MAC II

ELECTRONICS WORLD

RADIO & TV NEWS

NOVEMBER, 1959
50 CENTS

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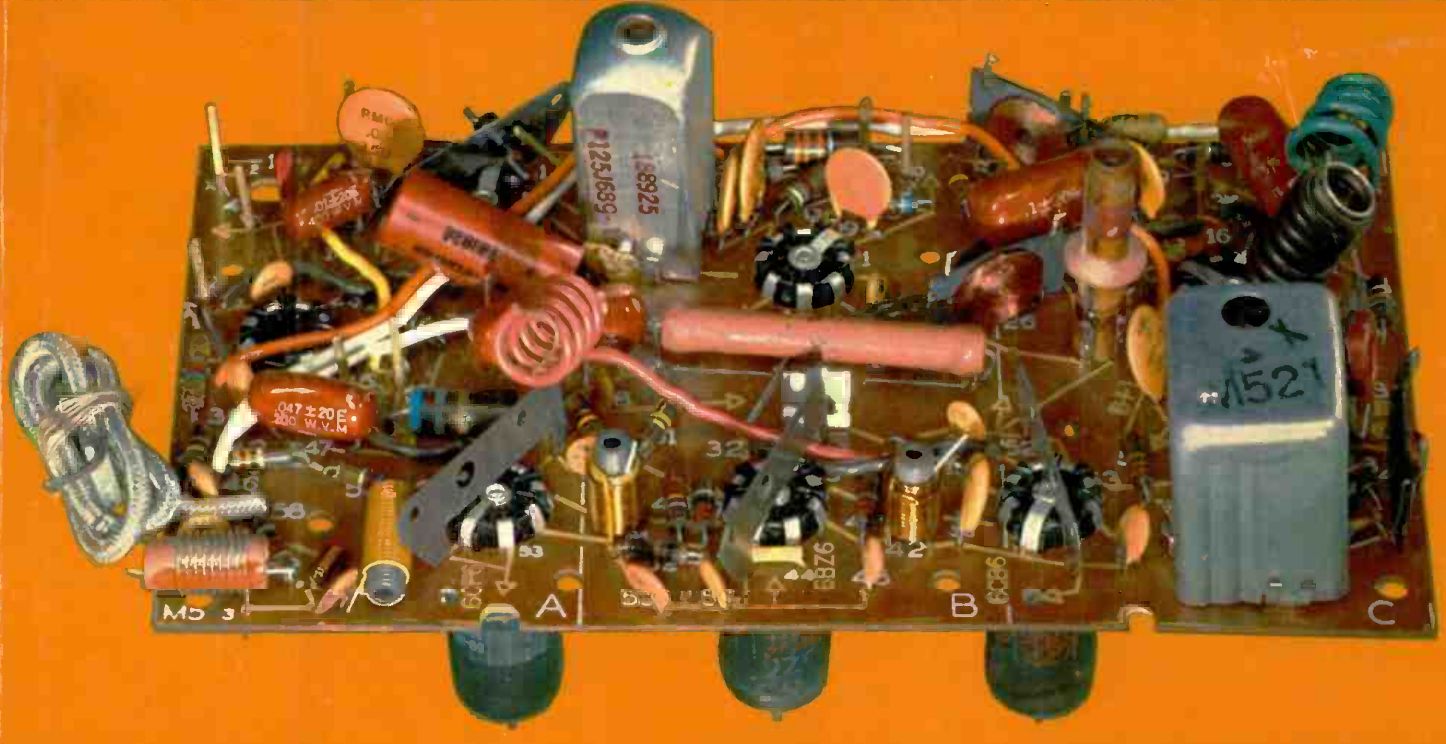

NEW PRINTED BOARDS USE ROAD-MAP TECHNIQUE

(SEE PAGES 50 & 51)

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Unrivaled for— **RELIABILITY, OPERATING STABILITY and UNIFORMITY**

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Implemented and fully proven by Amperex, a unique manufacturing technique originating with Philips of the Netherlands now enables Amperex to provide you with production VHF transistors of unparalleled laboratory quality at truly reasonable prices.

The new Amperex "alloy-diffusion" P-N-P transistors combine the best qualities of both the alloy and the diffusion approaches to transistor construction. As a result of the special "self-jigging" techniques, a maximum degree of uniformity is achieved. Thus the necessity for "selection" is completely eliminated.

The Type OC170 is designed for use as a mixer oscillator in short wave receivers, as an IF amplifier in FM receivers, and as a broadband linear amplifier for instrumentation and industrial applications. The OC170 features a high cut-off frequency of 70 Mc and a low collector-to-base capacitance of 1.8 $\mu\mu$f.

The Type OC169 is designed for lower frequencies and gain.

The Type OC171 is designed for use as a local oscillator and preamplifier in FM receivers and has a cut-off frequency of 100 Mc.

The Breakthrough... How It Was Accomplished!

This VHF transistor breakthrough was made possible by a new alloy-diffusion process, a manufacturing method that combines the best features of the currently used alloy and diffusion processes, without their drawbacks.

The limitation of the alloy process is encountered when attempting to manufacture transistors with an average cut-off above 20 Mc. In this process the collector and emitter elements are fused (or alloyed) to the base. For this to be successfully accomplished the base must be relatively thick and the thickness very accurately controlled in order that during the fusion process the collector and emitter elements do not flow through the base and short the transistor. This relatively thick base increases the transit time, precluding any usable response above 20 Mc.

In the diffusion process the base is formed on the collector by gaseous diffusion in a high temperature oven. Very thin bases can be manufactured by this method with low transit time and very high cut-off frequencies. In this process the problem lies in attaching the emitter junction and base lead.

In the AMPEREX "alloy-diffusion" process, alloying and diffusion take place simultaneously. The transistor is built up on a piece of P-type germanium. Two small pellets are placed on the germanium. Pellet B, the base pellet, contains only an N-type impurity. Pellet E, the emitter pellet, contains a P-type and an N-type impurity.

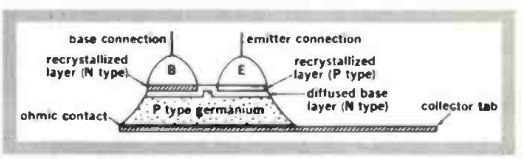
When this assembly is heated at a certain temperature, the germanium dissolves into the metal pellets until saturation is reached, and the pellet impurities diffuse into the solid germanium.

However, the P-type impurity in pellet E has such a low diffusion constant, that for practical purposes it does not penetrate into the germanium. The N-type impurity in pellets E and B has a much greater diffusion constant and readily penetrates into the solid germanium to form a diffused N-type layer underneather the pellets.

When the assembly is cooled down, a layer of germanium recrystallizes from the pellets as in the normal alloy technique. The recrystallized layer of pellet E contains many atoms of the P-type impurity and is, therefore, a P-type germanium layer. The germanium layer recrystallized from pellet B is, of course, the N-type because there are no other impurities in the pellet.

Connections are made to the germanium and the metal pellets and a P-N-P transistor is obtained. The original P-type germanium is the collector, pellet B the base, and pellet E the emitter.

This process makes it possible to mass produce transistors with a base layer of a few microns for very short transit time and high cut-off frequencies. The yield is also very high which enables AMPEREX to supply these transistors at low prices.



MAXIMUM RATINGS		OC169	OC170	OC171
V_{CE}		20 V	20 V	20 V
I_C		10 mA	10 mA	5 mA
P_C at Tamb. = 45°C		50 mW	60 mW	60 mW
TYPICAL CHARACTERISTICS				
Cut-off frequency	$f_{\alpha b}$	70 Mc	70 Mc	100 Mc
Power gain	Pg at 0.45 Mc	35 db	57 db	–
	Pg at 10.7 Mc	20 db	31 db	–
	Pg at 100 Mc	–	–	23 db
Noise figure	NF at 0.45 Mc	4 db	4 db	–
	NF at 10.7 Mc	5 db	5 db	–
	NF at 100 Mc	–	–	11 db

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FIRST Stereo Seven — new seven-inch 33⅓ rpm record

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Danvers, Massachusetts

Electronic manufacturing division of Columbia Broadcasting System, Inc.

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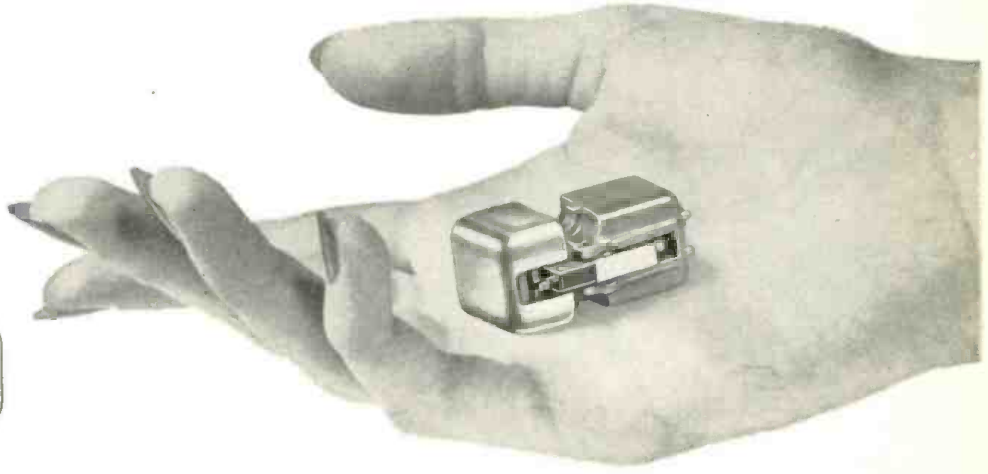

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Oliver P. Ferrell
Editor
Hi-Fi Review
as quoted in issue of Aug. 1959

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Wm. A. Stocklin
Editor
Electronics World
as quoted in issue of Sept. 1959

"... listening tests did not show up any flaws. Frequency response from 30 to 15,000 cps (limits of our test) was within 2.25 db of flat. Provides about the best channel separation available of any checked with the exception of [cartridge selling for $65.00] in the frequency range from about 5000 to 9000 cps."

C. G. McProud
Editor
Audio
as quoted in issue of Sept. 1959

"... is even better than its predecessor with respect to output, channel separation and extended frequency response and the two channels balance within ±2 db to 15,000 cycles. The shielding has been improved and the grounding of the shield and the method of shorting the two 'ground' terminals are well thought out."

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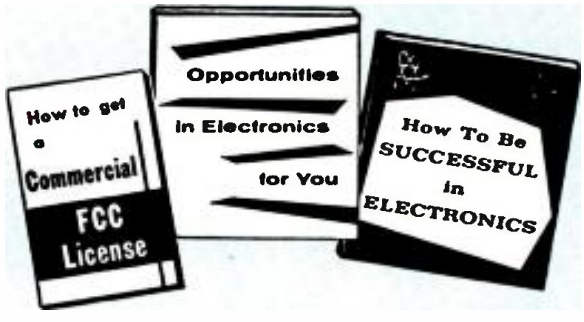

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RN-35

...for the Record

By W. A. STOCKLIN
Editor

CITIZENS BAND OPERATION

WELL, the FCC is beginning to bear down heavily on many 27-mc. Class D Citizens Band licensees. Those in the industry never doubted that the time would come when the FCC would have to take action, but we are all somewhat surprised that it is coming so soon. Possibly we should not have been if we consider the number of applications that are being filed daily. The FCC has issued approximately 58,000 Citizens Band licenses. Of this number, there are probably some 30,000 that are Class D. Remember that this is only from the first of this year and the pace has stepped up rapidly to a point where some 5000 new Class D applications are being filed each month. After all the years of amateur radio, there are only about 180,000 to 200,000 licensed operators in this country. Of this number, perhaps only about 100,000 are active. If the pace continues in Class D authorizations, these may very well surpass the number of amateur radio licenses. Again, let's consider that the allowed radio spectrum for Class D operation is only a small fraction of that allowed to the radio amateurs. It should be obvious that overcrowding of the band is practically a certainty.

To cope with this problem, the FCC is contemplating some rule changes which may limit transmission times and operating frequencies for the Class D operator. But no one should sit back and criticize the Commission for these moves. Opening up the Class D Citizens Band has been of tremendous help to the electronic industry and to the great numbers of individuals who now have their licenses. But, violation notices will be in vogue and operation will be stopped if the operators today do not abide by the rules and regulations set up by the FCC for this type of operation. (Refer to article "Violations of the Citizens Radio Service Rules," which appears on page 106 of this issue. This band is *not* to be used for DX purposes or for general chit-chat as is allowed on the ham bands. The Class D band was set aside strictly for point-to-point operation for personal or business use and for those citizens who have real need for direct communication. It is not to be used to discuss Aunt Martha's upcoming party—as one would use the telephone. There is no time limit on transmissions now and the FCC probably would not consider any changes in this rule if present operators would use this service wisely.

There are movements afoot for groups to unite in protest to the FCC concerning the present methods of operation that are permitted. No one would consider this unethical providing the complaints are justified and not simply selfish. Every holder of a Class D license today would probably like to have the FCC cut off future applicants. This certainly would be one answer but it is a selfish solution and certainly unrealistic.

Time limits on contacts will probably be set up and the FCC no doubt will follow up with many other limitations through necessity.

There are quite a large number of companies now manufacturing Citizens Band equipment. They are, in many respects, divided into two groups: those who produce the more costly equipment for the commercial users of this band and, on the other hand, those companies who produce the lower-priced equipment looking toward the non-commercial or personal users. These two groups have been plaguing the FCC for rule changes directed solely to their own fields of interest. This is an unfortunate situation and it is our hope, since there is no unified voice for the operators, that the FCC does not permit itself to be swayed toward any single interest but will consider the interests of everyone.

Everyone should bear one thought in mind. The limitations set forth by the FCC when the Class D Citizens Band first opened were not too restrictive and, obviously, severe restrictions were not necessary. There were so few licensees at the beginning that one could take certain operating liberties without the danger of interference. But as more and more operators go on the air, it will become necessary for all to live strictly by the rules and, further, to conform to any rules that may be promulgated in the future for the benefit of all. Only in this way will the band be utilized fully and to its best advantage by all concerned. -30-

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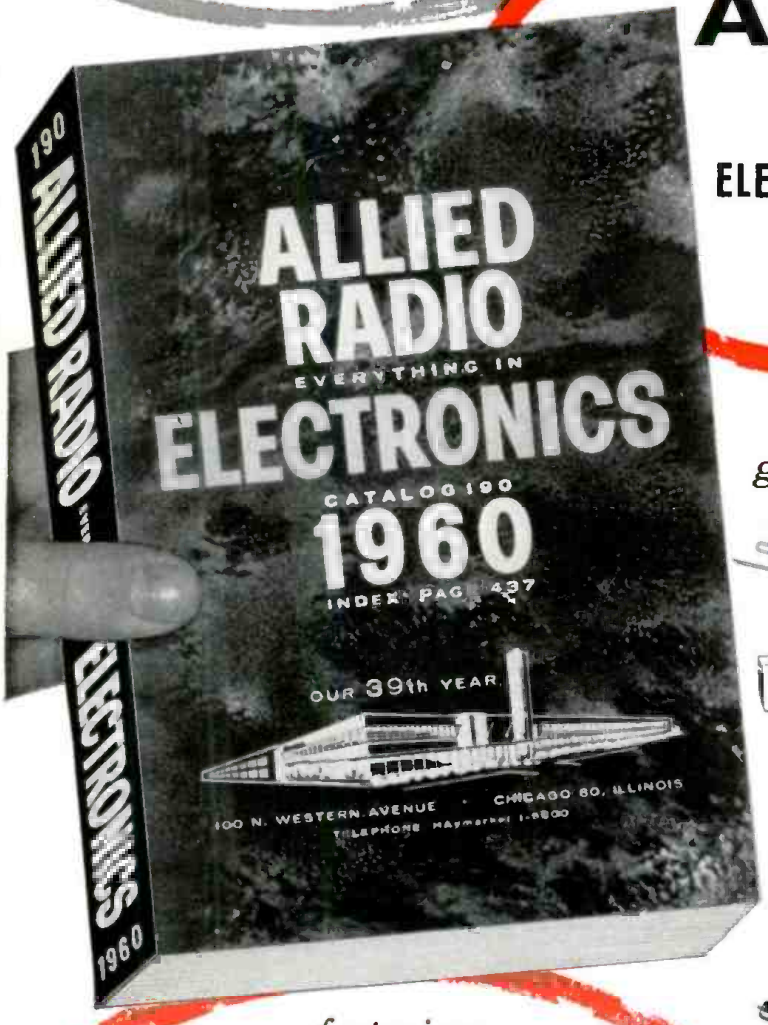

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OUR STEREO TEST RECORD

To the Editors:

May we thank you for sending us one of your stereo test records because that phasing check is worth twice the price and is most satisfactory. We cannot imagine a better solution to this perplexing difficulty than the one you have come up with. It seems infallible and certainly belongs with every stereo system.

I. C. WHITTEMORE, JR., Manager
Sirocco Enterprises
Milford, Connecticut

We are still receiving many nice comments from users of our stereo-monophonic test record. The phasing test is quite simple to use and really works.—Editors.

* * *

TRANSISTOR STEREO TAPE SYSTEM

To the Editors:

Hobbyists who contemplate the building of the equipment described in my article "All-Transistor Stereo Tape System" (July, 1959 issue of ELECTRONICS WORLD) will be interested to know that a saving of about $13.00 can be realized by substituting the following semiconductors.

Use a 2N525 in place of a 2N43 for V_2 and V_3 of Fig. 6.

Use 1N1692's in place of 1N1115's for the bridge of Fig. 15 (no heat sink required).

Hobbyists may also be interested in knowing that a similar system with seven- to eight-watts per channel appears in the new fourth edition of the *General Electric* Transistor Manual that is now available. This system uses less expensive transistors since it operates from a lower voltage supply.

D. V. JONES
General Electric Co.
Syracuse, New York

We know our readers will be very interested in the above suggestions from Author Jones with respect to his tape system.—Editors.

* * *

TRANSISTOR PHONO PREAMP

To the Editors:

A question has come up on the derivation of the input impedance (18,000 ohms) indicated in my article "Transistorized Phono Preamp for Stereo" (August, 1959 issue). It was said that this impedance is the result of the parallel combination of R_1 (240,000 ohms) and R_2 (24,000 ohms). Of course, the actual parallel resistance is 21,800 ohms. However, as far as impedance multiplication is concerned, only resistor R_2 is multiplied since only it is connected between base and emitter. Therefore, in order to compute the effective input impedance of the preamp, it is necessary to multiply the value of R_2 at each frequency and then parallel this multiplied value with the fixed R_1. Obviously, this method is cumbersome and would be difficult to describe effectively.

In order to avoid this, the 18,000-ohm figure mentioned actually represents an *effective* parallel resistance that can be multiplied by the input impedance multiplication factor and yields proper results for reasonably small values of multiplication (below about 100). Therefore, 18,000 ohms was listed in order to avoid complexity in the discussion. Since this use of 18,000 ohms is not overly confusing and simplifies the understanding of the basic processes—it was used.

FRANCES A. GICCA
Sr. Engineer
Raytheon Co.
Bedford, Massachusetts

We appreciate having Author Gicca clear up this point for our readers.—Editors.

* * *

A "TOUGH DOG" TAMED

To the Editors:

I was working on a *Westinghouse* chassis V-2317 that was so full of ambition it insisted on showing three complete, steady pictures. I was just about ready to start substituting components from the tuner to the picture tube when the postman delivered the July issue of ELECTRONICS WORLD.

I happened to see the article "Tame TV 'Dogs' with Technique" by Warren J. Smith on page 58. It was a case of perfect timing. I followed the advice given, and in two minutes, the set was working properly.

WILLIAM NEILSON
San Jose, California

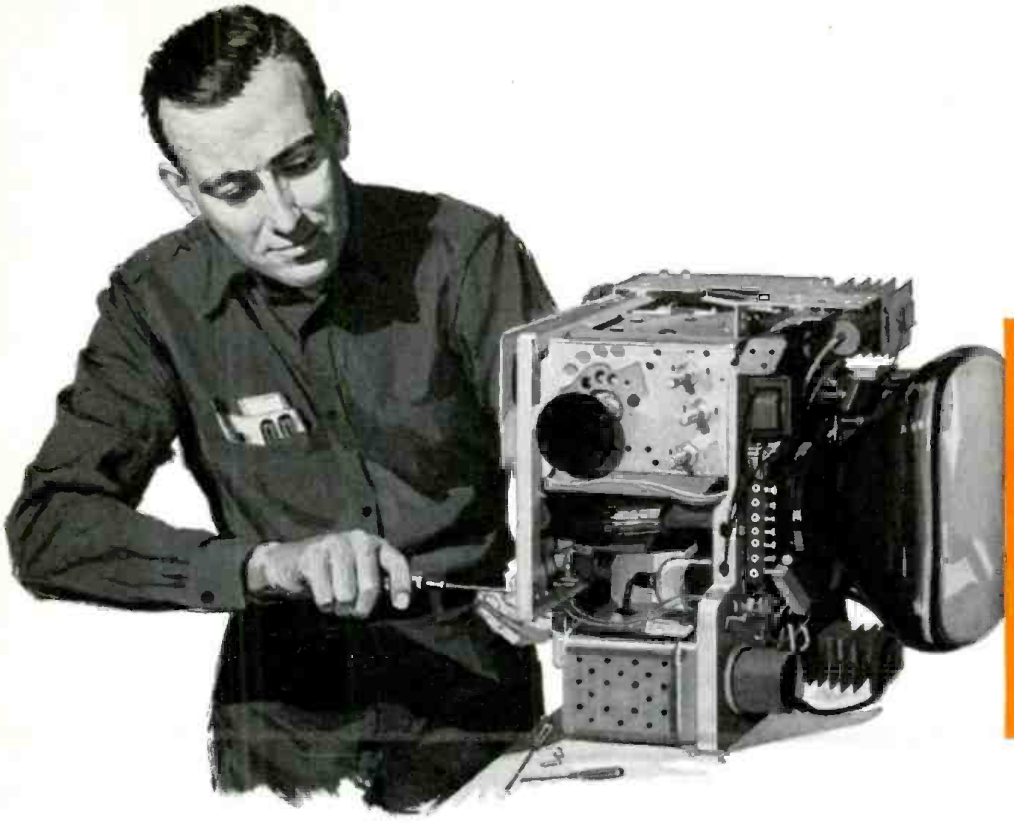
That's what you call split-second timing.—Editors.

* * *

SHOCK HAZARDS

To the Editors:

I appreciated Mr. Greenfield's article "Eliminating Shock Hazards" in the August, 1959 issue of ELECTRONICS WORLD. I feel that he should have included a fourth step in his conversion procedure, to wit: Check the outlet to which the equipment is to be connected to be sure that the wider slot is indeed the ground side of the line. Perhaps this will occur to most everyone really interested in carrying out your safety procedures, but I feel it is worth mentioning because I have tried using a similar technique and discovered that many electricians realize that all power equipment that is not of the three-



Today's FP is available in the improved "red top" design with new positive leakproof seal that ends the possibility of leakage. A new patented spring clip mounting gives improved resistance to shock and vibration plus improved heat dissipation.

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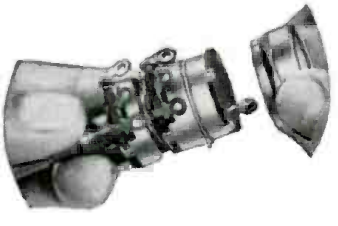

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prong variety is not polarized, and they don't really take the time to insure the proper wiring of receptacles (regardless of the National Electrical Code and most local codes). This opinion has been borne out in talking to a number of electricians.

I have no doubt that Mr. Greenfield's method of enlarging the ground prong on equipment is the best way, but a simple and effective method can be accomplished by placing the cutting end of a pair of "dikes" at the hole near the end of the prong and splitting the end thereof, while concomitantly enlarging the width of the prong. This has worked well for me on a number of occasions.

Let's have more "fold-outs." I've used every one you have had to good advantage.

DON A. POTTS
Electronic Service
Kansas City, Kansas

Perhaps the precautionary check mentioned above should not have been taken for granted in the article. Also, local practice may vary. Our experience indicates that, around New York at least, the recommended wiring will be found in all but very old installations.—Editors.

* * *

ONE-TUBE FM FRONT END

To the Editors:

I read with some concern your article in the August issue of ELECTRONICS WORLD titled "Don't Dodge the One-Tube FM Front End" (page 52).

It is certainly true that tuners of this type are in wide use today. However, my concern is with the reference to the *General Instrument* tuner and the *Telefunken* tuner and (the lack of reference) to the *Gorler* tuner.

Paragraph three of the article appears to infer that *Admiral, Motorola,* and *RCA-Victor* are using one of the aforementioned tuners. These manufacturers plus others are using the tuners manufactured by the *Julius Karl Gorler Co.* of Mannheim, Germany, sold nationally through this sales office.

R. J. SHERWOOD, President
Sherwood Sales Inc.
Chicago, Ill.

The article mentioned a few but not all manufacturers to highlight widespread use of the "general type of one-tube wonder." Paragraph three states: "relatives of it are being used in the FM lines of such manufacturers as Admiral, Motorola, and RCA-Victor." To J. K. Gorler and others not mentioned we say, "Welcome, relatives!"—Editors. —30—

NOTES ON TWO-WAY RADIO SERVICE

FOR THIS clarification of certain points discussed in Jack Darr's "Hints on Two-Way Radio Service" (April, 1959) and additional information, we are indebted to the Federal Communications Commission in Washington, D. C.; William E. Clyne, Marine Supervisor in the FCC office at San Pedro, Calif.; and Author Jack Darr himself, in response to the comments of the first two.

The form number given for renewal of operator's license (212W) is incorrect. Actually FCC Form 756 (with 756B) is used. With respect to station-license renewal, the applicant should not wait until the last month before expiration of the old one to file for renewal. The Washington source states that renewal applications should be submitted "not less than 30 days nor more than 60 days prior to the expiration date." The California source, quoting another portion of the regulations, says, "An application for renewal of license shall be filed at least 90 days prior to expiration, with certain exceptions."

Concerning the licensing of personnel who will use and operate equipment, it is not necessary for the truck drivers, policemen, and others who operate the *mobile* units to obtain such licenses. This requirement is mandatory only for personnel at the base station. In fact, the FCC would prefer to avoid the issuing of unnecessary licenses, as this creates a burden.

Other points were raised, but most seem to indicate that, despite adherence to the general regulations laid down by the FCC, there is considerable variation in local practice. The best thing to do, when in doubt or when seeking information, is to get in touch with the nearest FCC field office. If it is distant, ask the inspecting engineer of the office to drop by on one of his field trips. —30—

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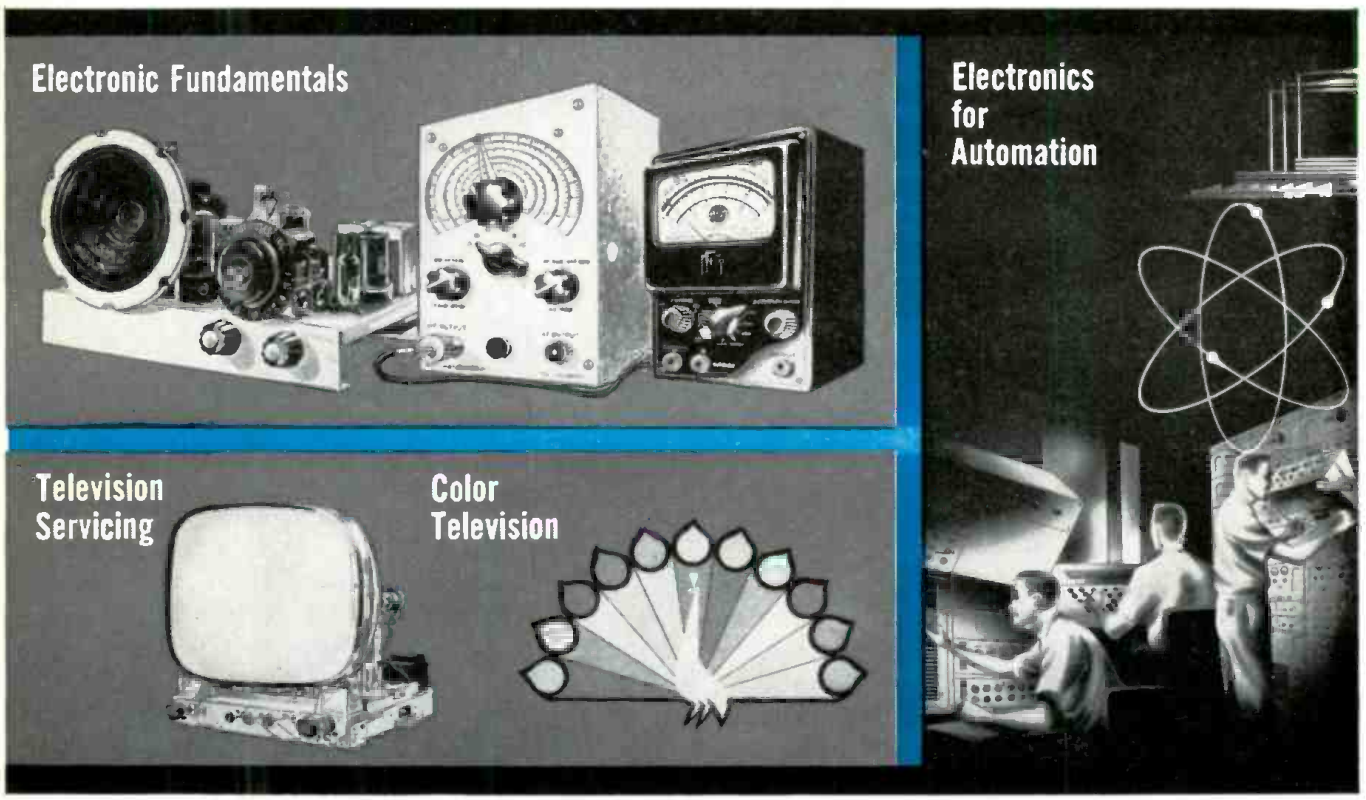

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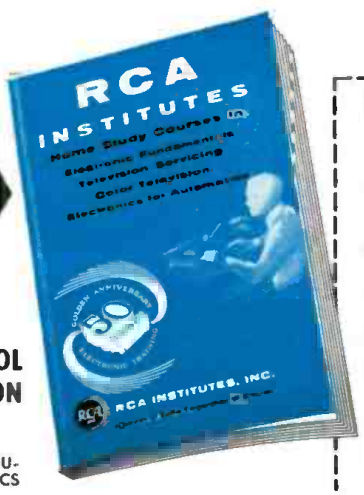

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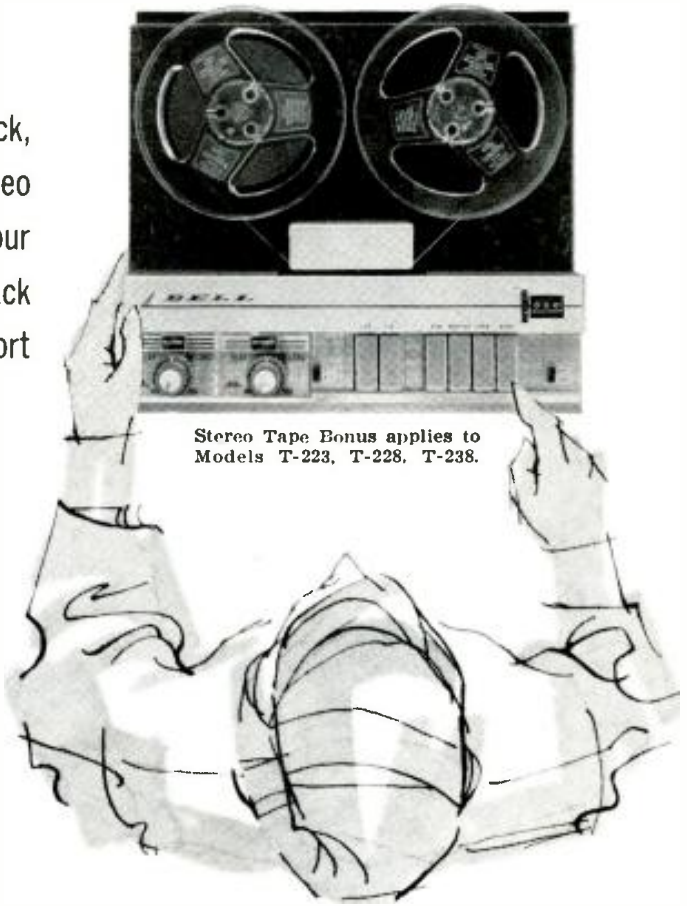
Four new 4-track, 7½ ips Bel Canto Stereo Tapes **free**—to start your library with a 4-track Bell Tape Transport



Stereo Tape Bonus applies to Models T-223, T-228, T-238.

With scores of brand new 4-track stereo tapes already available, now's the time to buy the tape transport you've wanted for your stereo system. Make sure it's a Bell . . . because only Bell gives you a STEREO BONUS of four new 4-track stereo tapes to help you start your tape library with a Bell Tape Transport.

These stereo bonus tapes have been carefully selected from the complete Bel Canto library. Wonderful music. More than 2 hours of enjoyable listening. Worth nearly $32.00 to you!

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If you already own a Bell Tape Transport, ask your Bell dealer about easy-to-install 4-track-head conversion kits for as little as $25.00.

See and hear the Bell Stereo Tape Transport—and get the bonus tapes shown on this page when you buy. Do it today at your Bell dealer's.

Bell dealers offer this **stereo record bonus,** too!

*Four Mercury LP Stereo Records, worth nearly $24.00, as a bonus when you buy a model 3030 Bell Stereo Amplifier—now priced at only $149.95**

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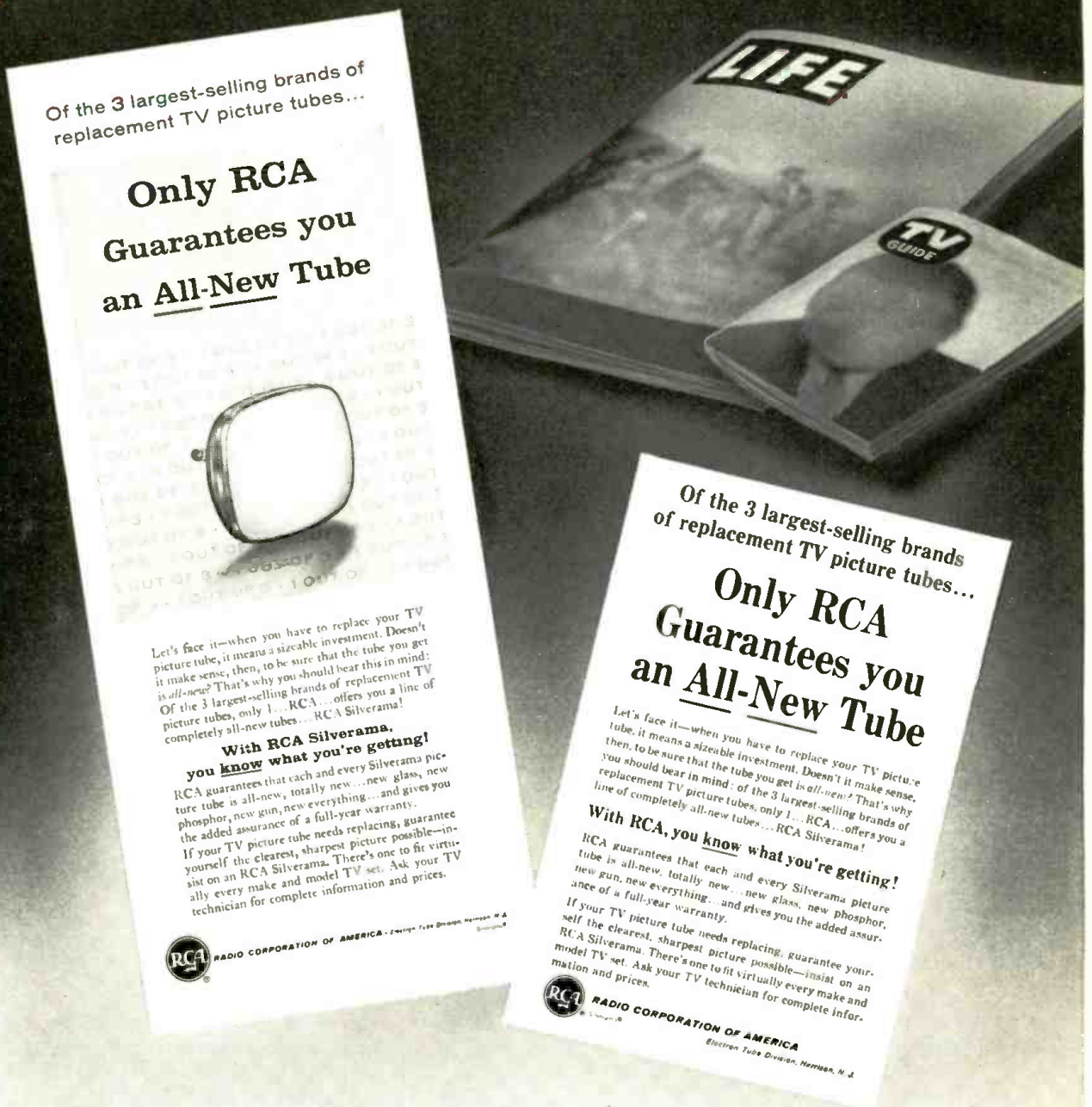


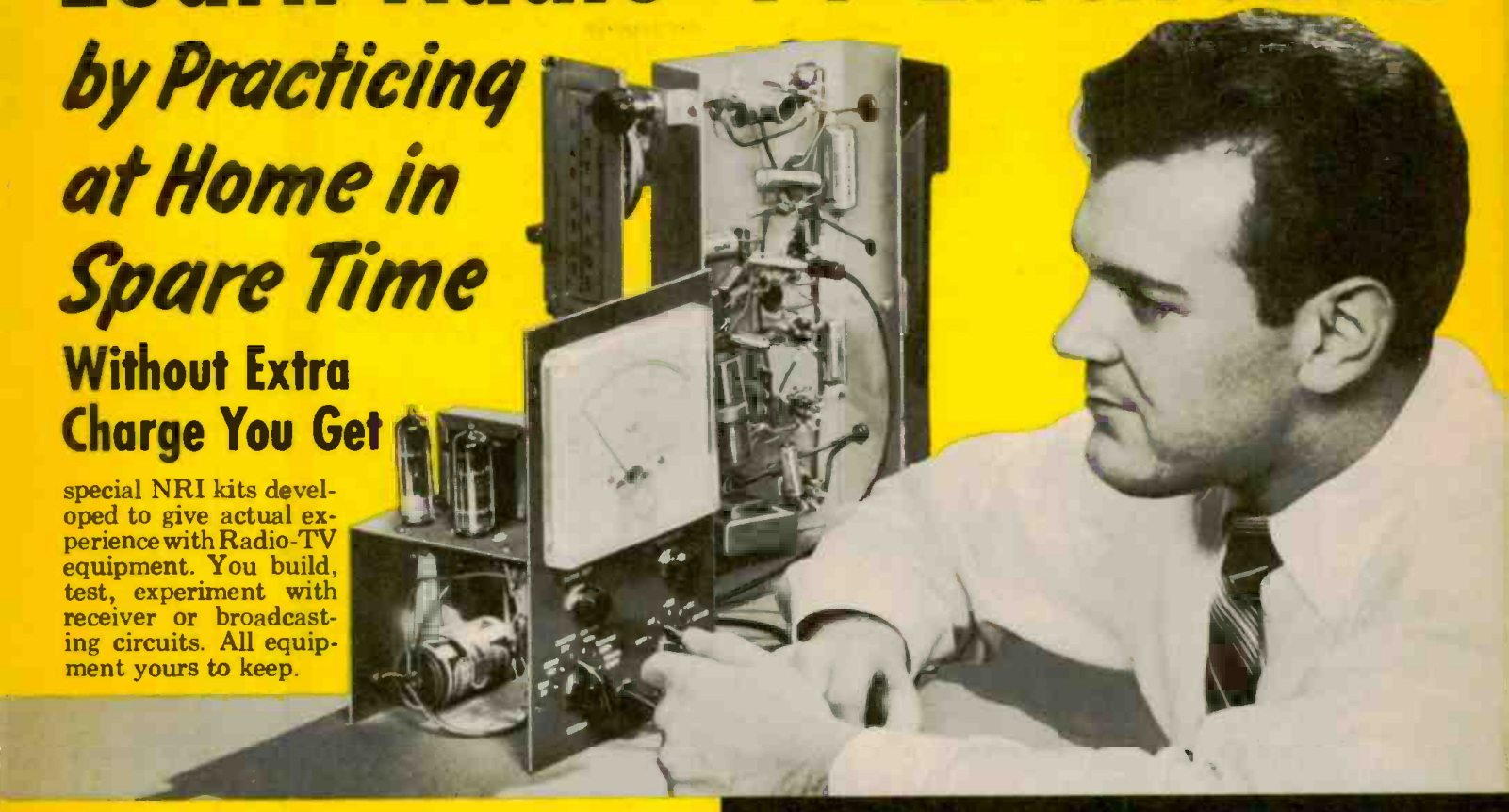
Ads like these in Life and TV Guide are pre-selling millions of TV-set owners on RCA Silverama Picture Tubes. Cash in!

RADIO CORPORATION OF AMERICA
Electron Tube Division *Harrison, N. J.*

Silverama ®

Learn Radio-TV Electronics

by Practicing at Home in Spare Time



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special NRI kits developed to give actual experience with Radio-TV equipment. You build, test, experiment with receiver or broadcasting circuits. All equipment yours to keep.

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

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

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

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

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NRI has devoted over 40 years to developing simplified practical training methods. You train at home in spare time. Get practical experience, learn-by-doing.

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NRI Has Trained Thousands for Successful Careers in Radio-TV

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

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"I have repaired more than 2,000 TV and Radio sets a year. NRI training certainly proved to be a good foundation." H. R. GORDON, Milledgeville, Georgia.

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"Early in my training I started servicing sets. Now have completely equipped shop. NRI is the backbone of my progress." E. A. BREDA, Tacoma, Washington.

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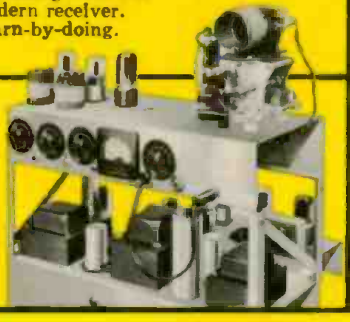
NRI Servicing Course includes all needed parts. By introducing defects you get actual servicing experience practicing with this modern receiver. Learn-by-doing.

YOU BUILD This 17 Inch Television Receiver

As part of your NRI course you can get all components, tubes, including 17" picture tube, to build this latest style Television receiver; get actual practice on TV circuits.



YOU BUILD Broadcasting Transmitter

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

YOU BUILD Vacuum Tube Voltmeter

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

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4000 TV and Radio stations offer interesting positions. Govt. Radio, Aviation, Police, Two-Way Communications are growing fields. Trained Radio-TV Operators have a bright future.

J. E. Smith, Founder

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

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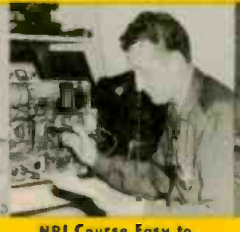
Now Quality Control Chief

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



NRI Course Easy to Understand

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

Works on Color-TV

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

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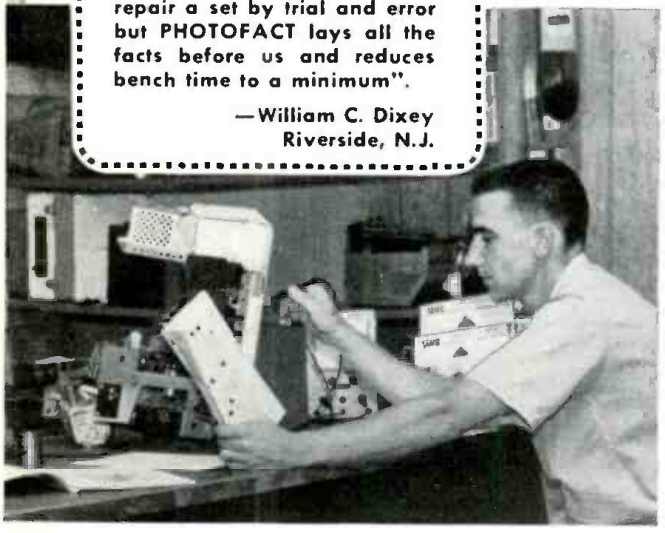

"PHOTOFACT gives us the best and latest information on part numbers, etc., as well as excellent schematics. Couldn't do without them".

—Johnny Wheeler
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Yes, if you are one of the thousands of owners of a complete PHOTOFACT Service Data Library, you are enjoying maximum earnings. It's inevitable, because no matter how expert you are, you can always *save more time* on *any* job, get *more* jobs done daily—EARN MORE, DAY IN AND DAY OUT...

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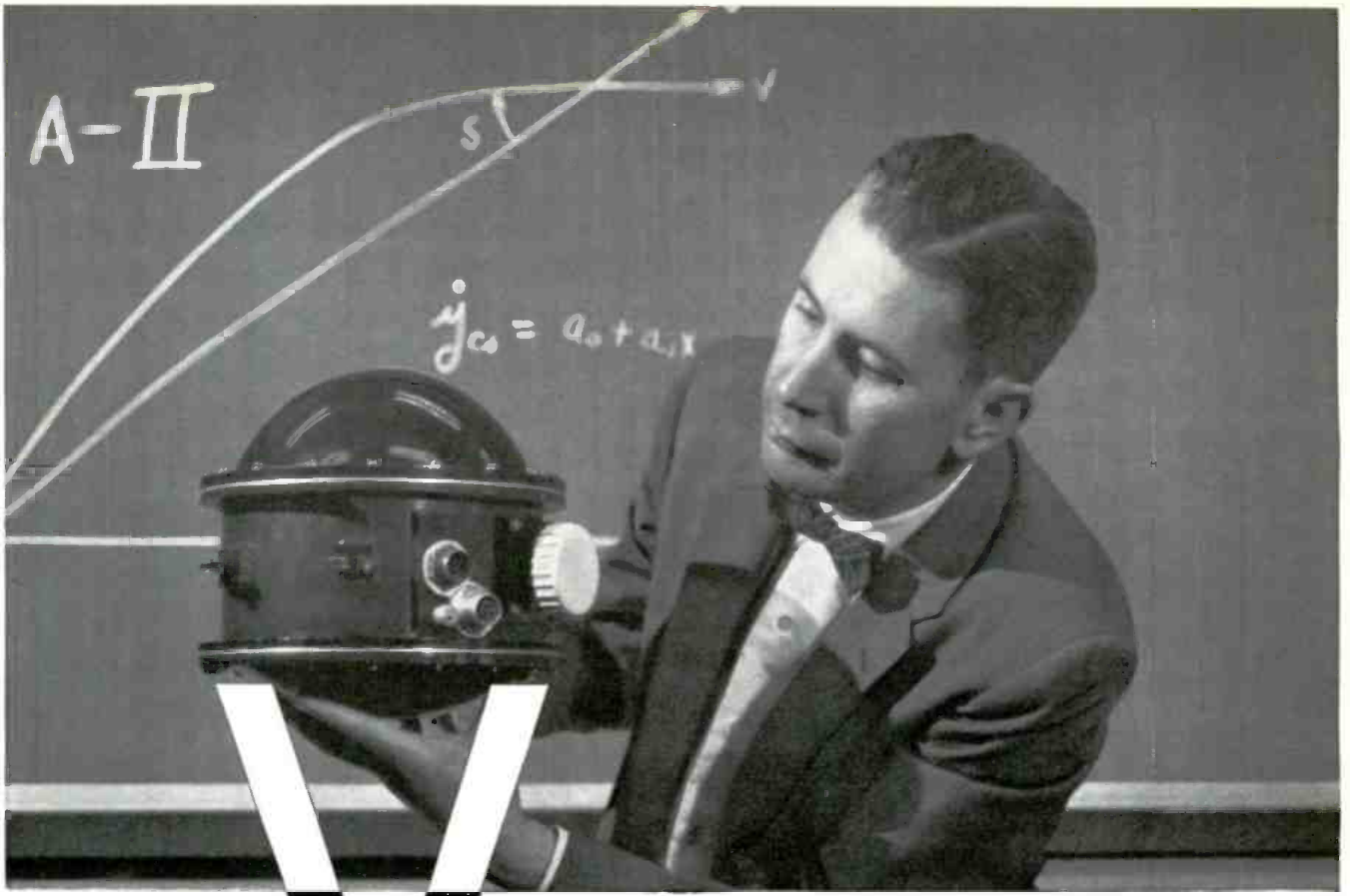


Edwin Felch, project director in charge of developing the Titan guidance system, holds the "voice" of the ICBM.

VOICE OF A GUIDED MISSILE

This is a missile-borne transmitter. It is the "voice" of a missile in flight . . . part of a new radio-inertial guidance system developed by Bell Telephone Laboratories for the Ballistic Missile Division of the Air Force.

This versatile system helped deliver the nose cone of a Thor-Able test missile precisely to its South Atlantic target area—5000 miles from Cape Canaveral, Florida. So accurately was the nose cone placed that a waiting group of ships and planes retrieved it in a matter of hours. It was the first nose cone ever to be recovered after so long a flight.

The command guidance system which made such accuracy possible combines precision tracking radar with a special Remington Rand Univac computer. Fed a steady stream of signals from the missile-borne transmitter, the ground-based equipment compares the missile's flight path with the preselected path. Corrective steering orders are computed and transmitted automatically to the missile. The ground station monitors the progress of the flight continuously and obtains immediate evaluation of mission success. And since the principal control equipment is kept on the ground, expendable hardware in the missile itself is minimized.

This radio-inertial guidance system is a product of the Bell Laboratories-Western Electric development-production team. It is in production at Western Electric for the first operational squadrons of the Titan intercontinental ballistic missile.

Bell Labs scientists and engineers developed the world's most versatile telephone network and much of our nation's radar. They have constantly pioneered in missile systems. From their storehouse of knowledge and experience comes this new achievement in missile guidance.

BELL TELEPHONE LABORATORIES

World center of communications research and development

Verdict:

Collaro

stereo
record players
are innocent
of rumble,
wow, flutter

or any noises
that
interfere
with enjoyment
of music

The Constellation, Model TC-99—$59.50

The Continental II, Model TSC-840—$49.50

The Coronation II, Model TSC-740—$42.50
*The Conquest II, Model TSC-640—$38.50

Transcription Turntable, Model 4TR-200—$49.50

Manual Player, Model TP-59—$29.95

ROCKBAR *Corporation*

Every Collaro stereo record player is built with typical British attention to every detail. They are precision engineered and rigidly tested to give truly professional performance and the ultimate in operating convenience. Here are some of the more important features that make Collaro the logical choice for stereo or monophonic records. • Performance specifications exceed NARTB standards for wow, flutter and rumble — with actual performance test reports accompanying each model TC-99. • Extra-heavy, die-cast, non-magnetic turntables (weighing up to 8½ lbs.). Extra-heavy weight is carefully distributed for flywheel effect and smooth, constant rotation. • Shielded four-pole motors are precision balanced, screened with triple interleaved shields to provide extra 25 db reduction in magnetic hum pick-up. • Detachable five-terminal plug-in head shells (on TC-99, TSC-840, TSC-740, TP-59) provide two completely independent circuits, guaranteeing ultimate in noise reduction circuitry. • Transcription-type stereo tonearms are spring-damped and dynamically counterbalanced to permit the last record on a stack to be played with virtually the same low stylus pressure as the first. • All units are handsomely styled, available with optional walnut, blond and mahogany finished bases or unfinished utility base. There's a 4-speed Collaro stereo record player for every need and budget! Prices slightly higher in the West. For free catalog on the Collaro line, write to: **Rockbar Corporation, Dept.EW-11 Mamaroneck, N. Y.** (*Not shown. Similar in appearance to The Coronation.)

RC-14

CHANNEL MASTER®

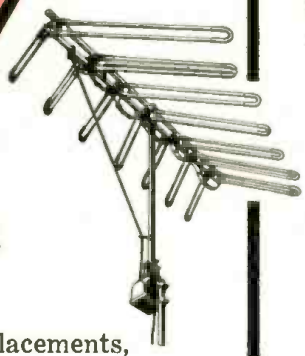
Channel Master is telling the T-W story to almost every family in the United States with the MOST SPECTACULAR ANTENNA PROMOTION OF ALL TIME!

STARRING
JOHN PAINE
in ABC-TV's
"The Restless Gun"

STARRING
GALE STORM
in ABC-TV's
"The Gale Storm Show"

STARRING
BOB CUMMINGS
in ABC-TV's
"Love That Bob"

the STARS ★ are out FOR THE T-W



2 NATIONAL TELEVISION NETWORKS!

★ ★ ★ ★ ★

4 TOP-RATED TV SHOWS!

★ ★ ★ ★ ★

8 WEEKS OF STAR-STUDDED PROMOTION!

THE BEST OF ANTENNAS DELIVERS THIS BEST OF PROMOTIONS!

To help you sell more antenna replacements, Channel Master commercials will be broadcast from coast to coast by 4 of America's most popular TV shows over the entire NBC and ABC networks—210 TV stations.

In addition to this full network coverage, 2 powerful national magazine campaigns will put the T-W story into 17 million homes... many of them right in your community.

These ads are aimed at telling consumers that their antenna installations are becoming old, worn out, obsolete, and that for the best possible TV reception they should replace their antennas with the T-W. This campaign has been designed to create new business for you by making the TV family T-W conscious.

ONLY CHANNEL MASTER GIVES THE DEALER THIS KIND OF SUPPORT!

PLUS

2 HARD-HITTING NATIONAL MAGAZINE CAMPAIGNS!

★ **FARM MAGAZINES**

To reach the rural market ...where the big fringe installations are sold!

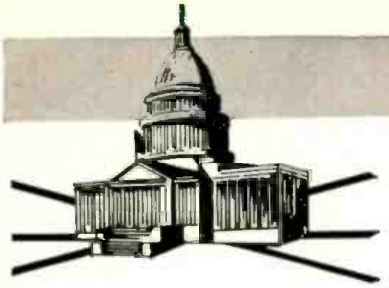
FARM JOURNAL
SUCCESSFUL FARMING
PROGRESSIVE FARMER

★ **GENERAL MAGAZINES**

To reach the vast readership of these widely-read publications... in every city and hamlet in the country!

SATURDAY EVENING POST • CORONET

Now meet the real star of the show...



Spot News

Latest Information on the Electronic Industry

By ELECTRONICS WORLD'S WASHINGTON EDITOR

IN-FLIGHT TV CAMERA SETUP DEVELOPED TO DETECT ENGINE ICING—A closed-circuit television system is now being used by the Wright Air Research and Development Command (Dayton, Ohio) to detect and study the crippling effects of icing conditions within 6000 horsepower engines of a four-engine turboprop C-133 cargo aircraft. TV scanning, via a camera mounted on the outside of the nacelle of the No. 3 engine, faced downward into the engine, covers a section of the inlet guide vanes and various moving parts of the engine. Inside the plane, a project engineer views a screen intently as ice forms, builds up, and breaks off, carefully noting the effects produced by falling pieces of ice tumbling into the engine and cutting off or limiting critical air flow. A KB-29 tanker plane is being used to set the stage for icing conditions by spraying water into the cold air high in the sky. Trailing behind the tanker, the cargo plane flies into the spray. The introduction of closed-circuit TV now permits observations which would previously have been impossible because of adverse location and environment.

SCORES OF CLASS D CITIZENS RADIO RULE VIOLATIONS REPORTED BY FCC—A wide misunderstanding of the purpose of Class D Citizens Radio Service—evidenced by approximately 100 violation notices issued—has become a disturbing factor, the FCC reported recently. Of the rule violations cited, 44 were for misuse of the short-distance provision; another ruling, involving conversation limitations, which notes that communications should be carried out in minimum practicable time, was reported to have been violated 61 times. Off-frequency operation was responsible for 57 citations, while overmodulation accounted for 3 instances. The Commission is so concerned over this situation that it is carrying out an intensive educational campaign to make it clear that Citizens Radio has no relation to Amateur Radio Service and that it may not be used to conduct ham communications, such as calling "CQ" (except in an emergency) and trying to contact distant stations. (See "For the Record", page 8 and "Violations of Citizens Radio Regulations", page 106.)

MISSILE TEST SLED TRACK WIRED FOR SOUND TO FRIGHTEN BIRDS—The famed 35,000-foot missile track at Holloman Air Research and Development Command AFB, New Mexico, has been wired for sound to frighten off the many birds perched on the glistening rails and the cause of unbelievable damage to sleds traveling at hypersonic speeds of more than 3000 miles per hour. Since the birds cannot hear the approaching sleds racing at faster-than-sound speeds, it was decided to scare them by jarring the air with recordings of machine-gun blasts, hawk cries, and thunder—all pumped into rows of speakers mounted up and down the track. Commenting on the incidents which prompted this installation, test supervisor R. C. Rethmel said that recently the impact of a bird on a 212-pound monorail sled caused a jagged 10-inch hole through a quarter-inch steel nose cone. Additional accidents of this kind included a 4-inch rupture in the wedge-like steel prow of a sled speeding at 2850 mph.

SOUTHERN MISSILE SCHOOL SEES WEAPON-REPORT PICTURE OVER CCTV FROM WASHINGTON—A 45-minute film on weapons was transmitted recently from Washington via a closed-circuit TV network to the Army Ordnance Guided Missile School at Redstone Arsenal, Alabama, 730 miles from the nation's capital. The pictorial report, introduced by Major General J. H. Hinrichs, the Army's Chief of Ordnance, was also seen on a 20 by 15 foot screen in the ballroom of the Sheraton-Park Hotel during the closing session of the annual meeting of the Association of the U. S. Army.

HIGH-FIDELITY TAPE RECORDINGS are now being used in a new training device to help sonar operators distinguish the characteristic "bark" of a school of frolicking porpoises from the tell-tale blip of an enemy submarine. This new Sonar Operators' Target Classification Trainer System is being supplied by ITT and consists of a device in which the magnetic tape runs at a speed of 60 ips with 14 separate recording tracks of information being "played" simultaneously. In addition to identification of the target, its bearing can also be simulated by the system. The sonar trainer incorporates all types of sonar-received sounds, enabling seamen to distinguish actual or real targets from false ones. -30-

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Model G-77 (Complete with G-Stand),
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When you're looking for the ultimate in cardioid microphones, consider these advanced features of Astatic's Model 77 and see if you don't agree that no other manufacturer has SO MUCH TO SING ABOUT—the most positive anti-feedback characteristics ever achieved, -18 db; exclusive Mylar diaphragm that is pop-proof and blast-proof, retains like-new flex properties for more years; an exclusive sintered bronze method of acoustic phase shifting that creates the industry's top directional characteristics; -52 db output and exceptionally flat response through 30 to 15,000 cps.

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Within the Industry

WALTER A. CLEMENTS has been appointed to the position of vice-president in charge of distributor sales and advertising for *Littelfuse, Inc.*, Des Plaines, Illinois.

The company, manufacturers of fuses for the electronic, electrical, and automotive markets, also announced the appointment of Herbert A. Cornelius to vice-president in charge of sales to industrial manufacturers.

These appointments are said to be part of the firm's long-range expansion program.

* * *

ELECTRONIC INDUSTRIES ASSOCIATION has announced the following chairmen for the fiscal year 1950-60. They are:

John B. Swan, Jr., *Philco Corp.*, renamed chairman of the traffic committee.

Michael F. McCormack, *Sylvania Electric Products Inc.*, re-appointed chairman of the tax committee.

Ben Edelman, *Western Electric Co.*, renamed chairman of the educational coordinating committee.

* * *

EDWARD C. HUGHES, JR. has been appointed to the position of manager, commercial engineering, *RCA* electron tube division. He succeeds Robert S. Burnap who recently retired.

