 1 amp., and 300 VDC at 10 Ma. Uses two 12AX7's and one 12AU7.

MODEL WA-P2
$19.75
Shpg. Wt. 7 Lbs.



❷ *Heathkit* 20-WATT HIGH FIDELITY AMPLIFIER KIT

This Heathkit Model offers you the least expensive route to high fidelity performance. Frequency response is ± 1 db from 20-20,000 cps. Features full 20 watt output using push-pull 6L6's, and incorporates separate bass and treble tone controls. Preamplifier and main amplifier are built on the same chassis. Four switch-selected compensated inputs and separate bass and treble tone controls provide all necessary functions at minimum investment. Features miniature tube types for low hum and noise.

Uses 12AX7, two 12AU7's, two 6L6G's and a 5V4G. A most interesting "build-it-yourself" project, and an excellent hi-fi amplifier for home use. Well suited, also, for public address applications because of its high power output and high quality audio reproduction. Another Heathkit "best-buy" for you!

MODEL A-9B
$35.50
Shpg. Wt. 23 Lbs.

❸ *Heathkit* 7-WATT AMPLIFIER KIT

The redesigned Model A-7D features a new type output transformer for tapped screen operation, and provides improved sensitivity, reduced distortion, and increased power output.

The full 7-watt output of the Model A-7D is more than adequate for normal home installations. Frequency characteristics are ± 1½ db from 20 to 20,000 cps. Potted output and power transformers employed. Push-pull output – detailed construction manual – top quality parts – high quality audio without great expense. Output transformer tapped at 4, 8, and 16 ohms. Bass and treble tone controls provided on the front chassis apron.

MODEL A-7D
$16.95
Shpg. Wt. 10 Lbs.

Model A-7E: Provides a preamplifier stage with two switch-selected inputs and RIAA compensation for variable reluctance or low level cartridges. Preamplifier built on same chassis as main amplifier. Model A-7E. Shipping weight 10 lbs. $18.50.

HEATH COMPANY
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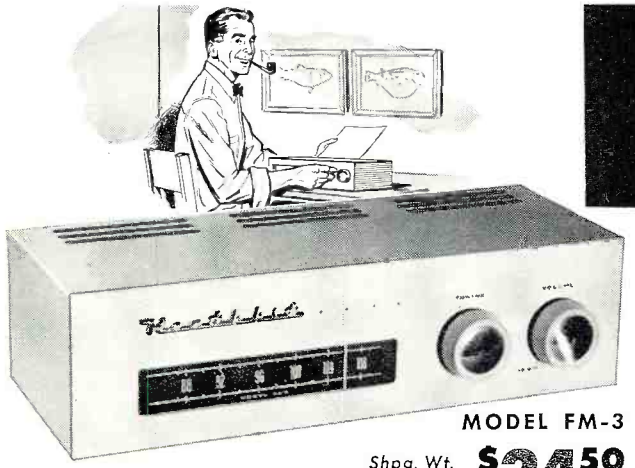
BENTON HARBOR 15, MICHIGAN



MODEL FM-3

Shpg. Wt. 7 lbs. **$24.50** (with cabinet)

Brand New HEATHKIT HIGH-FIDELITY FM TUNER KIT

Features

- *Brand New, Modern FM Circuit Using Latest Type Miniature Tubes.*
- *Low-Noise Cascode RF Stage—Two IF's—Ratio Detector —Stage of Audio.*
- *Extremely Good Sensitivity and Band-Pass for Outstanding Performance.*
- *Strikingly Attractive Satin-Gold Finish to Match Heathkit Model WA-P2 Preamplifier.*
- *Compact Physical Dimensions for Most Pleasing Appearance and Increased Circuit Efficiency.*

The new Heathkit Model FM-3 features tremendous circuit improvements and brand new physical design. Sensitivity is better than 10 μv. for 20 db of quieting, and it employs a completely modern tube line-up for high gain and stable operation. Incorporates its own power supply, and has provision for low-level or high-level output at low impedance.

The attractive Model FM-3 matches the WA-P2 Preamplifier in color, styling, and physical size.

Incorporates automatic gain control, a highly stabilized oscillator, and illuminated tuning dial. Educational treatment of construction manual simplifies assembly for the newcomer to electronics. *IF* and *ratio* transformers are *prealigned*, and the front-end tuning unit is pre-assembled and aligned. Uses 6BQ7A as a cascode type RF stage, 6U8 oscillator-mixer, two 6CB6's as IF amplifiers, a 6AL5 ratio detector, a 6C4 audio amplifier, and 6X4 rectifier.

HEATHKIT BROADCAST-BAND RECEIVER KIT

Build your own radio receiver with confidence, even if you are a beginner. Complete instructions supplied.

Features transformer-type power supply, high-gain miniature tubes, built-in antenna, 5½" speaker, and planetary tuning from 550 Kc to 1500 Kc. Adaptable for use as AM Tuner and phono amplifier. Educational treatment of the construction manual helps the beginner learn about radio circuits and parts as he builds.

CABINET: Fabric covered plywood cabinet with aluminum panel as shown. Part 91-9, Shpg. Wt. 5 lbs., $4.50.

MODEL BR-2

$17.50 *Less Cabinet*

Shpg. Wt. 10 lbs.

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

G-E Test Points

(*Continued from page 48*)

and effective bias control circuit which maintains the bias on the first grid of the 6BY6 at a level which assures optimum cancellation of noise pulses, regardless of incoming signal strength. The a.g.c. voltage is developed by grid rectification at the second grid of the 6BY6 and this voltage, after suitable filtering, is applied to the first two video i.f. stages. Delayed a.g.c. voltage from this same source is also applied to the tuner r.f. amplifier with a diode section of the 6T8 working as a clamper to prevent the delayed a.g.c. voltage from going positive. Test point VII is tied directly to the plate of the 6BY6 and is very useful for checking clipper action with an oscilloscope. A .01-μfd. capacitor (or larger) should be used in series with the scope lead to this point to block off the d.c. voltage that is present.

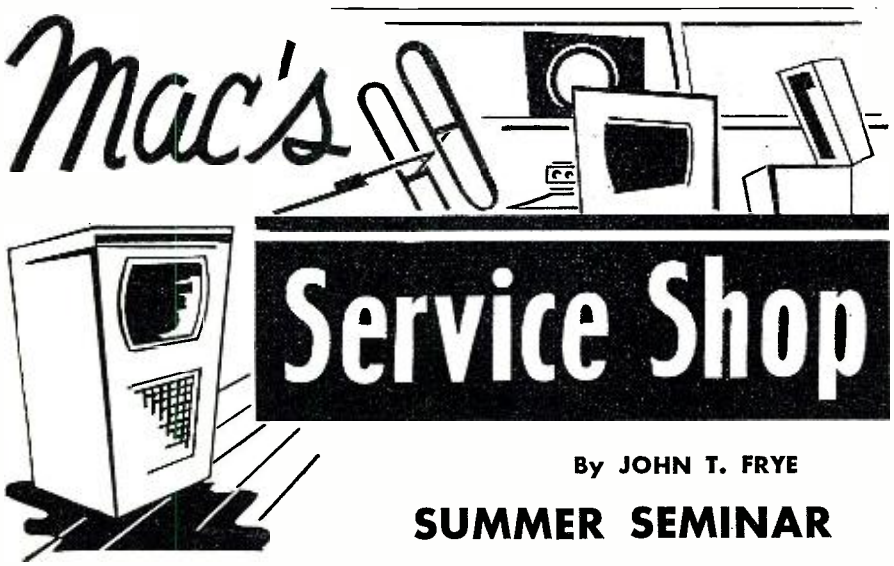
The vertical deflection circuit consists of a 6BL7 dual triode working as a blocking oscillator and output stage. The excellent stability of this form of oscillator eliminates tunable interlace —that is, the vertical circuit will remain in interlace at any setting of the vertical hold control that locks in the picture.

If the vertical hold control will not center after replacing the 6BL7, change the 820,000-ohm resistor in series with the control to 1 megohm. This occurs with some types of replacement 6BL7's.

Horizontal deflection circuitry makes use of a dual-selenium phase detector, a 7AU7 stabilized, cathode-coupled multivibrator, and a 6BQ6GA output stage. A 6AX4GT damper and 1B3GT high-voltage rectifier complete this section of the receiver. A ⅜-ampere high-voltage fuse is wired in at the cathode of the damper tube and this can be reached by removing the access plate on the bottom side of the chassis mounting board. If the phase detector should become faulty and if a selenium replacement is not available, a pair of germanium diodes, properly connected, may be substituted.

The power supply uses a full power transformer with a 5U4GA/B rectifier. The 135 "B+" volts are picked off the cathode of the 6AS5 audio output tube by "stacking" this stage in series with the +275-volt line. The +135 volts is fed to the audio limiter and the video amplifier screen, among other tubes. Failure of the 6AS5 tube will, therefore, kill both audio and video.

To adjust the horizontal stabilizer circuit, short test point VI to chassis, connect test points VIII and IX together with a 1000-ohm resistor, and adjust the horizontal hold potentiometer so that the picture drifts back and forth. Remove the resistor and adjust stabilizer coil slug (through hollow shaft of hold pot) so that picture again floats. Now remove the short on test point VI and readjust hold potentiometer. —30—



By JOHN T. FRYE

SUMMER SEMINAR

THE soft little breeze drifting through the wide open doors of the service shop felt good to Mac and his helper, Barney, as they worked away at the bench on this warm June afternoon. Mac glanced up from the new TV tuner he was installing in time to see Barney toss a selenium rectifier he had just removed from a three-way portable into the trash barrel.

Making sure he had Barney's attention but without saying a word, Mac fished a dime from his pocket and nonchalantly flipped it into the barrel.

"Hey! You popped your cork?" Barney asked anxiously. "Wasn't that a dime you just threw into the barrel?"

"That's right. If you can throw away money so can I."

"What do you mean: *I* throw away money? My mother never had any stupid children."

"Didn't you just toss a selenium rectifier into the trash barrel?"

"Sure, but it wasn't any good."

"Remember my telling you selenium is in short supply and that rectifier manufacturers have asked us to save old rectifiers so the selenium can be reclaimed?"

"Yes, now that you mention it, I do recall your saying something about that. In fact, I also have a hazy recollection that our parts salesman mentioned he would give us ten cents for every old rectifier we turned in, no matter what the size. It just sort of slipped my mind."

"Well, just sort of slip into that trash barrel and fish out the rectifier you tossed in as well as any others you may have discarded when I wasn't looking. And while you're in there, you may as well recover my dime."

"OK, Boss," Barney said with a broad grin on his freckled face; "and you certainly made your point. I may forget Ohm's Law or even the color of my Margie's eyes, but the sight of a Scotsman throwing away money is something I'll *never* forget."

Fortunately the barrel had been dumped only a day or so before; so recovering the rectifier and dime was easy. Barney placed the rectifier in a cardboard carton and facetiously marked the outside "Old Diamonds, Old Gold, Old Selenium Rectifiers," Etc." and placed it beneath the bench. Then he turned his attention to what Mac was doing.

"Did lightning clobber that tuner?" he wanted to know.

"Yep, and it did such a good job that a complete replacement is the only practical repair."

"Another case in which the lightning arrester obviously fell down on the job," Barney offered. "Sometimes I think those things are just a waste of money."

"Lightning arresters are something like kids," Mac said with a tolerant smile. "People expect more out of them than they can deliver, and they get a lot of blame they do not deserve. A properly installed lightning arrester with a short direct lead to a really good ground will do an excellent job of protecting a TV set from surges induced into the antenna and feedline by nearby lightning strokes, but only a fool would expect it to furnish protection from a direct stroke to the antenna itself. Neither will a lightning arrester afford protection against damage by lightning that is going from the set into the antenna."

"From the set into the antenna!" Barney repeated. "What kind of crazy talk is that?"

"It's not crazy at all. In fact, most of the lightning damage in this area is caused by surges going up the feedline rather than down it. Keep in mind that the majority of the antennas around here are of the yagi-inspired type that has the driven element directly connected to the boom, the boom connects to the mast, the mast connects to the tower, and the tower is grounded. In other words, the antenna is actually at ground potential.

"Now let's review what happens when a stroke of lightning sends a surge along the 'hot' wire of the power line to which the TV set is connected. This surge comes in on one side of the line cord and promptly goes through the line bypass capacitor, if one is present, to the chassis. If no capacitor is used between the line and the chassis, as is often the case, the surge may jump the switch and reach the chassis by breaking down the insulation between the power transformer primary and the core or one of the other, grounded windings. Once on the chassis it goes through the grounded center-tap of the antenna coil connected through the turret switch to the antenna terminals, up the lead-in to the antenna, and back down the mast and the tower to the ground, where it had been heading all the time.

"When you look at the charred coil and the melted turret contacting fingers, there is no way of telling which direction the surge was travelling when it passed through them. In fact, the natural conclusion to reach would be that the damage was done by a surge coming down the feedline; but actually the chances are that it was going up the feedline as I described. Whenever you are checking out a set with these symptoms, be sure and test for a short-circuit between both sides of the line cord and the chassis before letting the set out of the shop. It is a good idea to disconnect the resistor often found between one side of the line and the chassis while making this test so that a high value of leakage, that can quickly change to a low value when the line voltage is applied, may be spotted. If there is a short-circuit between one side of the line and the chassis, there will be a fifty-fifty chance of burning out another antenna coil as soon as the antenna is connected and the set plugged in. If the side of the line cord that is shorted happens to be plugged into the grounded side of the light line, nothing may happen until the plug is removed and turned over; but *then* the smoke will roll or the fuse will blow."

"The best insurance against lightning damage would seem to be to yank the line cord whenever a storm is approaching."

"Truer words were never spoken. Putting all your trust in a lightning arrester is like barring the attic window against burglars and leaving all the rest of the doors and windows wide open. If all our customers followed our advice and pulled out their TV line cords when a thunderstorm approached or when they left home for any length of time in the summer, our lightning repair business would drop to a very low figure."

"Then why tell 'em?" Barney demanded.

Before Mac could answer an elderly lady entered the shop. Miss Perkins was on vacation; so Mac went into the front part of the shop to give the customer her small clock radio.

"Here you are, Mrs. Nelson," he said. "I found the noise you mentioned, and a new tube took care of that; but I'm puzzled by your saying the radio was dead. It started off as soon as I turned it on, and I have kept it running for two whole days without any cutting

We CHALLENGE any other antenna to outperform our new

Seldom has an antenna aroused as much enthusiasm as our wonderful new Power-Helix. Its performance in Black and White and Color has been so remarkable, so outstanding, that we challenge any other antenna to surpass it.

A single bay of the new JFD Power Helix will:

OUTPERFORM a 10-element cut-to-channel Yagi on each high band channel from 7 to 13.

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We do not make nor should you take this challenge lightly.

It is backed by astonishing on-the-job performance under all operating conditions. You can extend to all your customers this same iron-clad guarantee of performance ... whether it is a new set sale ... a replacement antenna installation ... or a color TV installation.

You be the judge. Try the Power-Helix. If it doesn't perform as we say... you name the forfeit.

EDWARD FINKEL, Sales Manager

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PX911	*1-Bay Power-Helix*	**$35.00**
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out. Could it have been possible you did not have the clock switch turned on? This is one of the few sets I have come across that uses two turn-on switches connected in series: one on the volume control and one on the clock."

"You mean those little knobs on the clock have something to do with the radio?" the little old woman asked with a puzzled expression.

It quickly developed the radio was a Christmas present and that the donor had not explained how it worked. The owner had never known there was any connection between the clock and the radio. To her, a clock-radio was simply a clock and a radio. Fortunately, the clock switch had been left in the "Manual" position; so the switch on the volume control had served to turn the radio on and off. An inquisitive visiting grandson had apparently turned the clock switch to "Off," where Mac had found it; and so the volume control switch could not turn on the set.

Gently and patiently Mac explained the working of the combination. Not only did he show her how to set the clock controls so that the radio would be turned on or off at a given time, but he also made certain that she understood the clock switch had to be left at "Manual" if she wished to use the volume control switch for turning the set on and off.

"Boy! How dumb can you get?" Barney sniggered after she had thanked Mac warmly and departed with her set.

"Let's have none of that kind of talk!" Mac said sternly. "There's no reason why she should understand the workings of a clock-radio without instruction. And there are dozens of fields, from churning butter to diapering babies, in which her knowledge and experience would make us both look like real dopes. Let me make it clear for once and for always that in this shop our Senior Customers are to receive every courtesy, consideration, and kindness."

"I'm sorry, Mac," Barney said with a red face. "I know better than to say anything like that."

"Sure you do. I heard you griping the other day how color TV, printed circuits, u.h.f., and transistors were piling in on us faster than we could grasp them; but did you ever stop to think what a bewildering array of basic new inventions and discoveries have come into use during the span of that woman's life? Electric lights and power, automobiles, airplanes, radio, TV, motion pictures, jet propulsion, antibiotics, atomic energy—these are just a few of the things she has had to understand and learn to live with and use during her lifetime. It is truly wonderful that she and her contemporaries have been able to take all this in stride."

"That's a fact," Barney warmly agreed.

"And while we're on the subject, I want you to give these older customers of ours a little special treatment. I'm not saying this just out of sentiment. As the normal life span increases, elderly people are becoming more and more important to our economy as a whole; and they play a particularly important part in the radio and TV service picture."

"How's that?"

"To active working people, radio and TV are just a couple more forms of amusement bidding for attention; but to many retired persons they constitute practically the only form of entertainment regularly enjoyed. This makes the radio receiver or TV set assume an importance not always understood by the service technician. It's hard for him to comprehend how lonely an elderly person may feel when his or her set is out of order; yet both of us have heard these people say it's almost like having someone dead in the house when the radio or TV is on the fritz."

"Then you want me to make every effort to return old people's sets in a hurry."

"That's the ticket. I hope that we can do a little plain and fancy record breaking in this part of our servicing operation.

"More than that. When you return a set to them, make sure they know how to get the most out of it. Try to have the owner tune the set while you watch. If he's doing anything wrong, tactfully show him how it should be done. You'll find these people are deeply grateful for any help you can give and for your intelligent interest in their

problems. They make loyal, highly-vocal customers who will provide us with an astonishing amount of effective word-of-mouth advertising once they are convinced we are honest, capable, and friendly. Be sure and note that word 'friendly.' It is important in dealing with any customer, but friendliness is especially appreciated by elderly people."

"Gotcha!" Barney exclaimed as he made an understanding circle with his thumb and forefinger. —30—

Simplified Preamplifier

(*Continued from page 70*)

As for the omission of tone controls, there is one observation to make concerning the use of compensated loudness controls. Before a loudness control was installed, quite often it was necessary to "add bass and treble" at low listening levels. After its installation, the bass and treble controls were seldom used. It is realized that tone controls are a matter of personal preference, and that many users deem them a prime requirement. Still, there are those who feel they can do without tone controls, and this preamplifier should suit them admirably. Then, too, additional gain must be provided to make up for the insertion loss of tone control circuits, and this can mean a noise or hum problem because of the added gain required. As a result, the only controls are a selector switch and a loudness control. Since the power comes from the main amplifier, the switching is done at that point, so that the only a.c. on the preamplifier chassis is the 6.3 volts for the heaters.

With only two tubes, two controls, and no complicated switches to construct (roll-off and turnover switches can turn into a pain in the neck) this preamplifier presents no difficult construction problems. No special tricks or circuits were used to eliminate noise and hum, but with the loudness control fully advanced, the complete absence of noise and hum makes it easy to leave the whole rig on; there is no pilot light on this preamplifier chassis, but a large obvious one is installed elsewhere and it is considered a "must." The 6J7 is still a good tube for this use with regard to noise, hum, and microphonics. As far as the "gimmicks" to get rid of hum and noise—some cause more troubles than they cure and unless the builder has had considerable experience with troubleshooting, the best method is the "simpler the better." Caution should be taken to keep the grid-cathode loop as small as possible, physically, or else use a ground bus for all ground returns. If low-noise type resistors are readily available, they should be used. Otherwise, the use of two-watt cathode and plate resistors will reduce the likelihood of "resistor noise."

The point of the whole thing is this—build it carefully and simply. Then, if the problems of noise and hum present themselves, *then* eliminate them. The best single source of suggestions may be found in *RCA's* "Radiotron Designer's Handbook," 4th edition, Chapter 18, Section 2.

REFERENCES

1. *Rose, Arthur J.: "Simplified Design of Feedback Equalizers,"* Radio & Television News, *September, 1954.*
2. *Childs, Ulric J.: "The Childs' Custom-Built Amplifier,"* Radio & Television News, *July, 1951.*
3. *: "Versatile Phonograph Amplifier," Audio Engineering, March, 1949.*

—30—

ARRL CONVENTION

THE Denver Radio Club will play host to the 1956 ARRL Rocky Mountain Division Convention on June 9 and 10th.

The affair will be held at Elkhorn Lodge, Estes Park, Colorado in the heart of the Rocky Mountains. The facilities of Estes Park and nearby Rocky Mountain National Park will be available to conventioneers.

Activities for all have been planned by the committee in charge and will range from technical talks to fishing and mountain trips. There will be fun for the entire family.

Registration fee is $3.50 per person. A special rate of $2.50 applies for reservations received before June 3rd.

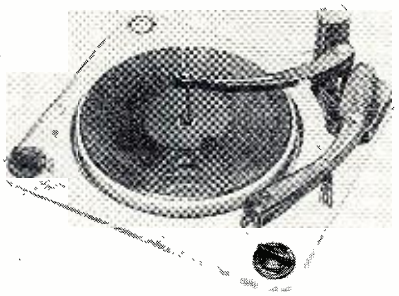
For full information or reservation forms, write to Taylor Shreve, WØCXW, 1230 Valentia St., Denver 20, Colo. —30—

New Hi-Fi-Audio Equipment

FOUR-SPEED CHANGER

The *Collaro Division* of *Rockbar Corporation,* 650 Halstead Avenue, Mamaroneck, New York has announced the availability of a new changer, the Model RC-456, which has been designed to operate at the four standard speeds of 78, 45, 33⅓ and 16⅔ rpm.

The new model is identical in quality and performance to its 3-speed



predecessor. It features automatic intermix, automatic idler disengagement, etc., found in the earlier model. A new feature has been added that permits manual operation at all speeds.

For further information write Mort Wimpie in care of the company.

MOISTURE-PROOF MIKE

American Microphone Company, Pasadena affiliate of *Elgin National Watch Company,* has announced the availability of a moisture-proof carbon microphone which has been specifically designed for mobile communications applications.

The rugged microphone has a variety of outdoor applications and the

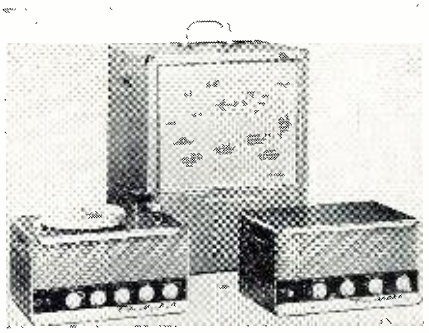
addition of a special rubber boot makes it completely moisture-proof. Known as the C504C, the microphone is housed in a Bakelite case measuring 2⅛" x 1⅝" and weighing 9 ounces. With a 40 ohm impedance and a frequency response from 200 to 5000 cps, the microphone should be used as a close-talking unit.

COMMERCIAL AMPLIFIERS

Bell Sound Systems, Inc., 555 Marion Road, Columbus 7, Ohio has introduced a new line of commercial amplifiers which has been designed for the "budget" market.

The "Pacemaker" line consists of eight models with various accessories, including a 10-watt a.c. amplifier, a 10-watt system comprising a 10-watt a.c. amplifier and speaker, a 20-watt a.c. amplifier, a 33-watt a.c. amplifier, two 6-volt, 20-watt mobile amplifiers (one with single-speed and one three-speed phono top), and two 12-volt, 20-watt mobile amplifiers (single- and three-speed phono tops). Accessories include three-speed phono top and a systems case which will fit all models (except Model PM-10S) and carries two 12" speakers and 25 feet of cable.

Write to H. H. Seay, general sales



manager of the company, for complete details on any or all of the "Pacemaker" items.

AUDIO COMPONENTS

Lafayette Radio, 100 Sixth Avenue, New York 13, New York has announced the availability of three new pieces of audio equipment.

The PK-100 transcription turntable and the PK-90 viscous damped transcription tone arm are said to embody many of the design features of professional equipment. The third item, the SK-58, is an imported 12" coaxial speaker. It provides a range of 30 to 15,000 cps and is rated at 20 watts maximum input. Voice coil impedance is 8 ohms.

The player consists of a 3 pound, 12", die-cast, lathe-turned aluminum turntable. Dynamic balance and an extra heavy rim effect smooth flywheel action. A four-pole shaded motor provides all three record speeds

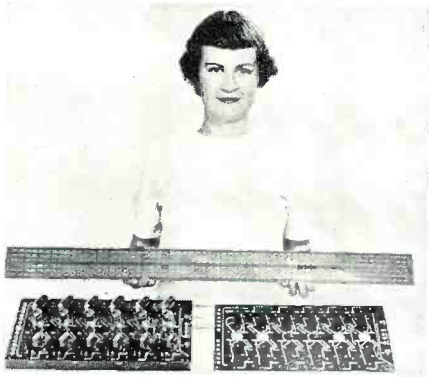
with a variable control permitting adjustment of all speeds to within ±7%.

Additional details on any or all of these units are available from the company.

PRINTED CIRCUIT ORGAN

Electronic Organ Arts, 4878 Eagle Rock Blvd., Los Angeles 41, California has announced the release of printed circuitry for its line of "build-it-yourself" electronic organs.

The first of the units is a tone generator chassis consisting of a double-sided etched panel eliminating all wir-



ing. Assembly is reduced to merely mounting the oscillator components and soldering the connections. Wiring time has been reduced by one fourth. Each solder point and note is labeled to further simplify construction.

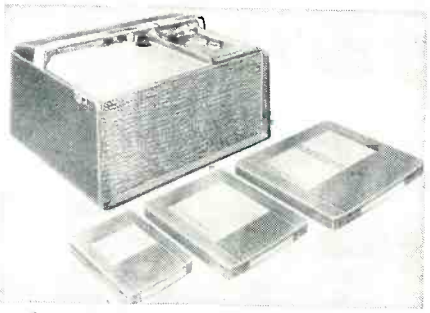
Write the company for full details on this new line.

LONG-PLAY TAPE CARTRIDGE

The *Sound Electronics Laboratory,* a division of *G. H. Poulsen & Company,* Toledo, Ohio has developed a long-play tape cartridge which is said to be the first to play a full hour at 7½ ips.

Called "Fidelipac," the cartridge is only slightly larger than standard 1200-foot reels and stores more easily. Half-hour and 15-minute size cartridges are similarly comparable to standard 600- and 300-foot reels.

Housed in a colorful plastic case of



modern design, the cartridge is simply inserted in the playing device and automatically locked in proper position. The tape itself is never touched or handled so that nicks and wrinkles are avoided, resulting in longer tape life.

RECORDER CONSOLETTE

The *RCA Victor Radio and "Victrola" Division,* Camden, New Jersey has released a new high-fidelity tape re-

corder consolette which features three speakers in a roll-around cabinet.

Tradenamed "The Legislator" (Model 7TRC1), the new unit has been especially designed for playing back professional or home-recorded tapes as well as recording high-quality voice or music. It features a newly-designed six-tube amplifier which provides 5 watts of undistorted output. The amplifier is specifically matched to the magnetic head of the tape transport. One 8" and two 3½" speakers are included in the cabinet.

The recorder will handle either 7½ or 3¾ ips tapes.

DELUXE GARRARD CHANGER

Garrard Sales Corp., Port Washington, New York is now marketing a deluxe three-speed record changer, the Model RC88 "Triumph II."

The new unit includes the company's pusher platform and 1-piece bent spin-

dle which has no moving parts. In addition, the design includes a full manual position which gives the automatic changer the convenience of a manual player.

An entirely new "true-turret" drive with 1-piece pulley assures accurate speed without audible flutter, wows, or rumble, eliminating drive belts. The shaded 4-pole induction motor has a dynamically-balanced weighted rotor.

Stylus pressure and pickup height are adjustable on the tone arm. It is designed to accommodate all popular high-fidelity cartridges now on the market.

Write the company for full specifications.

COMPLETE SYSTEM

Harman-Kardon, Inc., Westbury, Long Island, New York is currently marketing a quality system, the "Solo," Model TA-10.

The new unit combines the tuner

characteristics of the firm's new "Overture" AM-FM tuner with the preamplifier and 10-watt characteristics of its "Prelude" model. The

THE FISHER

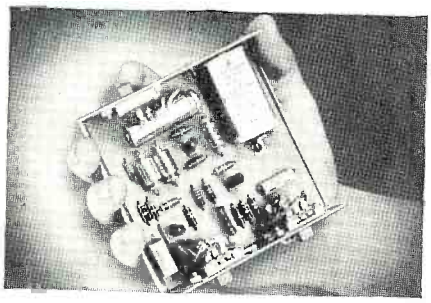
World's Foremost High Fidelity Components

■ These outstanding instruments reflect the truly professional standards of design and workmanship that have made FISHER the quality leader for two decades. Best in price and performance!

Series 80-C · MASTER AUDIO CONTROL

■ "Breathtaking!"—*Edward Tatnall Canby.* The Master Audio Control can be used with any amplifier. Provides professional phono *and* tape-head equalization, full mixing and fading facilities. Two cathode follower outputs. Uniform response within 0.25 db. 20 to 20,000 cycles. IM distortion and hum virtually *non-measurable.* EIGHT CONTROLS: Bass, Treble, Master Volume, Dual Phono/Tape Equalization, Calibrated Loudness Balance, Line Switch, Five Channel Selector Push Buttons, Five Input Mixer/Level Controls. Seven Inputs. Self-powered. Three AC outlets. SIZE: 12¾" x 7¾" x 4¼" high. WEIGHT: 10 lbs. *Mahog. or Blonde Cabinet Available.*

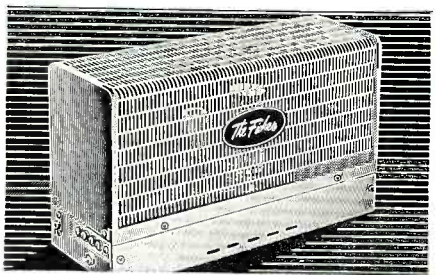
Cabinet $9.95 · Chassis Only $99.50



Model TR-1 · All-Transistor PREAMPLIFIER

■ Another great FISHER achievement—the first all-transistor high fidelity product. Absolutely *zero* hum and microphonism. Phono or microphone preamplifier. Response 20 to 20,000 cycles within 0.5 db. Handles all popular magnetic cartridges, including very low-level types (no transformer necessary!) Noise level 65 db below 10 millivolts input, for high impedance cartridges. RIAA equalization. Handles output lead up to 200 feet long. Three transistors, printed circuit wiring, fully shielded. THREE CONTROLS: Power/Volume, Impedance Selector Switch, Phono/Microphone Selector Switch. SIZE: 2" x 4⅛" x 4½" deep. WEIGHT: 12 ounces.