In his new post Mr. Hughes will be responsible for the technical publications of the electron tube division.

He joined the company in 1930 as a technical writer and three years later was promoted to manager, amateur radio tube and apparatus sales section. Subsequent promotions led to his appointment in September, 1958 as administrator, commercial engineering programs of the electron tube department.

* * *

ROBERT F. CHAMBERS, of *Hycon Manufacturing Co.*, has been appointed chairman of the executive committee of the western branch, military relations department, Electronic Industries Association.

Also announced were the following appointments of committee chairmen for this department: George Hogg, Jr., *Westinghouse Electric Corp.*, accounting and cost principles; A. David Russell, *Sylvania Electric Products Inc.*, facilities and government property; Frank E. Greene, *RCA*, general contract provisions; Elmer J. Gorn, *Raytheon Co.*, patents and copyrights; C. L. Covington, *Texas Instruments Inc.*, renegotiation; and Edwin P. James, *Collins Radio Co.*, termination.

* * *

JENSEN MANUFACTURING COMPANY, division of the *Muter Company*, has broken ground for a new engineering building adjoining its Laramie Avenue plant in Chicago . . . **CLEVITE ELECTRONIC COMPONENTS** is now located at 3405 Perkins Avenue, Cleveland 14, Ohio . . . Construction has begun on **RAYTHEON COMPANY'S** sixth building to be located along Route 128, Boston's "Electronics Highway" . . . **NEWARK ELECTRIC COMPANY** has recently purchased additional land for its West Coast branch at 4747 W. Century Blvd., Inglewood, Calif.

* * *

HERB HOROWITZ has been appointed director of *Audio Empire*, the high-fidelity product arm of *Dyna-Empire, Inc.*, Garden City, New York.

Prior to joining this firm, Mr. Horowitz spent many years as chief engineer of *Electro-Sonic Laboratories, Inc.* and chief of audio products for *CBS Columbia* during which time he was responsible for a number of high-fidelity component designs.

In his new position, Mr. Horowitz will be responsible for marketing and promotion, as well as supervision of the engineering, of the company's product line.

* * *

ROBERT W. CARR has been named manager of the microphone development department of *Shure Brothers, Inc.* . . . *General Electric Co.* has announced the following appointments: **DALE L. BUNDAY**, national product planning manager for two-way radio equipment; **JOHN R. CRITTENDEN**, "severe environment specialist"; and **JAMES E. PITMAN**, manager of product planning for point-to-point communication equipment . . . **RICHARD M. ROSS** has been named to the newly created post of manager of marketing services for the semiconductor division of *Sylvania Electric Products Inc.* . . . *CBS Electronics* has appointed **WARREN E. DALBKE** district manager, equipment sales . . . *Amperex Electronic Corp.* has appointed **JOHN MESSERSCHMITT** to the position of manager, power tubes and renewal sales and **IRWIN RUDICH** to the post of manager, special purpose tubes

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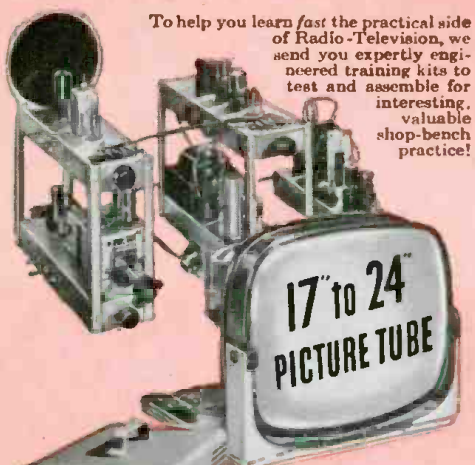
To help you learn *fast* the practical side of Radio-Television, we send you expertly engineered training kits to test and assemble for interesting, valuable shop-bench practice!



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and semiconductors . . . **CARL SCHLADEN** has been named manager, manufacturing division of *Orr Industries Inc.* . . . **KENNETH R. JACKSON** has been appointed to the position of technical assistant to the director of *Packard Bell Computer Corp.* . . . **S. EDWIN PILLER** has been appointed group supervisor of the SSB section of the *Eldico Electronics Division* of *Radio Engineering Labs.* . . . *Cornell-Dubilier Electric Corp.* has made known the following elections to its board: **THOMAS M. COLE, FRANK H. ROBY, EDWARD BIERMA,** and **LOUIS W. COLE** . . . *Erie Resistor Corp.* has appointed **WILLIAM G. TUSCANY** as senior sales representative of the electronics division . . . **JACOB B. TAYLOR** has been elected executive vice-president, finance and **LEON C. GUEST, JR.** has been elected vice-president and controller of *General Telephone & Electronics Corp.* . . . **WILLIAM M. WEBSTER** has been appointed director, electronic research laboratory, *RCA Laboratories* . . . **ZAMBRY P. GIDDENS** has been named to the newly created post of executive vice-president of *Dynamics Corporation of America* . . . **FREDERICK R. LACK** has been elected a director of the *Sprague Electric Company.*

* * *

HAROLD A. WHEELER has been elected a vice-president and director of *Hazeltine Corporation.* He is president of *Wheeler Laboratories, Inc.,* a recently acquired, wholly owned subsidiary of *Hazeltine.*

Mr. Wheeler has been a consultant to the research and development board of the Department of Defense and is currently a consultant to the scientific advisory board of the National Security Agency.

An early pioneer in the electronics industry, Mr. Wheeler founded the Laboratories in 1947. The firm has played important roles in designing microwave circuits and antennas for the Nike family of missiles and the Terrier-Tartar, as well as similar special electronics equipment for the Titan and Thor-Able missiles.

* * *

WILLIAM H. THOMAS, president of *James B. Lansing Sound, Inc.,* has been elected president of the Electronic Industry Show Corporation, heading operations for the 1960 Electronic Parts Distributors Show. He succeeds William S. Parsons, president of *Centralab.*

George E. Wedemeyer, president of *Wedemeyer Electronic Supply Company* has been elected vice-president; Mrs. Helen S. Quam, vice-president, treasurer, and distributor sales manager of *Quam-Nichols Company* is now secretary; and Edward Rothenstein, general manager of *Arco Electronics, Inc.,* is the newly elected treasurer.

Eight new directors have taken office for two-year terms. They are:

(*Continued on page* 98)

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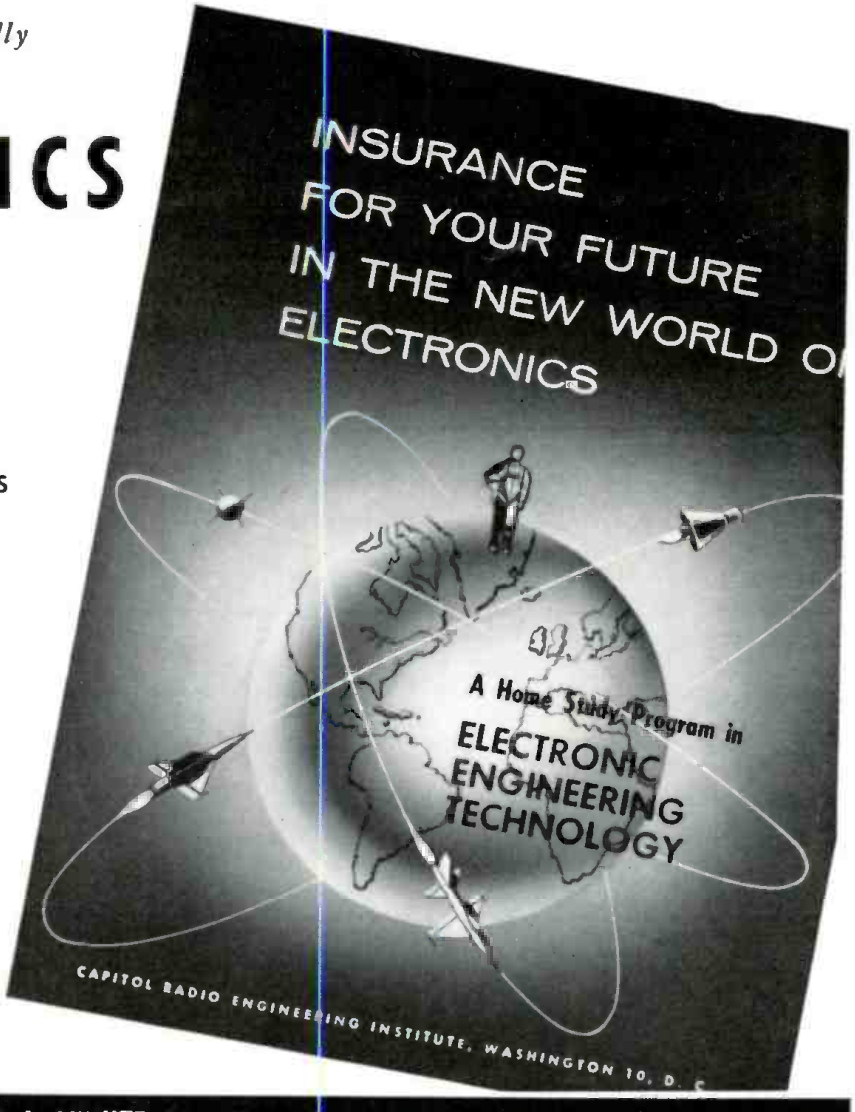

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Powerful booster or amplified coupler provides sharp, clear pictures on 1, 2 or more TV sets with only one antenna. 10 db gain as 1-set booster, 5 db gain per set as amplified 2-set coupler. No-loss 4-set distribution system with B-T A-104 4-set coupler. New 6DJ8 frame-grid tube for highest signal gain. 24.95 list

NEW VHF ANTENNA BOOSTER, MODEL AB-2

Brilliant, clear reception in fringe and weak signal areas — more than 10 db gain on all VHF channels. Utilizes advanced RF amplifier circuit with frame-grid tube for maximum signal-to-noise ratio. Can be mounted up to 500 feet from remote control unit. 53.95 list

Model AB-FM for superior FM reception. 53.95 list

'NO-STRIP' 2-SET COUPLER, MODEL A-102

300 ohm coupler provides low-loss, matched installation for superior two-set performance. Delivers more signal to each TV or FM set, with greater inter-set isolation than other couplers. No ghosts, no smears. Ideal for outside or indoor mounting, color TV, FM. 3.50 list

Model A-104 — 4 set coupler, list 4.50; Model A-105 high-low antenna list 3.50; A-107 UHF-VHF Mixer, list 3.50; A-100 Outdoor Mounting Kit, list 90¢

DISTRIBUTION AMPLIFIER, MODEL DA8-B

Powerful all-channel amplifier ideal for small TV systems (garden apartments, motels, TV showrooms), provides 8 isolated TV outlets from 75 or 300 ohm input and delivers more than 10 db gain on all VHF channels. Requires no tuning or other special accessories. 94.50 list

for every reception area — primary or fringe. for every type of installation — one set to 100

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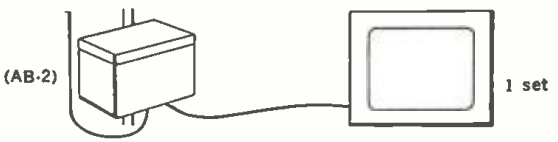
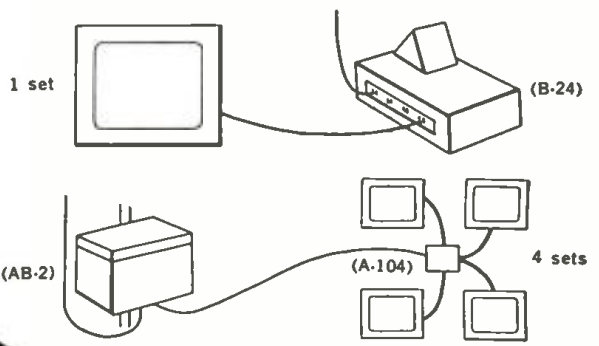
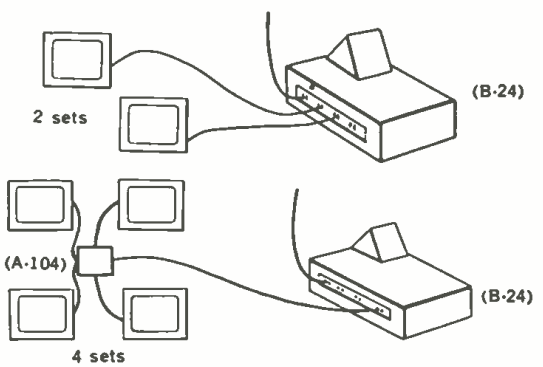


INTERMEDIATE SIGNAL AREA



PRIME SIGNAL AREA



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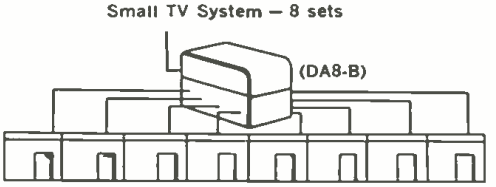

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Stereo Preamplifier HF85

70W Stereo Power Amplifier HF87
28W Stereo Power Amplifier HF86

FM Tuner HFT90
AM Tuner HFT94

Stereo Integrated Amplifier AF4

12W Mono Integrated Amplifier HF12
Other Mono Integrated Amplifiers:
50, 30, & 20W (use 2 for stereo)

2-Way Bookshelf
Speaker System HFS1
3-Way Speaker System HFS3
2-Way Speaker System HFS5

HF81 Stereo Amplifier-Preamplifier selects, amplifies, controls any stereo source & feeds it thru self-contained dual 14W amplifiers to a pair of speakers. Provides 28W monophonically. Ganged level controls, separate balance control, independent bass & treble controls for each channel. Identical Williamson-type, push-pull EL84 power amplifiers. **"Excellent"** — SATURDAY REVIEW; HI-FI MUSIC AT HOME. **"Outstanding quality . . . extremely versatile."**—ELECTRONICS WORLD LAB-TESTED. **Kit $69.95. Wired $109.95.** Includes cover.

HF85 Stereo Preamplifier is a complete, master stereo preamplifier-control unit, self-powered for flexibility & to avoid power-supply problems. Distortion borders on unmeasurable even at high output levels. Level, bass, & treble controls independent for each channel or ganged for both channels. Inputs for phono, tape head, mike, AM, FM, & FM-multiplex. One each auxiliary A & B input in each channel. Switched-in loudness compensator. **"Extreme flexibility . . . a bargain."**— HI-FI REVIEW. **Kit $39.95. Wired $64.95.** Includes cover.

New HF87 70-Watt Stereo Power Amplifier: Dual 35W power amplifiers of the highest quality. Uses top-quality output transformers for undistorted response across the entire audio range at full power to provide utmost clarity on full orchestra & organ. IM distortion 1% at 70W, harmonic distortion less than 1% from 20 to 20,000 cps within 1 db of 70W. Ultra-linear connected EL34 output stages & surgistor-protected silicon diode rectifier power supply. Selector switch chooses mono or stereo service; 4, 8, 16, and 32 ohm speaker taps, input level controls: basic sensitivity 0.38 volts. Without exaggeration, one of the very finest stereo amplifiers available regardless of price. Use with self-powered stereo preamplifier-control unit (HF85 recommended). **Kit $74.95. Wired $114.95.**

HF86 28W Stereo Power Amplifier **Kit $43.95. Wired $74.95.**

FM Tuner HFT90: Prewired, prealigned, temperature-compensated "front end" is drift-free. Prewired exclusive precision eye-tronic® traveling tuning indicator. Sensitivity: 1.5 uv for 20 db quieting; 2.5 uv for 30 db quieting, full limiting from 25 uv. IF bandwidth 260 kc at 6 db points. Both cathode follower & FM-multiplex stereo outputs, prevent obsolescence. Very low distortion. **"One of the best buys in high fidelity kits."** — AUDIOCRAFT. **Kit $39.95*. Wired $65.95*,** Cover $3.95. *Less cover, F.E.T. Incl.

New AM Tuner HFT94. Matches HFT90. Selects "hi-fi" wide (20c — 9kc @ —3 db) or weak-station narrow (20c — 5kc @ —3 db) bandpass. Tuned RF stage for high selectivity & sensitivity; precision eye-tronic® tuning. Built-in ferrite loop, prealigned RF & IF coils. Sensitivity 3 uv @ 30% mod. for 1.0 V out, 20 db S/N. Very low noise & distortion. High-Q 10 kc whistle filter. **Kit $39.95. Wired $65.95** Incl. Cover & F.E.T.

New AF-4 Stereo Amplifier provides clean 4W per channel or 8W total output. Inputs for ceramic/crystal stereo pick-ups, AM-FM stereo, FM-multi stereo. 6-position stereo/mono selector. Clutch-concentric level & tone controls. Use with a pair of HFS-5 Speaker Systems for good quality, low-cost stereo. **Kit $38.95. Wired $64.95.**

HF12 Mono Integrated Amplifier provides complete "front-end" facilities and true high fidelity performance. Inputs for phono, tape head, TV, tuner and crystal/ceramic cartridge. Preferred variable crossover, feedback type tone control circuit. Highly stable Williamson-type power amplifier circuit. Power output: 12W continuous, 25W peak. **Kit $34.95. Wired $57.95.** Includes cover.

New HFS3 3-Way Speaker System Semi-Kit complete with factory-built ¾" veneered plywood (4 sides) cabinet. Bellows-suspension, full-inch excursion 12" woofer (22 cps res.), 8" mid-range speaker with high internal damping cone for smooth response, 3½" cone tweeter. 2¼ cu. ft. ducted-port enclosure. System Q of ½ for smoothest frequency & best transient response. 32-14,000 cps clean, useful response. 16 ohms impedance. HWD: 26½", 13⅞",14⅜". Unfinished birch **$72.50.** Walnut, mahogany or teak **$87.50.**

New HFS5 2-Way Speaker System Semi-Kit complete with factory-built ¾" veneered plywood (4 sides) cabinet. Bellows-suspension, 5⅛" excursion, 8" woofer (45 cps res.), & 3½" cone tweeter. 1¼ cu. ft. ducted-port enclosure. System Q of ½ for smoothest frequency & best transient response. 45-14,000 cps clean, useful response. HWD: 24", 12½", 10½". Unfinished birch **$47.50.** Walnut, mahogany or teak **$59.50.**

HFS1 Bookshelf Speaker System complete with factory-built cabinet. Jensen 8" woofer, matching Jensen compression-driver exponential horn tweeter. Smooth clean bass; crisp extended highs. 70-12,000 cps range. 8 ohms. HWD: 23" x 11" x 9". Price **$39.95.**

LGS-1 Brass Tip Matching 14" Legs — $3.95.

HFS2 Omni-Directional Speaker System (not illus.) HWD: 36", 15¼", 11½". **"Eminently musical"** — HIGH FIDELITY. **"Fine for stereo"** — MODERN HI-FI. Completely factory-built. Mahogany or walnut **$139.95.** Blond **$144.95.**

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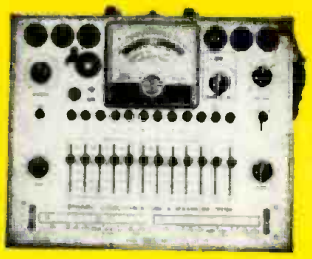

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DYNAMIC CONDUCTANCE TUBE & TRANSISTOR TESTER #666
KIT $69.95 WIRED $109.95
Complete with steel cover & handle

B
TV-FM SWEEP GENERATOR AND MARKER #368
KIT $69.95 WIRED $119.95

C
RF SIGNAL GENERATOR #324
KIT $26.95 WIRED $39.95

D
PEAK-TO-PEAK VTVM #232 & UNIPROBE (pat. pend)
KIT $29.95
WIRED $49.95

E
COLOR & MONOCHROME DC TO 5 MC LAB & TV 5" OSCILLOSCOPE #460
KIT $79.95 WIRED $129.50
5" PUSH-PULL Oscilloscope #425:
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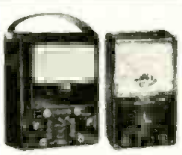

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Preserving & Cooking Food With Electronics

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

Fresh bread baked six months ago—fresh milk a year old—sirloin steak cooked in seconds—these and other food miracles are possible today, thanks to electronics.

FOOD is one of man's basic needs and when electronics invades the food industry, miracles are naturally expected. We count on these miracles because we have seen them happen in other areas where electronics has created completely new industries, as was the case with radio and TV, or in the many military applications where entirely new concepts of warfare are possible because of electronics.

The parade of electronic miracles continues. Like most "miracles" in our industry, the impact of electronics on the field of food storage and cooking will not come suddenly but rather through gradual evolution. Only when we look back to today from a vantage point ten years in the future will we realize the great extent to which electronics has contributed to our comfort, well-being, and enjoyment.

Frozen foods are a casually accepted part of our daily diet and, although only 15 years ago they were rare, we have become quite used to them. In a similar way canned foods were once a rarity and then, between the two World Wars, became commonplace. Now both canned and frozen foods appear to be headed for some stiff competition. An entirely new process, using neither heat nor cold, promises to preserve our food from the day of harvest until we need it—fresh and unspoiled.

Bread baked six months ago? Strawberries in November? Fresh milk a year old? All these are quite possible and some of them are already available on a laboratory basis. The trick that makes these "miracles" possible is the amazing power of the electron and its cousin, the *gamma* particle.

Cooking by microwaves is another application of electronics to the food industry but this technique is not quite as novel since it has been used in restaurants and institutions for several years. The new aspect of microwave cooking is its introduction into the home at prices comparable to the more conventional stove and the reliable, simple circuitry used in such units.

How Foods Are Preserved

Before going into the matter of food preservation we must first know what makes various foods spoil. We know that heat tends to hasten the decay of most foods but, unless frozen at very low temperatures, many fresh foods rot or deteriorate even when refrigerated. Food chemists have learned that there are two major factors which contribute to spoilage. One is the growth of micro-organisms, bacteria, of various microbes which multiply and cause decay. The second factor is largely chemical and is due to enzymes which cause changes in the chemical structure of organic matter. Both these attackers must be forestalled in order to preserve any food, but because bacterial changes occur much faster, the exclusion of bacteria alone will

help extend the food's storage life.

Every housewife knows that either heat or cold help to preserve food, although the length of time this preservation lasts varies widely. In the home, the heating or freezing processes cannot reach the temperature extremes possible in the commercial food processing plant, but the method is basically the same. Canned food is generally heated to kill all micro-organisms and then sealed under vacuum to prevent outside contamination. In deep freezing, storage temperature must be kept low because both micro-organisms and enzyme action are slowed at very low temperatures.

Both heating and freezing alter the color, taste, and texture of some foods. Potatoes, for example, cannot be frozen raw and bread that has been overheated just isn't bread. A little thought will quickly show the limitations of both these conventional preservation methods. The new irradiation scheme uses neither heat nor cold but attacks micro-organisms and enzymes by "atomic shotgun" bombardment. It has been found that when most foods are bombarded with high-speed electrons or with *gamma* particles, the micro-organisms are destroyed. The exact theoretical explanation for this process is still under study, but the principle seems to be that the molecular structure of most foods is loose enough to pass these high-speed particles while the microscopic animal life of the bacteria is smashed by them. Whatever the mechanism of the process, the practical facts are that it is possible to pass food in sealed plastic bags under an electron beam or source of *gamma* radiation and, after only seconds of exposure, the food remains edible for long periods of time. The heat rise in the food is insignificant and neither heat nor cold is required to sterilize or store the sealed food container.

A typical example is the two slices of bread shown in Fig. 2. Both are two months old, but while the untreated bread is practically decomposed, the slice irradiated by a 1 mev (million electron volt) electron beam is still fresh and edible.

On hearing of this nuclear miracle, it is natural to wonder about the danger of radiation contamination. This danger might exist if the neutrons used could induce radioactivity into the food or the container. *Gamma* radiation (which accompanies some nuclear changes and is similar to x-rays but of shorter wavelength) does not produce atomic changes in the food atoms and leaves no radioactive material in the tissues. The same applies to electrons. We know that just because x-rays have passed through one's hand this does not make the hand radioactive or give it the power to emit radiation after the x-ray machine is turned off. In a similar manner, food remains edible and non-radioactive after an exposure to *gamma* particles, electrons, or x-rays. The electron beams used for food preservation are similar to the beam which "paints" the picture on the face of the cathode-ray tube, but here a vacuum is not required, nor is a special cathode structure needed. Electrons in the air are accelerated until their speed reaches the equivalent of several million electron volts. This speed is achieved either by high-voltage machines such as the Van de Graff generator or by high-frequency units such as the linear accelerator.

Electron-beam treatment has certain advantages over *gamma* radiation in that relatively few technicians are required in the process and there is little danger to personnel of overexposure to harmful radiation. The exact dosages are easily controlled and monitored, but the penetrating power of the electron beam is relatively low. Fig. 1 shows cranberries in plastic bags passing under the swept electron beam of an early experimental high-voltage machine. With a 10-million-volt gen-

▲ Fig. 1. Cranberries are passed under swept beam of a super voltage electron beam generator by conveyor belt and subjected to electron bombardment and sterilization.

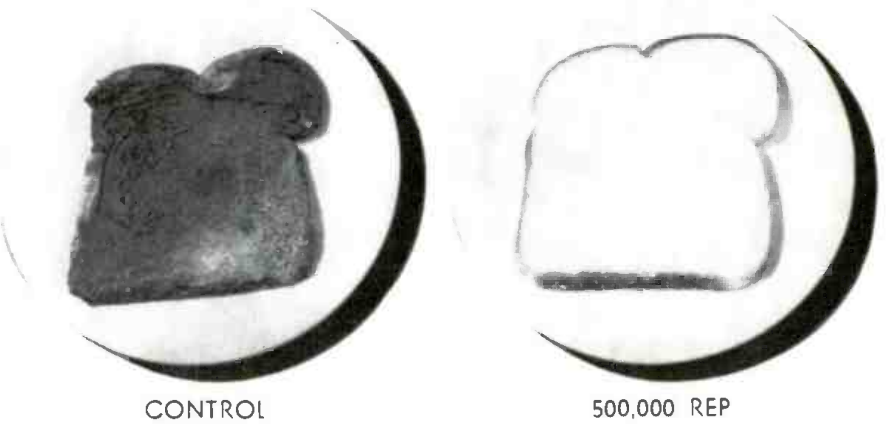
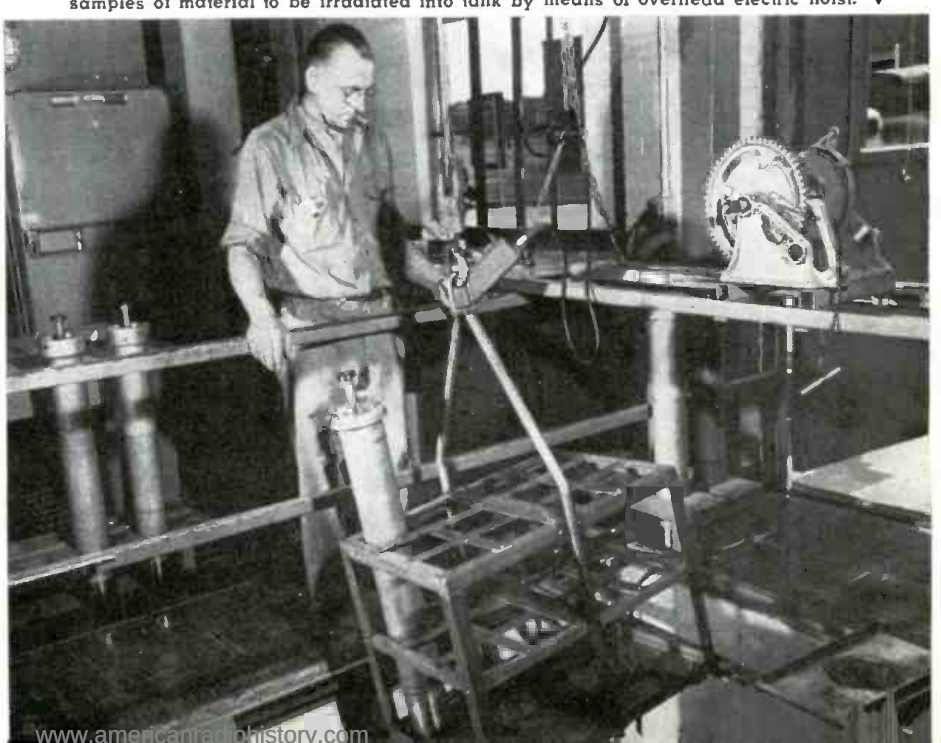
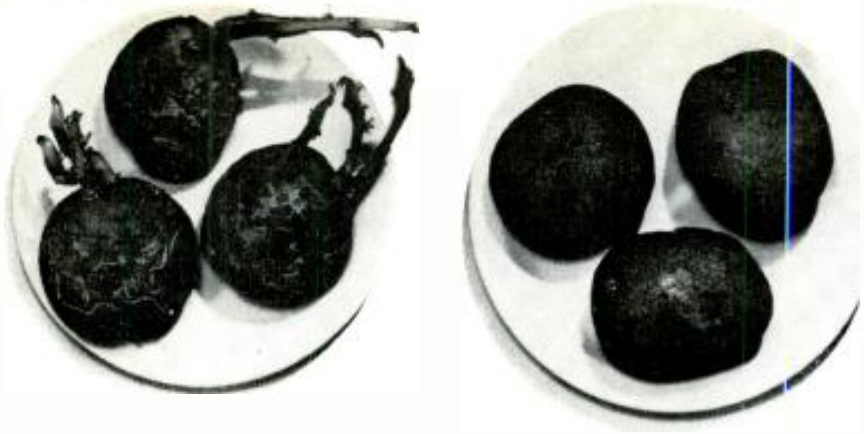


Fig. 2. Both pieces of bread were stored at room temperature for two months. The untreated control slice is moldy and not edible while the irradiated slice (right) is fresh. REP (Roentgen Equivalent Physical) indicates amount of radiation used.

Fig. 3. A research worker is lowering a sealed, thin-wall aluminum urn containing samples of material to be irradiated into tank by means of overhead electric hoist. ▼





CONTROL 10,000 REP

Fig. 4. Irradiation inhibits sprouting of potatoes, as shown in this photo taken six months after harvest. The potatoes at right were irradiated two months after harvest.

erator, the penetration is less than 2½ inches, which would hardly be suitable for a side of beef, for example.

At the Army Ionizing Radiation Center in Lathrop, California, a new linear accelerator will be available which will generate up to 24-million electron volts and have a penetrating power of 6 inches. It will be able to handle 3000 pounds of food per hour at a high level of radiation and will approximate at least pilot plant operation of a future commercial enterprise.

Sources of *gamma* radiation have much greater penetrating power but the handling of radio-isotopes, in general, still requires extreme care and specially trained personnel must be employed. The biggest problem in this area is to use *gamma* sources which do not also emit other radiation and which can be controlled. Various atomic waste products have been used experimentally, but since they are usually part of a nuclear reactor installation, the precautions involved in handling such materials have thus far presented a serious drawback to their efficient use for food preservation. Fig. 3 shows how food samples are irradiated at Argonne National Labs. Special containers, monitoring meters, and hoists are required because of the dangers of radioactivity. After extensive study, it was decided to provide the Army Ionizing Radiation Center with radioactive cobalt 60 as a source of *gamma* radiation. The energy level of this source will be approximately two million Curies which will probably make it the largest single source of *gamma* radiation in the country. With a really effective means of irradiating food by either method, it will be possible to resolve some of the remaining problems and, in a short time, radiation preservation can be extended to many more foods.

Present Limitations

Certain subtle chemical changes, caused by either type of radiation, result in flavor or odor variations in some foods which limit the usefulness of this preservation method in the case of such foods. These changes are very slight, but to the person accustomed to certain flavors or odors, the particular food "just doesn't taste right." Strawberries, butter, milk, and cheese, for example, can be sterilized for long storage life, but the changes in their taste or odor are sufficient to make them unacceptable at the present time. Carrots, pork, ham, spinach, peas, and

Fig. 5. Raytheon's Mark III Radarange oven.

mackerel, on the other hand, develop no noticeable change after irradiation and taste just like the familiar fresh food. Several means have been found to reduce the undesirable changes in taste and odor. Irradiation in the absence of oxygen, in a frozen state, or with the addition of ascorbic acid solves this problem in many foods.

Future Uses

In addition to long-term storage, irradiation can also be used in smaller dosages to inhibit sprouting in potatoes, as shown in the photo of Fig. 4, eliminate insect infestation of grain, and kill trichina parasites in pork and ham. When grain is irradiated, all insects, larvae, and eggs are destroyed, permitting almost indefinite storage in sealed bags. These effects, in themselves, are of great importance in the food industry since spoilage due to these and similar causes result in millions of dollars loss annually.

Food preserved by radiation need not be refrigerated, but it must be sealed off from any attack by bacteria, insects, or parasites after sterilization. Plastic containers, bags, or cans which can be hermetically sealed are used to store irradiated food.

For the past four years, the U. S. Army has been conducting a series of experimental feedings of irradiated food with human volunteers and with many generations of rats. No bad effects have been reported, either to the human subjects or to any of the generations of laboratory animals.

These studies are far from complete and before irradiated foods appear in neighborhood markets several years are bound to elapse. There is no doubt, however, that at least for many types of food, irradiation will be the standard means of preserving it. Just as the advent of frozen foods brought new delicacies to the average dinner table and changed our buying, storing, and preparation habits, so will food irradiation make itself felt. New, lighter, and more efficient packaging means will be used, shipping and storing will be cheaper and simpler, and, especially in areas where refrigeration is not generally available, food spoilage will be greatly reduced. For the average American the biggest improvement in his daily diet will be the availability of fresh fruits and vegetables at all seasons, without the changes necessitated by freezing or canning.

Electrons for Cooking

Most of our readers have heard about cooking with microwave energy, but both the principles and the actual circuitry are not widely understood. Unlike the irradiation method of preserving food, microwave cooking is already being employed in restaurants throughout the country and now effi-

Fig. 6. Tappan electronic oven for home.

cient home-type microwave stoves are being advertised at less than a thousand dollars. Fig. 5 shows the "Mark III Radarange"—a restaurant-type model—while Fig. 6 is the latest *Tappan* electronic range, listed at $895.00. We will discuss briefly the principles of microwave cooking and then describe the actual equipment from the point of view of the technician who might have to service this latest "electronic servant."

Electronic cooking differs from industrial dielectric heating only in that the frequencies used are much higher and in its application to foods rather than plastics. All foods contain water to some degree and are therefore quite "lossy" when it comes to microwaves. Those familiar with testing radar equipment will recall the use of water loads to test out high-energy radar transmitters. In effect, the food represents the load of the microwave transmitter which is the heart of the microwave oven. The simplified diagram of Fig. 8 shows the basic circuit of an electronic cooking device. The resonant circuit in microwave work is usually a cavity and, when this has "lossy" material in it, it is just as if a resistor were connected across the tank circuit. The energy in the cavity is dissipated in the food, heating it up. The r.f. energy penetrates the food completely and this creates a uniform heating effect. Microwave ovens make it possible to bake bread without crust, roast meats without splattering or burning the outside fat, and perform many other similar tricks.

It will be apparent that metal dishes in such an oven would not merely "load" the cavity but detune or even "short" it electrically. For that reason all microwave cooking is done in glass, porcelain, or ceramic dishes. These materials have very small losses at microwave frequencies and therefore remain relatively cool. This means that there will be no burned-on foods—making them easier to clean and handle. In most cases, food is cooked in the same dish in which it is served.

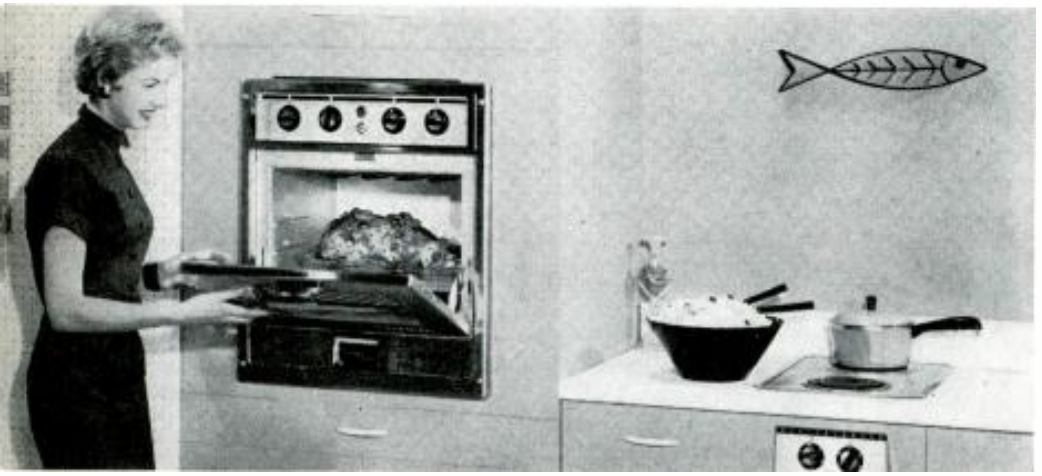


Fig. 7. Westinghouse electronic range and surface cooking unit do all of the work.

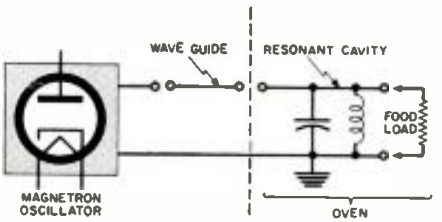


Fig. 8. Basic circuit for microwave oven.

Microwave Oven Circuit

Fig. 9 is a partial schematic of the *Raytheon* "Mark III Radarange," which is typical of heavy-duty restaurant installations. We have omitted the various safety interlocks, timers, relays, and motors which make up the actual electrical system. Also omitted are two pumps which circulate the cooling liquid which serves as heat exchanger for cooling the two Type QK-707 magnetrons.

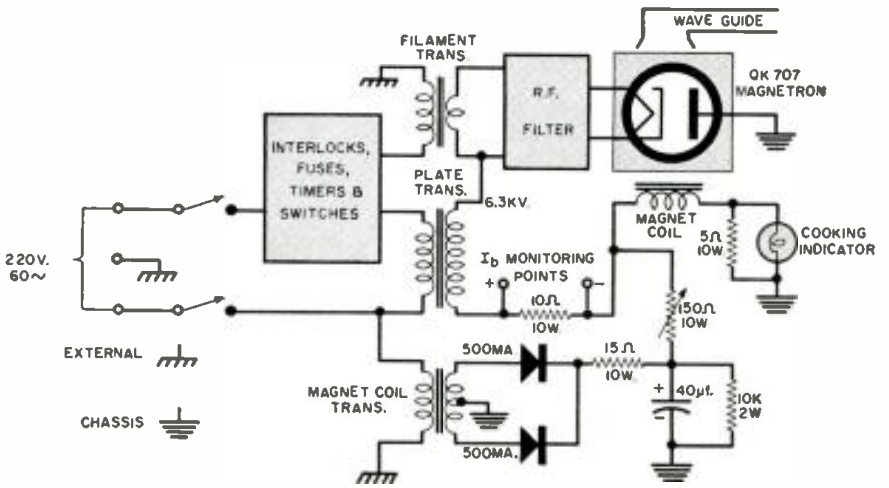
The "Mark III Radarange" delivers 1600 watts of microwave energy at 2450 mc. and, as can be seen from the diagram, is modulated by the 60-cps line voltage. With the plate grounded, the filament and cathode are at negative 6.3 kilovolts r.m.s. Oscillation is produced by separate electromagnets surrounding the magnetrons and the d.c. power for these coils is obtained through full-wave selenium rectifiers. Microwave energy is generated into the cavity of the magnetron tube and is conducted by means of a waveguide into the cooking cavity—the oven. Two identical magnetrons are used with separate power sources for filament, plate, and magnet coil, but in Fig. 9 the circuit of only one is shown. Use of two magnetrons permits applying only half the cooking power, 800 watts, for smaller loads.

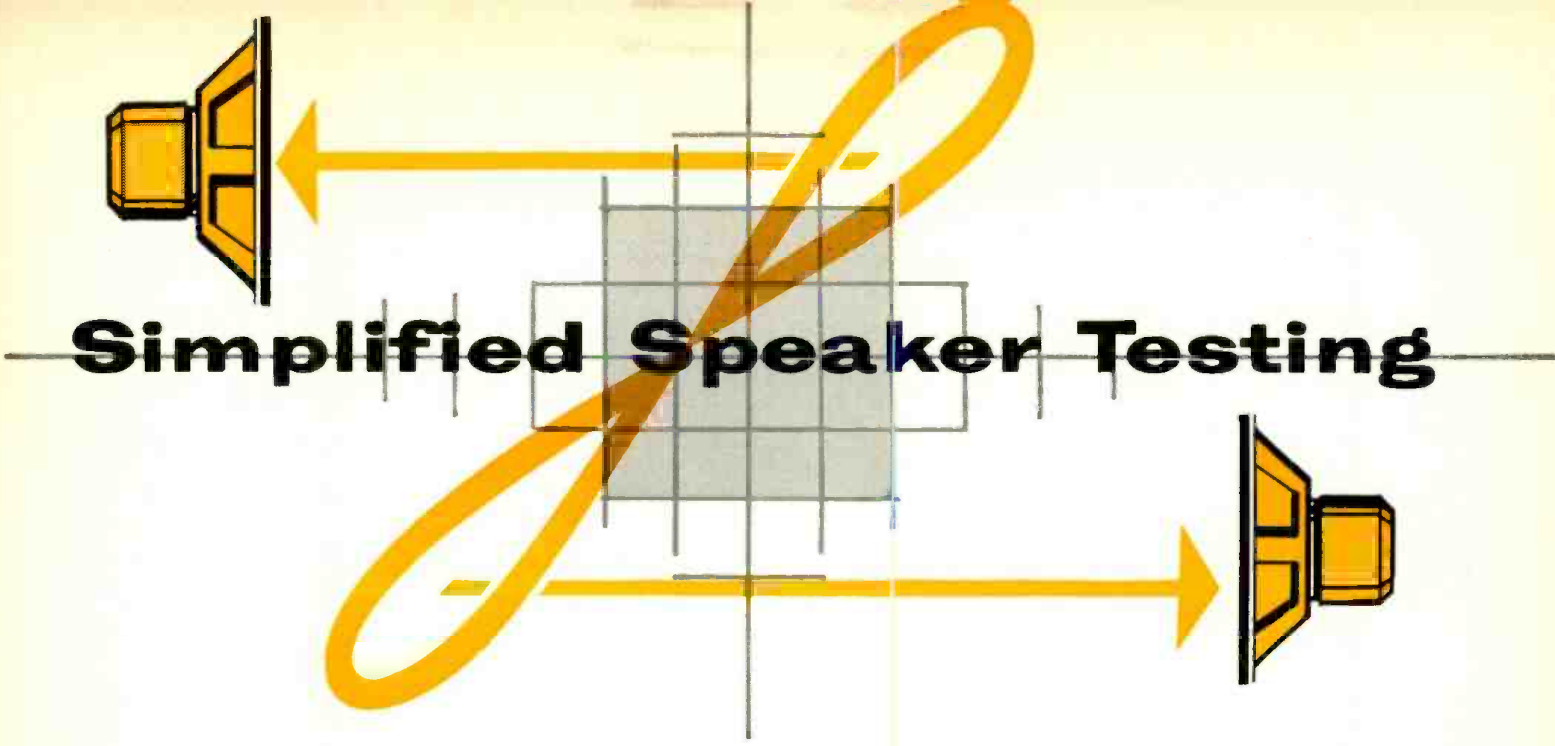
One of the important features of most ovens is the "stirrer"—a fan-like device which rotates in the cavity during the cooking cycle. In an ordinary microwave cavity there are spots where the r.f. energy level reaches zero. Unless the food load is distributed correctly, it could happen that some parts would receive less cooking energy than the rest. Housewives cannot be expected to consider correct electronic loading of a cavity and for this reason, the stirrer is introduced. It detunes the resonant cavity slightly and, by rotating, deflects some energy in a semi-random fashion. This dispersion assures an even energy distribution, irrespective of the size or placement of the food in the oven.

We mentioned that microwave cooking results in uniform heating of the foods and this means that there would be no brown crusts on meats, pies, etc. The formation of such a crust is actually incidental to the cooking process and, in most microwave ovens, this feature is added by means of regular, resistance-type heating elements. In the photograph of Fig. 7 the browning elements can be seen at the top of the oven cavity. Foods are usually cooked first and then browned to just the right coloring. The total oven time, even with the browning, is still only a fraction of that normally required with conventional stoves.

(*Continued on page* 141)

Fig. 9. Simplified circuit diagram of the Raytheon Radarange electronic oven.





Simplified Speaker Testing

By R. D. HERLOCKER

Use an oscilloscope and audio oscillator to measure loudspeaker impedance, phase angle, and distortion.

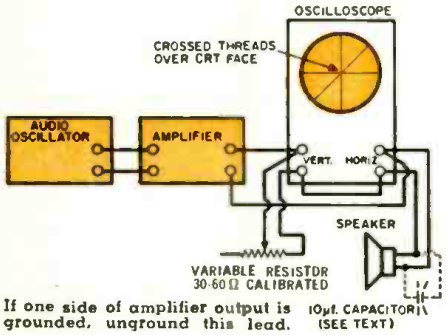
MANY audiophiles test their own amplifiers either as a matter of routine maintenance to keep their equipment in top-notch working order or to modify them for improved operation. On the other hand, it seems that relatively few make any attempt to check the performance of their speaker systems. This is in spite of the well-known fact that the average amplifier of today is freer from distortion and has a more uniform frequency response than even the better speakers now in use.

What accounts for this difference in attitude? Is it because so many of the factors controlling response and distortion are "built-in" to the speaker and thus are presumably not subject to improvement? Or is it because so many persons seem to have the idea that in order to determine any significant characteristics of a speaker system, test equipment is needed which is beyond the reach of all but well (and expensively) equipped laboratories?

It is quite true that many items which affect response and fidelity are inherent in any speaker and are fixed at the time of manufacture. However, other factors, which are also quite important in determining the over-all response of the system, are very much under the control of the user. These controllable factors are primarily those which are concerned with mounting or enclosing the speaker and locating it within the room, and their importance should not be underestimated. For example, a speaker with a free-air resonance near 30 cycles, or even lower, and a smooth response above that point, may sound best in an infinite-baffle type of enclosure, while another speaker with a sharp resonance falling within the normal bass range (50 to 70 cycles, for instance) may need a bass-reflex type enclosure to tame the resonance and generally smooth out the lower end of its range. The type, amount, and location of sound absorbing material within the enclosure will also affect the response, but usually in a higher range, since the lack of such material may permit other resonances due to reflections within the enclosure. Then, too, if tests can be made in the room in which the speaker is to be used, it will probably be found that the location of the speaker in the room has a considerable effect on its performance. This is particularly true in the case of stereo reproduction.

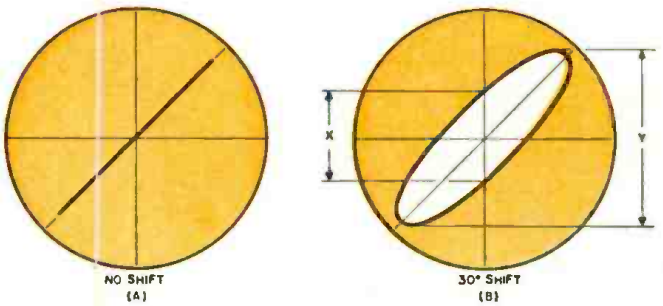
It seems to be commonly felt that any measurements of loudspeaker performance must necessarily be made with a lot of complicated and expensive equipment, which might typically include a microphone which has been calibrated over the frequency range to be tested, an expensive audio oscillator, a couple of amplifiers, distortion and output meters, and other associated pieces of equipment, and preferably including either an anechoic chamber or "wide open spaces" for free-field testing. Rigorous testing under these conditions will undoubtedly give results which are as nearly definitive as can be had and which will correlate well with the sounds as actually heard. Of course, we all recognize that these sounds constitute the ultimate test of any audio system, although in many cases where the sound is considerably less than perfect, tests, even on the small scale which can be made at home, will help to pinpoint the cause or causes of faulty response, and may suggest measures to improve the

Fig. 1. Equipment setup for speaker tests.



If one side of amplifier output is grounded, unground this lead.

Fig. 2. Shown here are a pair of distortion-free oscilloscope traces with and without some phase shift.



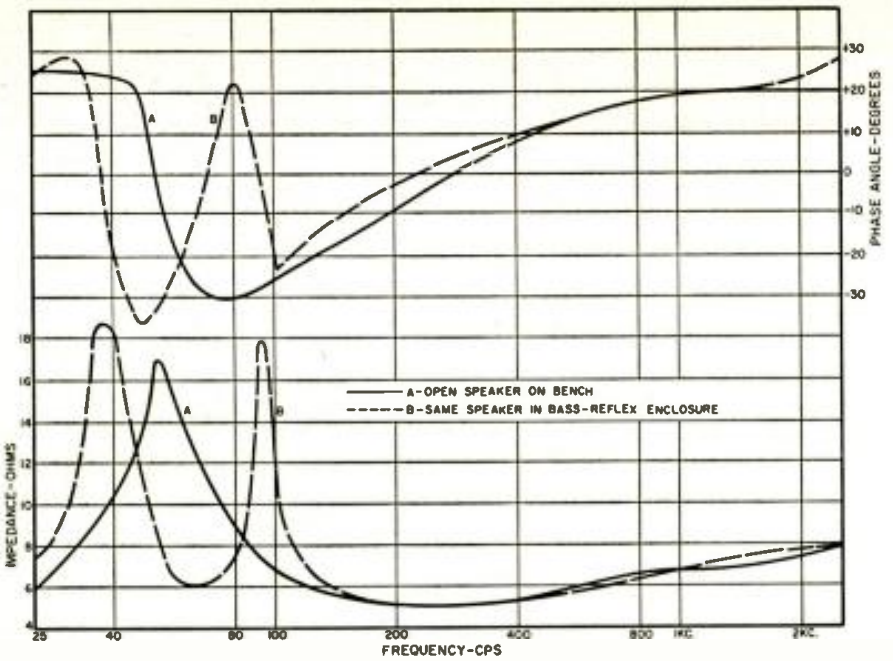


Fig. 3. Typical phase-angle and impedance curves for mounted and unmounted speaker.

over-all performance of the system.

Equipment

Much valuable information about your speaker and its performance can be obtained with simple equipment, such as is available to many experimentally inclined audio fans. The characteristics which can be measured with this simple setup are those which involve the electrical system of the speaker, either directly or because of energy reflected back into it from the mechanical or acoustical systems. They include impedance and phase shift and qualitative indications of harmonic distortion and useful power handling capacity. The equipment needed includes an audio oscillator capable of producing good sine waves over the desired frequency range: 20 to 20,000 cycles should be more than adequate; a power amplifier: ten watts is big enough for most purposes, but it must be free from distortion over the frequency range to be measured; an oscilloscope: practically any one will do; and a calibrated wire-wound variable resistor. Thirty ohms maximum resistance is about right for working with 8-ohm speakers and 50 to 60 ohms for 16-ohm speakers. The resistor calibration can be made with a low-range ohmmeter,

X/Y = sin ø	ø	X/Y = sin ø	ø
0.00	0°	0.50	30°
0.05	3	0.55	33½
0.10	6	0.60	37
0.15	9	0.65	40½
0.20	12	0.70	44½
0.25	15	0.75	48½
0.30	18	0.80	53
0.35	21	0.85	58
0.40	24	0.90	64
0.45	27	0.95	71
		1.00	90

Table 1. Abridged sine-function table.

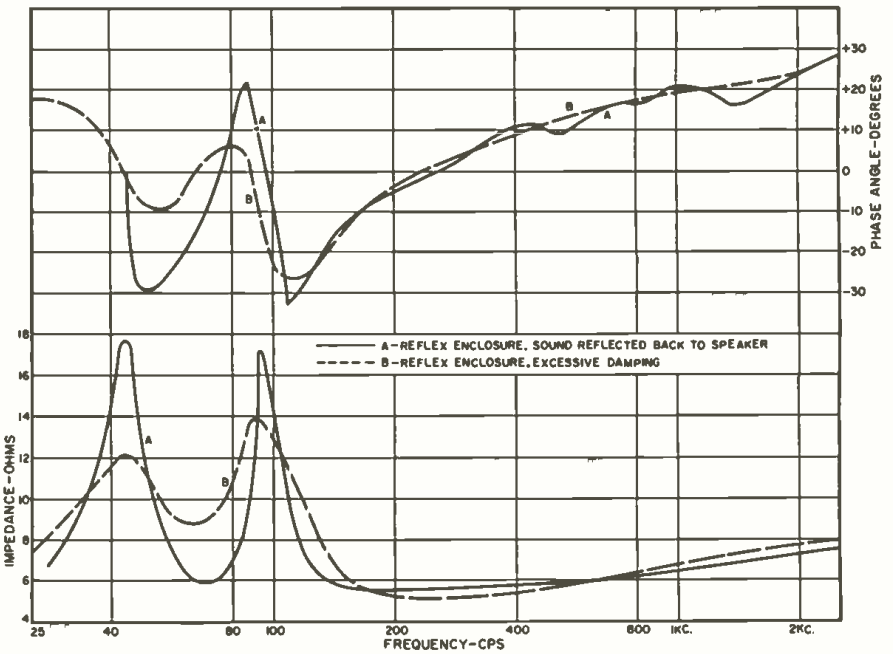


Fig. 4. Phase and impedance curves in reflex cabinet under two different conditions.

such as is incorporated in any vacuum-tube voltmeter. This gives sufficient accuracy for present needs, since relative values are more important than absolute values in this application.

The equipment is connected as indicated in Fig. 1. If the oscilloscope does not have a measuring grid over the face of the cathode-ray tube for determining the size of the trace, a satisfactory substitute may be made by simply fastening three threads over the face of the tube with *Scotch* tape. One of these should go vertically across the center of the face and the second horizontally, as determined by the vertical and horizontal traces of the oscilloscope. The third thread is to go across the intersection of the first two, at a 45° angle, from lower left to upper right. For all measurements to be discussed here, the oscilloscope must be adjusted so that the vertical and horizontal gains are equal and the no-signal point is at the intersection of the three threads.

Impedance

Impedance is the simplest characteristic of a speaker to measure. Using the hook-up of Fig. 1, feed a single-frequency signal into the oscilloscope network, adjusting the amplifier output so that the trace nearly fills the face of the cathode-ray tube. Adjust the variable resistor to give a trace that falls on the 45° thread, as in Fig. 2A, if the trace is a single line. If the trace is an ellipse instead of a line, as is more apt to be the case, the proper resistor setting will put the trace with the long axis of the ellipse on the 45° thread, as in Fig. 2B. The impedance of the speaker at the frequency being tested is now the same as the resistance of the variable resistor. Measurements should be repeated at intervals over the desired frequency range and a curve drawn connecting the measured points, as in Fig. 3, for easier visualization of the results. Impedance should be plotted against the logarithm of frequency. Usually a change of 20% to 25% in frequency between adjacent points is permissible, although intermediate points will be needed at frequencies where a small change in frequency produces a disproportionately large change in impedance, as is the case in the vicinity of resonant frequencies.

Phase Shift

The elliptical trace which will be found throughout a large part of the frequency range of any speaker is a direct reflection of phase shift in the speaker. Phase shift can be caused by reactive components in the electrical, mechanical, or acoustic networks of

the speaker and is inherent in these networks. While it can be modified by changes in any of these networks, the acoustic network is the only one which can be readily changed by the home experimenter, since this is the one which is controlled by speaker mounting and by enclosure dimensions and design. Phase shift, in itself, is neither good nor bad in its effect on the sound put out by the speaker system. What is bad is the presence of abrupt changes in phase shift, especially at frequencies differing widely from the bass resonant frequency or frequencies of the system.

The phase shift of a speaker system can be readily determined at the same time the impedance is being measured. Measurements of two dimensions of the oscilloscope trace are needed at each frequency. These are the overall height of the trace and its height through the center (Y and X, respectively, in Fig. 2B). Now $X/Y = \sin \phi$ so the value of the phase angle, ϕ, can be found in any trigonometry table from the ratio between these two heights, or it may be estimated from the abridged sine table given in Table 1.

Whether the reactance causing the phase shift is inductive (positive shift) or capacitative (negative shift) can easily be checked by momentarily placing a capacitor across the speaker terminals, as shown by the dotted lines in Fig. 1. The value of the capacitor is not important, as long as it is large enough to change the shape of the ellipse noticeably when contact is made. A 10 μf. filter capacitor has served quite satisfactorily in the author's tests. If the ellipse is fatter with the capacitor in the circuit, the shift is negative and the reactance of the speaker is capacitive. If the ellipse becomes thinner when the capacitor is placed in the circuit, the shift is positive and the speaker reactance is inductive.

At high frequencies there is normally a positive shift of 20° to 45°, since the inductive reactance of the voice coil is sufficient to have a noticeable effect in this range. At some intermediate frequency, the phase angle will pass through zero and then become negative as the frequency is lowered. Near the resonant frequencies of the speaker and enclosure, the phase angle is apt to undergo quite rapid changes, as shown in Fig. 3. These rapid changes may indicate unevenness of response, particularly if the amplifier with which the speaker is to be used is not highly damped. At frequencies above about 200 cycles, an uneven phase curve is related to the response. For example, the rather erratic phase curve A in Fig. 4 was found to be due to reflections from an enclosure wall, back to the speaker cone. The disturbance was not large enough to show up on the impedance curve. A small change in the enclosure, to eliminate the reflections, smoothed out the curve, as in B of Fig. 3, and at the same time removed a distinct coloration which earlier had been noticed in the sound from this particular speaker-enclosure combination.

The internal damping of a bass-reflex enclosure has quite an effect on the impedance and phase curves obtainable, as well as on the sound emanating from it. This point is illustrated by a comparison of curves B of Figs. 3 and 4, which were taken with the same speaker-enclosure combination. The only difference between the two sets of conditions was that, for curves B of Fig. 4, additional damping material was used, including cotton sheeting across the port to provide extra acoustical resistance at that spot. Curves B of Fig. 4 can be seen to be much smoother, without the sharp impedance peaks or sudden phase changes at resonant frequencies noted in curves B of Fig. 3. However, a price must be paid for all this, which is not apparent from examination of the curves. The low end was quite smooth sounding, but very noticeably weakened by the additional damping. The moral is that test results such as these should always be interpreted in conjunction with actual listening.

Distortion

Harmonic distortion developed in the speaker is made apparent in this test procedure by deviations of the oscilloscope trace from the straight line or elliptical shapes previously discussed. It is in this connection that a distortion-free amplifier between the audio oscillator and the speaker is especially important, since a distorted signal being fed to the speaker will complicate the trace on the oscilloscope and may easily make it seem that the speaker is distorting the signal when, in reality, the amplifier or even the generator, may be responsible for the distortion.

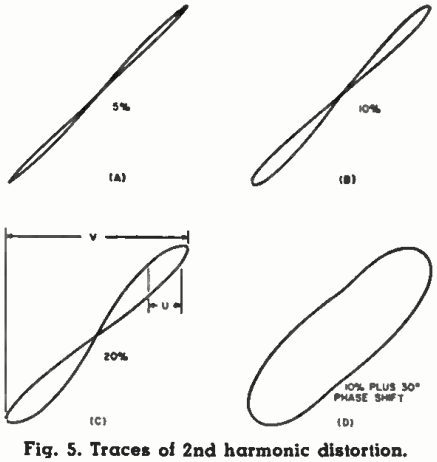
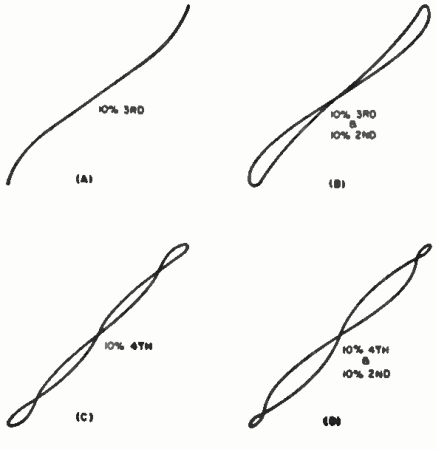


Fig. 5. Traces of 2nd harmonic distortion.

Fig. 6. Oscilloscope traces that contain both 3rd and 4th harmonic distortion.



Accurate measurements of harmonic distortion are not feasible by this method although, with care, a fairly good estimate may be had. In the useful audio-frequency range, by far the commonest harmonic distortion met with is second harmonic, otherwise known as doubling, in the lower frequency range. Figs. 5A, B, and C show the traces obtained with 5%, 10%, and 20% second harmonic added to the fundamental frequency without any phase shift in the speaker. Fig. 5D shows a trace containing 10% second harmonic, but with a 30° phase shift of the fundamental. It is obviously almost impossible to get any valid estimate of harmonic distortion from a trace of this type, so to be able to estimate the distortion, the phase shift must be compensated for. This can be done, at least approximately, by shunting either the variable resistor or the speaker with a suitable capacitor, until the phase shift is eliminated on the oscilloscope trace. The value of the capacitor will have to be found by trial, since it is dependent on frequency, the impedance being shunted, and the phase shift to be compensated. The capacitor should be placed across the speaker, as in Fig. 1, to compensate for a positive (inductive) phase shift or across the resistor to compensate for a negative (capacitive) shift. When second harmonic distortion alone is present, it may be estimated as follows:

$$\%\ Second\ Harmonic \approx 100\ (U/V)$$

where U is the width of the widest part of the curve and V is the overall width of the trace (see Fig. 5C).

Third and higher harmonics will be found much less often. Their estimation does not seem to be practical with this simplified testing setup. Examples of curves containing third and fourth harmonics, alone and in combination with second harmonics, are given in Fig. 6, so that they can be identified, even though they cannot be measured. Third harmonic distortion (no phase shift) gives a curved line, while the fourth harmonic alone gives a triple crossing loop. It can be seen from examination of Figs. 5 and 6 that analysis of the traces to give distortion values is feasible only in the simplest cases.

Some indication of the power handling capacity of a speaker can be had by repeating the tests, particularly in the low-frequency range (say below 200 cycles) at successively higher powers, cutting back the oscilloscope gain as power is increased to keep the trace on the face of the tube. At any given frequency the voltage across the speaker and its impedance can be

(*Continued on page* 126)

A Compact Beam for the Citizens Band

By **HARTLAND B. SMITH** / **An easy-to-build 2-element beam antenna that just about triples the effective power of your Citizens Band rig.**

THE "ground plane" is undoubtedly the most popular type of Citizens Band antenna. It is an excellent choice when you want omni-directional coverage for dispatching nearby mobile units. However, it is not adapted for long-haul contacts between fixed stations. This is because the ground plane radiates a signal to all points of the compass. In view of the 5-watt limit imposed on Class D stations, the loss of power which results from such a scattering of energy cannot be tolerated if you wish to maintain solid copy communication over distances of 20 miles or so.

A beam antenna, designed to concentrate your signal in one direction, must be employed for long distance point-to-point work. Actually, a beam is desirable for all contacts between fixed stations, even over relatively short distances, because it can radiate such a strong signal toward the desired station. At the same time, its directive pattern will reduce or prevent co-channel interference to stations located either to its side or rear.

The compact beam shown in Fig. 1 consists of two elements—a radiator and a director. The radiator receives power from the transmitter by means of a 75-ohm coaxial cable. The director, about 4% shorter than the radiator and spaced .1 wavelength from it, is parasitically excited, that is, no electrical connection exists between the director and the radiator. Since its elements are only a little longer than those of a channel 2 television yagi, the beam should arouse a minimum of comment from the neighbors when it is installed in a residential area. It is so light that even a thin TV antenna mast may be used as a support and a low-cost TV rotator will easily turn it in any desired direction. The inexpensive materials required in its construction can be readily purchased either locally or by mail.

Horizontal polarization, as used in this antenna, tends to discriminate against automobile ignition noise, a form of interference which seems to be at its worst in the vicinity of 27 mc. Anything you can do to reduce the effect of ignition noise will help to extend the distance over which weak signals can be heard and worked. Another factor which favors the horizontal beam for Citizens Band use is the 20-foot height restriction imposed on antennas by the FCC. It is the center- or high-current portion of a half-wave antenna that does most of the radiating. The higher you can put the center of the antenna, the greater your transmission range will be. If a vertically polarized 27 mc. beam is constructed, its high-current portion will be 8½ feet below that of a horizontal beam, providing both are installed so that no part of either one is more than 20 feet above the supporting structure.

A difference in antenna height of only 8½ feet can have a distinct effect on the performance of your station. For example, during preliminary tests of the beam under discussion, it was operated at a point 29 feet above ground. Later, when it was finally mounted permanently at 37 feet (17 feet above the house roof) results were greatly improved. The signal from the transmitter jumped 7 db on the meter of a communications receiver situated at ¼ mile and 10 db on a set located 2 miles away. Furthermore, a station in an unfavorable location, at a distance of 7 miles, which was previously unreadable started to come in loud and clear. The extra 8 feet of antenna height was easily equal to a 500% increase in transmitter power, possibly a 1000% increase if you have implicit faith in receiver "S" meters.

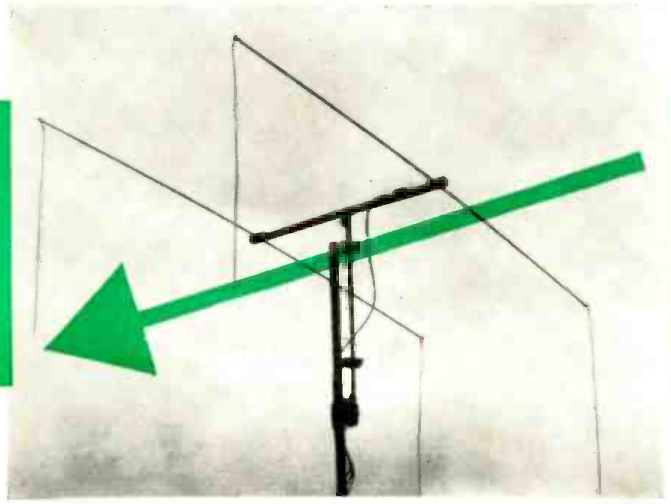
There are two popular ways to restrict antenna size. You can either use short elements which are resonated with loading coils or you can use bent full-length elements. The author prefers the latter approach, because loading coils reduce antenna efficiency and are often affected adversely by wet weather. Loading coils also tend to complicate and weaken the structure of a beam.

Construction

The elements of the antenna shown in Fig. 1 are standard 12-foot lengths of ½" aluminum tubing to which are added aluminum wire droopers. When purchasing the tubing, make certain that it is hard, not soft aluminum. Specify either 61ST6 or 6061T6. If you can't procure such tubing locally, it may be obtained by mail from *World Radio Laboratories*, Council Bluffs, Iowa or *Dick's*, Cherry Avenue, Rt. 1, Tiffin, Ohio. The tubing must be ½" in diameter. Any other size will invalidate the dimensions of Fig. 2.

The boom which supports the radiator and director is a 48" length of 1" x 2" clear pine. Two pieces of 1" x 2" each 4" long are used for element clamps. A 3" piece of 1" x 2" acts as a clamp for the coaxial cable. Place one of the 4" blocks at the end of the 48" piece and drill three holes for No. 6

Fig. 1. The author's beam uses an antenna rotator on a short mast.



wood screws through the block and partially through the boom as shown in Fig. 4A. Now place the other 4" block of wood at the opposite end of the boom and drill it in the same manner. Fasten the two blocks tightly to the boom.

A *Telco* 8800-U antenna mount is used to hold the boom to the mast or rotator. It should be attached at the center of the boom with a couple of 3/16" bolts that are 1¼" long. Drill the holes for these bolts now, but don't fasten the 8800-U to the boom yet because it will be in the way of some of the work which follows.

Drill a ½" hole 17¾" from one end of the boom. This hole is for the coaxial cable which will later be pulled up through it. The 3" block of wood used for a cable clamp must be hollowed out lengthwise on its underside, with a file or saw, to provide room for the cable which will pass beneath it. The groove should be just a little bit smaller than the cable. Then, when the block is securely fastened to the boom by two 1½" No. 6 wood screws, there will be just enough pinching action to hold the cable in place. The correct location for the cable clamp is shown in Fig. 3.

Exactly 2" from each end of the boom, along the cracks between the boom and the 4" blocks, drill ½" holes for the aluminum elements. This operation must be performed with great care. Unless the two holes are exactly at right angles to the long dimension of the boom, the elements will not be parallel in the finished antenna. As a result both the appearance and performance of the beam may suffer. You can do this rather precise job best with a drill press. However, if you're careful, even a hand brace will provide acceptable results.

Loosen the screws which hold the tubing clamp blocks just enough so that the elements may be pushed through the holes drilled for them. Carefully center the elements so that their weight is equally distributed on each side of the boom. Tighten the clamping blocks. Drill a small hole at the center of each block. These holes should extend only far enough to penetrate the tops of the elements. No. 8 sheet metal screws, 1" long, go through these holes and are drawn up tightly. See Fig. 4A.

A standard Bakelite two-terminal tie-point is fastened to the side of the boom. Make certain that its nearest terminal is exactly 5" from the radiator. The antenna mount may now be bolted to the underside of the boom. Use both lockwashers and flat washers under the heads of the bolts and lockwashers under the nuts. Just before tightening the nuts securely, give the bolts, nuts, and washers a heavy coating of exterior house paint. The paint, along with the lockwashers, will help to keep the bolts from loosening under the strain set up by wind and vibration.

One end of the coaxial cable should be cut and stripped. Solder about a 12" length of No. 20 plastic covered hookup wire to the exposed shield braid. A 5" piece of hookup wire should be soldered to the cable's center conductor. Carefully tape the end of the coax to prevent the entry of moisture. Feed the cable through the half-inch hole in the boom. Put the 3" grooved piece of 1" x 2" over it and tighten the two screws so that the cable is clamped firmly in place. The end of the cable should be flush with the edge of the 3" block which is nearest the radiator.

The droopers are cut from No. 8 aluminum TV ground wire and are soldered to the ends of the elements. Soldering to aluminum can be a rather tricky process. However, if you take your time and use the proper tools, you will be able to produce joints between the droopers and elements which are both mechanically and electrically sound. Use a gun or iron rated at least 200 watts. A torch is not recommended because it will heat the aluminum so fast that it will oxidize before the solder can get a chance to take hold. Use wire-type solder that contains no flux. Rosin-filled radio solder and acid-core solder are unsuitable. "Sal-Met" flux, which is listed in most radio catalogues, works well on aluminum and should be used for this particular operation.

At the ends of the elements, for a distance of about 1½", scrape the metal with a knife or clean it with sandpaper until it is bright and shiny all the way around. Absolutely no dark oxidized spots should be allowed to remain. Apply a thin coating of flux over the entire cleaned area. Heat the iron until you are sure that it has reached its normal operating temperature. Put a small amount of solder on the tip of the iron and then touch the tip to the flux-covered area. More solder should now be applied to the element, right next to the point where the iron is touching it. As soon as the solder begins to melt, slowly rub the tip of the iron back and forth across the metal. If the aluminum has been properly cleaned and coated with flux and has been heated sufficiently by the iron, the

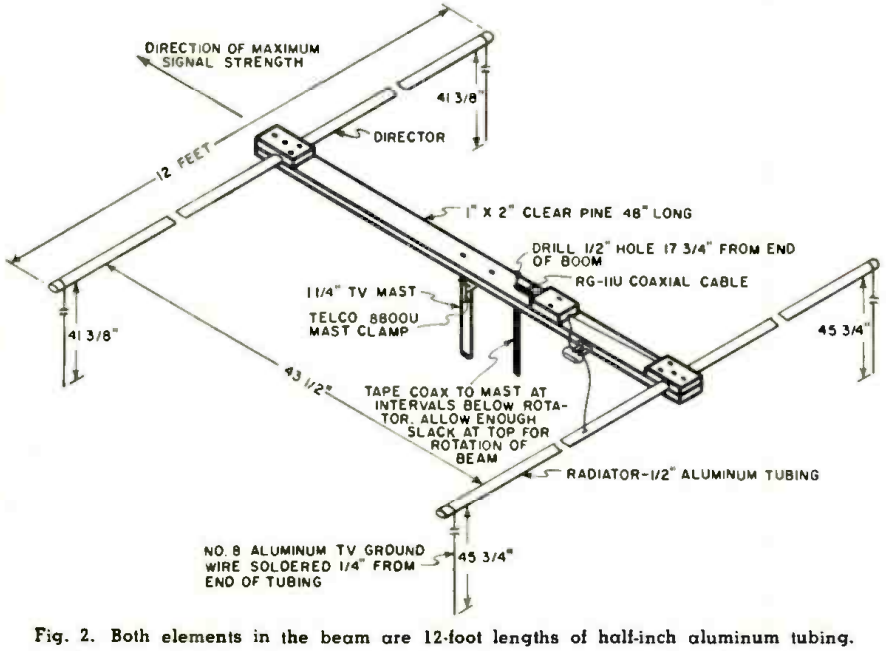
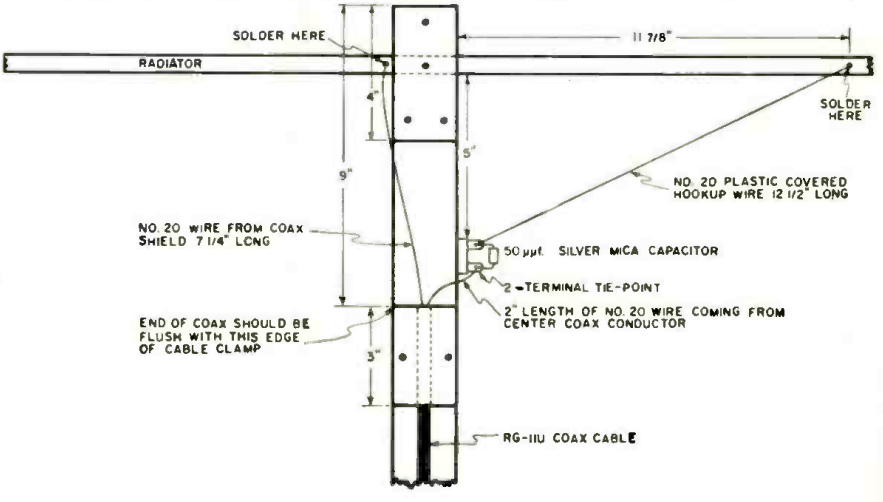


Fig. 2. Both elements in the beam are 12-foot lengths of half-inch aluminum tubing.

Fig. 3. The coax line used with the beam is connected to the radiator in this manner.



solder will flow over it like water. Keep working the iron back and forth, adding a little solder until the end of the element has been completely covered. Tin both ends of each element in this manner.

Cut a piece of the aluminum ground wire to a length of about 55". Tin one end of the wire with solder for a distance of 4", just as you did with the elements. After the wire has cooled, carefully wrap one turn of it around an element, ¼" from the end. Dab a little flux on the area and now apply a generous amount of solder to the wire and element. Use enough heat to insure that the newly added solder fuses with that which was previously applied during the tinning process. Attach the other three droopers in the same way. After they are all in place, trim them to the exact lengths shown in Fig. 2.

The longer of the two pieces of No. 20 wire, the one attached to the shield of the coax, is now soldered to the radiator as close as possible to the element clamp. This lead must be kept short. Cut off any excess beyond that required to reach the radiator. The shorter piece of No. 20 wire is trimmed so that it barely reaches the nearest terminal of the tie-point. Another piece of No. 20 wire, approximately 12½" long runs from the tie-point terminal nearest the radiator to a spot on the radiator which is exactly 11⅞" from the edge of the boom. See Fig. 3.

In case you lack the necessary tools and supplies required for effective soldering, the droopers may be bolted to the boom and the No. 20 wires from the coax can be attached to solder lugs which are fastened to the radiator by means of No. 6 sheet metal screws. These alternatives, however, are inferior ones which should be accepted only as a last resort. Whether you use solder, or bolts, seal all connections to the elements with Scotch electrical tape.

The leads of a *Cornell-Dubilier* 22R-5Q5 50 $\mu\mu$f. 5% tolerance silver mica capacitor should be trimmed until they are just long enough to reach between the two terminals of the tie-point. Wrap the capacitor with electrical tape to protect it from the ravages of rain and snow. Solder it to the two tie-point terminals. Don't attempt to use a substitute for the specified capacitor. Any deviation in the value of this part will adversely affect the match between the feeder and the radiator. Standing waves will then appear on the coax and the over-all efficiency of the antenna system will suffer. *Never* connect a high-powered transmitter to the beam! Although the capacitor will easily take all the output a 5-watt Citizens Band rig can deliver, it will go up in smoke if it is subjected to any great amount of radio-frequency energy.

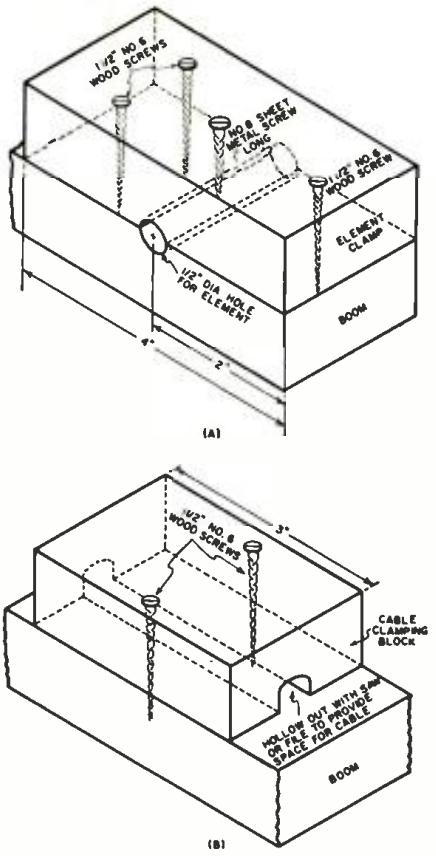


Fig. 4. Details of the element clamps (A) and clamp for the coaxial cable used (B).

Erecting the Beam

After giving the boom a couple of coats of paint, you can clamp the beam either to a standard 1¼" TV mast or to a TV rotator. Due to the antenna's small size and light weight, you should have little trouble mounting it at the legal limit of 20 feet above the roof of your home or office. A neat installation will result if the coaxial cable is tightly taped to the mast at 2-foot intervals. Near the rotator, however, you must allow sufficient slack in the cable so that the antenna is free to make at least one revolution without putting excessive strain on the coax. Keep the 75-ohm feeder as short as possible. Every extra foot of line will cause additional signal loss. RG-11U cable probably offers the best compromise between efficiency and cost.

Provisions for adequate lightning protection should never be overlooked when installing an outside antenna. Be sure to effectively ground the mast and install a lightning arrester on the coax at the point where it enters the building. A suitable arrester is the *Cush-Craft* "Blitz Bug," a unit which has been designed especially for coax. It is available from many suppliers who cater to the amateur radio trade.

Results Obtained

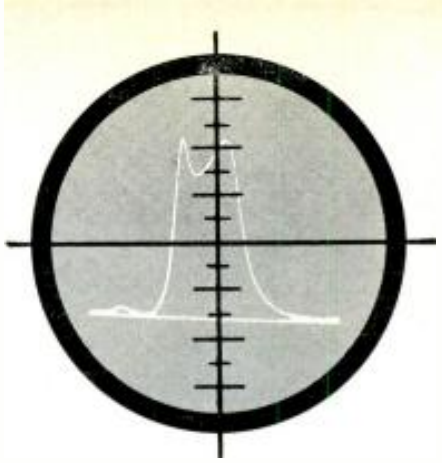
Results obtained with the beam, when used in conjunction with the "Versatile Citizens Band Transmitter" (ELECTRONICS WORLD, August 1959 issue) have been very good even though the author lives in a valley and is surrounded by trees, houses, and power lines. Over a two-mile path, with beams at both ends of the circuit, signals are S9 plus 40 db. A station 12½ miles away, which is equipped with a dipole and the transceiver described in the March, 1959 issue of this magazine, comes in at S9 plus 10 db. Another station 21 miles away has a beam and is received well above the noise level. Signals are 100% readable in both directions.

Although horizontal and vertical antennas usually aren't very compatible, a mobile unit equipped with an *Elmac* CD-5 "Citi-fone" transceiver and a base-loaded 42" whip has been heard on the beam with good strength at a distance of 11 miles. Another mobile, 8 miles away in the downtown section of a large city, pushed the meter on the NC-300 receiver clear up to 30 db over S9. Undoubtedly he was in a very favorable spot at the time. Nevertheless, this kind of performance shows that the beam is capable of doing a good job on mobile contacts besides functioning well in point-to-point work.

The standing-wave-ratio which appears on the feedline at midband is less than 1.1 to 1. This rises to not more than 1.3 to 1 at the band edges. The front-to-back ratio is better than 16 db, while the front-to-side ratio is in the neighborhood of 45 db. Since the antenna is such an excellent performer, there seems little reason to doubt that its gain closely approaches 5.5 db (a 3.5 times power increase), the theoretical maximum for a two-element beam. Consequently, if you construct a similar antenna it should make your little 5-watt Citizens Band rig sound like a 15 watter, at the very least. To achieve significantly better results you'd need a full sized three-element beam, one with a 14-foot boom and 17-foot elements. —30—

MATERIALS LIST FOR BEAM ANTENNA

1	6-foot length of 1" x 2" clear pine
8	No. 6 woodscrews, 1½" long
2	No. 8 sheet metal screws, 1" long
2	3/16" bolts, 1¼" long with 2 nuts, 2 flat washers, and 4 lock washers
1	Telco 8800U antenna mount
1	two-terminal tie-point with small woodscrew for mounting it
1	25-foot length No. 8 aluminum TV ground wire
2	12-foot lengths of ½" 61ST6 or 6061T6 aluminum tubing
1	Cornell-Dubilier 22R5Q5 50 $\mu\mu$f., 5% silver mica capacitor
1	3-foot length No. 20 plastic-covered hookup wire
1	piece RG-11U coax cable (long enough to reach from beam to transmitter)
1	roll wire-type solder without flux
1	"Sal-Met" flux
1	roll Scotch electrical tape
1	small can outside house paint



Are You "Alignment Happy"?

By KEN BRAMHAM

Instead of "re-aligning out" circuit defects, use your scope and sweep equipment to pinpoint such faults.

EDITOR'S NOTE: In "The Outside Call: What to Take Along" by Murray Barlowe, which we ran last July, the author said, "we are convinced that most r.f. and i.f. adjustments are sufficiently stable so that they should not require re-adjustment for the life of the receiver! . . . the bulk of our alignment work is the direct result of activity on the part of screwdriver-happy customers and technicians!" Also writer Jack Darr, discussing the service of two-way communications equipment in one of his articles, says, "Actually the receiver section . . . should almost never need alignment. However, there is an unfortunate habit prevalent among many technicians to 'play' with i.f. adjustments with very little provocation."

The emphasis necessarily given to tricky alignment procedures in technician training programs has left many with the attitude that alignment should be the first rather than the last resort. This attitude gives particular relevance to Ken Bramham's sensible appraisal of the problem.

CORRECT ALIGNMENT of a TV receiver is necessary for full picture detail, but how many re-alignment jobs are really necessary? Let us assume that a TV receiver is correctly aligned at the factory (they usually are), that it gives a satisfactory picture in the dealer's showroom, and that it continues to do so in the customer's home until such time as a breakdown occurs. Then, during the repair process, the technician decides it is necessary to re-align the i.f. circuits. For what reason?

A typical i.f. stage consists of a tube, two transformer windings, two or three resistors, and a couple of bypass capacitors. The tuned circuits, which were correctly adjusted at the factory, are each made up of one transformer winding and the capacitance introduced by the windings plus the inter-electrode capacitance of the tube. If re-alignment is needed, one of these quantities of inductance or capacitance in one of the i.f. stages must have changed.

A change in the inductance of the coil would affect the tuning, but what could change the inductance to so great an extent? The number of turns or the coil diameter would hardly be changed or, if it has, it is time to change the transformer before attempting to re-align the circuit. The slug position, which would not change of its own volition, would have to be changed by someone at the time of the breakdown. That is not very probable.

How about a change in circuit capacitance? This is far more likely: the tube could suddenly have changed its electrode positions, shorted, or become gassy and completely changed its inter-electrode capacitance values. There is a slight chance that an alignment job may restore the set to operating conditions—a very slight chance. A much better method is to install a new tube.

Large changes in resistance values are needed to change the i.f. tuning. This can only be corrected by replacement of the resistor involved. A shorted cathode bias resistor, for example, will permit changes in signal strength to vary the alignment curve.

Obviously, retuning at one particular level of signal strength and a.g.c. action is not going to remedy this condition.

Do the foregoing points mean that the service shop can throw out its complement of alignment equipment or, if it has not yet acquired the instruments adequate for alignment work, that this acquisition may no longer be considered necessary? Not at all. The importance of such equipment cannot be overstated. It is only the use to which it is put that is open to question.

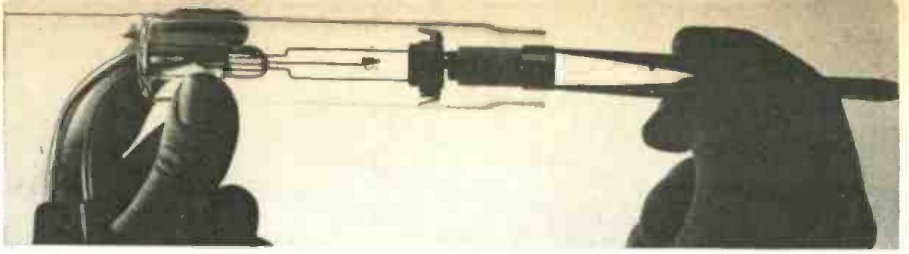
The first and most important application of the sweep generator and scope is to *observe* the alignment curve —without attempting any adjustments whatever. With this approach, curve observation can often provide a more rapid method of localizing a specific circuit defect than other techniques, particularly where the fault is obscure. Finally, in those relatively rare cases where re-alignment is indeed called for, its necessity can be demonstrated with the minimum amount of guesswork by eliminating other possibilities.

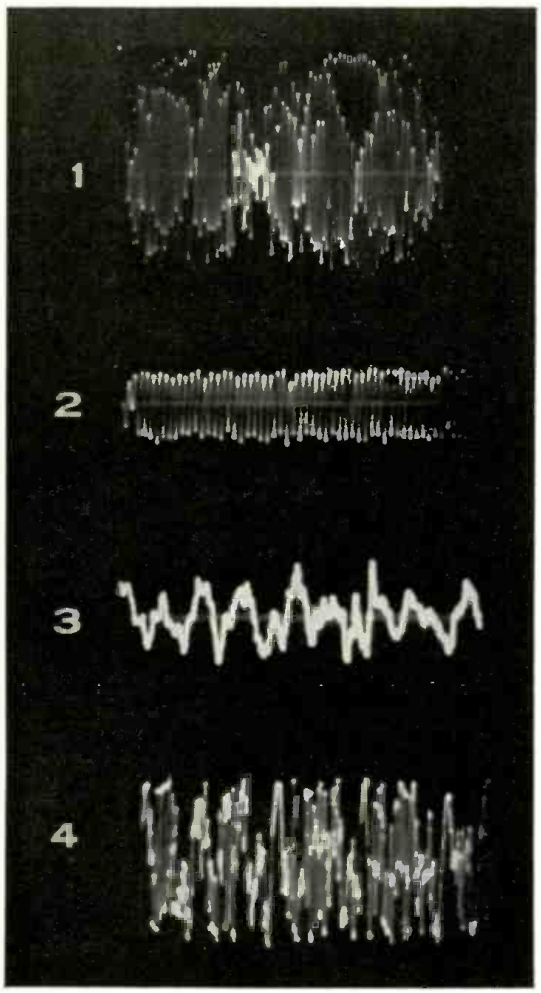
Starting with the tubes, components may be substituted one at a time until an appreciable change in the response curve is noted. This immediately indicates a significant difference in value between the old component and the one with which it is replaced. A change in curve shape will invariably be accompanied by a change in over-all amplitude—and the latter may be either an increase or decrease depending on the type of failure involved. For example, a gassy tube or a shorted cathode resistor could increase circuit gain at the expense of proper curve shaping. Replacement with a new, good tube or resistor would therefore decrease gain while restoring the curve shape.

Re-alignment for increased bandwidth (and consequently for reduced gain) may compensate for a circuit fault *without correcting that fault.* The result usually is a callback when signal conditions change or when the fault becomes worse. This applies to any component failure that produces overloading on strong signals: the failure may be in the a.g.c., video-output, or sync circuits. A similar condition which may be located during an alignment check is failure of the video-detector diode.

Perhaps the worst instances of un-

(*Continued on page* 134)





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Ultra-Sensitive Combat Radar

Demonstrating an almost human ability to tell differences in targets, a new Army surveillance radar, designed and developed by *Hazeltine Corp.*, can distinguish between moving trains and vehicles, at ranges up to 20,000 yards, and personnel at ranges up to 10,000 yards. The radar, the AN/TPS-25, uses pulse doppler techniques and presents its information aurally to the operator. An experienced operator can even tell the difference between a man and a woman target because differing walking methods produce audible differences in the received signals. Waveforms above are scope traces of the sounds heard with the following targets in range: (1) moving train, (2) moving automobile, (3) walking man, and (4) walking woman.

▲

"Transistorized" Electron Tube

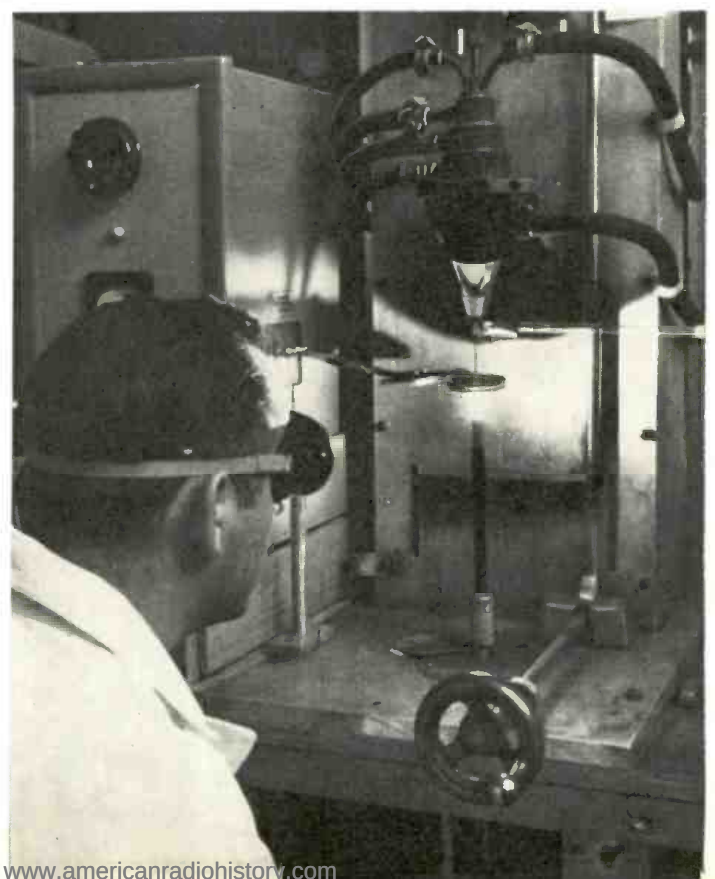
Experimental electron tube, being developed by *Westinghouse*, gets its supply of electrons from tiny crystals of silicon carbide. The crystal replaces the hot, power-consuming cathode. The tube depends on a new form of electron emission discovered in the semiconductor silicon carbide. Successful application of the discovery would result in a "solid state" electron tube that would combine many of the advantages of semiconductors and vacuum tubes. The crystal is inside the cartridge being inserted in the tube.

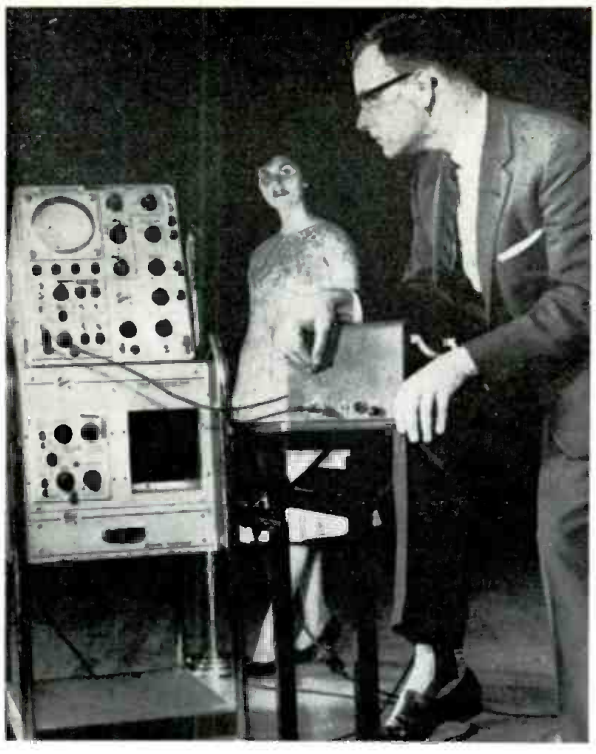
Recent Developments in Electronics

Crystals from Rust

"Flameless fusion," a method of transforming a few cents worth of rust-like substance into a nearly perfect crystal worth hundreds of dollars to the electronics industry, has been disclosed by *ITT*. The method produces a monocrystalline ferrite. Scientists hope it will be a new electronic workhorse like some semiconductors. To produce it, r.f. in the metal loop (center) heats a powdered mixture of ferric oxide, a form of common rust, and other oxides.

▼



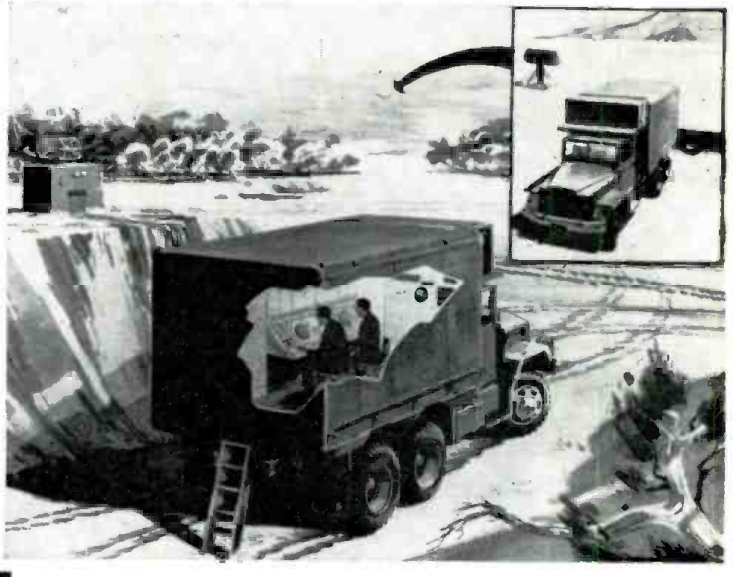


P.A. Feedback Stopped by Modulator

As he switches on frequency-shift modulator, *Bell Telephone Laboratories'* Manfred R. Schroeder observes reverberations of the voice of girl at microphone in background. By shifting frequencies of room reverberations slightly as they feed back into microphone, instability of public-address systems is minimized and a two-fold increase in gain is permitted.

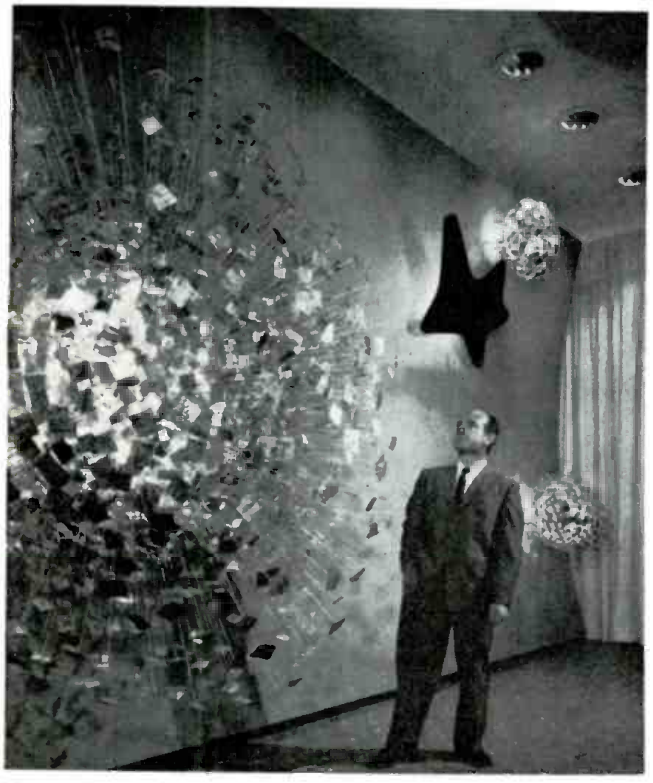
Electronic Air-Defense System

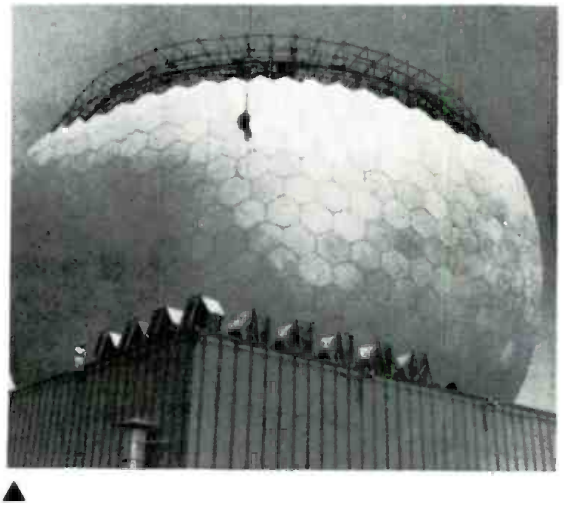
Use of the U. S. Army's new technical air-defense system (AN/MSQ-18) is shown in this panoramic view of a battalion-level combat area. Cut-away shows radar operator at operations central monitoring hostile aircraft picked up by radar at left. Commander with him makes target assignments to missile batteries. Inset shows one of these distant batteries, with its local radar, power supply equipment, and truck which houses coder-decoder unit that is part of anti-aircraft system. The new system was announced by U. S. Army Signal Corps and *Hughes Aircraft Co.*



"World Communications" Sculpture

Internationally known sculptor-in-metal Harry Bertoia is shown with his abstract sculptural grouping at *Zenith Radio Corp.'s* display salon in Chicago. First of his work to be used in consumer products showcase, the glittering brass units symbolize world communications in the atomic age. Smaller units at right represent sight, sound, and electronic control and respond to transmissions of light from 8-foot main unit.

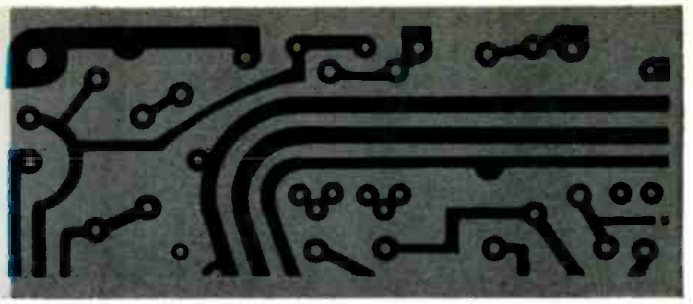




Giant Radar Test Dome

Giant 140-foot diameter dome, made by *Goodyear Aircraft Corp.* from pressed paper faced with plastic-impregnated fiberglass, is being erected east of Camden, N. J. It will be used by *RCA* as a radome to protect huge radar antennas of the type to be constructed in the Far North for the Air Force's Ballistic Missile Early Warning System.

Printed Boards:



Roadblocks or Road Maps?

Significant changes in these panels may overcome objections by service technicians and set owners.

WHEN THE early outcry against the use of printed boards in TV sets began to gather momentum, proponents of these panels had a conventional answer ready. Any innovation meets resistance at first, and printed wiring was no exception. Increasing familiarity with the board would produce acceptance and the furor would die down. But the furor lasted.

That there were causes for the opposition aside from sheer novelty soon became clear. Witness the stand of a few leading manufacturers who flatly committed themselves to the continued use of hand wiring, at least until the newer technique could be brought to a more satisfactory stage of development.

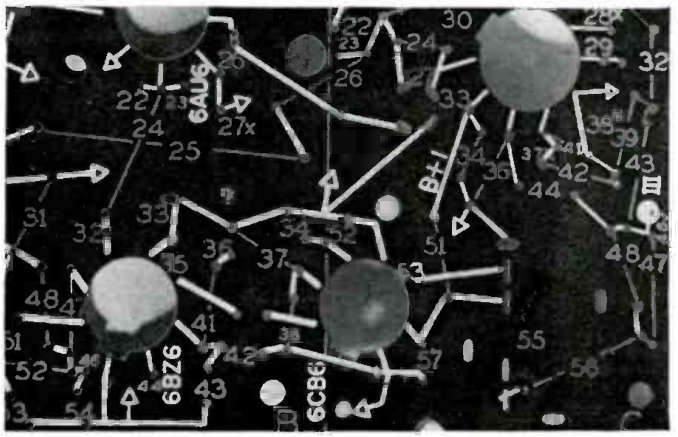
In favor of printed wiring from the outset has been the accuracy it makes possible in the mass duplication of desired circuits. Out-and-out errors in hand wiring, as well as less obvious but often significant variations introduced by the human factor, could be wiped out. Reduced fabrication costs would be reflected in lower consumer prices—a commendable achievement if quality were not simultaneously impaired. As to arguments against the panels, these were numerous but more difficult to analyze.

Typical of the confusion surrounding the matter is the use of the term "printed circuits" to describe the boards. Strictly speaking, the technique of printing or depositing actual circuit components is not the issue. One form of printed-circuit technique has been in use for some time—even in hand-wired sets—without causing prolonged debate. Single-package networks of components, like vertical-integrating of audio-coupling assemblies, fall into this class. Actually the controversy centers about the replacement of conventional connecting wires by conductive strips that have been plated or otherwise "printed" on non-conductive chassis boards, and also about the secondary changes that this practice has brought in its wake.

However, the error in terminology marks only the beginning of the confusion. There was much doubt as to *why* printed wiring was being resisted. Were the drawbacks so inherent in the basic technique that printed wiring should be abandoned, or could they be resolved? To find the answers, the two industry groups most directly concerned with the problem got together. The Institute of Printed Circuits, a non-profit manufacturers' group, joined hands with the National Alliance of Television & Electronic Service Associations in conducting an extensive survey (see "Service Industry News," June, page 129, and July, page 136). The results were fruitful. Although some conclusions had already been reached and some changes were already under way, the survey confirmed or refuted some of the guesses, brought additional facts to light, and accelerated the trend to a new look.

Objections to the boards were based on problems of long-term reliability in use as well as service difficulties. In fact, these two considerations often run together. Most complaints involved the following factors: 1. Board breakage, 2. Lifting of conductors. 3. Mounting of controls, tube sockets, and other components. 4. Component placement on both sides of a board, 5. Accessibility, 6. Circuit tracing, and 7. Component identification. The order of presentation is the one most convenient for discussion, without regard to relative importance.

Fig. 1. Part of the component side of a G-E printed panel.



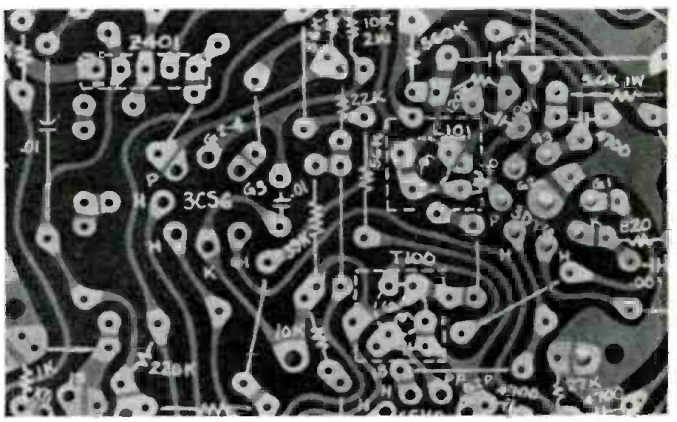


Fig. 2. Westinghouse uses schematic notations for clarity.

Since some of these points may be further subdivided and others overlap each other, we would appear to be left, still, with confusion. However, balancing this out, we find that resolving one of several related problems often automatically takes care of the others. Let's take an example. A tendency to board breakage may be eliminated by strengthening the board itself or by mounting it more securely in the receiver. Whichever approach is used, a complaint that may have been registered under either of two different headings is answered.

Several approaches have been applied to increase board strength. Using improved, stronger base materials, increasing board thickness, re-inforcing the basic compound with

such materials as fiberglass—all have proved to be useful.

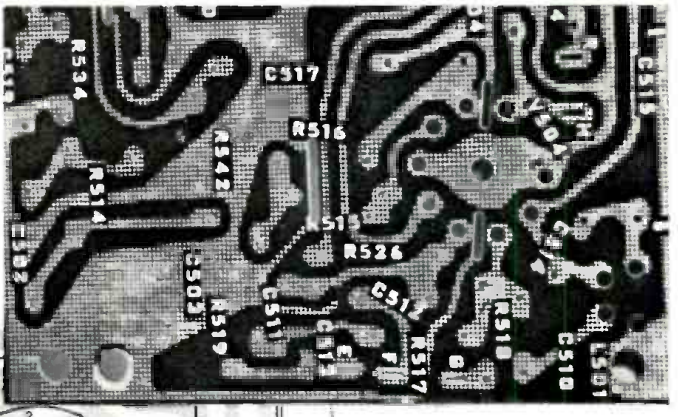
Lifting of the conductive strips has been cut back by new plating techniques that provide a better bond to the panel, and also by improved materials for coating the conductive strips that aid in adhesion. Mounting problems involving controls, tube sockets, and the like have been handled by redesigning these items somewhat so that they are lighter and more adaptable to use in printed-wiring techniques. Take the case of the i.f. can in the lower right-hand corner of the *G-E* board depicted on the cover. It is *plugged* into the panel rather than being soldered. Snap it off and you find that the transformer-detector assembly inside is itself a separate, miniature board that plugs into contacts on the main board. It may be removed for service or replacement without a soldering iron.

As to the mounting of components on both sides of the board, most manufacturers no longer do this. However, as the *G-E* board just mentioned proves, it is possible to continue the practice, to some extent, while eliminating the problem. All components except tubes are on one side. This makes tube sockets available on the component side for convenience in measuring—but how does one get at the tubes for removal? (We now find ourselves led into the related problem of accessibility.) The answer lies in the way chassis boards are mounted in the receiver. They are placed vertically rather than horizontally. More important, these panels are viewed on edge from the back of the set. Thus either side is equally available.

Another treatment of the accessibility problem is used by *Motorola*. Their first TV set to mark the swing away from complete hand wiring (see "Innovation in Plated Circuitry," October, page 100) incorporates a main chassis board that sits horizontally at the bottom of the cabinet, much in the manner of a conventional, metal chassis. However, since all components are mounted on the top side, accessibility is good without board removal. When removal does become necessary, this is easier to accomplish than with conventional chassis. Securing screws are removed and the board, which is plugged into a series of contacts along its forward edge, is simply slid back. If continuity is desired while the board is out of the cabinet, the long strip of contacts may also be unscrewed and removed with the board. Leads from this contact strip to the rest of the set have been deliberately made long enough to permit this.

The most dramatic changes in new printed-wire panels involve the related factors of component identification and

(*Continued on page* 142)



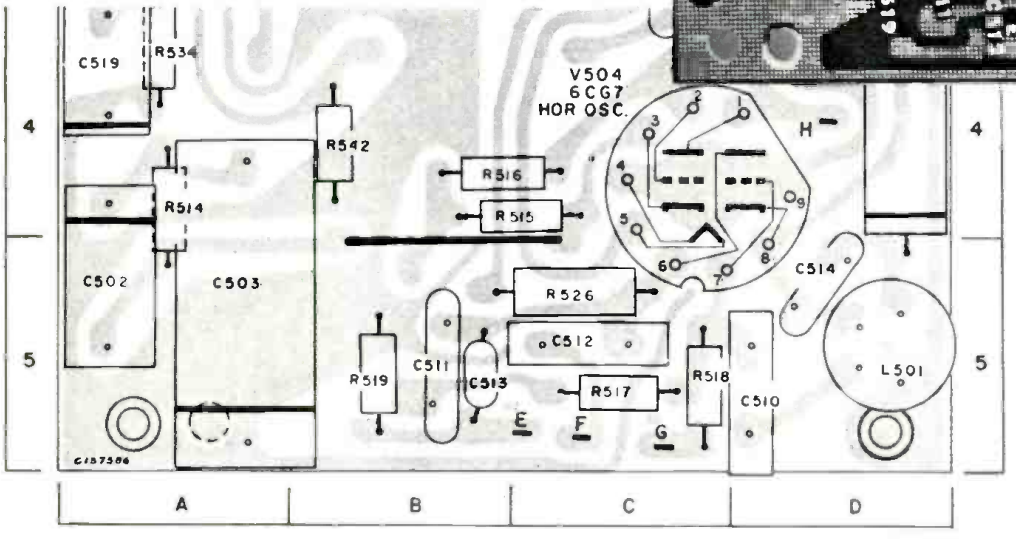


Fig. 3. (Left) Part of a printed-board diagram from the manufacturer's service data, to assist in component location.

Fig. 4. (Above) Part of the component side of an actual RCA board that corresponds to the portion in the diagram of Fig. 3.

COVER STORY

IF THE ADAGE, "There are many ways to skin a cat," needs new support, the variety highlighted by the printed-wiring boards on this month's cover could do the job. When the use of these panels in TV receivers began several years ago, it brought with it many service problems. Not the least of these was the difficulty in circuit tracing, which is essential to trouble-shooting. Now aware of this obstacle, set makers are moving in the direction of easier component and circuit identification. Although the broad goal is the same, the techniques for achieving it are quite varied.

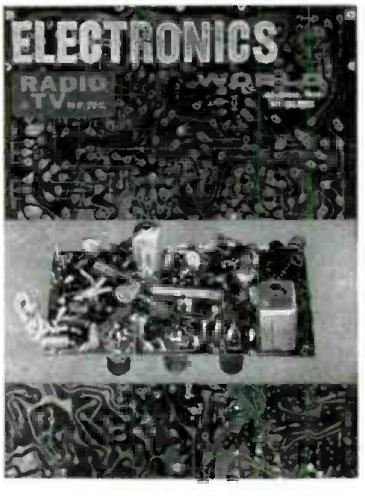
The Westinghouse board shown at the top of the cover and projecting into the bottom center appears with the wiring (bottom) side up. The green insulating coating highlights all connections made by board wiring. Nonconductive yellow ink is used to identify all tubes, components (including values), and connections found on the reverse (top) of the board. The result is a "built-in" schematic.

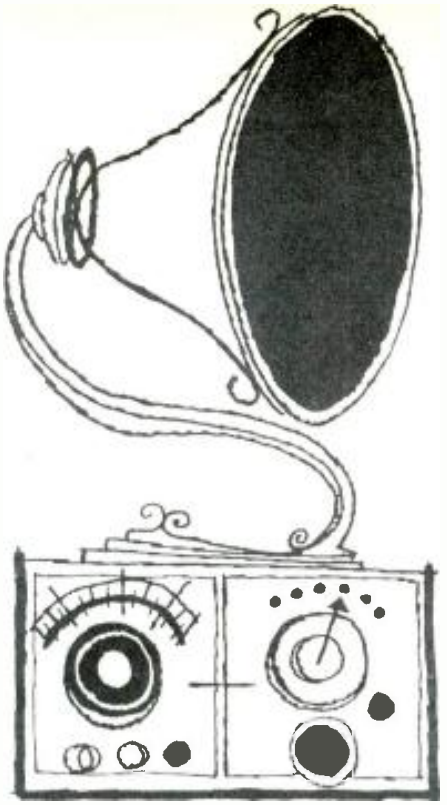
On the G-E board, shown running horizontally through the center of the cover, components are also mounted on the top side of the board except for tubes. However, tube-socket contacts are available at the top for testing. Key points, tube types, and connections are also marked on this side, with plating on the tube side.

The new Motorola board, a portion of which appears at the lower right, has wiring plated on both sides. However, all components are mounted on the top only, and a complete picture of circuit connections is printed on both sides. Here identification and tracing are predicated on a color code based on the EIA code, with combinations of four basic colors used.

Part of the bottom of an RCA board, in the lower left-hand corner, shows what the unadorned wiring looks like after it has been plated on. On the other side of this unit, the wiring pattern has been duplicated faithfully in ink. Also in ink are the identifying numbers of all components, printed next to the top-mounted components themselves. For easy correlation with the service data covering the TV sets, code numbers used on the boards are the same as those on the schematics. —30—

(Cover photo by Bob Loeb)





Is Your Business Geared for Change?

By **WILLIAM LEONARD**

Your ability to stay alive depends on continuous adaptation to factors you do not yourself control.

BACK IN THE DAYS just prior to World War I, when women's skirts started to creep above the shoe tops, the owner of a business dealing in dry goods and ready-to-wear dresses vowed he would never handle dresses or patterns that would expose women's ankles to the lecherous gaze of the pool-hall and street-corner habitués. A few years later, still adamant in his opinion that the revealing styles of women's dresses were immoral, he was unable to salvage anything from his bankrupt business.

This merchant, who was successful as long as consumer wants and preferences pleased him, was the prototype of thousands of small retailers and dealers who, since then, have failed because they refused to bow to the dictates of change and to adjust their businesses to conform to its requirements. Just a cursory examination will reveal that the rapid acceptance by the public of innovations in food, drug, and wearing-apparel retailing swept thousands of die-hard dealers out of business. These were the men who refused to join in the march of progress or, at any rate, the march of change.

The fast-moving pace of modern business will not tolerate laggards. To stay in the race, owners of small businesses must be alert opportunists, ready to take advantage of every new product or service that will add volume and profit to their businesses.

The trend of modern business concerned with the general public is a steady shift away from product specialization. The rapid public acceptance of the "service club" idea is a straw in the wind. Across-the-board service on any product used in the home has a strong consumer appeal because it meets a definite need.

Consider the drug business. There was a time when the filling of prescriptions was the most important factor in drug-store operation. Today, in modern drug stores, the prescription department is usually located in an obscure corner. The do-it-yourself tube tester is probably situated where a customer can spot it quickly when he comes in the front door. Service dealers may not approve of its presence there but, to the drug-store owner, it is just one of the thousands of items that help provide the income to keep his store in operation.

Is it unethical or "immoral" for a drug store to sell electronic tubes? A druggist feels no moral responsibility if some customer takes a lethal overdose of aspirin tablets purchased at his store. Neither is he inclined to throw out his cigarette counter because some authorities claim heavy smoking is a contributing factor in the increase of lung cancer. So why should he be concerned when Joe Public, electing to fix his own TV set, messes it up with tubes purchased at his store?

In view of the fact that the majority of TV service shops leaned heavily on the income from their tube sales to take care of their operating expenses, it is understandable that they would be deeply concerned over the loss of this business to non-electronic retail establishments. Under the most favorable circumstances, it is very difficult to sell time and labor at a profit. The average charge for a home service call is barely enough to pay for the time involved and the transportation, without contributing anything toward the shop overhead and operating expenses. Because of that, a substantial part of the service dealer's income must come from the sale of components, tubes, or other products. Since it is apparent that the trend toward self-servicing of TV sets will continue, and set owners will buy tubes wherever it is most convenient at the time they want them, dealers must re-orient their methods of operation and handle products that will provide income to compensate for the loss of tube sales.

In the early days of the revolution in retailing, druggists were up in arms when grocery stores started handling packaged drugs, hair tonics, and other items that had been considered essentially drug-store products. Since then the transition in the philosophy of drug-store merchandising has contributed substantially to the breakdown of vertical retailing. The main product consideration now in either type of store is not its type, but whether the product will sell in sufficient volume to warrant the capital investment and the space required to handle it.

Now take a brief look at the changes that have taken place in the business of servicing TV sets. Large service contractors handled the bulk of the business during the early boom days of the industry. These businesses folded up rapidly when contract service was abandoned and set owners were left to their own devices to get the service they required. This shifted the business into the hands of thousands of small dealers and paved the way for hundreds of TV technicians to establish their own businesses.

Records indicate that, for a period of several years, eighty per-cent of the TV service calls could be completed in the home by replacing burned out or ineffective tubes. Dealers enjoyed profit on the tubes they sold plus the charge for the service call. But set owners took a dim view of a situation where they had to pay from eight to fifteen dollars for service that required only a few minutes to perform and needed only the replacement of a tube or two. This is what paved the way for the do-it-yourself tube testers.

Now the service industry is faced with a tightening market and a trend toward lower income per service call. What can the average dealer do under these conditions to maintain his establishment as a business that will continue to provide worthwhile income?

A number of opportunities are open to him. The one which is best for a particular business can be determined only on the basis of the local conditions and circumstances peculiar to the individual shop and its owner. The most important factors are the shop location, available display and selling area, the basic motivation of the dealer, and the capital available for change and possible expansion.

The simplest and easiest move for a TV service dealer to make is to shift part of the business emphasis into some other type of electronic products. For instance, the sale of high-fidelity components, stereo units, and stereo conversions are naturals for any electronic service shop. However, in order to take full advantage of the growing opportunities in the audio field, the dealer must do a top-flight promotion job to identify his business with these products.