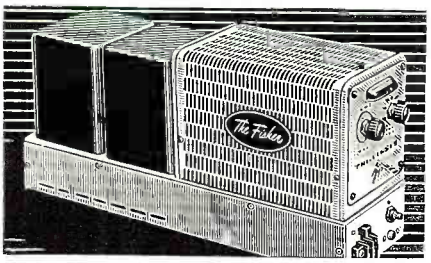
Price $27.50 · Battery $1.95 · 110 VAC Power Supply $4.95



Model 20-A · LAB STANDARD AMPLIFIER

■ Low in cost, terrific in quality! It is the 15-watt amplifier thousands of hi-fi enthusiasts have requested. Meets the most exacting demands. Traditional FISHER workmanship, handsome appearance. Advanced design throughout. Frequency response within 0.1 db, 20 to 20,000 cycles at 15 watts. Less than 0.7% distortion. IM distortion less than 1.5% at 10 watts. Hum and noise better than 90 db below full output. Internal impedance: 1 ohm for 16-ohm operation, giving damping factor of 16, assuring low distortion and superior transient response. Output impedance: 4, 8 and 16 ohms. SIZE: 13" x 4¼" x 6¾" high. WEIGHT: 13 pounds.

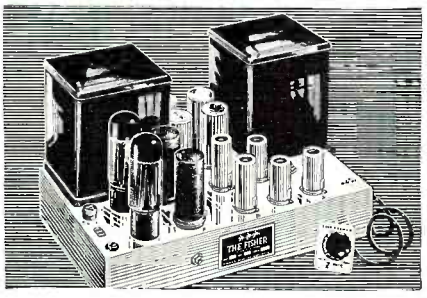
Price Only $59.50



Model 80-AZ · LAB STANDARD AMPLIFIER

■ Great new FISHER amplifier with PowerScope, a *visual* Peak Power Indicator. More clean watts per dollar than any amplifier in its class. 60 watts peak! Less than 0.5% distortion at 30 watts (0.05% at 10 watts.) IM distortion less than 0.5% at 25 watts. Uniform response within 0.1 db, 20 to 20,000 cycles. Within 1 db, 10 to 50,000 cycles. Hum and noise virtually non-measurable (better than 96 db below full output!) THREE CONTROLS: Z-Matic, PowerScope, and Input Level. Output: 8 and 16 ohms. SIZE: 15¼" x 4¼" x 6⅞" deep. WEIGHT: 22 pounds.

Price Only $99.50



Model 50-AZ · LAB STANDARD AMPLIFIER

■ World's finest all-triode amplifier and moderately priced. 100 watts peak! Less than 1% distortion at 50 watts (0.08% at 10 watts.) IM distortion below 2% at 50 watts. Response uniform within 1 db, 5 to 100,000 cycles. Hum and noise level 96 db below full output! Unusually high reserve power handling capacity. High efficiency, excellent transient response and linearity. Oversize components, famous FISHER workmanship throughout. Equipped with FISHER Z-Matic for variable damping. 8 and 16-ohm outputs. SIZE: 8¾" x 14½" x 9" high. WEIGHT: 41 pounds.

Price Only $159.50

Prices Slightly Higher in the West

WRITE TODAY FOR COMPLETE SPECIFICATIONS

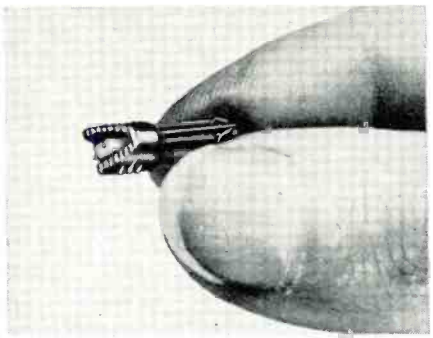
FISHER RADIO CORPORATION · 21-23 44th DRIVE · L. I. CITY · N. Y.

whole is housed in a brushed copper and black cabinet which measures only 4" high. Nine front panel controls offer every conceivable facility and include separate phono roll-off and turnover, rumble filter, "Dynamic Loudness Contour," plus equalization for tape recorder heads and a tape recorder output.

E-V "POWER POINT"

Electro-Voice, Inc., Buchanan, Michigan has developed a new miniaturized phonograph cartridge which has been tradenamed "Power Point."

The cartridge consists of a miniature nylon case, ¼" x ¾", enclosing a



ceramic generating element to which synthetic sapphire or natural diamond needle tips are directly connected.

Three mounting mechanisms are available. These are fixed mount for single-speed machines and turnover and turnunder mounts for multiple speed machines. The "Power Point" can be mounted into any tone arm having standard 7/16", ½", or ⅝" mounting centers which makes it possible to use the cartridge in practically any phonograph.

"KARLSON 15"

Karlson Associates, Inc., 1610 Neck Road, Brooklyn 29, New York has recently added a new version of the "15" to its line of speaker enclosures.

The new model is the product of advanced research which indicated the desirability of making a few changes in the internal dimensions of the original "15" enclosure.

The improved version is available in kit and finished form to suit any purse and requirements.

AUDIO CATALOGUES

MAGNECORD RECORDERS

Magnecord, Inc., 1101 South Kilbourn Avenue, Chicago 24, Illinois has a series of data sheets available covering its complete line of tape recorders for home and professional use.

Information on the M90 professional series, the "Citation" for home use, the PT6-Series 5, and the professional series for rack or panel mounting is available on request.

When writing for data, outline your requirements and the company will supply data on pertinent recorders.

MIXER-AMPLIFIER

A new technical bulletin describing its transistorized mixer-amplifier has just been issued by *Baird Associates,*

SERVICEMEN: NOW YOU CAN REDUCE YOUR RECTIFIER NEEDS TO 4 TYPES WITH

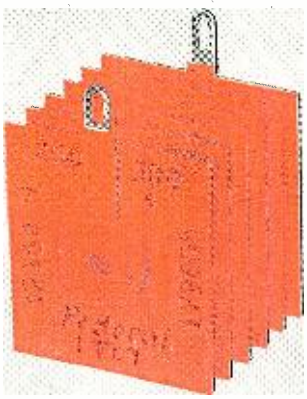
Federal's

HI-DENSITY

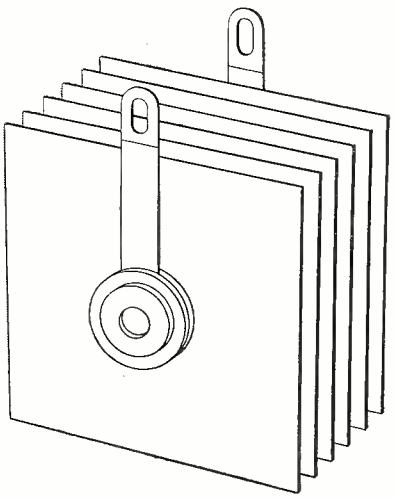
SELENIUM RECTIFIERS

Engineered to handle 90% of your radio-tv replacements!

Nearly 50% SMALLER...!



ACTUAL SIZE



More compact packages increase rectifier capacity of your kit ...save time on service calls!

SEE YOUR FEDERAL DISTRIBUTOR!

COMPARE—

Compare, Mr. Serviceman, Federal's new 250-300 Ma. HI-DENSITY stack with its larger predecessor of the *same rating!*

Just 4 types—ranging up to 600 Ma.—are needed to meet 90% of your requirements for radio-tv replacements.

Now you can *really* simplify rectifier replacement . . . with these smaller, lighter, higher-temperature, longer-lasting, more versatile HI-DENSITY stacks. Get the facts!

A Research and Development Triumph of Federal

Federal Selenium Rectifiers are listed in Howard W. Sam's Counter-Facts and Photo Facts

Federal Telephone and Radio Company

A Division of INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION
COMPONENTS DIVISION • 100 KINGSLAND ROAD • CLIFTON, N. J.

In Canada: Standard Telephones and Cables Mfg. Co. (Canada) Ltd., Montreal, P. Q.
Export Distributors: International Standard Electric Corp., 67 Broad St., New York

Federal
FEDERAL TELEPHONE & RADIO FTR
A DIVISION OF ITT

Inc., 33 University Road, Cambridge 38, Mass. as its TP101.

The two-color data sheet discusses the outstanding features of this unit, which has been designed especially for remote-pickup recordings and interviews as well as in conjunction with outside p.a. systems.

The data sheet is well-illustrated with complete electrical and mechanical specifications. Information on other exclusive features is included, as is a frequency response curve.

APPROVED FLYER

Approved Electronic Instrument Corp., 51 Vesey Street, New York 7, N. Y. has just issued a six-page flyer covering its line of audio equipment kits.

Included in the flyer are complete details on the firm's AM and FM tuners, AM-FM tuner, 6- and 20-watt amplifiers, a preamp, and a binaural twin-channel amplifier kit. In addition, two pieces of test equipment, a TV field strength meter and a u.h.f. signal generator, are pictured and described in detail.

"TRU-SONIC" SOUND

Stephens Manufacturing Corporation, 8538 Warner Drive, Culver City, California has issued a 4-page catalogue describing its line of loudspeaker cabinets and systems.

Details of cabinetry, physical specifications, speaker, and network data are included for the firm's "Catalina," "Caravan" and "Coronet" models as well as specifications on the "Tru-Sonic" super-tweeter.

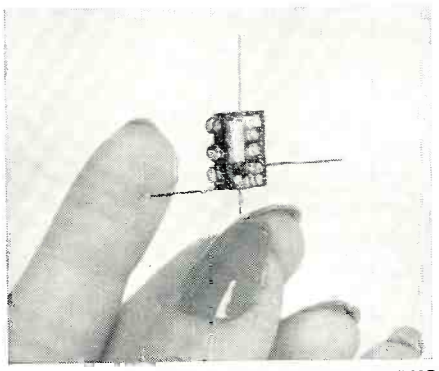
Write the firm direct for a copy of this publication. —30—

SUB-SUBMINIATURE AMPLIFIER

PHILCO'S Government and Industrial Division has demonstrated a sub-subminiaturized amplifier, which has a gain of 70 db and a power gain of 10 million, using its M-1 alloy junction transistors. The transistors themselves are so small that 20 can be placed on a dime!

The amplifier, below, constructed for demonstration purposes, is about the size of an ordinary pencil eraser. The company envisions its application in guided missiles, computers, hearing aids and other equipment where size and ruggedness are design factors.

The M-1 is a "p-n-p" type and will operate on as little as one ten-thousandth of a watt. Production has already started on the transistors. —30—



to predict weather conditions if they received continuous weather reports from a much wider area. If a series of stations similar to the Bureau's marine unit were placed over wide areas of the Pacific Ocean, for example, they could give operations officers and meteorologists frequent reports, making possible a complete weather picture for the entire ocean. If moored in the Caribbean, these stations might also give warning of hurricanes as they begin to form.

The automatic station translates information from each of five weather-sensing elements into three-letter groups in continual code and transmits the coded signals on a pulse-modulated carrier frequency at about 6 megacycles. These signals can be received on standard communications receivers and compared with a decoding table which gives numerical values for each of the meteorological variables measured. A single transmission takes three minutes. During this interval six items of information are broadcast. The first transmission is a three-letter signal identifying the station. Coded transmissions follow containing information on: air temperature between — 25° and — 110° F; water temperature between 15° and 90° F; barometric pressure between 950 and 1050 millibars; wind speed from 0 to 68 knots; and wind direction oriented from magnetic north.

The vessel which carries the weather-sensing and radio-transmitting equipment is 20-feet long and 10-feet wide.

In operation, at some predetermined time after a suitable warmup period, a master timer closes the contacts that feed power to all circuits. A chronometer watch, rewound by motor at the time of station activity to insure accuracy over extended periods of time, furnishes reliable master control. When the power is applied, a program timer, which consists of a number of circular switches driven by a constant-speed motor, inserts a precision resistance into a self-balancing bridge. As the first radio signal to be transmitted is the station-identifying signal, this precision resistor, instead of one of the weather variable resistances, is the first contacted in the program timer. The resistance of a helical potentiometer at the bridge-balance point matches this resistance. On the same shaft with the potentiometer is a rotary code-selector switch that selects letters on a code generator; these letters then correspond to the value of the resistor inserted into the bridge. The code generator, a drum made up of eight metal rings insulated from each other, has the code characters machined in relief on the inner circumference of the rings. A comb-type brush contactor sweeps inside the drum, contacting the raised segments. The raised code characters designated by the selector switch, when in contact with the comb, close a key-

ing relay circuit. Then, over a 20-second interval, the transmitter is keyed in code with a three-letter group. Sending speed can be controlled by the comb speed, and a rate of five to seven signal repetitions during the 20-second interval permits even inexperienced operators sufficient time to copy the signal.

During the interval when the station is identifying itself, a resistance determined by the first of the five weather variables is connected to the bridge circuit. At the end of the identification interval, a 10-second delay ensues, while bridge balance and code selection occur. Then the first of the weather data is broadcast. While this signal is being transmitted, the next weather variable is selected, and then transmitted at the end of the first weather signal. The remaining variables are transmitted in like manner. Altogether, the three-minute transmission period contains six transmission intervals of 20 seconds duration, each preceded by 10-second balancing intervals. At the conclusion of the transmission period, the master timer contacts are broken to remove power from the equipment until time for the next period of station activity.

ELECTRONIC DIGITAL COMPUTERS that can give the geographical fallout pattern of radioactivity resulting from a nuclear explosion, have also been developed in Washington by NBS. It is believed that these computers when given the necessary weather data, together with certain information about the bomb, will assist in predicting what the distribution and intensity of radioactivity will be on the ground, after the bomb has been detonated. The problem solution is displayed on a cathode-ray tube, over which a map on a transparent backing can be laid. Radioactive intensity at any ground point up to 500 miles from the explosion can then be measured by the brightness at the corresponding point on the tube screen.

In the model built, there are two 6-foot relay racks of equipment, including power supplies and one oscilloscope. A 21-inch display oscilloscope has been mounted separately. There are about 106 tubes and 58 silicon junction diodes in the basic gear. The total power requirement is about 1500 watts.

While this is not a simulation analogue computer, it uses analogue techniques to mechanize the fallout problem. In particular, time in this computer is used for sequencing only, and has no direct significance in terms of the time variable in the original physical model.

The computer obtains the ground coordinates and radioactivity intensities of all the particles by producing continuously varying voltages proportional to the slowness of the particles and to the height intervals, by scanning these voltages over the full ranges of the variables, and simultaneously developing the corresponding fallout positions and intensities as voltages. The position voltages deflect the beam of the oscilloscope, and the radioactivity voltage modulates the intensity of the beam. The display on the cathode-ray tube then provides a map of the fallout of the radioactive dust, while the luminance (brightness) of the tube represents the total intensity of the fallout at any geographical location.

CONSTRUCTION PERMIT grants picked up during the early Spring months, with a number going to ultra-high stations, as indicated in the listing given below.

IN BELGIUM, the Ministry of Public Instruction, in collaboration with many Belgian scientific organizations, recently held an exhibition devoted to radio-astronomy. The event, it was said, heralded a new era; one that can be compared to the momentous period during the seventeenth century when the telescope was invented.

Paying tribute to the new art, Belgian scientists said that radio-astronomy is of greater interest to the man in the street that he may realize; it has provided a new vast window to the outside world.....L.W.

NEW TV GRANTS SINCE FREEZE LIFT

Continuing the listing of construction permits granted by FCC since lifting of freeze. Additional stations will be carried next month.

STATE	CITY	CALL	CHANNEL	FREQUENCY	POWER*
California	Sacramento	———	46	662-668	19.1
"	Redding	———	7	174-180	12.1
Georgia	Atlanta	———	30	566-572	69.2
Kentucky	Owensboro	———	14	470-476	20.9
Pennsylvania	Philadelphia	———	29	560-566	224

NEW CALL LETTER ASSIGNMENTS

STATE	CITY	CALL	CHANNEL	FREQUENCY
Arizona	Yuma	KYAT	13	210-216
Arkansas	Hot Springs	KSPS	9	186-192
Colorado	Montrose	KREX	10	192-198
New Mexico	Clovis	KICA	12	204-210

CALL LETTER CHANGES

STATE	CITY	CALL	CHANNEL	FREQUENCY
T.H.	Honolulu	KTCA (Formerly KULA-TV)	4	66-72

*ERP=(effective radiated power, kw.)

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SAVE ON THESE QUALITY knight-kit TEST INSTRUMENTS

5" Wide-Band Oscilloscope Kit
F-144 **69.00**

Printed Circuit VTVM Kit
F-125 **24.95**

Tube Tester Kit
F-143 counter type **29.75**
F-142 portable type **34.75**

VOM Kit
1000 Ohms/Volt
F-128 **15.95**

VOM Kit
20,000 Ohms/Volt
F-140 **28.50**

In-Circuit Capacitor Checker Kit
F-119 **11.65**

Audio Generator Kit
F-137 **31.50**

Resistance-Capacitance Tester Kit
F-124 **18.75**

High-Gain Signal Tracer Kit
F-135 **23.75**

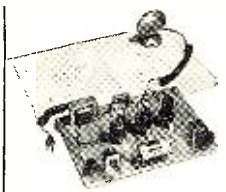
RF Signal Generator Kit
F-145 **19.75**

Resistance Substitution Box Kit
F-139 **5.95**

Capacitance Substitution Box Kit
F-138 **5.50**

FAMOUS knight-kits FOR THE HOBBYIST

"Space Spanner" 2-Band Receiver Kit
S-243 **13.95**
S-247 cabinet, **2.85**

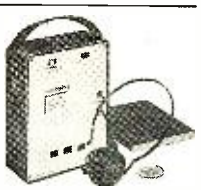


"10-in-1" Lab Kit
S-265 **12.45**

"Ranger" Superhet Receiver Kit
S-735 **14.85**

"Ocean Hopper" Receiver Kit
S-740 **10.75**

Transistor Radio Kit
S-765 **3.95**



Geiger Counter Kit
S-242 **15.95**

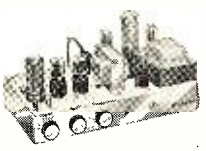
3-Way Portable Radio Kit
S-730 **19.95**

Photoflash Kit
S-244 **28.50**
S-246 AC supply, **3.40**

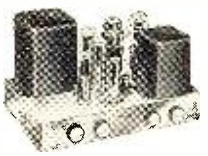
Wireless Broadcaster Kit
S-705 **8.75**

TOP QUALITY HIGH FIDELITY knight-kits

Basic 25-Watt Deluxe Amplifier Kit
S-755 **41.50**



10-Watt Hi-Fi Amplifier Kit
S-234 **22.95**



20-Watt Hi-Fi Amplifier Kit
S-750 **35.75**

LOW-COST knight-kits FOR THE AMATEUR

50-Watt CW Transmitter Kit
S-255 **42.50**

Self-Powered VFO Kit
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Code Practice Oscillator Kit
S-239 **3.95**

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Unusual Uses for Soldering Gun

By **WILLIAM P. REED**

How to use the gun as an audio signal source and to check intermittents.

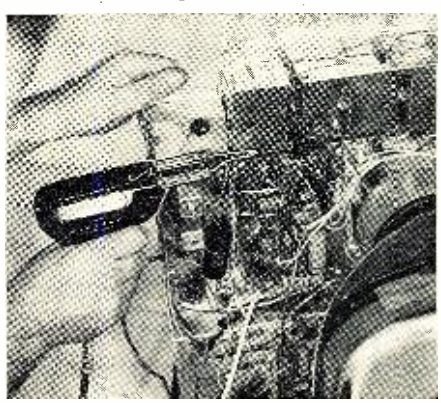
ALTHOUGH soldering is a routine operation with standard practices in every electrical repair shop, there are some specialized techniques which even the most ingenious technician may not have yet encountered. Two such unusual uses for an electric soldering gun are described here.

It is possible to use the low-frequency field at the heated tip of a soldering gun as an on-the-spot substitute signal source, thus overcoming the necessity of removing the TV or radio set under repair to a location where a signal generator is available. For example, loss of sound in a TV receiver would indicate trouble in the audio section. If the energized gun tip is held several inches from the grid circuit of the audio amplifier, the low-frequency hum of the gun should be readily audible in the loudspeaker. If the hum is inaudible or very weak, this indicates a defect somewhere in the following circuits.

Another convenient technique is employed in the loss of sound, picture, horizontal sync, or vertical sync due to a thermal intermittent. The heated gun is placed approximately ⅛" beneath any suspected component (resistor, capacitor, coil, etc.). The heat of the soldering-gun tip, by expanding the internal component wiring, produces a simulation of the thermal condition, and severs the connection to the external lead or changes the value of the component sufficiently to establish that it is the culprit. This technique is especially adaptable in tracking down component drift most pronounced in tuners or other r.f. circuits.

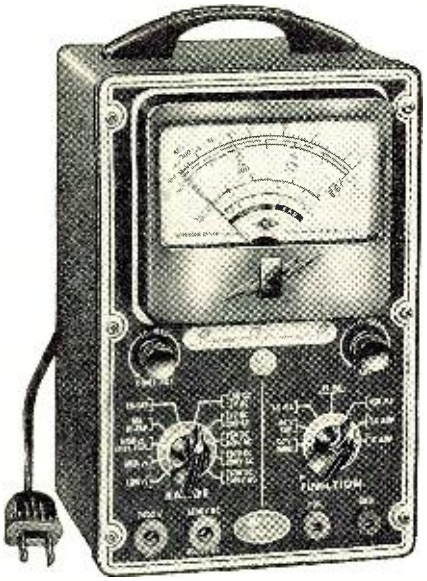
A useful hint when using a soldering gun (preferably 100-watt type) to repair printed wiring is to first press the trigger for full heat before soldering, then release the trigger and, as the gun cools, tin the tip and apply solder to the joint. Press the trigger of the solder gun intermittently for more heat. —30—

Using a soldering gun as a signal source for testing audio circuits of TV set.



Superior's new Model 670-A

SUPER ME ER



A COMBINATION VOLT-OHM MILLIAMMETER PLUS CAPACITY REACTANCE INDUCTANCE AND DECIBEL MEASUREMENTS

SPECIFICATIONS:

D.C. VOLTS: 0 to 7.5/15/75/150/750/1,500/7,500 Volts

A.C. VOLTS: 0 to 15/30/150/300/1,500/3,000 Volts

OUTPUT VOLTS: 0 to 15/30/150/300/1,500/3,000 Volts

D.C. CURRENT: 0 to 1.5/15/150 Ma. 0 to 1.5/15 Amperes

RESISTANCE: 0 to 1,000/100,000 Ohms 0 to 10 Megohms

CAPACITY: .001 to 1 Mfd. 1 to 50 Mfd. (Good-Bad scale for checking quality of electrolytic condensers)

REACTANCE: 50 to 2,500 Ohms, 2,500 Ohms to 2.5 Megohms

INDUCTANCE: .15 to 7 Henries 7 to 7,000 Henries

DECIBELS: —6 to +18 +14 to +38 +34 to +58

ADDED FEATURE:

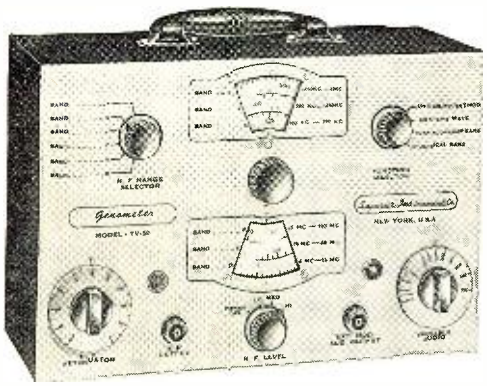
Built-in ISOLATION TRANSFORMER reduces possibility of burning out meter through misuse.

The Model 670-A comes housed in a rugged, crackle-finished steel cabinet complete with test leads and operating instructions.

$28.40 NET

Superior's New Model TV-50

GENOMETER



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- √ Bar Generator
- √ Cross Hatch Generator
- √ Color Dot Pattern Generator
- √ Marker Generator

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Single-Sideband

(*Continued from page* 54)

problems to solve particularly when the service to be rendered must be of the highest quality. Where high quality continuously stable service is to be rendered, frequency stability on the order of ±5 cps might possibly be required. When considered at a carrier output frequency of 20 mc., this stability might be difficult to attain. It would appear that some system of automatic frequency control or frequency synthesis would be necessary. There are various methods of obtaining a frequency-synthesized master frequency[7]. Good high-frequency quartz oscillating crystals are currently available with an inherent stability on the order of 1 part in 10^6 per day. This is assuming that the quartz crystal is pre-aged and in a temperature-controlled oven. If operation below 10 mc. is contemplated, the frequency stability problem assumes proportions of a somewhat minor nature. There are many services that do not operate above 10 mc. and therefore the frequency stability problem is not as severe as previously considered.

(2) A second problem facing the engineer would be the design of adequate sideband generating filters. Conventional filter design can be used for filters from the high audio frequencies through approximately 100 kc. using *LC* type networks. For frequencies above 100 kc. it will probably be necessary to consider some means such as quartz crystal filters, or magnetostriction or mechanical-type filters. There are currently available on the commercial market filters of each type which might be considered by the equipment design engineer. If the engineer wishes to design a suitable single-sideband filter he must keep in mind that the slope or skirt selectivity of the filter used must be extremely good so as to separate the low-frequency speech components on one side of the carrier from the low-frequency speech components on the other side of the carrier frequency. This means, in general, that the skirt selectivity characteristic of the filter must drop at least 60 db in one kilocycle. This is a rather strict requirement placed upon the filter but it is possible to design and build filters to do this satisfactorily.

(3) The third problem that might confront the engineer is the design of suitable audio- and radio-frequency phase-shift networks. It is suggested that the design engineer consult the original paper by R. B. Dome[8] as well as those by Saraga[9] and Luck[10]. The design engineer must select his parameters carefully and make sure that he is considering the proper audio-frequency bandpass to be transmitted. In general, the speech spectrum from 300 to 3000 cps is satisfactory for the male voice in communication service. However, in other classes or higher grades of commercial service it might be necessary to consider a wider band of audio frequencies to be transmitted. This places stricter requirements on the audio phase-shift network and makes the design procedure more complex.

(4) A fourth problem confronting the design engineer is one already mentioned, this is the heterodyning system. The spurious mixture products that appear in the heterodyning process can be of a very serious nature. If not carefully considered, the spurious mixture products can cause interference to channels which might, conceivably, be considerably removed from the desired operating frequency. Once a design is assumed and a model built, the output should be carefully checked by a continuous-coverage communications receiver loosely coupled to the generator output to determine if spurious mixture products are being radiated.

(5) The fifth problem to be considered is that of proper linear amplification. If a high quality single-sideband signal has been generated either by the filter or the phasing system the signal can be seriously deteriorated by poor design and operation of the linear amplifiers following the generator. It would be foolish to generate a superior single-sideband signal and later cause it to deteriorate by poor linear amplification. The final criterion of the single-sideband suppression is, in most cases, the degree to which the amplifiers remain linear and do not generate non-linear distortion products in the amplification system. The use of speech compression, speech limiting, or an automatic gain control system is worth considering. The use of negative feedback around the r.f. linear amplifiers is also worthwhile and has been adopted commercially by at least one manufacturer.[11] Grounded-grid amplifiers, in themselves, provide a certain amount of negative feedback as an inherent part of their amplification system and might well be worthy of consideration by the equipment design engineer. The problems facing the SSB design engineer are difficult but not insurmountable.

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(To be continued)

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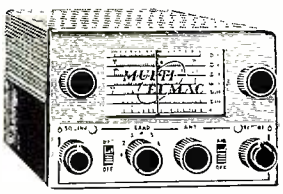

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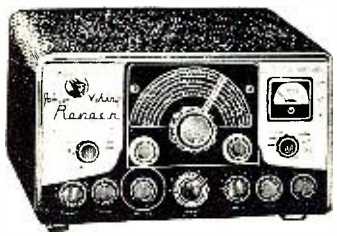

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More Notes on Electronic Ignition System

By **CHARLES ERWIN COHN**

Another author offers a means for simplifying the system originally presented in our July 1955 issue.

THE electronic ignition system described in the July and September 1955 issues of RADIO & TELEVISION NEWS is an interesting device which can improve a car's performance and contribute to economy of operation.

There are, however, additional improvements which can be made on this original circuit which will reduce the cost and increase its utilization while, at the same time, making the circuit less critical to build and adjust.

The first modification can be made in the power supply circuit, as shown in Fig. 1. Here T_1 is an ordinary vibrator power transformer which can be salvaged from any old car radio. V_1 and V_2 are two rectifier tubes which are used for "B+" and bias respectively. Some people may question the wisdom of using vacuum tube rectifiers instead of the selenium rectifiers used in the original circuit since the latter are considered more "modern," however, they are rated at only 130 volts r.m.s. input voltage and by the time enough of them are connected in series to operate within the ratings at the higher voltages used in this unit, the assembly is bulkier and more expensive than if rectifier tubes are used. The .01 μfd., 1600 volt capacitor is a buffer which was not used in the original circuit.

The other possible modification is in the triggering circuit of the thyratron. Fig. 2 shows a circuit using a medium-mu triode, V_3, with the ignition points in the grid circuit. When the points are open, the tube is cut off by the negative bias. When the points are closed, the grid is shorted to ground and a plate current flows. Then, when the points open, the tube cuts off and the rapid decay of plate current produces an inductive kick in the windings of T_2, which is an ordinary 3:1 audio transformer. This pulse, when applied to the grid of the thyratron, will, if positive, fire it. The pulse will be positive, with the transformer connections shown, for the usual run of transformers. Improper firing of the thyratron, with a blue glow appearing around the element leads below the electrode structure, is an indication of incorrect polarity. In this case, the connections to one of the transformer windings should be transposed.

The advantage of this circuit is that the pulse voltage produced is so large that reliable firing will be obtained with very large thyratron grid bias, eliminating the critical bias problem which was an objectionable feature of the earlier circuit. The bottom end of the secondary of T_2 should be connected to the full voltage of the negative supply. As previously mentioned, tube V_3 may be any medium-mu triode but, if the circuit of Fig. 1 is also employed, it would be convenient to use one section of a double-triode, such as the 6SN7 or 12AU7, using the other section, diode-connected, as the bias rectifier V_2. Then a tube such as a 6X4 or 6X5 (with plates connected together) can be used for V_1.

Another possible simplification in the original circuit is the elimination of the thermal relay which, basically, is superfluous. In case of a breakdown of the electronic ignition system, it is very simple to reconnect the conventional system. The original ignition capacitor should be retained so that it can be re-installed in case the electronic system fails. Also, if the spark gaps have been enlarged, they must be returned to the settings recommended by the factory. Of course, the likelihood of system failure can be reduced by careful assembly and the use of quality parts throughout. It is a good idea to carry spare tubes, an extra vibrator, and fuses since these are the items most subject to failure.