Marching along hand-in-hand with

(*Continued on page* 136)

RADIO AMATEUR PREFIXES

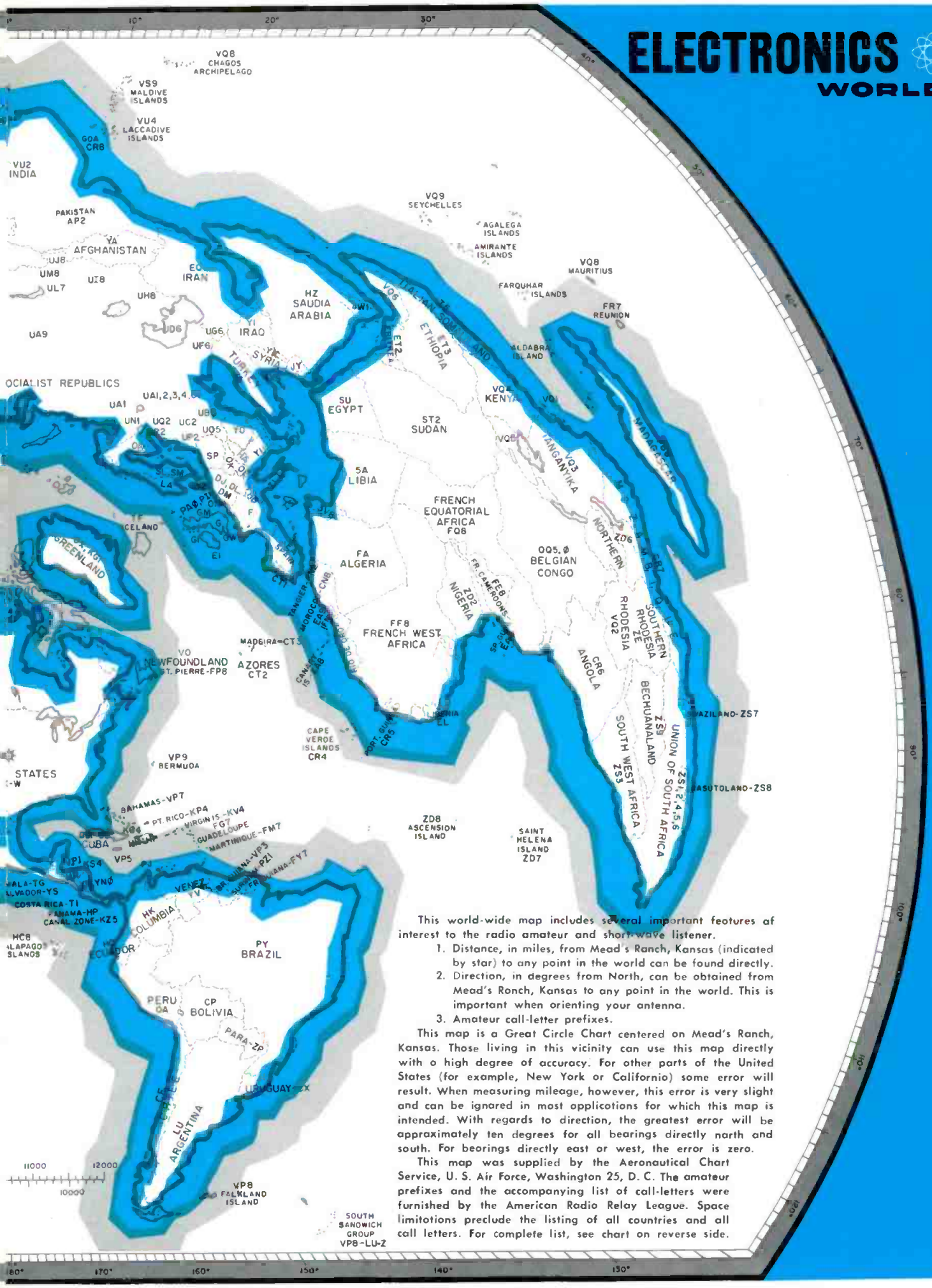
CALL	LOCATION
AC3	Sikkim
AC4	Tibet
AC5	Bhutan
AP2	Pakistan
BV (C3)	Formosa
C (unofficial)	China
C9	Manchuria
CE	Chile
CE	Juan Fernandez
CE0	Easter Island
CM, CO	Cuba
CN2	Tangier
CN8	Morocco
CP	Bolivia
CR4	Cape Verde Islands
CR5	Portuguese Guinea
CR5	Principe, Sao Thome
CR6	Angola
CR7	Mozambique
CR8	Goa
CR9	Macao
CR10	Portuguese Timor
CT1	Portugal
CT2	Azores
CT3	Madeira Islands
CX	Uruguay
DJ, DL, DM	Germany
DU	Philippines
EA	Spain
EA6	Balearic Islands
EA8	Canary Islands
EA9	Ifni
EA9	Rio de Oro
EA9	Spanish Marocco
EA0	Spanish Guinea
EI	Republic of Ireland
EL	Liberia
EQ	Iran
ET2	Eritrea
ET3	Ethiopia
F	France
FA	Algeria
FB8	Amsterdam & St. Paul Islands
FB8	Comoro Islands
FB8	Kerguelen Islands
FB8	Madagascar
FB8	Tromelin Island
FC (unofficial)	Corsica
FD	Togo
FE8	French Cameroons
FF8	French West Africa
FG7	Guadeloupe
FI8	French Indo-China
FK8	New Caledonia
FL8	French Somaliland
FM7	Martinique
FN2	French India
FO8	Clipperton Island
FO8	French Oceania
FP8	St. Pierre & Miquelon Islands
FQ8	French Equatorial Africa
FR7	Reunion Island
FS7	Saint Martin
FU8, YJ1	New Hebrides
FW8	Wallis & Futuna Islands
G	England
GC	Channel Islands
GD	Isle of Man
GI	Northern Ireland
GM	Scotland
GW	Wales
HA	Hungary
HB	Switzerland
HC	Ecuador
HC8	Galapagos Islands
HE	Liechtenstein
HH	Haiti
HI	Dominican Republic
HK	Columbia
HK0	Archipelago of San Andres & Providencia
HL	Korea
HP	Panama
HR	Honduras
HS	Thailand
HV	Vatican
HZ	Saudi Arabia
I1, IT1, IP1	Italy
I1	Trieste
I5	Italian Somaliland
IS1	Sardinia
JA, KA	Japan
JT1	Mongolia
JY	Jordan
JZ0	Netherlands New Guinea
K, W	United States of America
KA0, KG6I	Bonin & Volcano Islands
KB6	Baker, Howland & American Phoenix Islands
KC4	Navassa Island
KC6	Eastern Caroline Islands

CALL	LOCATION
KC6	Western Caroline Islands
KG4	Guantanamo Bay
KG6	Mariana Islands
KH6	Hawaiian Islands
KJ6	Johnston Island
KL7	Alaska
KM6	Midway Islands
KP4	Puerto Rico
KP6	Palmyra Group, Jarvis Island
KR6	Ryuku Islands
KS4	Swan Islands
KS4	Rancador Cay & Serrana Bank
KS6	American Samoa
KV4	Virgin Islands
KW6	Wake Island
KX6	Marshall Islands
KZ5	Canal Zone
LA	Jan Mayen
LA	Norway
LA	Svalbard
LU	Argentina
LX	Luxembourg
LZ	Bulgaria
M1	San Marino
MP4	Bahrein
MP4	Qatar
MP4	Trucial Oman
OA	Peru
OD5	Lebanon
OE	Austria
OH	Finland
OH0	Aland Islands
OK	Czechoslovakia
ON4	Belgium
OQ5, OQ0	Belgian Congo
OX, KG1	Greenland
OY	Faeroes
OZ	Denmark
PA0, PI1	Netherlands
PJ	Netherlands West Indies
PJ2M	Sint Maarten
PK1, PK2, PK3	Java
PK4	Sumatra
PK5	Netherlands Borneo
PK6	Celebes & Molucca Islands
PX	Andorra
PY	Brazil
PY0	Fernando de Noronha
PY0	Trindade & Vaz Island
PZ1	Netherlands Guiana
SL, SM	Sweden
SP	Poland
ST2	Sudan
SU	Egypt
SV	Crete
SV	Dodecanese
SV	Greece
TA	Turkey
TF	Iceland
TG	Guatemala
TI	Costa Rica
TI9	Cocos Island
UA1, 2, 3, 4, 6,	European Russian Socialist Federated Soviet Republic
UA1	Franz Josef Land
UA9, UA0	Asiatic Russian S.F.S.R.
UA0	Wrangel Island
UB5	White Russian S.S.R.
UD6	Azerbaijan
UF6	Georgia
UG6	Armenia
UH8	Turkoman
UI8	Uzbek
UJ8	Tadzhik
UL7	Kazakh
UM8	Kirghiz
UN1	Karelo-Finnish Republic
UO5	Moldavia
UP2	Lithuania
UQ2	Latvia
UR2	Estonia
VE, VO	Canada
VK	Australia
VK	Tasmania
VK	Lord Howe Island
VK9	Cocos Island
VK9	Nauru Island
VK9	Norfolk Island
VK9	Papua Territory
VK9	Territory of New Guinea
VK0	Heard Island
VK0	Macquarie Island
VP1	British Honduras
VP2	Anguilla
VP2	Antigua, Barbuda
VP2	British Virgin Islands
VP2	Dominica
VP2	Grenada & Dependencies
VP2	Montserrat
VP2	St. Kitts, Nevis
VP2	St. Lucia

CALL	LOCATION
VP2	St. Vincent & Dependencies
VP3	British Guiana
VP4	Trinidad & Tobaço
VP5	Cayman Islands
VP5	Jamaica
VP5	Turks & Caicos Islands
VP6	Barbados
VP7	Bahama Islands
VP8	Falkland Islands
VP8, LU-Z	South Georgia
VP8, LU-Z	South Orkney Islands
VP8, LU-Z	South Sandwich Islands
VP8, LU-Z	South Shetland Islands
VP9	Bermuda Islands
VQ1	Zanzibar
VQ2	Northern Rhodesia
VQ3	Tanganyika Territory
VQ4	Kenya
VQ5	Uganda
VQ6	British Somaliland
VQ8	Chagos Islands
VQ8	Maritius
VQ8	Rodriguez Island
VQ9	Seychelles
VR1	British Phoenix Islands
VR1	Gilbert, Ellice Islands & Ocean Island
VR2	Fiji Islands
VR3	Fanning & Christmas Islands
VR4	Solomon Islands
VR5	Tonga Islands
VR6	Pitcairn Island
VS1	Singapore
VS2	See 9M2
VS4	Sarawak
VS5	Brunei
VS6	Hong Kong
VS9	Aden & Socotra
VS9	Maldive Islands
VS9	Sultanate of Oman
VU2	India
VU4	Laccadive Islands
VU5	Andaman & Nicobar Islands
XE, XF	Mexico
XE4	Revilla Gigedo
XV5	Cambodia
XW8	Laos
XZ2	Burma
YA	Afghanistan
YI	Iraq
YK	Syria
YN, YN0	Nicaragua
YO	Roumania
YS	Salvador
YU	Yugoslavia
YV	Venezuela
YV0	Aves Island
ZA	Albania
ZB1	Malta
ZB2	Gibraltar
ZC3	Christmas Island
ZC4	Cyprus
ZC5	British North Borneo
ZC6	Palestine
ZD1	Sierra Leone
ZD2	Nigeria
ZD3	Gambia
ZD4	Gold Coast, Togoland
ZD6	Nyasaland
ZD7	St. Helena
ZD8	Ascension Island
ZD9	Tristan da Cunha & Gough Island
ZE	Southern Rhodesia
ZK1	Cook & Manihiki Islands
ZK2	Niue
ZL	Chatham Islands
ZL	New Zealand
ZL1	Kermadec Islands
ZM6	British Samoa
ZM7	Tokelaus
ZP	Paraguay
ZS1, 2, 4, 5, 6	Union of South Africa
ZS2	Prince Edward & Marion Island
ZS3	Southwest Africa
ZS7	Swaziland
ZS8	Basutoland
ZS9	Bechuanaland
3A	Monaco
3V8	Tunisia
3W8	Vietnam
4S7	Ceylon
4W1	Yemen
4X4	Israel
5A	Libya
9G1, ZD4	Ghana
9K2	Kuwait
9M2	Malaya
9N	Nepal
9S4	Saar

OFFICIAL A.R.R.L. COUNTRIES LIST
Courtesy of American Radio Relay League

reat circle chart



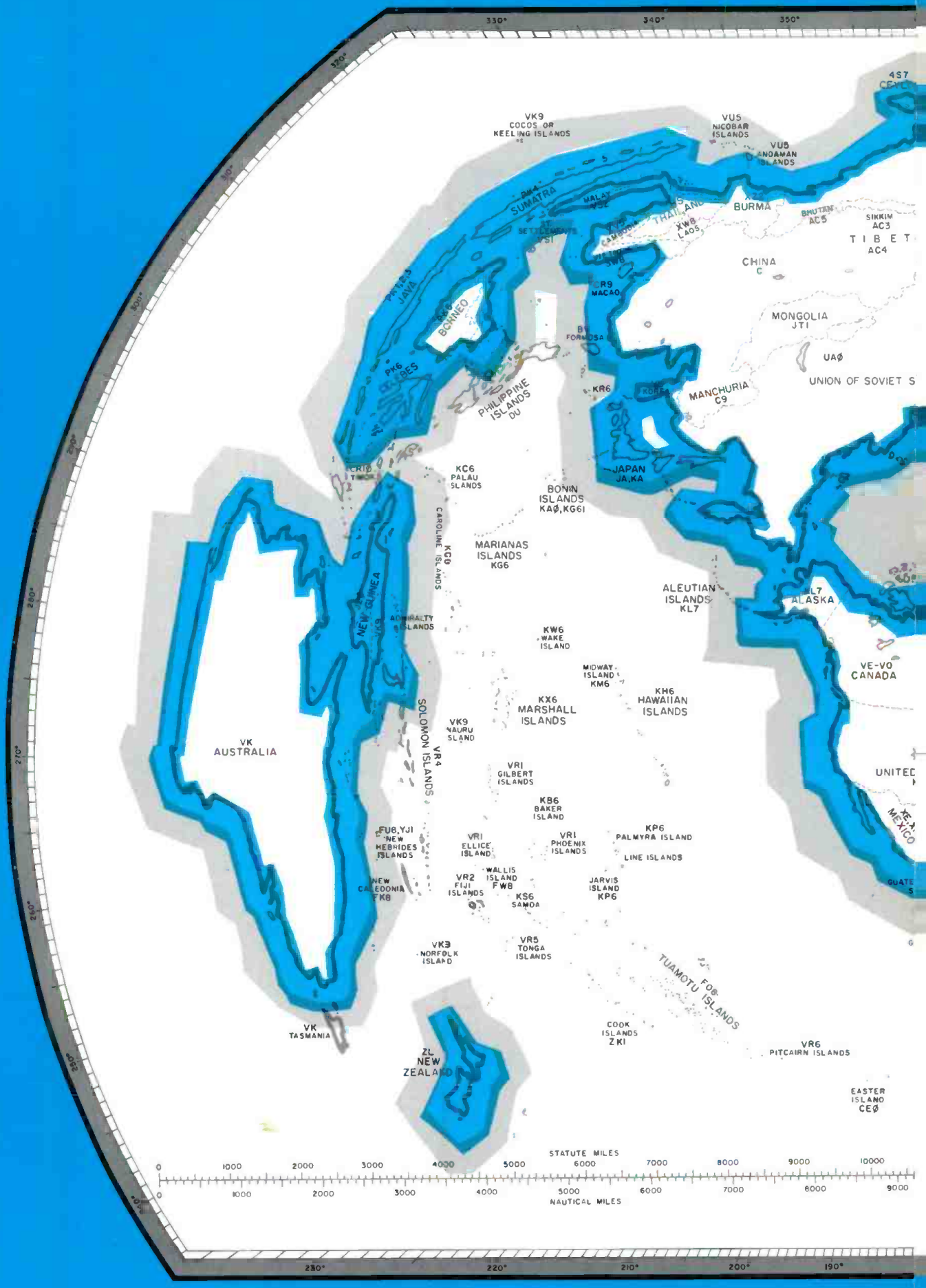
This world-wide map includes several important feotures of interest to the radio amateur and short-wave listener.

1. Distance, in miles, from Mead's Ranch, Kansas (indicated by star) to any point in the world can be found directly.
2. Direction, in degrees from North, can be obtained from Mead's Ronch, Kansas to any point in the world. This is important when orienting your antenna.
3. Amateur call-letter prefixes.

This map is a Great Circle Chart centered on Mead's Ranch, Kansas. Those living in this vicinity can use this map directly with o high degree of accuracy. For other parts of the United States (for example, New York or Californio) some error will result. When measuring mileage, however, this error is very slight and can be ignored in most opplicotions for which this map is intended. With regards to direction, the greatest error will be approximately ten degrees for all bearings directly north and south. For beorings directly east or west, the error is zero.

This map was supplied by the Aeronautical Chart Service, U. S. Air Force, Washington 25, D. C. The amateur prefixes and the accompanying list of call-letters were furnished by the American Radio Relay League. Space limitotions preclude the listing of all countries and all call letters. For complete list, see chart on reverse side.

radio amateur g



Alphabetical Listing of Countries with Prefixes

CALL	LOCATION
VS9	Aden & Socotra
YA	Afghanistan
OH0	Aland Islands
KL7	Alaska
ZA	Albania
FA	Algeria
FB8	Amsterdam & St. Paul Islands
VU5	Andaman & Nicobar Islands
PX	Andorra
CR6	Angola
VP2	Anguilla
VP2	Antigua, Barbuda
LU	Argentina
UG6	Armenia
ZD8	Ascension Island
VK	Australia
OE	Austria
YV0	Aves Island
UD6	Azerbaijan
CT2	Azores
VP7	Bahama Islands
MP4	Bahrein
KB6	Baker, Howland & American Phoenix Islands
EA6	Balearic Islands
VP6	Barbados
ZS8	Basutoland
ZS9	Bechuanaland
ON4	Belgium
VP9	Bermuda Islands
AC5	Bhutan
CP	Bolivia
KA0, KG6I	Bonin & Volcano Islands
ZC5	Borneo, British North
PK5	Borneo, Netherlands
PY	Brazil
VS5	Brunei
LZ	Bulgaria
XZ2	Burma
FE8	Cameroons, French
XV5	Cambodia
VE, VO	Canada
KZ5	Canal Zone
EA8	Canary Islands
CR4	Cape Verde Islands
KC6	Caroline Islands, Eastern
KC6	Caroline Islands, Western
VP5	Cayman Islands
PK6	Celebes & Molucca Islands
4S7	Ceylon
VQ8	Chagos Islands
GC	Channel Islands
ZL	Chatham Islands
CE	Chile
C (unofficial)	China
ZC3	Christmas Island
FO8	Clipperton Island
T19, VK9	Cocos Islands
HK	Colombia
FB8	Comoro Islands
OQ5, OQ0	Congo, Belgian
ZK1	Cook & Manihiki Islands
FC (unofficial)	Corsica
TI	Costa Rica
SV	Crete
CM, CO	Cuba
ZC4	Cyprus
OK	Czechoslovakia
OZ	Denmark
SV	Dodecanese
VP2	Dominica
HI	Dominican Republic
CE0	Easter Island
HC	Ecuador
SU	Egypt
G	England
FQ8	Equatorial Africa, French
ET2	Eritrea
UR2	Estonia
ET3	Ethiopia
OY	Faeroes
VP8	Falkland Islands
VR3	Fanning & Christmas Islands
PY0	Fernando de Noronha
VR2	Fiji Islands
OH	Finland
BV (C3)	Formosa
F	France
UA1	Franz Josef Land
HC8	Galapagos Islands
ZD3	Gambia
UF6	Georgia
VP8, LU-Z	Georgia, South
DJ, DL, DM	Germany
9GI, ZD4	Ghana
ZB2	Gibraltar
VR1	Gilbert, Ellice Islands & Ocean Island
CR8	Goa
ZD4	Gold Coast, Togoland
SV	Greece
OX, KG1	Greenland
VP2	Grenada & Dependencies
FG7	Guadeloupe
KG4	Guantanamo Bay
TG	Guatemala
VP3	Guiana, British
PZ1	Guiana, Netherlands
CR5	Guinea, Portuguese
EA0	Guinea, Spanish
HH	Haiti
KH6	Hawaiian Islands
VK0	Heard Islands
HR	Honduras
VP1	Honduras, British
VS6	Hong Kong
HA	Hungary
TF	Iceland
EA9	Ifni
VU2	India
FN2	India, French
FI8	Indo-China, French
EQ	Iran
GI	Ireland, Northern
EI	Ireland, Republic of
YI	Iraq
GD	Isle of Man
4X4	Israel
I1, IT1. IP1	Italy
VP5	Jamaica
LA	Jan Mayen
JA, KA	Japan
PK1, PK2, PK3	Java
KJ6	Johnston Island
JY	Jordan
CE	Juan Fernandez
UN1	Karelo-Finnish Republic
UL7	Kazakh
VQ4	Kenya
FB8	Kerguelen Islands
ZL1	Kermadec Islands
UM8	Kirghiz
HL	Korea
9K2	Kuwait
VU4	Laccadive Islands
XW8	Laos
UQ2	Latvia
OD5	Lebanon
EL	Liberia
5A	Libya
HE	Liechtenstein
UP2	Lithuania
VK	Lord Howe Island
LX	Luxembourg
CR9	Macao
VK0	Macquarie Island
FB8	Madagascar
CT3	Madeira Islands
VS2, 9M2	Malaya
VS9	Maldive Islands
ZB1	Malta
C9	Manchuria
KG6	Mariana Islands
KX6	Marshall Islands
FM7	Martinique
VQ8	Mauritius
XE, XF	Mexico
KM6	Midway Islands
UO5	Moldavia
JT1	Mongolia
3A	Monaco
VP2	Montserrat
CN8	Morocco
EA9	Morocco, Spanish
CR7	Mozambique
VK9	Nauru Island
KC4	Navassa Island
9N	Nepal
PA0, PI1	Netherlands
FK8	New Caledonia
VK9	New Guinea, Territory of
JZ0	New Guinea, Netherlands
FU8, YJ1	New Hebrides
ZL	New Zealand
YN, YN0	Nicaragua
ZD2	Nigeria
ZK2	Niue
VK9	Norfolk Island
LA	Norway
ZD6	Nyasaland
FO8	Oceania, French
VS9	Oman, Sultanate of
VP8, LU-Z	Orkney Islands, South
AP2	Pakistan
ZC6	Palestine
KP6	Palmyra Group, Jarvis Island
HP	Panama
VK9	Papua Territory
ZP	Paraguay
OA	Peru
DU	Philippines
VR1	Phoenix Islands, British
VR6	Pitcairn Island
SP	Poland
CT1	Portugal
ZS2	Prince Edward & Marion Island
CR5	Principe, Sao Thome
KP4	Puerto Rico
MP4	Qatar
KS4	Rancador Cay & Serrana Bank
FR7	Reunion Island
XE4	Revilla Gigedo
VQ2	Rhodesia, Northern
ZE	Rhodesia, Southern
EA9	Rio de Oro
VQ8	Rodriguez Island
YO	Roumania
UA9, UA0	Russian S.F.S.R., Asiatic
UA1, 2, 3, 4, 6	Russian S.F.S.R., European
UB5	Russian S.S.R., White
KR6	Ryukyu Islands
9S4	Saar
FS7	Saint Martin
YS	Salvador
KS6	Samoa, American
ZM6	Samoa, British
HK0	San Andres, Archipelago of & Providencia
VP8, LU-Z	Sandwich Islands, South
M1	San Marino
VS4	Sarawak
IS1	Sardinia
HZ	Saudi Arabia
GM	Scotland
VQ9	Seychelles
VP8, LU-Z	Shetland Islands, South
ZD1	Sierra Leone
AC3	Sikkim
VS1	Singapore
PJ2M	Sint Maarten
VR4	Solomon Islands
VQ6	Somaliland, British
FL8	Somaliland, French
I5	Somaliland, Italian
ZS3	Southwest Africa
EA	Spain
ZD7	St. Helena
VP2	St. Kitts, Nevis
FP8	St. Pierre & Miquelon Islands
VP2	St. Vincent & Dependencies
ST2	Sudan
PK4	Sumatra
LA	Svalbard
KS4	Swan Islands
ZS7	Swaziland
SL, SM	Sweden
HB	Switzerland
YK	Syria
UJ8	Tadzhik
VQ3	Tanganyika Territory
CN2	Tangier
VK	Tasmania
HS	Thailand
AC4	Tibet
CR10	Timor, Portuguese
FD	Togo
ZM7	Tokelaus
CR5	Tonga Islands
I1	Trieste
PY0	Trindade & Vaz Island
VP4	Trinidad & Tobago
ZD9	Tristan de Cunha & Gough Island
FB8	Tromelin Island
MP4	Trucial Oman
3V8	Tunisia
TA	Turkey
UH8	Turkoman
VP5	Turks & Caicos Islands
VQ5	Uganda
ZS1, 2, 4, 5, 6	Union of South Africa
K, W	United States of America
CX	Uruguay
UI8	Uzbek
HV	Vatican
YV	Venezuela
3W8	Vietnam
KV4	Virgin Islands
VP2	Virgin Islands, British
KW6	Wake Island
GW	Wales
FW8	Wallis & Futuna Islands
FF8	West Africa, French
PJ	West Indies, Netherlands
UA0	Wrangel Island
4W1	Yemen
YU	Yugoslavia
VQ1	Zanzibar

OFFICIAL A.R.R.L. COUNTRIES LIST
Courtesy of American Radio Relay League

Subdivided Hi-Fi Speaker Enclosure

By **D. F. REHBERGER**
Physics Dept., Univ. of Penna.

Complete construction details on unusual "infinite baffle" employing inexpensive speakers, based on a British design.

A GREAT deal of design and experimental manpower has been, and is being, expended in the improvement of low-frequency response in a given area—particularly with regards to cost. Considering size and price, most speaker-baffle combinations result in a compromise, with the low-frequency response below 500 cycles suffering. The major cause of poor low-frequency response, and one often overlooked in enclosure designs, is failure to remove low-frequency standing-wave effects from within the cabinet. Size and cost are limiting factors in conventional designs, as they usually go hand-in-hand so that the resulting system is either large or expensive, or both, without possessing the desired performance characteristics. Realistic reproduction is, of course, the prime concern but this can only be obtained after the basic problems of standing-wave effects and panel resonances are solved.

The purpose of the design to be discussed is to solve the major problems of enclosing a speaker in a baffle so that it produces good results, without the need for gimmicks or novelties. The design, basically a completely closed box or so-called infinite baffle, utilizes subdivisions as an acoustic filter, resulting in extremely good performance at a cost far less than the price normally paid for an enclosure to be used in the usual high-fidelity system. The size, too, has been reduced, being only 10-inches deep by 24-inches high.

The cabinet encloses a volume of air that is compressed and rarefied with the cone movement. This causes the bass-resonant frequency of the speaker to rise, due to the interaction of the speaker's resonant frequency with the resonant frequency of the air column. Besides the "air-column resonance," the reflective properties of the inside walls create standing waves at all but the high frequencies. Standing-wave effects with loudspeakers would be analogous to the standing-wave principle with transmission lines. Where there is no reflection from the load, in this case the interior of the cabinet, the sound waves would decrease exponentially toward the load. However, when the load reflects back part of the incident energy, it combines with the direct energy and varies, as to amplitude, periodically along the distance. This results in nodes (nulls) and antinodes (peaks). At a certain frequency and distance, with the rear of the cone located near an antinode, the output would be reduced by a large amount. The action of nodes and antinodes results in uneven response from the front of the cone and is attributed to standing-wave effects.

The reflecting sound waves (standing-wave effects) within the enclosure can be eliminated at all frequencies above about 500 cps by use of sound absorbing material within the cabinet. Below this frequency the standing waves cannot be eliminated successfully without some type of acoustic filter.

Panel resonances tend to color the program and produce noding if not constructed with extremely rigid panels. Good speaker enclosures of conventional design must be heavy and properly reinforced, with some being sand-filled or built with brick or reinforced concrete. Such a rigid cabinet would improve the transient response of the system, thereby resulting in a much cleaner output sound.

One of the early designs incorporating effective damping of standing waves was presented by D.E.L. Shorter of the *BBC* and consisted of subdividing partitions inside the cabinet (British Patent No. 696,671).[1] He states that the principle of subdivision may be achieved in various ways and the enclosure would have to be divided into many small sections, each of which would be unable to support standing waves at the low-frequency end. To prevent any reflecting-wave effects at higher frequencies, he suggests the use of sound absorbing material placed over two or more compartments around the back of the speaker. This prevents the cabinet from receiving any sound at high frequencies and eliminates the need for further acoustic treatment.

Of the many possibilities, the method used to subdivide the cabinet involved mounting radial partitions around the rear of the speaker. This not only accomplishes the necessary subdivision of the cabinet but also provides extremely rigid construction, re-

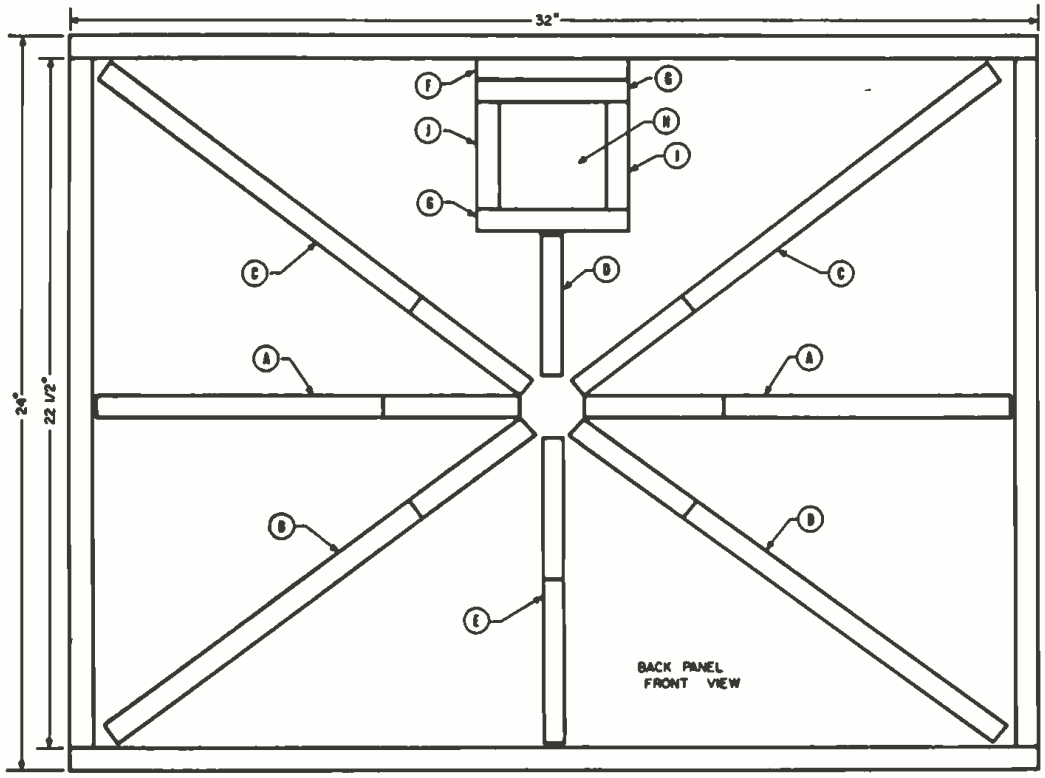
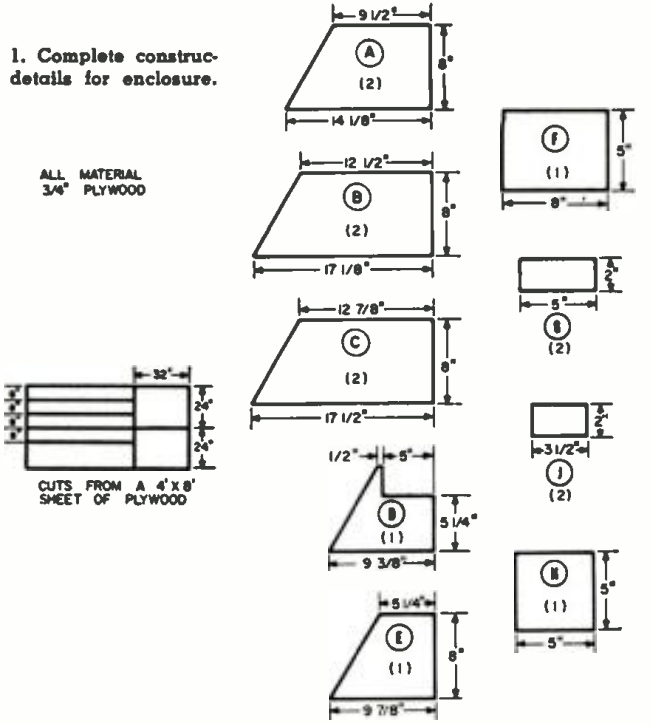
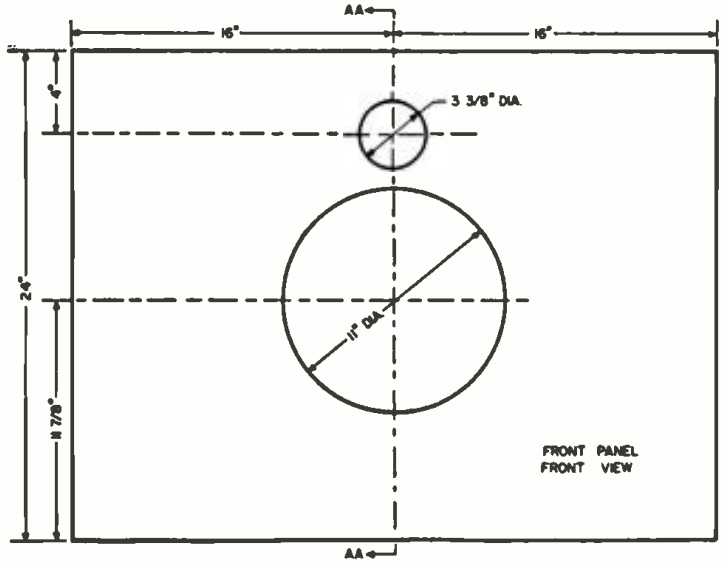
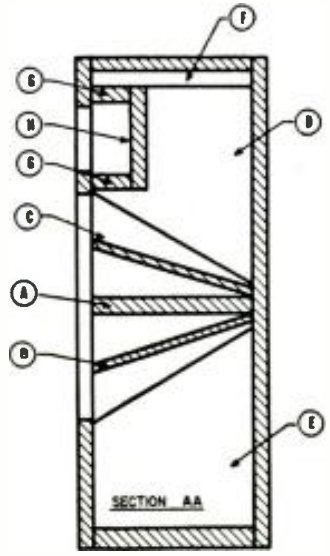
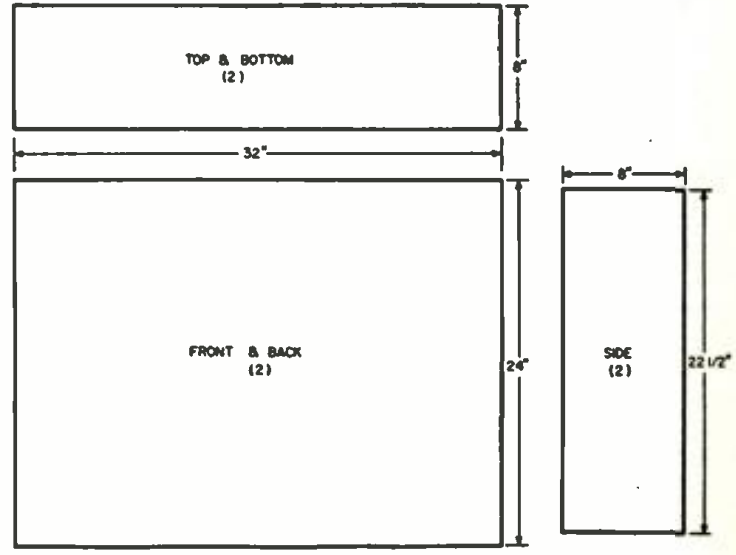


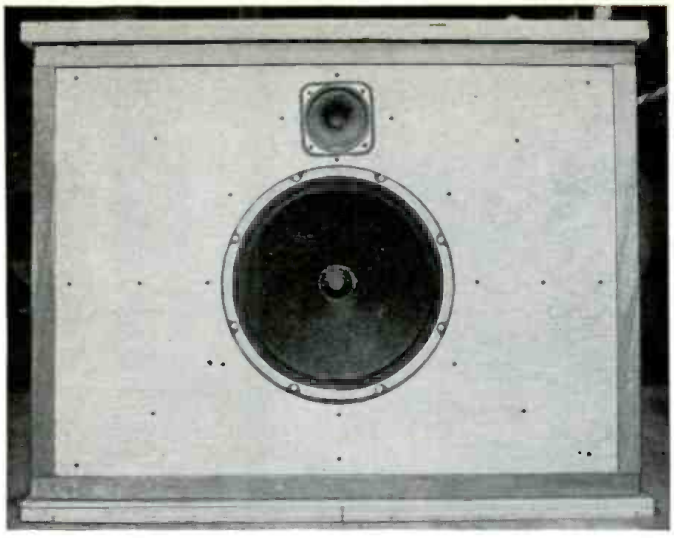
Fig. 1. Complete construction details for enclosure.



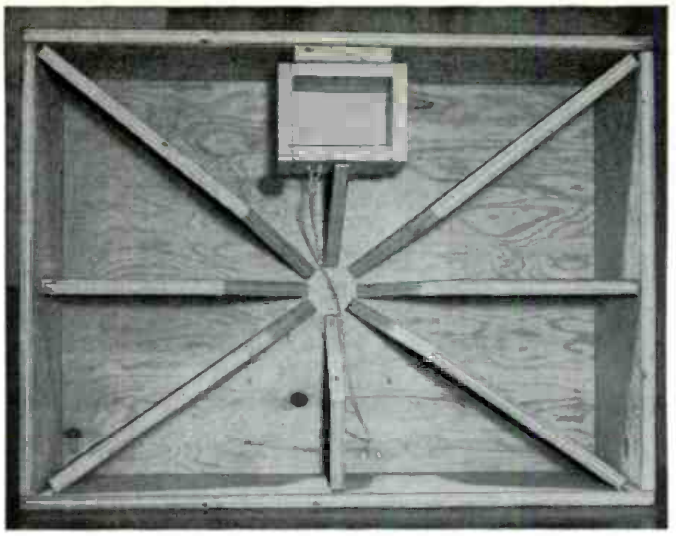








Front-panel view with speakers mounted, prior to being covered.



Front view of the back panel with the dividing partitions shown.

ducing the resonances of the panels.

The cone of the speaker used was treated, as suggested by Mr. Shorter, to obtain a reduction in the speaker's bass-resonant frequency by providing a freer suspension. The first model tested with the recommended speaker did not show any peaks below 1000 cps and it was felt that resonances were eliminated to a point where no further experimentation was necessary.

To obtain good, smooth response throughout the required range, without audible peaks or dips, the choice of speakers becomes fairly critical. Of the many 12-inch speakers tried, the *Jensen* P-12-P, which nets for about $17.00, was found to be most satisfactory with this enclosure. The tweeter is not as critical as the low-frequency unit but must have a smooth output without cone break-up and a level that matches the P-12-P. The *Jensen* P-35-VH, which costs about $4.00, matches the P-12-P and helps to provide the results obtained in the response curve of Fig. 2A. A simple high-pass filter is used, consisting of a 1-μf. capacitor in series with the tweeter, which makes up the "crossover network."

Treating the Woofer

A method of lowering the bass-resonant frequency can be applied to any large cone speaker that is not already treated (viscous edge damping) and provides a marked improvement. The cone edge, and only the edge, is impregnated with a hygroscopic material which will retain moisture in the cone edge and keep it more compliant. This results in a freer suspension and a lower bass-resonant frequency.

The method of making the seal required for the woofer is illustrated above.

The cone edge is first treated with a wetting agent which provides a rapid path for the penetration of the hygroscopic material. The most convenient wetting agent is *Kodak* "Photo-Flo," available in four-ounce bottles at photographic supply houses. For use, dilute a bottle-cap-full of "Photo-Flo" in eight ounces of water (or 1-100 solution).

While the cone edge is still wet apply the hygroscopic solution. This is a saturated solution of calcium chloride (silica gel). The solution is made by dissolving as much calcium chloride as possible in about four ounces of water at room temperature. Allow the mixture to set a day and if none of the crystals has settled out of solution, dissolve more calcium chloride. A one-

(*Continued on page* 112)

The placement of the sound-absorption material may be seen through woofer hole.

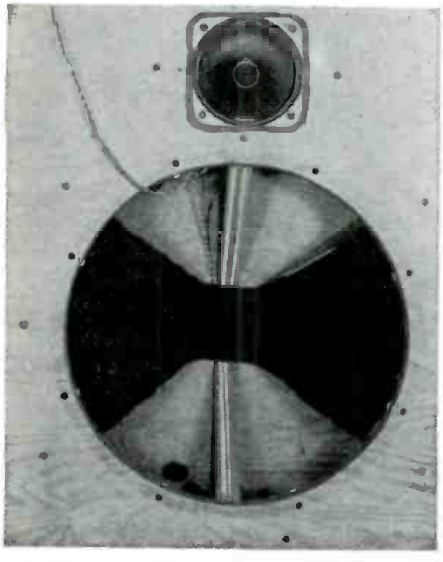
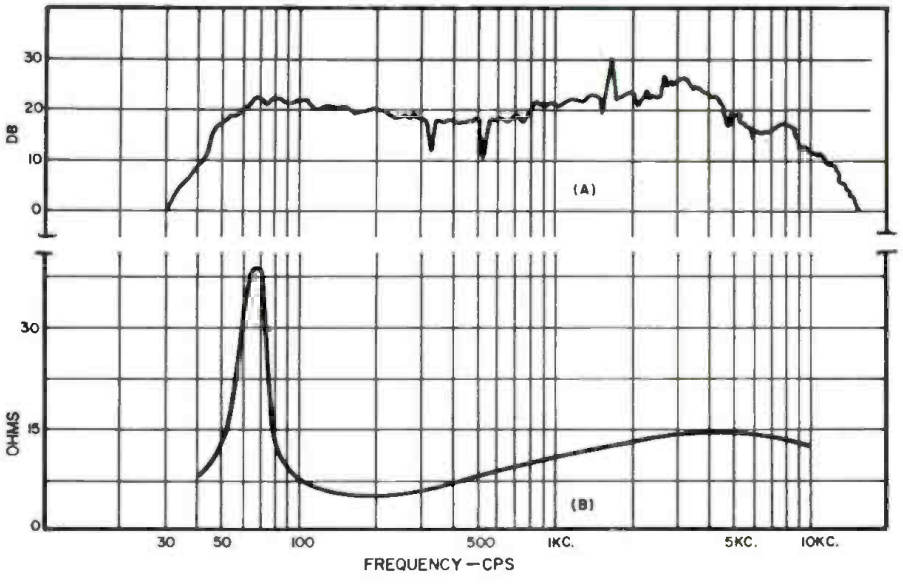


Fig. 2. (A) Acoustic output and (B) impedance curve of the speaker system described.



ELECTRONICS WORLD

LAB TESTED

Citizens Band Transceiver Kit

Tunable superregen receiver combined with single-channel 5-w. transmitter.

The Heath CB-1 is available either in kit form at $42.95 or wired at $60.95.

IT was not too long ago that your editor received his Class D Citizens Band station license and we are now operating with the call 1W1542 out of Connecticut. Our plans involve using this equipment for personal applications, but, at the same time, we will take the opportunity of checking out various pieces of Citizens Band equipment. It took the FCC sixty-five days to process our application, which is not too bad considering the large number of Citizens Band and other service applications received.

There are quite a few companies planning to market equipment designed for Class D operation and all of them are working under crash programs to complete their designs. By the time this issue is published anyone interested in this type of operation should have a wide selection of equipment from which to choose.

One of the earliest designs to hit the market is the *Heath Company's* Model CB-1. This is the first unit we have been able to check and it gave us an opportunity to put our newly acquired license to use.

The circuit of the *Heath* unit is almost identical to the one published in our March, 1959 issue ("Build This Citizens Band Transceiver" by Don Stoner). This one created quite a stir, not only among our own readers but also in the entire industry. The *Heath* unit employs a different power supply and some other minor circuit changes. The CB-1 is a transceiver, combining both the transmitter and the receiver in a single package and using some of the same circuits for both transmitting and receiving. It is self-powered for 117-volt operation but an external adapter can be obtained from *Heath* to convert the unit to 6- or 12-volt battery operation. (See circuit on facing page.)

The transmitter section, which is crystal-controlled in accordance with FCC requirements, is designed around a single tube, a 6AU8. The receiver is of the superregenerative type which does have some limitations when compared to a superheterodyne but it has the one great advantage of providing high sensitivity by means of a very simple circuit. Basically *Heath's* design is about as simple as can be had. All the frills, such as squelch circuits and push-to-talk microphone operation, have been omitted in order to keep the cost as low as possible.

EDITOR'S NOTE: Almost too late—but just hours before we go to press—we found time to make further tests. We mounted one of Heath's units in our boat and with the standard mobile-type, quarter-wave whip antenna, we extended our range of coverage from Stamford, Conn. to the shores of Long Island, giving us a total distance of ten miles. Seven miles of this was across water and actual reception improved as we crossed Long Island Sound. Even at the ten-mile limit, the performance was exceptionally good, indicating that even greater distances can be covered with this equipment.

The actual construction of the kits turned out to be extremely simple. One of the units was built by a 15-year-old boy who completed the construction in about twelve hours, including the entire tuning procedure, using a dummy load.

One problem that did come up, which we believe is inherent in most Citizens Band units available today, is that even if perfect adjustment is achieved when using a dummy load (either pilot lamp or resistive type), the adjustments may be thrown off when an antenna is connected. Obviously the dummy load is not an exact equivalent circuit. We have talked to several manufacturers regarding this problem and there seems to be no simple solution. Some manufacturers are advising their customers to perform transmitter adjustment procedures while on the air. This, of course, is against FCC regulations at the present time if such adjustments cause "improper operation." We have heard, though, that the FCC is considering permitting on-the-air adjustments on commercially built or kit built units that meet certain oscillator design requirements. Each manufacturer, of course, should be in a position to advise regarding this particular point. In our case a neighbor, who holds a second class commercial operator's license, was more than pleased to make the proper on-the-air adjustments for us.

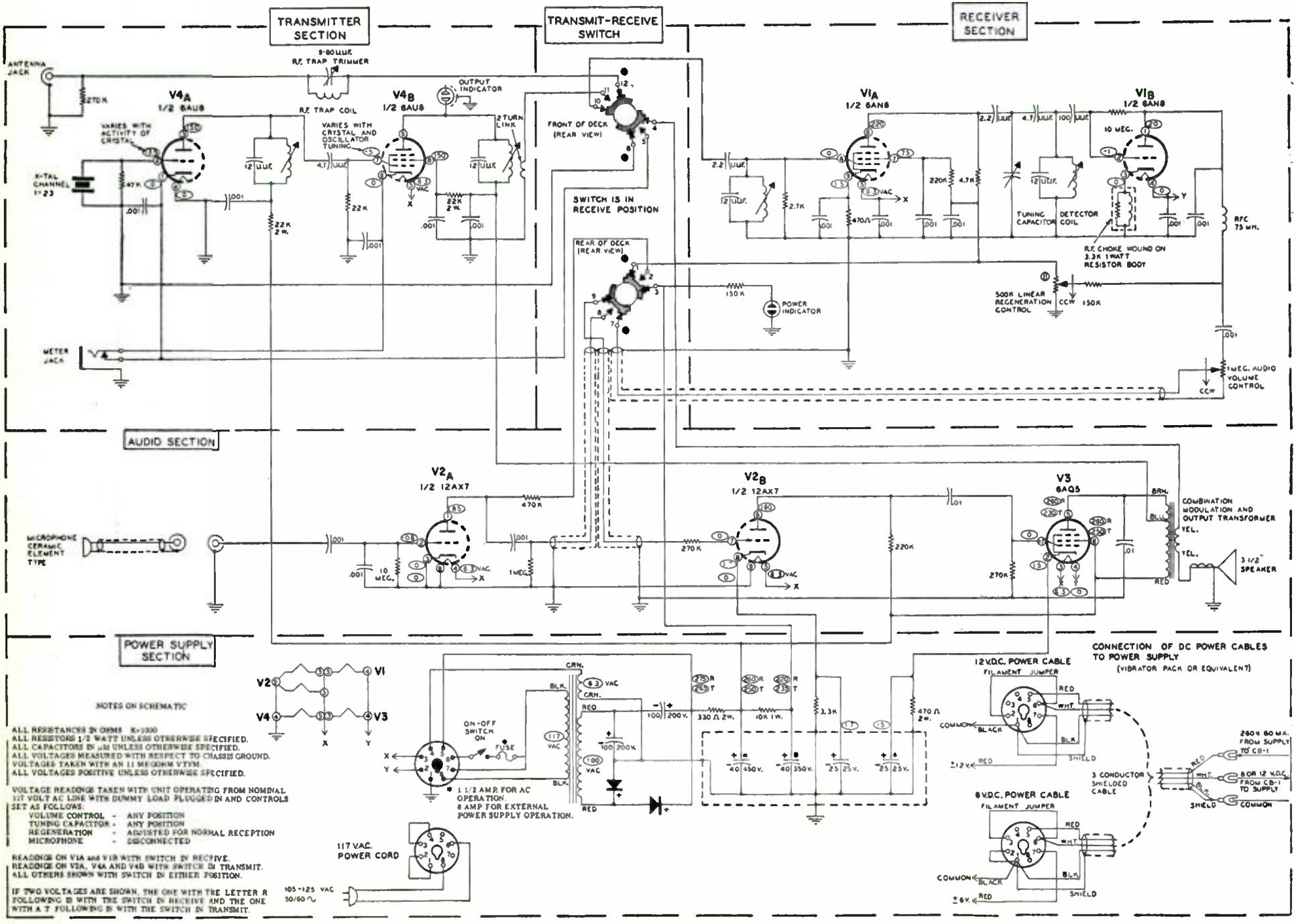
One of our greatest pleasures was in field testing the units. We had heard many comments to the effect that Citizens Band units should provide reliable coverage anywhere from one mile to the ridiculously high figure of 3000 miles. Our particular area of operation is far from ideal. We certainly can never cover any great distances in that we are in an extremely wooded location and somewhat in a valley since a high ridge encloses us on one side. Our first attempt was made using low-priced utility antennas (45½-inch base-loaded whip) at both stations, with one of the stations located inside the house and the other in a car as a mobile unit. Our distance of operation was just short of one mile. We then installed a quarter-wave ground-plane antenna, *Heath's* Model CBS-1, on top of the house about twelve feet below the maximum permitted height. The utility antenna was still being used on our mobile unit. We were then able to extend our coverage to approximately two miles.

Our next attempt was made with a standard quarter-wave 27-mc. whip on the mobile unit. Our coverage was again extended, this time to just over three miles. We were backed up against the Long Island Sound at this

(*Continued on page* 111)

▶

Complete schematic diagram of Heath's CB-1 Citizens Band transceiver for Class D use.



NOTES ON SCHEMATIC

ALL RESISTANCES IN OHMS K=1000
ALL RESISTORS 1/2 WATT UNLESS OTHERWISE SPECIFIED.
ALL CAPACITORS IN μfd UNLESS OTHERWISE SPECIFIED.
ALL VOLTAGES MEASURED WITH RESPECT TO CHASSIS GROUND.
VOLTAGES TAKEN WITH AN 11 MEGOHM VTVM.
ALL VOLTAGES POSITIVE UNLESS OTHERWISE SPECIFIED.

VOLTAGE READINGS TAKEN WITH UNIT OPERATING FROM NOMINAL 117 VOLT AC LINE WITH DUMMY LOAD PLUGGED IN AND CONTROLS SET AS FOLLOWS:

- VOLUME CONTROL - ANY POSITION
- TUNING CAPACITOR - ANY POSITION
- REGENERATION - ADJUSTED FOR NORMAL RECEPTION
- MICROPHONE - DISCONNECTED

READINGS ON V1A and V1B WITH SWITCH IN RECEIVE.
READINGS ON V2A, V4A AND V4B WITH SWITCH IN TRANSMIT.
ALL OTHERS SHOWN WITH SWITCH IN EITHER POSITION.

IF TWO VOLTAGES ARE SHOWN, THE ONE WITH THE LETTER R FOLLOWING IS WITH THE SWITCH IN RECEIVE AND THE ONE WITH A T FOLLOWING IS WITH THE SWITCH IN TRANSMIT.

Restoration of Old-Time Wireless Gear

By **HOWARD S. PYLE**

Over 160 pieces of gear have been restored in last 2 years and display set up in cooperation with local parts dealers.

THERE is perhaps no more nostalgic group of "Old Timers" in the world than the early day amateur and professional "wireless" operators. Fond memories of the flashing, crackling sparks, the smell of ozone, the breathless searching for a more sensitive spot on a tiny mineral crystal, brings a lump to the throat of the real "wireless" pioneer. "Wireless" was romance; patient hand-filing of nickel and silver to blend within a glass tube and form a "coherer" detector; laborious winding of hundreds of turns of wire on a cardboard tube to form a "tuner"; melting paraffin on the kitchen range to pour in half a cigar box stacked with alternate sheets of tinfoil and paper to create a "condenser"! And the thrill . . . the ecstasy of holding one's breath to catch every faint dot from a powerful station some fifteen miles distant with this crude, inefficient but serviceable, home-made apparatus from days gone by!

Those days, alas, are forever past. "Radio" has replaced "wireless" . . . inert, unimaginative metal-encased vacuum tubes have taken the place of the brightly glowing incandescence of the early deForest "audion" bulbs which, in their turn, pushed the crystal detector in the background. Relatively small glass-enclosed electron tubes and even the tiny transistor are receiving excellent signals around the world from transmitters occupying no more space than a conventional shoe box or, at most, an orange crate!

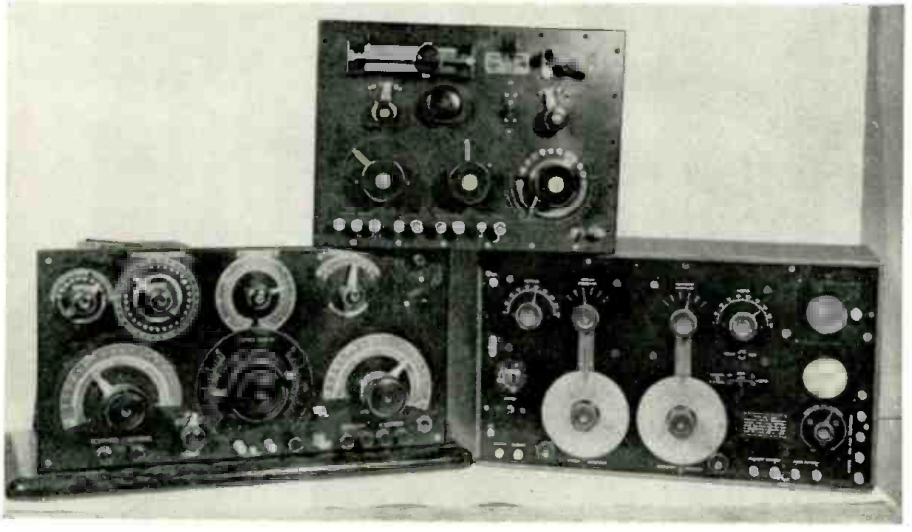
Just as amateur radio today is a far cry from amateur "wireless" of the past, commercial applications of communication without wires has also undergone a complete transformation. No longer is a shipboard operator faced with the necessity for "tearing the works" from a huge, coffin-like open core transformer to find and repair the flash-over in the 20,000-volt secondary; no more does he patiently file the points of a rotary spark gap nor does he have to clean the surfaces of the quenched type.

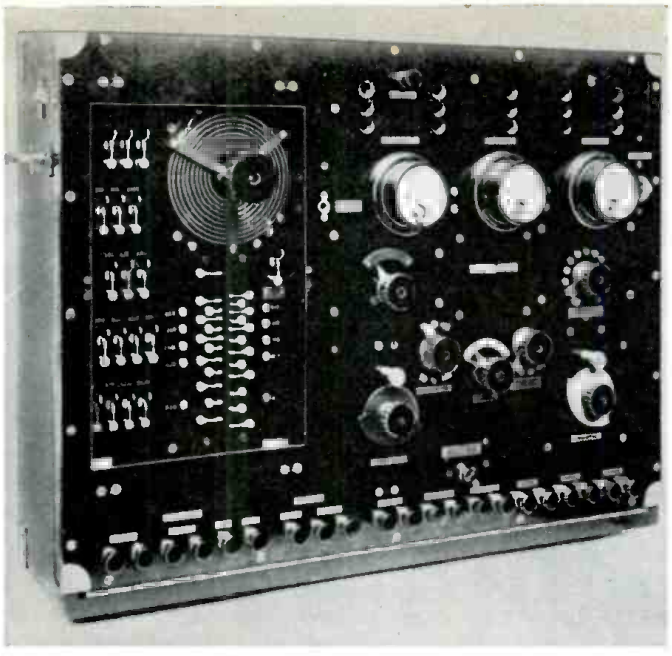
Such thoughts as these constantly flick through the minds of the real "Old Timers." I am no more immune than other pioneer "wireless" operators. Could we possibly bring back a semblance of the "good old days"? This started a train of thought. I well knew that a goodly number of old-time amateur and professional operators had been collecting what they could in the way of early day "wireless" equipment and had set up their own private "museums" where they could drool by the hour and occasionally proudly display their pioneer collections to sympathetic visitors. Ed Raser, W2ZI in Trenton, N. J. and Vance Phillips, W6GH of Santa Barbara, Calif., are outstanding examples of collectors of old "wireless" gear and both have impressive displays. Why could not I also begin to gather what I could from whatever sources available?

The "kick-off" came when a local radio club presented me, as the then Chairman of the Pacific Northwest Chapter of the Veteran Wireless Operator's Association, with a Navy type SE-1420 receiver of World War I vintage. A marvelous receiver for the times, it represented the foremost scientific advances and out-performed any previous receivers developed by any nation. Its immediate predecessor, the SE-143, was every bit as good but did not incorporate an "audion" detector. The Navy Department, although having had a number of experimental installations of deForest's little "hair pin in a pickle bottle" for several years, was still somewhat skeptical of the superiority of the audion over more conventional methods of detection. Early day "audions" were gassy and erratic, required critical adjustment of both plate and filament voltages, and were frequently burned out by careless operation. Operators were unfamiliar with the new device and many had only mediocre success. Rather than bother with the relatively intricate adjustment procedures, many took the "easy" way and reverted to the mineral crystal detector.

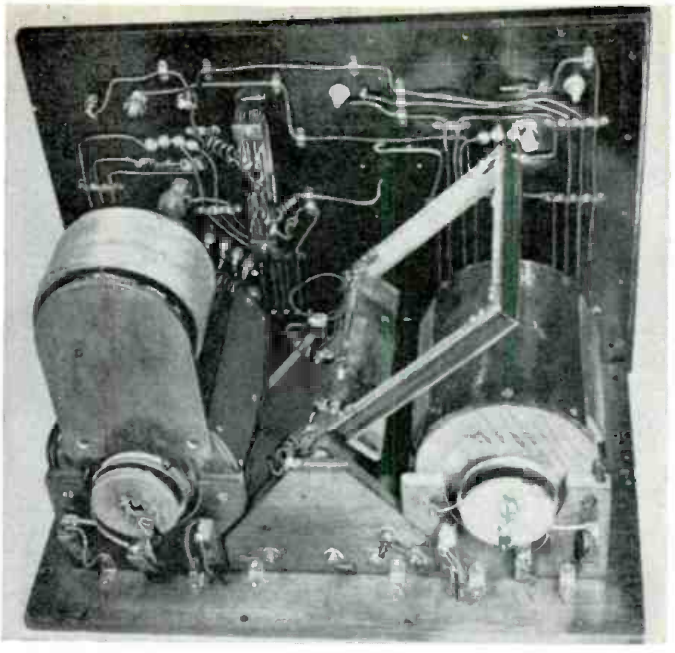
With continued improvement in the "audion" bulbs themselves by a number of prominent licensees under deForest's patents, many of the drawbacks were eliminated. Better exhaustion of the envelope, stabilization of the elements, and elimination of necessity for critical voltage adjustments, went a long way to popularize deForest's "Aladdin's Lamp." With the development by the *Bell Telephone Laboratories* and *Western Electric* of the oxide-coated filament and the consequent introduction of the "VT-1" and "VT-2" types of tubes, "audion" detection became even simpler from an operating standpoint than the time-tried crystal method and was manifold more efficient. The SE-

Some pioneer commercial wireless receivers restored to original appearance and operating condition by author. (Top) Canadian Marconi Co. marine receiver with carborundum crystal detector, widely used in Canadian vessels around 1910. (Left) A popular receiver of the Marconi Wireless Telegraph Co. of America. Equipped with a "Cerusite" crystal detector, this type 106-D receiver was standard equipment on many vessels of the American merchant marine from about 1914 to 1917. (Right) The famous Navy type SE-1420, the first U. S. Naval receiver to be produced with an integral audion or vacuum tube. This was produced during World War I and found wide usage in the Naval service and on commercial vessels during and after the war.





The first commercially produced radiotelephone and telegraph transmitter and receiver unit made on a production basis was the Western Electric CW-936. The unit was installed on sub-chasers of the Navy in World War I and its use was rapidly extended to other Navy ships. Oxide-filament VT-2 vacuum tubes were employed for the transmitter and the smaller VT-1's for the receiver.



Internal view of the early Canadian shipboard receiver. Hardwood was used for coil forms, brackets, and supports. Hard rubber was used for the panel and for curved protector over right-hand coil. Since variable tuning capacitors had not as yet come into very wide usage at that time, tapped variometers, loading coils, and coupling coils were used to vary the tuning.

143 receiver, while not "audion" equipped integrally, did make provision for both an external "audion box" and an external crystal detector. A "tickler coil" was also incorporated in the design so that full advantage could be taken of the regenerative and oscillating properties of the audion. The combination of the SE-143 receiver and its associated type SE-1071 "Audion Control Box" proved so successful that the SE-143 receiver was re-designed to incorporate the "audion" integrally and, with a few additional refinements, became the SE-1420.

The SE-1420 receiver presented to me was in horrible shape electrically, mechanically, and in general over-all appearance. The whole thing had possibilities but I could foresee the many hours it would take to restore it. Was it worth it? I decided that it was.

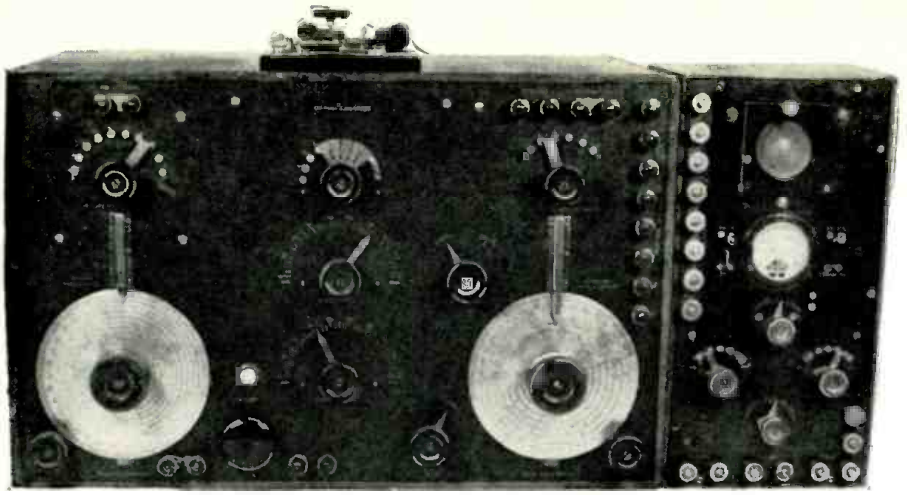
The internal assembly appeared to present less of a problem than the cabinet and front panel. As a "feeler" I started there. Every soldered joint was unsoldered, surplus solder removed with a discarded toothbrush, and the joints re-soldered with resin-core solder. Broken connections were repaired and a few frayed wires replaced. The connecting links and other mechanical contrivances were removed and put on a buffing wheel, using medium-grade jeweler's rouge as a polishing medium. Coils and similar parts were carefully cleaned with a stiff bristle brush and re-lacquered. The inner surface of the panel was cleaned with an automotive lacquer cleaner and wiped with a lightly oiled cloth. The result was a feast for the eye! Internally, I had the good old SE-1420 looking as good or better than when it left the factory!

Next, the front surface of the panel. Alcohol, lacquer thinner, white gasoline, and several cleaning fluids made discouragingly little impression on the panel scum. As a last resort, painter's thinner (plain old turpentine) proved the answer. The scum came loose like frosting on a cake! Not bad. Next, a good grade of automotive chrome cleaner, using the reliable old standby, the discarded toothbrush, for an applicator, worked wonders on the switch points, binding posts, dials, and other metal parts. Once more the panel was washed with turpentine which removed the residue from the chrome cleaner. All front panel bright work was then given a high gloss polish using the medium jeweler's rouge and a lamb's wool buffing wheel chucked in a quarter-inch electric drill. The final touch was a thin coat of liquid furniture polish on the Bakelite panel itself, well burnished with the lamb's wool wheel.

And now, the cabinet. Paint removers of various kinds were common in the local hardware store. A little discussion with an intelligent clerk and I came home with a "can of magic." I mean that; all I did was brush it on generously, let it set for an hour or so and wipe off the residue with a damp cloth! Presto! I saw mahogany! Spotty of course, with some varnish clinging here and there, but a fine grade of sandpaper on a disc fitted in the electric drill chuck and I was down to bare wood with a beautiful grain. No filler was required as the original stain and varnish had filled the pores. Two coats of water white clear lacquer and I had "a thing of beauty."

The final step was an actual receiving test. The crystal detector was connected to the marked posts as well as a a pair of headphones, an antenna, and ground. Mechanical moving parts, such as internal coupling links, switch levers, etc., all worked smoothly (I had previously given them a treatment of "clock oil" with a small artists' brush). Setting the dials and switches to the approximate frequency of a local broadcast station, I connected a dry cell to the test buzzer battery terminals, pushed the "test" button which actuated the buzzer, and went back many years to the thrill of hunting for a sensitive spot on the crystal. And . . . I found one! Manipulating the dials slightly, I heard faint music; a bit more twiddling and I was listening to voice and music of superb quality . . . not loud, but very plainly audible. The crystal detector and tuning component portions worked. All that remained was the "audion." The original "VT-1" vacuum tube was still in the socket; whether good or bad was anyone's guess. Hooking a few old dry cells to the filament terminals, I turned up the rheostat. No soap; the tube remained cold and dark.

My collection of old tubes contained a couple of VT-1's and a VT-2; what shape they were in I had no idea but digging them out of their nest I found one of the VT-1's with a continuous filament and it glowed (dully, as they did with their oxide-coated filaments). Now for a plate battery. I was stumped there until it occurred to me to take 45 volts from the power plug on my little amateur transmitter. Connecting this, I donned the headphones, turned up the filament rheostat, and wiggled the "tickler" knob. Nothing; absolutely nothing! Fiddle as I did, brought no change. I ran a continuity check through the binding posts from



U. S. Navy type SE-143 receiver introduced early in World War I. The audion or vacuum-tube detector was contained with its controls in the separate cabinet at the right. A silicon-antimony crystal detector (on top of main cabinet) was provided in case the audion proved unreliable. Although the audion was incorporated as an integral part of the later type SE-1420 receiver, provision for crystal detection appeared in the SE-1420 as well since there were many who were skeptical of the tube.

the front panel . . . whoops, an open somewhere in the plate circuit. Nothing for it but to remove the umty-teen screws from the panel and pull it out of the cabinet. A point-to-point check revealed an error. In re-soldering the internal connections I had inadvertently reversed the positive and negative plate leads. Correcting this, I tried again; still nothing.

It occurred to me that mere reversal of terminal connections would most certainly not indicate an "open" on the ohmmeter; must be an actual open circuit somewhere. There was; right at the plate terminal of the tube socket; I had apparently overlooked that in re-soldering. Easily fixed and back under the headphones. Oh, brother! The soft, gentle "hiss" as I turned the regeneration control up into the oscillating range. The local broadcast station (I had not changed the tuning settings since changing from crystal to audion) was many times louder, accompanied by the whistle of his carrier while my tube was oscillating. Backing down on the regeneration control brought him in full and clear without a trace of the carrier.

I tuned around . . . all through the broad range of the receiver (250 to 8000 meters) . . . "frequency" then was an awesome word used only by scientists! I heard many signals both modulated and pure c.w.; several broadcast stations, ships at sea, tone modulated telegraph stations, marine and airway beacons. I had it made! A dignified, professional receiver operating most excellently and presenting an appearance equal to its debut from the production line!

It was fascinating work; slow, tiresome, and hard, but the great sense of satisfaction which comes from accomplishment, far overrode the effort expended. I was enthusiastic for "more." Where to acquire other "antiques" like this? Inquiry among local hams brought many pieces of early amateur equipment, both receiving and transmitting. I went to work on these with equally satisfying results. An amateur friend on a trip to Canada ran across a 1910 *Canadian Marconi Company* shipboard receiver in a farmer's barn! A couple of "fins" changed hands and a few days later he delivered it to me . . . a real prize!

A "strike" equal to that in the Yukon in '98, to my notion, turned up when the owner of the *Washington Radio & Television School* in Seattle gave me the key to his basement storeroom and invited me to ". . . get a shovel and clean it out!" What a find! The present school is one which had its inception in 1914 when the *Marconi Wireless Telegraph Company of America* established training schools strategically located throughout the country to relieve the shortage of trained wireless operators. Practically all of the original *Marconi* equipment plus some later, but now obsolete, apparatus had been gathering dust for lo, these many moons in a dark storeroom in the basement of the Seattle YMCA where the training school has always been located!

Two Navy SE-143 receivers, a *Marconi* Type 106-D receiver, *Federal Telegraph Company* "tone changer," World War I Navy frequency meter, a *Kolster* "Decremeter," and myriads of more minor "rarities" over which I simply gloated! I took them all! My basement shop and my outdoor shack were literally bulging with these "wireless ghosts of the past," and more kept coming in from various sources! I had to establish a routine. As I acquired equipment, I stored it in the outdoor shack, bringing it to the basement shop a piece at a time to work on. Fine, but the problem went further; after completion, what?

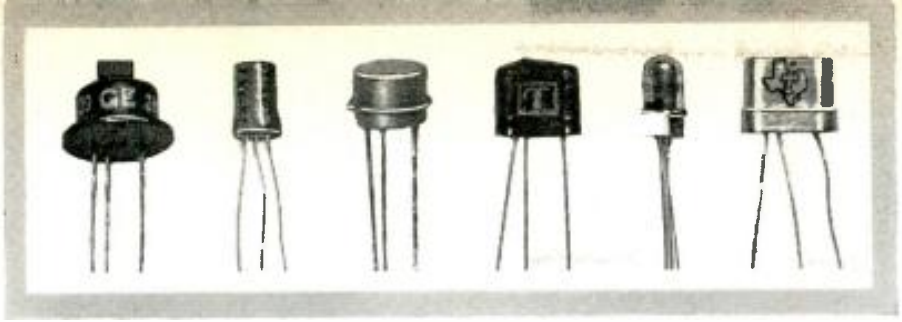
Space was not a particular problem but why should I keep these mementos of bygone days for my own pleasure and entertainment and that of the relatively few Old Timers who were my particular cronies? Why not place them where *all* of the hams and professional operators in my local area could also enjoy them?

In discussing this with other enthusiastic "wireless" pioneers, the suggestion was made that perhaps one of the local electronic supply stores would be sufficiently interested to donate display space. Following this thought, I approached the proprietor of one of the leading establishments of this type in Seattle. He was enthusiastic and offered to supply not only the space but a large, double showcase, fitted with locked doors in which to set up such a display. The next thought was to "divorce" such an exhibit from personalities; make it a group-sponsored display, rather than that of a private individual. The Northwest Chapter of the Quarter Century Wireless Association was contacted; they enthusiastically agreed to officially sponsor the amateur equipment portion of such an exhibit. Local members of the Veteran Wireless Operator's Association were most agreeable to acting as sponsors for the commercial equipment so displayed. I agreed to act as "curator" for both organizations and to take care of the few minor details involved. We were off!

It has been just about 2 years since the spark was struck. The Seattle display remained in place for an entire year and was viewed by many hundreds of amateur and professional operators not only with local addresses but the register shows visitors from nearly every state in the Union and a number of foreign countries! Not only operators but many laymen . . . "the man on the street," visited and enjoyed the display. The equipment carried sufficient explanatory information on neatly typed cards so that an appreciation of what "wireless" was, was conveyed to the non-technical visitor as well as to members of the commercial operating profession and the radio amateur fraternity. The Seattle store reluctantly gave up the display because they needed the space and the exhibit was then moved to a similar store in Spokane, Wash., for an indefinite "run."

Equipment continued to be loaned or donated; every bit of it was restored and put in working condition. The Spokane exhibit, although but a few months old at this writing, already occupies two whole show cases and the overflow apparatus was sufficient to permit the establishment of similar "museums" in Tacoma, Wash., and Portland, Ore. where the electronic distributors have also enthusiastically cooperated.

It is *fun!* For you Old Timers with nostalgia for the "good old days" you'll get an immense amount of satisfaction and pleasure from establishing such a program. At the same time you are giving the current generation of hams as well as professional operators a chance to gain a much more intelligent idea of the birth, development, and growth of their hobby and/or profession. —30—



Some low-power (left) and multi-watt (below) transistors, shown about full size.

Transistor and Diode Substitutions

By E. G. LOUIS / **What to look out for when you want to substitute one transistor for another in some construction project.**

THE average hobbyist or technician should have little or no difficulty modifying typical construction projects to use substitute transistor and diode types if he has a fair understanding of circuit operation and either owns or can borrow such basic test gear as a multitester, signal generator, transistor tester, etc.

Transistors

If only *general* characteristics are considered, all currently available transistors can be grouped into a few general classes: low-power audio types, high-power audio units, low-power r.f. types, and special-purpose units. The latter group includes not only special transistors such as tetrodes and surface-barrier units but related semiconductor devices with transistor-like characteristics, such as the Unijunction transistor, the Thyristor, and the controlled rectifier. Popular "experimenter's transistor" types included in the first three categories are listed in Table 1.

Within any of these basic classes, individual transistors may have either *n-p-n* or *p-n-p* characteristics and may be manufactured by any of a variety of methods. Detailed electrical specifications and maximum ratings may vary considerably from one unit to another, depending on type number and intended application.

Thus, in the low-power audio group we may find high- and low-gain units, low-noise transistors, high-voltage types, units made with either germanium or silicon, grown or alloy junction types, etc. In Table 1, the *p-n-p* and *n-p-n* types are listed separately but, in practice, all low-power audio units may be considered as a single class.

In general, any transistor within a general class may be substituted for any other transistor type within that class providing: (*a*) maximum ratings are not exceeded, (*b*) circuit parameters, bias, and load values, are adjusted for optimum performance, and (*c*) the circuit can tolerate minor variations in the characteristics required.

Let's consider a few specific examples.

If you have a circuit calling for, say, a CK722, a type 2N107 or 2N34 will probably work in the same circuit if bias values are re-adjusted. Or if the diagram calls for a 2N307, you should be able to use a 2N554 in the same circuit.

As far as circuit operation is concerned, re-adjusting bias and load values for optimum performance generally will be enough to insure acceptable operation. There are, however, exceptions to this rule. For example, if the diagram calls for a high-gain audio transistor and a low-gain unit is substituted, the circuit may still work but may not have enough "hop." Similarly, if a preamp or hearing-aid diagram calls for a low-noise transistor, a general-purpose unit may "work" satisfactorily, but the background noise level may be unacceptable.

At this point, we can state another general rule: transistors in different general classes *are not interchangeable*. Thus, a multi-watt power transistor, such as the 2N255, *cannot* be used as a substitute for, say, a 2N229.

Neither of these two general rules applies to the "special-purpose" class and, as might be expected, there are a few exceptions. For example, an r.f. transistor, such as the CK768, often can be used in an audio circuit. Similarly, due to their broad tolerances, it is quite common to find that an *individual* "audio" transistor will work in r.f. applications.

This leads to the statement of another "general rule": transistors with "superior" characteristics or higher maximum ratings may be substituted for other types—other specifications being the same. For example, in a given r.f. amplifier circuit, a transistor with a 5 mc. cut-off should work just as well (perhaps better) as a type having a 3 mc. cut-off, other specifications remaining the same. Similarly, a power transistor with a maximum rating of, say, 50 volts (collector-to-emitter) will serve as a satisfactory substitute for a unit with a maximum rating of, say, 24 volts—but not *vice versa*.

Specifications

As far as selecting a substitute unit for use in a construction project is concerned, a transistor's most important electrical specifications are: (*a*) kind, *i.e.*, triode, tetrode, etc.; (*b*) basic type, that is, *n-p-n* or *p-n-p*; (*c*) saturation

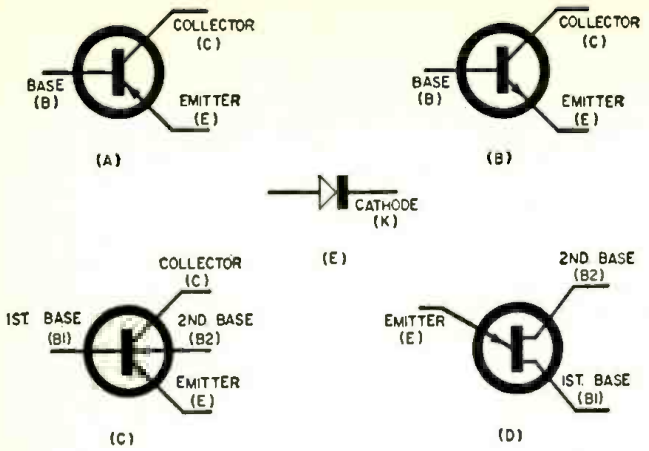


Fig. 1. Symbols for semiconductor devices. (A) "p-n-p" triode transistor. (B) "n-p-n" triode, (C) "p-n-p" tetrode—"n-p-n" is similar, with reversed arrow, (D) Unijunction transistor, (E) diode.

(or leakage) current; (*d*) maximum ratings; (*e*) gain (*beta*); and, in the case of r.f. or high-speed switching applications, (*f*) its cut-off frequency. If these basic specifications can be matched between two units (of different type number), there is a good chance that the units are directly interchangeable (except for lead connections) in most experimental circuits.

In a few instances, other specifications may become important. In a high-gain audio circuit, for example, low-noise units may be mandatory. In critical r.f. circuits, interelectrode capacities may have to be matched for optimum performance.

Often, transistors with different type numbers will be almost identical except for one specification. Where this is the case, the "better" transistor is generally a satisfactory replacement for the other. For example, the CK721 is basically a high-gain version of the CK722. The 2N256 is identical to the 2N255 except for maximum voltage rating.

A certain amount of leeway must be allowed in making a choice on specifications alone. Remember that transistors are manufactured to rather broad tolerances. A manufacturer's specification may indicate only a mean or average value. Thus, in checking through a random assortment of, say, CK722 transistors, you may find two or three that have a *higher gain* than that specified for its "high-gain" brother, the CK721. By the same token, you may encounter an "audio type" with a *higher* r.f. cut-off frequency than a typical "r.f." unit.

Occasionally, a schematic diagram will specify a type number that is not readily available and for which electrical specifications are as hard to determine as the transistor itself is to locate. Here, the schematic symbol representing the transistor, the circuit arrangement, and other component values (such as transformer impedances and bias resistor values) will provide a good clue to the "unknown" transistor's specifications and allow the experimenter to select a suitable replacement.

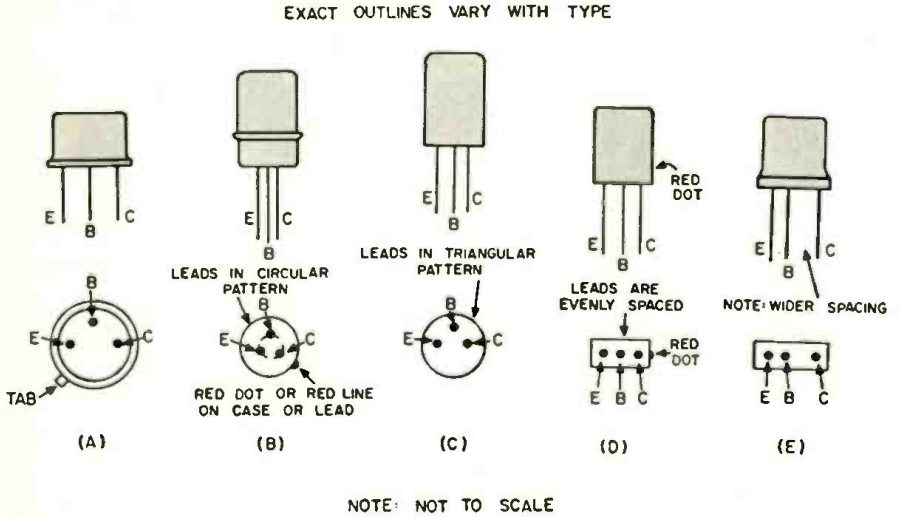


Fig. 2. Electrode lead connections for common low-power and r.f. triode transistors.

The basic schematic symbols used to represent transistors and related semiconductor devices are given in Fig. 1. The *p-n-p* and *n-p-n* triode symbols are shown in Figs. 1A and 1B respectively, a *p-n-p* junction tetrode symbol in Fig. 1C, and the Unijunction transistor symbol in Fig. 1D. A common diode symbol (Fig. 1E) is included for comparison.

Now, suppose you are planning to build a broadcast-band superhet receiver. You can identify all transistors except the one used as an i.f. amplifier. How do you pick a suitable type?

If the symbol shown in Fig. 1B is used, you know that an *n-p-n* unit is needed. Further, since the transistor used is an i.f. amplifier, you know that its cut-off frequency must be well above the receiver's i.f. (455 kc., for example). Chances are a unit with a 3 to 5 mc. cut-off would be used. If the receiver has two i.f. stages, a moderate-gain transistor may be used in each stage; if a single i.f. stage is employed, probably a high-gain type would be used. Finally, take a look at the receiver's power supply. If a 6-volt battery is called for, the transistor should have a maximum (emitter-collector) voltage rating of *at least* 12 volts.

By referring to the condensed specification charts supplied by semiconductor manufacturers (or found in the catalogues issued by the larger mail-order parts distributors), you should have no difficulty selecting a transistor which will meet these basic requirements.

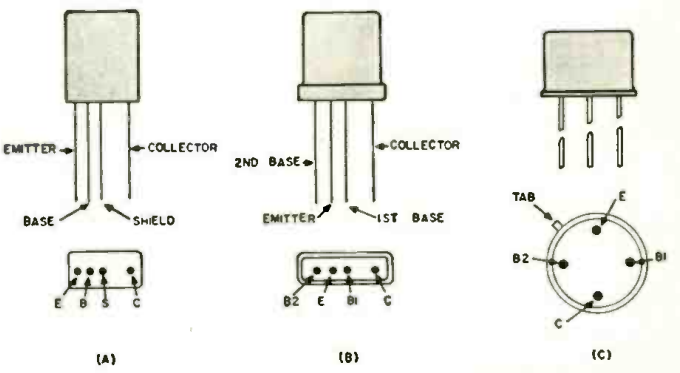
A similar technique can be employed in selecting transistors used in other stages of a receiver, amplifier, preamp, hearing aid, or test instrument.

Lead Connections

Unfortunately, semiconductor manufacturers have not as yet adopted an industry-wide standard covering the physical shape and basing arrangement to be used in making transistors. Two basic "standards" are in use—one proposed by JETEC and the other suggested by EIA. However, not all manufacturers adhere to either of these "standards." Most have at least one "standard" of their own, although they may produce several type numbers matching either JETEC or EIA standards.

The experimenter wishing to use a

Fig. 3. Not all four-lead transistors are tetrodes. A triode drift r.f. transistor, such as the 2N247, uses the arrangement at (A). Typical tetrode lead connections are shown at (B) and (C).



replacement (substitute) transistor type is often faced with a real problem involving the mechanical installation of different unit, especially if the equipment is wired to use a transistor socket or if he is unable to obtain basing information for his substitute unit.

If a transistor socket is used, it may be possible to reposition the transistor's leads to fit into the proper socket holes, using a pair of "jeweler's" long-nose pliers. Care must be exercised not to short the leads nor to bend the leads too close to the transistor body since they may break off.

Where repositioning of leads is impossible, the transistor may be permanently soldered into the circuit. Use as long leads as practical and complete the soldering operation quickly. Use a clean, hot, well-tinned iron. Hold the lead being soldered with a pair of long-nose pliers since this serves as a heat sink to conduct heat away from the transistor itself.

BASIC TYPE	TYPE NUMBER	MANUFACTURER	REMARKS
Low-Power Audio (p-n-p)	CK722	Raytheon	
	CK721	Raytheon	Higher gain unit
	GT222	General Transistor	
	2N222	General Transistor	
	2N107	General Electric	
	2N34	Sylvania	
	R-65	Texas Instruments	
	R-66	Texas Instruments	
	R-72	Texas Instruments	
Low-Power Audio (n-p-n)	2N35	Sylvania	
	2N229	Sylvania	
	GT229	General Transistor	
	R-67	Texas Instruments	
	R-68	Texas Instruments	Higher gain unit
R.F.-I.F. Units	CK768	Raytheon	p-n-p
	2N170	General Electric	n-p-n
	2N233	Sylvania	n-p-n
	AO-1	Philco	30 mc. Surface Barrier
High-Power Units (all p-n-p) Multi-watt audio	2N255	CBS Electronics	
	2N256	CBS Electronics	12-volt version
	2N307	Sylvania	
	2N554	Motorola	

Table 1. A listing of some of the popular transistors used by experimenters.

Although the physical shape and size of transistors will vary considerably from one manufacturer to another, most adhere to several common basing arrangements. As far as low-power audio and r.f. transistors are concerned, nearly every unit will use one of the five basing arrangements shown in Fig. 2. With this diagram as a guide, you should have no difficulty identifying the emitter, collector, and base connections of the transistors you use. The JETEC "standard" basing arrangement is shown in Fig. 2A while the EIA basing is shown in Fig. 2E.

When using this basing guide, remember that the physical arrangement of the leads is important, not their actual spacing. For example, the arrangements shown in B, C, and D may be used for both "normal" sized transistors, where lead spacing may be moderate, and for subminiature "hearing-aid" types, where extremely close spacing between leads may be used.

Four-terminal transistors may be encountered from time to time. While many of these are tetrodes (see Fig. 1C), some may be triodes with an internal shield. The basing arrangements used for both triode and tetrode 4-terminal transistors are shown in Fig. 3. Note that the lead arrangement for a 4-terminal triode, Fig. 3A, and for a tetrode, Fig. 3B, may be identical. To identify the type of transistor used, refer to the schematic diagram or to the unit's type number. A "2" prefix is used to identify triodes, for example, 2N107, 2N247, etc. A "3" prefix identifies tetrodes, for example, 3N24, 3N30, etc.

Multi-watt power transistors, like low-power units, may be made in any of a variety of physical shapes and sizes and with various lead arrangements. These units may be identified by: (*a*) their larger physical size; (*b*) their mechanical design, usually such that they can be mounted directly to a metal plate or chassis; and (*c*) their electrical construction—in most cases the unit's collector is connected *directly* to its outer metal case.

The most common power-transistor basing arrangements are shown in Fig. 4. In the case of units employing the designs of Figs. 4B and 4C, an electrical connection to the collector is obtained by attaching a lead to the transistor's case.

Special Techniques

In the case of vacuum tubes, it is not uncommon to find two or more types that are fully interchangeable, that is, the alternate types can be plugged into the same socket and, in most cases, circuit performance remains unchanged without any need for modification of component values, voltages, or readjustment of trimmers or similar components.

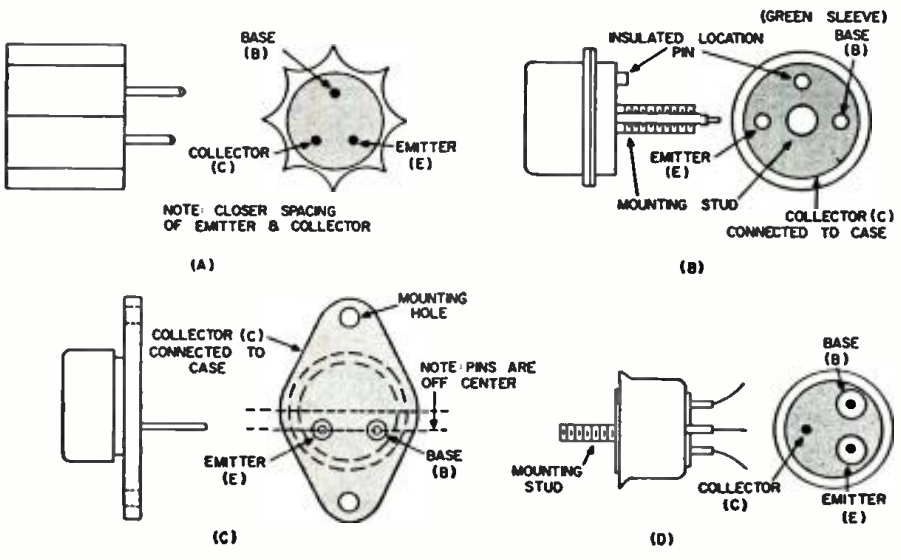
Where transistors are concerned, however, this seldom happens. While any of a large number of transistors may "work" in a given circuit, there is generally some small change in performance and, often, a re-adjustment of bias voltages or circuit component values may be necessary to obtain optimum performance.

If low-cost transistors are used—units which are manufactured to rather broad tolerances—it may be found that even transistors of the *same type number are not fully interchangeable.* In some cases, circuit values must be tailored for best performance with the individual transistor used.

When choosing a substitute transistor, then, first try to pick a unit of the same general class (low-power audio, for example) with the same electrical characteristics (*p-n-p* or *n-p-n*) and with specifications as close as possible to those of the unit you wish to replace. Pay particular attention to leakage current, gain, cut-off frequency, and maximum ratings.

If you are unable to find a substitute meeting these requirements, pick a unit

Fig. 4. Electrode lead connections for popular multi-watt transistors. In all of these, the collector is internally connected to the unit's metal case.



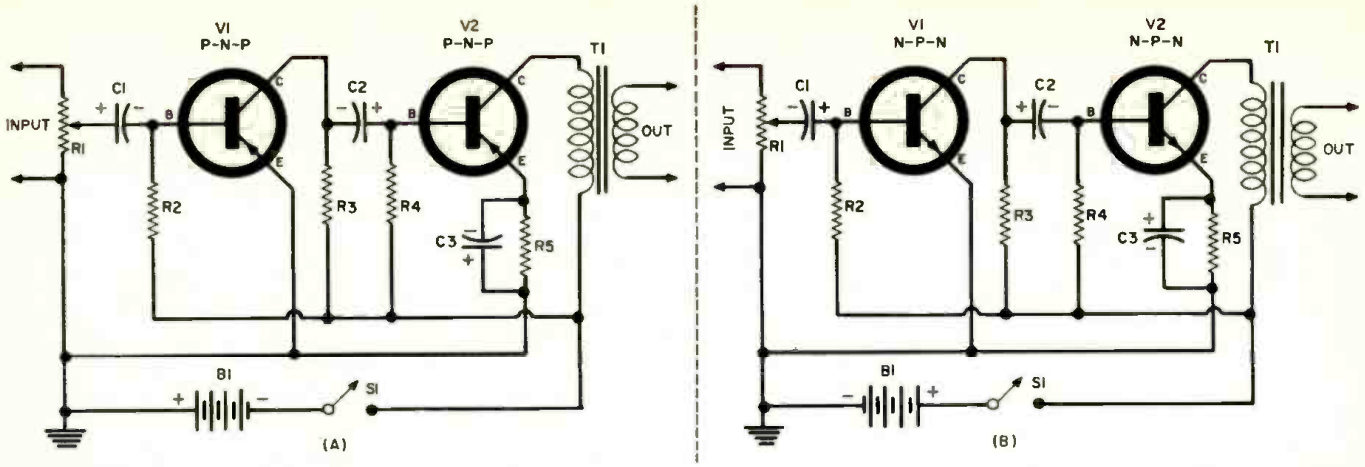


Fig. 5. Typical two-stage amplifiers with "p-n-p" and "n-p-n" transistors. Note changes in d.c. polarities and polarized components.

which differs from the original in some minor specification—a 2N256 as a substitute for a 2N255, for example.

Sometimes you may have a choice of a number of different transistors. Where this is the case, you can often pick "duplicate" units by using an inexpensive transistor tester to select two or more units having identical leakage *and* gain characteristics. Such a technique is valuable, too, for selecting matched pairs of transistors for use in class B push-pull amplifier circuits.

Where circumstances preclude your choosing a substitute transistor of the same electrical type (*p-n-p* or *n-p-n*), you can often substitute units of the *opposite* type, provided other specifications (gain, leakage, etc.) are similar. The proper technique is illustrated in Fig. 5.

A two-stage resistance-coupled amplifier using cascaded *p-n-p* transistors in the common-emitter configuration is shown in Fig. 5A. Appropriate *n-p-n* transistors with similar electrical specifications may be used in this circuit if (*a*) the power-supply polarity is reversed, B_1; (*b*) the polarity of electrolytic capacitors is reversed, C_1, C_2, and C_3. The same circuit modified for *n-p-n* units, is shown in Fig. 5B. Note that the connections to battery B_1 and to capacitors C_1, C_2, and C_3 have been reversed. In practice, any *polarized* component (such as diodes or polarized relays) would have to have its connections reversed when changing from one transistor type to another.

Once a substitute transistor has been installed, circuit performance and general operation should be checked. In some cases, any change in performance will be so small as to hardly justify modification of component values or bias voltages. In most cases, however, some modification of the circuit itself may be required to restore optimum circuit performance.

Where r.f. circuits are involved, for example, complete re-alignment may be indicated. Neutralization adjustments, if provided, should be checked. Generally, a re-adjustment of base bias voltages will be needed. Refer to Fig. 6.

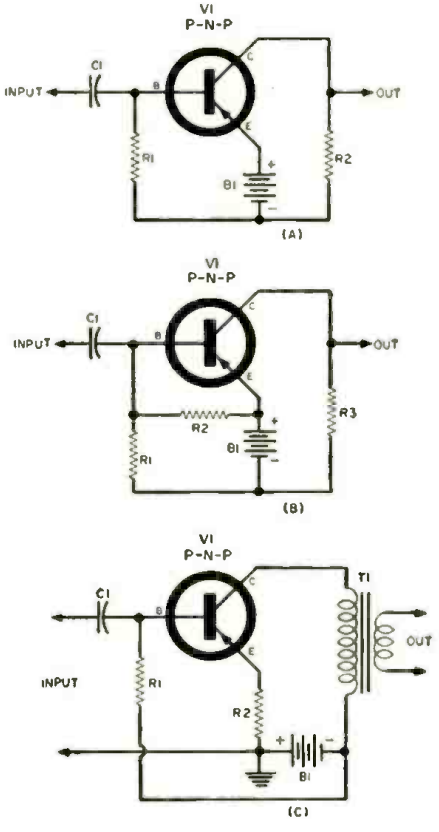
If the biasing arrangement shown in Fig. 6A is employed, base bias current may be re-adjusted by changing the value of R_1. If the biasing arrangement shown in Fig. 6B is used, base bias may be changed by varying the ratio of voltage divider R_1-R_2. In either case, a resistance substitution box is handy for determining final component values.

Irrespective of the method used, final bias resistance values should be determined experimentally for optimum circuit performance rather than by attempting to meet arbitrary bias current or voltage figures. In this way you can compensate, to a large extent, for both gain *and* leakage differences between the substitute transistor and the original unit.

If the substitute transistor has much higher gain than the original unit, the circuit may become unstable and may develop a tendency to oscillate. Often, any tendency towards instability will be corrected when you adjust bias currents. However, in stubborn cases, an unbypassed emitter resistor may be added to the circuit. This will introduce degenerative feedback, reducing stage gain and improving over-all stability.

Referring to Fig. 6C, unbypassed emitter resistor R_2 has been added to a common-emitter single-ended amplifier. In circuits using low-power transistors. R_2 may have a value between 100 and 2000 ohms. Where power transistors are used, R_2 may have a value between .5 and 10 ohms.

Fig. 6. Transistor biasing arrangements are shown at (A) and (B). The unbypassed resistor in emitter circuit (C) reduces gain.



Diodes

In most experimental construction projects, diode characteristics are not too critical hence semiconductor diode substitutions are relatively easy to make.

Where a diode is used as a power rectifier, simply choose a replacement with peak voltage and current ratings *at least* equal to those of the original unit. Higher ratings may be used; for example, a 75 ma. selenium rectifier may be used as a replacement for a 60 ma. unit of the same voltage rating.

If a small diode is used as a detector or limiter, any diode with similar characteristics will generally work as well without any circuit modification. For most applications in receivers and instruments, general-purpose types, such as the 1N34A or CK705, may be used almost universally.

Occasionally, a diode may be used as a mixer or modulator in u.h.f. circuits. Here, any similar type designed for this general application will serve as well. The 1N82 is a popular u.h.f. mixer, for example. In some instances, a slight re-adjustment of r.f. circuit trimmers may be needed when a substitute diode is installed.

Finally, if a diode is used in a critical special-purpose application, as a zener diode or in test instrument circuits, for example, it is best to stick to exact replacements. If a substitute is mandatory, pick a unit with *identical* electrical characteristics. —30—

NUMBERS SYSTEMS and CODES

By **ED BUKSTEIN**
Northwestern TV and Electronics Institute

Various counting and letter-coding methods that are convenient with electronic computing equipment.

ANYONE who attempts to read a cornerstone date expressed in Roman numerals is immediately impressed by the clumsiness of this form of notation. The confusion becomes even greater when one accustomed to our decimal system considers that, although V represents 5 and II represents 2, VII does not represent 52. Try a simple calculation, like multiplying XXV times IV (without converting to familiar decimal digits), and the shortcomings of the Roman system will be even more obvious. It is apparent then that the ease with which a given calculation can be performed is determined, to a large extent, by the number system used.

The choice of number system is particularly important in the electronic computer because it determines the degree of complexity of the circuits required to store the numbers and to perform the calculations. It is for this reason that the binary number system and its modifications are used extensively in computer practice.

Since the decimal system, based on tens, hundreds, thousands, and so on, is the one by which we count, we tend to take it for granted that it is the only possible "natural" system. As a matter of fact, it is purely arbitrary, and other systems have actually been used in various parts of the world at certain points in history. We have already become familiar with the binary system, because it is a convenient one to use in connection with prevalent electronic counting circuits. However, other systems for counting are also used, and familiarity with them therefore is well worth a little study.

One of the characteristic features of a number system is its *radix*, or "fundamental" quantity, which may be defined as the number of permissible symbols used in the system. The familiar ten-symbol or *decimal* number system has a radix of ten, because quantities are specified by combinations of ten permissible symbols: 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9. A number system based on the 26 letters of the alphabet (*aaa, aab, aac, aad,* etc.) would be a system of radix 26.

An automobile mileage indicator illustrates an important characteristic of orderly number systems. Each numbered wheel in the mileage indicator advances through all permissible symbols up to 9 and then returns to 0. At this time, the numbered wheel in the next position to the left advances to its next permissible symbol. In a number system based on the letters of the alphabet, *aaz* would therefore be followed by *aba*, and *bzz* would be followed by *caa*, which would be followed by *cab*.

As shown in Fig. 1A, the positional values of the decimal number system are ones, tens, hundreds, thousands, and so on. To specify a given quantity, the proper symbols must therefore be written down in the proper order. The number 3749, for example, differs from the number 3479 because the symbols are written in a different order. This idea of positional values, although it now seems obvious and elementary, represents one of the giant steps in the development of mathematics. The number 3749 is actually an abbreviation meaning 3 thousands, 7 hundreds, 4 tens, and 9 ones. This also may be expressed in powers of ten (since ten is the radix of our system), as follows: $3 \times 10^3 + 7 \times 10^2 + 4 \times 10^1 + 9 \times 10^0$.

The Octal System

As the name implies, the octal number system has a radix of eight because it has only eight permissible symbols: 0, 1, 2, 3, 4, 5, 6, and 7. The symbols 8 and 9 are not used in this system, as shown by the following examples of octal numbers: 1347, 256, 714423, and 20435. As in other orderly number systems, counting progresses according to the following rule: *When all of the permissible symbols have appeared in one position, the first permissible symbol again appears in this position, and the next position (to the left) advances to its next permissible symbol.*

This can be visualized by imagining a mileage indicator in which each of the numbered wheels carries the symbols 0, 1, 2, 3, 4, 5, 6, and 7. When a given wheel has advanced through all of the permissible symbols up to 7, it returns to 0 and the wheel to its left advances. Such an indicator would show mileage expressed as an octal number.

Since, as indicated in Fig. 1B, the positions of an octal number represent ones, eights, sixty-fours, etc., octal number 125 actually means 1 sixty-four, 2 eights, and 5 ones. This may be expressed in powers of eight (since eight is the radix) as: $1 \times 8^2 + 2 \times 8^1 + 5 \times 8^0$. The decimal system equivalent of octal number 125 can be determined by evaluating the above expression:

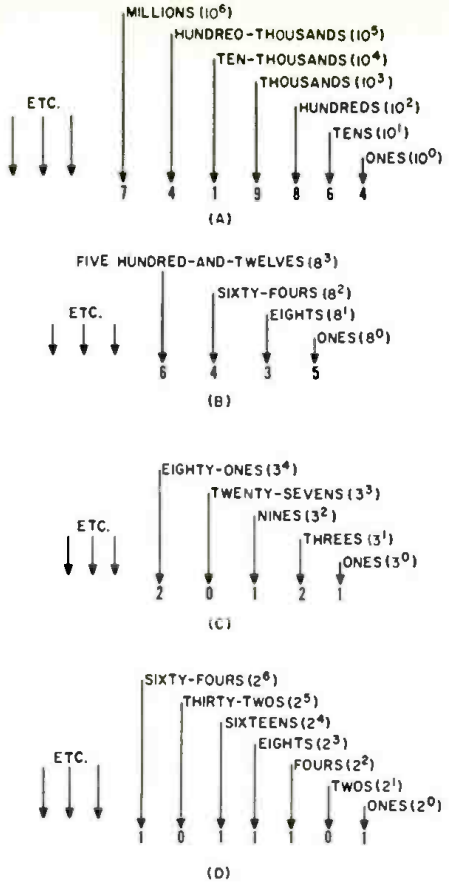


Fig. 1. Positional values of decimal, octal, trinary, and binary number systems. Values are successive powers of the radix of each system. See text for details.

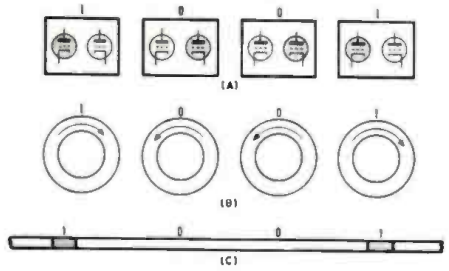


Fig. 2. Binary numbers can be stored in (A) flip-flop stages in which either the left-hand or right-hand tube is conductive; (B) magnetic cores which can be magnetized either clockwise or counterclockwise and (C) magnetic tape magnetized in one direction to represent binary 1 and the opposite direction to represent binary 0. See text.

$1(64) + 2(8) + 5(1) = 64 + 16 + 5 = 85.$

The Trinary System

The trinary number system has a radix of three since the only permissible symbols are 0, 1, and 2. Symbols such as 3, 4, 5, and higher are not used in specifying trinary numbers as indicated by the following examples: 122-102, 2001, and 1112.

Fig. 1C shows the positional values of the trinary system: ones, threes, nines, twenty-sevens, and up. Trinary number 212 therefore actually means 2 nines, 1 three, and 2 ones. This may be expressed as: $2 \times 3^2 + 1 \times 3^1 + 2 \times 3^0$. Trinary number 212 can therefore be converted to its decimal system equivalent as follows: $2(9) + 1(3) + 2(1) = 18 + 3 + 2 = 23$.

The Binary System

The binary number system has only two permissible symbols, 0 and 1, and is therefore a system of radix two. As in other orderly number systems, each position advances to the next symbol after all permissible symbols have appeared in the preceding position to the right. Binary counting can be visualized by imagining a mileage indicator in which each of the number wheels carries only two symbols: 0 and 1. When one of the wheels advances from 1 to 0, the wheel to its left advances to the next permissible symbol. Such an indicator would show mileage expressed as a binary number.

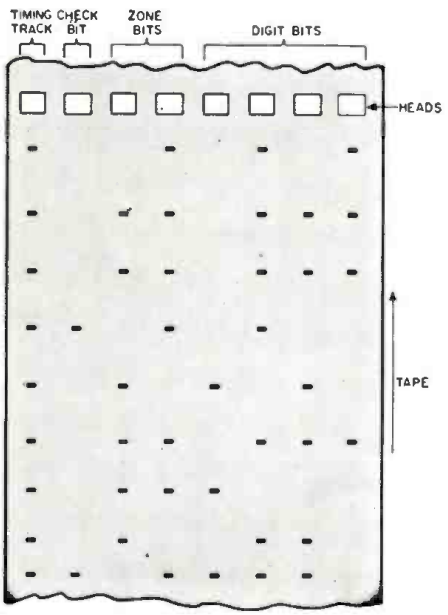
As shown in Fig. 1D, the positional values of the binary number system are ones, twos, fours, eights, sixteens, and up. Binary number 10110 therefore means 1 sixteen, 0 eights, 1 four, 1 two and 0 ones. This may be expressed as: $1 \times 2^4 + 0 \times 2^3 + 1 \times 2^2 + 1 \times 2^1 + 0 \times 2^0$. Binary 10110 can therefore be converted to its decimal system equivalent as follows: $1(16) + 0(8) + 1(4) + 1(2) + 0(1) = 16 + 4 + 2 = 22$.

The octal, trinary, and binary equivalents of the familiar decimal numbers from 0 to 20 are listed in Table 1. As shown, octal number 10, which should be read as "*octal one-oh*" and not as ten, is equivalent to decimal number 8: $1 \times 8^1 + 0 \times 8^0 = 1(8) + 0(1) = 8$.

In the trinary column of Table 1, 10 follows 2 since all of the permissible symbols have been used in the right-hand position. Trinary number 10 (*trinary one-oh*) is equivalent to decimal number 3.

In the binary column of Table 1, 10 follows 1 because all of the permissible symbols have appeared in the right-hand position. Binary 10 (not to be read as ten) is equivalent to decimal number 2.

Fig. 3. Section of magnetic tape coded according to Table 5. Small rectangles represent magnetized areas corresponding to binary 1. For discussion refer to text.



The binary number system is used extensively in electronic computers, as noted, because it results in a simplification of the circuits and components required to store and manipulate the data. A binary (flip-flop) stage, for example, can be used as a storage device because it can exist in either of two stable states: left-hand tube at cut-off and right-hand tube conducting or left-hand tube conducting and right-hand tube at cut-off. One of these states can represent 0 and the other 1. Fig. 2A illustrates the use of four flip-flop stages to store binary number 1001. Binary numbers can also be stored in ring-shaped magnetic cores. Such cores can be magnetized in either of two directions (clockwise or counterclockwise) and can therefore be used to store so-called binary "bits." Four cores storing binary number 1001 are shown in Fig. 2B, with arrows indicating direction of magnetization. Magnetic tapes and drums are also frequently used as storage devices for binary numbers. The binary bit 1 may be represented by magnetization in one direction and the bit 0 by magnetization in the opposite direction. Or else, as with tape (Fig. 2C), an area magnetized in one direction represents binary bit 1 while an area magnetized in the other direction represents 0.

Storage of numbers expressed in the decimal system would require the use of circuits having ten stable states or of magnetic devices having ten possible directions of magnetization. It is obvious that such circuits and components would be considerably more complex than those used for storing binary numbers.

The two permissible symbols of the binary system are known as *bits*. Binary numbers 101011, 1101, and 10110 are therefore 6-bit, 4-bit, and 5-bit numbers respectively. Some computers are designed to handle binary numbers 30 to 40 bits in length.

Binary Codes

Since the quantities involved in a calculation are initially expressed in decimal notation, and since computers are usually designed to operate on binary numbers, the decimal numbers must be converted to binary quantities before the computer can use them. This process of conversion is tedious and time-consuming. It is possible, of course, to design into the computer the circuits necessary to perform this conversion. This expedient, however, increases the complexity and size of the equipment. For this reason, a combination binary-decimal system is frequently used.

In one such system, known as *binary-coded decimal*, the decimal number is converted to binary on a digit-by-digit basis. Table 2 shows the 4-bit binary equivalents of the decimal digits. Decimal number 149 would therefore be expressed, in binary-coded decimal, as 0001 0100 1001. Note that this digit-

DECIMAL	OCTAL	TRINARY	BINARY
0	0	0	0
1	1	1	1
2	2	2	10
3	3	10	11
4	4	11	100
5	5	12	101
6	6	20	110
7	7	21	111
8	10	22	1000
9	11	100	1001
10	12	101	1010
11	13	102	1011
12	14	110	1100
13	15	111	1101
14	16	112	1110
15	17	120	1111
16	20	121	10000
17	21	122	10001
18	22	200	10010
19	23	201	10011
20	24	202	10100

Table 1. Octal, trinary, and binary equivalents of decimal numbers. Each system, as discussed by author, uses a limited number of different symbols according to its radix.

by-digit conversion differs from *pure* binary, in which decimal 149 would be expressed as 10010101.

Circuit design can sometimes be simplified by the use of 4-bit combinations other than those listed in Table 2. The frequently used *excess-3 code*, which has certain advantages that will be noted shortly, is shown in Table 3. Here, the 4-bit combination used to represent decimal 2 is the same as that used to represent decimal 5 in the system shown in Table 2. Likewise, the excess-3 representation for decimal 4 (Table 3) is the same as the representation for 7 in the other code (Table 2). It is this feature which accounts for the name *excess-3* code. Conversion of a decimal number to excess-3 code also is made on a digit-by-digit basis. Decimal number 12470 would therefore be represented as 0100 0101 0111 1010 0011.

One of the advantages of the excess-3 code is that it avoids use of the 4-bit combination 0000. This permits the computer to distinguish between the quantity zero (0011) and the combination 0000, which may be produced as a result of circuit failure. This aids in the detection of malfunctioning equipment. Another advantage of the excess-3 code is that a decimal digit expressed in this code can be subtracted from 9 simply by changing the ones to zeros and the zeros to ones. To subtract 3 from 9, for example, the 4-bit combination representing 3 (0110) is changed to 1001, which is the representation for 6. This convenient characteristic of the code simplifies the design of some of the arithmetic circuits of the computer.

Some applications require the use of a code in which the 4-bit representations of any two consecutive integers differ in only one bit. A code of this type, known either as a *cyclic* code, *reflected-binary* code or *Gray* code, is shown in Table 4. Note that the representations for 5 and 6 differ in only one bit, the representations for 6 and 7 differ in only one bit, and so on. By contrast, the excess-3 code may involve several bit changes, as in going from 0111 (4) to 1000 (5).

Alphabetic Codes

Computers are frequently required to handle alphabetic as well as numerical data. This is particularly true in data-processing computers designed for business applications. The sample code in Table 5 shows a comprehensive code using bit combinations to represent numerals, alphabetic characters, punctuation marks, and math symbols. The decimal digits from 0 through 9 are represented by 4-bit combinations according to the excess-3 code in this case (although other codes may be used).

DECIMAL	BINARY-CODED DECIMAL
0	0000
1	0001
2	0010
3	0011
4	0100
5	0101
6	0110
7	0111
8	1000
9	1001

Table 2. Conversion of decimal numbers to pure binary is tedious and time-consuming. Binary-coded decimal permits digit-by-digit conversion. Decimal 963, for example, converts to the binary 1001 0110 0011.

DECIMAL	EXCESS-3 CODE
0	0011
1	0100
2	0101
3	0110
4	0111
5	1000
6	1001
7	1010
8	1011
9	1100

Table 3. Excess-3 code uses 4-bit combinations to represent decimal digits. Decimal number 429 converts to 0111 0101 1100.

DECIMAL	REFLECTED BINARY
0	0000
1	0001
2	0011
3	0010
4	0110
5	0111
6	0101
7	0100
8	1100
9	1101

Table 4. In the reflected-binary code, the 4-bit combinations representing successive decimal integers differ in only one bit.

Each 4-bit combination is used to represent not only a numeral but also as many as three other characters. The combination 1011, for example, is used to represent the numeral 8, the letter *Y*, and the letter *Z*, and the comma. To differentiate among these four possible meanings, the 4-bit combination 1011 is preceded by two other bits known as *zone bits*. The 6-bit combination 001011 therefore represents the numeral 8, and 011011, 101011, and 111011 represent *Y*, *Z*, and *comma* respectively.

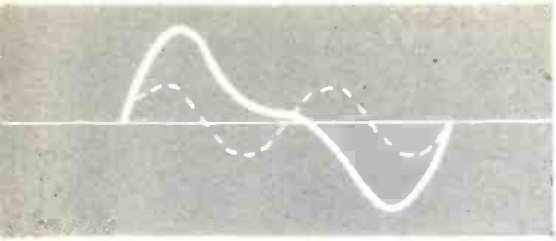
Such 6-bit combinations, when used to represent numerals and other characters, are often preceded by a seventh bit known as a *check* or *parity* bit. The check bit is used for error-detecting purposes, and may be either 0 or 1, whichever satisfies the following requirement: the 7-bit combination should contain an *odd* number of "ones." The 7-bit representations for 8, *Y*, *Z*, and *comma* would therefore be 0001011, 1011011, 1101011, and 0111011 respectively. Each of these combinations has, as required, an odd number of ones.

This feature is useful in detecting such errors as may occur in the computer as a result of dust or surface defects on a magnetic tape. For example, a defect might result in the production of a noise pulse that could be mistaken for a pulse representing binary 1. When such an error occurs, one of the bits in the 7-bit representation changes, and the total number of ones becomes even instead of odd. This condition can be recognized by appropriate error-detecting circuitry in the computer. The latter can then be made to sound an alarm.

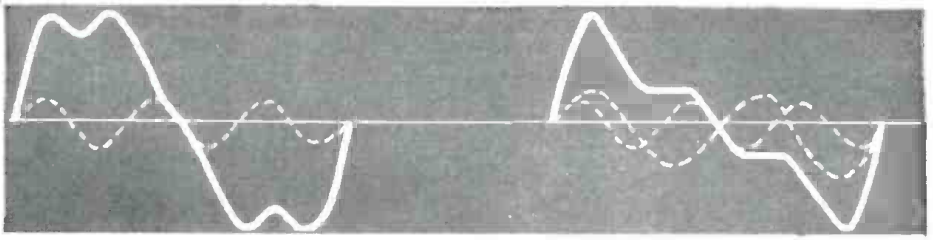
Fig. 3 illustrates a section of magnetic tape employing 7-bit coding. The small rectangles represent areas of magnetization corresponding to binary bit 1. An additional track, to the left, having a binary 1 recorded in each position is known as a *timing track*. The so-called *sprocket bits* recorded in this track, which serve to identify the locations of the 7-bit combinations, are used to activate the circuits required later to *read* the information from the tape. —30—

	ZONE BITS			
	00	01	10	11
0000				
0001			=	≠
0010			+	÷
0011	0	A	B	C
0100	1	D	E	F
0101	2	G	H	I
0110	3	J	K	L
0111	4	M	N	O
1000	5	P	Q	R
1001	6	S	T	U
1010	7	V	W	X
1011	8	Y	Z	,
1100	9	.	?	:
1101		$	%	—
1110		!	'	
1111				

Table 5. Code shown uses 6-bit combinations to represent numerals, alphabetic characters, punctuation, math symbols, etc. The letter R, for example, is represented by 111000.



HARMONIC DISTORTION



What It Is and How It's Measured

By **MILTON S. SNITZER**
Technical Editor, ELECTRONICS WORLD

The meaning and significance of one of the most important specifications of high-fidelity gear.

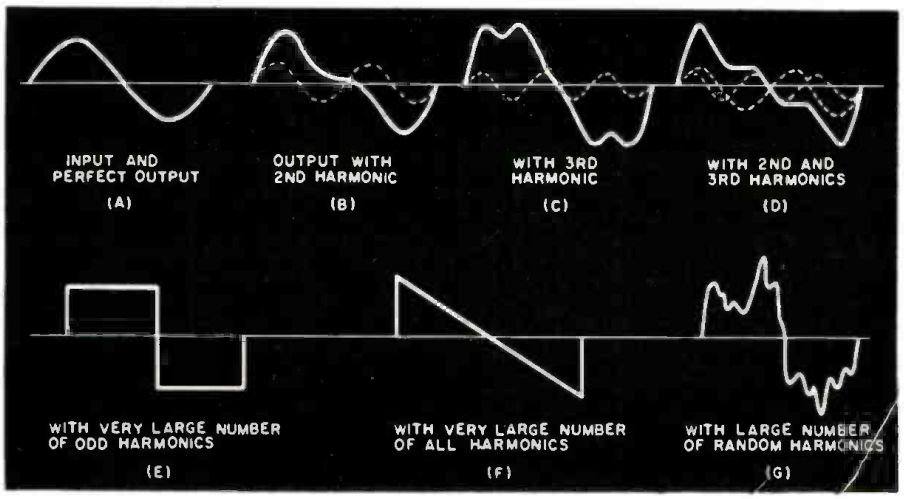
THE rich harmonies of music and the characteristic tonal quality of musical instruments are largely the result of the presence of harmonics. For example, if low C is struck on a concert grand piano, high amplitude harmonics, up to almost the fiftieth of the 32.7-cps fundamental tone, are present. As a matter of fact, the soundboard of the instrument is not large enough to radiate frequencies much below 50 or 60 cps, so that the fundamental is missing entirely. Further, the tonal quality, or *timbre*, of musical instruments depends on harmonic structure.

High-fidelity amplifiers, however, are not musical instruments and they must not insert their own tone color into the sound being handled. The job of this equipment is to reproduce, as exactly as possible, the original quality of the sound. This task is far from simple since only absolutely perfect equipment is entirely free from all types of distortion which alter the nature of the sound signal.

The hi-fi enthusiast must therefore tolerate some distortion, or some change in the sound signal, although with good equipment the extent of such distortion may be below the level where it can be perceived.

Of the several types of distortion to which equipment is subject, one of the most important is *harmonic distortion*. This occurs when the unit being used alters the shape of the sound signal the same way that it would be altered if harmonic frequencies were added to it.

Fig. 1. Some examples of severe harmonic distortion discussed in the text.



For example, assume that a pure 1000-cps sine wave were applied to a perfect amplifier. Its output would be exactly the same as its input (Fig. 1A), except for an increase in amplitude, and we would have no distortion. On the other hand, if the output were as shown by the solid-line waveforms of Figs. 1B or 1C, then harmonic distortion is present. The circuit acts as though it were generating additional frequencies, which when added to the original pure sine wave, produce the waveforms shown. The distorted wave of Fig. 1B is the result of adding a second harmonic to the fundamental sine wave; the distorted wave of Fig. 1C is the result of adding a third harmonic. When the circuit alters the waveform so that it looks like Fig. 1D, then, in effect, both second and third harmonics have been added. Other distorted waveforms shown in Fig. 1 are the result of adding a larger number of harmonics.

Though almost no music is purely sinusoidal, or lacking in harmonics, we do not want our equipment to generate the harmonics. This is the job of the original sound source whose output must not be modified in any way by the reproducing device. The perfect amplifier then, one whose output varies directly and exactly in accordance with the input, will produce an output waveform that is a replica of the input. It will not modify the waveform and appear to add harmonics to distort the original signal in any way.

Total Harmonic Distortion

The distortion factor of a signal waveform is the ratio between the

total r.m.s. values of all the harmonics to the total r.m.s. value (the fundamental plus all the harmonics). When this factor is expressed as a percentage, we have a measure of the percentage of total harmonic distortion (THD). To be more specific, the percentage of THD is equivalent to the square root of the sum of the squares of all the harmonics divided by the square root of the sum of the squares of the fundamental and the harmonics, all multiplied by 100. If we have a distorted waveform with an r.m.s. value of 100 volts and we find that we have, in addition to the fundamental signal, a second harmonic of 4 volts and a third harmonic of 3 volts, our percentage of THD is 5% ($[\sqrt{4^2+3^2}/100] \times 100$).

Distortion Limits

But just how little distortion should we have in our hi-fi system? In general, we can tolerate less distortion with music than with speech. Also, as we increase the range of frequencies that our system covers, we can tolerate less distortion. This is part of the price we must pay for being able to reproduce the full musical range. What is more, for frequencies above about 400 cps, we can tolerate far less distortion than at the lower frequencies.

It is not easy to set down definite limits we should seek for total harmonic distortion. The reason for this is that the figure given actually lumps together all the harmonics without specifying what types of harmonics are involved. For example, consider a waveform with a THD of 5%. Now nothing is said as to whether this percentage represents mainly even harmonic, odd harmonic, or a combination of all harmonics. What is more, if there are several harmonics, nothing is indicated in the percentage figure as to the relative amplitudes of the various harmonics making up the total. Any of the conditions just mentioned would produce a different waveform and a different effect on the listener. In general, listeners will tolerate a much larger amount of even harmonic distortion than odd harmonic. Then again, some circuits and even some tubes are more prone to emphasize certain harmonics than others. The harmonic distortion in most push-pull stages, for example, is largely odd-harmonic distortion, the even harmonics being cancelled out.