The only other possible use for the thermal relay specified in the original circuit is the provision for instant starting without the delay involved

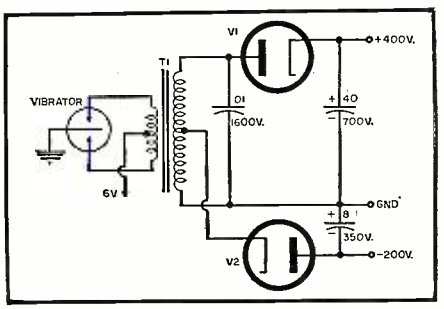
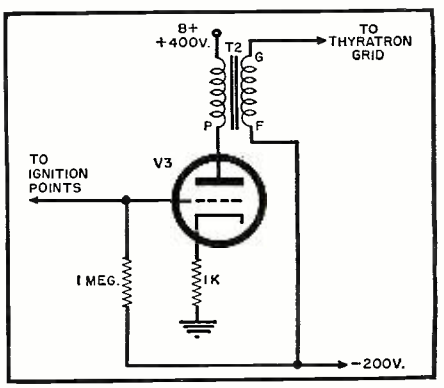
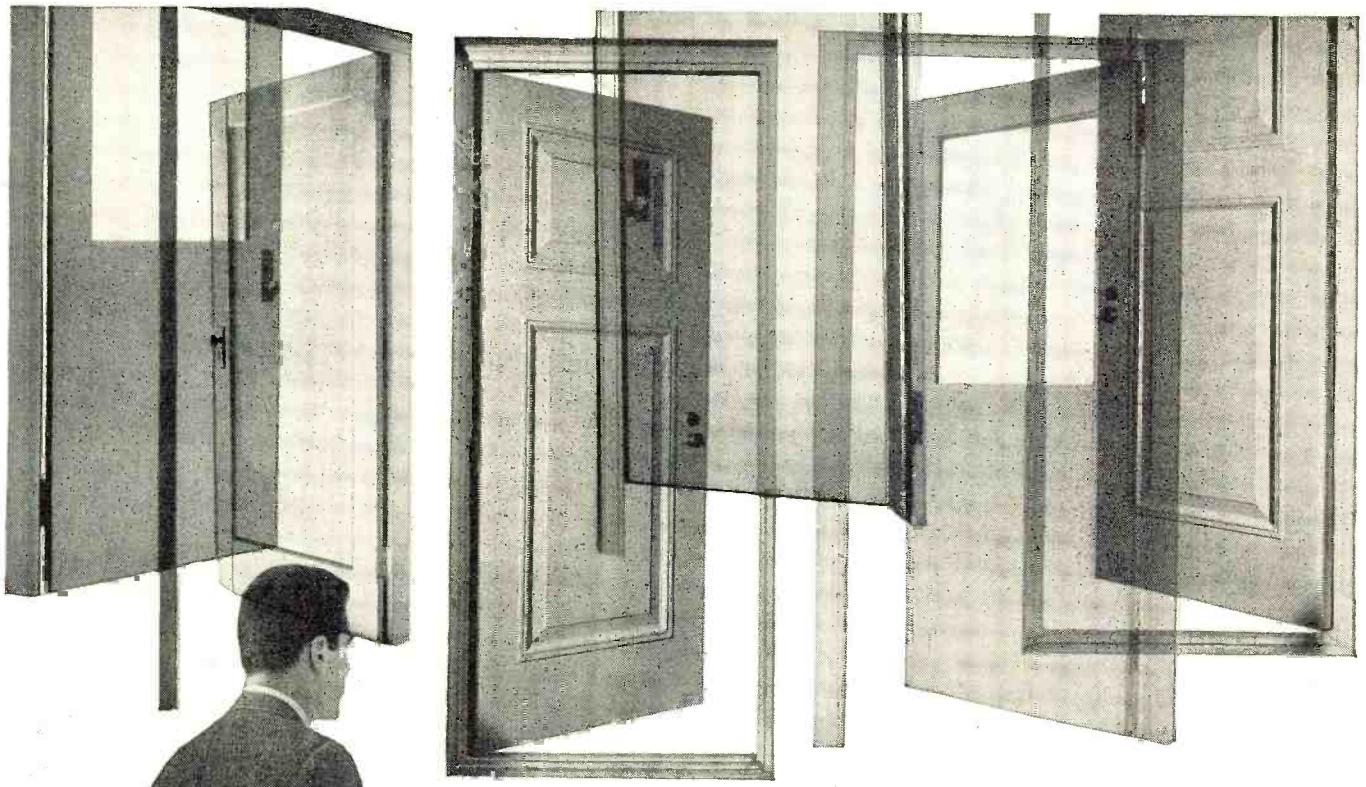


Fig. 1. Power supply circuit modification.

Fig. 2. Improvement in triggering circuit.





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with tube warmup. In this author's opinion this is completely unnecessary since he feels that the type of pampered driver who is unwilling to wait 15 seconds or so for tubes to warm up is not capable of appreciating the advantages of an electronic ignition system anyway. In addition, dependence on the conventional system for starting is a definite disadvantage. It will be explained later how the major contribution of electronic ignition is the fact that it permits increased sparkplug gap. Since starting is the most critical condition for the conventional system, such operation would lose much of the benefit of the electronic system by restricting the spark gap to that which the conventional system uses. Actually, cold-weather starting performance of the electronic system should be excellent since the filter capacitors will hold their charges and the tube cathodes their emission even after the battery voltage drops under starter load. This can be enhanced by using the largest possible filter capacitors.

In order to grasp the possibilities of this ignition system, it is necessary to digress momentarily to consider the role of the ignition system in the overall operation of the engine. First consider the mixture of gasoline vapor and air which is burned in the cylinders. There are certain proportions of gasoline to air which are ignitable, mixtures richer (more gas) or leaner (less gas) than this "range of burning" will not fire. It has been found that maximum fuel economy at cruising speed is obtained with the leanest mixture which will burn while maximum power is obtained with a slightly richer mixture. All modern carburetors have means for automatically enriching the mixture when maximum power is required so it is possible to "lean" the mixture for maximum economy without loss of power.

With these considerations in mind, it is possible to visualize the requirements for the ignition system. It happens that the mixture becomes harder to ignite as the extremes of the "range of burning" are approached. Thus, the maximum power mixture is easy to ignite with the usual spark and thus little gain in power will be noted with improved ignition. However, to ignite leaner mixtures requires longer sparks and, if a spark longer than usual is provided, then it will be possible to burn leaner mixtures and thus realize greater fuel economy.

Thus, the utilization of the electronic ignition system should proceed on this basis. The first step is to find the maximum spark gap that can be employed. This will be the longest gap that will allow easy starting in cold weather, since that is the most critical condition. With ordinary sparkplugs, another limit is imposed by the distance from the center electrode to the plug shell. Obviously, the spark gap cannot be greater than this distance.

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One or two people can both see or hear the program with the loud speaker cut-off. The hard-of-hearing can listen to radio or TV without turning the volume so high that others can't stand the noise. Comes complete with miniature phone and 20 ft. of cable. Shpg. wt. 3 lbs.

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set, the next step, which is essential for maximum benefit, is to re-adjust the carburetor to take advantage of the increased range of burning provided by the larger spark. This is done by trying leaner jets. The mixture that should be used is the leanest that will provide smooth running at steady speeds of 20 miles per hour and above. The idling mixture screws should also be re-adjusted for the leanest mixture which will provide smooth idling. If the mixtures are not "leaned" too far and if the carburetor mixture control system is working properly to enrich the mixture on heavy loads, there should be no difficulty with valve burning.

If the electronic ignition system is properly built and if the engine is tuned to take advantage of the system's capabilities, maximum performance and reliability should be obtained. —30—

VOLTAGE BOOST FOR PORTABLE

By J. WESLEY SWAUGER

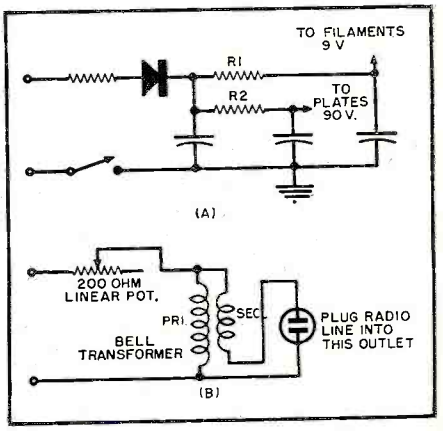
THE oscillator of a 3-way portable often fails to operate when the set is connected to a.c. if the line voltage is a little below normal. If the set is equipped with short-wave bands, it is especially sensitive to line voltage variations at the higher frequencies. The modifications described here were performed on an RCA Model 36QP radio. It will now work well from 85 to 130 volts. Other portables may be similarly modified.

First reduce the value of the dropping resistors in the power supply. See Fig. 1A (R_1, 2500 ohms, was paralleled by a 5000-ohm unit; R_2 was changed from 1800 ohms to 270 ohms by replacement.) Battery operation will not be disturbed since none of these components are in the circuit when the batteries are connected. With these resistance values, operation should be good to below 95 volts a.c.

Then install a 10-volt bell transformer, connected as an autotransformer, as shown in Fig. 1B, to provide another 10 volts of boost giving operation to below 85 volts a.c. (A 200-ohm potentiometer is inserted in the circuit to protect the tubes when line voltage is normal. Only about two-thirds of its range is needed for protection up to 130 volts a.c.)

In many areas and for many sets only one of these methods may be sufficient. —30—

Fig. 1. Two voltage boosting methods.



LIFETIME GUARANTEED TUBES

BRAND NEW

PICTURE TUBES

- RCA Licensed
- One Year Unconditional Guarantee

Type	Price	Type	Price
10BP4	$11.90	17BP4	$20.63
12LP4	$14.38	19AP4	$24.81
14BP4	$16.86	21AP4	$28.79
16RP4	$19.38	21EP4	$28.79
16LP4	$19.38	24AP4	$42.50

Picture Tubes shipped F.O.B. Harrison, N. J.
Above types are most popular. However, you may order any equivalent size at the same price.

NEW INDOOR ANTENNA

Both UHF and VHF. Brings better reception than most outdoor antennas. Use on top of TV.

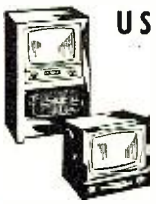
List Price $9.95

Your Price

Lots of 3 $3.29

$3.99 each

USED TV SETS



Picture Tube Guaranteed To Work!

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- RCA
- Philco
- GE
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- Zenith
- Capehart
- Others

10" SET
Table Model . . . $16.95
Console $19.95

12" SET
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14" SET
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Console $31.00

16" SET
Table Model . . . $32.00
Console $34.95

17" SET
Table Model . . . $37.00
Console $39.00

All prices F.O.B. Harrison, N. J. Prices on request for 19", 20", 21" and 24" sets.

LOOK WHAT YOU GET FREE!

FREE BONUS BOX With Every $25 Order

- 1 RCA Cheater Cord
- 10 Assorted resistors
- 10 Assorted 2 color "blank" tube cartons
- 1 6BQ6GT tube
- 1 6AU6 tube
- 1 6CB6 tube

FREE CLOCK RADIO

With Every $125 Purchase Within 30 Days

Wakemaster clock radio with famous Sessions clock movement wakes you to music or alarm. May be purchased outright from MAJOR BRAND for $17.95. In ivory or rust.

FREE GIFT CERTIFICATE* worth $5 toward the purchase of any of our merchandise on future orders will be sent with any order of $50 or more.

* Free Gift Certificate cannot be used to obtain another certificate unless order is $55 or more.

HERE'S HOW LIFETIME GUARANTEED TUBES SAVE YOU MONEY!

- We Guarantee to Replace Tubes Labeled MAJOR BRAND Forever
- Each Tube Individually Boxed and Guaranteed
- Over A Half Million Tubes Always In Stock
- Immediate Shipment
- Free Postage On All Orders With Full Remittance
- There are fewer "call backs"
- There are no "out of date" tubes
- "Peak Performance" testing in our fully equipped Testing Department before shipment guarantees quality

0Z4	.43	6A7	.57	6K6GT	.37	12AV6	.35
1A7GT	.43	6A8	.45	6K7	.39	12AV7	.67
1A7G7	.43	6AB4	.43	6K8	.65	12AX4GT	.65
1B3GT	.65	6AC7	.67	6L6	.68	12AX7	.58
1C5GT	.41	6AF4	.79	6L7	.42	12AZ7	.63
1D5GP	.43	6AG5	.50	6N7	.60	12B4	.68
1E7GT	.41	6AG7	.69	6Q7	.40	12BA6	.46
1G6GT	.41	6AH6	.69	654	.40	12BD6	.48
1H4G	.43	6AJ5	.70	65A7	.45	12BE6	.46
1H5GT	.47	6AK5	.54	65C7	.48	12BH7	.60
1J6GT	.47	6AL5	.39	65G7	.41	12BY7	.65
1L4	.45	6AQ5	.46	65H7	.43	12BZ7	.61
1L6	.55	6AR5	.46	65J7	.43	12CU6	.95
1LA4	.57	6AS5	.48	65K7	.45	125A7	.45
1LA6	.47	6AS6	1.70	65L7GT	.55	125J7	.45
1LB4	.57	6AS7G	2.19	65N7GT	.55	125K7	.45
1LC5	.49	6AT6	.39	65Q7	.39	125N7GT	.56
1LC6	.47	6AU4GT	.65	65R7	.42	125Q7	.37
1LD5	.57	6AU5GT	.59	65S7	.41	125R7	.45
1LE3	.57	6AU6	.42	6T4	.95	12V6GT	.45
1LG5	.57	6AV5GT	.65	6T8	.68	12X4	.37
1LH4	.64	6AV6	.39	6U8	.75	14A7	.42
1LN5	.47	6AX4GT	.60	6V3	.80	14B6	.38
1N5GT	.50	6AX5GT	.57	6V6GT	.46	14Q7	.50
1R5	.50	6B4G	.52	6W4GT	.39	19BG6G	1.15
155	.42	6B8	.69	6W6GT	.53	19T8	.65
1T4	.50	6BA6	.47	6X4	.34	24A	.39
1U4	.47	6BA7	.58	6X5	.34	25AV5GT	.78
1U5	.42	6BC5	.47	6X8	.73	25BQ6GT	.78
1V2	.65	6BC7	.80	6Y6G	.55	25L6GT	.47
1X2	.61	6BE6	.45	7A4	.45	25W4GT	.43
2A3	.55	6BF5	.40	7A5	.53	25Z5	.37
2A5	.57	6BF6	.50	7A6	.45	25Z6	.37
2A7	.55	6BH6	.50	7A7	.43	27	.25
3A4	.51	6BJ6	.47	7A8	.45	35A5	.46
3A5	.50	6BK5	.68	7B5	.39	35B5	.50
3AL5	.45	6BK7	.76	7B6	.42	35C5	.50
3AU6	.46	6BL7GT	.75	7B7	.41	35L6GT	.47
3BC5	.54	6BN6	.58	7B8	.45	35W4	.34
3BN6	.70	6BQ6GT	.78	7C4	.39	35Y4	.34
3CB6	.52	6BQ7	.78	7C5	.42	35Z3	.39
3Q4	.46	6BY5G	.58	7C6	.43	35Z5GT	.34
3Q5GT	.57	6BZ7	.88	7C7	.45	37	.29
3S4	.47	6C4	.37	7E5	.45	50A5	.46
3V4	.47	6C5	.35	7E6	.55	50B5	.50
4BQ7	.89	6CB6	.49	7E7	.70	50C5	.50
4BZ7	.95	6CD6G	1.15	7F7	.59	50L6GT	.43
5AW4	.75	6D6	.48	7F8	.70	75	.42
5BG6G	1.15	6E5	.44	7G7	.75	76	.42
5J6	.63	6F5	.37	7H7	.50	77	.38
5T4	.69	6F6	.38	7J7	.75	78	.38
5U4G	.43	6G6	.40	7K7	.75	80	.34
5U8	.74	6H6	.38	7L7	.75	84/6Z4	.44
5V4G	.59	6J4	1.79	7N7	.50	117L7GT	1.09
5Y3	.31	6J5	.39	12AT6	.37	117N7GT	1.09
5Y4G	.36	6J6	.47	12AT7	.66	117P7GT	1.09
5Z3	.41	6J8G	.85	12AU6	.41	117Z3	.35
				12AU7	.53	117Z6GT	.63

ALL PARTS SHIPPED F. O. B. FROM HARRISON, N. J.

WE PAY ALL POSTAGE on orders shipped in USA, Territories and APO's. Send only purchase price of merchandise. Please include approximate postage on foreign shipments. All orders subject to prior sale. Add 25c handling on orders under $5.00. Quantity users write for special discount.

Write for FREE Tube List—Order Blank—and FREE Sample Tube Carton. We want Y-O-U on Our Mailing List!

SPECIAL SURPRISE

Mention where you saw our ad and we will send you FREE three 6SNGT's with any order of $10 or more.

Write Dept. RN-6

MAJOR BRAND TUBE CO.

Romano Bldg. ESsex 4-1106 Harrison, N. J.

Buying a Loudspeaker?

(*Continued from page* 58)

variety of units using either or both of these features. The purpose of the bass reflex and other types of enclosure, as well as of folded horns, is to achieve extended low-frequency response with a uniform characteristic. Such units, correctly designed, can give extremely flat frequency response and clean reproduction of all frequencies considered individually. The enclosure must be used with the type of unit for which it is designed for good results, because the whole thing is designed as an entity.

The important thing to listen for in judging performance is integration of the sound, to make sure one doesn't get the impression that the low frequencies are being filled in from the floor, while the high frequencies get squirted at you from somewhere else. Some of these units do extremely well in this regard, especially in view of the problems presented by this kind of construction. On the other hand, some, while they give a good frequency response, sound very unnatural.

Single Channel or Stereophonic

If you are going for a single-channel system, that is, you want to play simple single-channel recordings of the normal type, then one loudspeaker system is going to be responsible for all the sound that you hear. All the problems discussed in the foregoing are based on the single-channel idea of reproduction because, to date, this is the most popular and most readers will probably be going out to buy this kind of system.

On the other hand, a stereophonic system offers certain advantages, although the program material is apt to be more costly, because whichever kind we buy, we have to pay for two channels of recording instead of only one, and the system is bound to be more costly, because we have to buy two sets of amplifiers and two loudspeaker systems. But we do have certain advantages in the choice of loudspeaker systems.

When using a stereophonic system we do not have to consider the larger units that are required to give an effective "spread" for reproduction of orchestral, and large-area-source type program material, in a single-channel reproduction. We can concentrate on the type of loudspeaker that by itself gives reasonably good point-source representation, and rely on the fact that we have two of them operating on the stereophonic principle to change the character of the program material according to the subject.

A solo source is usually presented with more stress over one of the loudspeaker units using the other one merely as the background. This means that the point-source effect of the individual speaker unit comes into play and gives effective solo presentation. When a wide spread is required for full orchestra or organ music, the two units go into action at full volume and with slight difference in material presented over each, so as to give a real sense of breadth in the reproduction.

So, while stereophonic reproduction raises the cost in every other section of the system, it may help us somewhat in making a speaker selection (except that we need two).

A Few Words About Budget

In this article we have not mentioned the matter of cost, merely the methods of construction and the points to look, or rather listen, for, but some readers are bound to want to know, "Can I get a good unit on my budget?" The answer is, most certainly, "Yes."

There are many good loudspeakers on the market and you can shop around amongst the low-price units to find one that will give you satisfaction.

At the same time, however, you will find units in the higher price bracket that will certainly give *better* reproduction than the best of the low-cost ones.

If you are looking for a low-cost unit, don't try the dual, triaxial, or multi-unit systems, go for a single unit that is really good.

If you are prepared to pay quite a little more and get something that is still better, then go in for one of the more complicated systems. Listen to as many kinds as you can, and be careful in making your selection to be sure that it fulfills all your requirements to the satisfaction of your own ears.

Or, if you feel you want to go for a really good system, but have not the money to get it all at once, it may be a good idea to decide on your ultimate, then buy it in easy stages. First get the middle range unit, which will at least give good reproduction of the most essential part of the spectrum, then later the woofer and tweeter units, with the necessary crossovers. At least one manufacturer has a scheme such as this worked out to help you.

Again, don't trust someone else's judgment, not even mine—we all have different ears! —30—

"ANNUAL GABFEST"

THE Uniontown Amateur Radio Club has scheduled its Seventh Annual Gabfest for Saturday, June 30th beginning at noon.

The affair will be held on the Club grounds on the Old Pittsburgh Road, just off Route 51, about 2 miles north of Uniontown, Pa.

A program consisting of an auction and sale of radio gear, a raffle, horseshoe pitching, and movies has been planned by the committee.

Snacks will be available at the Club House. Registration is $1.50 and full details on the affair are obtainable from the Club (W3PIE), P. O. Box 849, Uniontown, Pa.

The club will welcome visiting hams. The group's transmitters will be on the air to help guide guests to the site of the hamfest. —30—

Sales Aids

HI-FI DEMONSTRATION SYSTEM

A complete high-fidelity demonstration system especially designed to help record dealers demonstrate and sell more hi-fi records has been announced by *Gray Research and Development Co.* of Manchester, Conn.

The full tonal range system is available on a liberal, long-term rental-purchase plan. The system consists of the company's "Viscous damped tone arm," turntable, amplifier, preamplifier, and speaker.

Details on this demonstration unit are available from the company.

* * *

"TUNE-UP" PROMOTION

The Tube Department of *General Electric Company*, Schenectady 5, New York is sponsoring a nation-wide television and radio tune-up program to provide new customer contacts for service dealers who sell the company's tubes.

The local-level tune-up plan, a part of the company's "Circus of Values"

sales program, is being augmented by a series of color ads in consumer publications which will run through June.

Using the national ad as an "eye-opener," the local dealer may tie in his own shop by the use of local promotions such as newspaper ads, radio spots, TV commercials, and direct mail circulars. These sales and promotion aids are being made available through the firm's tube distributors.

* * *

CAMPAIGN SPECIAL

Zenith Radio Corporation of Chicago is making the 1956 Presidential campaign the focal point of a hard-hitting sales drive designed to reverse the normal mid-summer slump in television receiver purchases.

The campaign, dubbed the "Presidential Special," features display materials and ads which tie-in with the election year theme. Window and counter card

display pieces are printed in red, white, and blue with "X in the Square" accents familiar to voters. Tying merchandise to election year balloting, slogan lines urge prospective TV set buyers to "Vote for Quality," etc.

In addition to the store promotion package of banners and cards, dealers will receive a collection of 30 newspaper ad mats, ranging all the way from one and two columns in width to full-page size.

* * *

PHILCO TV ANTENNAS

Philco Corporation, Philadelphia, Pa. has adopted an all-color package with bold surface design and selling messages to boost product identity of its outdoor TV antennas.

With blue printing on solid yellow background, the box can be used for

store display. One of the first all-color packages for such merchandise, the corrugated box is made by *Stone Container Corporation.* Lightning flashes and angular patterns symbolize the "Fast Lock" feature of the aluminum antenna. Pertinent descriptive material and unit identification data is also carried on the container.

* * *

MONARCH CHANGER PROMOTION

Discus Corporation, 225 West 34th Street, New York, N. Y. has launched and intensive, full-scale advertising and promotion program on the BSR "Monarch" automatic record changer.

Both consumer and dealer media will be used extensively throughout the year and point-of-purchase material and other dealer sales aids will be made available by the firm.

Write the company for full details on the program.

* * *

PORTABLE PROMOTION

Zenith Radio Corporation will use two thousand billboards and color ads in national magazines to launch its new line of portable radio receivers.

The program will be augmented by direct mail, window displays, newspaper ads, and point of sale features. At the retail level, dealers will be able to utilize a unique window display that can be tailored to fit almost any space requirement. In full scope, the windows will display seven banners at the glass, each banner streamer ties to seven corresponding sections of the display against the background or at window floor level. The window can be arranged as a full-width, three-section display, showing as many as 20 *Zenith* portables or can be narrowed down to a single display panel mounting three sets.

* * *

SERVICE DEALER POSTER

Sprague Products Company, North Adams, Mass. is now making available copies of its recent advertisement, *"Sprague* Salutes the Independent Service Dealer," in the form of a window-sized blow-up.

The two-color poster, measuring 22" high by 17" wide, is printed in orange and black on stiff paper for mounting on window fronts or properly backed easels.

Service dealers may obtain a copy of this poster from the company's distributors or by writing the company direct on their letterhead. Ask for poster RP-15.

* * *

A "DO TOUCH" DISPLAY

Webster Electric Company of Racine, Wisconsin is now distributing a three-piece merchandising display which is unique in that the customer is invited to try out the firm's "Retract-o-matic" tone arm instead of obeying the usual injunction, "do not touch."

Shipped flat, the display made of heavy-duty cardboard unfolds with a flap coming down out of a rectangular window which frames the product name and sales message. A 45 rpm record fits securely over a raised section of the flap and the tone arm sets into an aperture at the back of the flap to achieve the effect of a record player.

The tone arm can be dropped, pushed down, or across the record to demonstrate the "Retract-o-matic" feature. A pocket on the flap holds literature.

The display is being furnished without charge with each order for 12 tone arms.

* * *

BATTERY REPLACEMENT GUIDE

Ray-O-Vac Company, 212 E. Washington Ave., Madison, Wisconsin is now offering a new dual-purpose radio battery replacement guide and comparative slide chart.

Designed to end the problems of conflicting and confusing radio battery numbering systems, the slide chart shows the company's new radio battery numbers (NEDA number system), the old *Ray-O-Vac* numbers, and numbering systems of the other major radio battery manufacturers. In addition, the

comparative guide enables anyone to immediately note the type of battery at a glance.

The chart itself is made of quality materials and riveted construction with a bead chain holder so that it can be fastened to a floor, counter, or wall merchandising display or hung near the dealer's counter or display shelf.

* * *

NEW TUBE "DRESS"

RCA's Tube Division has begun packaging its aluminized "Silverama" picture tubes in striking new cartons which feature larger, easy-to-read tube type numbers on the new labels which are topped by the red-and-white *RCA* symbol set against an aluminized background.

The labels have been designed to speed up distributors' inventory movement by providing faster identification of product, brand, type and classification.

* * *

RAY-O-VAC LABEL DESIGN

Ray-O-Vac Company, 212 E. Washington Ave., Madison, Wisconsin has introduced a striking new label design featuring a diamond motif that ties in with the company's 50th anniversary celebration this year.

This unusual package design was designed with an eye to attracting the attention of the vast consumer market for portable radio batteries. Increased emphasis on new packaging, point-of-sale, and merchandising aids is designed to be of direct benefit to dealers.

The new label retains the firm's red, yellow, blue, and white colors and carries the NEDA battery numbering code.

* * *

"CRASH TEST" PROMOTION

The Radio and "Victrola" Division of *RCA Victor* is using dramatic stroboscopic photos and filmed commercials to promote its line of portable radios.

The "crash test" photos and films, showing an "Impac" portable radio case surviving a drop from a helicopter, emphasize the non-breakable feature of these plastic cases which are guaranteed for five years. These cases are being used on five of the six new portables in the *RCA* line.

Full-color, full-page ad insertions are being carried in mass-circulation publications emphasizing this theme. The films will be carried on nationwide TV shows and the test will be described on company-sponsored radio programs.

* * *

SHADOW BOX DISPLAY

A new "Price Cut" shadow box display for point-of-purchase use has been announced by *Minnesota Mining and Manufacturing Co.,* Dept. A6-78, St. Paul, Minn.

The 11" x 16" three-dimensional display calls attention to the new low price of "Scotch" brand No. 111 magnetic tape with the legends "Price Cut" and "Save $2.00." It is made of heavy cardboard, printed in two colors and is designed either for shelf or counter-top use.

Dealers and distributors of "Scotch" brand magnetic tapes can obtain the new display free from the firm's salesmen or by writing the manufacturer direct. —30—

A 50-Watt Amplifier

(*Continued from page 63*)

loading such as is caused by speaker cables. Even as little as 500 $\mu\mu$fd. of capacitance across the speaker leads may throw these amplifiers into oscillation.

In this design high-frequency ringing is practically eliminated by proper choice of capacitor across the feedback resistor. On a loudspeaker load, there is a minimum ring or overshoot on square waves to 20 kc. Even the new electrostatic tweeters with their high capacitive loading will not deteriorate high-frequency performance nor will long leads to the loudspeaker introduce instability.

At low frequencies the fact that there is only one stage with coupling capacitors leads to a wide margin of stability. In addition, the output transformer has about 200 henrys primary inductance so that its response is flat down to 6 cps. This insures low phase shift at low frequencies, which makes it practical to maintain low-frequency response of the amplifier to below 10 cps and still have complete low-frequency stability. Some designs gain stability by restriction of bandwidth. That has not been done with this circuit.

It is worth mentioning that the design of an output transformer to be used in a screen loaded circuit is quite critical since capacitive transfer between windings can produce multivibrator or oscillator action in the coupling from plates to screens.[3] This is avoided in the present design by using four primary sections each of which has the same proportion of screen load impedance. A unique para-coupled winding arrangement gives tight coupling between all sections without capacitive transfer between windings. As a result, low leakage reactances are obtained without high interwinding capacitances, and both bandpass and stability characteristics are improved.

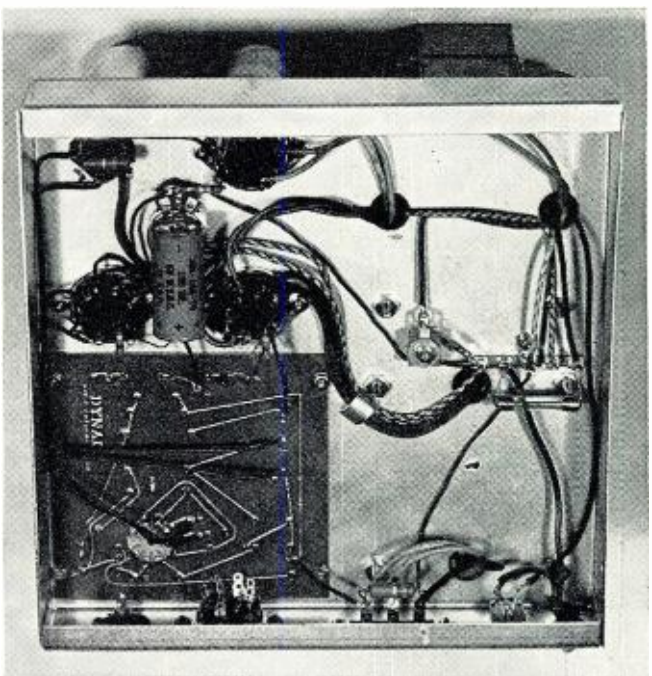
The Power Supply

The power supply is quite simple, utilizing capacitor input with resistive filtering. Substantial decoupling is included to preserve the low-frequency stability characteristics.

The general configuration and the time constants of the power supply have been integrated to give instantaneous recovery on overload signals. High level signals are neatly and symmetrically clipped when their peak power exceeds 100 watts, and concurrent program material is unaffected. In the listening tests which accompanied the design work, it was observed that some amplifiers collapse temporarily on overload, and their power capabilities are substantially less on musical material than on steady-state signals—another lack of correlation between dynamic and steady-state test methods.

Amplifier Performance

The amplifier's performance in terms of conventional steady-state measurements is illustrated in Figs. 1 and 2. The intermodulation distortion (40 cps and 7 kc. mixed 4 to 1) shown in Fig. 1 is extremely low, due to the linearity of the output stage and transformer augmented by 20 db of feedback. The response curve (Fig. 2A) is of interest as it shows that there is no peaking of response outside the audio band and also that response within the band is flat at all levels up to full output. The curve of Fig. 2B shows harmonic distortion at 50 watts of output, over the entire audio spectrum. Most harmonic distortion measurements are shown for 1000 cps where distortion is at a minimum.



Under chassis view of the commercial version of amplifier. The printed circuit assembly, shown at lower left, can be omitted in favor of individual parts if the home constructor duplicates the circuit using his own components.

This socket never had it so good...

. . . It is about to hold an AMPEREX Type 6CA7/EL34, one of a complete line of new, specially designed tube types for high-quality audio applications.

Used in existing circuits, with minor bias changes, the 6CA7 gives higher power output with lower distortion because of its true pentode linearity. In circuits specifically designed to take advantage of its unusual capabilities, the 6CA7 sets a new high standard of performance. Two 6CA7's in push-pull will deliver up to 100 watts.

Most of the tubes in this newly developed AMPEREX 'preferred' line replace conventional types with an appreciable improvement in performance . . . each offers the unbeatable combination of ultra-advanced design by Philips of the Netherlands *plus* up-to-the-minute research for American applications by AMPEREX, leader in communications and industrial tubes since 1927. Many of the world's leading manufacturers of high-fidelity equipment are already designing and building complete amplifier systems with *every* tube an AMPEREX 'preferred' type!