Because of these variables, and others, the harmonic distortion percentage certainly does not tell the whole story. It does, however, provide a convenient, easily duplicated test that permits one unit to be compared with another. Olson[1] has conducted distortion tests with a limited number of critical observers using single-ended, 3-watt triode and pentode amplifiers. Following are the approximate percentages of total harmonic distortion with wide-range reproduction for three subjective conditions:

DISTORTION	%THD
Perceptible	0.7 (music) 0.9 (speech)

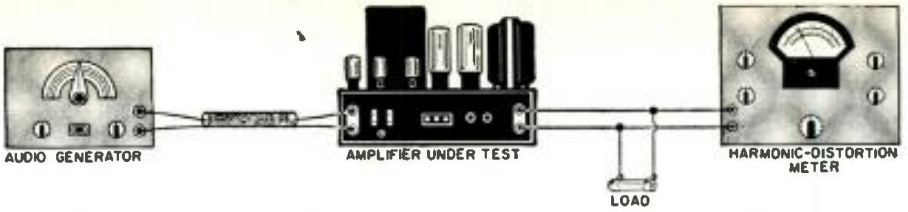


Fig. 2. The basic setup that is employed in measuring total harmonic distortion.

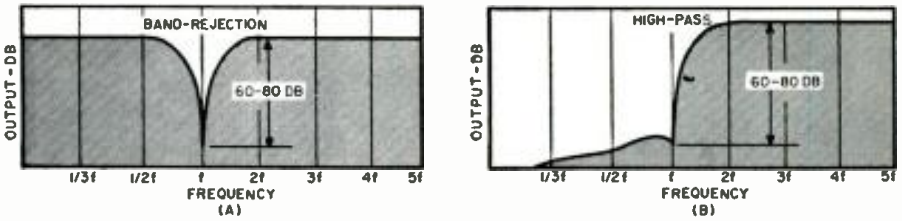


Fig. 3. The two types of response curves used in harmonic distortion analyzers.

DISTORTION	%THD
Tolerable	1.3-1.8 (music) 1.9-2.8 (speech)
Objectionable	2.0-2.5 (music) 3.0-4.2 (speech)

Other tests, made with telephone line equipment by the British Post Office in conjunction with the *BBC*, disclosed the following results for *just detectable* second and third harmonic distortion:

For 2nd harmonic—up to 25% below 100 cps; up to 3% below 200 cps; up to 1% below 400 cps; below 1% above 400 cps.

For 3rd harmonic—up to 5% below 100 cps; up to 2% below 200 cps; up to 1% above 400 cps.

More experimental work is certainly required along these lines, but it is safe to say that THD figures below 1 per-cent are very good, while figures below 0.5 per-cent are exceptional.

Harmonic Distortion Measurement

The measurement of total harmonic distortion percentage can be done with the setup shown in Fig. 2. A low-distortion audio generator, set to the frequency at which THD is to be measured, is connected to the equipment under test. This equipment, perhaps a preamp or power amplifier, is properly loaded and adjusted to produce a level of output at which it is desired to make the measurement. A harmonic distortion meter, which can read %THD directly, is then connected across the load.

The harmonic distortion meter consists of a selective audio voltage amplifier, with adjustable attenuation, whose output is connected internally to a vacuum-tube voltmeter circuit. The selective amplifier is needed so that the fundamental frequency may be suppressed in order to take a measurement of the remaining harmonics. The most common way to obtain this selectivity is with a tunable Wien bridge or bridged-T network that puts a sharp notch in the instrument's response (Fig. 3A). With the notch set to the frequency of the audio generator, the fundamental is removed. The meter now has applied to it all the other components in the waveform—mainly harmonics, but also hum and noise.

In using the instrument, the selective amplifier is first bypassed entirely and a meter reading is taken of the amplifier's output. This reading is that of the fundamental frequency plus the distorting harmonics. The meter is adjusted for full-scale (100%) reading. Now the selective amplifier is switched in and carefully balanced to suppress the fundamental. The residual meter indication now reads directly in percentage of total harmonic distortion.

Some harmonic distortion meters use sharp cut-off high-pass filters to eliminate the fundamental (along with hum and noise below the fundamental frequency) and pass all the harmonics (Fig. 3B). Since such filters are not usually adjustable, these instruments may use a half dozen or so filters with different cut-off frequencies to permit measurements to be made at various fundamental frequencies. With such meters only the harmonics and high-frequency noise are measured since the low frequencies are not passed. The measurements taken with the two types of instruments yield somewhat different figures. What is more, the consumer usually does not know which type has been used to make the measurement. In most cases, however, the bridge-type unit, which is far more common, will be the instrument used.

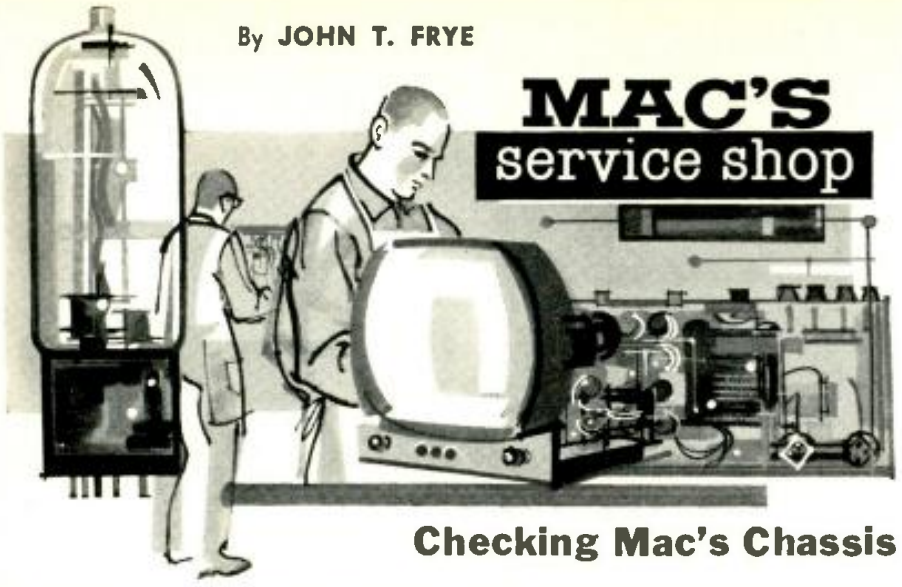
In the early days of hi-fi, it was common to take harmonic distortion measurements at only one or two frequencies around the middle of the audio band, commonly 400 or 1000 cps. With improvements in the quality of equipment, however, many manufacturers are anxious to show just how good their units are. Hence, now it is common to make THD measurements throughout the entire range from 30 to 15,000 cps or even from 20 to 20,000 cps. Such measurements impose a severe test on an amplifier or preamplifier because it is far more difficult to handle the very low and very high frequencies with a minimum of distortion than it is to handle the mid-frequencies.

It is also common to make amplifier THD measurements over a wide range of output powers, up to the full rated

(*Continued on page* 84)

By JOHN T. FRYE

MAC'S service shop



Checking Mac's Chassis

BARNEY was working alone at the service bench. Mac, his employer, had gone to the local clinic early in the morning for his annual physical checkup. About an hour before closing time, though, the door opened and Mac strode in, looking rather strange and out of place in the shop in "civvies."

"Hi," Barney greeted him; "you gonna live?"

"Hate to disappoint you, but it looks like it," Mac answered with a grin.

"What kind of a going over do they give you?" Barney asked curiously. "I never had a checkup."

"Well, let's see now," Mac drawled as he perched himself on a high stool and clasped his long arms around his knees. "I'll have to try and give it to you in language you can understand. The first thing they did was shuck my chassis out of the cabinet so they could work on it. Before going any farther they wanted to be sure, just as we would, that nothing was overheating; so they checked my operating temperature with a thermometer.

"Then the Doc got out a sort of signal tracer with a pair of fancy chrome-plated earphones and checked my local oscillator. It was ticking away right on frequency; but this guy was a good technician and wanted to see the waveform, just as we like to look at the waveform of the bias oscillator of a tape recorder. He used an electrocardiograph to do this. Personally I thought the trace showed a good bit of odd-harmonic distortion, but the Doc said it was OK, and I didn't argue. I remembered how we hate having a customer tell us how to do our job. Incidentally, while Doc was using the signal tracer he did a good bit of checking around in what I would call my converter and i.f. section to see if he could hear any unusual noise.

"Apparently he couldn't, for he put away the signal tracer and got out his meter. This seemed to be a sort of cross between a clamp-on type and a slide-back v.t.v.m., for he wrapped the test lead around my arm and then pumped up pressure with a little squeeze-bulb. Anyway he got a pretty good potential reading on the meter, and then he tried a little 'circuit disturbance' testing by having me hop up and down a few times to see if this made the meter reading change much. The reading must have been close enough to the proper potential expected, for he put that thing away, too.

"Next on the agenda was some 'signal injection' testing. He had me cross my knees and then rapped me just below the kneecap with a little rubber hammer that I'd like to have for rapping tubes. Every time he injected a pulse signal into the nervous system in this fashion my foot would kick, and that seemed to make him happy.

"From there I went to what I figure must have been a 'front-end-or-tuner-specialist.' He took a real lively interest in my ears, eyes, nose, and throat. When he got to the eyes he found my stereo balance wasn't quite what it should be; so he wrote a prescription for a new pair of lens to take care of that. He also ran a frequency response check on my ears and found the response was drooping a few db on the high-frequency end, but I guess that goes along with getting old and wise—especially old.

"Oh yes, I almost forgot, they ran a sort of efficiency check on me, too. They called it basal metabolism, but actually all they did was check my idling current, you might call it. An interesting thing was that they did this by the same roundabout method we use when we measure the voltage drop across a resistor to get at the current through it. The energy required to maintain the basic body functions is indicated by the amount of heat thrown off by the body at rest in a twenty-four hour period. Since it would be extremely difficult to measure this directly, they simply measured the amount of oxygen I consumed in a given period of time. They know that every liter of oxygen consumed by a normal person under controlled conditions gives off 4.825 calories of heat; so figuring out my basal metabolism rate was as easy as using Ohm's Law."

"I can see you felt right at home," Barney said enviously. "While you were goofing off with pretty nurses fluttering all around, I was wrestling with the worst bunch of stupid, crabbed, demanding, insulting, ornery customers I've seen in many a day."

A smile creased Mac's face, and finally he broke into a reminiscent chuckle. "That brings up one more thing I learned today," he said, "something I'm sure I'll remember for a long, long time. I told the doctor I had been feeling a little pooped lately but that I couldn't tell if I were run down or just lazy. That led to talk about how a person could tell when he really needed a vacation, and Doc came up with this story about how a doctor friend of his decided the matter:

"When this doctor would begin to wonder about himself, he would park his car behind his office and let himself quietly in through a back door. Then he would tiptoe forward through his suite of rooms until he came to a spot where a camouflaged peephole permitted him to look into his waiting room without being seen. He would take a long and careful look through that peephole, and when he saw the waiting room was filled with nothing but slobs, he knew it was time to take a vacation!"

Barney laughed in spite of himself. "That makes a lot of sense," he agreed. "Customers aren't really all angels one day and all fiends the next; but the way we feel can make them so. The next time I run into a string of goat-getters, I'll remember the doctor and his waiting room."

"Well," Mac said as he walked over to the bench, "what did you do today to help me pay the whopping bill I have in my pocket? You've been turning out sets like hot-cakes, I hope, I hope!"

"Not exactly," Barney said hesitantly.

"What do you mean: 'Not exactly'?" Mac demanded.

"Well, I've been working on that little transistor set on the bench ever since lunch."

"What's the matter with it?"

"Take a listen," Barney said as he slowly tuned the receiver across the broadcast band. At the high end of the band reception was fair, but as the dial was turned to the lower frequencies, the background noise rose higher and higher until it almost swamped stations normally heard with good noise quieting.

"How's the alignment?"

"Right on the button; I checked it twice."

"Did you try signal injection and signal tracing to try and find out which circuits were not acting normally?"

"When I run an i.f. signal into the input of the converter-oscillator transistor, it goes right on through; and the sensitivity seems good; but when I try to pull in a station, especially one below 1000 kc., the signal-to-noise ratio is stinko."

"Hm-m-m-m, did the customer give you any clue?"

(*Continued on page* 110)

SAVE 1/2 THE TIME

in TV Trouble-Shooting

Make Twice The Profit!

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MODEL 1075

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Thousands of service technicians already save thousands of hours every day with the amazing B&K TELEVISION ANALYST. Enables you to inject your own TV signal at any point and watch the resulting test pattern on the picture tube itself. Makes it quick and easy to isolate, pin-point, and correct TV trouble in any stage throughout the video, audio, r.f., i.f., sync, and sweep sections of black & white and color television sets—*including intermittents.* Makes external scope or wave-form interpretation unnecessary. Enables any serviceman to cut servicing time in half, service more TV sets in less time, really satisfy more customers, and make more money. Color generator provides both rainbow pattern and color bars.

MODEL 1075 TELEVISION ANALYST. Complete with standard test pattern, white dot, white line, and color-bar slide transparencies, and one clear acetate. Net, **$259.95**

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CIRCUIT ANALYZER

Saves many hours of service work. Provides vertical and horizontal sync and driving pulses that enable you more easily and quickly to check out every stage in the sync and sweep sections of a television receiver.

Tracks down troubles in the horizontal and vertical output circuit including defective output transformer and yoke; checks for shorted turns, leakage, opens, short circuits, and continuity. Includes unique high-voltage indication. Eliminates trial and error replacements.

Model A107 Dyna-Sweep. Companion unit for use only with B&K Model 1075 Television Analyst for driving source. **Net, $49.95**

Model 1070 Dyna-Sweep. Same as Model A107 but has its own horizontal and vertical driving pulse, and is used independently of the Model 1075. **Net, $69.95**

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Canada: Atlas Radio Corp., 50 Wingold, Toronto 10, Ont.
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- Runs up to 500 hours on standard batteries
- Deluxe features at half the cost
- Easy to assemble

HEATHKIT TCR-1

$45.95

"YOUR CUE" TRANSISTOR CLOCK RADIO KIT (TCR-1)

Take all the deluxe features found in the most expensive clock-radios, add the convenience of complete portability, plus a modern 6-transistor battery operated circuit . . . then slash the price at least in half, and you have the new Heathkit "Your Cue" Transistor Portable Clock Radio.

Packing every modern clock-radio feature into a compact, beautifully styled turquoise and ivory plastic cabinet, "Your Cue" lulls you to sleep, wakes you up, gives you the correct time and provides top quality radio entertainment in and out-of-doors. It can also be used with the Heathkit Transistor Intercom system, opposite page, to provide music or a "selective alarm" system for one or more rooms covered by the intercom system.

An "Alarm-set" hand, hour hand, minute hand and sweep second hand grace the easy-to-read clock dial. All controls are conveniently located and simple to operate. The "lull-to-sleep" control sets the radio for up to an hour's playing time, automatically shutting off the receiver when you are deep in slumber. Other controls set "Your Cue" to wake you to soft music, or conventional "buzzer" alarm. A special earphone jack is provided for private listening or connection to your intercom or music system. At all times crystal-clear portable radio entertainment is yours at the flick of a switch.

The modern 6-transistor circuit features prealigned IF's for ease of assembly. A tuned RF stage and double tuned input to the IF stage assure top performance. The built-in rod-type antenna pulls in far-off stations with outstanding clarity while a large 4" x 6" speaker provides tonal reproduction of unusual quality.

Six easily obtainable penlight-size mercury batteries power the radio receiver up to 500 hours, while the clock operates up to 5 months from a single battery of the same type. Ordinary penlight cells may also be used with reduced battery life.

The handsome two-tone cabinet, measuring only 3½" H. x 8" W. x 7½" D. fits neatly into the optional carrying case for beach use, boating, sporting events, hunting, hiking, or camping.

Wherever you are, you'll find "Your Cue" your constant companion. Shpg. Wt. 5 lbs.

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HEATHKIT
NO. 93-3

$4.95

Shpg. Wt. 2 lbs.

HEATH COMPANY/Benton Harbor, Mich.

a subsidiary of Daystrom, Inc.

New Transistor Intercom Kit

TALK WITH ANY OR ALL FIVE STATIONS WITH YOUR OWN INTERCOM SYSTEM

- Battery Power Permits Placement Anywhere
- Versatile Unit has Many Important Uses
- Complete Privacy of Conversations Assured

TRANSISTOR INTERCOM KIT (XI-1 and XIR-1)

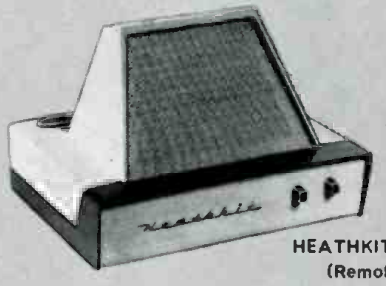
A flexible, versatile transistor intercom, has been developed by Heath engineers to enable you to set up your own communications system at an unbelievably low price.

Consisting of a master unit (XI-1) and up to five remote stations (XIR-1), the system is designed for any remote unit to call the master, for any remote station to call any other remote station, or for the master unit to call any single remote unit or any combination of remote units. Complete privacy is assured, since a call to a remote station cannot be interrupted or listened to while the remote unit is in operation unless switched in by the master unit. Used with clock-radio, opposite page, it can serve as a music or "selective alarm" system.

Transistor circuitry means long life, instant operation and minimum battery drain. Eight ordinary, inexpensive "C" flashlight batteries will run a unit for up to 300 hours of normal "on" time. Circuitry is especially designed for crisp, clear intelligible communication and the instant operation feature allows tuning of the units off between calls, extending battery life. Use of battery power does away with power cords, allowing each unit to be placed where most convenient. Only two wires are required between the master unit and each remote station. Beautifully styled, the Heathkit Intercom presents a new approach in design. Both master and remote stations have two-piece cases in ivory and turquoise for a rich, quality appearance. Batteries not included. Shpg. Wt. 6 lbs.

HEATHKIT XI-1 (Master)

$27.95



HEATHKIT XIR-1 (Remote)

$6.95

Shpg. Wt. 4 lbs.

AC POWER SUPPLY (XP-1)

A permanent power supply for 24-hour operation of the XI-1 Intercom on household current. Converts 110 V. AC to well filtered 12-volt DC output, eliminating the need for batteries. Power supply is small, compact and fits in space normally occupied by batteries.

HEATHKIT XP-1 ..... $9.95

NEW IMPROVED DESIGN

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HEATHKIT SP-2A (stereo) Shpg. Wt. 15 lbs.

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$5.70 down. $6.00 mo.

STEREO-MONO PREAMP KIT (SP-2A, SP-1A)

Get the SP-2A Stereo Preamp kit now, or the SP-1A monophonic version which you can easily convert to stereo whenever you choose by assembling the second channel (C-SP-1A) and plugging it into your SP-1A.

The SP-2A permits stereo, two channel mixing, or either channel monophonic use, and includes a remote balance control.

Six inputs (12 in the stereo version) accommodate tape, magnetic phono and microphone, plus three separate high level inputs. Level controls provided on "mag. phono" and high level inputs. Switch selects NARTB equalization for tape head input, and RIAA, LP or 78 RPM compensation for mag. phono input

HEATHKIT SP-1A (monophonic) Shpg. Wt. 13 lbs. $37.95

HEATHKIT C-SP-1A (not shown) (converts SP-1A to SP-2A) Shpg. Wt. 4 lbs. $21.95

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New

55 WATT HI-FI AMPLIFIER KIT (W-7A)

Utilizing advanced design in components and tubes to achieve unprecedented performance with fewer parts, Heathkit has produced the world's first and only "dollar-a-watt" genuine high fidelity amplifier. Meeting full 55-watt hi-fi rating and 50-watt professional standards, the new improved W-7A provides a comfortable margin of distortion-free power for any high fidelity application.

The sleek, modern styling of this unit allows unobtrusive installation anywhere in the home. The clean, open layout of chassis and precut, cabled wiring harness makes the W-7A extremely easy to assemble. Shpg. Wt. 28 lbs.

HEATHKIT W-7A

$54.95

SPECIFICATIONS—Power output: Hi-Fi rating, 55 watts. Professional rating, 50 watts. **Power response:** ±1 db from 20 cps to 20 kc at 55 watts output. **Total harmonic distortion:** Less than 2% from 30 cps to 15 kc at 55 watts output. **Intermodulation distortion:** Less than 1% at 62 watts output using 60 cps and 6 kc signal mixed 4:1. **Hum and noise:** 80 db below 55 watts, unweighted. **Damping factor:** Switch on front panel for selecting either maximum (20:1) or unity (1:1). **Output impedances:** 4, 8 and 16 ohms and 70-volt line. **Power requirements:** 117 volts, 50/60 cycles, 90-160 watts. **Dimensions:** 8½" D. x 6¼" H. x 15" W.

New HEATHKIT Stereo Amplifiers

HEATHKIT SA-1

$79.95

FOR THE FINEST IN STEREO...

"DELUXE" 20-WATT STEREO AMPLIFIER KIT (SA-1)

Offering every deluxe feature imaginable in a stereo amplifier, the SA-1 also provides 20 watts per stereo channel and 40 watts total monophonic power. Separate bass and treble tone controls for each stereo channel permit you to adjust sound reproduction to suit your taste. A 4-position function switch (stereo, stereo reverse, channel A, channel B) makes it possible for any monophonic source to be fed into either channel individually or to both channels simultaneously. By adjusting the individual channels, you can even impart a pseudo-stereo effect to monophonic program material. A special "dimension" control eliminates the "hole-in-the-middle" effect sometimes produced through varying stereo recording practices. The SA-1 features five switch-selected inputs for each channel; magnetic phono, tape head, and three auxiliary inputs for high level sources. A special sixth position on the selector switch permits use of a monophonic magnetic phono cartridge, through either or both channels. Magnetic phono inputs are RIAA equalized; tape head input is NARTB equalized. All inputs, except that for the "tape head" feature individual level controls. Ganged volume controls permit adjusting the gain of both channels simultaneously, and a separate balance control allows precise channel balancing. Internal amplifier controls for each channel are also provided. Beautifully styled with vinyl-clad steel cover in leather-like texture of black and inlaid gold design. Shpg. Wt. 30 lbs. Available Soon.

New

HEATHKIT SA-2

$52.95

YOUR BEST DOLLAR VALUE IN STEREO...

14-WATT STEREO AMPLIFIER KIT (SA-2)

Complete control of your entire stereo system is at your fingertips with this versatile Stereo Amplifier-Preamplifier combination. Providing 14 watts per stereo channel, or 28 watts total monophonic, the SA-2 offers every modern feature required in a master stereo control center, and at a price to please the budget minded. Shpg. Wt. 23 lbs.

SPECIFICATIONS—Power output: 14 watts per channel, "hi-fi"; 12 watts per channel, "professional"; 16 watts per channel, "utility". **Power response:** ±1 db from 20 cps to 20 kc at 14 watts output. **Total harmonic distortion:** less than 2%, 30 cps to 15 kc at 14 watts output. **Intermodulation distortion:** less than 1% at 16 watts output using 60 cps and 6 kc signal mixed 4:1. **Hum and noise:** mag. phono input, 47 db below 14 watts; tuner and crystal phono, 63 db below 14 watts. **Controls:** dual clutched volume; ganged bass, ganged treble; 4-position selector; speaker phasing switch. **AC receptacle:** 1 switched, 1 normal. **Inputs:** 4 stereo or 8 monophonic. **Outputs:** 4, 8 and 16 ohms. **Dimensions:** 4½" H. x 15" W. x 8" D. **Power requirements:** 117 volts, 50/60 cycle, AC, 150 watts (fused).

New

HEATHKIT SA-3

$29.95

GO STEREO FOR $29.95

ECONOMY STEREO AMPLIFIER KIT (SA-3)

This amazing performer delivers more than enough power for pure, undistorted room-filling stereophonic sound at the lowest possible cost. Featuring 3 watts per stereo channel and 6 watts as a monophonic amplifier, the SA-3 has been proven by exhaustive tests to be more than adequate in volume for every listening taste.

You will find its ease of assembly another plus feature. Heathkit construction manuals, world famous for their clarity and thoroughness, lead you a simple step at a time to successful completion of the kit. Larger than life-size diagrams show you exactly what each part looks like, where it goes, and how it is installed.

The amplifier is tastefully styled in black with gold trimmed control knobs and gold screened front and rear panel. A tremendous buy at this low Heathkit price! Shpg. Wt. 13 lbs.

SPECIFICATIONS—Power output: 3 watts per channel. **Power response:** ±1 db from 50 cps, 20 kc at 3 watts out. **Total harmonic distortion:** less than 3%; 60 cps, 20 kc. **Intermodulation distortion:** less than 2% @ 3 watts output using 60 cycle & 6 kc signal mixed 4:1. **Hum and noise:** 65 db below full output. **Controls:** dual clutched volume; ganged treble, ganged bass; 7-Position selector; speaker phasing switch; on-off switch. **Inputs (each channel):** tuner, crystal or ceramic phono. **Outputs (each channel):** 4, 8, 16 ohms. **Finish:** black with gold trim. **Dimensions:** 12⅛" W. x 6¾" D. x 3¼" H.

New HEATHKIT Amplifiers & Tuners

A NEW AMPLIFIER AND PREAMP UNIT PRICED WELL WITHIN ANY BUDGET

14-WATT HI-FI AMPLIFIER KIT (EA-3)

This thrilling successor to the famous Heathkit EA-2 is one of the finest investments anyone can make in top quality high fidelity equipment. It delivers a full 14 watts of hi-fi rated power and easily meets professional standards as a 12-watt amplifier.

Rich, full range sound reproduction and low noise and distortion are achieved through careful design using the latest developments in the audio science. Miniature tubes are used throughout, including EL-84 output tubes in a push-pull output circuit with a special-design output transformer. The built-in preamplifier has three separate switch-selected inputs for magnetic phono, crystal phono or tape, and AM-FM tuner. RIAA equalization is featured on the magnetic phono input. Shpg. Wt. 15 lbs.

NOTE THESE OUTSTANDING SPECIFICATIONS—Power output: 14 watts, Hi-Fi; 12 watts, Professional; 16 watts, Utility. **Power response:** ±1 db from 20 cps to 20 kc at 14 watts output. **Total harmonic distortion:** less than 2%, 30 cps to 15 kc at 14 watts output. **Intermodulation distortion:** less than 1% at 16 watts output using 60 cps and 6 kc signal mixed 4:1. **Hum and noise:** mag. phono input, 47 db below 14 watts; tuner and crystal phono, 63 db below 14 watts. **Output impedances:** 4, 8 and 16 ohms.

HEATHKIT EA-3

$29.95

NEVER BEFORE HAS ANY HI-FI AMPLIFIER OFFERED SO MUCH AT SO LOW A PRICE

New

"UNIVERSAL" 14-WATT HI-FI AMPLIFIER KIT (UA-2)

Meeting 14-watt "hi-fi" and 12-watt "professional" standards, the UA-2 lives up to its title "universal" performing with equal brilliance in the most demanding monophonic or stereophonic high fidelity systems. Its high quality, remarkable economy and ease of assembly make it one of the finest values in high fidelity equipment. Buy two for stereo. Shpg. Wt. 13 lbs.

SPECIFICATIONS—Power output: Hi-Fi rating, 14 watts; Professional rating, 12 watts. **Power response:** ±1 db from 20 cps to 20 kc at 17 watts output. **Total harmonic distortion:** Less than 2% from 20 cps to 20 kc at 14 watts output. **Intermodulation distortion:** Less than 1% at 14 watts output using 60 cps and 6 kc signal mixed 4:1. **Hum and noise:** 73 db below 14 watts. **Output impedances:** 4, 8 and 16 ohms. **Damping factor:** Switched for unity or maximum; maximum damping factor 15:1. **Input voltage for 14 watt output:** .7 volts. **Power requirements:** 117 volts 50/60 cycles, 55 watts. **Dimensions:** 10" W. x 6½" D. x 4¾" H.

HEATHKIT UA-2

$22.95

MORE STATIONS AND TRUE FM QUALITY ARE YOURS WITH THIS FINE TUNER KIT

New

HIGH FIDELITY FM TUNER KIT (FM-4)

This handsomely styled FM tuner features better than 2.5 microvolt sensitivity, automatic frequency control (AFC) with on-off switch, flywheel tuning and prewired, prealigned and pretested tuning unit. Clean chassis layout, prealigned intermediate stage transformers and assembled tuning unit makes construction simple—guarantees top performance. Flywheel tuning and new soft, evenly-lighted dial scale provide smooth, effortless operation. Vinyl-covered case has black, simulated-leather texture with gold design and trim. Multiplex adapter output also provided. Shpg. Wt. 8 lbs.

SPECIFICATIONS—Tuning range: 88 to 108 mc. **Quieting sensitivity:** 2.5 uv for 20 db of quieting. **IF frequency:** 10.7 mc. **Image ratio:** 45 db. **AFC correction factor:** 75 kc per volt. **AM suppression:** 25 db. **Frequency response:** ±2 db 20 to 20,000 cps. **Harmonic distortion:** Less than 1.5%, 1100 uv, 400 cycles 100% modulation. **Intermodulation distortion:** Less than 1%, 60 cycles and 6 kc mixed 4:1 1100 uv, 30% modulation. **Antenna:** 300 ohms unbalanced. **Output impedance:** 600 ohms (cathode follower). **Output voltage:** nominal .5 volt (with 30% modulation, 20 uv signal). **Power requirements:** 105-125 volts 50/60 cycle AC at 25 watts. **Overall dimensions:** 4½" H. x 13¼" W. x 5½" D.

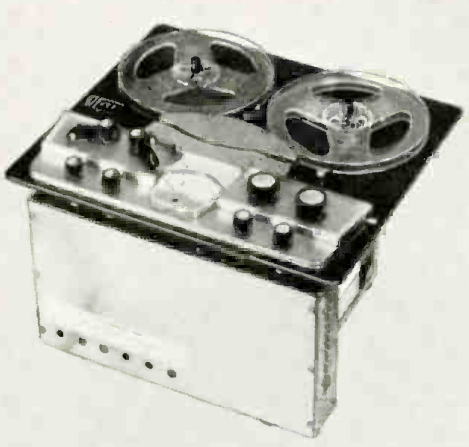
HEATHKIT FM-4

$34.95

HEATH COMPANY/Benton Harbor, Mich.

a subsidiary of Daystrom, Inc.

New HEATHKIT® Tape Recorders



- Choice of 3 Outstanding Models
- Compare With $350-$400 Machines
- Preassembled Tape Mechanism
- Choice of Monophonic or Stereo models
- Complete versatility
- Easy to assemble, easy to use

PROFESSIONAL QUALITY TAPE RECORDER KITS (TR-1 Series)

Enjoy the incomparable performance of these professional quality tape recorders at less than half the usual cost. These outstanding kits offer a combination of features found only in much higher priced professional equipment, generally selling for $350 to $400. Not the least of these special features is the handsome styling which characterizes the kits . . . a semi-gloss black panel is set off by a plastic escutcheon in soft gold, which is matched by black control knobs with gold inserts. The mechanical assembly, with fast forward and rewind functions, comes to you completely assembled and adjusted; you build only the tape amplifier. And, you'll find this very easy to accomplish, since the two circuit boards eliminate much of the wiring. Separate record and playback heads and amplifiers allow monitoring from tape while recording and a "pause" control permits instant starting and stopping of tape for accurate cueing and tape editing. A digit counter is provided for convenient selection of any particular recording. Push-pull knob provides instant selection of 3¾ or 7½ IPS tape speed. Safety interlock on record switch reduces possibility of accidental erasure of recorded tapes. Shpg. Wt. 30 lbs.

SPECIFICATIONS—Tape speed: 7.5" and 3.75" per second. **Maximum reel size:** 7". **Frequency response (record-playback):** ±2.5 db, 30 to 12,000 cps at 7.5 IPS; ±2.5 db, 30 to 6,500 cps at 3.75 IPS. **Harmonic distortion:** 1% or less at normal recording level; 3% or less at peak recording level. **Signal-to-noise ratio:** 50 db or better, referred to normal recording level. **Flutter and wow:** 0.3% RMS at 7.5 IPS; 0.35% RMS at 3.75 IPS. **Heads (3):** erase, record, and in-line stereo playback (TR-1C, monophonic playback). **Playback equalization:** NARTB curve, within ±2 db. **Inputs (2):** microphone and line. **Input impedance:** 1 megohm. **Model TR-1D & TR-1E outputs (2):** A and B stereo channels. **Model TR-1C output (1):** monophonic. **Output levels:** approximately 2 volts maximum. **Output impedance:** approximately 600 ohm (cathode followers). **Recording level indicator:** professional type db meter. **Bias erase frequency:** 60 kc. **Timing accuracy:** ±2%. **Power requirements:** 105-125 volts AC, 60 cycles, 35 watts. **Dimensions:** 15½" W. x 13½" D. Total height 10¾". **Mounting:** requires minimum of 8½" below and 1½" above mounting surface. May be operated in either horizontal or vertical position.

MODEL TR-1C Monophonic Tape Deck: Monophonic Record and Playback. **$159.95** $16.00 DWN. $14.00 MO.

MODEL TR-1D Two Track Stereo Tape Deck: Monophonic Record and Playback, plus Playback of 2-track Pre-recorded Stereo Tapes (stacked). **$169.95** $17.00 DWN. $15.00 MO.

MODEL TR-1E Four Track Stereo Tape Deck: Monophonic Record and Playback, plus Playback of 4-track Pre-recorded Stereo Tapes (stacked). **$169.95** $17.00 DWN. $15.00 MO.

MODEL C-TR-1C Conversion Kit: Converts TR-1C to TR-1D (see TR-1D description above). Shpg. Wt. 2 lbs. **$19.95**

MODEL C-TR-1D Conversion Kit: Converts TR-1D to TR-1E (see TR-1E description above). Shpg. Wt. 2 lbs. **$14.95**

MODEL C-TR-1CQ Conversion Kit: Converts TR-1C to TR-1E (see TR-1E description above). Shpg. Wt. 2 lbs. **$19.95**

STEREO-MONO TAPE RECORDER KITS (TR-1A Series)

Here are the tape recorders the avid hi-fi fan will find most appealing! Their complete flexibility in installation and many functions make them our most versatile tape recorder kits. This outstanding tape recorder now can be purchased in any one of three versions. You can buy the new two-track (TR-1AH) or four-track (TR-1AQ) versions which record and play back both stereo and monophonic programming, or the two-track monophonic record-playback version (TR-1A) and later convert to either two-track or four-track stereo record-playback models by purchasing the MK-4 or MK-5 conversion kits. The tape deck mechanism is extremely simple to assemble. Long, faithful service is assured by precision bearings and close machining tolerances that hold flutter and wow to less than 0.35%. Power is provided by a four-pole, fan-cooled induction motor. One lever controls all tape handling functions of forward, fast-forward or rewind modes of operation. The deck handles up to 7" tape reels at 7.5 or 3.75 IPS as determined by belt position. The TR-1A series decks may be mounted in either a vertical or horizontal position (mounting brackets included). The TE-1 Tape Electronics kits supplied feature NARTB equalization, separate record and playback gain controls and a safety interlock. Provision is made for mike or line inputs and recording level is indicated on a 6E5 "magic eye" tube. Two circuit boards simplify assembly.

MODEL TR-1A: Monophonic two-track record/playback with fast forward and rewind functions. Includes one TE-4 Tape Electronics kit. Shpg. Wt. 24 lbs. **$99.95** $10.00 DWN. $9.00 MO.

TR-1A SPECIFICATIONS—Frequency response: 7.5 IPS ±3 db 50 to 12,000 cps; 3.75 IPS ±3 db 50 to 7,000 cps. **Signal-to-noise ratio:** better than 45 db below full output of 1.25 volts/channel. **Harmonic distortion:** less than 2% at full output. **Bias erase frequency:** 60 kc (push-pull oscillator).

MODEL TR-1AH: Two-track monophonic and stereo record/playback with fast forward and rewind functions. Two TE-4 Tape Electronics kits. Shpg. Wt. 36 lbs. **$149.95** $15.00 DWN. $13.00 MO.

TR-1AH SPECIFICATIONS—Frequency response: 7.5 IPS ±3 db 40 to 15,000 cps; 3.75 IPS ± db 40 to 10,000 cps. **Signal-to-noise ratio:** 45 db below full output of 1 volt/channel. **Harmonic distortion:** less than 2% at full output. **Bias erase frequency:** 60 kc (push-pull oscillator).

MODEL TR-1AQ: Four-track monophonic and stereo record/playback with fast forward and rewind functions. Two TE-4 Tape Electronics kits. Shpg. Wt. 36 lbs. **$149.95** $15.00 DWN. $13.00 MO.

TR-1AQ SPECIFICATIONS—Frequency response: 7.5 IPS ±3 db 40 to 15,000 cps; 3.75 IPS ±3 db 40 to 10,000 cps. **Signal-to-noise ratio:** 40 db below full output of .75 volts/channel. **Harmonic distortion:** less than 2% at full output. **Bias erase:** 60 kc (push-pull oscillator).

HEATH COMPANY/Benton Harbor, Mich.

a subsidiary of Daystrom, Inc.

New "Acoustic Suspension" Hi-Fi Speaker System Kit

HEATHKIT AS-2U (unfinished)

$69.95

HEATHKIT AS-2M (mahogany) **$79.95**
HEATHKIT AS-2B (birch) **EACH**

NOW—FOR THE FIRST TIME —EXCLUSIVELY FROM HEATH

ACOUSTIC SUSPENSION HI-FI SPEAKER SYSTEM KIT (AS-2)

A revolutionary principle in speaker design, the Acoustic Research speaker has been universally accepted as one of the most praiseworthy speaker systems in the world of high fidelity sound reproduction. Heathkit is proud to be the sole kit licensee of this Acoustic Suspension principle from AR, Inc., and now offers for the first time this remarkable speaker system in money-saving, easy-to-build kit form.

The 10" Acoustic Suspension woofer delivers clean, clear extended-range bass response and outstanding high frequency distribution is provided by the specially designed "cross-fired" two-speaker tweeter assembly.

Another first in the Heathkit line is the availability of preassembled and prefinished cabinets. Cabinets are available in prefinished birch (blond) or mahogany, or in unfinished birch suitable for the finish of your choice. Kit assembly consists merely of mounting the speakers, wiring the simple cross-over network and filling the cabinet with the fiberglass included. Shpg. Wt. 32 lbs.

SPECIFICATIONS—Frequency response (at 10 watts input): ±5 db, 42 to 14,000 cps; 10 db down at 30 and 16,000 cps. **Harmonic distortion:** below 2% down to 50 cps, below 3% down to 40 cps at 10 watts input in corner room location. **Impedance:** 8 ohms. **Suggested amplifier power:** 20 watts minimum. **Suggested damping factor:** high (5:1 or greater). **Efficiency:** about 2%. **Distribution angle:** 90° in horizontal plane. **Dimensions:** 24" W. x 13½" H. x 11⅝" D.

New Test Equipment

HEATHKIT FMO-1 Price to be announced

AN INSTRUMENT LONG-AWAITED BY SERVICE TECHNICIANS EVERYWHERE!

HEATHKIT FM TEST OSCILLATOR KIT (FMO-1)

Here in one compact, easy-to-use instrument are provided all the test signals and sweep frequencies required for fast, easy alignment and troubleshooting of RF, IF and detector sections of FM tuners and receivers. An instrument unique in the test equipment field . . . being the only one of its type designed especially for FM service work.

SPECIFICATIONS—Output frequencies: for RF alignment, 90 mc (FM band low end), 100 mc (FM band middle range), 107 mc (FM band high end). **Modulation:** 400-cycle incidental FM. **IF and detector alignment:** 10.7 mc sweep. **Sweep width markers:** 300 kc to over 1 mc, variable, 10.7 mc (crystal), 100 kc sub-markers. **Modulation:** 400-cycle AM. **For other applications:** 10.0 mc (crystal) and harmonics, 100 kc, 400-cycle audio. **Controls:** main frequency selector, modulation switch/concentric level control, marker oscillator switch/concentric level control, sweep width—power switch, output control, AF-RF (source impedance) switch. **Power supply:** transformer, selenium rectifier. **Power requirements:** 105-125 V, 50/60 cycles, 12 watts. **Cabinet size:** 7¾" H. x 4¾" W. x 4¾" D.

HEATHKIT RF-1

$27.95

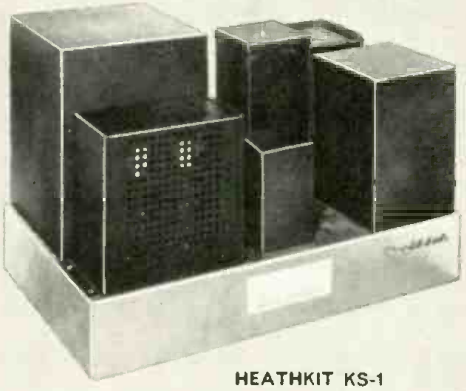
PREASSEMBLED AND ALIGNED BANDSWITCH/COIL ASSEMBLY

RF SIGNAL GENERATOR KIT (RF-1)

Moderately priced, and capable of precision performance the RF-1 provides highly accurate and stable RF signals for trouble-shooting and aligning RF and IF circuits of all kinds. Modulated or unmodulated RF output of at least 100,000 microvolts is available, controlled by both fixed-step and continuously variable controls. A built-in 400 cycle audio generator with 10-volt output provides internal modulation of RF signal and is available separately for audio tests. A preassembled bandswitch and coil assembly, aligned to factory precision standards, eliminates the need for special alignment equipment. Shpg. Wt. 7 lbs.

SPECIFICATIONS—Frequency range: Band A, 100 kc to 320 kc; Band B, 310 kc to 1.1 mc; Band C, 1 mc to 3.2 mc; Band D, 3.1 mc to 11 mc; Band E, 10 mc to 32 mc; Band F, 32 mc to 110 mc. **Calibrated harmonics:** 110 mc to 220 mc. **Accuracy:** 2%. **Output:** impedance, 50 ohms; voltage, in excess of 100,000 uv on all bands. **Modulation:** internal, 400 cycles approx. 30% depth; external, approx. 3 V across 50 k ohm for 30%. **400 cycles audio output:** approx. 10 V open circuit. **Tube complement:** V1 12AT7 RF oscillator, V2 6AN8 modulator and output. **Power requirements:** 105-125 V 50/60 cycles AC, 15 watts. **Aluminum cabinet dimensions:** 6½" W. x 9½" H. x 5" D.

New HEATHKIT Ham Radio Gear



HEATHKIT KS-1

$169.95

TOP POWER WITH ECONOMY AND SAFETY

KILOWATT POWER SUPPLY KIT (KS-1)

The KS-1 is designed as a companion to the "Chippewa" Linear Amplifier and is also suitable for supplying plate power to most other RF amplifiers in the medium to high power class. The KS-1 features an oil-filled, hermetically sealed plate transformer to minimize corona, a swinging choke in the filter circuit for good regulation, and a 60-second time delay relay to permit adequate heating of the mercury vapor rectifiers before application of plate voltage. All components are conservatively rated and well insulated for long life and dependable service. Shpg. Wt. 105 lbs.

SPECIFICATIONS—Maximum DC power output: 1500 watts. **Nominal DC voltage output:** 3000 or 1500 volts. **Maximum DC current output:** Average 500 ma, peak 1000 ma. **Regulation:** 180 to 600 ma (typical linear amplifier), 8%; 0 to 300 ma (typical class C amplifier), 10%; 0 to 500 ma, 15%. **Ripple:** Less than 1%. **Tube complement:** (2) 866A mercury vapor rectifiers. **Recommended ambient temperature:** 50 to 100 degrees F. **Circuit:** Two half-wave mercury vapor rectifiers in a full wave, single-phase configuration with swinging choke input filtering. **Line power requirements:** 115 V, 50/60 cycles, 20 amperes; 230 V, 50/60 cycles, 10 amperes. **Chassis size:** 17¾" W. x 12" H. x 13" D.

HEATHKIT KL-1

$415.00

MOVE TO THE TOP IN TRANSMITTING POWER

"CHIPPEWA" KILOWATT LINEAR AMPLIFIER KIT (KL-1)

The KL-1 operates at maximum legal amateur power inputs in SSB, CW or AM service using any of the popular CW, SSB and AM exciters as a driver. Premium tubes (4—400's) push the "Chippewa" to top performance levels while a centrifugal blower provides more than adequate cooling. Shpg. Wt. 70 lbs.

SPECIFICATIONS—RF section: Driving power required (10 meters): Class AB1 (tuned grid) 10 watts peak; Class C (tuned grid) 40 watts; Class AB1 (swamped grid) 60 watts peak. **Power input:** Class AB1 (SSB-voice modulation) 2000 watts PEP; Class AB1 (SSB-two tone test) 1300 watts; Class AB1 (AM linear) 1000 watts; Class C (CW) 1000 watts. **Power output (20 meters):** Class AB1 (SSB-voice modulation) 900 watts PEP; Class AB1 (SSB-two tone test) 550 watts; Class AB1 (AM linear) 300 watts; Class C (CW) 750 watts. **Output impedance:** 50 to 72 ohms (unbalanced). **Input impedance:** 50 to 72 ohms (unbalanced). **Band coverage:** 80, 40, 20, 15 and 10 meters. **Panel metering:** 0 to 50 ma, grid current; 0 to 100 ma screen current; 0 to 5000 volt plate voltage; 0 to 1000 ma plate current. **Tube complement:** Final tubes, (2) 4-400A; clamp tube, (1) 6DQ6; voltage regulators, (4) OD3, (2) OC3. **Power requirements:** AC (power supply primary circuit), 250 watts, 115 volt, 50/60 cycles; DC, 3000 to 4000 volts, 450 ma. **Cabinet size:** 19½" W. x 11¾" H. x 16" D.

HEATHKIT XC-2

$36.95

2-METER CONVERTER KIT (XC-2)

Extends coverage of the Heathkit "Mohawk" Receiver to the 2-meter band. May also be used with receivers tuning a 4 mc segment between the frequencies of 22 and 35 mc when appropriate crystal is used. Shpg. Wt. 7 lbs.

SPECIFICATIONS—Noise figure: 4.5 db; 1 uv signal provides 20 db thermal noise quieting. **Sensitivity:** approx. .1 uv input will provide a signal better than 6 db over noise level. **Gain:** approx. 40 db. **Pass band:** essentially flat 144 to 148 mc; approx. 35 db down at 143 and 149 mc. **Image rejection:** better than 100 db (tunable). **Output impedance:** 50 to 75 ohms. **Input impedance:** 50 to 75 ohms; 300 ohms with balun. **Frequency:** input, 144 to 148 mc; output, 22 to 26 mc with crystal supplied. **Tubes:** 6AM4, 6BS8, 6EA8, 12AT7. **Crystal:** .005% 3rd overtone. **Power requirements:** 150 volts DC at 50 ma (dropping resistor supplied for 210 VDC RX-1 operation) 6.3 volts AC/DC at 1.375 amps. **Size:** 9" W. x 5½" H. x 4¾" D.

HEATHKIT UT-1

$28.95

"BEST BUY" UTILITY POWER SUPPLY KIT (UT-1)

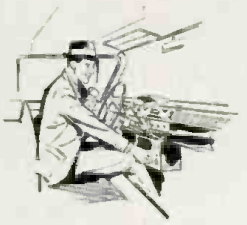
This power supply is ideal for converting the Heathkit "Cheyenne" and "Comanche" mobile transmitter and receiver to fixed station operation; or may be used to provide necessary filament and plate voltage for a wide variety of amateur equipment. Features silicon diode rectifiers, high capacity filters for superior dynamic regulation, and line filtering to minimize TVI and reduce receiver line noise. On ICAS basis, provides 150 watts DC plus filament power for 6.3 volt or 12.6 volt filament applications (6.3 VAC., 8 amps. or 12.6 VAC., 4 amps.; 600 VCD., 250 ma or 600 VDC, 200 ma and 300 VDC., 100 ma). Less than 1% ripple; excellent regulation. Housed in attractive green and gray-green cabinet measuring 9" long, 4¾" wide, 6" high. Shpg. Wt. 15 lbs.

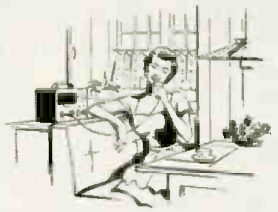
New Citizen's Band Transceiver

WIRED OR KIT FORM

HEATHKIT CB-1
$42.95
(kit model)

HEATHKIT W-CB-1
$60.95
(wired model)
$6.10 dwn., $6.00 mo.





Both models include transceiver, crystal, microphone and two special power cords.

- No Tests to Take—No Operator's License Required
- Any Citizen 18 or Older Can Have Own Station
- Hundreds of Business and Personal Uses

CITIZEN'S BAND TRANSCEIVER KIT (CB-1)

The Heathkit CB-1 Citizen's Band Transceiver is a compact radio transmitter and receiver combination designed to operate on the new 11-meter "Citizen's Band". No tests to take, no special knowledge or operator's license required . . . you need only fill out forms we supply, and mail them to FCC to apply for station license. Operates just like any short wave radio used by police and other communication services. Front panel switch selects both "transmit" and "receive". Two or more Heathkit Transceivers provide you with your own 2-way radiotelephone system for making necessary business and personal contacts with family, friends or associates. A Heathkit accessory power supply makes the CB-1 completely portable for use in cars, trucks, boats, etc., using 6 or 12 volt batteries. With appropriate accessory antenna, the CB-1 can be used for communicating between truck and office, home and automobile, boat and shore, farm-house and field . . . literally hundreds of useful applications. Comes complete with microphone, 2 power cords for mobile or fixed operation, station ID card, call letters, and crystal for one channel and FCC application form. Order power supply and antenna separately. Attractively styled in two-tone "mocha" and "beige". Shpg. Wt. 10 lbs.

SPECIFICATIONS—Receiver type: Superregenerative detector w/rf stage. **Power input:** 5 watts maximum to plate of final RF amplifier (FCC requirement). **Transmitter frequency control:** Third overtone type quartz crystal operating within 0.005% of marked channel frequency between −20° and +130° F. **Modulation:** AM plate and screen modulation automatically limited to less than 100% (FCC requirements). **Power supply:** Internal 117 V, 50/60 cycles, AC (35 watts). For 6 V battery power, use Model VP-1-6 Vibrator Power Supply (6.5 amps); for 12 V battery power, use VP-1-12 (4 amps). **Total B+ requirements:** 260 volts at 60 ma; total heater requirements, 6.3 volts at 1.8 amps, or 12.6 volts at 0.9 amps. **Power rectifier:** 2 silicon diodes in full wave voltage doubler circuit. **Microphone:** Combination hand-held and desk type, ceramic element, plastic case, with cord and connector. **RF output impedance:** 50 ohms. **Speaker size:** 3½" (round). **Undistorted audio power output:** Approximately 1 watt. **Line cords:** Two supplied, one for AC operation, one for battery operation. Power circuits automatically switched when appropriate line cord is plugged in. **Cabinet dimensions:** 8" H. x 6" D. x 9¾" W.

SPECIFY FREQUENCY CHOICE
(1st and 2nd choice)

CLASS D CITIZEN'S BAND FREQUENCIES

26.965 mc	27.035 mc	27.115 mc	27.185 mc
26.975 mc	27.055 mc	27.125 mc	27.205 mc
26.985 mc	27.065 mc	27.135 mc	27.215 mc
27.005 mc	27.075 mc	27.155 mc	27.225 mc
27.015 mc	27.085 mc	27.165 mc	*27.255 mc
27.025 mc	27.105 mc	27.175 mc	

*This channel shared with Class C Radio Control.

ANTENNAS

CBU-1 "UTILITY" ANTENNA.....$9.95
Good coverage, portable antenna for temporary mobile or fixed installations. 45½" base-loaded antenna, 12' connecting cable, mounting bracket and clip. 3 lbs.

CBM-1 "MOBILE" ANTENNA.....$19.95
Best coverage mobile installation. Easy to install spring base, ¼ wave, 9' whip; 15' connecting cable and necessary hardware. 7 lbs.

CBF-1 "FIXED LOCATION" ANTENNA...$19.95
Excellent coverage, ¼ wave "ground plane", 9' elements; 50' connecting cable and mounting bracket. 7 lbs.

WIRED AND KIT FORM POWER SUPPLIES FOR MOBILE USE

6 volt Vibrator Power Supply for use with 6 volt batteries.
KIT—Model VP-1-6. Shpg. Wt. 4 lbs.....$7.95
WIRED—Model WVP-1-6. Shpg. Wt. 4 lbs.....$11.95

12 volt Vibrator Power Supply for use with 12 volt batteries.
KIT—Model VP-1-12. Shpg. Wt. 4 lbs.....$7.95
WIRED—Model WVP-1-12. Shpg. Wt. 4 lbs.....$11.95

HEATHKIT

ORDER BLANK

NOTE: all prices and specifications subject to change without notice.

Enclosed find ( ) check ( ) money order. Please ship C.O.D. ( )

On Express orders do not include transportation charges—they will be collected by the express agency at time of delivery.

On Parcel Post Orders include postage for weight shown. All prices are NET F.O.B. Benton Harbor, Michigan, and apply to Continental U.S. and Possessions only. 20% Deposit required on all C.O.D. orders.

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QUANTITY	ITEM	MODEL NO.	PRICE
	☐ SEND FREE HEATHKIT CATALOG	POSTAGE	
		TOTAL	

HEATHKITS are also available at your Dealer see listing on next page

Harmonic Distortion

(Continued from page 73)

power output. In general, as the output power is increased, so is amount of distortion. Usually, the increase is smooth and gradual up to the overload point, where there is a sudden jump in distortion. Amplifiers should be rated at a power just below this overload point, while the THD is still only a small value. In the case of preamps, measurements are frequently made with certain input and output voltages. For example, we might measure distortion at 1-volt input and 1-volt output or else at .5-volt input and 2-volts output.

A high-quality 50-watt hi-fi amplifier might have the following THD specification: "Total harmonic distortion below 1% from 20 to 20,000 cps within 1 db of 50 watts." Such an amplifier would probably have no trouble at all in producing up to a full 50 watts of output at less than 1% THD over most of the audio range. At the very extremes of the range, however, it would still be generating less than 1% distortion at powers up to 40 watts (which is 1 db below 50 watts).

Another unit might be rated as follows: "Total harmonic distortion below 2% from 30 to 15,000 cps." This amplifier might very well have a THD of a fraction of 1% at 1000 cps, but distortion would not exceed the 2% figure at full-rated power output over the frequency range specified.

A measurement of total harmonic distortion, then, although it does not tell the whole story, is one of the most useful performance specifications that can be measured.

REFERENCE

1. Olson, Harry F.: "Acoustical Engineering" D. Van Nostrand Co., New York.

—30—

QUICK SOLDERING

By WILLARD WEISS

A WELLER or similar type soldering gun can be used to heat joints by the resistance method. By cutting off the end of the regular copper heating element and applying the two ends to the joint to be soldered and closing the trigger switch, heat is developed directly in the joint itself.

This method will develop a rapid and localized high temperature and, in crowded chassis, will help prevent damage to adjacent components.

The author has found this technique to be useful when soldering components such as precision resistors, diodes, and transistors to turret lugs on terminal boards. It is important not to overheat these types of components.

If a "Variac" is available, it may be used to control the heating rate and temperature by plugging the soldering gun into the "Variac" and reducing the line voltage.

After using this technique for some time, the author hasn't observed any damage to the soldering gun. In actual fact, the gun runs cooler than normal since it heats the point more rapidly than usual. —30—

page ads in the nation's top magazines tell the story!

The New JERROLD TV-FM RECEPTOR* Ends Rabbit Ears!

the first really small really powerful TV-FM antenna

- No gadget or unproven gimmick . . . it's guaranteed by Jerrold Electronics Corporation.
- No more rabbit ears cluttering up the top of the TV set!
- Even eliminates outside antennas in many areas!
- Easy to install, slides over line cord of TV or FM set!
- Push button tuning for best reception . . . set it and forget it!
- Absolutely safe . . . uses no electricity!
- Designed for VHF, UHF, Color and FM!
- Handsomely packaged in a self display unit. Priced to sell fast!

the new antenna that hides while it works!

Model TVR **$5.95** List

JERROLD

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*Trade Mark Patent Pending

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Jerrold Electronics (Canada) Limited

Export Representative: CBS International, New York 22, N. Y.

Hi-Fi-Audio Product Review

PORTABLE MEGAPHONE

Audio Equipment Company, Inc. of Port Washington, L.I., New York has recently released a transistor-powered portable megaphone which is being marketed as the "Audio Hailer" Model S-168.

The circuit includes a three-stage push-pull amplifier using three power transistors and one voltage amplifier

transistor. Acoustic output is 115 db at 5 feet, power is 7 watts. The entire circuit is powered by twelve flashlight cells whose battery life approximates shelf life.

The megaphone has a two-tone green, weatherproof baked-enamel housing with a die-cast aluminum pistol grip handle. The unit measures 12¾" over-all and weighs 5¾ pounds. A colorful data sheet giving complete specifications on this new unit is available from the manufacturer on request.

MATCHED MIKES FOR STEREO

Shure Brothers, Inc., 222 Hartrey Ave., Evanston, Ill. has introduced high-fidelity matched microphones

which permit tape recording fans to obtain professional quality stereo tapes.

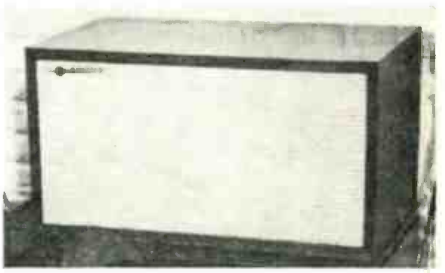
The Model 55S "Unidynes" are precision made and guaranteed to be matched within 2 db across their entire frequency range of from 50 to 15,000 cps. "Unidynes" are unidirectional dynamic microphones with multi-impedance switches to permit matching low (35-50 ohms), medium (150-250 ohms), or high (100,000 ohms and up) impedance inputs. Their super-cardioid pickup patterns make them effective at a 75 per-cent greater distance than standard microphones, according to the company.

The manufacturer will supply full details and price information on these new matched microphones upon request.

BOOKSHELF SPEAKER

ALCOR, Inc. of Ithaca, New York is currently in production on a new bookshelf speaker system which is especially adapted to stereo applications.

The "Polaris" incorporates a radical tweeter design which uses acoustic reflection to provide smooth, wide dispersion even at the highest audible frequencies. This wide dispersion makes it unnecessary to sit exactly midway between the speakers to hear balanced



stereo and allows several listeners in various parts of the room to enjoy excellent reproduction.

The woofer is a soft-suspension, cast-frame, low-frequency driver and is used with a true *LC* crossover. Amplifier distortion is reduced since the system presents a nearly constant impedance to the amplifier at all frequencies. The system may be used with any amplifier rated at 10 watts or better. Frequency response is 35 to 17,500 cps.

The enclosure measures 11¾" x 11¾" x 24¾" and will fit any 12" bookshelf. It is available in unfinished birch, genuine blonde or dark mahogany, and genuine walnut or cherry finishes.

Write the manufacturer direct for complete details and prices.

FISHER TUBE LINE

Fisher Radio Corporation, 21-21 44th Drive, Long Island City 1, N. Y. is now marketing a new line of laboratory tested and matched-paired vacuum tubes for audio, radio, and television applications.

According to the company, the laboratory matching of tubes in pairs makes it possible to balance sensitive

"The new Citation Kits represent for me the successful culmination of years of research and experimentation to achieve the ultimate in high fidelity design."

Stewart Hegeman, Director of Engineering, Citation Kit Division, Harman-Kardon, Inc.