POWER AMPLIFIER TYPES

6CA7/EL34 – Exceptionally linear high-power output pentode with low-voltage drive requirements. Up to 100 watts in push-pull.

EL84 – Unique AF power pentode combining high gain and linearity with 9-pin miniature construction. Up to 17 watts in push-pull.

VOLTAGE AMPLIFIER TYPES

EF86 – High-gain pentode with exceptionally low hum, noise and microphonics.* Particularly suitable for preamplifier and input stages. Equivalent to the Z739 and the 5879.

ECC81 — Medium-gain dual triode with low hum, noise and microphonics. Replaces the 12AT7 without circuit changes.

ECC82 – Low-gain dual triode with low hum, noise and microphonics.* Replaces the 12AU7 without circuit changes.

ECC83 – High-gain dual triode with low hum, noise and microphonics.* Replaces the 12AX7 without circuit changes.

RECTIFIER TYPES

EZ80 – Indirectly heated, full-wave rectifier with 6.3 v, 0.6 amp heater, 90 ma output capacity and 9-pin miniature construction.

EZ81 – Indirectly heated, full-wave rectifier with 6.3 v, 1 amp heater, 150 ma output capacity and 9-pin miniature construction.

GZ34 – Indirectly heated, full-wave rectifier with 5 v, 1.9 amp heater and 250 ma output capacity. Octal base. Replaces the 5U4G without circuit changes with the advantage of lower tube voltage drop because of the unipotential cathode.

**Maximum levels specified and guaranteed*

Detailed data, circuits, application information, as well as engineering assistance are available to manufacturers and professional designers of electronic equipment from the AMPEREX Semiconductor and Special-Purpose Tube Department.

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while at frequency extremes distortion is higher. In this amplifier, the increase in harmonic distortion at 20 cps and 20 kc. is very low, and harmonic distortion is kept below 1% over the entire band even at the 50 watt level. This means that response at full power is essentially distortion free—a condition rarely met in audio amplifiers even when they exhibit flat response at full power.

It is difficult to depict the performance specifications which are related to good transient performance. As shown in Fig. 3, the square-wave performance from 20 cps to 20 kc. exhibits minimum ringing while preserving fast rise time. This does not indicate, however, how the amplifier responds to non-recurrent signals.

Fig. 4 shows two oscillograms which evaluate the performance of the circuit under dynamic transient conditions. Fig. 4A shows a d.c. pulse from a 1.5 volt battery—a signal which drives the amplifier close to overload. The initial impulse is the switching in of the battery, and the second trace represents removal of the voltage. Both impulses are instantaneously damped on the first half cycle without transient disturbances.

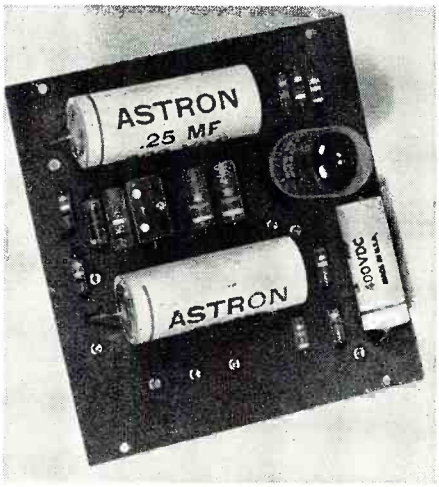
Fig. 4B is an even more rugged test of transient performance. This shows switching from 40 watts of 1000-cycle signal to 6 watts. This drastic change in amplitude has absolutely no effect on performance, and there is no surging or bouncing which can be observed.

These tests are first approximations to what happens under musical listening conditions. They show that the amplifier can handle suddenly changing high level material without violent voltage swings, grid blocking, or other actions which are involved in poor response to large transient signals.

The power output of the amplifier is adequate for practically any home installation, even with low efficiency speakers. Since power is undistorted at frequency extremes and momentary overloads have minor effect, the useful loudness levels can be pushed up to higher intensity than can be obtained from some amplifiers of nominally higher power rating based on mid-band sine-wave testing.

It is as difficult to quantify the reproducibility characteristics of a circuit as it is to specify its transient performance. This amplifier, as a commercial kit, includes a printed circuit panel with all the wiring up to the grids of the output stage. This eliminates a major source of variability and insures reproducibility. However, the stability margin of the circuit is such that almost any direct layout can be used without danger of motorboating or high frequency oscillation. Within the normal 10% tolerance range of components, the IM distortion will not exceed 1% at 50 watts. With parts trimmed for minimum distortion, the IM can be made as low as .25% at 50 watts.

Thus the circuit, in addition to con-



Top view of the printed circuit board used in the amplifier showing the location of several important components.

ventional distortion and frequency specifications, exhibits outstanding transient performance, adequate wideband power capability, and reproducibility. These are the criteria sought for listenability.

Listening Tests

The author has always insisted that the acid test of an amplifier is the listening test. Even the most superlative specifications do not guarantee that the amplifier will sound well. Therefore, extensive listening tests were made on this circuit through various stages of its development and after the design was frozen. These were made on the basis of comparisons with other amplifiers of high quality using a variety of speaker systems with AB switching panels. In addition the amplifier was put to the test of liveability—use in normal home conditions of various individuals for periods ranging up to six months. Reactions of listeners confirmed the design premises of the amplifier as most testers agreed that the new amplifier *sounded better*. These listener reactions agreed in several directions:

"Dirty" program material seemed to be cleaned up. The passages on records which had appeared to be slightly overcut now seemed smoother and less raspy. This was interpreted as meaning that those high level passages required the added power and transient response of the new amplifier.

The mid-band "garbled" effect which is frequently associated with speaker systems which have crossover networks was diminished with the new circuit. This apparently stems from the fact that the method of operation of 6CA7/EL34's does not deteriorate performance on a complex reactive load to the same extent as occurs with conventional circuitry.

Heavy low-frequency passages had better definition. This can be attributed to several factors: greater power capability, low distortion at the low-frequency end of the band, and complete low-frequency stability. Even on speakers of nominal 10 watt rating,

the extra clarity of the bass was apparent.

High frequencies were smoother and had less coloration. Some of the test group were not aware of this until *after* they had lived with the new amplifier, grown accustomed to it, and tried to return to their previous units. Then the old favorite sounded rough and screechy by comparison. This is an interesting psychological phenomenon which shows up in acoustical testing—change for the better is not as apparent as change for the worse. The irritation factor is more obvious in retrogressive change while improvement does not seem to make as great a difference.

Another interesting phenomenon which the listening comparisons revealed was that the high stability circuit was generally operated at higher and more realistic volume levels than comparison equipment. When intensities were high, the comment "turn it down" was not heard for the new circuit though it was often applied for the other models. It has been noted before that both wider bandwidth and higher powers are accepted only when accompanied by lower distortion, non-peaked response, and generally cleaner sound. It seems evident that the specific performance qualities of this amplifier produce less listener irritation which permits higher level use without corresponding listener fatigue.

All in all, some very reluctant testers were converted to the new arrangement even though they had approached the listening tests doubting the possibility that such a simple amplifier could be as good, much less better, than the amplifiers which they were using. These reactions prompt the author to repeat the same thought as he expressed in 1951 when describing the first "Ultra-Linear" amplifier:[4]

"For sheer listening pleasure this amplifier represents the best that can be achieved at the present state of the art. Others who have had the opportunity to hear and try the circuit agree with this; and these beliefs will not be shaken until something comes along which *sounds* better, or at least sounds as good and can be built for lower cost."

As pointed out, this power amplifier can be easily duplicated by the home builder. Any of the special components are available direct from *Dyna Company*, 5142 Master St., Philadelphia 31, Pa. For those who would rather buy the unit in kit form (the "Dynakit Mark II"), it is available from local parts jobbers or from the company direct for $69.75.

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2. *Hafler, David: "Modernize Your Williamson Amplifier," Audiocraft, January 1956.*
3. *Leakey, D. M. and Gilson, R. B.: "UL Output Transformer," Wireless World, January 1956*
4. *Hafler, David and Keroes, H. I.: "An Ultra Linear Amplifier," Audio, November 1951.*

—30—

WIDE-RANGE PHASE SHIFTER FOR FREQUENCY MEASUREMENTS

By RUFUS P. TURNER

A WELL-KNOWN scheme for measuring an unknown audio frequency in terms of a known frequency is the "spot-wheel method." In this scheme, a signal of known frequency is made to trace a circle pattern on an oscillosope screen. The unknown frequency is applied to the Z-axis input of the scope and either punches a number of holes in the circle or produces a series of bright spots on it, depending upon the polarity of the unknown signal. The unknown frequency is determined by counting the number of spots or holes and multiplying the known frequency by this number.

The circular trace is obtained through a simple phase-shift network consisting of a single capacitor and resistor. Actually, the circuit as it has been shown in previous articles has two practical disadvantages soon discovered by the reader: (1) A good circle (or any kind of circle, for that matter, which is large enough to make readings) is not obtained at very many frequencies. (2) A common ground is not possible between the instruments which are operated from the power line, and this leads to hum trouble, body capacitance effects, and various types of interaction. These factors can make the scheme completely useless at the higher frequencies.

The circuit shown in Fig. 1 overcomes these obstacles in the following ways. (1) A transformer is employed to couple in the standard-frequency signal. This permits a common ground between the standard source, unknown source, and oscilloscope. The transformer may be any inexpensive interstage unit designed to operate between a single plate and single grid. (2) By employing two capacitors and a range switch, a good, large circular trace may be obtained with standard signal inputs from 20 to 20,000 cycles. The capacitors, one 0.1 μfd. and one 1 μfd., are 200-volt tubulars. The 1 μfd. unit provides a range of 20 to 2000 cycles, and the 0.1 μfd. unit 2000 to 20,000 cycles.

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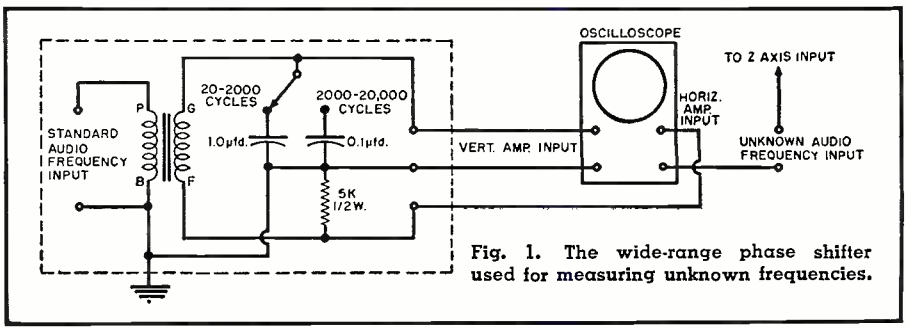


Fig. 1. The wide-range phase shifter used for measuring unknown frequencies.

Linearity Generator

(*Continued from page 59*)

grid of the left half of the 12AT7.

The right half of the 12AT7 is used as the r.f. carrier oscillator in an ultra-audion circuit. The oscillator covers the frequency range of approximately 45 to 100 megacycles (channels 7 through 13 are covered by harmonics). Plate voltage of the oscillator and modulation percentage is controlled by the "R.F. Gain" potentiometer in the plate circuit.

The left half of the 12AT7 is variously used as a video amplifier, gating tube, and plate modulator.

Power and all signal functions are controlled by the 6-position switch.

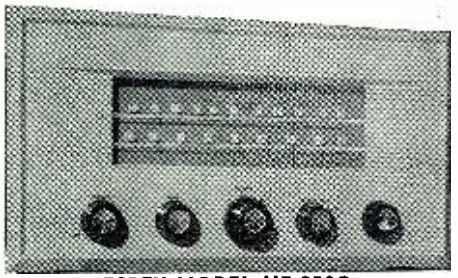
In the "Off" position, no power is applied. Heater voltage is applied to all tubes but the "B+" voltage remains off, and the 0A2 voltage regulator does not glow when the switch is in the "Standby" position.

In the "Vertical" position, and all following positions, regulated +150 volts d.c. is applied to the 6J6's and the 12AT7. The first 6J6 generates pulses which are applied through the switch to the cathode of the left half of the 12AT7. These negative-going pulses are amplified and superimposed upon the plate voltage for the r.f. carrier oscillator, modulating it and causing white vertical bars to appear on the television screen. In the "Horizontal" position the switch removes the pulses from the cathode of the left half of the 12AT7 and applies pulses from the second 6J6 to the grid. These positive-going pulses are amplified, inverted, and superimposed upon the plate voltage for the r.f. oscillator, modulating it and causing horizontal bars to appear upon the television screen.

For the cross-hatch pattern, the switch applies pulses to the cathode and to the grid of the left half of the 12AT7. These signals are amplified and combined, and the composite signal is superimposed upon the plate voltage for the r.f. oscillator, modulating it and causing a cross-hatch, or grid, pattern to appear upon the television screen. In "Dots" position, the switch retains the same functions as in the "Cross-hatch" position, and also connects the cathode of the left half of the 12AT7 to a positive point on a voltage divider. This biases the tube to beyond cut-off so that it now acts as a gating tube, conduction being possible only during application of pulses from the second 6J6 into its grid. These positive-going pulses are of a magnitude sufficient to overcome the positive bias on the cathode, allowing the tube to conduct. Since, for the duration of these pulses, the left half of the 12AT7 is able to conduct, pulses supplied to its cathode are amplified and superimposed upon the plate voltage of the r.f. oscillator, modulating it and causing white dots to appear upon the television screen. —30—

NEW 1957 MODEL 25 WATT 12" COAX SPEAKER $18.95

14 TUBE ESPEY HI-FI CUSTOM FM-AM CHASSIS



RESPONSE FROM 10-22,000 CPS—PUSH-PULL 6V6'S—TWIN TONE CONTROLS—WILLIAMSON TYPE CIRCUIT—INPUTS FOR V.R., CRYSTAL, TAPE, RADIO OR TV

SALE PRICE $84.95 LESS SPEAKER

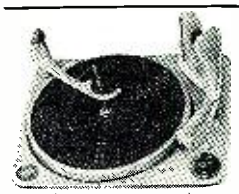
ESPEY MODEL HF-250C
WITH MONARCH UA6U CHANGER $112.95

New 1956 model, 14 tube FM-AM chassis. A true Hi-Fidelity receiver built by a nationally famous maker of fine custom chassis. Espey Model HF-250C, 14 tube FM-AM chassis with push-pull 6V6, 10 watt audio. You could spend $200 to $250 for a separate tuner and amplifier and not have the quality of this receiver. Ultra-Linear output used in Williamson type circuit gives frequency response of 10 to 20,000 cps. Output taps of 4, 8 and 16 ohms. Separate RF stages for FM and AM assure high sensitivity. Temperature compensated FM front end for minimum drift. Separate bass and treble tone controls. Pre-amp for all types of magnetic cartridges. 2nd input for crystal phono, tape recorder or TV. 3 position equalizer for accurate reproduction of all records. Built-in antennas for both FM and AM. Response plus or minus 1 db from 10 to 22,000 cps. Harmonic distortion less than 1%. Sensitivity: FM, 8 mv for 30 db quieting; AM, 75 mv for 6 db signal to noise ratio. Off-on-volume and equalizer are combined on a concentric control. Has 2 AC outlets on rear of chassis. Beautiful edge lighted flywheel inertia slide rule dial. Size; 7¾"x13½"x10" deep. Ship. wt. 24 lbs. (not mailable) Model HF-250C. Sale price, $84.95. With heavy duty Utah 15" coaxial PM speaker, both for only $99.95.

Buy either of these new Phillips "Norelco" speakers with your Espey chassis. Made by Phillips of Holland. Features Ticonal magnet, improved cone design, built-in mechanical cross-over and copper ring fitted into air gap keeps voice coil impedance independent of frequency.

Model 9760M, $54.95 list 12" Phillips speaker, response 30 to 20,000 cps, rated at 20 watts with Model HF-250C Espey chassis, both for only $99.95.

Model 9762M, $99.95 list 12" Phillips speaker, response 22 to 20,000 cps, rated at 20 watts with Model HF-250C Espey chassis, both for only $119.95.



NEW IMPORTED MONARCH HIGH FIDELITY AUTOMATIC CHANGER

WITH GOLDRING #500 VAR. REL. CARTRIDGE

SALE PRICE $29.95

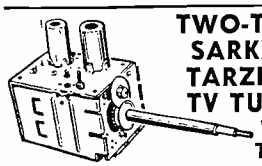
Monarch Model UA6U—new, imported high fidelity 3 speed automatic record changer. Plays 7", 10" and 12" records automatically. Intermixes records of the same speed in any order. Features a 4 pole high fidelity motor eliminating rumble and wow. Pickup automatically returns to rest and motor turns off after last record has played. Full size 10" turntable has molded rubber pallet for better record cushioning. Base size, 10⅞"x13¾". Tone arm is counter balanced to assure minimum record wear. The changer features, at no added cost the regular $9.90 net value Goldring #500 variable reluctance cartridge for the finest high fidelity record reproduction. Output 10 millivolts. Response, 20 to 16,500 cps. It requires the same input gain as popular American made variable reluctance cartridges. Model UA6U, Monarch automatic changer with Goldring cartridge, ship. wt. 15 lbs. Sale price, $29.95: Large spindle for 45 RPM records, $1.88 extra.

NEW CHROME WEBCOR CHANGER WITH RPX-050 G.E. VAR. REL. CART. $34.95

New Webcor model 1121-270, chrome plated, 3 speed automatic record changer with RPX-050 General Electric variable reluctance cartridge. Has heavy 4 pole motor. Plays all 3 speeds and all 3 sizes. Shuts off automatically after last record. Has neutral position to prevent damaging of drive wheels. Chrome plated. Size 12¾"x13½". Requires 2½" below and 6" above mounting board. Shipping wt. 15 lbs. Only a few to sell at this low price of $34.95.

G.E. VR CARTRIDGE WITH DIAMOND 1 MIL STYLUS SIMILAR TO RPX-052A $15.95

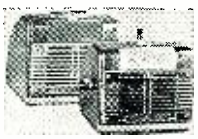
Stock No. VR-52A, genuine General Electric variable reluctance cartridge similar to RPX-052A Golden Treasure model. Has new turnabout baton stylus with plug-in 1 mil diamond and 3 mil sapphire stylus. This is the model that GE furnishes to the changer manufacturers and it has a stainless steel case instead of the gold plated case. We made a terrific purchase and pass the saving on to you. Only a few hundred to sell. A regular $23.00 value on sale at McGee for only $15.95.



TWO-TUBE SARKES-TARZIAN TV TUNER WITH TUBES

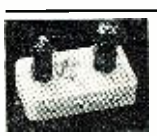
$7.95 EA., 2 FOR $15.00

No. TT-3A, 2 tube Sarkes-Tarzian 12 channel TV tuner. 21-25 mc. Popular in many makes. Ideal for general replacement use too. Has 6J6 and 6BC5 tubes. Used in CBS, Arvin, Crosley, etc. Makes a good replacement for one tube tuners. 3½" shaft. Takes SCK-2 knob set described above. Sale price, $7.95 each, 2 for $15.00 with tubes.



3-STATION MASTER SUB-STATIONS $3.95 EACH $16.95

Powerful 3 station master. Chrome plated metal case 7½" x 6" x 5", 3 tube AC-DC amp. Press-to-talk switch on top. Volume control, switch and station selector on side. Master is quiet except when call switch is pressed at sub. Use with one to 3 subs. Model MPM-A3, Ship. wt. 10 lbs., $16.95. Matching substation PM-A5, with 5" PM and call-back switch, $3.95 ea.; 3 for $10.00. Requires 3 wire intercom cable, $1.95 per 100 ft.; 500 ft. for $8.95.

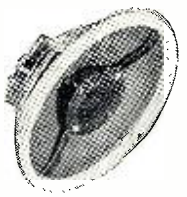


MINIATURE BROADCASTING STATION FOR MICROPHONE AND PHONO WITH CRYSTAL MICROPHONE

SALE PRICE $9.95

Sensational new model MCL-E3 miniature broadcasting station for microphone and phonograph. Can be received on any broadcast radio in the home. No wires to connect, tunes in just like a radio station. Has input jacks for crystal mike or record player. Complete with 12K8 and 70L7 tubes and instructions. Operates on 110 volts AC. Simple to operate; one control fades from microphone to record. Frequency can be adjusted so as not to interfere with local radio stations. Miniature broadcasting station, complete with crystal hand mike and instructions. Ship. wt. 4 lbs. Net price $9.95.

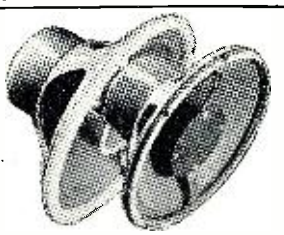
NEW 1957 MODEL



25 WATT 12" COAXIAL SPEAKER

- ★ 14½ oz. G.E. 12" WOOFER—
- ★ 3½" COAXIALLY SUSPENDED TWEETER—
- ★ BUILT-IN CROSSOVER—
- ★ ALUMINUM VOICE COIL WOOFER—

McGee's new 1957 model, GE-120XT, 12" 25 watt high fidelity coaxial PM speaker. No frills or dummy pot cover, it's all speaker value. Features a General Electric 12", 14½ oz. Alnico V woofer with aluminum voice coil and exponential, molded seamless cone. The tweeter is a specially made 1.47 oz. Alnico V, 3½" speaker which extends the high frequency response to 17,500 cps. It is electrically connected to accept only the upper register of audio. Only two wires connect this complete high fidelity speaker to any 8 ohm amplifier. Ship. wt. 8 lbs. Stock No. GE-120XT. McGee Sale price, $18.95.



McGee's Famous 12 AND 15 INCH COAXIAL P.M. HIGH FIDELITY SPEAKERS

$12.95 12-Inch Model CU-14Y

$23.95 15-Inch Model P15-CR

Model CU-14Y, 12" high fidelity coaxial PM speaker. Response from 30 to 17,500 cps. Full 6.8 oz. Alnico V magnet in the 12" woofer. Special coaxially suspended high frequency tweeter. Built-in crossover network. Only two wires to connect to your radio or amplifier. Matches 3.2 to 8 ohm output. Don't confuse this speaker with many cheap speakers that are offered. This is a fine quality speaker. Stock No. CU-14Y. Sale price $12.95 each, two for $25.00.

Model P15-CR, 15" high fidelity coaxial PM speaker. Response down to 20 cps. and up to 17,500 cps. Full 21½ oz. Alnico V magnet in the 15" woofer. Specially made, coaxially suspended 5" high frequency tweeter. Built-in crossover network. Only two wires to connect. Matches 3.2 to 8 ohm output transformer. A regular $62.50 list speaker. Model P15-CR. McGee's Sale Price $23.95.

McGee's new 15" Junior coaxial PM speaker. 15" woofer has 6.8 oz. Alnico V magnet. 5" coaxially suspended tweeter with crossover. Only two wires to connect to any 8 ohm radio or amplifier. Frequency response from 40 to 15,000 cps. Model No. M15-CR, 15" Junior coax PM speaker, Sale price, $16.95.

NEW—SMALL VOLT-OHM METER

2000 OHMS PER VOLT AC-DC WITH TEST LEADS

McGEE SCOOP SALE PRICE $9.95

2 FOR $19.50—4 FOR $37.00

New, small Volt-Ohm meter 5¼" tall, 3⅝" wide and 1½" thick. 3¼" meter. Sensitivity 2000 ohms per volt. DC volts 0 to 1000 in 5 ranges; AC volts 0 to 1000 in 5 ranges; DC current 0 to 500 ma. in 3 ranges; Resistance 0 to 1.5 megohms in 2 ranges; Decibels minus 20 to plus 16 (0db .774 volts). A thin, compact instrument small enough to fit in your service kit. A fine imported meter specially priced at $9.95 for this Radio & TV News ad. Never before have we offered an instrument value like this. Model TP-5, complete with test leads. Sale price, only $9.95. Ship. wt. 2 lbs. Special quantity price, 2 for $19.50, or buy 4 for only $37.00.

New, larger size Volt-ohm meter Model MT-1A, 6¼" tall, 4¼" wide and 2⅝" thick. 2000 ohms per volt. Similar in appearance to Model TP-5, except that it is larger, has 3½" meter and 4 resistance ranges instead of 2. Model MT-1A. Ship. wt. 2 lbs. Sale price, $12.95 each, 2 for $25.00.

NEW 6-TUBE, 12-VOLT UNIVERSAL MOUNTING AUTO RADIO WITH 5" x 7" OR 6" x 9" SPEAKER

SALE PRICE $29.99

6-TUBE, 6-VOLT WITH SPEAKER $19.99

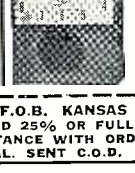
McGee makes another tremendous purchase and passes the saving on to you. This universal mounting, 6 tube, 6 volt auto radio is a full superhet with fully tuned R.F. stage. Made to sell at a much higher price, by one of America's best known manufacturers. Its very thin and compact construction lends it to a neat underdash installation in most any car or truck. Or, you can arrange a place in the dash for custom installation. (Dial requires a cut-out 5½" long x 2½" high; two control holes on 7" centers. A minimum of 6¾" depth behind dash.) When mounted underdash it extends only 2⅛" below. Overall size; 9" wide, 4¼" high and 7¼" deep. Requires no more room under your dash than an ordinary auto radio remote control head. Not intended for an exact custom panel fit, but it lends itself very well for your custom installation ideas. Can be custom fit in most late model cars and trucks. Has no built-in speaker, but is furnished with a heavy duty 6x9" speaker. This is the most popular size auto radio speaker. Tubes: 6BE6, 2—6BD6, 6AV6, 6AQ5 and 6X4. Ship. wt. 12 lbs. Stock No. AH-759. McGee's sale price, $19.99 for the radio complete with 6x9" speaker. 3 section top cowl antenna, $2.29 extra.

NEW 12-VOLT MODEL WITH SPEAKER $29.99

Model AH-1259, 12 volt universal mounting auto radio. This is the same set as pictured above (AH-759), except made for 12 volt model 1955 and 1956 cars. Stock No. AH-1259 with 6x9" or 5x7" speaker, $29.99. Stock No. RP-232X, 6x9" rear seat speaker kit for 12 volt cars, $4.99 extra.

NEW 8 TUBE 6 VOLT PUSH-BUTTON MODEL $39.95

New model SH78555, 8 tube, 6 volt universal mounting auto radio with push-buttons and 2-5x7" PM speakers. These sets were made for Hudson but due to their small compact construction they can be fit into the dash of many cars. Also, ideal for underdash mounting. Has 8 tubes with push-pull 6AQ5 output. Same general appearance and size as model AH-759 pictured above. Ship. wt. 14 lbs. Stock No. SH78555, Sale price, $39.95. Top cowl antenna $2.29 extra.



6" SESSIONS CLOCK-TIMER With Plastic Cabinet $3.95

6" Sessions Clock-Timer in plastic case 7" x 9⅝" tall, 3" deep. Was intended for a kitchen clock radio. Lower part of case was used for a small radio chassis. Lower portion has a usable space of 6¾" x 4" high and 2⅜" deep with 3" diameter hole in front. Many ways this attractive clock and cabinet could be used, such as mounting a small bell below the clock for use as a kitchen clock and timer. Clock has sweep second hand and 15 amp. 125 volt switch to turn on appliances at any pre-set time. Case available in Ivory, Green or Yellow. Stock No. MCT-63, Sessions Clock Timer with case of your color choice. Sale price only $3.95.

McGEE RADIO COMPANY

PRICES F.O.B. KANSAS CITY
SEND 25% OR FULL REMITTANCE WITH ORDER. BAL. SENT C.O.D.

TELEPHONE VICTOR 2-5092
1903 McGEE ST., KANSAS CITY, MISSOURI

AMERICA'S FINEST VALUES IN "LOW COST" HIGH FIDELITY

ECONOMY 20 WATT AMPLIFIER $22.95

Model HF-20

NEW 1956 MODEL

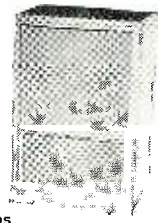
Push-Pull 6L6 Output Tubes
Response 30-15,000 CPS
Bass and Treble Tone Controls
Input for Xtal or Dynamic Mike
Input for Xtal or V.R. Phono

With CU-14Y, 12" Coax Speaker...$32.95
With P15-CR, 15" Coax Speaker...$42.95
With Imperial IV System.....$39.95
With SP-12125CR.....$44.95 With HF-33GE $69.95

A tremendous High Fidelity amplifier value. Response 30 to 15,000 cps. Electronic bass and treble boost by separate tone controls. Use this amplifier with any record changer having crystal or variable reluctance cartridge, radio tuner or high impedance crystal or dynamic microphone. 20 watts power output. Use with any 4 or 8 ohm speaker or 250 ohm line. Chassis size, 7⅜" x 10½" x 7¼" high. Complete with tubes: 2—6L6, 2—6C4, 12AX7 and 5U4G. This is a terrific value. A ready to use high fidelity amplifier at less than the cost of a kit. Ship. wt. 17 lbs. Model HF-20, 20 watt Hi-Fi amplifier. McGee's sale price, $22.95.

CONSOLE HI-FI SPEAKER SYSTEM $49.95

12" G.E. PM WOOFER—10" PM MID-RANGE—8" G.E. MODEL 850 MID-HIGH RANGE SPEAKER AND 600 CYCLE L-C CROSSOVER NETWORK.



Have Juke Box tone quality in your own home. Strictly High fidelity. Three speakers all connected to a 600 cycle frequency dividing network, so that only 2 wires feed the system from any 4 or 8 ohm radio or amplifier. A variable tone compensating control incorporated in the circuit makes brilliant highs or boomy lows to your own taste. Any amplifier that you now have will give you a much wider selection of acoustical arrangements with this speaker system. The 3-way system is shipped ready to connect to your amplifier or hi-fi radio. Equipped with a General Electric 12" woofer, an 8" famous G.E. 850 plus a 10" middle range speaker. Frequency response 30 to 15,000 cps. Take your choice of cabinets: blonde oak, walnut or mahogany. (Specify finish desired when ordering) 37" high, 24" wide and 20" deep. Ship. wt. 75 lbs. Stock No. HF-33GE. Sale price, $49.95.

Model HF-44GE, console speaker system, same as above except has a heavy duty 12" G.E. PM Model 1201, plus 8" G.E. PM Model 850, 10" mid-range speaker and 5" hard cone tweeter. Sale price, $54.95. (Specify cabinet finish.)

Model HF-55GE, super deluxe quality console speaker system, same as HF-33GE described above, except has 15", 21 oz. Alnico V magnet woofer, 10" mid-range PM speaker and Model 4401 University horn type tweeter. All 3 systems incorporate 600 cycle L-C type crossover network with variable tone compensating control. Model HF-55GE, Sale price $69.95 (specify cabinet finish).

DELUXE CONSOLE SPEAKER SYSTEM $89.50

15" UTAH WOOFER—8" GE—2 - 5" TWEETERS—CROSSOVER

New, deluxe quality High-Fidelity console speaker system. Has 15" Utah woofer with 21 oz. Alnico V magnet, 8" model 850 G.E. mid-range speaker and two Utah 5" tweeters. This is the finest console speaker system that we offer. Available in blond oak or natural mahogany finish. Cabinet size, 43" high, 31" wide and 23" deep. Has ¾" length doors with attractive hardware and ornament on grill below doors. All 4 speakers are connected to a 600 cycle frequency dividing network, so that there are only 2 wires to connect to any 4 or 8 ohm output of your radio or amplifier. Has variable tone compensating control built-in. Model HF-15CR4, deluxe quality Hi-Fi console speaker system. Ship. wt. 150 lbs. (Specify cabinet finish desired.) Sale price, $89.50.