THESE ARE STRONG WORDS from a conservative audio engineer. But the proof is overwhelming. All that's necessary is a look at the technical specifications of the new Citation I Stereophonic Preamplifier Control Center and Citation II 120 Watt Stereophonic Power Amplifier.(We'll gladly send them to you.

Hegeman is recognized as one of the world's great audio engineers. His original designs for the famous Brociner amplifier and preamplifier, and the Hegeman-Lowther speakers, are still regarded as classics by audio engineers and audiophiles. In his capacity as head of the kit engineering group at Harman-Kardon, he has again created new classics.

Easily Assembled— Professional Performance

THERE ARE MANY exciting new concepts built into the Citation Kits. The engineering is so wonderfully precise that the instrument constructed by the kit builder will duplicate the precision of the finest factory-assembled products. Here are some of the remarkable new assembly features that distinguish the Citation Kits:

Military Type Construction: For ease of assembly and durability, rigid phenolic boards are used. *Special Cable Harness:* Unique harness template enables builder to make a professional cable harness to facilitate wiring and insure accuracy. *Special Aids:* Resistors and condensers are filed individually on special component cards so that they can be quickly identified. Wire strippers are supplied free with each kit to produce clean wire junctions.

The Citation I Stereophonic Preamplifier Control Center

HERE IS THE FIRST brilliant expression of the advanced design concepts which sparked the new Citation Kit Line: the incomparable Citation I, Stereophonic Preamplifier Control Center.

The Citation I consists essentially of a group of circuit blocks termed active and passive networks. Active networks incorporate the vacuum tubes and furnish amplification; passive networks consist of resistors and condensers and provide precise equalization. The active networks are treated as one- or two-stage amplification units, flat over an extremely wide frequency range, and each one of these networks is surrounded by a feedback loop. *This results in levels of distortion so low as to prove unmeasurable.* The passive networks are constructed of precision components and are designed for minimum phase shift.

PROFESSIONAL STEP-TYPE tone controls are used on the new Citation I. They overcome the limitations of continuously variable potentiometers; each position on a step control can be engineered to perform a specific function which is absolutely repeatable when necessary. The flat position of the controls by-passes all tone control circuitry, thereby eliminating transient distortion and phase shift.

Other features include: The new Citation Blend Control which introduces a continuously variable amount of cross-feed between the two channels to eliminate the "hole-in-the-middle" effect of many stereo records; DC heated preamplifier filaments; six silicon diode rectifiers to provide unexcelled B+ and filament regulation; separate turnover and rolloff controls to provide precise equalization.

The Citation I is available with an optional walnut hardwood enclosure which sets off its magnificent sculptured satin-gold escutcheon. The Citation I... $139.95; Factory Wired... $239.95; Walnut Enclosure, WW-1... $29.95.

The Citation II 120 Watt Stereophonic Power Amplifier

HERE IS ALL the power required from a stereophonic amplifier. Two 60 Watt Channels—with a combined peak power output of 260 Watts!

The Citation II reflects a dramatic new approach to amplifier design. Audio engineers have discovered that the characteristics of an amplifier in the non-audible range strongly influence sound quality in the audible range. This can be determined in critical listening tests where the program material for each amplifier is laboratory controlled.

Because of this vital consideration the Citation II is engineered to produce frequencies as low as 5 cycles virtually without phase shift. At the high end—the amplifier has a frequency response beyond 100,000 cycles without any evidence of ringing or instability.

AUDIO ENGINEERS have also found that the higher the degree of feedback—*and the consequent lower distortion*—the more apparent the improvement in sound quality and the greater the reduction in listener fatigue. In order to increase the degree of feedback in the Citation II, a "multiple loop" technique is used in contrast to conventional "single loop" techniques. This results in a 20/1 to 30/1 reduction in distortion compared with the 10/1 to 20/1 reduction in conventional amplifiers.

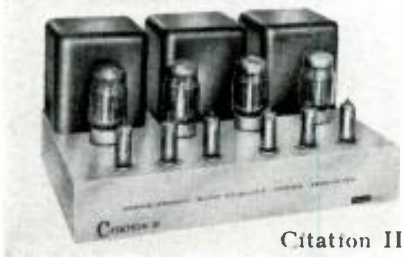
Other important Citation II features include: video output pentodes in all low level stages for exceptional wide frequency response and low distortion; power supply consisting of four silicon diode rectifiers, choke and heavy duty electrolytics with potted power transformer for superb regulation and long life; bias meter to adjust individually the plate current of each KT88 for balance and lowest distortion.

The Citation II is a handsomely styled brown and gold instrument with an optional Charcoal Brown protective cover. The Citation II... $159.95; Factory Wired ... $219.95; Charcoal Brown Enclosure, AC-2... $7.95.

All prices slightly higher in the West.

For a complete report on the new kits write to Harman-Kardon, Inc., Citation Kit Division, Dept EW-11, Westbury, N. Y.

Citation I



Citation II

Build the Very Best **CITATION KITS** *by* **harman kardon**

circuits and maintain this balance with perfect stability. While the new tube line was introduced primarily for use in the company's own audio components, the tubes are completely interchangeable with all standard brands and may be used in any equipment.

The new matched tubes are currently available at audio salons and service shops.

INTEGRATED STEREO AMP

Lafayette Radio Corp., 165-08 Liberty Ave., Jamaica 33, N. Y. has announced the availability of a new stereo preamp-amplifier which is being offered in both kit and wired versions.

The KT-250 has been designed to handle all stereo or mono sources. Each channel will provide 25 watts of power (50 watts if used in the mono mode) with terminations for 4-, 8-, or 16-ohm speakers.

The full range of controls includes a unique "blend" control which provides continuously variable channel separation from full monophonic to full stereo. This control may be used to reduce the exaggerated channel separation found in some stereo source material or to eliminate vertical rumble when playing a monophonic record with a stereo cartridge. Individual or simultaneous level control of both channels is made possible by the use of a clutch-type volume control and each channel has its own bass and treble controls.

Frequency response at normal listening level is 17 to 21,000 cps ± 1 db. Hum and noise is 74 db below rated output at full volume for high-level inputs and − 54 db for low-level inputs. Harmonic distortion is less than 0.25% and IM distortion is less than 1%. Channel separation, with separation control in full stereo position, is greater than 50 db.

The unit measures 14½" x 12¾" x 4½" including the legs and knobs. Write the company direct for full details on both the wired and kit models.

TURNTABLE SPEED INDICATOR

Sela Electronics Company, 545 West End Ave., Chicago 24, Ill. is currently marketing a turntable speed indicator, the Model T-7.

This new strobe flasher incorporates an advanced-design gas discharge bulb in conjunction with a germanium diode rectifying circuit and operates from 117-volt, 60-cycle power sources.

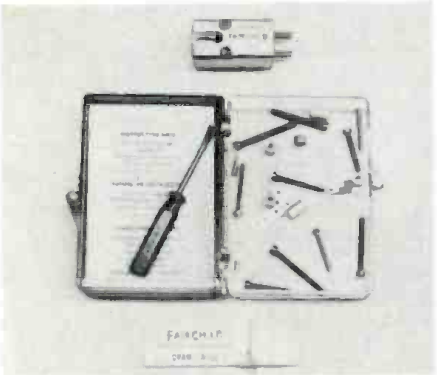
Flash duration on each cycle is as short as 100 microseconds, imparting sharp bar images to the rotating stroboscopic markers. The strobe card is marked in concentric bands for different phonograph speeds. Clockwise

movement means that the turntable is too fast while the counterclockwise rotation indicates too slow operation. There are four concentric marker circles on the strobe card for 16⅔, 33⅓, 45, and 78 rpm.

For a data sheet on this new device, write the company direct.

CARTRIDGE INSTALLATION KIT

Fairchild Recording Equipment Corp., 10-40 45th Ave., Long Island City 1, N. Y. is now supplying a free



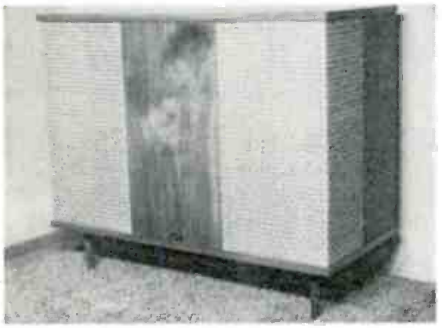
cartridge installation kit, complete with necessary tools, with its new stereo and monophonic cartridge, Model SM-1.

The kit includes, in addition to the usual hardware, a gram gauge, small screwdriver, and instructions printed in three languages. The gram gauge, for measuring stylus pressure on recordings, can be retained for continuing verification of pressure to preserve both records and stylus.

HARTLEY "DUO" SPEAKER

Hartley Products Company, 521 E. 162nd St., New York 51, N. Y. is now offering a deluxe model of its "Duo Stereo" speaker system in a single cabinet.

The cabinet is crafted in natural woods, with the angled speaker mount-



ing boards hidden by a grille which encloses the corners—giving a more conservative appearance. The enclosure houses two full-range speakers which deliver both stereo channels evenly throughout the room by direct radiation and reflection from the walls.

The enclosure is available with or without companion speakers. Write the manufacturer for prices and finishes.

"DYNAKIT" 40-W. AMPLIFIER

Dynaco Inc., 617 North 41 St., Philadelphia 4, Pa. is now offering a new 40-watt amplifier in both wired and semi-assembled kit form.

Tradenamed the "Dynakit Mark IV," the circuit features the firm's A-470 output transformer and is suitable for either stereo or monophonic applications. The amplifier delivers its rated 40 watts of power at less than 1% distortion within the 20 to 20,000 cps range. Frequency response is ± 1 db from 10 to 40,000 cps. Noise is better than 90 db below rated output. Transient response, as evaluated by pulse tests and square waves, is said to be excellent.

The circuit uses matched EL-34 tubes driven by the new 7199 pentode-triode tube. The use of prewired printed circuitry, detailed step-by-step instructions, and pictorial diagrams enables even novice kit builders to construct this amplifier quickly and easily. Average construction time is said to be about 3 hours.

The Mark IV measures 5"x14"x6½" and weighs 23 pounds. It is finished in bright nickel with charcoal brown vinyl coated cover.

MULTIPLEX ADAPTER

Sherwood Electronic Laboratories, Inc., 4300 N. California Ave., Chicago 18, Ill. has developed a multiplex adapter which enables reception of any of the various stereo multiplex programs now being transmitted experimentally over FM stations throughout the country.

Matrix circuitry, switching, and balance adjustments are included in the SMX adapter for both the *Crosby* sum/

difference system and split-channel systems. The subchannel bandpass extends from 22,500 to 120,000 cps and is adequate to receive transmissions at 26, 41, 50, or 67 kc. with up to 60 kc. bandwidth.

Normal monophonic FM tuner reception is possible with the Model SMX power switch off without upsetting either the adapter controls or interconnecting cables. The unit is self-powered and can be operated with any FM tuner.

The adapter can be housed in an accessory case which is available in brown or black Flextone. The unit measures 5¾"x10½"x4" and weighs 8 pounds packed for shipping.

BLANK TAPE CARTRIDGES

The Electron Tube Division of *Radio Corporation of America*, Harrison, N. J. has announced the availability of magnetic tape cartridges containing blank

tape and suitable for all home recording applications.

The new pre-threaded and self-contained units can provide up to two full hours of monophonic play or one full hour of stereo play on one cartridge.

Made of rugged plastic, the small compact units may be easily stored. The cartridge also has an automatic safeguard which prevents accidental erasure. Windows on both sides of the cartridge show the amount of unrecorded tape remaining.

These blank cartridges are currently available at authorized *RCA* dealers as Type 264C1.

ALTEC "DUPLEX" SPEAKER

Altec Lansing Corporation of Anaheim, Calif. is now in production on a new "Duplex" speaker with controlled linear excursion.

The Model 605A is the successor to the company's 604D and features improvements in both the bass and treble sections. In the bass section the 605A has high-compliance suspension components for controlled linear excursion, stress-free assembly for ultimate linearity of the suspension system, a voice coil confined to a uniform magnetic field, magnetic field high flux density for optimum damping, and a low cone resonance of only 25 cps for reproduction of the lowest bass notes.

The treble section improvements include a lighter voice coil, a higher acoustic transformation, and smoother high-end response. Power rating is 35 watts with frequency response from 20 to 22,000 cps. Resonant frequency is 25 cps and impedance 16 ohms. Vertical distribution is 40 degrees while horizontal distribution is 90 degrees. Crossover frequency is 1600 cps.

The speaker measures 15¾" in diameter and is 10" deep. Shipping weight is 36 pounds.

AUDIO CATALOGUES

RECOTON CATALOGUE

Recoton Corp., 52-35 Barnett Ave., Long Island City 4, N. Y. has announced publication of its 8th annual catalogue and simplified replacement needle reference guide.

Well illustrated, this 12-page publication includes the firm's complete line of phono needles, cartridges, accessories, and sales promotion material. It serves as a handy reference manual for dealers. Copies are obtainable without charge direct from the manufacturer.

—30—

Measuring Your Audio Power Output

By **HAROLD REED**

Comparative tests with load resistor and voltmeter and voltmeter-ammeter method show surprising results.

WHEN checking the power output of an audio amplifier, it is customary to use a substitute load resistor of ohmic value equivalent to the amplifier output impedance. The temperature of the load resistor, unless of considerably higher power rating than the power output of the amplifier under test, will rise rapidly and its rated resistance value may change enough to result in erroneous measurements. This deviation can be serious when making critical distortion tests.

Suppose, as an example, an amplifier rated at 20 watts output is being checked with a 4-ohm resistor load. The amplifier output would be adjusted to obtain 8.95 volts across this load. Thus, it would be said that $W = E^2/R$, or $8.95^2/4 = 20$ watts. Also, suppose the load value rises due to heating by just 0.7 of an ohm. The author has seen this occur when using a good sized resistor for the load. Then, with this same output voltage, the power would be $8.95^2/4.7$, or only 17 watts. A distortion measurement made under these conditions may look very good and it would be assumed that it was taken at the 20-watt level. This same amplifier may severely distort the signal waveform as the maximum power output is approached.

Therefore, to check a 20-watt amplifier at rated output, make certain it is delivering 20 watts to the load. Sometimes, the last few watts can change the scope waveform pattern from a Jekyll to a Hyde. Heating of the load resistor must be avoided. Its power rating should, preferably, be at least 5 times the power output of the amplifier.

Amplifier power output measurements have been made by the voltmeter-ammeter method. The voltmeter is connected across the load resistor as before and the ammeter is inserted in series with this load. Then, it would be assumed that $W = EI$. This can prove to be even more erroneous.

Ordinary a.c. ammeters are designed for low-frequency applications and although their accuracy may be given as 2% of full scale, the deviation from this tolerance value is considerable with increasing signal frequency.

An example of this discrepancy is shown in Table 1. The data given in this table was obtained from measurements made with a representative low-frequency a.c. meter, 0-2 amperes. A load resistor of known ohmic value and high power rating, to avoid heating, was used in these measurements. It is readily seen that $W = EI$ does not equal E^2/R except in one case. This equality is observed only at a frequency of 30 cycles.

Using a low frequency as described, both methods may be employed to provide a double check on the power output figure. When the amplifier is first turned on, note the E^2/R and $E \times I$ values which should result in about the same power output figure. After running the amplifier for about 15 minutes re-adjust the output voltage, if necessary, to the level first noted. Again note the product of $E \times I$ and, if it is not equal to E^2/R, then the load resistor has changed value due to heating.

As mentioned previously, most a.c. meters have a full-scale accuracy within 2%. In the previous example given for a 20-watt amplifier, if the meter should be off by the full 2% either on the high side or low side, the indicated power output would be 20.4 watts or 19.6 watts, respectively, a negligible deviation from true power output. It is advisable to work in the upper half of the meter scale to minimize error.

Some manufacturers offer, for an additional charge, a.c. meters designed for operation at higher frequencies. *Weston*, for example, will supply meters designed for operation up to 2500 cycles.

When using ordinary type a.c. meters for audio power measurements, stick to frequencies under 100 cycles or apply a suitable correction factor which can be derived by obtaining test data on the particular meter as shown in Table 1. -30-

Table 1. These are the results of the a.c. ammeter test performed by the author. A 4-ohm load resistor was employed and the output voltage of the amplifier was held at a constant 4-volt output. The power being delivered in this case was 4 watts.

FREQ. (cps)	OUTPUT CURRENT (I)	OUTPUT POWER (W)
30	1.0 amp.	4.0
50	.99	3.96
100	.98	3.92
500	.96	3.84
1000	.95	3.80
10,000	.80	3.20
20,000	.65	2.60

Dependability is a built-in feature of all Delco Radio Service Parts!

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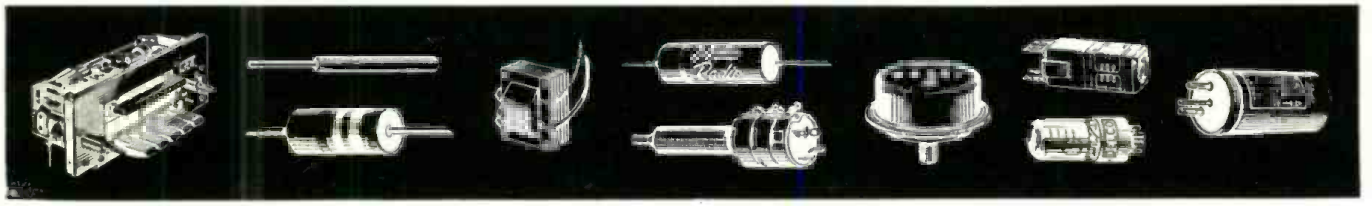

New Tube Tester Data

Owners of RCA hole-card automatic testers: here are hole locations to be punched for new tubes.

RCA AUTOMATIC TESTER, WT-110A

TUBE TYPE	HOLE LOCATIONS TO BE PUNCHED	NOTES
4BA6	A3, B4, C7, C2, D1, E6, G5, I6, I10, J2, K6, L1, L6, L7, M4, M6, N1, N6	
4DE6	A3, B4, C7, C2, D1, E6, G5, I6, I7, J1, K5, L7, L8, L1, M6, M1, N6, N5	
5BZ7	A4, B5, B9, C8, D7, F1, G6, I7, I8, J1, K4, L1, L6, L7, M4, M10, N1, N9	Test P1 and P2
5EA8 Pentode	A1, B5, C7, D2, E3, G6, I6, I10, J2, K3, L1, L6, L7, M5, M10, N1, N9	
5EA8 Triode	A4, B5, C8, D9, G1, I6, I9, J1, K1, L1, L6, L7, M5, M10, N1, N9	
5EH8 Pentode	A4, B5, C6, C1, D7, E8, G9, I10, I6, J2, K4, L1, L7, L6, M5, M10, N1, N9	
5EH8 Triode	A4, B5, C6, C1, D2, G3, I6, I10, J2, K8, L8, L6, L1, M5, M10, N1, N9	
6BX7GT	A7, B8, C6, C3, D4, D1, F2, G5, J7, K5, L6, L7, L1, M10, M4, N9, N2	Test P1 and P2
6DE7 Triode 1	A4, B5, C8, D7, G6, I10, I6, J7, K10, L7, L6, L1, M10, M4, N9, N2	
6DE7 Triode 2	A4, B5, C9, D2, G1, I6, I10, J10, K9, L8, L6, L1, M10, M4, N9, N2	
6DK6	A2, B4, C7, C2, D1, E6, G5, I10, I7, J1, K7, L8, L6, L1, M10, M4, N9, N2	
6DN7 Triode 1	A8, B7, C6, D4, G5, I6, I10, J6, K5, L1, M3, M10, N9, N1	
6DN7 Triode 2	A8, B7, C3, D1, G2, I10, I6, J8, K7, L7, L6, L1, M5, M10, N9, N1	
6DT5	A4, B5, C7, D2, C1, G9, I10, I6, J9, K6, L7, L6, L1, M10, M4, N9, N2	
6DT8	A4, B5, C3, C8, D2, D7, F1, G6, J1, K6, L1, L6, L7, M10, M3, N1, N9	Test P1 and P2
6DW5	A4, B5, C7, D3, D6, E1, G9, I6, I10, J8, K1, L1, L6, L7, M4, M10, N2, N9	
6EA8 Pentode	A4, B5, C7, D2, E3, G6, I6, I10, J2, K3, L1, L6, L7, M4, M10, N2, N9	
6EA8 Triode	A4, B5, C8, D9, G1, I6, I9, J1, K1, L1, L6, L7, M4, M10, N2, N9	
6EB8 Triode	A4, B5, C1, D2, G7, I6, I10, J2, K6, L1, M10, M3, N9, N1	
6EB8 Pentode	A4, B5, C6, D7, E8, G9, I10, I7, J1, K7, L8, L6, L1, M10, M4, N9, N2	
6EH8 Pentode	A4, B5, C6, C1, D7, E8, G9, I10, I6, J2, K4, L1, L7, L6, M10, M4, N9, N2	
6EH8 Triode	A4, B5, C6, C1, D2, G3, I6, I10, J2, K8, L8, L6, L1, M10, M4, N9, N2	
6SV7 Pentode	A7, B8, C3, D2, E4, G6, I10, I6, J2, K3, L4, M10, M5, N9, N2	
6SV7 Diode	A7, B8, C3, G5, I6, I10, K7, L7, L6, L3, M10, N9, M4, N2	Reject if below 4
6U7G	A7, B2, C5, C8, D10, E4, G3, I6, I10, J6, K10, L6, L7, L1, M3, M10, N1, N9	
8BQ5	A4, B5, C3, D2, E9, G7, I6, I10, J5, K7, L1, L6, L8, M5, M10, N3, N9	
8CN7 Triode	A4, A5, B9, C6, D7, G8, I6, I10, J2, K7, L1, M4, M6, N1, N6	For gas test, see instructions
8CN7 Diode	A4, A5, B9, C3, F2, G1, K7, L3, L6, L8, M4, M6, N1, N6	Test P1 and P2 Reject below 3
8EB8 Triode	A4, B5, C1, D2, G3, I6, I10, J2, K6, L1, M3, M10, N2, N9	
8EB8 Pentode	A4, B5, C6, D7, E8, G9, I10, I7, J1, K7, L8, L6, L1, M10, M3, N2, N9	
8SN7GTB	A7, B8, C6, D1, D4, F2, G5, I6, I10, J1, K1, L1, L9, M2, M10, N1, N9	Test P1 and P2
12A4	A4, B5, C1, D7, G9, I6, I10, J4, K6, L1, L6, L8, M2, M10, N4, N9	
12AH7GT	A7, B8, C2, C4, D1, D5, F6, G3, I6, I10, J6, K6, L1, M2, M10, N4, N9	Test P1 and P2
12BW4 Diode	A4, B5, C9, F1, G7, I6, I10, K5, L5, L6, L10, M2, M10, N3, N9	Test P1 and P2
12DT5	A4, B5, C7, D3, E1, G9, I6, J9, K6, L6, L7, L1, M10, M2, N4, N9	
12DT8	A4, B5, C3, C8, D2, D7, F1, G6, J1, K6, L1, L6, L7, M2, M10, N4, N9	Test P1 and P2
12EK6	A3, B4, C7, C2, D1, E6, G5, I10, I6, J1, K6, L6, L7, L2, M10, M2, N9, N4	
12EN6	A2, B7, C8, D5, E4, G3, I10, I6, J9, K10, L9, L6, L1, M10, M2, N9, N4	
12J7GT	A2, B1, B7, C5, C8, D10, E4, G3, I6, I10, J6, K8, L1, M2, M10, N4, N9	
12SR7 Triode	A7, B1, B8, C3, D2, G6, I6, I10, J7, K8, L1, M2, M10, N3, N9	
12SR7 Diode	A7, B1, B8, C3, F4, G5, K8, L4, L6, L7, M2, M10, N3, N9	Test P1 and P2 Reject below 3
13DE7 Triode 1	A4, B5, C8, D7, G6, I10, I6, J7, K10, L7, L6, L1, M10, N9, M1, N3	
13DE7 Triode 2	A4, B5, C9, D2, G1, I6, I10, J10, K9, L8, L6, L1, M10, M1, N9, N3	
17BQ6GTB	A2, B7, C8, D5, E4, G10, I8, I10, J10, K5, L1, L6, L7, M3, M9, N2, N8	
17D4	A7, B8, C3, G5, I6, I10, K5, L4, L6, L10, M4, M9, N2, N8	

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Again, without peer!...still the best super high frequency tweeter at any price...tested and top-rated again in September by laboratory reports!

REALISTIC ELECTROSTAT-3 $27.50

$2 Down

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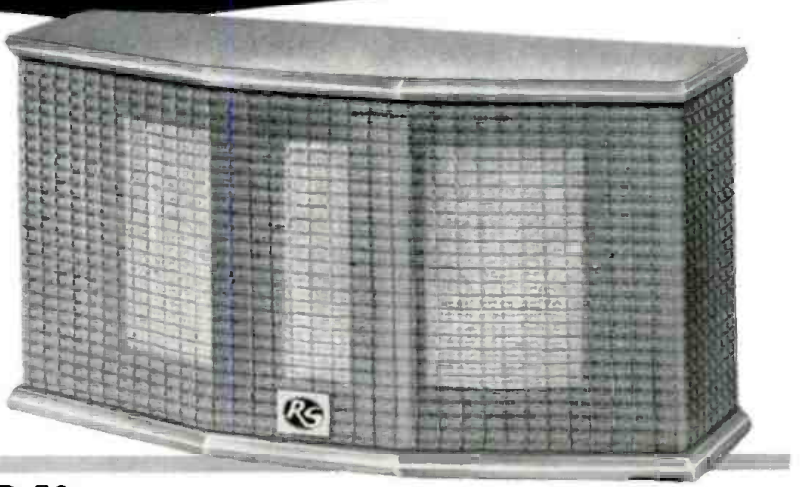
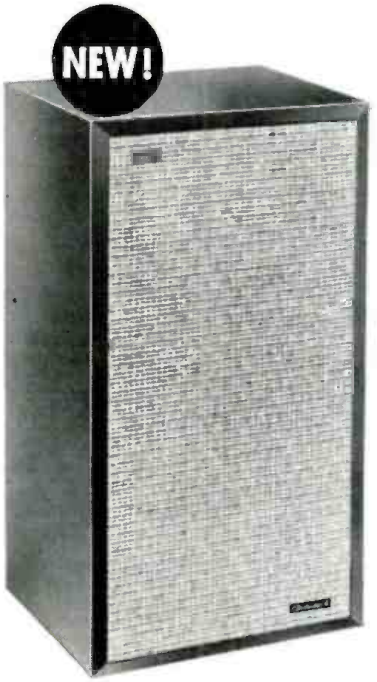


REALISTIC FULL-RANGE ELECTROSTAT-4 $119.50

$5 Down



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"Magnificence goes full-range" in a complete 3-way "pneumatic compression" speaker system built with, around and for the sensational Electrostat-3 tweeter! (With "lows" and "middles" that match the quality of those "highs"!). New Electrostat-4 features built-in Electrostat-3, new-design mid-range cone speaker, amazingly rugged high compliance woofer, self-enclosed built-in 3-way Crossover with polarizing supply and a complete set of rear panel balance controls. Completely sealed and enclosed in fine furniture-finish cabinet 24¾" x 13½" x 11" deep. Ship. wt. 41 lbs.

FREE Bargain Bulletins

1960 Electronic Guide

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$6.95

Designed for the Electrostat-3—may be used with any 8 or 16 ohm tweeter-woofer combination. 5000 cps crossover, plus built-in low frequency attenuator control for perfect tweeter-woofer balance. Screw terminals, no soldering. Ship. wt. 2 lbs.

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- ☐ Send . . . FREE Bargain Bulletins 12-months subscription FREE. Famous Radio Shack Bargain Bulletins give you first crack at hi-fi, "ham", optical, record VALUES!
- ☐ Send . . . 1960 Electronic Guide Over 40,000 items, plus articles, illustrations, etc. 312 book-size 8½ x 11 pages. Biggest, most valuable handbook ever! Only 35c.
- ☐ Send Electrostat-3 tweeter, No. 36CX017Y (mahogany) @ $27.50
- ☐ 8-ohm Crossover network, No. 91L534 @ $6.95
- ☐ 16-ohm Crossover network, No. 91L531 @ $6.95
- ☐ Electrostat-4 speaker system, No. 90LX243 (mahogany) @ $119.50
- ☐ Complete stereo system, No. 92LX195 @ $96.50

Name_____

Address_____

City_____ Zone____ State_____

☐ Check ☐ Money Order ☐ C.O.D.

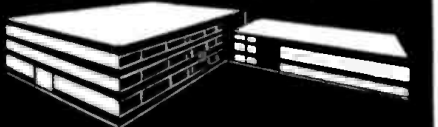
STEREO SURPRISE!

A *component* hi-fi stereo system at a price actually less than a mediocre *phonograph!* Famous imported British Monarch 4-speed intermix changer, stereo crystal cartridge with diamond stylus, new Realistic Stereo-7 amplifier, 2 Realistic Solo-I speaker systems (cabinets included!). Nothing else to buy in the system the experts now call the "stereo buy of the year"! Ship. wt. 47 lbs.

Radio Shack's Complete Stereo System . . .
the sound that fooled the experts in a recent hi-fi magazine article!

$5 DOWN $96.50

RADIO SHACK CORPORATION



167 WASHINGTON STREET, BOSTON 8, MASS.
730 COMMONWEALTH AVENUE, BOSTON 17, MASS.
230-234 CROWN STREET, NEW HAVEN 10, CONN.

Service Notes

OLYMPIC V-O TRANSFORMERS

TV chassis HA, HB, HD, HE, HF, HJ, and HH use part TR-2579 as the original vertical-output transformer. If this unit should become defective, the available, suitable replacements are transformers TR-25791, -25791-1, and -25791-2. Although these are satisfactory, differences in color coding of the leads may produce confusion unless care is taken. If the new unit is TR-25791 or -25791-1, connect the red lead to pin 1 of the vertical-output tube (6CM7); the blue lead to the filtered, boosted "B+" tie point on the terminal strip; the yellow lead to chassis ground; and the green lead to pin 7 of the yoke socket. If the replacement unit is TR-25791-2, connect the blue lead to pin 1 of the vertical-output tube (6CM7); the red lead to the filtered, boosted "B+" tie point on the terminal strip; the green lead to ground; and the yellow lead to pin 7 of the yoke socket.

MOTOROLA: INTERMITTENT PIX

If TV receivers using the TS-542 chassis exhibit an intermittent loss of video information, two specific possibilities are worth checking out before investing the time that will be required by conventional localization techniques. First try moving the channel selector knob. If this movement tends to induce the symptom, C_{22}, a .001-μf. feed-through capacitor in the tuner circuit, will probably be in need of replacement. Mechanical stress on this component produced by manipulation of the selector may cause intermittent shorting, disabling the mixer.

If the symptom does not appear to originate at the point just noted, check the ground connection on the chassis plug in which the wires from the front-panel controls are terminated. A poor ground connection here, which can be corrected by simple re-soldering, may also cause the symptom of intermittent video.

SYLVANIA: HEATER CHECKING

Although the S-110 TV chassis, widely employed throughout the *Sylvania* line, uses series-string wiring for the tube heaters, the usual problem of locating a single, burned-out heater when the entire string is extinguished has been simplified. A rapid narrowing-down of suspects can be performed before any tubes need be checked individually and without removing the chassis from the cabinet, reducing possibilities to four tubes or fewer.

First an ohmmeter is used to check the CRT heater (pins 3 and 4) directly at the CRT base. Continuity of heaters

in the tuner section may be checked next by placing the ohmmeter leads across the two filament lugs mounted on top of the tuner subchassis. To check out heaters of the 5T8, 5BR8, 5AQ5, and 12BY7, the socket on the base of the CRT is removed (Fig. 1A) and one ohmmeter lead is inserted in the hole for pin 4. The other lead is connected to circuit ground. If no discontinuity has been observed to this point, one ohmmeter lead is now moved to the tuner filament connecting pin nearest to the shaft (Fig. 1B) and the other lead is moved to the contact of the a.c. interlock shown in the illustration: included in this part of the string are the 10DE7, 12AX4, 12DQ6, filament-dropping resistor R_{300} and "on-off" switch SW_{300}. The connection shown in Fig. 1C, from the hole on the CRT socket for pin 3 to one of the tuner filament connections, will include the 3CS6, 6CG7, and all 3BZ6 i.f. tubes. If an open reading is obtained in this string of five, another step is possible. A check between one tuner filament pin (Fig. 1D) and pin 3 of the 1st video i.f., which is accessible from the top of the chassis board, will check continuity of the three 3BZ6 tubes separately. 30

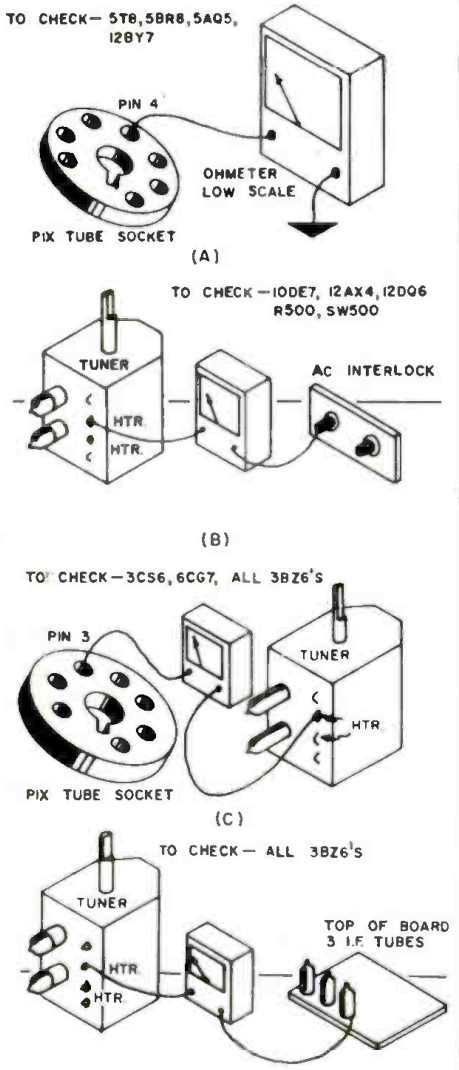


Fig. 1.

Within the Industry

(*Continued from page 32*)

Hugh Moore, *Lerco Electronics, Inc.*, representing WEMA; Robert E. Svoboda, *Amphenol-Borg Electronics Corp.*, representing EP & EM; Robert Ferree, *International Resistance Co.*, representing PACE; Norman A. Triplett, *The Triplett Electrical Instrument Co.*, representing EIA; and Sam Poncher, *Newark Electric Co.*, William Green, *Electronics Center, Inc.*, Joseph S. Forti, *Electronic Wholesalers, Inc.*, and C. T. Kierulff, *Kierulff Electronics, Inc.*, all of whom will be representing NEDA.

* * *

HEWLETT-PACKARD COMPANY has acquired all outstanding stock of **BOONTON RADIO CORP.** The firm will become a wholly owned subsidiary of the parent organization . . . Stockholders of *Howard W. Sams & Co., Inc.*, *The Waldemar Press, Inc.*, and *The Howard Company* have approved a merger of the three firms under the corporate name of **HOWARD W. SAMS & CO., INC.** . . . **MOTOROLA INC.** has acquired **THE DAHLBERG COMPANY.** The acquisition also includes the wholly owned sales subsidiary, *Dahlberg, Inc.* . . . **GONSET DIVISION.** *Young Spring & Wire Corp.*, has announced the sale of inventory, design, and manufacturing rights of its former *Link Mobile Radio Division* to the **PLATT SALES CORPORATION** . . . **ARNOUX CORPORATION** has announced the acquisition of the common stock and personnel of **INSTROL, INC.** . . . **CORNELL-DUBILIER ELECTRIC CORP.** has completed negotiations with the **TOSHIBA COMPANY** of Japan to form a new international manufacturing-distribution association to market the Far Eastern firm's transistors in the U.S.

* * *

ELECTRONIC INDUSTRIES ASSOCIATION has re-appointed J. A. Milling, president of *Howard W. Sams & Co., Inc.*, chairman of the Association's distributor relations committee.

In addition, the following were named by the EIA president, David R. Hull, as members of the committee for the fiscal year 1959-60: N. A. Triplett, co-chairman, *Triplett Electrical Instrument Co.*; E. P. Atcherley, *Sylvania Electric Products Inc.*; H. F. Bersche, *RCA*; F. J. Chamberlain, *Clarostat Manufacturing Co.*; E. Clover, *Triad Transformer Corp.*; R. D. Ferree, *International Resistance Co.*; C. Golenpaul, *Aerovox Corp.*; J. H. Hauser, *CBS Electronics*; A. N. Haas, *Bud Radio, Inc.*; E. T. Herbig, Jr., *E. F. Johnson Co.*; J. D. Hughes, *Littelfuse, Inc.*; R. S. Laird, *Ohmite Manufacturing Co.*; W. L. Larson, *Switchcraft, Inc.*; H. S. Quam, *Quam-Nichols Co.*; W. Stuart, *Belden Mfg. Co.*; R. E. Svoboda, *Amphenol-Borg Electronics Corp.*; E. Templeton, *P. R. Mallory & Co., Inc.*; J. T. Thompson, *Raytheon Co.*; and B. E. Vinkemulder, *Centralab, Div. Globe Union, Inc.* —30—

WALTER ASHE has hallicrafters NOW!

AMATEURS–WHY WAIT for "PROMISED" DELIVERY on your new Single-Sideband Equipment?

Guaranteed same day shipment of any SSB equipment on this page!

Why wait for promised delivery on equipment that may take months to hit the market . . . when Walter Ashe can make actual delivery on all Hallicrafters Single Sideband equipment. We can make shipment the same day your order reaches us!

TIME PAYMENT TERMS AVAILABLE ON ALL EQUIPMENT!

YOUR PRESENT XMITTER or RECEIVER IS WORTH BIG MONEY

Get Our "Surprise" Allowance

Tell us what you have to trade . . . any name brand equipment made since 1946 . . . and we'll rush our biggest-ever "Surprise" allowance that is sure to make you wonder how Walter Ashe can do it. Incidentally, all used equipment we sell is checked thoroughly and guaranteed to work the same as new. Whether you're trading up to new or purchasing used equipment . . . you're always money and satisfaction ahead at Walter Ashe!

Why Wait? Get on S S B With This Powerhouse Combination...NOW!

HALLICRAFTERS HT 32 A
CW-AM-SSB Transmitter
Amateur Net
$695
Shipping Weight 85 Lbs.

HALLICRAFTERS HT 33 A
LINEAR KW
Amateur Net
$795
Shipping Weight 130 Lbs.

HALLICRAFTERS S-107
All Band RECEIVER
Amateur Net
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Shipping Weight 19 Lbs.

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HALLICRAFTERS
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SX-110 RECEIVER
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Shipping Weight 36 Lbs.

NEW 1960 CATALOG READY!

Here's the "ham's own" catalog . . . compiled and designed entirely with the amateur in mind. Exclusively new mobile and fixed station equipment . . . parts and supplies . . . of interest to the amateur. Rush coupon for your copy.

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WALTER ASHE RADIO CO.
YOUR ONE-STOP SUPERMARKET
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☐ Rush New Catalog
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For_____
(Show make and model of equipment desired)

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Largest Induction Heating Project

Simulates high temperatures found in high-speed flight.

THE age of manned space vehicles may be brought closer to reality by a new radio-energized heat testing device designed by *General Electric's* Communication Products Dept. to simulate high temperatures encountered in high-speed flight. Described as the first undertaking of its scope in the world, the new electronic equipment uses r.f. induction heating principles. The equipment required is being built by *G-E* for the Air Force.

The contract involves several million dollars and provides for initial installation at the Aircraft Structures High-Temperature Laboratory maintained by the Air Force at Wright Patterson Air Force Base near Dayton, Ohio.

Designated as "Project Heat," the system will concentrate a total of 10 million watts of r.f. energy in a relatively small area of approximately 100 square feet. It is the largest induction heating project that has ever been undertaken and is the result of a decade of research in the field.

Up to now, space vehicle experiments of the Air Force have been conducted using infrared lamps, plasma jets, shock tubes, and similar equipment. The major advantage of induction heating is that it can be readily controlled and yet it can create temperature changes at an extremely high rate. The purpose of "Project Heat" is to provide valuable test data to engineers designing aircraft, missiles, and space vehicles. Similar techniques will eventually be used for a wide variety of applications by other government agencies and aircraft manufacturers.

The r.f. induction equipment for this project will be especially designed to operate compatibly with the Air Force's existing radiant heat system at Wright Field. The over-all system will consist of forty power loops with associated load-matching networks. Each is capable of inducing 250,000 watts of r.f. power into the test specimen at frequencies within the range of 200 kc. to 2 mc. The equipment has provision for future extension to 5 mc.

The over-all contract, awarded to *Helldoerfer-Castellini,* prime contractor, of Dayton, Ohio, calls for a complete system installation including 60-cycle back-up power equipment to be supplied by *G-E's* Apparatus Sales Division. Original feasibility studies were carried out by scientists at the University of Florida. The *Vitro Corporation* in New York is the architectural engineer for the facility. —30—

How to keep your profits from going to the "dogs"!

AVOID CALLBACKS DUE TO PREMATURE TUBE FAILURE...

...when you replace a defective horizontal output tube check operating cathode current.

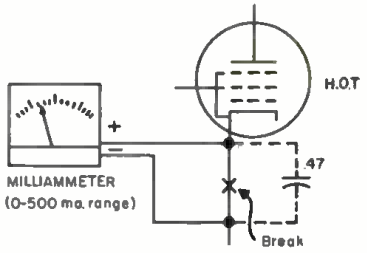
Premature horizontal output tube ("H.O.T.") failure can be caused by excessive cathode current—*higher than recommended by the manufacturer*—due to misadjustment or defective components in the horizontal output stage. Whenever you replace the "H.O.T.", protect your profits with these precautions: (1) measure "H.O.T." cathode current; (2) if excessive, find the trouble and fix it; and (3) adjust Horizontal Drive, Width, and Linearity.

Keep your hard-earned profits to yourself. Take time to check "H.O.T." cathode current. And, do as most successful service technicians do: always replace defective horizontal output tubes with *power-to-spare* RCA tubes. They pay off in fewer callbacks, finer reputation, and bigger profits.

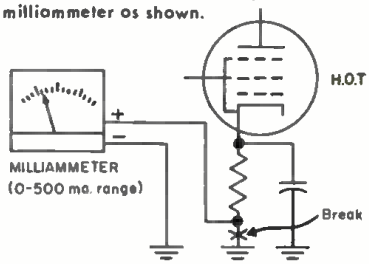
RCA-6DQ6-A—typical of RCA's excellent tube quality. Mount structure is designed to give maximum heat dissipation, prevent "hot spots" on the plate, allow cooler operation of the grids—help cut callbacks! Available at your RCA Tube Distributor.

RADIO CORPORATION OF AMERICA
Electron Tube Division *Harrison, N. J.*

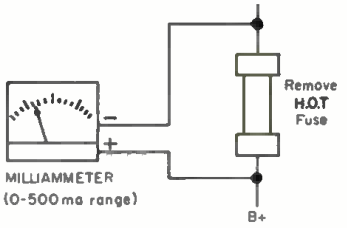
4 SIMPLE WAYS TO MEASURE "H.O.T." CURRENT



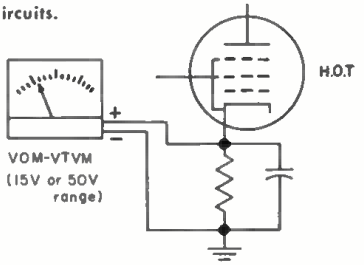
Disconnect cathode circuit of the "H.O.T." socket. Connect 0.47 μf capacitor and dc milliammeter as shown.



If "H.O.T." circuit has bypassed cathode-bias resistor, connect milliammeter as shown.



Remove "H.O.T." circuit fuse. Connect meter across fuse holder as shown. Indicated current will be slightly higher than actual cathode current because it includes boosted "B" current to vertical oscillator and/or other circuits.

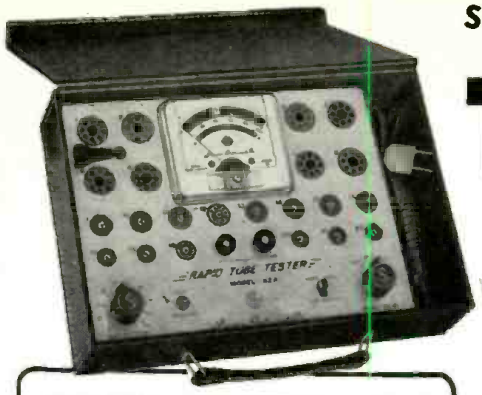


Measure dc-voltage across "H.O.T." cathode-bias resistor. Voltage should not exceed value shown in service data for the set. Compute cathode current by dividing the voltage by the resistance.

TYPICAL RCA "H.O.T." TYPES AND MAX.▲ DC CATHODE CURRENT (MILLIAMPERES)	
6AU5-GT	110
6AV5-GA	110
*6AV5-GT	110
*6BG6-G	110
6BG6-GA	110
*6BQ6-GT	110
6BQ6-GTB/6CU6	112.5
*6CB5	200
6CB5-A	220
*6CD6-G	200
6CD6-GA	200
6DQ5	285
6DQ6-A	140
12AV5-GA	110
12BQ6-GTB/12CU6	112.5
12DQ6-A	140
17BQ6-GTB	112.5
17DQ6-A	140
*19BG6-G	110
19BG6-GA	110
*25BQ6-GT	110
25BQ6-GTB/25CU6	112.5
25CD6-GA	200
25CD6-GB	200
25DN6	200

*Discontinued RCA Type—Replaced by RCA "A" or double-branded version.

▲Values shown are measured with the receiver operating at a line voltage of 117 volts, 60 cycles.



Superior's New Model 82A

Multi-Socket Type TUBE TESTER

TEST ANY TUBE IN 10 SECONDS FLAT!

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

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

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

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

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

SPECIFICATIONS

- Tests over 600 tube types • Tests OZ4 and other gas-filled tubes • Employs new 4" meter with sealed air-dampling chamber resulting in accurate vibrationless readings • Use of 22 sockets permits testing all popular tube types and prevents possible obsolescence • Dual scale meter permits testing of low current tubes • 7 and 9 pin straighteners mounted on panel • All sections of multi-element tubes tested simultaneously • Ultra-sensitive leakage test circuit will indicate leakage up to 5 megohms

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

SUPERIOR'S NEW MODEL 83

C.R.T. TESTER

TESTS and REJUVENATES ALL PICTURE TUBES

ALL BLACK AND WHITE TUBES

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

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

ALL COLOR TUBES

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

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

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

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

GENOMETER

7 Signal Generators in One!

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

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

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

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

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

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

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

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

$47.50 NET

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

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

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

EXAMINE BEFORE YOU BUY!

USE APPROVAL FORM ON NEXT PAGE

SUPERIOR'S NEW MODEL 77

VACUUM TUBE VOLTMETER

WITH NEW 6" FULL-VIEW METER

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

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

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

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

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

AS AN ELECTRONIC OHMMETER: Because of its wide range of measurement leaky capacitors show up glaringly. Because of its sensitivity and low loading, intermittents are easily found, isolated and repaired.

- ✓ Model 77 uses a selenium-rectified power supply resulting in less heat and thus reducing possibility of damage or value changes of delicate components.
- ✓ Model 77 meter is virtually burn-out proof. The sensitive 400 microampere meter is isolated from the measuring circuit by a balanced push-pull amplifier.
- ✓ Model 77 uses selected 1% zero temperature coefficient resistors as multipliers. This assures unchanging accurate readings on all ranges.

SPECIFICATIONS

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

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

$42.50 NET

SUPERIOR'S NEW MODEL 80

20,000 OHMS PER VOLT ALLMETER

Model 80 — ALLMETER . . . Total Price $42.50—Terms: $12.50 after 10 day trial, then $6.00 monthly for 5 months if satisfactory. Otherwise return, no explanation necessary!

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

- ✓ **6 INCH FULL-VIEW METER** provides large easy-to-read calibrations. No squinting or guessing when you use Model 80.
- ✓ **MIRRORED SCALE** permits fine accurate measurements where fractional readings are important.
- ✓ **CAPACITY RANGES** permit you to accurately measure *all* condensers from .00025 MFD to 30 MFD in addition to the standard volt, current, resistance and decibel ranges.
- ✓ **HANDSOME SADDLE-STITCHED CARRYING CASE** included with Model 80 Allmeter at no extra charge enables you to use this fine instrument on outside calls as well as on the bench in your shop.

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

SPECIFICATIONS:

7 D.C. VOLTAGE RANGES
(At a sensitivity of 20,000 Ohms per Volt)
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November, 1959

Violations of Citizens Radio Regulations

Off-frequency operation and improper use of the service are responsible for the FCC issuing large numbers of citations to licensees for violations.

EDITOR'S NOTE: The following material is reprinted from a recent Federal Communications Commission release. This information should be read by all who are interested in using the new Class D Citizens Radio Service.

THE Commission's monitoring stations are continuing to detect violations of the Citizens Radio Service Rules and are issuing large numbers of citations to licensees.

The violations cited fall mainly into two large groups—off-frequency operation and the use of Citizens Radio Service stations for communications which are not permissible.

It is the licensee's responsibility to see that his equipment is at all times operating in accordance with the Citizens Radio Service Rules. Off-frequency operation can be guarded against by having measurements made by a service engineer or other person who has the proper frequency-measuring equipment and the skill required to use it. The answer to the question of how often depends upon the equipment used. Some equipment may require daily checks whereas more stable equipment may not require frequency checks for six months.

Most citations for improper use result from the mistaken belief that the Citizens Radio Service (particularly the Class D Service) is similar to the Amateur Radio Service with respect to permissible communications and that amateur-type communications (such as calling "CQ," working distant stations for the fun of talking to someone that far away, and so on) are permitted. Nothing is farther from the truth.

The Citizens Radio Service was set up by the Commission on a regular basis in 1947. At that time, frequencies were made available only in the 460-470 mc. band. Later, one other frequency, 27.255 mc. was made available for control (not communications) purposes only. In September, 1958, two new groups of frequencies (one group for control purposes and the other for voice communications) were made available. However, control stations are licensed as "Class C" and voice stations as "Class D." No changes were made in the scope of permissible communications.

The new frequencies were set up in a band formerly assigned to the Amateur Radio Service in the 27-mc. region. For this reason, it seems likely that the former association of these frequencies with the Amateur Radio Service is partly responsible for the misunderstanding regarding the use of Class D stations. Some licensed amateurs have obtained Citizens Radio licenses and are continuing to operate on Class D frequencies much as they did when the frequencies were available to holders of amateur licenses. It is also apparent that many who could not or would not obtain amateur licenses have seized upon the Class D Service to carry out activities which are permissible only in the Amateur Radio Service. It seems to be these two groups who are receiving most of the violation notices being issued by the Commission's monitoring stations.

Licensees should remember that:

The Citizens Radio Service was set up to provide for the radio communications *needs* of the citizens of the United States on much the same basis as a party-line telephone, and Citizens Radio stations must be used with the same consideration of other users.

The Amateur Radio Service is available to all citizens of the United States who are interested enough to qualify themselves—and the knowledge and code skills required to obtain a Novice Class ham license are easily acquired.

Citizens Radio, properly used, is a valuable communications tool for the professional man (such as the doctor and engineer), the small businessman, and the plain citizen. Improperly used, it can be made worthless to everyone because of excessive interference.

Continued violations of the rules will result in license revocation and loss of all operating privileges.

Any Citizens Radio station may communicate with any other Citizens Radio station (except Class C) for the purpose of exchanging necessary and useful communications.

Don't put your Citizens Radio transmitter on the air unless you have a message which you need to send. —30—

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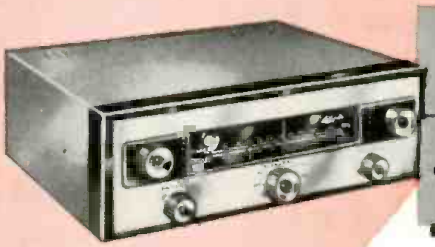

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Same as *HF-681*, but with 2-Lafayette Eliptoflex Series Bookshelf Enclosures (please specify finish.) Shpg. Wt., 143 lbs.

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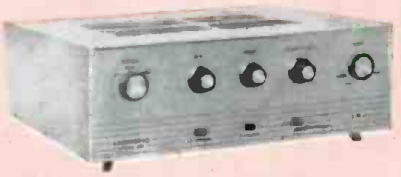

- 36 - WATTS MONAURALLY - 18 - WATTS PER CHANNEL
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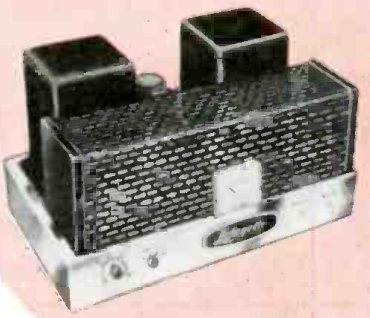

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Here's ultra-stability in a 70 watt basic power amplifier employing highest quality components conservatively rated to insure performance and long life. Features matched pair KT 88's and wire range linear Chicago output transformer, variable damping control, meter for bias and balance and gold finish chassis. Frequency response 10-100,000 cps ± 1 db. Hum and noise 90 db below full output. IM distortion less than 1½% at 70 watts, less than 0.3% below 30 watts. Harmonic distortion less than 2% at 70 watts from 20 to 20,000 cps ± 1 db. Output impedance 4, 8 and 16 ohms. Handsome decorative cage perforated for proper ventilation. Size 14½ x 10 x 7¾" including cage and knobs. Shpg wt., 40 lbs.

KT-400—In Kit Form ..... 6.95 Down ..... Net **69.50**

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Mac's Service Shop

(*Continued from page 74*)

"None that helps. He said the radio went dead when he was on vacation over East a month ago, and he took it to a shop and had it repaired. The technician told him that he had replaced the converter transistor. The set seemed to work fairly well when he was listening to strong local stations, but when he got where he knew what constituted normal reception for the little receiver, he was quickly aware that it was not working right. Of course I checked the new transistor in the transistor tester, and it checks quite good. All the voltages seem normal, and everything is quiet when I listen to the unmodulated i.f. signal from the generator feeding through from the input of the converter."

Mac studied the compact chassis of the little set for a few minutes, and then he held the point of the solder gun close to the oscillator coil until a wax seal fastening one of the two windings to the cardboard core was softened. Working very gently, he slid this winding toward the other, stopping every now and then to listen to the receiver that was tuned to a station on the low end of the band. As the coil was moved, the signal-to-noise ratio improved spectacularly. By trial and error Mac determined the best position for the coil winding, and the wax was permitted to set again.

"I got mad at those customers this afternoon because I was really mad at myself for not being able to find what was wrong with that set," Barney confessed. "Now I'm madder than ever. All the symptoms I reeled off to you so glibly pointed to low injection voltage from the local oscillator, but that possibility never crossed my mind."

"Don't be too hard on yourself," Mac consoled. "That doesn't occur very often in tube sets—or at least it doesn't occur in such a severe form as we had in this receiver; but it does happen fairly often in transistor sets when the oscillator transistor is changed. The reason is simply that transistors are not yet as uniform as tubes. So-o-o-o, when a converter-oscillator transistor is changed, it quite often is necessary to vary the coupling between the windings of the oscillator coil so as to reset the injection voltage to the optimum value."

"What gets me," Barney muttered, "is how you *know* these things. How many times have you run across this condition before?"

"This is the first time," Mac confessed blandly.

"Then how—?" Barney began.

"I read about it in an article on transistor receivers and tucked it away in a corner of my mind," Mac explained. "When you started talking about the converter being changed and demonstrating the symptoms, little wheels started to turn and came up

with the answer. Learning by experience is fine, and I'm all for it; but there's only one thing wrong with experience: it gives the examination first and the lesson afterward. Study and reading is after all simply a method of benefiting by someone else's experience, and that's why I like to see you with your nose in a book or magazine pretty often. Well, cut off the bench and the lights and let's close up shop. We've both had a hard day."

"I'm with you," Barney said with a tired sigh. "I'm going home and curl up with a good book!" -30-

Heath CB Transceiver

(*Continued from page* 60)

point but transmission was extremely good and we believe that if we had been able to extend our tests we could have increased the range considerably. Remember that our tests were made under fairly extreme conditions. If one were to operate this type of equipment in the Midwestern plains areas, for example, or between two high hills or mountains, we believe that reliable coverage up to about ten miles could be obtained. Any further extensions of reliable transmissions beyond this are most unlikely unless unusual atmospheric or sky-wave conditions prevail.

Another important point to consider is that reception drops rapidly in metropolitan areas. Large buildings and an accompanying increase in electrical interference will, of course, limit the transmission range considerably. -30-

MARS SCHEDULES FOR NOVEMBER

THE First Army MARS SSB Technical Net, which operates on 4030 kc. upper sideband, Wednesdays at 9 p.m. (EST), has announced the following speakers for November.

Nov. 4—"SSB Exciter Circuits for a New Beam Deflection Tube" by Harold Vance, K2FF, manager sales engineering, distributor products, RCA Electron Tube Division.

Nov. 11—"Modern Communications Receiver Circuitry" by Byron Goodman, W1DX, asst. technical editor, ARRL.

Nov. 18—"Tubes vs Transistors in R.F. Circuits" by Kenneth Redmond, applications engineer, Amperex Electronics Corp.

Nov. 25—"Transistorized Gadgets and Gimmicks" by Robert Gunderson, W2JIO, editor, Braille Technical Press.

* * *

THE Long Island Section of the IRE is conducting an experiment in cooperation with local high schools making available to them the experience of members of local industry. The MARS Eastern Technical Net, in conjunction with this program, is presenting a series of eight radio talks on successive Sunday afternoons which can be heard from 2 to 4 p.m. (EST) on 7540 kc. and 13,715 kc.

This series began in October and the November schedule will include such topics as elements of radar, guided missiles and propulsion systems, elementary particles, applications of the atom, and semiconductors. -30-

Subdivided Speaker Enclosure

(*Continued from page* 59)

pound bottle of $CaCl_2 6H_2O$ should be enough, as only about half would be required. *Kodak* "Print Flattening Solution," used straight, would be an ideal substitute for the calcium chloride solution.

No matter which solution you pick, apply it with an acid brush or a paint brush. In the case of the calcium chloride solution, re-apply after about ten hours.

Because of the unique internal construction of the enclosure there is a need for a new method of speaker mounting and the final finishing of the complete enclosure. This can be accomplished by having the grille cloth removable instead of the back panel. All units built to date have been made of ¾-inch plywood, as this adds to the weight and rigidity. The enclosure can be made from a single 4 x 8 foot sheet and most lumber yards will make the cuts if the buyer doesn't have the equipment. The four pieces, 8 x 56 inches, must be within 1/16-inch on the 8" cuts, as these make up the top, bottom, sides, and partitions.

The entire enclosure is assembled using No. 5 flat-head woodscrews, 1½-inches long. White glue is used throughout to provide a good air-tight seal. The top, sides, and bottom are first assembled, followed by the back, partitions, and tweeter box. Wiring is completed next and then the front is secured in place.

The acoustic material is ordinary rug padding and is placed across two chambers on each side of the speaker as shown in the photograph. The 12-inch speaker is mounted in place with 10-24 "Tee-Nuts" (available at hardware stores) and round-head machine screws, one-inch long. If woodscrews are used they should be ¾-inch, No. 8 round-head. The tweeter is mounted with No. 6 round-head woodscrews, ¾-inch long. Both speakers are sealed with "Mortite," available at local hardware stores in four-ounce packages as shown in one of the photographs. Be careful, when tightening the screws, not to damage the cone or warp the chassis.

The most practical method of finishing the enclosure is to use grille cloth to cover both sides as well as the front. This reduces the total surface of finished wood to a minimum. The cloth is stretched around the cabinet and secured in place with wood strips and wire nails.