NEW IMPERIAL IV with General Electric 8 in. HIGH FIDELITY SPEAKER $19.95

New 1956 Model IMPERIAL IV, High fidelity speaker system with General Electric 8" speaker. Housed in a high quality leatherette covered plywood cabinet 10" x 10" x 24" long. Fully enclosed; covered on all sides except back. Use as an auxiliary speaker or with any high fidelity radio, amplifier or home music system. The IMPERIAL IV contains a General Electric Model 850 extended range high fidelity 8" PM speaker with 6.8 oz. Alnico V magnet and curvelinear cone with 8 ohm voice coil and a 5" tweeter. Response 50 to 15,000 cps. Model IV Imperial $19.95. Ideal for use with HF-20 and IMP-30 amplifiers described above.

IMPERIAL VI 3-WAY SPEAKER SYSTEM $29.95

1957 Model Imperial VI, 3-way speaker system. Baffle is of heavy wood, leatherette covered. Similar in appearance to the Imperial IV pictured above, except 4" taller and 1" deeper. Equipped with 3 matched speakers. A 12" G.E. Model 1203 with 9 oz. Alnico V magnet, plus 5¼" PM for middle range and 3" tweeter. Simple to connect to any high fidelity amplifier. (8 ohms impedance). Stock No. IMP-VI, Sale price, $29.95. Ideal for use with HF-20 and IMP-30 amplifiers described above.

THEATER QUALITY HIGH FIDELITY SPEAKER SYSTEM $39.95

15" WOOFER PLUS—ELECTROVOICE MODEL 847 MID-HIGH RANGE SPEAKER — 600 CYCLE LC CROSSOVER.

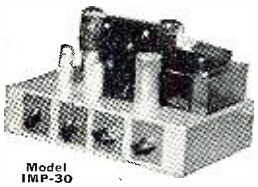
A theatre quality, powerful speaker system for homes and sound demonstration rooms. This speaker arrangement will connect to any high fidelity audio amplifier (8 ohms impedance) Features a 15" extra heavy duty woofer which is equal to a PM speaker with up to 10 lbs. of Alnico V magnet. This woofer reproduces the low audio register from 600 cycles down to 20 cps. An Electro-Voice Model 847 horn type speaker is used for the middle range and high range of audio. These two speakers are connected to a 600 cycle inductive-capacity crossover network. Built in the network is the field exciter for the 15" woofer. You could spend over $100 for a speaker system and not beat this one. Stock No. EV-15847X, McGee's sale price, $39.95.

NEW 15" COAXIAL IMPERIAL SPEAKER SYSTEM SALE PRICE $34.95

20 to 17,500 CPS
BUILT-IN CROSSOVER
CHOICE OF BLOND, MAHOGANY OR MAPLE

Imperial Model 15-BF speaker system. Choice of blond, mahogany or maple finish cabinet. Baffle is equipped with a 15 watt, 15" coaxial, high fidelity PM speaker with coaxially suspended 5" tweeter. Built-in crossover connects the tweeter electrically to the woofer. Only 2 wires to connect to any 8 ohm output from your high fidelity amplifier. Ideal for use with our Imperial 30 or HF-20 amplifiers described above. Frequency response down to 20 cps and up to 17,500 cps. Baffle is approximately 24" square and 18" deep. Overall height is 40". Baffle has acoustical lining for fine musical reproduction. This speaker system compares with units selling for $100.00. Stock No. IMP-15BF, 15" coaxial speaker and baffle. Ship. wt. 53 lbs. Sale price, $34.95. Specify cabinet finish; blond, mahogany or maple when ordering. Stock No. IMP-XPR, speaker system same as above, except equipped with our P15-CR, 15" coaxial PM speaker described on opposite page. Sale price, $39.95.

IMPERIAL 30 WATT AMPLIFIER $29.95



Model IMP-30

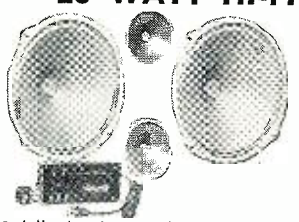
NEW 1956 MODEL

Push-Pull 6L6 Output Tubes
Response 15-20,000 CPS
Bass and Treble Tone Controls
Compensated Gain for G.E. Cart.
Input for Xtal or Dynamic Mike

With CU-14Y, 12" Coax Speaker .$39.95
With P15-CR, 15" Coax Speaker..$49.95
With Imperial IV Speaker System.$46.95
With SP12125CR .....$51.95 With HF-33GE $76.95

New 1956 model 7 tube Imperial 30 watt High Fidelity audio amplifier. A $100.00 list value for only $29.95. Features a heavy 4 lb., specially wound high fidelity output transformer with 15% inverse feed-back; push-pull 6L6 output tubes and frequency response from 15 to 20,000 cps. Matches 8 or 16 ohm speakers. You can center your entire custom music system around this low cost 30 watt amplifier. This Imperial 30, 30 watt amplifier may be used with any radio tuner or record player. It will drive any speaker system that you may have. Use from one to ten 8" speakers or any 12" or 15" coaxial speaker or any 3-way speaker system. Tone compensated input for either a crystal phono pickup or a General Electric variable reluctance pickup. Also, has input for crystal or high impedance dynamic microphone. 4 controls are mike gain, phono gain, treble tone and bass boost tone control. This amplifier weighs 21 lbs. net. Full size transformer components would cost you up to $15.00 if purchased separately. Gold color chassis is 12¼" x 7¾" x 7¼" high. Complete with tubes: 6AT6, 6AU6, 6C4, 12AU7, 2—6L6GA, plus 5U4G rectifier. Stock No. IMP-30, 30 watt Imperial High-Fidelity amplifier complete with tubes and diagram. Ship. wt. 23 lbs., Sale price only $29.95.

25 WATT HI-FI SPEAKER SYSTEM



2-12" Woofers
2-5" Tweeters
Power Supply and L-C Cross-over Network

SALE PRICE $24.95

25 watt, High-Fidelity Dynamic Speaker System, complete with 2000 cycle genuine inductance-capacitance cross-over network, two 12" woofer speakers, two 5" high frequency tweeter speakers and separate 110 volt AC power supply for only $24.95. Frequency response 20 to 18,000 cps. Both the woofers and the tweeters are fine quality dynamic speakers with fields excited to saturation by the power supply. Tweeters are specially made with cones designed to respond only to the high frequencies of the audio spectrum. The 2000 cycle cross-over network is of the high quality inductance-capacitance type which prevents frequencies below 2000 cps from entering the tweeters and eliminates frequencies above 2000 cps from the woofer circuit. The cross-over network system is simple to connect to any 4 or 8 ohm output of your high fidelity audio amplifier or radio. No. SP-12125CR, High Fidelity Dynamic Speaker System. Ship. wt. 15 lbs. Sale price, $24.95.

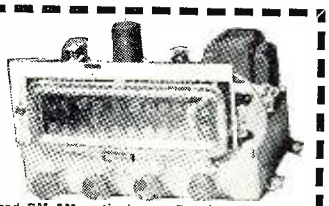
No. SPS-12125, High Fidelity Dynamic Speaker System, as described above, but less the 2000 cycle cross-over network and with a separate attenuator control. Sale price, $14.95. Ideal for use with HF-20 and IMP-30 amplifiers described above.

AIR KING FM-AM TUNER

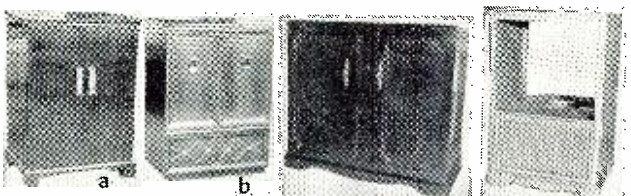
SELF POWERED

Use with any Audio Amplifier

SALE PRICE $24.99



Air King factory built, 6 tubes self-powered FM-AM radio tuner. Receives broadcast 540 to 1620 kc and FM 88 to 108 mc. Use with any Hi-Fi audio amplifier or connect it to your TV set for FM-AM reception. Selector switch has 4 positions for TV-Phono-FM and AM. 3 other controls are volume-off-on, tone and tuning. With tubes: 12AT7, 2—6AU6, 6AL5, 6SQ7, and 5Y3 rectifier. Chassis size, 11½" x 7½" x 6¼" high. Illuminated slide rule dial 7½" x 2½", with escutcheon plate and knobs. Self-powered with its own power transformer. Air King FM-AM tuner chassis No. 703 as used in Air King model 17K1C combination TV-Radio-Phono with power supply added. Note: A separate audio amplifier is required to operate a speaker. Stock No. AIR-K6, self-powered FM-AM tuner, complete with tubes, knobs and diagram. Ship. wt. 10 lbs. Sale price, $24.99.



a b

$59.95 $59.95 NRT-21M $59.95 BT-210 $22.95

27" Mahogany Full Door Cab. $59.95

(a) No. 27-MA. Mahogany with full doors for 21", 24" and 27" TV. 43" h. 30¼" w. 23" deep. Chassis area 27¾" w. 25" h. 18¼" deep. Baffle for 10" speaker. A beautiful cabinet that cost the factory over $100. Made for a $600 TV set. Ship. wt. 135 lbs. Sale price, $59.95. Blank panel $5.00 extra. Shipped with 27" mask and safety glass.

27" ¾ Door Mahogany Cab. $59.95

(b) No. 27-34MA. Mahogany with ¾ doors for 21", 24" and 27" sets. 43" h. 31¼" w. 22¾" deep. Chassis area 27½" w. 26¾" h. 21" deep. Baffle cut for 2 10" speakers. Made for one of America's largest TV builders. Cost over $100. Ship. wt. 135 lbs. Sale price, $59.95. Blank panel $5.00 extra. Shipped with 27" mask and safety glass.

DELUXE 21" MAHOGANY TV-PHONO CABINET

No. NRT-21M, DeLuxe piano finish mahogany combination radio-phono-TV cabinet for 20" or 21" TV chassis. Beautiful full door style with matching front panels. 37" high, 40½" wide and 22¾" deep. Baffle cut for a 12" speaker. TV chassis area 21" high, 23½" wide and 19" deep. Changer shelf 15" x 17" with 9" height clearance. Ship. wt. 165 lbs. No. NRT-21M, mahogany cabinet, sale price, $59.95. 21" mask and safety glass, $6.95 extra.

21" BLONDE $22.95—MAHOGANY OR WALNUT $19.95

No. BT-210, blonde oak 21" TV cabinet. 37½" high, 24" wide and 20½" deep. TV chassis area 20½" high, 23½" wide and 18½" deep. Baffle cut for 10" speaker. Open front, no blank panel furnished. Shipping weight 68 lbs. Sale price, $22.95.

No. WT-210, walnut 21" TV cabinet, same as above. Sale price, $19.95.
No. MT-210, mahogany 21" TV cabinet, same as above, Sale price, $19.95.

McGEE RADIO COMPANY

PRICES F.O.B. KANSAS CITY
SEND 25% OR FULL REMITTANCE WITH ORDER. BAL. SENT C.O.D.

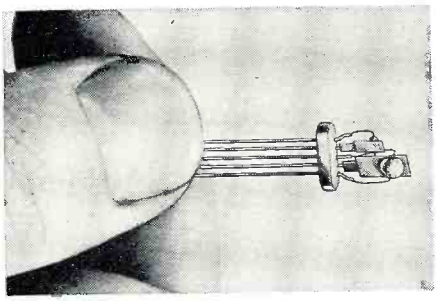
TELEPHONE VICTOR 2-5092
1903 McGEE ST., KANSAS CITY, MISSOURI

What's New in Radio

TANDEM TRANSISTOR

The *Marvelco Electronic Division* of *National Aircraft Corporation,* 3411 Tulare Ave., Burbank, California is now offering a newly-developed tandem transistor which is said to increase the utility and versatility of semiconductor devices.

In the MT-1 two d.c.-coupled transistor elements are housed in a single case and form a simple two-stage cascade. The tandem transistor combines



extremely high current and power gain with a high ratio of input-to-output resistances. In addition it is a variable *beta* transistor equivalent to a variable *mu* pentode.

Write the company for full details on this component.

NEW CBS TRANSISTORS

CBS-Hytron, Danvers, Massachusetts has announced the addition of a pair of *p-n-p* alloy-junction germanium transistors to its semiconductor line.

The 2N180 and 2N181 are designed for general purpose, low-frequency applications and feature a wide variety of applications because of the collector dissipation of 150 mw. for the 2N180 and 250 mw. for the 2N181.

An additional feature is their ability to maintain high amplification at high current levels, thus lending themselves to medium power applications such as the output stage of a portable radio receiver.

Complete specifications on these new units are available in the form of an engineering data sheet, E-264, which the company will forward on written request.

DISC CATHODE

Superior Tube Company, 1844 Germantown Ave., Norristown, Pa. is now in production on a disc cathode which permits manufacturers to use a narrower glass neck in television tubes, reducing the deflection yoke to save production costs of TV sets.

The new unit has the same size nickel shank and cap and uses the same heater as the company's ED1-2 disc cathode but has a smaller diameter ceramic disc. The diameter of the disc in the new unit is .365" ± .005", in contrast to the standard .490" with the same tolerance. The outer diameter of the tube attached to the disc is .121" ± .001" in both the new unit and the standard.

Complete information on these new narrow-neck cathodes and other products in the company's line of components for the electronic industry is available from the company.

TRANSISTORIZED MICROPHONE

Radio Corporation of America's Communications Products Department, Camden, New Jersey has announced the development of a transistorized microphone which has been designed specifically for two-way mobile communication applications.

The new Type CX-50 microphone is completely interchangeable with conventional mobile carbon mikes used in this application and provides appreciable improvement in the intelligibility, voice quality, and reliability.

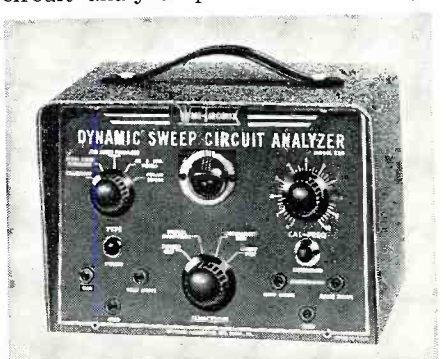
The unit features a reluctance-type microphone mechanism and a built-in transistor preamplifier which increases the sensitivity of the reluctance mechanism to the level of high-sensitivity carbon microphones.

The microphone, which is housed in a rugged plastic case, measures 6½" long, 2-11/32" wide, and 1-11/16" deep and weighs only 9 ounces. It comes complete with a 65-inch cable which is self-coiling to 18 inches.

DYNAMIC SWEEP ANALYZER

Winston Electronics, Inc., 4312 Main St., Philadelphia 27, Pa. has added a new TV test instrument to its line of servicing equipment.

The "Win-Tronix" dynamic sweep circuit analyzer provides for the dy-



namic troubleshooting of horizontal and vertical deflection and sync circuits. The Model 820 supplies 60-cycle saw-tooth, 15 kc. horizontal saw-tooth, and horizontal output transformer

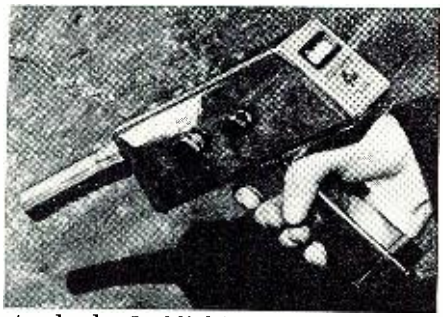
drive for rapid troubleshooting of both sync and sweep circuits by signal substitution. Accessory probes produce the synchronization pulses.

The company will supply additional data upon request.

TRANSISTORIZED COUNTER

Universal Atomics Corporation, 19 East 48th Street, New York 17, N. Y. is now offering a transistorized Geiger counter which is lightweight and gun-shaped for convenience.

The Model UAC #411 uses seven transistors and operates from two



standard flashlight batteries. The counter is weatherproofed and rugged enough to meet military specifications for temperature ranges and vibration tests.

A convenient carrying holster that fits on the belt keeps the counter handy and available for instant use yet out of the way when the operator needs both hands free for other operations.

Write the firm for full details and prices.

"PACKAGED" TV COMPONENTS

A new "package" of television components designed to insure better reception at a reduced cost in color as well as black-and-white receivers is now being offered by *Standard Coil Products Co., Inc.,* 2085 N. Hawthorne Ave., Melrose Park, Illinois.

The "package" consists of a tuner, i.f. strip, sync generator, and delay line. The company also announced that the circuitry for the four major units that comprise the "package" will be made available without charge to manufacturers who wish to make the equipment themselves.

TV manufacturers are invited to write the company for details on the commercially-built line or information on the circuitry.

NEW TYPE CAPACITOR

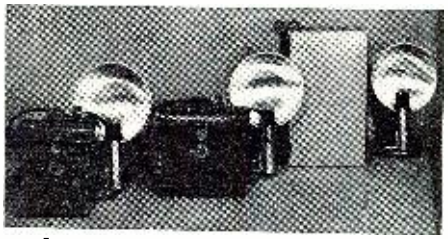
Sprague Electric Company of North Adams, Mass. has announced the development of a new type of electrolytic capacitor designed especially for miniaturized circuitry applications.

In its smallest version the new capacitor is the size of the head of a common kitchen match, only ⅛" in diameter by ¼" long, and is rated at 12 μfd.

The new "Tantalex" capacitors are high capacity, small-sized units especially suitable for transitor circuitry. Write the company for full details.

ELECTRONIC FLASH KITS

Technical Apparatus Builders, 109 Liberty Street, New York 6, New York is now offering a series of electronic flash kits which are easy to assemble



and offer a variety of operational modes to meet individual requirements.

Currently available are battery and battery-a.c. models, all of which are characterized by compactness and light weight.

A data sheet covering the five units in the line is available from the manufacturer on request.

SOLDERING GUN

Wall Manufacturing Company, Grove City, Pa. is now offering its "Trig-R-Heat" instant soldering gun in two models, the 238T (without light) and the 238LT (with light).

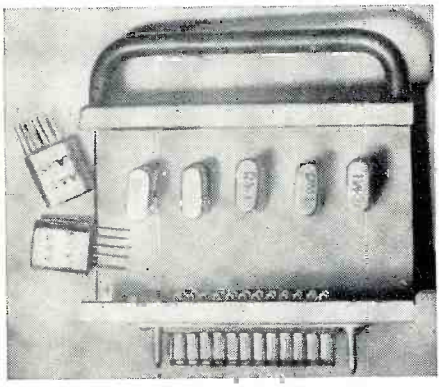
Both guns provide instant heat upon operation of the trigger. They will work on either a.c. or d.c., any cycle. The gun weighs 8 ounces and comes with a six-foot *UL*-approved 3000 cycle cord and plug.

Write the company for a copy of the data sheet covering this equipment.

CUSTOM PRINTED COMPONENTS

Acoustical Electronic Laboratories, 3785 Broadway, New York 32, N. Y. is now in a position to supply a variety of printed circuits to the industry.

Included in the current line are potted and sealed transistor circuits such



as flip-flops, audio and r.f. oscillators, multivibrators, d.c. amplifiers, gates, saw-tooths, oscillator inverters, and similar units.

The units may be plugged in and used "as is" or the leads may be cut off and the units soldered into bales to form computers and allied electronic circuits. Typical units measure .750" long, .717" wide, and .312" tall. NBS circuits or special circuits on a custom basis are also available.

Write the company direct for a copy of a data sheet covering the units or for additional information on special items.

9-INCH PICTURE TUBE

The Tube Department of *General Electric Company,* Schenectady, New York has developed a 9-inch rectangular picture tube designed for application in personal portable television receivers.

One of the unique features of this unit is the use of a one-piece funnel

and face plate assembly which results in a bulb design offering minimum

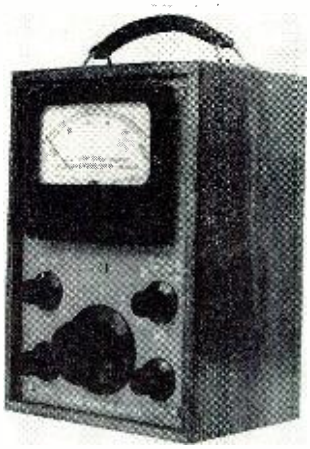
weight and maximum viewing area for any given diagonal.

The screen size of the new tube is 6" x 7½", which provides an approximate screen area of 40 square inches. The tube weighs approximately 2 pounds and measures 13 1/16" over-all. It is a magnetic deflection, electrostatic focus type with a 6800 volt design center anode voltage. Recommended operating voltage is 5500 volts. The base is a standard 7-pin type.

JUNCTION TRANSISTOR ANALYZER

Quantum Electronics, Inc., 1921 Virginia St., NE, Albuquerque, N. M., has added a junction transistor analyzer to its line of transistor test equipment.

The MHI Mod. V unit features 3%



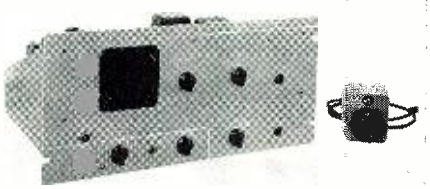
of full-scale accuracy, extended *beta* and I_e ranges, battery test under load, mercury cell power supply, measurement of true dynamic small signal *beta*, self-contained and portable, and complete transistorization.

The company will supply full details on request.

STATIC REJECTOR

CGS Laboratories, Inc., 391 Ludlow Street, Stamford, Conn., has developed a new static rejector which is designed to improve the reliability of code communication by reducing message losses and operator fatigue caused by static noise and receiver drift.

The new "Trak" unit contains filters which analyze the receiver's audio output at the signal frequency and on each side of it. Noise signals in the



sideband regions are instantaneously subtracted from the center channel output, chopping "holes" in the signal when noise occurs and leaving only the code signal to be copied.

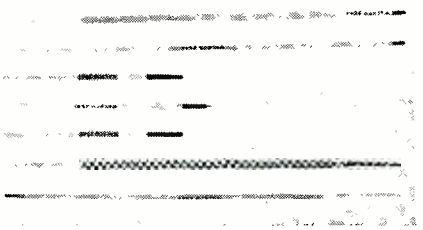
Additional noise protection is furnished by an adjustable pulse-width discriminator which, when set to the appropriate words-per-minute rate, eliminates all impulses shorter in

duration than one dot. In addition, high-amplitude noise pulses are clipped in special bi-stable trigger circuits.

A technical leaflet giving circuit information, specifications, and tube complement is available from the manufacturer.

TV ALIGNING TOOLS

Walsco Electronics Corporation, 3602 Crenshaw Boulevard, Los Angeles 16, California has seven new alignment tools in its line of color and black-and-white service aids.



Included are molded nylon, iron-core aligners which are double-ended and have hex-end diameters varying from .075" to .125" to fit all currently-used slug openings. The ends of these tools are undercut on one side to enable the technician to reach and align bottom slugs.

Another unit is designed for use with i.f. cans that have smaller than standard openings. To reach difficult spots where ordinary 5" or 6" tools are too short, the company has two 11" tools for perfect alignment without undesirable hand capacity.

AUDIO OSCILLATOR

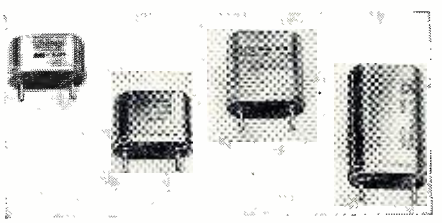
Hewlett-Packard Company, 275 Page Mill Road, Palo Alto, California has developed a new audio oscillator, the Model 201C, which is especially useful in low distortion, high accuracy measuring such as amplifier, loudspeaker, frequency comparison, and other high-fidelity measurement applications.

The new unit covers the frequencies from 20 cps to 20 kc. in three bands with a calibration accuracy of ± 1%, frequency stability of ± 2% or .2 cps, and a full-range frequency response of ± 1 db. Output is 3 watts or 42.5 volts into 600 ohms. Distortion is less than .5% from 50 cps to 20 kc. at 1 watt and less than 1% from 20 cps to 20 kc. at 3 watts output.

Complete information on this new item of audio test gear is available from the manufacturer.

MINIATURE PLUG-IN CAPACITORS

U. S. Electronics Development Corp., 1323 Airway, Glendale 1, California, is



now in production on a line of miniature capacitors designed for plug-in aplications in printed circuits.

Known as "Crys-Cap," the new units are contained in hermetically-sealed standard-size crystal cans ranging from 7/16" to 1½" maximum seated height. Suitable for use in miniaturized electronic equipment utilizing printed circuitry, the new units offer maximum design versatility for single, multiple, and gang mounting with maximum space saving, simple replacement, and highest reliability.

Capacities from .001 μfd. to 1 μfd., voltages of 50, 100, 200, 300, 400 and 500 volts d.c., and tolerances of ±1, 5, 10, and 20% are available. Detailed information is available. —30—

TUBELESS AUTOPILOT

REVERSING the current trend toward the electronic operation of most equipment, Federal Telephone and Radio Company has developed a tubeless and transistorless "Autopilot" which has been designed specifically for small private and executive-type airplanes.

Light in weight and moderately priced, the control unit is installed in the cockpit where it occupies a space only 3" x 4¾" x 2¼".

The gyro-servo assembly can be installed in the baggage compartment or other convenient spot where it occupies a space just 15" x 11⅛" x 6⅛". A compact modified "turn-bank" indicator is installed on the cockpit instrument panel.

Available in two models—for single-engine aircraft which have coordinated ailerons and rudder and for two-engine planes or single-engine planes with uncoordinated ailerons and rudder, the units weigh 17 and 19 pounds respectively.

According to the company, these new units offer many of the operating conveniences of the larger models designed for commercial aircraft. The system permits selection of roll or pitch stabilization, or both, giving positive control at all times. The system is also capable of being adapted to accept control signals from a radio coupler, controlling both radio range and ILS systems. The "Autopilot" operates on either 12 or 24 volt input, which is the power normally available in small private or executive-type planes. —30—

Cockpit view of the small control unit for Federal's "Autopilot" system. In addition, the system consists of a "turn-bank" indicator on the instrument panel and the gyro-servo assembly, installed in remote spot.

Certified Record Revue

(*Continued from page* 60)

These big clubs have the money, they have no restrictions on what they record and actually this would be the ideal time for them to start, since they are slowly recording the standard repertoire. This would make a more easily assimilable choice of music available on stereotape. This is when they are recording the Dvorak 5th, and the Tchaikovsky 6th, etc. For the most part, the big record companies would be reluctant to record these warhorses again due to the plethora already in the catalogue and while no one wants to discourage them from recording their current repertoire, you can readily understand that it would be easier for them to sell, say, a Beethoven 5th, rather than a "Mathis der Maler" by Hindemith, if they could justify the cost of recording a new Beethoven 5th just to have it on stereo. Since most of them would probably not change their recording plans, (at least not initially) due to the cost factor, the logical method of supplying the "warhorse repertoire" on stereo tape would be through the clubs.

Well, it's a fascinating subject but I'm running out of space. I'll conclude with this. If a club comes out with a subscription plan which would guarantee the release of a certain number of three-channel stereotapes each month, and someone puts out a three-channel stereo system for around a thousand dollars (and I think it can be done for far less) this I'd like to sell, and given proper demonstration facilities, I'd have writer's cramp taking the orders!

Equipment used this month: Pickering "Fluxvalve" cartridge, *Pickering* arm, *Components Corp.* turntable, *Marantz* "Audio Consolette," two 60-watt *McIntosh* amplifiers, *Jensen* "Imperial" speaker, *Electro-Voice* "Georgian," and *Ampex* tape equipment.

KHATCHATURIAN
GAYNE BALLET SUITE
MASQUERADE SUITE

Philharmonia Orchestra conducted by Aram Khatchaturian. Angel 35277. RIAA curve. Price $4.98.

This is the fourth performance of the "Gayne Suite" to appear in the LP catalogue, and is by all odds the best. For a starter, the composer himself is conducting, and while it is true that some composers make awful botches of conducting their own scores, such is decidedly not the case here. Rather, Khatchaturian adds a new dimension to the work, in an interpretation entirely different in concept from that of the other conductors. To my ears at least, there seems to be a great deal more material in the score than my previous experience with the work would indicate. I would say that Khatchaturian, secure in his grasp of the work, manages to imbue his colorful score with considerably more power and vigor than the other conductors could summon.

In a score which has often been accused of being banal and somewhat trite, this spirited, more idiomatic reading proves a saving grace. Oddly enough, on first listening to the opening "Dance of the Young Maidens" you get the impression that Khatchaturian is going to drag his feet, the tempi being much slower than expected. But they pick up and soon he is driving the orchestra at a furious pace. Yet this is directed energy and one can perceive that the composer is striving for a definite effect . . . he wants to preserve, as much as possible, the authentic eastern flavor of the dances with their flashing rhythms and complicated beats. That he succeeds as well as he does is not only a tribute to his conductorial skill but to the magnificent playing of the Philharmonia Orchestra, with a special nod to the percussionists who with their unflagging traversal of the difficult rhythms do much to sustain the "native" feeling in the performance.

With such a fine and zestful performance, it is disappointing that *Angel* didn't choose to do all of the ballet rather than just the suite. In the 5th recording of the "Masquerade Suite" to appear, Khatchaturian is also at the head of the class. As with the "Gayne," it too derives a vigor from the conducting not apparent in the previous versions. Soundwise this is the finest recording yet produced by *Angel.* That's a large statement, but a listen to this will quickly convince the skeptical. There has been a growing brilliance in *Angel* recordings of late, and I hope they don't go any farther than they have here. In other words they have now achieved a beautifully balanced sound, clean and undistorted, with all instrumental detail heard with new sharpness and definition . . . and further "brightening" would only result in stridency. Naturally the spectacular scoring in "Gayne", especially in the "Lezghinka" section and in the famous "Sabre Dance", just cries out for the full hi-fi treatment and they receive it in full measure. Sharp incisive strings, clean bright trumpets and trombones, and some piercingly stratospheric woodwinds are a feature of the recording and in the elaborate percussion scoring calling for many unusual instruments, the impact and accuracy of them is outstanding. Recorded somewhat close-up, the engineers still managed fairly spacious acoustics for presence. Frequency response is in excess of anything previously noted with *Angel,* and the dynamic range and general recorded level is also greatly expanded. The milder scoring of the "Masquerade" is equally well recorded. If you like exciting music with an Oriental cast you won't go wrong with this recording.

RIMSKY-KORSAKOV
SCHEHERAZADE

Pittsburgh Symphony Orchestra conducted by William Steinberg. Capitol P8305. RIAA curve. Price $3.98.

Oh no! Not another "Scheherazade"! Why this is the 21st version to appear on LP! Well friends, all I can say is that as long as this colorful score continues to be a favorite of the hi-fi fan, new editions are bound to crop up now and then. And you must remember that many people have certain preferences in conductors and no doubt many have been eagerly awaiting a Steinberg reading. Or perhaps, they prefer the *Capitol* type of sound, maybe they want the superbly quiet *Capitol* surfaces . . . there are many reasons and you can be sure that *Capitol* didn't pay the high costs of an American recording without the promise of an adequate return.

This disc has much to recommend it, in many ways it is one of the most musical versions of "Scheherazade", with Steinberg taking things at a reasonable pace and not striving for special hi-fi effects. Which is not to say that this is not a fine clean recording, in the matter of string tone alone, Steinberg has created a minor miracle and all other orchestral elements are heard with crisp undistorted brilliance. Frequency range, dynamics, acoustics, all are up to the usual high standards of *Capitol* and of course we have the ubiquitous and always welcome dead quiet surfaces that characterize this company's recordings. Summing up, this is not as exciting a recording as the Ansermet/*London* or Dorati/*Mercury* versions, but it has virtues of its own and should find more buyers than many of the previous editions.

TCHAIKOVSKY
1812 OVERTURE
CAPRICCIO ITALIEN

Minneapolis Symphony Orchestra con-

ducted by Antal Dorati with University of Minnesota Brass Band, Bronze Cannon Strasbourg, France 1761 (Courtesy U. S. Military Academy, West Point) Bells of the Harkness Memorial Tower, Yale University. Spoken commentary by Deems Taylor. Mercury MG-50054. RIAA curve. Price $3.98.

It would be a most undiscerning person who could look at this formidable title and credit listing and fail to realize that something unusual was afoot. And in fact it will be a rare dodo of a hi-fi fan who doesn't acquire this recording. For this is, at long last, the eagerly awaited *Mercury* version of Tchaikovsky's greatest fire breathin' ripsnortin' thorobred warhorse, the "1812 Festival Overture." This recording is almost beyond belief . . . it is probably the most awesome outpouring of sound since the monster concerts of the 1880's and '90's when orchestras of 2000 men and choruses of 20,000 would perform things like the "Anvil Chorus", complete with 150 uniformed firemen pounding on real anvils with real sledge hammers! If you think I'm exaggerating and you are the fortunate possessor of a really big speaker system and 50 or 60 watts of power, just crank your gain good and wide and play the last 4 or 5 minutes of the "1812", making certain you duck and have your head well protected with at least a football helmet or, better still, a Grand Prix racing helmet. See!!! What did I tell ya! Now you have firemen too, someone having turned in an alarm, and you've probably got men in blue coats too, with shiny badges inscribed with the word "Police"! Of course there will probably be some hero-type wise guy who can *take anything* and he will turn in false alarms so timed that the arriving bells of the firemen will synchronize nicely with the bells in the "1812", giving an added fillip of realism.

Quite seriously, this takes the potted palm as the most exciting recording ever made. When some time ago I called the *Mercury* version of Stravinsky's "Rite of Spring", the "finest recording since the invention of the phonograph", I thought it would be a long time before anything could oust it from that exalted position. But remarkable as that recording was, it now must make way for this "1812 Overture". This is, without doubt, the greatest achievement in the art of disc recording. I really feel that this is about as far as we can go with disc recording as we know it today. Oh, conceivably some new cutter or technique might extract one further iota of sound quality and realism from the tape original, but I feel that we will reach the point where we switch to tape (and probably it will be stereo) before that will happen. I would also venture to say that due to the scoring of the "1812" which is unique in all of music, it is doubtful if any other piece of music could have the mighty sonic impact and the tremendous excitement it generates. Because of this, the present recording of the "1812" should remain as the highest pinnacle of the disc recording art for a long, long time to come.

Right about here someone will interpose the question, "What's so good about this recording, after all there are twenty other versions in the LP catalogue". A fair question, but the truth of the matter is that this is the *only* version recorded with the *original scoring*, which I should have mentioned when I said the scoring was unique. To call the scoring unique is probably understatement . . . in addition to a very large orchestra, the brass choir from a brass band is indicated, along with 16 cannon shots and the pealing and ringing of as many church bells as possible. This was supposed to have happened at the premiere in 1880, outdoors in the great square (now Red Square) in front of the Kremlin in Moscow. The cannon was to have been actuated by electric push-button from

the conductor's podium and the bells to start ringing at a prearranged signal.

Tchaikovsky never saw the fruition of this idea, as the plan fell through, but the score was published with all the markings for the special effects . . . the brass band parts, the interpolation of the cannon shots, the entry and duration of the bell ringing. Believe it or not, what you hear on this disc is the first performance of the "1812" with this original scoring. Of course I'll have to qualify that statement a little . . . I don't know of any place in America where one could set up a symphony orchestra outdoors, with brass band and booming cannon and have all the bells in town ring at the conductor's pleasure. No, sir! You are hearing the original score all right, but *via* the magic trickery of tape. To make this fantastic record the *Mercury* people first recorded Dorati and the Minneapolis Symphony and the brass band in Northrop Auditorium at Minneapolis. Then they journeyed to Yale University to record the bells of famous Harkness Tower. With the eager aid of a number of Yale students all the bells in the Tower from the 1500 pounders to the big 7-tonner were rung with wild abandon and recorded. Next they went to West Point where with the aid of the curator of the U. S. Military Academy Museum, a genuine bronze Napoleonic cannon was resurrected (incidentally going Tchaikovsky one better, who, had his plans materialized was going to use the then current models of Russian field pieces) and inspected by an ordnance crew and set up for firing for the first time in 170 years! There is a special section on the record with narration by Deems Taylor which details the recording of the cannon and the bells too, so I won't go any further on this point.

Suffice it to say, the engineers got their cannon shots and returned to their studio where the really tough job was about to begin. Imagine the difficulty of re-recording the one cannon shot which was deemed satisfactory so that the required sixteen shots could be integrated into the score at the proper places. Then came the problem of the bells . . . even with husky Yale students pulling away lustily the Harkness bells couldn't produce the clangor of the thousands of bells in Moscow. So the original bell tape was speeded up to twice the original speed and recorded and then this new tape was recombined with the original and then subsequently dubbed into the master tape at the appropriate spots and for the proper duration. Whew! What a job! The finished master tape was ready for transfer to disc, and with the tremendous dynamics involved proved to be a formidable task. If you will look at the blank space at the end of the recording near the label, you will see the figures "MF-7", which indicates that a total of 7 lacquer masters were cut before one was found to be satisfactory for pressing!

As to the performance of the "1812", Dorati has done himself proud, he has essayed tempi which would allow a moderately paced reading in the opening passages with a gradual increase as the tension of the work develops. Unlike many of his contemporaries however, Dorati does not let the score run away with him. He keeps a firm rein on all orchestral elements, preferring to grow in power and sonority, building tower on tower a mighty tonal structure, which culminates in the shattering explosive grandeur of the climax. The Minneapolis players, as if sensing they are going to make phonographic history, follow Dorati's urgings with splendid precision and spirit. The result is some of the finest orchestral sound yet heard from this group. Soundwise, this is a recording where superlatives are almost meaningless, since all elements are recorded with fantastically "live" quality. But mention must surely be made of the last part from the battle scene on to the closing climactic Czarist anthem. You have never heard a more hugely proportioned, darkly resonant string tone, nor the fabulous brazen weightiness of the combined brass of the orchestra and band . . . you can practically feel this stentorian blare, and all the percussion, from the smash of cymbal to the pile-driver power of the tympani and floor-jarring blasts of the bass drum, is perfectly clean and articulate. When the cannon shots come, with a big speaker system the effect can only be described as a "punch in the belly", and if ever there was a supreme test of transient response, this is it! I laugh when I think what's going to happen when some character tries to reproduce these cannon shots at a fairly good level through his commercially packaged so-called hi-fi set. Boy, is he going to learn the truth, and fast! Now take all the orchestra and brass band sound, and the booming smash of the cannon and add the bells . . . the din and clangor is truly stupendous! And watch your gain, as the dynamic range on this record probably exceeds by a wide margin anything previously attempted. If you start the first part of the "Overture" at what seems a reasonable room level, I assure you the climax will blow you right out of the room!

It seems almost anti-climactic to talk about the work on the flip side of this monumental recording, but as a matter of fact under ordinary circumstances this version of "Capriccio Italien" would be cause for the loudest huzzahs. In fact this is such a tremendous orchestral *tour-de-force,* that it easily qualifies as among the very top few of *Mercury's* super recordings. Every element is reproduced with stunning accuracy and cleanness, and Dorati has here taken the opposite course from the "Overture" and he races along at a pretty fast pace in his reading and in the final 3 or 4 minutes, he drives the orchestra faster and faster until the tempi are literally frenetic and the orchestra is playing just about as fast as it can and still have instrumental articulation. A tremendously exciting reading with the best sound of any version in existence. For lovers of percussion this is a "must" and at the very end of the work there is a shattering tympani roll that will long be remembered. I hardly need to recommend this disc to all and sundry for both of the works involved, this is the longest single review I have ever written, but I believe that if through its obvious enthusiasm you are stimulated into getting this disc, you will thank me for the hi-fi thrill of your life!

PROKOFIEV
LIEUTENANT KIJE SUITE
L'Orchestre de la Societe des Concerts du Conservatorie de Paris conducted by Sir Adrian Boult.
THE LOVE OF THREE ORANGES
The London Philharmonic Orchestra conducted by Sir Adrian Boult. London LL1294. RIAA curve. Price $3.98.

Here is a bonus package from *London* for lovers of Prokofiev among which I number myself. Sir Adrian might seem at first glance an odd choice for this repertoire, but then one remembers his associations and excellent work with many modern scores and a listen soon confirms that our fears are unfounded. His readings have much to recommend in the way of vigor and spriteliness, and his light hand on the orchestral reins is appreciated. His tempi are generally reasonable although I felt that the opening of "Kije" was a mite on the draggy side. I still prefer the old Koussevitsky reading of "Kije" to any other, but in view of the terribly dated sound, this is an acceptable substitute. Sir Adrian defers to no one in his reading of the "Three Oranges" and with the superb sound this is the recording of choice. Overall sound quality is in the best *London* tradition, with nice clean strings, rich wood-

winds, bright crackling brass, and percussion of notable accuracy and articulation, especially in evidence in "Kije." Add nice spacious acoustics and good surfaces and you have a notable addition to the Prokofiev catalogue.

PUCCINI

TURANDOT (COMPLETE OPERA)
Renata Tebaldi, Mario del Monaco, Inge Borkh, Fernando Corena, and others with Alberto Erede conducting chorus and orchestra of L'Academia di Santa Cecilia. London XLLA 36. RIAA curve. Price $14.96. Three discs.

This Puccini opera has all but disappeared from the stage of the Met and it is hard to fathom this neglect. Certainly its Oriental motifs make for colorful staging and the score itself has not only beauty, but is interesting in its exotic orchestration. Well, if "Turandot" languishes in New York, that situation does not obtain in Italy where performances are fairly frequent. For "Turandot" lovers in this country lamenting their plight, *London* has a fabulous new album here that should placate you and which is almost as good as sitting in the Academia. In his role as Calaf, del Monaco is at the top of his form and without prejudice to some of his other roles, I feel this is possibly his most successful portrayal. He holds down the decibels somewhat in this role and more of the inherent beauty of his voice comes through, especially his justly famous high voice. Tebaldi is in glorious voice as Liu, although casting her in that role seems a little surprising, since a voice of her power is hardly needed. Inge Borkh as Turandot leaves something to be desired. Her voice, while pretty, is not forceful enough for the demands of the role and one remembers the rough-fibered but intense performance of Cigna in the old *Cetra* set. However, as a saving grace, Borkh is a good actress and this helps make her deficiency less noticeable. The roles of Timur and Ping, Pang, and Pong are ably handled with Corena as Ping the most artistically satisfactory.

Erede is an old hand with this sort of repertoire and he guides the good-sounding orchestra and his chorus and soloists through a performance which is certainly the best available. With the rich scoring the *London* engineers have had a field day and this must be reckoned as among the finest opera sound that *London* has produced. Even if all the Puccini you know is "Madame Butterfly" I think this opera has great appeal and I think you will find a listen to it quite rewarding.

MOZART

PIANO CONCERTO #27 IN B FLAT MAJOR

SONATA #11 IN A MAJOR FOR PIANO

Wilhelm Backhaus, pianist with Vienna Philharmonic Orchestra conducted by Karl Bohm. London LL1282. RIAA curve. Price $3.98.

For this month's contribution to the Mozart Bicentennial, we have a superb new recording of his magnificent 27th piano concerto, and his 11th piano sonata. There is no question that this is the recording of choice among the seven versions now available. The Casadesus on *Columbia* is an old recording and in spite of its many virtues as a performance, the sound negates its consideration. The Badura-Skoda performance on *Westminster* had the advantage of excellent sound, but good as the pianist is, he can't compete with the incredibly smooth mature artistry of Backhaus. Backhaus traverses this score with what seems like consummate ease, yet a closer listen reveals the dedicated artist, the painstaking craftsman who threads his way

(*Continued on page* 134)

carefully through the pianistic pitfalls. Yet, in doing so, the performance does not sound stilted nor too studied.

Much the same could be said for Backhaus' handling of the famous 11th sonata. Although one might add that free of the responsibility of the concerto form, Backhaus is, if anything, still smoother, and the notes flow with a fluid grace that belies the difficulties of construction. The sound is somewhat perplexing, for the most part it is the usual excellent *London* job of nice clean piano and string tone, good brass, woodwinds, percussion, all wrapped up in appropriately spacious acoustics. But in the opening bars of the second movement of the concerto, there is a lot of flutter in the piano, as well as what sounds like overload distortion. The individual piano notes "break-up." I tried the passage through a number of different preamps and amplifiers, used about four makes of high quality cartridges, switched speakers four or five times. Unhappily the distortion persisted, and I am forced to conclude that by chance I was sent a bad review copy. However, the over-all sound and the really splendid performance make up for it, even if the defect is common on all copies. For Mozart lovers this concerto is a "must" and the sonata, free of the distortion in the concerto, is equally desirable.

PHILHARMONIA POP CONCERT
Philharmonia Orchestra conducted by Herbert Von Karajan. Angel 35327. RIAA curve. Price $4.98.

When one of the world's great orchestras is turned loose on a potpourri of "pops," the results can sometimes be surprising! Karajan does nobly in some of the numbers and is less than comfortable with some others. His best job is on the "Thunder and Lightning Polka" and the "Tritsch-Tratsch Polka"; the polka from "Schwanda the Bagpipe Player" is worth the price of the record and nicely fills the need for a new recording to replace the ancient Ormandy reading. Sound here is again of the new brighter quality that *Angel* seems to be embracing, and the virtuosity of the Philharmonia is well served by the clean undistorted quality.

LECUONA
ANDALUSIA
ALBENIZ
SONGS OF SPAIN
Leonard Pennario, pianist. Capitol P8319. RIAA curve. Price $3.98.

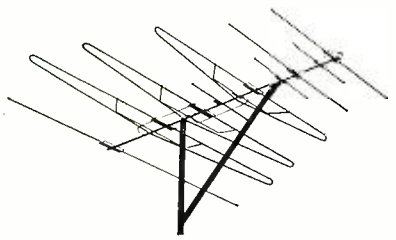
This is the type of repertoire in which young Pennario shines. Here is where he can exhibit his dazzling technical proficiency and the natural flair he seems to have for Spanish keyboard music. He has an amazing command of all the ornamentation and flourishes that are part of the Spanish piano idiom. He goes along fluently in the "Andalusia" and delivers a particularly exciting reading of the popular "Malaguena." The Albeniz has more musical substance and Pennario applies his talents in suitably expressive manner. Fine piano sound here with little if any harshness or transient ringing. A very pleasant record to listen to, with nice quiet surfaces.

I still haven't been able to catch up with the Mozart flood and were I to review all of them the column would be filled with nothing else, which is as good a way as I know to kill interest. I really feel they are overdoing this Mozart celebration and they are going to make some people almighty sick of his name if they don't taper off. I'm all for honoring him and I think it's most appropriate to do this *via* new recordings of his major works. I have already reviewed most of the big works, but next month I hope to be ready with a report on all the new "Don Giovanni" recordings, and possibly the "Coronation Mass." —30—

Antenna News

DEEP FRINGE ANTENNA

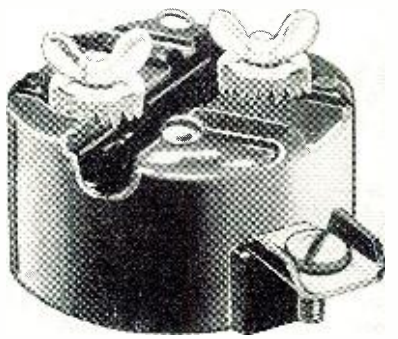
Tescon TV Products Co., Springfield Gardens, N. Y., has available a new deep fringe antenna, the "Super Scanner," featuring high gain and flat response over the entire v.h.f. band.



A new phasing method is used for improved performance. Sharp directivity is assured by the design of the elements and the antenna configuration. Top-quality aluminum is used throughout and the antenna is well-braced mechanically.

LIGHTNING ARRESTER

General Cement Mfg. Co., 919 Taylor Avenue, Rockford, Ill., has just been granted U. S. Patent No. 2,728,896 for its model 8642 universal-type lightning arrester. This unit is intended for use with every type of v.h.f. and u.h.f. television lead-in, either outdoors or indoors. It carries the approval of the *Underwriters' Laboratories.*



This lightning arrester, which is of the round type, will mount on walls, pipes, or masts, and has toothed circular contacts.

FERRITE COIL ANTENNA

Vidaire Electronics Mfg. Corp., Lynbrook, N. Y., is making available a new ferrite coil antenna for replacement in radio receivers.

Called the "Ferri-Loop," the model FL-6 is designed to fit into tight places and is easy to install. It may be used as a direct replacement for air-core loop antennas. It is furnished complete with mounting hardware.

AUTO RADIO ANTENNA

United Motors Service, Division of *General Motors Corp.,* Detroit, Mich., is introducing a new "Delco" dual automobile radio antenna designed for rear deck installation on cars.

Each antenna is chrome plated and consists of three sections with built-in anti-rattlers. When fully extended, the antenna is 30 inches. The base assembly has been designed for top mounting.

The antennas are packed two to a carton with all necessary fasteners and leads.

—30—

Printed Circuits

(*Continued from page 51*)

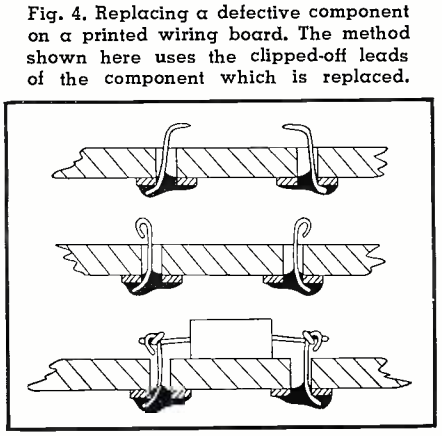
times it is left on the card after dip soldering since the heat of dip soldering tends to drive the activating agents out of the flux. There is also the theory that if no flux cleaner is applied, the residue is not distributed over the entire card. Complete removal of the residue is the only safe solution to this problem.

Repairing and Servicing

The printed circuit using deposited resistors on a ceramic plate is virtually impossible to service, outside of making a replacement of the entire unit. The printed-circuit assembly shown in Fig. 1A presents a removal problem since the leads are not flexible and are placed in a square pattern. The leads may be clipped at the board or a special soldering iron, which makes contact at all soldered joints simultaneously, may be used. This iron is not commercially available as yet but will be in the near future. This type of construction is just beginning to make its appearance in commercial use. Circuits made by depositing a conductive ink or paint can be serviced, provided care is taken. Circuits made by etching or by plating the conductor on the base should present no trouble if a few simple rules are observed.

First, consider the circuit which has the conductor lines printed with a conductive ink onto the insulating base. This type of circuit may be recognized by the grainy structure of the entire pattern; often the mesh of the silk screen used to deposit the ink or paint may be seen on the pattern. Scraping lightly with a knife will remove some of the pattern from the base, but soldering directly to the bare pattern is often very difficult. However, since the components have been soldered in place at the factory, there is usually enough solder at the point of connection to make the needed repair. If silver is used in the conductive ink, the recommended solder to be used is tin/lead containing a small percentage of silver. Otherwise, the applied solder will absorb the silver from the pattern and in most cases remove it from the base before soldering has been accomplished.

Fig. 4. Replacing a defective component on a printed wiring board. The method shown here uses the clipped-off leads of the component which is replaced.



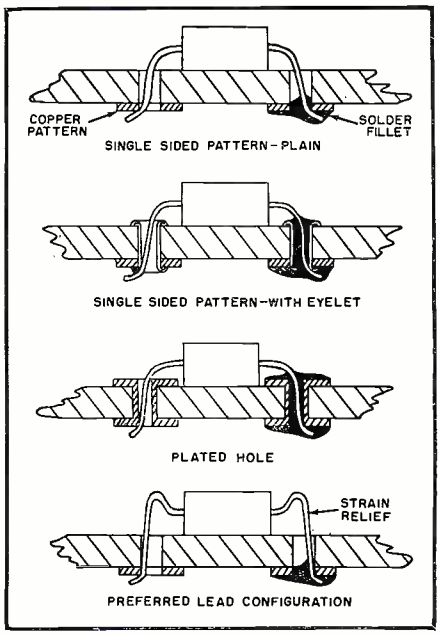


Fig. 5. With most printed-wiring boards, the circuit is plated on one side, the components are placed on the other. The various methods of connecting the components to the wiring are shown here.

In lieu of a silver-bearing solder, use 60/40, tin/lead solder in conjunction with a small low-wattage soldering iron. The wattage should not exceed 35 to 40 watts with an ⅛" to 3/16" diameter tip.

Apply only enough heat to the defective component lead to allow it to be removed. Before soldering in the new component lead, clean the lead with a glass eraser, fine sandpaper, or steel wool. This allows the solder to act upon a clean surface, thus using a minimum of heat. After inserting the component in place, heat the lead and then apply solder, allowing it to run from the lead onto the pattern. Keep the iron in contact with the molten solder just long enough to get the proper flow so as to prevent a cold joint.

With etched- or plated-conductor patterns, as with the conductive-ink type, the application of too much heat will destroy the bond between the conductor and the base material. It is still important to use a low-wattage iron and 60/40 solder. This has almost the lowest melting point of any tin/lead solder. As in the first example with the conductive ink, the component lead may be unsoldered from the pattern. Another means of replacement, especially for resistors and capacitors is to clip the lead at the body of the component. The new component is then mechanically connected to the old leads as shown in Fig. 4. Finally, the leads are soldered for good electrical contact.

The majority of printed-wiring boards which the service technician will encounter will have a pattern on only one side of the board. Small components are mounted from the reverse side and then soldered in place as shown in Fig. 5. If there are heavy components or external wire connections mounted to the board, the mounting

hole may be fitted with eyelets for greater strength and to eliminate the possibility of the copper foil delaminating at this point.

Boards which have a conductor pattern on both sides sometimes employ eyelets as a means of feedthrough connection. On this type of construction the service technician will encounter a big headache. If the eyelet has not been properly inserted and rolled or staked in place, a poor or no connection will exist. Do not rely on soldering a component or wire lead only to the eyelet; make sure the eyelet is properly soldered to the circuit pattern. If continuity is not obtained when eyelets are used, check all sections and joints of the circuit pattern with an ohmmeter or continuity checker. Do not rely on visual inspection.

Once necessary solder repairs have been made, the printed-wiring board should be cleaned of all flux. If an excessive amount of flux has been used and has formed a pool around the pattern, wait for it to cool. This allows it to become fairly brittle and the majority of it may be removed by chipping it off with a knife. Take care not to damage the pattern. The remaining flux may be dissolved by applying a mixture of equal parts toluene, alcohol, and acetone. A small amount of carbon tetrachloride, trichlorethylene, or perchlorethylene, which are easily obtainable solvents, will also serve the purpose. Application may be made using an old toothbrush or other stiff bristle brush. A general over-all cleansing may be had by using isopropyl alcohol or denatured alcohol. As stated before, the procedure outlined applies to the servicing of all types of printed wiring or printed-circuit work.

The service technician will do himself and the customer a big favor if he finishes the job by applying a protective coating. Such a coating seals the board against excessive moisture, prevents corrosion of the copper pattern, helps maintain a high insulation resistance, and improves the appearance of the work. Two items which are currently available for this work are acrylic plastic spray and *General Cement* "Print Coat." Both of these items may be purchased in spray cans for convenient use or brushed onto the work with a small brush. Care should be taken that the board is dry before application of these protective coatings. Do not allow the coating to deposit too heavily around solder joints, since future repairs may be difficult.

Printed wiring is assuming increasing importance in the electronic industry and the service technician will be coming into more frequent contact with this new method of manufacture. It helps eliminate the "rat's nest" of wiring common to most home radio and TV sets and thus makes servicing of the set easier. After a little experience in the technique of proper servicing, the service technician will find his work simplified by this new trend in electronic assembly. —30—

Within the Industry

(*Continued from page* 30)

awarded the Benjamin Garver Lamme Medal, one of the nation's top honors for meritorious achievement in electrical engineering.

The gold medal, sponsored by the American Institute of Electrical Engineers, is awarded annually for outstanding accomplishment in the development of electrical apparatus or machinery. It will be presented to Dr. Hanna at the association's nationwide technical meeting to be held in San Francisco during June.

* * *

DR. WILLIAM E. TAYLOR has been appointed chief engineer of the materials research department of *Motorola's* Semiconductor Products Division. He has been associated with the company's semiconductor program since its inception in 1952 as senior project leader of materials research division.

He was formerly associated with the Oak Ridge National Laboratory as a metallurgist. He received his Bachelor and Doctor of Science degrees from Purdue University. He served for four years as a field artillery officer during World War II.

* * *

THE AMERICAN SOCIETY FOR QUALITY CONTROL will hold its 10th annual convention in Montreal on June 6, 7, and 8.

Montreal's "Palais du Commerce," which offers complete convention facilities under one roof, will be headquarters for the convention. Over 2000 delegates from the U. S. and Canada are expected to attend. More than 80 speakers from the U. S., Europe, and Canada will address the convention.

Full program details and information on registration and reservations are available from R. Vance Ward, c/o *Canadian Industries Limited,* P.O. Box 10, Montreal, Quebec.

* * *

JOHN A. DOREMUS has been named vice-president in charge of engineering at *Aircraft Radio Corporation* . . . **SANFORD L. CAHN** has been elected executive secretary of the Institute of High Fidelity Manufacturers. . . . The board of directors of *Emerson Radio and Phonograph Corporation* has elected **DR. HAROLD GOLDBERG** to the post of vice-president in charge of research . . . **NORMAN CAPLAN,** formerly assistant director of engineering and research, has been promoted to manager of mobile radio products of the *Bendix* Radio Division . . . **R. E. CARLSON,** manager of the high-fidelity division of *Fairchild Recording Equipment Company,* has been promoted to the post of vice-president and general manager of the firm. He succeeds **RAY F. CREWS** who has resigned . . . **RUS-**

SELL D. GAWNE is the new general sales manager for *General Cement Mfg. Co.* of Rockford. He was formerly sales manager of *Crescent Industries'* home instrument division . . . *Rohn Manufacturing Company,* manufacturers of TV and communications towers, has named **RICHARD A. KLEINE** to the post of sales manager. He will work with the company's representatives and jobbers throughout the U.S. and Canada . . . **SIDNEY A. SCHNEIDER** has been appointed service manager for *Crescent Industries, Inc.'s* products. He was formerly with *American Television Company* . . . **W. ROPP TRIPLETT,** general manager of *Triplett Electrical Instrument Company of* Bluffton, Ohio, has been named president of the company succeeding his father, **RAY L. TRIPLETT** who has become chairman of the board . . . **ALBERT COUMONT,** service coordinator and staff assistant to the Parts Division of RETMA, has resigned his post to take a position with the *Sprague Electric Co.* of North Adams, Mass. **TYLER NOURSE** will serve as staff assistant for the Parts Division. He has been with the RETMA for five years . . . **WILLIAM GROMMES** of *Precision Electronics* has been elected to the board of directors of the Institute of High Fidelity Manufacturers to serve for the 1956 term. He succeeds **AL KAHN** of *Electro-Voice* in the post . . . **HAROLD A. DeMOOY** has been appointed manager of manufacturing for *RCA's* receiving tube activities at Harrison and Woodbridge, N. J., Indianapolis, Ind., and Cincinnati, Ohio. He will make his headquarters at Harrison . . . **LT. COL. L. J. FISHKIN** has been appointed Chief, Office of Technical Liaison, Office of the Chief Signal Officer. He was formerly a member of the executive staff . . . **KENNETH H. BROWN** has been appointed service manager of *Westinghouse's* television and radio division in Metuchen, New Jersey . . . **HOWARD J. CHRISTIANSON,** a well-known radio and electronics rep, was killed in an auto accident in Wisconsin recently. He was associated with the *R. Edward Stemm* organization in Chicago . . . **ROY E. NELSON** is the new manager of microwave tube planning and promotion for the *RCA* Tube Division in Harrison, N. J. . . . The post of advertising and sales promotion manager for the television-radio division of *Westinghouse* has gone to **RUSSELL W. JOHNSON** who formerly served as assistant advertising manager . . . **JAMES E. HERBERT** has been appointed vice-president in charge of sales for *Hoffman Electronics Corporation* of Los Angeles. He was formerly general sales manager of *Motorola Inc.* . . . **ARTHUR H. JONES** is the new director of engineering for *Motorola's* national defense department . . . **ALBERT N. KASS,** general manager of *Radio Electric Service Co. of Penna.,* has been appointed vice-president of the firm and elected to the board of directors . . . The appointment of **V. HUBERT CAMPBELL** to the post of assistant chief engineer of the radio tube division, has been announced by *Sylvania.* He will maintain offices in Emporium, Pa. . . . **ROBERT M. FICHTER** is the manager of *Westinghouse's* product development department at its television-radio division operation in Metuchen, N. J. . . . **CAPT. HENRY E. BERSTEIN** will join the RETMA staff about July 1st as military engineering coordinator. He is presently commanding officer and director of Navy Electronics Laboratory in San Diego . . . *Chatham Electonics* has named **B. F. STEIGER** to the post of vice-president. He was formerly chief engineer of the division . . . **HERBERT I. SEGAL** has been elected president of *Van Norman Industries, Inc.,* of Springfield, Mass.

* * *

JOHN A. RADO has joined the Electronics Department of *Diamond Power Specialty Corp.* as chief engineer.

He was formerly associated with *Telechrome Manufacturing Corporation* where he was assistant chief engineer, directing work on information storage devices, color TV receivers, and studio equipment development.

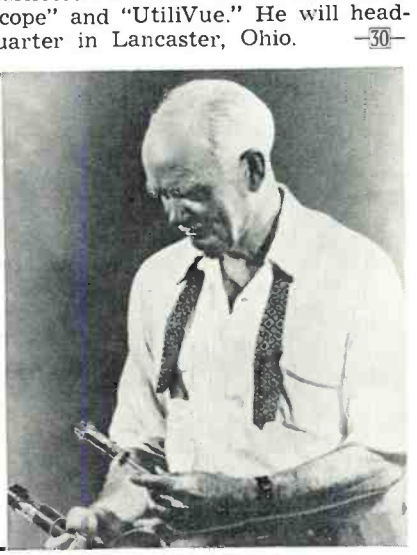
In his new post he will be responsible for the development of the firm's closed-circuit television line which is marketed under the tradenames "Utiliscope" and "UtiliVue." He will headquarter in Lancaster, Ohio. —30—

PRESIDENT HAILS DR. LEE DE FOREST

ON THE occasion of the 50th anniversary of the invention of the radio tube, President Dwight D. Eisenhower has extended warm personal greetings to its inventor, Dr. Lee de Forest.

In a letter to Dr. de Forest, the President acknowledges our indebtedness to the inventor for making modern radio, television, and radar possible. He also further states "You must also feel great satisfaction in remembering your past decades of service and in anticipating future achievements that your handiwork has made possible."

The President closed his letter by saying "May you enjoy many more years in which to witness the fruit of your labors."



dial into a private telephone system and dial any land based telephone of that system directly without the assistance of a telephone operator.

Privacy depends upon the cooperation of all licensees operating on the same frequency within communicating range of each other. All mobile units operated by all licensees on the same channel in the same vicinity will have to be equipped with decoders, whether of the tone or pulse type, not necessarily of the same manufacture. All receivers will be muted until the proper tone signal or pulse code is received. Naturally, only one conversation can take place on the one channel at any one time but bedlam can be avoided by adding the privacy feature.

Improved Equipment

Today's mobile radio equipment is more selective, more stable, and much more compact than the equipment of five years ago. Nearly all sets are of the single package type with transmitter, receiver, and power supply housed in one case. All transmitters contain modulation limiters and meet higher technical standards.

Miniature tubes, wherever applicable, are now used in both transmitters and receivers. Gone are the loctals and octals in most cases. Dynamotors are being used less often with vibrators taking their place, even for supplying high power transmitters.

To meet all kinds of application requirements, radio equipment must be available for operation from a variety of power sources. Some manufacturers provide interchangeable power supply chassis which permit the use of the same basic type of mobile unit in all applications. Most modern mobile units designed for motor vehicle installation are operable from either a 6 or 12 volt battery without extensive modification or exchange of power supply chassis. In some cases, a.c.-operated radio equipment is used in combination with an inverter to provide a.c. from an odd battery voltage.

Fork-lift trucks may be equipped with 24, 32, or 36 volt batteries. Rail applications may require operation from 6, 12, or 32 volt batteries in cabooses, 64, 72, 110, or 115 volt batteries and, in some cases, 117 volts a.c. from a converter on locomotives.

The "walkie-talkie" is a necessary part of many mobile radio systems. Portable transceivers for use in the 25-50 mc. and the 152-174 mc. v.h.f. bands are common. However, for the 450-470 mc. u.h.f. band, there are none available. The notable exception is the variety of Citizens Radio units which can be operated only on 465 mc. There is a great need for a 450-470 mc. "walkie-talkie" which will meet commercial service requirements.

(*Continued on page* 142)

Very little effort is being made in that direction. Development of new "walkie-talkies" for the v.h.f. bands utilizing vacuum tubes is virtually at a standstill. It seems that everyone is anticipating the transistorized "walkie-talkie" and therefore there is little point in investing money in the development of a tube type unit. In the meanwhile, the excellent tube type "walkie-talkies" which utilize both wet and dry batteries, are earning their keep.

A "walkie-talkie" for commercial purposes, employing transistors, has been developed and is being produced by *Motorola*. A complete series of transistorized portable radio units replaces the earlier types which use vacuum tubes exclusively. The new sets employ transistors but they also use tubes. However, the use of transistors has permitted drastic design changes since more space is available and power requirements are lessened. The "Handie-Talkie" (*Motorola* tradename) line starts at $305. Power output in the 25-50 mc. band is rated at 1½ watts and 1 watt for the 144-174 mc. band model. The packset, larger counterpart of the "Handie-Talkie," is rated at 5 watts r.f. output in the high band and 8 watts in the low band.

Snap-on power supplies of various types are available. There are three different types of battery power supplies plus an a.c. power unit. The wet cell battery pack uses nickel-cadmium batteries guaranteed for the life of the radio. When this unit is used with the "Handie-Talkie," it may also be operated from the 6 or 12 volt battery of an automobile.

The development of this line of transistorized portable radio transceivers opens new applications such as a base station for small community police departments. By switching snap-on power packs, the set may be quickly converted from portable or mobile use to a base station. However, in spite of the significance of this development, the world is still waiting for the fully transistorized "walkie-talkie" which will really revolutionize the mobile radio business.

"Walkie-Talkies" are finding many novel applications. Here a photographer receives instruction via a Motorola set while shooting news photos at a political convention.

Sales and Service

The bulk of mobile radio equipment is sold directly by the manufacturer to the user. *RCA, Motorola,* and *G-E,* which account for at least half of the industry's sales volume, employ large sales forces. *Bendix* and *Federal* also sell through salaried sales engineers. Until the recent government decree which prohibits them from doing so until rates are filed and approved, the *Bell Telephone* companies leased equipment to operators of private mobile radio systems. *Kaar, Comco,* and *Du Mont* sell their equipment through independent dealers.

More different manufacturers make equipment for use in the 152-174 mc. v.h.f. band than any other type. However, there is a greater demand for 25-50 mc. band equipment. Although there are fewer customers eligible for licensing in the 25-50 mc. band, they often make larger purchases.

A considerable amount of equipment for the 450-470 mc. u.h.f. band has been sold, but is not up to expectations. Since licensing in the Citizens Band between 460 and 470 mc. is simple, almost every businessman who operates vehicles is a prospect. The deterrents to sales have been insufficient education of the potential buyers and the higher cost of u.h.f. equipment. It is anticipated that equipment costs will come down as volume increases.

Prospects eligible for licensing in the 25-50 mc. band as well as other bands generally prefer to operate in this band because of its longer range and in spite of occasional possible skip interference. In simple terms, this band can be categorized as intended for county-wide communications whereas the 152-174 mc. and 450-470 mc. bands provide city-wide coverage. The freedom from noise and the remarkably solid urban area coverage of a properly installed 450-470 mc. band system are important sales features.

Most mobile radio systems are maintained by independent service organizations. Railroads, in the main, employ their own radio technicians but in some locations farm out radio maintenance. Police and fire departments also farm out such work when the work load is not sufficient to warrant the full-time employment of technicians and an investment in test equipment.

The most likely market for the enterprising radio service organization is in the industrial field. Most factories installing radio on fork-lift trucks and plant protection cars will not add radio technicians to their pay rolls. The maintenance of the radio equipment will be generally farmed out.

Independent mobile radio service contractors seldom work on an hourly or job basis. Instead, service is rendered on the basis of a flat monthly fee per mobile unit, plus a higher fee

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BC-230 Transmitter—2500-7700 KC w/Coils..U:	8.95
BC-347 Amplifier—1/6F8G tube...N: $3.95; U:	1.95
BC-357 Beacon Rec.—75 MC.....N:	4.95
BC-367 Amplifier—2/6V6 tubes...N: $4.95; U:	2.95
BC-375 Transmitter .....Used:	29.95
Tuning Units f/BC-375; TU-5-6-7-8-9-10-26, U: Ea.	3.95
Cables f/BC-375/BC-191, PL-61, 64 or 59, each end: Ea.	2.75
BC-442 Antenna Relay Box—w/Cond.....New:	2.95
BC-463 Trans.: 67-74 MC. 20 Watt. 16 Tubes.U:	16.95
BC-603 Receiver FM—20-28MC.....Used:	29.95
BC-604 Trans.: FM—30 Watt. 20-28 MC..Used:	18.95
BC-500 Trans. & Rec.: 25 Watt, 20-28 MC.New:	59.50
BC-617 Receiver Only. 30-40 MC w/Dyn..Used:	24.95
BC-654 Transceiver: 3800 to 5800 KC.....Used:	34.95
BC-709 Amplifier—Battery Operated.....New:	1.95
BC-745 Transceiver: 3 to 6 MC.....Used:	14.95
BC-924 Trans. FM—30 Watt. 27-38.9 MC..New:	24.95
BC-966 I F F—160-211 MC. 13 tubes.....Used:	5.95
BC-1158 Trans.: 50 Watt. 53.3-95 MC.....New:	39.95
BC-1206 Receiver: 200 to 400 KC.....New:	9.95
RM-12 Radio-Telephone, Remote Control..Used:	19.95
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Less Tubes:	9.95
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TBY Transceiver: 20-80 MC. 4 Bands. w/Tubes.U:	19.95
R1/ARR-1 Receiver—Converts to 2 or 6 Meters..	2.95
RT-7/APN-1 Altimeter—440 MC.....Used:	9.95
RT-34/APS-13 Transcvr. Comp. less tubes...U:	3.95
R-74/CRW-2 Receiver—53-88 MC—6 Tubes..N:	9.95
TG-34A Keyer: 115/230 V 50-60 cy. w/Tubes.N:	16.95
TG-10 Keyer: Complete w/Tubes.....Tested U:	14.95
T-121 Transmitter—3-4 MC with Coder.....	7.95
Range Beam Filter, Navy Type $1.95; FL-8 Used:	1.49
EE-8 Field Telephones—Checked .....Used:	14.95
BD-72 Portable 12 Line Switchboard.....Used:	39.95
Sound Powered Head & Chest Set—Checked....	3.95
Sound Powered Head & Handset f/Mark II.Used:	2.95
TS-9 Handset w/Switch—No Plugs.N: $3.95—U:	1.95
TS-13 Handset w/Switch. PL-68 & PL-55.Used:	5.95
TS-15 Handset w/Switch. PL-68 & PL-55.New:	7.95
T-17 Microphone—Used. Checked.....	3.95
HS-30 Headset—Hearing Aid Type—L.N.....	1.50
CD-874 Cord—f/HS-30—Low Imp., w/PL-55.U:	.59
CD-515 Cable for BC-669.....	2.75
CD-605 Cord—F/HS-30—High Imp. w/PL-54.N:	.79
CD-307 Cord—w/PL-55 & JK-26.....U:	.59
CD-318 Cord—2/PL-68, JK-48, & SW-141...U:	.89

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Tubular steel, copper coated painted in 3 ft. sections, screw-in type. MS-53 can be used to make any length with MS-52-51-50-49 for taper. Any section.....@ 50¢ Each

Larger Diameter Section: MS-54.....75¢

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12	625	225	DM-35	9.95	12.95
12	230	90	PE-133	4.95	6.95
12 or 24	540	450	DA-14		14.95
12 or 24	230	100	DA-12		8.95
14	220	70	DM-24	4.95	7.95
14	1030	260			
	515	215	DM-42	4.95	9.95
14	375	150	BD-83	3.95	4.95
14 VDC	330	150	BD-87	3.95	5.95
14	250	50	DM-25	6.95	8.95
14	1000	350	BD-77	14.95	29.95
24	250	60	PE-86		8.95
28	1000	350	PE-73	8.95	

12 to 24 VDC PM Dynamotor—Supplies 24 VDC 2 A, from 12 VDC. also 500 V 50 MA. @ 6 VDC will supply 12 VDC & 250 V 50 MA.

#0515.....New: **$4.95**

GN-45 HAND CRANK GENERATOR—Supplies 6.3 VDC and approx. 250 to 500 VDC. Complete with legs, seat and Hand Cranks which have to be turned 50 to 70 RPM to supply voltage (Used with BC-654).....Complete Set: **$9.95**

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Pictured at Right—115 VAC 60 Cycle SINGLE TYPE—100 CFM —2¼" intake; 2" outlet. Complete size: 5"x6"— No. 1C939..... **$8.95**

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115 VAC 60 cycle COMPACT TYPE—108 CFM; Motor built inside squirrel cage; 4½" intake; 3⅝"x3" Dis. Complete size: 4½" W x 8⅜" H x 8⅛" D —No. 2C067..... **$14.95**

115VAC 60 Cycle FLANGE TYPE—140 CFM; 3½" intake; 2½" Dis. Complete size: 7½" W x 7¼" H x 6¾" D—No. 1C807..... **$13.95**

115 VAC 60 cycle FLANGE TWIN—275 CFM; 4½" intake; 3¼"x3" Dis. Complete size: 11¾" W x 3⅜" H x 8-1/16" D—No. 2C069.... **$21.95**

115 VAC 60 Cycle BLOWER—200 CFM; 4" intake; 3"x5" outlet. Overall size: 8"x7"x6". Bodine Motor NSI-33. Removed from New Equipment. #BOD-200..... **$14.95**

115 VAC 60 Cycle BLOWER—100 CFM; 3¾" intake; 2" outlet; Rd. Flange with Flap Director. Overall size with bracket: 8" L x 6½" W x 7" H. Removed from New Equipment. Diehl Motor FB-2106-6 No. FDBL-2106..... **$6.95**

Same as above, but with 12-Curved Director. No. CDBL-2106..... **$7.95**

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(Pictured) In portable leather case, with Test Leads. 2½", 0-15 AC and 0-3 AC Scale..... **$5.95**

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0-1 MA Weston 506; 2½" Rd. 3.95

0-3 RF AMMETER IS-128; 2½" Rd.....NEW: 2.95

0-8 Amp RF w/Thermocouple IS-89; 2½" Rd... 4.95

0-15 AC-DC—2½" Rd.; IS-122..... 4.95

0-500 MA DC—2½" Rd.; IS-22..... 4.95

0-150 V. 60 cycle: Simpson; 3½" Rd..... 3.95

0-250 MA DC—DeJur, 3" Sq..... 3.95

OUTPUT—5 Ranges, 4000 ohm Imp.—Used..... 4.95

TRANSFORMERS— 115 V. 60 CYCLE PRI.:

600 VCT/100 MA—6.3 V/5 A.; 5 V/3 A. $4.95

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700 VCT/150 MA—5 V/3 A.; 6.3 V/4.5 A. CSD.. 3.95

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1890 V/12.6 MA—Tapped 2.5 V 2 A. 5.95

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600-0-600 VAC—200 MA. 12.5 V. 2 A.; 12.5 V. @ 2 A.; 5 V. @ 3 A.—#H-108—Price..... 8.95

250-0-250 VAC—50 MA. 24 V. 1 A.; and 6.3 V. 1 A.—#H-109—Price 4.95

Choke—12.5 Hy/100 MA.....$1.95

Choke—8 Hy/150 MA—200 Ohm—Open Frame.... 1.25

Choke—5 Hy/150 MA—85 Ohm..... 1.50

Choke—10 Hy/250 MA—2⅜" x 2" x 3" Potted.... 4.95

Choke—5 Hy/400 MA—1½" x 4" x 5⅜"..... 4.95

18.4 Hy. 1 Amp 100 Ohm—7⅝" x 5⅝" x 6¾".... 6.95

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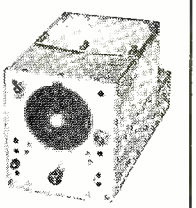

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Quality-Electronics Dept. T-6

319 Church Street New York 13, N. Y.

for the base station, plus tubes and parts. Sometimes tubes and parts are included in the flat fee.

The *Bell Telephone* companies have established mobile telephone centers throughout the country for maintaining mobile radio equipment used by subscribers to mobile telephone service as well as equipment leased by the *Bell* companies to operators of private mobile radio systems. *Raymond Rosen Engineering Products Company* of Philadelphia leases and maintains mobile radio systems in several eastern states. *RCA* also leases radio equipment and in some areas handles maintenance through the *RCA Service Company.*

Most equipment manufacturers are seeking qualified independent service organizations to whom they can refer their customers. *General Electric,* for example, advertises for hams to engage in mobile radio servicing as a part-time venture.

Entering this field requires that service personnel be licensed. Anyone making adjustments to a transmitter must work directly under the supervision of a licensed operator or must himself possess a first or second class radiotelephone operator's license.

The shop must be provided with adequate test equipment. Instruments which are often satisfactory for servicing home radio and TV sets may be inadequate for servicing mobile radio equipment. Accurate, FCC-approved, frequency measuring equipment is a necessity. A conventional tube tester may not be critical enough, in which case tubes may have to be tested in the set using the substitution method. To detect elusive tube troubles, some tube types may be checked for control grid emission in a grid circuit type tube tester.

Information about mobile radio equipment and what kind of test equipment is recommended may be obtained from equipment manufacturers. Unfortunately, an up-to-date book on mobile radio does not exist. Copies of FCC rules outlining equipment technical requirements and operating standards may be obtained from the Government Printing Office, Washington 25, D. C. A complete technician's library consists of FCC rules, parts 2, 10, 11, 13, 16, and 19, which sell for 15 cents each.

What's Ahead

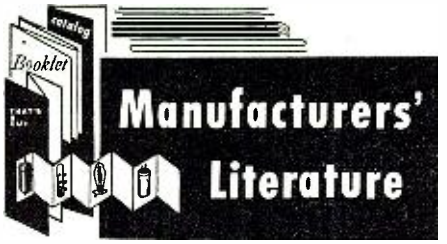
In the foreseeable future, split channel techniques will make more channels available. Narrow-band FM and the use of standard and single-sideband AM will make still more channels available. The continuing development of klystrons and other microwave tubes makes more imminent the shift of mobile radio into the microwave region. Ten years ago, E. A. Dahl, then electronics engineer for the *Rock Island Railroad,* demonstrated the feasibility of mobile radio at 2600 megacycles. Great technical strides have been made since then.

Mobile radio first employed AM, then switched to FM. Now there is a trend back to AM. For good reasons! AM equipment requires fewer tubes and permits simpler circuitry. The noise improvement of FM over AM at 160 and 460 mc. is not significant. Besides AM requires less bandwidth. AM may not supplant FM but it will come back into wider use.

This Vocaline Model JRC-400 transceiver is one of the units which has received FCC type approval for operation on the Citizens Band. Range of the unit is 10 miles, line-of-sight. It will operate successfully at one-half mile through most obstructions. The transceiver weighs about 4 pounds and can be operated from 6 volts d.c. or 115 volts a.c. It operates on 465 mc., has a power output of ⅓ watt, and an r.f. power input of 2 watts. Manufactured by Vocaline Co. of America, Inc., Old Saybrook, Conn., the JRC-400 retails for around $70.00 per unit. U. S. citizens over 18 years of age can obtain permission to operate with these transceivers by completing a simple, non-technical application form. No license examination is required for this type of authorization.

When the all-transistor mobile radio becomes available as a commercial product, the art will attain its greatest growth. Railroads, for example, will not have to spend three times as much for a caboose power supply as they do for the two-way radio unit. Power supply will not be a problem at remote wayside points. Base stations can be installed on hilltops where commercial power is not available. Glove compartment mobile radio units will simplify motor vehicle installations.

So what are we waiting for? Personal communication, transistorized mobile radio, and an economical system for multiplexing the mobile radio channel. But who is waiting? It is like the Hohokus, New Jersey, film executive who didn't buy a TV set because he was waiting for color. Now he is waiting for color "Phonovision." His neighbor has been waiting for the diesel automobile for 20 years. —30—



H.F. TRANSISTORS

General Transistor Corp., 95-18 Sutphin Blvd., Jamaica 35, New York is now offering copies of its new tentative specification bulletin describing its GT-760 series of high-frequency transistors.

The bulletin is available without charge on request.

RHEOSTAT POTENTIOMETERS

International Resistance Company, 401 N. Broad St., Philadelphia 8, Pa. has recently issued a catalogue data bulletin A-3 covering its line of 2-watt rheostat potentiometers.

The Type 2W components are described in detail as to construction, specifications, ratings, outline drawings of switches, shafts, locating lugs, nuts, etc. Detailed charts and graphs are also included in this 4-page publication which is available on request.

GONSET RECEIVER DATA

Gonset Co., 801 South Main Street, Burbank, California is currently offering a single-page data sheet covering its v.h.f. FM and AM receivers.

The four receivers in the new series have been designed for communications monitoring and emergency applications in the v.h.f. region. Pertinent data on each of these units is presented in concise, easy-to-use form.

A copy of this data sheet will be forwarded upon written request to the company.

POWER SUPPLIES

A supplement to its Catalogue 55 has been issued by *Lambda Electronics Corp.*, 11-11 131 Street, College Point 56, N. Y. in the form of two 4-page data sheets. One of the publications carries a check list of the units currently in the company's line while the second data sheet lists and pictures available heavy-duty, regulated models.

Either or both of these data sheets are available on request.

PRODUCTS FOR MANUFACTURERS

A comprehensive catalogue covering its extensive line of hermetically sealed terminals has been issued by *Electrical Industries*, 44 Summer Avenue, Newark 4, New Jersey, a division of *Amperex Electronic Corp.*

Included in the catalogue are compression seals, multiple headers, sealed terminals, capacitor end seals, threaded seals, transistor closures, miniature closures, and color-coded terminals. Each of these units is covered in a separate catalogue section which gives complete physical specifications, electrical characteristics, and photographs of available types.

A copy of this catalogue will be forwarded to manufacturers who make a letterhead request direct to the company.

"INDUCTRONIC INSTRUMENTS"

Weston Electrical Instrument Corp., Newark 5, New Jersey has just issued a new bulletin containing a series of technical articles on its line of "Inductronic Instruments."

Performance, applications, and ranges of the firm's Model 1411 d.c. amplifier are discussed in detail along with pertinent data on the accessory units that go with the amplifier.

Copies of this publication are available direct from the manufacturer.

MEASURING EQUIPMENT

Stoddart Aircraft Radio Co., Inc., 6644 Santa Monica Blvd., Hollywood 38, California is currently offering copies of a 4-page illustrated folder covering its line of very-low-frequency radio interference and field intensity measuring equipment.

The literature features the company's NM-10A, which combines laboratory precision with ruggedness and portability for all-weather field operation over a range of 14 kc. to 250 kc. Also included is information on a complement of accessories designed to accommodate every conceivable laboratory or field problem in locating and measuring voltage and current values of radio signals or radio interference.

FACILITIES BROCHURE

The Ordnance Division of *Elgin National Watch Company,* Elgin, Illinois has recently issued a 12-page brochure outlining its facilities for sub-contract work in the field of miniaturization.

The booklet sets up various applications of watch industry skills in the new field and graphically explains how these skills can be utilized by other industries.

This publication is available without charge. When writing, please specify the booklet on "Practical Miniaturization."

REPLACEMENT YOKES AND FLYBACKS

Todd-Tran Corp., 156 Gramatan Avenue, Mount Vernon, New York has recently issued a 16-page supplementary TV replacement guide of interest to the service industry.

The catalogue lists the company's yoke and flyback replacements for 50 different television receiver manufacturers. The manufacturers are listed alphabetically, with the sets listed numerically and the flybacks and yokes listed both by manufacturers' original part numbers and *Todd* replacement numbers.

Copies of this catalogue are available without charge from the manufacturer.

TRANSCONDUCTANCE ANALYZER

Complete details on its Model 901A transconductance analyzer and circuit designer are included in a four-page, two-color brochure recently published by *New London Instrument Company,*

Inc., 82 Union St., New London, Conn.

Specifications on the instrument as well as details on the theory behind its operation are covered in this brochure which is available without charge on request.

"TRANSISTORS I"

"The *RCA* Review," David Sarnoff Research Center, Princeton, New Jersey has announced the publication of a comprehensive book covering transistor theory, design, and use.

Since there has been such extensive research and development work on semiconductors, transistors, and their applications, scientific and engineering reports have accumulated in an unprecedented manner. This book comprises many previously unpublished reports.

The new 676-page book contains 41 technical papers by *RCA* scientists and engineers. All but ten of these are new papers never before published. In addition, the book contains abstracts of 46 other previously published technical reports dealing with transistors and semiconductor devices written by the company's scientists.

"Transistors I" is priced at $4.50 and is available from "The *RCA* Review."

"CIRCUIT DESIGNER"

Details on a new circuit designer which provides quick, positive facilities for rapidly synthesizing and testing innumerable circuits are included in a 4-page brochure recently issued by *Pomona Electronics Co., Inc.*, 1126 W. Fifth Avenue, Pomona, California.

Typical applications and complete specifications on the Model C-38 are given in this publication which will be sent without charge upon request.

TANDEM TRANSISTORS

The Marvelco Electronics Division of *National Aircraft Corporation*, 3411 Tulare Ave., Burbank, California is now offering a 4-page technical bulletin covering its new tandem transistor.

The bulletin contains illustrations of fundamental circuitry, description, applications, rating, cut-off frequency, electrical data, maximum ratings, and tandem parameters of the new unit.

"TROLMASTER" BULLETIN

R-Columbia Products Co., Inc., Highwood, Illinois has just issued a data sheet covering its 'TrolMaster" line of products.

Bulletin 22 includes details on the company's radio-TV control cleaner and lubricator, its "long shank" adapters for shafts up to 7" long, jumbo shaft adapters for auto radios, and "Kleentrol" solvent.

SERIES-STRING TUBES

A quick-selection chart listing the company's line of 600 ma. series-string receiving type tubes is now available from the Tube Department, *General Electric Company*, Schenectady, New York.

The chart classifies the 48 tube

types according to elements, lists typical service, heater voltages, maximum plate and screen dissipation ratings, and gives average characteristics.

The chart, ETU-1163-A is printed on heavy paper stock so that it can be fastened above the service bench for ready reference.

ARMATURES AND BRUSHES

Carter Motor Co., 2644 N. Maplewood Ave., Chicago 47, Illinois has published a bulletin listing its line of 12-volt replacement armatures and brushes to enable mobile radio transmitters originally operating from 6-volt auto batteries to be rewired and operated from the 12-volt batteries on late model cars.

Bulletin #156A covers equipment made by *Federal, General Electric, Harvey, Kaar, Motorola, RCA, Radio Specialties,* and *Wilcox* transmitters. It will be supplied without charge on request.

EICO CATALOGUE

Electronic Instrument Co., Inc., 84 Withers Street, Brooklyn 11, New York is now offering a colorful and comprehensive 12-page catalogue which lists its extensive line of instruments and kits.

Illustrated and described are v.t.-v.m.'s, oscilloscopes, voltage calibrators, electronic switches, tube testers, CRT testers, picture tube testers, RC bridges, flyback and yoke testers, signal and sweep generators, crystals, audio generators, bar generators, multimeters, battery eliminators, substitution and decade boxes, battery testers, signal tracers, Geiger counters, probes, and the firm's new 20-watt amplifier.

CHATHAM ELECTRONIC TUBES

Chatham Electronics, Livingston, New Jersey has just issued a 4-page brochure covering its line of electronic tubes for commercial, industrial, and military applications.

Included in the line are rectifiers, twin-power triodes, voltage regulators and reference tubes, thyratrons, hydrogen thyratrons, clipper diodes, and several special purpose tubes for various electronic circuit applications.

A copy of this brochure will be forwarded without charge upon written request to the manufacturer. Please write on your business letterhead.

TV LENS CATALOGUE

A new catalogue of selected lenses mounted to fit image orthicon studio and field cameras has just been released by *Burke & James, Inc.*, 321 South Wabash Avenue, Chicago 4, Illinois.

The new publication is an expansion of previous lists and include the full line from 1⅜" focal length to 40" focal length. In addition to the wide choice of lenses, this brochure lists a selection of accessory units.

The catalogue is available without charge on request. —30—

QUICK TOWER TRICK FOR REMOTE PICKUPS

When station WFLA-TV of Tampa was faced with the task of providing temporary microwave pickup facilities for a remote telecast from Clearwater they solved the problem nicely by using a new type portable telescopic tower developed by E-Z Way Towers, Inc. The tower was transported on a specially-designed trailer and erected, complete with microwave antenna, in 45 minutes. Two men performed the entire operation without leaving the ground. The company has designed and built four of these "portable" towers for TV station applications. A special panning head for the microwave dish permits the pickup equipment to be elevated with the tower and then rotated in the correct direction for signal pickup. The mounting will also permit the microwave dish to be tilted from 15 degrees below to 30 degrees above horizontal. The controls for panning and tilting can be operated with the tower fully or partially extended.

Marine Radio

(*Continued from page 65*)

coupling is adjusted, C_1 and L must also be varied to maintain resonance. Since the antenna capacity varies widely with frequency, the adjustments vary widely from channel to channel.

Further improvement in harmonic attenuation is provided by the pi-L network illustrated in Fig. 6. The plate capacitor, C_1, is variable, and a separate one is used for each channel. The antenna loading capacitor C_2 is relatively large, 1000 to 2000 $\mu\mu$fd.

This tank circuit is tuned to resonance by C_1 with the antenna disconnected. The antenna is then reconnected and the clip is moved over the antenna tuning coil for maximum antenna output. Adjustment of C_2 then provides the desired output loading. Minor readjustment of C_1 for resonance completes the tuning.

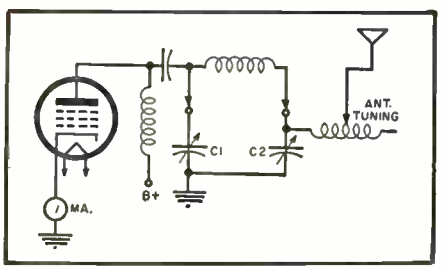
The system of Fig. 6 is superior to that of Fig. 5 in that the antenna is separately tuned to resonance and therefore, at the loading capacitor C_2 the antenna always appears as a low-value resistive load. Thus, the pi network can be designed to match this low resistance load of limited variation. This simplifies the network components and simplifies tuning. This circuit provides a minimum harmonic attenuation of over 60 db on the second harmonic and in excess of 70 db on higher harmonics.

One important recent regulation of the FCC that should be known to all service personnel working on marine radiotelephones and to consumers about to purchase such equipment is that contained in "Appendix to FCC Docket No. 11011," effective November 1, 1954. This includes the statement that:

> "(2) For ship stations on board any category of vessel, the authorized transmitter power on and after July 1, 1959, on frequencies between 2000 and 25,000 kc. assigned for communication by telephony shall not be less than the power designated in the following table:" (see Table 1).

There is other pertinent information in this appendix, as well as in other FCC bulletins. It is strongly suggested that all service technicians who now work on or intend to work on marine radios write to the FCC for literature on shipboard radiotelephones. —30—

Fig. 6. The tuning circuit shown here provides a minimum harmonic attenuation of over 60 db on the 2nd harmonic.



RADIO-TV Service Industry News

AS REPORTED BY THE TELEVISION TECHNICIANS LECTURE BUREAU

IN THE Spring of 1952, the business of television servicing was in a bad way. The bloom had gone off the peach during 1951. Service companies that had mishandled contract funds had folded up right and left and those remaining were fighting desperately to stay in business. The outlook was pretty grim.

Came July and the quadrennial political conventions. For the first time in history the public was given an opportunity to sit in the front row and observe how presidential candidates are nominated by the major parties. Television gave every set owner a ringside seat at both political conventions with the comfort of watching and hearing while seated in an easy chair in the living room.

The two conventions sparked a new boom in television sales and service that continued on into the following year. This helped the older service companies to re-establish their businesses on firmer bases and it helped a lot of technicians to establish their own service businesses.

This is another presidential election year. In August both major political parties will hold their conventions and nominate their choices for President and Vice-President. All of the television broadcasting companies have made arrangements to provide thorough coverage of both big events.

Color TV has been straining at the leash to get going. A few "breaks" that would provide pictures of unusual interest during the color telecasts could easily send the industry skyrocketing on another television boom. Regardless of whether color TV provides the spark for a new boom, service shops that are prepared for it will probably be swamped with business throughout the Fall and Winter months.

A business boom is pleasant to contemplate but the problem of the individual service shop operator is how he can best take advantage of it to capture the maximum amount of business at a profit and to entrench his business so that it will not be hurt when the boom subsides. A failing that is almost universal among small business operators is that they do not plan for the "rainy days" that always follow the good business periods.

Promotions

A study of the stream of small businesses that constantly comes and goes in every community provides a good yardstick to measure the relative importance of the numerous factors that influence the success or failure of any small business enterprise. In the tables of statistics covering business failures, lack of adequate capital is listed as one of the major causes of failure. This is only relatively true. Thousands of successful businesses have been built by people who started on the proverbial shoestring. The lack of adequate capital means that the owner did not have enough money to continue running the business the way he wanted to run it. He lacked the drive and the adaptability necessary to put it over before his money and credit ran out.

Despite the intense competition in the radio-television service business, some shops prosper and grow in communities where other shops are grabbing at straws to get the dollars they need to keep going. Of course, many factors are involved. The personality and drive of the shop owner play an important part in the success pattern of a service business. Such things as telephone answering techniques, the personal appearance of the technician, his ability to handle service customers tactfully, the appearance of the service car or truck, and the exterior and interior appearance of the service shop are vitally important. These are all very important in retaining customers after the first service call. The biggest job is to get enough new customers consistently to replace the drop-outs and to provide a steady increase in volume.

Keeping a steady stream of new business flowing into the shop is a prime requisite for the continued success of a service business. This calls for advertising and promotion at a cost that is within the means of the individual business. Many service companies spend from eight to ten percent of their gross incomes on advertising and promotion. They do it because they know that a continual stream of new business is vital to their continued success. They know, also, that this advertising and promotion helps to maintain the patronage of their old customers.

The kind, style, and extent of the advertising and promotion used is determined by the size of the business, local reading and buying habits, and the operating characteristics of the individual service business. A small, two-man, residential community service shop, for example, could not finance the kind of advertising programs that are used by a downtown, multiple-staffed service company. Yet the small, community shop can use promotions that are within its financial means and that will be effective for its particular operation.

Newspaper ads of the display type are expensive and usually beyond the means of the average service shop. Newspaper advertising is effective only if it is regularly used in a steady campaign focussed on one central idea or theme that will stick in the reader's mind. A group of shops can finance effective cooperative advertising campaigns at a nominal cost per shop. These are especially effective when they are supported by direct mail or bulletins delivered house-to-house by the individual shops with advertising copy tied in with the ad theme used in the newspapers.

Most small shops have found that the regular use of direct mail, the distribution of promotion material house-to-house by high school pupils, and the use of inexpensive "gimmicks" are the most effective and economical ways to carry on the necessary continuous promotions needed for their businesses.

By making a very nominal investment in addressing and typing equipment, even the smallest service business can easily fit a consistent direct mail promotional system into its regular operating procedures. Through the use of printed indicia on mailing pieces, inexpensive address plates, and a regular schedule of handling the mailing list by sections, a steady stream of advertising can be kept moving into the hands of prospective service customers.

Personalized or localized copy in direct mail cards, letters, or bulletins is usually the most effective way to get the recipient's attention. For instance, the average person would be interested to know that closed-circuit TV systems are being installed in lots of churches to accommodate the overflow crowds of churchgoers who cannot be seated in the regular auditoriums. That kind of information will heighten the reader's interest in TV and increase his awareness of the growing importance of television in all phases of his activities.

Trade magazines provide a stream of information that can be converted into interesting news to the average person. Any alert shop owner can capitalize on this news through regular mimeographed letters to a list of home owners in his community.

Men who use direct mail thoughtfully often hit on unusual ideas that pay off. Harry Stroman, who received the award as the "creative salesman of the year" at the NARDA conven-

tion last year, attributed his unusual success to his regular use of direct mail.

Mr. Stroman, who is a salesman for *Justis Brothers* of Newport, Delaware, accidentally discovered a direct mail "gimmick" that really paid off for him. During the past four years he had mailed more than 50,000 direct mail pieces. He considered his return only fair—about three sales out of each 100 letters. In a mailing last year he forgot to put his promotion piece in one of the letters. It was a simple mistake. But when the addressee called Mr. Stroman on the phone to inquire what was supposed to be in the letter, a sales "gimmick" was born.

In the first of a series of "shock" mailings, Mr. Stroman sent out hundreds of empty envelopes. He ruffled the back of each envelope to make it look as if someone had steamed it open, taken out the contents, and then sealed it again. Curiosity was aroused and the phone calls started to pour in. All of the regular customers who had been receiving mailings from Mr. Stroman during the past few years wanted to know why there wasn't something in the envelopes. The results were excellent. He averaged about six appliance and TV sales for every 100 letters mailed.

Another example of Mr. Stroman's ingenuity in making direct mail work for him is the plan he used last year in mailing his Christmas cards. He sent his cards out so they would arrive by December 1. Thus, his was usually the first, and only, card in the prospect's house for a week or so. As such it was an item of attention both to the family and to visitors.

Like all other forms of advertising, direct mail is effective only if it is used regularly and consistently. Its purpose is to form a strong bond of familiarity between the customer and the service shop so the customer will think of that shop when television or radio repairs are needed. This vitally important element of promotion is the one that is badly neglected by the majority of small service businesses. Without it. these businesses suffer badly from the lack of a sufficient volume of business during the slow part of every TV service cycle.

Opportunities

The rugged weather during the past winter played havoc with outdoor antenna systems in many areas. Alert TV service operators will promote TV antenna inspection plans during the spring months to provide service income during a period when they need it badly and to prevent an overload of work when the political conventions get underway. When service booms are not anticipated, established shops find themselves swamped with more work than they can handle. This quickly paves the way for a wave of new, untried competition that can sour the business through thoughtless pricing methods.

An important project that most service associations have overlooked is that of including basic facts about service pricing in their regular educational meeting programs. Realistic service pricing schedules are developed by delving into the simple economic fundamentals of charges in relation to costs of operating.

The basic commodity sold by a service business is time. Where a technician allocates, for example, sixty hours a week of his time to make a living and to pay the costs of operating his own business, he must figure his labor charges on the basis of his over-all income needs rather than on the time it takes to complete a single service call.

In the average three-man (owner and two technicians) service shop, the overhead and operating expenses add up to about $450.00 per week. Assuming that the owner handles all of the bench work and the two technicians are regularly employed in making home service calls, the minimum rate per hour per man that must be charged is $4.75. This also assumes that each of the field technicians is able to average a minimum of eight service calls per day.

A technician working alone from a business location will have to carry an overhead burden of at least two-thirds of that required for a three-man operation. To earn the same amount of net income as the owner of the three-man shop, he would have to get twice as much per call. In other words, he would have to get $10.50 per service call as compared to the $5.25 required in the three-man service company.

In today's economy, there are a number of costs that no man can escape paying no matter how economically he may run his business. He must have clothes, food, and transportation. He must have some means for service customers to contact him and this, logically, would be a telephone with directory listings. He must have tools, supplies, and a shop in which to work. There must be a provision for answering the telephone when the technician is out on service calls. All of these things cost money. Where these costs are honestly analyzed even in the smallest of "shoe-string" operations. the actual cost of making home service calls will be in excess of five dollars per call.

Technicians who think they can make a living by selling service at $2.50 per call are just kidding themselves. Assuming that for a time they can make up the difference in padded parts bills and the manipulation of tubes, they are not building anything stable or permanent for themselves. Set owners who fall for the $2.50 service charge one or two times, sooner or later make comparisons of total charges with neighbors which reveals the cheap chicanery of the cut rate service operator.

Men who are striving to build stable, substantial businesses for themselves in electronic servicing should plan to expand them to the size that is economically sound in the areas where

they are located. In most areas, the efficiently managed three-man type of service business has proved to be the most stable and profitable. The owners use promotional plans that have been proved sound in their localities and insure technician loyalty through profit-sharing plans.

Some men have done exceedingly well with five-men (four technicians and the owner) service businesses. In smaller communities the two-man type of service operation has proved very successful. It is interesting to note that a growing service business has its toughest hurdle to make when it expands beyond the five-man size. The additional overhead burdens for supervision, office, and stockroom personnel make it necessary to expand the volume to accommodate a nine- or ten-man company as quickly as possible.

Service operators who are looking forward to the day when they will be handling color TV installation and servicing should make a critical appraisal of their present operating procedures and their financial resources to determine whether they will be able to fit into the color TV servicing picture. Color TV will not sweep the country with the speed that monochrome TV accomplished. Its growth will be slower with critical discrimination in the type of shops that will fit into the business.

Service contracts and 12-month parts warranties will be standard practice for some time to come. The business will not be profitable for the shops that are not prepared with equipment and manpower to handle it. Manufacturers and dealers responsible for the satisfactory fulfillment of the contracts they sell will be cautious about the independent service shops they authorize to handle them.

In the early days of monochrome TV, service shops were able to finance the necessary capital investments in test instruments, parts stocks, service tools, etc., with the money they received on service contracts. The need for TV service was so great that it was easy to get into the business on a "shoe-string" and build a business by cautious handling of the contract money that was readily available. Color television installation and service will not allow that kind of capital financing. The shops that will be acceptable will have to have the equipment, personnel, and operating know-how before they get the business.

Several types of long-range financing programs are available to TV service companies to enable them to add the equipment necessary to handle color TV. A brochure on "How to Get a Business Loan from a Bank," which was prepared by an expert on this subject, is available at one dollar per copy from the TTLB Special Services Department, P. O. Box 1321, Indianapolis 6, Indiana.

Association News

The Indiana Electronic Service Association was officially formed in In-

dianapolis recently by the delegates from practically all local associations in the state. Robert M. Sickels, president of the Indianapolis Television Technicians Association was named temporary president. Frank Teskey, secretary of ITTA, was elected to serve as temporary secretary.

The organizing board of directors named to serve with Mr. Sickels includes Charles A. Conwell of Kokomo, president of RTSEA; J. E. Milton Snyder of Columbus, president of RTVSDA; Robert E. Luecke of Seymour, president of TVSMA of Jackson County, and James W. Baker of Anderson, vice-president of RTSEA. —30—

Transmission Lines

(*Continued from page* 39)

to a receiver located another 120 feet from the tower. For the low-band v.h.f. stations the attenuation with flat twin-lead (300-ohm) for the entire length would be less than 2 db nominally. If a u.h.f. station near 500 mc. were received on this installation the line loss alone would be over 4.5 db. Use of shielded twin-lead would double the attenuation.

Some of the latest coaxial cable types use Teflon and Fiberglas insulation. Extremely high temperature performance is the major advantage of these types and their greater cost dictates their use mostly in aircraft and missile systems. New miniature coaxial cable is also most frequently found in specialized government equipment.

Polyethylene has become the standard insulating material used in TV lead-ins. This plastic is quite tough and moisture resistant. Unfortunately it deteriorates rapidly under the ultraviolet rays from the sun. To overcome this drawback, most 300-ohm cable is pigmented with a brown material which keeps the ultraviolet rays out. Recently, some suppliers have come out with a silver-colored twin-lead which has even better resistance to the sun due to the reflective qualities of the silver-type pigmentation. Clear plastic twin-lead should never be used on exterior installations, but will perform satisfactorily where the sun cannot get at it.

In addition to the cables listed, most of the suppliers for community TV systems offer special varieties, usually double shielded. One community TV system uses "G" line, which consists only of an inner conductor and dielectric without an outer shield. The theory behind the operation of this type of transmission line was explained in the article, "The G-Line Antenna Lead-in," in the April, 1955, issue of RADIO & TELEVISION NEWS. Another type of lead-in that is quite popular where long transmission line lengths is the rule is open or "ladder" line, which consists of two solid conductors separated by small bars of solid polyethylene. —30—

Signal Probe

(*Continued from page* 69)

grid resistor is only one-tenth volt. This is true since the cathode and signal voltages are back-to-back or opposed. The grid resistor behaves as though it is ten times larger than it actually is. If the grid resistor is ten megohms, the apparent resistance is 100 megohms. By the proper choice of components, the cathode signal can be pushed to .98 volt, raising the input resistance even more. If the cathode output could be made exactly equal to the input signal, the impedance would be infinite!

In contrast to the high input impedance, the output impedance is only a few hundred ohms. The large amount of inverse feedback inherent in the circuit accounts for the low output impedance. Several feet of output cable can be run from the probe without hum problems or high frequency attenuation. Also, several measuring instruments can be paralleled across the probe's output.

One word of caution. Remember, the load connected to the cathode follower must be considered in parallel with the cathode resistor. Too much capacitance connected across the output or too low a load resistance can reduce the high impedance input feature.

Construction

The complete circuit is contained in a case small enough to fit the hand and be moved about easily. The smallest size "Minibox" (3¼" x 2⅛" x 1⅝") will make a good looking container for the works. It will be necessary to mount an angle bracket to support the tube, and a small terminal strip to secure the cable wires. The small amount of heat generated by the tube is easily radiated by the box. No ventilation holes will be necessary.

Leads to the probe are carried in a four-wire shielded cable. The signal-carrying wire is not individually shielded, since the low impedance makes it unnecessary. When the probe is used in very low level circuits, it may be necessary to use d.c. on the heater of the probe tube. Use a six volt dry-cell battery for this purpose. The heater current is only 150 milliamperes.

A jack is provided at the front of the case so that various clips and prods may be easily connected to the unit. R_1, shown in Fig. 3, should be mounted between this jack and the tube with its leads trimmed as short as possible. This resistor eliminates any tendency toward "ringing."

Operation

One of the first things noticed with the probe is an apparent increase in voltage gain of the instrument with which it is used. Just come within inches of a circuit and the probe picks up a signal. Actually, there has been no increase in gain. The high imped-

ance of the probe permits a very small coupling capacitance to transfer a greater portion of the signal to the grid circuit. Two micromicrofarads of coupling capacitance gives a signal down approximately 6 db at 400 cps.

Switch S_1 changes the probe to a detector circuit for low distortion detection or demodulation of r.f. signals. Opening this switch will bias the tube to cut-off, thereby producing rectification just like the so-called "infinite impedance" detector.

Here are a few experiments with the probe. First, connect the probe to a medium-gain audio amplifier and turn up the volume. Move the probe from side to side in the air and notice the change in hum level. This setup is actually plotting the electrostatic field within the room. Move the probe about an audio amplifier. Notice that the largest electrostatic fields are near the rectifier and its high-voltage plate leads.

Touch the probe to a wooden work bench—the hum becomes louder. Wood is normally considered an insulator, but the high resistance of the wood is no deterrent to the probe impedance.

When the probe is connected to circuits of ordinary impedance, it no longer behaves as an electrostatic detector. This reduces the 60-cycle component, in medium level circuits, to the level of the hum in the circuit itself. Nevertheless, it is sometimes desirable to further reduce 60-cycle sensitivity.

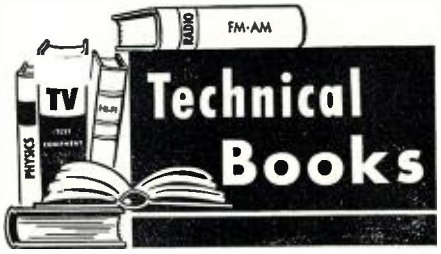
A parallel-"T" circuit can almost completely eliminate 60-cycle hum. The parallel-"T" is a null network that passes all but a single frequency. Fig. 4 shows an audio amplifier circuit for the probe using this method of hum reduction. (Figs. 5 and 6 are bottom and top views of the chassis.) The amplifier has a notched response at 60 cycles. This amplifier and the probe together make a very good signal tracer combination.

The "T" circuit in Fig. 4 can be adapted to other amplifiers. How much 60-cycle hum is eliminated depends upon the accuracy to which the "T" circuit is tuned to 60 cps. For most purposes, ordinary ten per-cent components are adequate. Several resistors can be placed in series to make up the exact values, or, the nearest RETMA values can be used.

The null network allows the detection of signals much weaker than the stray hum, without overloading the amplifier. Also, it is a relief to be rid of the monotonous hum always coming from the speaker. The notch is also broad enough so the 120-cycle harmonic is somewhat attenuated.

As mentioned earlier in the article, the probe is suitable for use ahead of an a.c. vacuum-tube voltmeter. Because the gain of the probe is slightly less than one, it may be necessary to apply a small correction factor to the meter scale.

If desired, headphones may be placed directly across the output of the probe. This makes a very compact, high-performance, one-tube probe. —30—



"HI-FI LOUDSPEAKERS AND ENCLOSURES" by Abraham B. Cohen. Published by *John F. Rider Publisher, Inc.,* New York. 355 pages. Price $4.60. Soft binding. $5.50. Hard binding.

If the reader wished to characterize this book in a single word, that word would be "practical." There is no high flown theory here, no cumbersome formulas, and no injunctions to "burn down the house and rebuild it like Carnegie Hall."

The author, whose writings are familiar to the readers of this magazine, is that rare combination of professional musician and engineer. This fact permits an ambivalence not often encountered among technical writers. He knows how to achieve the desired results with a slide-rule but he is willing to concede that most persons have to live in their homes as well as use them as "listening booths."

For this reason the audiophile who has been searching for an authoritative and practical handbook covering his hobby can stop now. This book provides all the answers to the problem of speakers and their enclosures. The text material is divided into three main sections dealing with the loudspeaker, the enclosure, and the listening room.

The book is written in easy-to-understand, non-technical language and is lavishly illlustrated with photographs of commercial units and line drawings covering operational principles. The complete elimination of mathematics from this discussion is somewhat of a *tour-de-force* and the reader will find it restful not to encounter a radical on every page.

Audio hobbyists as well as technicians who handle the installation and servicing of audio systems should have this book at hand to answer the hundreds of nagging questions that beset those of us who love and enjoy our "private orchestras."

* * *

"AUTOMATIC RECORD CHANGER SERVICE MANUAL" by Sams Staff. Published by *Howard W. Sams & Co., Inc.,* Indianapolis. 288 pages. Price $3.00. Paper bound. Volume 7.

In this, the seventh, volume of the publisher's "Changer Manual Series," complete service data is provided on seven record changers and twelve tape recorders which were produced during 1954 and 1955.

A complete description of the change cycles and the suggested remedies for correcting service faults are given for each of the changers. Schematics, parts lists, replacement parts data, and troubleshooting procedures are included for the tape recorders.

A cumulative index covering this and the previous six volumes is included for the convenience of the technician. The products of the following firms are included in this volume: *Ampro, Collaro, Columbia-Bell & Howell, Columbia Records, Crescent, Miracord, Knight, Magnecord, Pentron, RCA Victor, Revere, Sentinel, Silvertone, Electro-Tape, V-M,* and *Wilcox-Gay.*

* * *

"KEY CHECK POINTS IN TV RECEIVERS" by Sams Staff. Published by *Howard W. Sams & Co., Inc.,* Indianapolis. 165 pages. Price $2.00 Spiral bound.

This book has been prepared for the practicing TV technician and is designed to speed servicing and facilitate troubleshooting.

The book gives voltage measurements that should be present at various points in a normally operating receiver, along with the waveforms that are present at key points in the receiver. The peak-to-peak amplitudes are given alongside of the pertinent waveforms. Thus, by comparing the set on the workbench with the normal readings and patterns, diagnosis is simplified and speeded.

Receivers released late in 1951 and in 1952 are covered in this volume and represent the output of approximately fifty different manufacturers. The material is carefully indexed for maximum availability and usefulness.

* * *

"MULTIVIBRATORS" edited by Alexander Schure. Published by *John F. Rider Publisher, Inc.,* New York. 47 pages. Price $0.90. Paper bound.

Since multivibrators are now encountered in such varied equipment items as scopes, TV receivers, TV cameras, TV transmitters, computers, radar, electronic switches, multiplex telegraph transmitters, etc., it behooves the serious student of electronics to keep abreast of the times.

A book of this size cannot, of course, cover the subject in detail but it does a remarkable job of suggesting the scope of such applications and in providing fundamentals which act as a springboard to additional study.

The examples and circuitry given in this book are typical and, as such, will be helpful to the technician, student, and experimenter. The treatment is nonmathematical which will be welcome news to many would-be buyers.

* * *

"INTRODUCTION TO COLOR TV" by M. Kaufman and H. Thomas. Published by *John F. Rider Publisher, Inc.,* New York. 154 pages. Price $2.70. Paper bound. Second edition.

So rapidly has the art of color TV progressed since the first edition of this book was published early in 1954 that it was deemed necessary to present a second, up-to-date volume on the subject.

With the availability of new, large screen colors sets and a more lavish programming schedule, color television is slowly but surely gaining public acceptance. Although much of the color

receiver service work is still being handled by factory organizations (for engineering and control purposes) the day is not far off when the job will have to be tackled by the independent service technician.

Rather than trying to jump into the middle of the color picture the technician should begin now to prepare himself for the job he may soon face. This book is one way for him to get a head start over his competition.

The new and simplified circuitry that characterizes present-day color receivers is covered in detail along with a complete schematic of the new *RCA* Model CTC4 color set.

The text is lavishly illustrated which helps to clarify still further the already lucid presentation by the authors.

* * *

"PUBLIC ADDRESS" by N. H. Crowhurst. Published by *Norman Price (Publishers), Ltd.,* London. Available in the U. S. from *British Radio Electronics,* 1833 Jefferson Place N. W., Washington 6, D. C. 60 pages. Price $1.25. Paper bound.

This brief monograph is a "how-to-do-it-handbook" for the p.a. technician or would-be technician. The author first deals with the problems encountered in setting up public address systems on either a permanent or temporary basis.

A large section is devoted to the selection of suitable equipment for specific applications. Although the equipment the author discusses and uses for illustrative examples is, for the most part, of British manufacture, comparable units are available to technicians working on this side of the Atlantic.

We believe that this specialized book for a specialized segment of the service industry will find wide acceptance.

* * *

"BUILDING YOUR RECORD LIBRARY" edited by Roy H. Hoopes, Jr. Published by *McGraw-Hill Book Company, Inc.,* New York. 235 pages. Price $3.95.

This is a compilation of columns which originally appeared in the magazine *"High Fidelity"* as a monthly feature of the same name. The original material has been somewhat amplified and brought up-to-date to reflect newer record releases currently available.

The subject matter has been allotted to various reviewers who are "specialists" on certain musical categories, ranging from pre-Bach composers through the moderns, and from jazz through the spoken word and the special test record classifications.

Although the reviewers were originally limited to ten records in their categories, the listing at the end of each chapter has been amplified somewhat to allow the neophite collector a little added leeway in his choice.

General chapters on the joy of listening and the care and treatment of cherished discs round out the specialized material. Probably no two readers will agree on the library recommended by the reviewers (in some instances even

the reviewers don't agree) the listing forms an interesting foundation for the construction of a well-rounded collection.

* * *

"THE THEORY OF LINEAR ANTENNAS" by Ronold W. P. King. Published by *Harvard University Press*, Cambridge. 925 pages. Price $20.00.

This encyclopedic work is an advanced analytical study of electromagnetic radiation, transmission, reception, and scattering as related to practical structures.

The treatment is largely mathematical and the book is designed for graduate engineers and those with advanced degrees in physics and mathematics.

Charts and tables which relate the theoretical material to practical applications are also included in this volume. —30—

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ERRATA

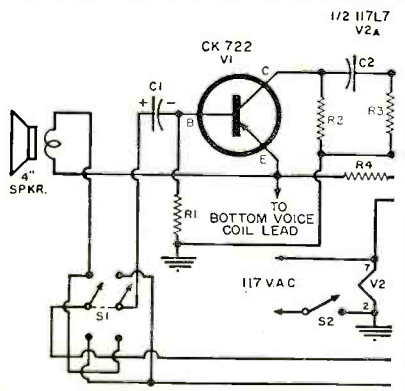
Several of our readers have inquired regarding the possibility of using other types of transistors for those specified in the article "Broadcast-Band Test Oscillator Using Transistors" (October 1955). If desired, a G-E Type 2N135 can be substituted for the TI228 (V_1) and a G-E Type 2N107 used in place of the TI200 (V_2). Since the G-E transistors are "p-n-p" types, it will be necessary to reverse battery polarity as well as the polarity of the crystal diode, CR_1. The value of resistor R_2 should be changed from 15,000 ohms to 10,000 ohms and that of R_4 from 15,000 ohms to 470 ohms.

* * *

A typographical error was made in the parts list accompanying the article "High Fidelity Performance with Mullard's 520 Circuit" in our April 1956 issue. In Fig. 3, page 67, R_6 should be 82,000 ohms, not 8200 as shown and C_6, C_7 should be .5 μfd., 400 v. capacitors not .05 μfd.

* * *

In connection with the article, "Transistor-Tube Intercom" which appeared in the February 1956 issue (page 108) the following corrections should be made. The transformer, T_1 is a Merit Type 2900 instead of a Stancor unit as specified. The switching circuit should be corrected as shown in the diagram below. Our apologies for the inconvenience we have caused our readers.



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JUNE 1956

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1LC6	.79	6C6	.49	12AU6	.62
1LD5	.85	6C8G	.85	12AU7	.75
1LE3	.79	6CB6	.68	12AV7	.95
1LH4	.85	6D6	.59	12AX7	.78
1LN5	.79	6E5	.75	12AY7	1.15
1N5GT	.59	6F5	.59	12BA6	.60
1R4	.65	6F6	.85	12BA7	.89
1R5	.65	6F6GT	.69	12BE6	.65
1S4	.65	6F7	.85	12BH7	.89
1S5	.65	6F8G	.72	12C8	.69
1T4	.65	6G6G	.72	12H6	.59
1T5GT	.69	6H6	.59	12J5GT	.65
1U4	.67	6H6GT	.49	12K7GT	.85
1U5	.59	6J5	.48	12K8	.69
1V	.65	6J5GT	.47	12SA7	.69
1V2	.59	6J6	.68	12SA7GT	.69
1V6	1.49	6J7	.82	12SC7	.75
1X2A	.85	6J7GT	.65	12SG7	.79
2A3	.95	6K6GT	.65	12SH7	.65
2A5	.65	6K7	.74	12SJ7	.65
2A6	.59	6K7GT	.59	12SK7	.69
2X2	.49	6K8	1.10	12SL7	.85
2X2A	1.35	6K8GT	.95	12SN7GT	.75
3A4	.50	6L6	1.69	12SQ7	.59
3A5	.64	6L6G	.98	12SR7	.59
3B7	.39	6L7	.95	12V6GT	.73
3D6	.39	6N7	.89	12W6GT	.87
3LF4	.85	6Q7	.85	14A7	.75
3Q4	.65	6Q7GT	.79	14B6	.69
3Q5GT	.75	6R7	.85	19BG6G	1.89
3S4	.65	6R7GT	.68	19T8	.95
3V4	.69	6S4	.57	25BQ6GT	1.25
5AW4	1.10	6SA7	.79	25L6GT	.65
5R4GY	1.45	6SA7GT	.79	25W4GT	.72
5T4	.90	6SB7Y	.87	25Z5	.75
5U4G	.58	6SC7	.72	25Z6	.62
5V4G	.88	6SF5	.72	30	.65
5W4GT	.65	6SF5GT	.69	32L7GT	.85
5X4G	.75	6SG7	.65	35A5	.68
5Y3GT	.49	6SH7	.74	35B5	.68
5Z3	.69	6SJ7	.69	35L6GT	.65
5Z4	.89	6SJ7GT	.59	35W4	.44
6A3	.95	6SK7	.64	35Y4	.65
6A6	.82	6SK7GT	.59	35Z3	.65
6A7	.89	6SL7GT	.75	35Z5GT	.44
6A8	1.05	6SN7GT	.75	41	.75
6A8GT	.95	6SQ7	.59	42	.69
6AB4	.59	6SQ7GT	.59	43	.79
6AB7	.95	6SR7	.55	50A5	.68
6AC7	.85	6SS7	.75	50B5	.68
6AF6G	.85	6ST7	.95	50C5	.68
6AG5	.72	6T8	.95	50L6GT	.62
6AG7	.98	6U5/6G5	.85	50Y6GT	.78
6AH6	.85	6U8	.95	53	.92
6AJ5	1.49	6V6	1.10	70L7GT	1.15
6AK5	.69	6V6GT	.59	75	.65
6AK6	.75	6W4GT	.65	77	.47
6AL5	.58	6W6GT	.79	78	.57
6AL7	.95	6X4	.48	80	.59
6AQ5	.57	6X5GT	.49	83	.95
6AQ6	.57	6Y6G	.89	83V	.95
6AT6	.52	7A4	.79	84/6Z4	.49
6AU5GT	1.10	7A5	.69	117L/M7GT	2.25
6AU6	.65	7A6	.78	117N/	
6AV6	.53	7A7	.75	P7GT	1.65
6AX4GT	.79	7A8	.75	117Z3	.68
6AX5GT	.69	7AG7	.95	117Z6GT	.95

TRANSMITTING AND SPECIAL PURPOSE TUBES

OA3/VR75	.86	250TH	18.95	959	1.32
OB3/VR90	.73	250TL	14.75	991	.29
OC3/VR105	.68	274A	1.40	1603	2.95
OD3/VR150	.68	274B	.85	1616	.50
1B22	1.25	304TH	7.95	1619	.30
1B23	2.68	304TL	9.95	1622	1.45
1B24	4.85	307A	1.10	1624	.95
1B27	12.95	350A	2.65	1625	.29
1B35	3.45	350B	2.35	1626	.19
1B38	33.50	371B	.85	1633	.85
1N21	.39	393A	4.50	1635	1.48
1N21B	1.45	WL417A	2.95	1641	1.35
1N23	.68	434A	2.95	1654	1.75
1N23B	1.40	450TH	47.50	2050	.93
1N34	.42	450TL	35.00	2051	.65
1N34A	.48	575A	9.95	5516	6.90
2AP1	4.95	705A	.68	5517	1.65
2C39A	12.45	707B	4.25	5637	4.95
2C40	7.45	714AY	35.00	5638	7.95
2C43	7.25	715C	10.95	5639	8.95
2C51	2.95	717A	.35	5642	.95
2D21	.65	721A	.65	5651	1.35
2E22	3.45	726A	6.95	5654	1.25
2E24	1.95	725A	2.95	5670	1.45
2E26	2.95	723A/B	8.45	5675	10.95
2E30	1.95	726B	32.50	5676	1.45
2J32	12.50	726C	32.50	5686	2.45
2J36	14.95	750TL	39.50	5687	2.65
2J51	97.50	801A	.38	5703	.95
2J55	39.50	802	2.45	5763	.95
2J61	12.95	803	1.40	5794	7.50
2J62	4.45	804	8.85	5814	.98
2K25	11.95	805	3.95	5819	34.50
2K28	27.50	806	4.85	5823	1.35
2K33A	56.90	807	1.18	5851	3.45
3AP1	2.90	808	1.25	5876	12.50
3B24	.95	809	2.20	5879	1.25
3BP1	2.45	810	9.90	5881	2.95
3C22	59.50	811	2.75	5886	2.75
3C23	3.45	812	2.45	6146	4.75
3C24	1.48	813	10.50	8005	4.75
3C45	5.95	814	1.50	8008	3.95
3D21A	3.95	815	1.50	8012	.98
3DP1	3.45	816	1.15	8013	2.65
3E29	8.43	826	.65	8014	67.50
4-125A	18.95	828	7.42	8020	1.45
4-250A	32.50	829B	7.95	8025	1.45
4C27	3.25	830B	.65	9001	.82
4C28	17.45	832	5.75	9002	.60
4C35	13.45	832A	7.95	9003	.90
4E27	7.95	833A	37.50	9004	.35
4X150A	22.45	836	1.45	9005	1.39
58P1	2.35	837	.88	9006	.25
58P4	1.95	838	.69	C1JA	10.95
5C22	27.50	845	4.85	C6J	6.45
5CP1	1.95	851	8.95	CK1005	.32
5CP7	7.95	860	2.75	CK1006	3.45
5D21	4.95	861	12.95	CK1007	.65
5FP7	1.37	866A	.98	F-123A	2.75
5JP1	12.45	869B	14.95	F-127A	22.50
5JP2	6.35	872A	1.25	F-128A	14.95
5LP1	7.40	876	.72	FG-17	2.90
5NP1	4.95	878	.48	FG-27	12.95
6AN5	2.75	884	.95	FG-32	3.95
6AS6	1.19	885	.95	FG-95	17.50
6AS7G	2.35	902A	2.95	FG-105	12.95
6C21	14.95	918	1.65	FG-172	17.95
6J4	2.55	923	1.25	HF-100	6.95
7BP7	4.95	927	.95	HF-200	9.95
12DP7	17.50	930	1.19	HF-300	17.50
15E	1.05	931A	2.45	WL-616	47.50
28D7	.75	954	.25	MX-408U	.50
100TH	6.25	955	.35	RK-65	7.50
211	.45	956	.35	RK-72	.50
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