Testing the Enclosure

It is quite obvious that the final test of a speaker system is by objective listening and this is something that cannot be put into words, due to the many variables. This leads to a need for visual information, hence, the frequency response and impedance curves shown in Fig. 2.

The frequency response curves were taken in an average living room, using the procedure described by G. A. Briggs[2] and devised by Shorter.[1] The microphone was placed on the axis of the 12-inch unit at a distance of one foot and the system then covered with sound absorbing material to reduce room effects. Heavy wool blankets were used as the damping material and room effects were reduced sufficiently to provide a good compromise between an anechoic chamber and a live listening room. Response curves taken by Shorter in the arrangement described were within 2 db below 1000 cps and within 1 db above 1000 cps of curves taken outside in free-field conditions. For response curves above 1000 cps, the microphone was moved back to three feet so as to include the output of both speakers.

The curves were plotted just as they appeared in the form of voltage changes converted to decibels, and peaks and dips were not altered in any way. This gives a representation of the acoustic output from 40 to 15,000 cps. Since the ear cannot detect narrow peaks or dips these can be ignored for all practical purposes, giving a much smoother over-all curve.

The two speakers are of different impedance, the woofer being 8 ohms and the tweeter 16 ohms. This difference helps give a smoother impedance curve (Fig. 2B), resulting in a better frequency response curve.

The transient response is very good, due to the absence of panel resonance and the use of an amplifier with a high damping factor. In order to realize the maximum performance of the system, it should be used with an amplifier having a damping factor of 5 or more. Most amplifiers using triodes or beam power tubes with feedback would be acceptable.

Since the methods of determining the efficiency of a speaker system are somewhat ambiguous, little will be mentioned here. This system is more efficient than most infinite baffle and reflex systems. It is safe to say that a 10-watt amplifier would be adequate for home use as only 50 to 80 milliwatts are required to provide a level of about 80 db (0 db = .002 dyne/cm²).

The results obtained certainly qualify this speaker system as a "high-fidelity" unit. Considering the initial cost, it is an excellent basic unit and two of them will make a fine stereo speaker setup.

In keeping with the wishes of the *British Broadcasting Corporation*, which has given the author permission to make use of its patent specifications, we wish to state that they are in no way connected with this specific design.

REFERENCES

1. Shorter, D. E. L.: "Sidelights on Loudspeaker Cabinet Design," Wireless World, November 1950.

2. Briggs, G. A.: "All About Audio and Hi-Fi—Testing Loudspeakers" (Part 4), RADIO & TV NEWS, *August 1957.*

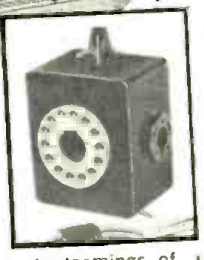
—30—

SHIPPED ON APPROVAL

NEW

CRT TESTER-REACTIVATOR Model CRT-2

Housed in hand-rubbed oak carrying case — completed with MULTI-HEAD*



NOW . . . a TESTER-REACTIVATOR really designed to test, repair and reactivate EVERY PICTURE TUBE MADE — whether black and white or color . . . with exclusive features never before found in picture tube testers.

Model CRT-2 $57.50 Net

TERMS: $13.50 within 10 days. Balance $11 monthly for 4 months.

The CRT-2 steps in and solves the limitations and shortcomings of present day CRT Testers. Unlike ordinary CRT testers that keep entering the field with a limited range of operation, the CRT-2 employs a new brilliantly engineered circuit designed to test, repair and reactivate every black and white or color picture tube made. The CRT-2 eliminates the guesswork and risk that until now, has always been present when a picture tube is reactivated. It accomplishes this by providing perfect control of either the 'Boost' or 'Shot' method of reactivation.

THE CRT-2 DOES ALL THIS RIGHT IN THE CARTON, OUT OF THE CARTON OR IN THE SET

TEST
- ✓ for quality of every black and white and color picture tube
- ✓ for all inter-element shorts and leakage up to one megohm
- ✓ for life expectancy

REPAIR
- ✓ Will clear inter-element shorts and leakage
- ✓ Will weld opens between any two elements in the tube gun

REACTIVATE
- ✓ The unique controlled 'SHOT' (high voltage pulse) method of reactivation provided by the CRT-2 will restore picture tubes to new life in instances where it was not possible before. Furthermore the high voltage is applied without danger of stripping the cathode as you always have perfect control of the high voltage pulse.
- ✓ The 'BOOST' method of reactivation also provided by the CRT-2 is used effectively on tubes with a superficially good picture but with poor emission and short life expectancy. It will improve definition, contrast and focus greatly and add longer life to the picture tube.

1. THE MULTI-HEAD (patent pending) . . . A SINGLE PLUG IN CABLE AND UNIQUE TEST HEAD — A tremendous advance over the maize of cable and adapters generally found with other testers. Enables you to test, repair and reactivate every type of picture tube with greater convenience than ever before . . . 50 degree to 110 degree types from 8" to 30", whether 12 pin base, 8 pin base, 14 pin base . . . even the very latest 7 pin base. A special color switch on the MULTI-HEAD enables you to test, repair and reactivate each of the red, green and blue color guns separately.
2. WATCH IT REACTIVATE THE PICTURE TUBE — You actually see and control the reactivation directly on the meter as it takes place, allowing you for the first time to properly control the reactivation voltage. This eliminates the danger of stripping the cathode of the oxide coating. It enables you to see the speed of reactivation and whether the build-up is lasting. You will see if the cathode contamination is too great and if the picture tube is too far gone to be reactivated.
3. CONTROLLED "SHOT" WITH HIGHER VOLTAGE FOR BETTER REACTIVATION — Stronger than any found in other testers . . . high enough to really do the job — yet controlled to avoid damage to the picture tube.
4. UNIQUE HIGH VOLTAGE PULSE CIRCUIT — Will burn out inter-element shorts and weld open circuits with complete safety to the picture tube.
5. VISUAL LIFE TEST — Enables both you and your customer to see the life-expectancy of any picture tube right on the meter. The fact that your customer can see the results of your tests as you make them virtually eliminates resistance to picture tube replacement when necessary.
6. TESTS, REPAIRS AND REACTIVATES SPECIAL LOW SCREEN VOLTAGE TUBES — Many new type picture tubes use special low voltage of approximately 50 volts. The CRT-2 will test, repair and reactivate these types with the same thoroughness as the regular types with complete safety.
7. SEPARATE FILAMENT VOLTAGES — Including the very latest 2.35 volt and 8.4 volt types as well as the older 6.3 volt types.
8. TESTS, REPAIRS AND REACTIVATES 'SF' PICTURE TUBES — found in the newest Sylvania and Philco TV sets. These picture tubes have different base pin connections than standard picture tubes and there is always an element of risk that the tube may be burned out when tested with ordinary picture tube testers. The CRT-2 is designed to accommodate this new base pin arrangement and will test the tube with no danger of damage.

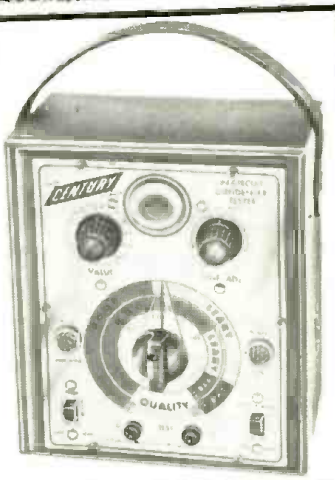
ADDITIONAL FEATURES

• Employs the time proven dynamic cathode emission test principle • Large 4½" meter with heavily damped movement for smooth action, accuracy and long life • Provides separate shorts test for each element in the picture tube • Filament continuity is shown on a separate glow indicator • An easy to read instruction manual contains all the latest testing information on old and new type picture tubes • Housed in handsome hand-rubbed oak carrying case with special compartment for MULTI-HEAD and line cord.

* patent pending

IN-CIRCUIT CONDENSER TESTER Model CT-1

Here is an IN-CIRCUIT CONDENSER that DOES THE WHOLE JOB! The CT-1 actually steps in and takes over where all other in-circuit condenser fail. The ingenious application of a dual bridge principle gives the CT-1 a tremendous range of operation . . . and makes it an absolute 'must' for every serviceman.



in-circuit checks:
- ✓ Quality of condensers even with circuit shunt resistance . . . (This includes leakage, shorts, opens, intermittents)
- ✓ Value of all condensers from 200 mmfd. to .5 mfd.
- ✓ Quality of all electrolytic condensers (the ability to hold a charge)
- ✓ Transformer, socket and wiring leakage capacity

out-of-circuit checks:
- ✓ Quality of condensers . . . (This includes leakage, shorts, opens and intermittents)
- ✓ Value of all condensers from 50 mmfd. to .5 mfd.
- ✓ Quality of all electrolytic condensers (the ability to hold a charge)
- ✓ High resistance leakage up to 300 megohms
- ✓ New or unknown condensers . . . transformer, socket, component and wiring leakage capacity

OUTSTANDING FEATURES

- Ultra-sensitive 2 tube drift-free circuitry
- Multi-color direct scale readings for both quality and value . . . in-circuit or out-of-circuit
- Simultaneous readings of circuit capacity and circuit resistance
- Built-in hi-leakage indicator sensitive to over 300 megohms
- Cannot damage circuit components
- Electronic eye balance indicator for every greater accuracy
- Isolated power line
- Housed in sturdy hammertone finish steel case . . . comes complete with test leads

Model CT-1 $34.50 Net

TERMS: $9.50 within 10 days. Balance $5 monthly for 5 months.

EASY TO BUY IF SATISFIED – *see order form on facing page*

FOR 10 DAY *FREE* TRIAL

Convince yourself at no risk that CENTURY instruments are indispensable in your every day work. Send for instruments of your choice without obligation . . . try them for 10 days before your buy . . . only then, when satisfied, pay in easy-to-buy monthly installments — without any financing or carrying charges added.

NOW a Battery Operated Peak-to-Peak VACUUM TUBE VOLT METER Model VT-1

WITH LARGE EASY-TO-READ 6" METER —

featuring the sensational new MULTI-PROBE * Patent Pending

No extra probes to buy! The versatile MULTI-PROBE does the work of 4 probes

❶ DC Probe ❷ AC-Ohms Probe ❸ Lo-Cap Probe ❹ RF Probe

The VT-1 is a tremendous achievement in test equipment. With its unique MULTI-PROBE it will do all the jobs a V.T.V.M. should do without the expense of buying additional probes. No longer do you have to cart around a maize of entangled cables, lose time alternating cables or hunting for a misplaced probe. With just a twist of the MULTI-PROBE tip you can set it to do any one of many time-saving jobs. A special holder on side of case keeps MULTI-PROBE firmly in place ready for use.

Housed in hammertone steel-case — complete with MULTI-PROBE

FUNCTIONS

DC VOLTMETER . . . Will measure D.C. down to 1.5 volts full scale with minimum circuit loading, and give accurate readings of scale divisions as low as .025 volts . . . Will measure low AGC and oscillator bias voltages from .1 volts or less up to 1500 volts with consistent laboratory accuracy on all ranges . . . Zero center provided for all balancing measurements such as discriminator, ratio detector alignment and hi-fi amplifier balancing.

AC VOLTMETER . . . True Peak-to-Peak measurements as low as 3 volts of any wave form including TV sync, deflection voltages, video pulses, distortion in hi-fi amplifiers, AGC and color TV gating pulses . . . Scale divisions are easily read down to .1 volts . . . Measures RMS at 1/20th the circuit loading of a V.O.M. . . . Unlike most other V.T.V.M.'s there is no loss in accuracy on the lowest AC range.

ELECTRONIC OHMETER . . . Measures from 0 to 1000 megohms . . . Scale divisions are easily read down to .2 ohms . . . Will measure resistance values from .2 ohms to one billion ohms . . . Will detect high resistance leakage in electrolytic and by-pass condensers.

RF and LO-CAP MEASUREMENTS . . . With these extra VT-1 functions you can measure voltages in extremely high-impedance circuits such as sync and AGC pulses, driving saw tooth voltages, color TV gating pulses, mixer output levels, I.F. stage-by-stage gain and detector inputs.

OUTSTANDING FEATURES

• Completely portable — self powered with long life batteries — permits use everywhere • New advanced pentode amplifier circuit assures amazingly low battery drain • Large 6" 100-microampere meter, many times more sensitive than meters used in most V.T.V.M.'s • Laboratory accuracy performance — 2% of full scale on DC, 5% of full scale on AC • Simplified multi-color easy-to-read 4-scale meter • No heat operation assures rigid stability and accuracy • Immune to power line fluctuations • Amplifier rectifier circuit with frequency compensated attenator — a feature found only in costly laboratory instruments • Meter completely isolated — practically burn-out proof • Hand-crafted circuitry eliminates the service headaches of printed circuitry • 1% resistors used for permanent accuracy • Separate RF ground return for low-loss RF measurement • Microphone type co-axial connector • Matching cover protects instrument face — snaps on and off instantly.

SPECIFICATIONS

- DC Volts — 0 to 1.5/6/30/150/300/600/1500 volts
- AC Volts (RMS and Peak-to-Peak) — 0 to 3/12/60/300/1200 volts
- Ohms — 0 to a billion ohms, 10 ohms center scale — Rx1/10/100/1K/10K/100K/1M
- RF — Peak reading demodulator supplied for use on all DC ranges
- Zero Center — available on all DC volt ranges with zero at mid-scale
- Decibels — from —10 Db to +10, 22, 36/50, 62 based on the Dbm unit: ODb-1MW in 600 ohms
- Impedance — 11 megohms DC, 1 megohm AC, 10 megohms Lo-Cap
- Input Capacity — 130 mmfd. RMS, 250 mmfd. Peak-to-Peak, 25 mmfd. Lo-Cap

Model VT-1 $58.50 Net

TERMS: $14.50 within 10 days. Balance $11 monthly for 4 months.

FAST-CHECK TUBE TESTER Model FC-2

Simply set two controls . . . insert tube . . . and press quality button to test any of over 700 tube types completely, accurately . . . IN JUST SECONDS!

Over 20,000 servicemen are now using the FAST-CHECK in their every day work and are cutting servicing time way down, eliminating unprofitable call-backs and increasing their dollar earnings by selling more tubes with very little effort. See for yourself at no risk why so many servicemen chose the FAST-CHECK above all other tube testers.

Housed in hand-rubbed oak carrying case complete with CRT adapter

PICTURE TUBE TEST ADAPTER INCLUDED WITH FAST-CHECK

Enables you to check all picture tubes (including the new short-neck 110 degree type) for cathode emission, shorts and life expectancy . . . also to rejuvenate weak picture tubes.

RANGE OF OPERATION

- ✔ Checks quality of over 700 tubes types, employing the time proven dynamic cathode emission test. This covers more than 99% of all tubes in use today, including the newest series-string TV tubes, auto 12 plate-volt tubes. 024s, magic eye tubes, gas regulators, special purpose hi-fi tubes and even foreign tubes.
- ✔ Checks for inter-element shorts and leakage.
- ✔ Checks for gas content.
- ✔ Checks for life-expectancy.

SPECIFICATIONS

• No time consuming multiple switching . . . only two settings are required instead of banks of switches on conventional testers • No annoying roll chart checking . . . tube chart listing over 700 tube types is located inside cover. New listings are added without costly roll chart replacement • Checks each section of multi-section tubes and if only one section is defective the tube will read "Bad" on the meter scale • 41 phosphor bronze beryllium tube sockets never need replacement • 7-pin and 9-pin straighteners mounted on panel • Large 4½" D'Arsonval type meter is the most sensitive available, yet rugged — fully protected against accidental burn-out • Special scale on meter for low current tubes • Compensation for line voltage variation • 12 filament positions • Separate gas and short jewel indicators • Line isolated — no shock hazards • Long lasting etched aluminum panel.

NOTE: The Fast-Check positively cannot become obsolete . . . circuitry is engineered to accommodate all future tube types as they come out. New tube listings are furnished periodically at no cost.

Model FC-2 $69.50 Net

TERMS: $14.50 within 10 days. Balance $11 monthly for 5 months.

CONVENIENT TIME PAYMENT PLAN — NO FINANCING CHARGES

ALL CENTURY INSTRUMENTS ARE GUARANTEED FOR ONE FULL YEAR

The extremely low prices are made possible because you are buying direct from the manufacturer.

CENTURY ELECTRONICS CO., INC.

CHECK INSTRUMENTS DESIRED

- ☐ Model CRT-2 CRT TESTER REACTIVATOR ..... $57.50 — $13.50 within 10 days. Balance $11 monthly for 4 months.
- ☐ Model CT-1 In-Circuit Condenser Tester ..... $34.50 — $9.50 within 10 days. Balance $5 monthly for 5 months.
- ☐ Model VT-1 Battery Vacuum Tube Volt Meter ..... $58.50 — $14.50 within 10 days. Balance $11 monthly for 4 months.
- ☐ Model FC-2 Fast-Check Tube Tester ..... $69.50 — $14.50 within 10 days. Balance $11 monthly for 5 months.

Prices Net F.O.B. Mineola, N. Y.

111 Roosevelt Avenue, Dept. 211, Mineola, New York

Please rush the instruments checked for a 10 day free trial. If satisfied I agree to pay the down payment within 10 days and the monthly installments as shown. If not completely satisfied I will return the instruments within 10 days and there is no further obligation. It is understood there will be NO INTEREST or FINANCING charges added.

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City ..... State .....

Mobile Receivers: Alignment & Service

By JACK DARR

Practical procedures and specific tips to help the technician with unfamiliar components and steps.

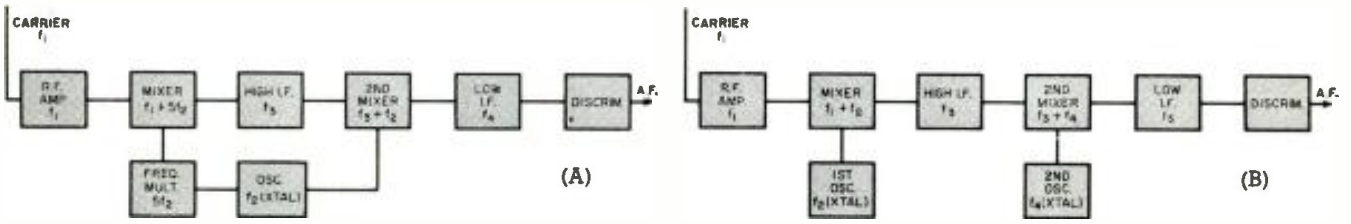


Fig. 1. Double superhet communications sets use either a frequency multiplier (A) or two separate oscillators (B).

NINETY-NINE per-cent of the mobile radio-communications equipment in use today employs frequency modulation. Greater relative freedom from noise and simplification of transmitter design are just two of the reasons for this preference. The receiver, a vital link in the system, must be kept at peak condition at all times. This becomes even more necessary with the new split-channel systems, where misalignment may seriously affect operation.

For the most part, earlier receivers and systems used a maximum allowable bandwidth of 40 kc., referred to as "40F3 emission." New standards that began in February, 1959 and will be in use on all bands by February, 1963 allow only ±5-kc. deviation (20F3 emission) to increase utilization of limited spectrum space. This sharpens the need for exact alignment procedures and precise equipment. A relatively slight degree of misalignment in a wide-band set of the past, which would be scarcely noticeable, may render a split-channel set virtually useless.

Receiver Circuits

Practically all commercial receivers use the same circuitry despite inevitable variations among manufacturers. This is a dual-conversion superheterodyne: the transmitted r.f. signal is picked up, beat against a local oscillator, and the resultant i.f. (known as the high i.f.) is amplified and beat against a second oscillator, resulting in the production of the low i.f. The latter is converted to audio by a discriminator circuit and amplified. Both oscillators will be crystal-controlled for stability. Frequency tolerance of split-channel sets is much smaller: in the 25-50 mc. band, instead of the old .01% tolerance, we have only .002%. Above this, in the 150-174 mc. and 450-570 mc. bands, instead of .005%, we have only .0005%!

Fig. 1 shows the two ways in which double-heterodyning is achieved: older production sets often used a single crystal oscillator for both stages, employing the oscillator fundamental to produce the low i.f. and a harmonic to produce the high i.f. as in Fig. 1A. Modern sets tend to use two separate crystal oscillators (Fig. 1B). The trend is toward the use of a standard frequency for the second oscillator that will be the same in all sets. *Motorola*, for example, uses a 455-kc. second i.f. and the second oscillator crystal is always 5955 kc. The first oscillator crystal is the only variable in the system, and is chosen so as to be always 5.5 mc. above the carrier frequency. This allows the use of a fixed high i.f. strip at 5.5 mc. In some of the older models, the high i.f. stages vary. Transformers were made in three "sets"; the same basic coils were used with different resonating capacitors.

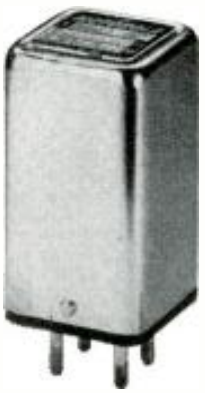


Fig. 2. Crystal in a temperature-controlled holder prevents frequency drift.

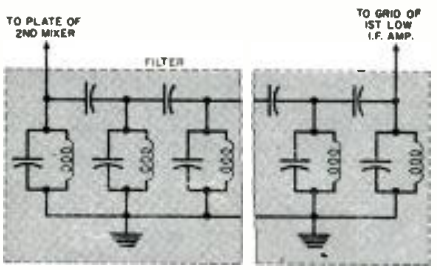
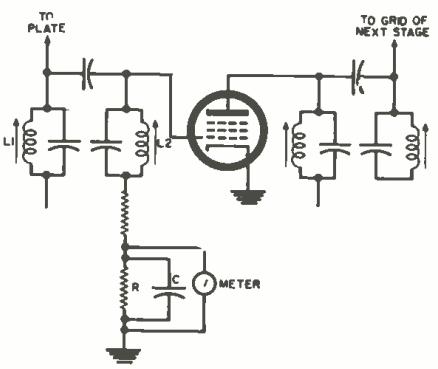


Fig. 3. Potted bandpass filter consists of a series of fixed-tuned i.f. tanks.

Fig. 4. One way of metering a stage's grid current for alignment purposes.



The low i.f. crystals work on their fundamentals. Most of the higher-frequency oscillators work on a harmonic of the crystal employed to allow the use of thicker crystals for greater stability. First crystals are mounted in heated holders, as shown in Fig. 2, with built-in thermostats, to insure constant temperature. This also insures stability. While some of the older sets used heated crystal holders, even these must be changed to better ones meeting the new standards.

Selectivity

A radio-frequency stage working in the v.h.f. bands, from 25 to 50 mc., has inherently rather broad tuning when compared to the desired bandwidth limits. Even the use of resonant cavities found in some high-band (150-170 mc.) sets leaves the r.f. amplifier with much to be desired. Most of the actual selectivity is accomplished in the design of the low i.f. stages, where special, fixed-tuned, bandpass filters (Fig. 3) follow the second mixer.

Functionally, these filters do a job similar to that of the crystal filters found in some communications receivers used by hams and short-wave listeners. The bandpass filters consist of a large number of resonant circuits, in series, permanently tuned to the low i.f., and permanently potted. They are designed with varying characteristics: older sets use filters with a ±15-kc. bandpass while split-channel models have only a ±5-kc. bandpass, but the curve has steep sides in either case to eliminate undesired signals and noise.

Alignment adjustments on most sets are inductive, using coils with adjustable slugs. In the past, some set makers sealed the tuning adjustments, but

most of the newer models leave them unsealed.

All of the commercial receivers seen by the writer so far, following the low i.f., use the Foster-Seeley discriminator circuit for audio detection. Most use dual, cascaded limiter stages preceding the discriminator.

Output Indicators

In any alignment procedure, some method of indicating when maximum output is reached is needed. In these FM receivers, the old, faithful "output meter across the speaker" is not recommended because of the presence of the limiters. Some other method must be used. Most receiver manufacturers have thoughtfully provided a built-in alignment indication system, although minor variations are found among different makes.

In FM receivers, the i.f. amplifier stages are operated very near to class C: each tube is driven into grid-current conduction, especially on large signals. The amplitude of each stage's grid current is directly proportional to the applied signal voltage, with the exception of the limiters, of course, which will saturate at certain levels.

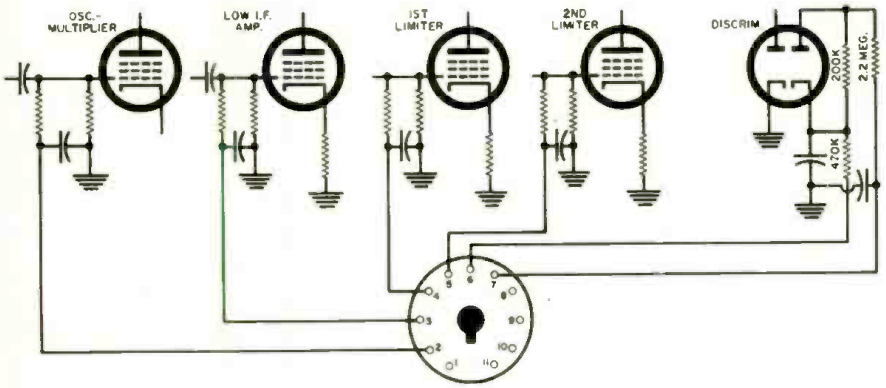


Fig. 5. Typical metering network for mobile receiver. Manufacturers may bring out test points to single multiple socket or separate pin jacks.

Thus, by setting up "metering points" in the grid return circuit of a stage, the amount of current can be read on a sensitive meter, as shown in Fig. 4. A "metering resistor" (R) is inserted in the grid circuit, bypassed for r.f. (by C), and the indicating meter connected across the resistor.

A v.t.v.m. on a low scale may be used, or a 0-50 microammeter, which then functions as a millivoltmeter, reading the voltage drop across resistor R. Thus, this connection may be used as an indication of the state of alignment of coils L_1 and L_2. Note the interstage coupling capacitors shown: these are quite common, especially in the high i.f. stages. The coils are often mounted in separate cans with *no* inductive coupling between primary and secondary.

Fig. 5 shows one typical metering circuit for a complete receiver (used by *Motorola*). All metering points are brought to a special metering socket on the chassis. In this case, a special test instrument made by the set maker (Fig. 6) should be used. The 11-prong plug is inserted in the metering socket of the receiver. Then each stage can be checked by means of a selector switch on the tester. Other measurements (not shown in Fig. 5) are provided on the tester, such as relay voltage and "B+."

There are three connections for the actual "peaking" of the i.f. stages: the low i.f. grid and the first and second limiters. The high i.f. may be aligned by metering the low i.f. grid current, while the low i.f. section is aligned by measuring the grid current of the first limiter. Two additional points are provided, as seen in Fig. 5, for properly aligning the discriminator: connected to pins 6 and 7 of the test socket, they are used for aligning the primary and secondary of the discriminator.

Other manufacturers use the same setup, with variations. Some use individual test-pin jacks on the chassis, and the meter is plugged into each in turn. Some of the older receivers included the test selector switch in the receiver itself, with only a single pair of jacks for the meter.

Bench Setup

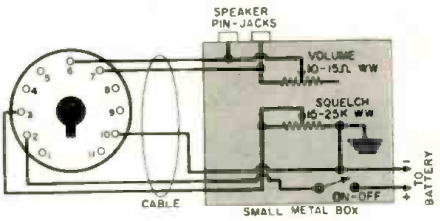
Vehicular 2-way sets are remotely controlled with the exception of the smaller units, which are mounted under the vehicle's dash with the controls on the front panel of the cabinet. The majority, however, are "trunk-mount" types, which use remote-control heads on the dash. Therefore, for bench testing, a substitute control head must be provided.

This is not too difficult: all that is needed is one of the special plugs used for interconnection on the particular set, and substitutes for the regular controls: volume and squelch. These, together with a switch, speaker, and the cabling, make up a control head (Fig. 7) that will operate the set on the bench. Such a unit might even be built into the bench panel. Volume-control circuits are nearly standardized, most being grid-circuit controls, with a few sets using low-value pads across the speaker itself, which the pot shown in Fig. 7 was intended to replace. Squelch controls will run from 15,000 to 25,000 ohms: as most of the sets work "in the center" of this range, a single 25,000-ohm wirewound control might be used for all or most of them. The details of the dummy control head for any shop will depend on the receivers most often encountered.

For a bench power supply, the writer prefers storage batteries with a small trickle-charger (4 amperes) because of the superior regulation and freedom from hum. In the older 6-volt sets, the power supply is called upon to provide up to 40 amperes intermittent drain for the transmitters: a power supply large enough to maintain regulation under such conditions would be very expensive. The only drawback to the use of batteries is the need for weekly water-level checking. Batteries under continuous charge, even though it is small, require an amazing amount of water! However, the benefits offered by this power-supply arrangement are well worth the chore.

Fig. 6. Motorola test set plugs into this maker's receivers for quick checks.

Fig. 7. One type of dummy control head to operate receiver on the bench.



Alignment Equipment

Actually the receiver sections of these communications sets should almost never need alignment. However, there is an unfortunate habit prevalent among many technicians to "play" with i.f. adjustments with very little provocation. As a result, the need for a complete bench re-alignment comes up every now and then. This requires a stable signal generator covering the range from 455 kc. up to at least 30 mc. For receiver alignment (as distinguished from transmitter alignment) there are many good, standard generators that will serve. As we shall see, accuracy of dial calibration is not as important as stability. Also, the generator does not have to provide the carrier frequency: work with the latter

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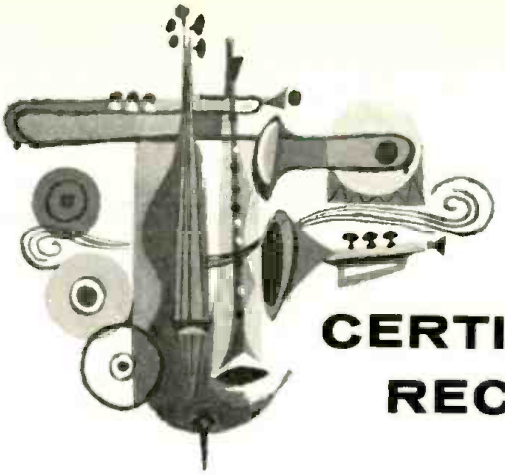

By
BERT WHYTE

CERTIFIED RECORD REVUE

BY the time you read this, the New York High Fidelity Show will be over and the new audio season officially launched. As in former years, I will try to bring you up to date on the newest developments, but publishing being what it is, my report will have to wait until next issue.

One thing I hope to find at the Show are some innovations in turntable design. It is pretty well known that the advent of the stereo disc created some formidable problems of turntable rumble. There is a vertical component of rumble that was present in some turntables of the pre-stereo era, and even though the 45-45 stereo disc system was designed to eliminate some of the problems inherent in a strictly vertical/lateral stereo groove, there is also a small vertical sensitive component in the 45-45 system. Now with many of the present-day smaller speaker systems which lack really low bass response, this rumble is no problem. But if one is using a pair of king-sized speakers that have very extended low-frequency response, this newly compounded rumble is causing a lot of grief.

There have been some design changes in turntables which were initiated to overcome the vertical rumble and some of them were very clever and fairly effective. But, if you are like me, that is, an absolute crank about any spurious noise such as hum and rumble, you would feel that there is still some residual rumble which is at a sufficient level to be obtrusive and annoying.

How much farther in practical terms . . . as regards cost, etc. . . . the manufacturers can go in reducing rumble in their turntables, is hard to say. Of course there is always the possibility of some laboratory genius coming up with a cheap and clever answer to the whole problem—which is what makes an audio show such a fascinating place—where hope is always burning in the *afficionado's* breast.

But, barring this, there are several things one can do to get rid of that nasty rumble. I've mentioned these ideas before, but it has been many years and long before the stereo disc. I freely confess these may not be the most elegant solutions to the problem . . . but they do *work*. The principal idea of rumble reduction here is to use a turntable mounting board of great mass and, preferably, high density. The resonant frequency of such a mounting is so low that even the finest cartridges with the very lowest frequency response will not reproduce this frequency.

There is a lot of work and a fair amount of money involved in this, but here goes . . . Among the best materials to use are steel plate, such as boiler plate, in thicknesses ranging from one-half to one inch; granite of good density from ¾- to 1½-inch thick; marble from 1- to 2-inches thick; and, as a last and least satisfactory resort, plywood, cemented by casein or other suitable strong adhesive from 1½- to 2-inches thick.

All of these mounting plates must be cut for the particular turntable and arm to be used. I need not tell you that this is no simple deal with steel, granite, etc. Generally, the work will be beyond the facilities and skills available at home and had best be left in the hands of experts. Once cut, the plates must be contained in a heavy frame or shell, usually constructed of at least ¾-inch ply. One other thing is advisable, and that is to have a square cut out of the plate at approximately the pivot point of most generally used arms. The cut square is then replaced by heavy plywood which can be bolted rigidly to the plate. The reason for this is that turntables don't change too much over a fairly long period of time and one of the top-quality units should provide good service for years. On the other hand, arm and pickup design change fairly frequently and if you have a hankering to try out the newest designs as they come along, then with the removable pivot block you can always replace the old arm and put in the new without the necessity for drilling all sorts of holes.

As a matter of fact, this is something I would like to see on commercial mounting boards and, if memory serves me, I think the *Thorens* people have some sort of similar scheme and at one time I believe *H. H. Scott* instruments had this facility.

Well, there you have it . . . it is a lot of trouble all right, but if you want noiseless backgrounds for your music, this is the only alternative I know of at the present time. As I said . . . maybe some genius at the Show will have it all worked out for us . . . we'll see.

WAGNER

DAS RHEINGOLD (Complete Opera) Kirsten Flagstad, George London, Jean Madeira, Set Svanholm, and other soloists with Vienna Philharmonic Orchestra conducted by Georg Solti. London Stereo OSA1309. Three discs. Price $17.85.

The only word for this recording is the much over-worked "monumental." It is simply staggering in its impact! This is a new point of departure in opera recording and will, in the future, be regarded as an important milestone in the art of stereo.

Take an absolutely superb cast, such as the seemingly ageless Flagstad as Fricka, George London as Wotan, Jean Madeira as Erda, Set Svanholm as Loge, and Gustav Neidlinger as the evil Alberich, add the tremendously vital and penetrating performance of Georg Solti, and the Wagnerian virtuosity of the Philharmonic, and then enrobe all in a stereo record-

ing of such scope and depth as to be almost frightening in its realism—and you have a brief idea of what is in store for the listener!

One could rave on about every aspect of this recording. As in most of its other opera recordings, *London* has not chosen to keep the stage action static . . . here, as never before, is the feeling of participating in an actual performance as the characters are so artfully deployed. Not only is this in terms of lateral positioning but in the superb realization of depth. The balance between voices and orchestra is such that nothing is lost nor inarticulate.

The over-all sound quality and the "special effects" beggar description. Frequency and dynamic range are tremendously wide. There is no discernible transient distortion and if you take pride in your system for its transient response, wait until you turn loose the sound of 18 tuned anvils, thunder sheets, and bass drum and tympani blasts galore. Near the end of the opera when Donner unleashes his thunderbolt, your hair will stand on end! This is the tremendous sound of a mighty blow by a heavy sledge on a big anvil accompanied by thunderous drum rolls! Lovers of brass can revel in the hugely sonorous Wagner tubas and bass trombones.

One could go on and on about the fabulous characterizations of the cast, but by now I think you get the idea. An overwhelming and thrilling experience, you must hear it to believe it!

BRAHMS
SYMPHONY #2
Minneapolis Symphony Orchestra conducted by Antal Dorati. Mercury Stereo SR90171. Price $5.95.

Dorati faces formidable competition from such Brahms specialists as Walter and Klemperer in this work. He comes off fairly well, as he conducts the work with a properly light hand and is a welcome relief from some of the funereal expositions I have heard. In the sound department Dorati has little competition as this is superbly registered stereo with everything in the right place and a notable smoothness and spacious acoustic perspective.

SCHUMANN
SYMPHONY #3 ("RHENISH")
Detroit Symphony Orchestra conducted by Paul Paray. Mercury Stereo SR90133. Price $5.95.

Paray's vigorous, spirited reading of this work was highly praised in the monaural version released some time ago. Here with the blandishments of stereo the appreciation of his artistry is heightened. Most impressive is his intelligent and expressive phrasing and his dynamic shadings. This is lovely stereo, not obtrusively directional, but with all the virtues we have come to expect, such as a fine sense of depth and the realistic acoustic perspective which is productive of this depth. All is very clean and smooth with good separation and no perceptible level or dynamic changes from the mono recording.

VAUGHN WILLIAMS
SYMPHONY #8 IN D MINOR
BUTTERWORTH
A SHROPSHIRE LAD
BAX
THE GARDEN OF FAND
Halle Orchestra conducted by Sir John Barbirolli. Mercury Stereo SR90115. Price $5.95.

The prize here is, of course, the Vaughn Williams symphony, the Bax and Butterworth pieces being nice atmospheric little works, pleasant to listen to but not of the stature of the symphony. This 8th symphony of Vaughn Williams has much in it that reminds one of his preceding work, the "Sinfonia Antarctica." It is not written in the usual symphonic form

but contains such oddities as a second movement for winds alone, the third movement for strings alone, and then with typical Vaughn Williams tongue-in-cheek it ends with a Toccata in which a great variety of percussive elements are used—such as glockenspiel, xylophone, vibraphone, tubular bells, and tuned gongs.

The performance is eloquent and definitive and it is obvious Sir John appreciates Vaughn Williams for dedicating the score to him. Not as accessible as some of Vaughn Williams other symphonies, nor hinting of the granitic sonorities that were to come in his 9th and last symphony, this still has much to recommend it. Soundwise the score receives the benefit of *Mercury's* stereo know-how and all rests very easy on the ear.

BRAHMS
SYMPHONY #1 IN C MINOR
Amsterdam Concertgebouw Orchestra conducted by Eduard Van Beinum. Epic Mono LC3603. Price $3.98.

A thoroughgoing and learned performance of this Brahms symphony is another legacy left to us by the late Van Beinum. This is not as incandescent as Toscanini's reading nor on the scale of Walter's, but then there is more Brahms in his reading and less of Van Beinum.

His musical language here is straightforward and is superbly translated by his "splendiferous" orchestra. The sound is gratifyingly clean, with especially fine strings and rich brass. For most tastes I think the pickup is just a bit spacious, which softens detail slightly. All is beautifully balanced however and, on the whole, very listenable.

MOZART
THE MAGIC FLUTE (Highlights)
Vienna Philharmonic Orchestra and Vienna State Opera Chorus and soloists, conducted by Karl Bohm. London Stereo OS25046. Price $5.95.

For those who like opera but who are loathe to wade through the complete recording (or who feel they cannot afford the entire set) this should be very welcome. The excerpts are wisely chosen and, of course, there is still the superb cast which includes Hilde Gueden, Wilma Lipp, Walter Berry, etc. Nor has there been any degrading of the wonderful stereo sound which, in *London* opera recordings, is a very special sound indeed. There are other highlights from *London* operas, all equally good buys.

SCHUMANN
CONCERTO IN A FOR PIANO AND ORCHESTRA
WEBER
KONZERTSTUCK IN F MINOR FOR PIANO AND ORCHESTRA
Friedrich Gulda, pianist with Vienna Philharmonic Orchestra conducted by Volkmar Andreae. London Stereo CS6082. Price $5.95.

Appearing previously in mono format, the over-all sound and general impression are favorably enhanced by the excellent stereo sound. Gulda, exposed to the merciless light of stereo, seems less facile and assured, but still turns in a reading better than most. He will run into severe competition from some of the keyboard giants, but with the high quality of the stereo may find favor with many. Lovely piano sound is aided by expert acoustic balance.

DVORAK
SYMPHONY #5
Cleveland Symphony Orchestra conducted by George Szell. Epic Mono LC3575. Price $3.98.

This old warhorse takes on new life and luster under the urgings of George Szell, who has an obvious affinity for this work. There

is a firmness and vitality to his reading, along with the most lovely lyrical exposition of the Largo heard in a long time. Fine sound too, with the *Epic* engineers taking advantage of the acoustic transformation recently given Severence Hall.

All is quite clean, with good balance among the various choirs of the orchestra. Good dynamic and frequency range aided by just enough reverb for smoothness and spaciousness without blurring inner detail.

RESPIGHI
ANCIENT DANCES AND AIRS FOR LUTE
(Suites 1, 2, and 3)
Philharmonia Hungarica conducted by Antal Dorati. Mercury Stereo SR90199. Price $5.95.

These lovely and delicate suites have been recorded before, but neither with the authoritative reading imparted by Dorati, nor the virtuosity of the orchestra, nor with the benefits of smooth stereo sound. The orchestra, composed of Hungarian refugees who fled during the 1956 uprising, has, in a relatively short time, established itself as a first-rank group.

Dorati, of course, enjoys wonderful rapport with his countrymen and this teamwork is evident in their performance. The works, originally for lute, have been transcribed for orchestra and the result is charming, lyrical pieces of wonderful transparency. The stereo sound is marvelously effective in showing these textures.

FRANCK
SYMPHONIC VARIATIONS
D'INDY
SYMPHONY ON A FRENCH MOUNTAIN AIR
Robert Casadesus, pianist, with Philadelphia Orchestra conducted by Eugene Ormandy. Columbia Mono ML5388. Price $3.98.

This is a recording which has been avidly awaited by Casadesus fans for a long time. They had enjoyed his matchless way with this score on the old recording made about 6 years ago, and now they can look forward to a modern recording, considerably upgraded in quality and of course with the further blandishments of stereo (which version I unhappily do not have).

Even in mono, however, the improvement is impressive. The piano was recorded moderately close-up and is in good balance with the orchestra. The tone is nothing short of opulent, a tribute to engineer and artist alike and, as abetted by the glorious Philadelphia sound, makes for a happy listening experience.

RAVEL
BOLERO
ALBORADA DEL GRACIOSO
FALLA
THREE CORNERED HAT SUITE
WEBER-BERLIOZ
INVITATION TO THE WALTZ
Paris Conservatoire Orchestra conducted by Albert Wolff. London Stereo CS6077. Price $5.95.

Potboilers all . . . yes, but they take on a new dimension in stereo and do not suffer unduly under the baton of Wolff. He is normally a bit more lighthanded than he is here, and I can only conclude that the intoxications of the stereo playback may have tempted him to "lay it on a bit." Some may like this gruffer quality in these lightweight works.

What makes this disc is the stereo sound. It is extremely finely wrought and very wide in frequency response, and I can warn you that if your pickup is the slightest bit "peaky," or your stylus is not tracking properly, the strings will sound brittle and edgy. Played under optimum conditions, the sound is quite exciting and very clean. —30—

SOUND ON TAPE

By BERT WHYTE

THERE is plenty of evidence at hand to show that tape is making a solid comeback. The furor over the merits of open reel *versus* cartridge is still going on . . . but shall we say the battle lines are now more firmly drawn . . . and don't be too surprised if a sudden truce is called in which the open-reel people also embrace the cartridge, and the cartridge people also decide to go along with the open reel. I really feel that co-existence will soon be the byword and I think that both factions are beginning to realize that any prolonged battle will scuttle the new upsurge of tape.

Naturally tape will be in full swing at the New York Hi-Fi Show, but I don't expect that we shall see any really revolutionary new equipment. Of course there will be more machines fitted with 4-channel heads and there will be a number of new cartridge machines. There will probably be more evidence of stereo recording facilities, in anticipation of regular stereo multiplex broadcasts. Also expect to see an expanded push to sell higher quality microphones with relatively low-priced tape machines. It is true that the Achilles heel of most home-recording machines is the poor mike that is usually furnished. You would be surprised just how much fine recording quality can be had from these units, when used with mikes in the $25 and up class. Needless to say, all this activity will furnish the tape manufacturers with a new market and already many companies which had stopped making stereo tapes are now back in business. Many of the companies have signed with *Ampex' United Tape Distributors* which will greatly facilitate getting tapes into the hi-fi dealers' shops. Well, whatever goes at the Show, I'll be reporting to you next month.

I'm happy to report that I have received the first batch of regular production 4-channel tapes and they are far, far better than the first samples I had. While the problem of cross-channel modulation still exists when played on my big system, it is now greatly reduced and, depending on the type of music on the tape is so low in some cases as to be unobtrusive. Played on the smaller system, there was no discernible crosstalk.

In addition to these nice developments, the tapes had a definitely brighter transient response and frequency range and dynamics were much improved. Tape hiss varied from brand to brand but, on the whole, was no more offensive than that heard on two-

channel tapes . . . on this question of hiss, it's like anything else . . . some people are more sensitive to it than others and of course it also depends on what level you are playing back the tape . . . the louder the playback . . . the louder the hiss. Also room acoustics contribute their bit . . . if the room is very hard you hear more hiss than with a well-damped room.

Anyway, on the whole, it's a good step forward—this latest batch—and I can tell you that several of the residual problems are being strongly attacked and should soon yield, in which case 4-channel tape should be off and running with real professional form!

SONGS OF THE FABULOUS THIRTIES

David Rose and his Orchestra. Kapp 4-channel stereo KT45004. Price $7.95.

Here is a really good tape. David Rose is, of course, an old favorite and he has an especially smooth way with a tune. On this tape he gives us a king-sized sampling of hits that were popular in the Thirties.

Among notable numbers are such items as "Stardust," "Deep Purple," "Begin the Beguine," and many others. This is big sound, with close-up recording leavened by spacious acoustics. Stereo directivity was good and not overdone, center fill was well handled. Over-all sound was clean and bright, strings especially smooth.

There was the least crosstalk on this tape of any I've heard so far, being, for the most part, absent. Frequency and dynamics seemed to be on a par with similar types of two-channel tapes and, in terms of hiss, played at good room filling level, it was present but not over-obtrusive.

SWINGING HIGH WITH ELLINGTON AND BASIE

The Big Bay Band conducted by Francis Bay. Omegatape 4-channel stereo ST4007. Price $9.95.

Alas, this is not really the Duke and the Count with their great bands, but is by way of a "salute" by the Big Bay Band, an *Omega* recording outfit. Nonetheless, the essential styles and all the great Basie and Ellington numbers are here and played fairly well considering the band is not Basie or Ellington.

The sound is the most attractive part, being very big and bright, recorded close-up, and with only moderately spacious acoustics to soften the contours and smooth out the rough spots.

The frequency range here came as close to anything of similar nature I have heard on two-track. Transient response was very good with percussives coming through cleanly. Cross-channel talk was a little more noticeable here, mainly because of the razzle dazzle type of music but here, again, it was below that experienced with the first tapes.

All-in-all, the tape quality has been encouraging and I hope to bring you some symphonic material next month.

—30—

Simplified Speaker Testing

(*Continued from page* 43)

measured at the power level at which the shape of the trace becomes markedly distorted. Volts squared divided by impedance equals watts (power), which in this case is the useful power capacity of the speaker. Two notes of warning on this kind of testing should be sounded: First, stay within the manufacturer's power ratings on both the speaker and the variable resistor to avoid physical damage to them. Second, a continuous tone, such as is produced in these tests, can seem intolerably loud even at a power input of only one to two watts. This last statement applies with double force to uninterested wives.

It might be of interest to point out that all of the impedance and phase shift curves shown in Figs. 3 and 4 were made using the same speaker, a twelve-inch, wide-range unit of standard make and all were made with the speaker in the same location in the room. In this manner, variables not directly concerned with the enclosure were eliminated. The primary purpose was to help in a study of the design of bass-reflex enclosures.

Interpretation of the test results has not been discussed in any detail, because that has been better covered in other recently published material both from the theoretical and design viewpoints [1, 5, 6, 7, 8, 9] and from the more subjective viewpoint of the would-be listener [2, 3, 4].

To sum up, this simplified loudspeaker testing technique can be used to measure speaker impedance and phase shift and to give a qualitative indication of distortion generated in the speaker or its enclosure and the useful power-handling capacity of the speaker. It must also be understood that there are several things this technique will not do. One is to measure the frequency response or range of a loudspeaker (for this, one needs the more sophisticated test methods referred to at the beginning of this article). Another, and probably most important of all, it will not replace a good pair of educated ears in making the final determination as to whether the sound produced is "right."

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—30—

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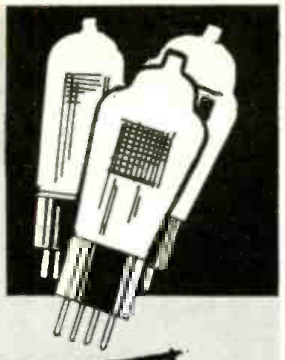

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1F5	3V4	6AK5	6BG6G	6CS6	6SH7	7C6	12AX7	12X4	50A5
1G4	4BQ7A	6AL5	6BH6	6CU5	6SJ7	7C7	12AZ7	14A7/12B7	50B5
1H5GT	4B58	6AM8	6BJ6	6CU6	6SK7	7E5	12B4	14B6	50C5
1L4	4BZ7	6AN8	6BK5	6D6	6SL7	7E6	12BA6	14Q7	50L6
1L6	4CB6	6AQ5	6BK7	6DE6	6SQ7	7E7	12BA7	19	56
1N5GT	5AM8	6AQ6	6BL7GT	6DG6GT	6SR7	7F7	12BD6	19AU4GT	57
1R5	5AN8	6AQ7	6BN6	6DQ6	6T4	7F8	12BE6	19BG6G	58
1S5	5AT8	6AR5	6BQ6GT	6F5	6U8	7G7	12BF6	19J6	71A
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1U4	5AZ4	6AT6	6BR8	6H6	6W6GT	7N7	12BQ6	24A	76
1U5	5BR8	6AU4GT	6BS8	6J4	6X4	7Q7	12BR7	25Z6GT	77
1V2	5J6	6AU5GT	6BY5G	6J5	6X5GT	7S7	12BY7	26	78
1X2	5R4	6AU6	6BZ6	6J6	6X8	7X6	12CA5	27	80
2AF4	5U4	6AU8	6BZ7	6J7	6Y6G	7X7	12CN5	35	84/6Z4
2BN4	5U8	6AV5GT	6C4	6K6GT	7A4/XXL	7Y4	12D4	35A5	117Z3
2CY5	5V4G	6AV6	6CB6	6K7	7A5	7Z4	12F5	35B5	
3A4	5V6GT	6AW8	6CD6G	6N7	7A6	12A8	12K7	35C5	
3A5	5X8	6AX4GT	6CF6	6Q7	7A7	12AB5	12L6	35W4	
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Mobile Receiver Alignment

(*Continued from page* 117)

can be done using the base station's transmitter as a signal source.

I.F. Alignment

The alignment procedure should begin with the discriminator with the generator set to the low i.f. Assuming the usual 455-kc. i.f., a crystal at this frequency can be used with the generator. If no crystal is on hand, tune an AM broadcast receiver to a station that is the closest to 910 kc. of those that can be received. Zero-beat the second harmonic of the generator (set at half the station frequency) against this station. If you know the station's exact frequency, you have a very accurate standard. Note the amount of error in dial calibration and use this as a guide for correctly setting the generator to 455 kc. If a station at exactly 910 kc. is not available, it may be best to use the two nearest transmissions, one on either side of that frequency. To avoid possible drift, the signal generator should be allowed to warm up for at least fifteen minutes before beginning alignment work.

Feed the 455-kc. signal into the first limiter grid, connect the meter to the discriminator secondary metering point, and adjust the secondary winding for a zero reading. If you have the right point, the voltage will go positive on one side and negative on the other, as the secondary alignment adjustment is turned. (A good, rough check of discriminator symmetry is possible here, by noting the amplitude of maximum meter deflection on either side of the zero-voltage point. The peaks should be equal.)

With the secondary aligned to zero, move the meter to the discriminator primary's alignment point, as shown in Fig. 5, and tune the primary slug for maximum. Next, move the meter to the grid of the second limiter and connect the signal generator to the output of the second mixer. The low i.f. transformers may now be aligned for maximum reading. If the reading shows a tendency to saturation (reaching a certain level and refusing to go higher), reduce the input signal level from the generator, or move the meter to the first limiter grid.

Sets Using Filters

If the receiver uses a fixed-tuned filter, this reliable network may be used to set the signal generator on the right frequency instead of the zero-beating process. Connect the generator to the second mixer grid, and the meter to either the low i.f. grid or first limiter grid. Now, tune the generator slowly through the low i.f., until a peak reading is found. This will be exactly on the peak frequency of the filter. If a distinct "flat top" is noted instead of a sharp peak because of the bandwidth characteristic of the filter, note the outer limits of the bandpass

(*i.e.*, the points where the reading begins to fall off) and set the generator halfway between them.

The High I.F. Stages

The high i.f. stages will usually be found somewhere in the range between 5 and 6 mc. Once again, extreme accuracy of the generator is not as important as stability: we can check the former. With the low i.f. section and discriminator properly aligned, move the meter back to the secondary of the discriminator. Connect the generator to the input of the first mixer. Now, move the generator dial back and forth in the vicinity of the high i.f. (Assume that this is near 5.5 mc.)

As you tune through the correct frequency, the meter will deflect either positive or negative, return to zero, then deflect in the other direction. Set the generator exactly at the point where the zero reading is obtained on the meter. Whatever its exact dial reading, the generator is now set up to produce the correct high i.f. The accurate, crystal-controlled first oscillator has helped establish this frequency! Now align all stages for maximum reading. The meter may be connected to the low i.f. grid or first limiter.

R.F. Alignment

If the signal generator will go up to the carrier frequency, it may be calibrated against the transmitter, again using the discriminator to locate the correct zero point. The r.f. stages are then aligned. Harmonics of the signal generator can also be used. For instance, in the 150-mc. band, a setting at 50 mc. will usually produce a third harmonic of usable amplitude. However, for best results, "rough in" the alignment adjustments on the r.f. stages with the signal generator, then connect an antenna to the receiver and finish the alignment using the base station's transmissions.

If the base station is very powerful, or very close, watch out for saturation of the limiters when these metering points are used. The low i.f. metering point may be a better choice. If the signal is still too high, take the antenna off or reduce the coupling.

Final Touch-up

For best results, make a final receiver check *after* re-installation in the vehicle, as follows: connect the meter to the low i.f. metering point, call the base station for a test transmission, and adjust the antenna transformer for maximum reading. Next, connect the meter to the discriminator secondary, get another test transmission, and set the secondary to exact zero reading.

If the base station's transmissions are too powerful for accurate adjustment of the antenna transformer, get in touch with another vehicle, far enough away to give a weaker signal, or wait until one of these vehicles calls the base station. In most radio systems, you won't have long to wait, as they stay pretty busy! —30—

How far can you go in electronics .

"Just being called a Field Engineer—an impressive title for a man without a degree—that really gives me a lift."

This is James A. Pieratt talking. With a high school education and Navy Technical training behind him, he holds a key job in one of America's most important electronic projects. He's an IBM Computer Units Field Engineer on the SAGE program.

Jim Pieratt is 25, lean, crew-cut and soft-spoken. He smiles modestly when you ask him about his accomplishments. We were curious to know whether he had been technically inclined when he was a youngster.

"The truth is that I didn't become interested in electronics until I joined the Navy," he says. "Before that, the only technical thing I might have done was to take a couple of alarm clocks apart. I chose electronics in the Navy because I thought there was a future in it."

Change of attitude

"A lot of fellows may think, as I did, that a computer is too complicated for anybody but an Einstein to understand. It's not so. I didn't know this when I went for my employment interview—and I wondered if the algebra and trig I'd taken at Kalamazoo Central High would qualify me. Then my interviewer told me a little about computers . . . how they work and what my job would be after I finished IBM school. I made up my mind right then; I wanted this job."

Training school

Soon, Jim Pieratt and 21 other fellows with more or less similar backgrounds started training in Kingston, New York, getting on really intimate terms with IBM's electronic giant. Marvel of complexity though it is, when it sits on the floor and you study it part by part, the computer loses its mystery. Little by little, you begin to understand the whole from the sum of the components.

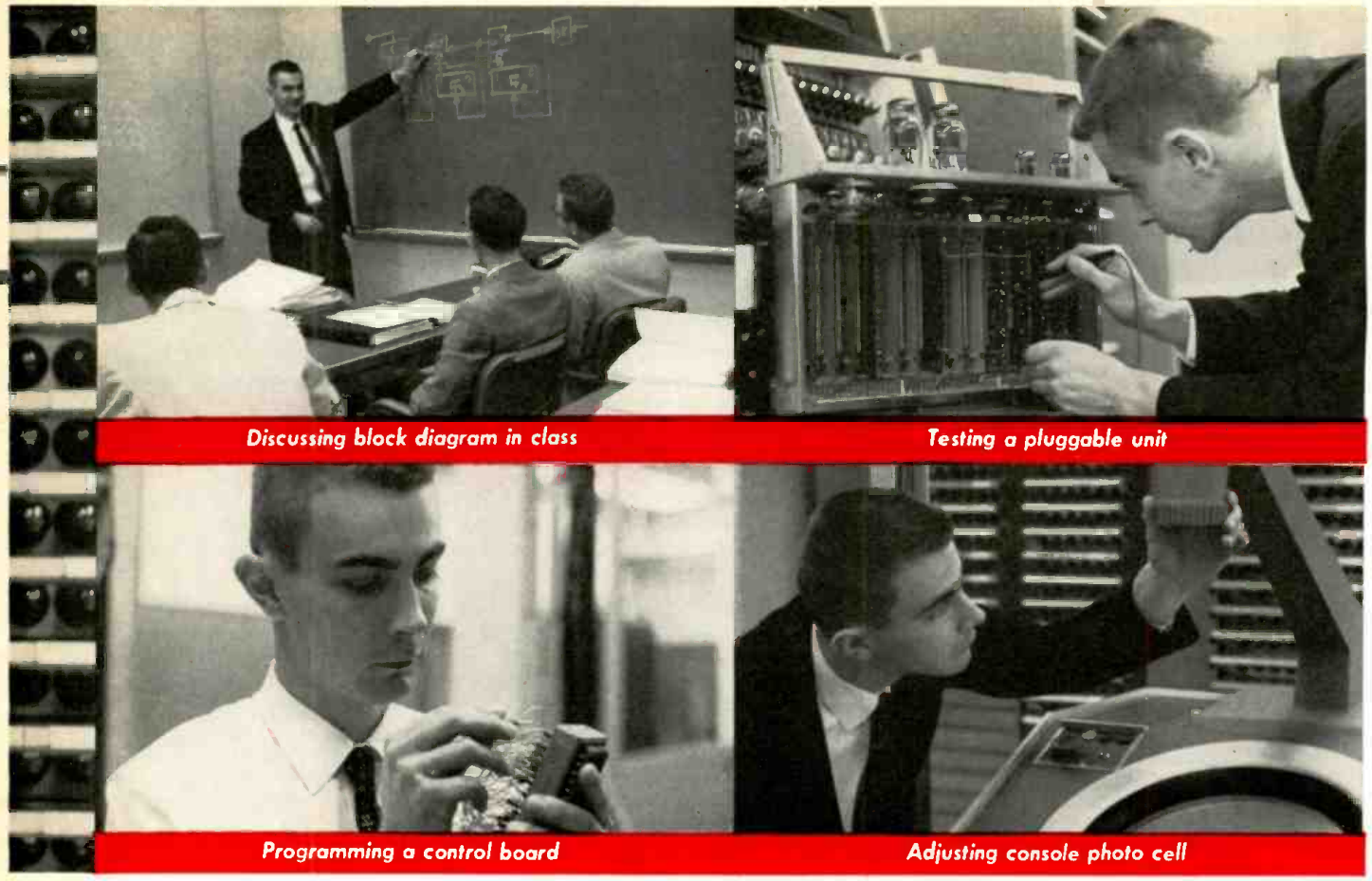
"The 20 weeks I spent in training were very happy," he says. "It's interesting all the way. They encourage you to think for yourself and your efforts are recognized. During the training period, I received a living allowance in addition to my salary."

Strategic job on the SAGE project

Jim Pieratt is stationed in North Dakota, near Grand Forks. His duties include installing, checking and testing out computer units. The giant electronic computers are the very heart and mind of SAGE (Semi-Automatic Ground Environment). To the input section of the computer comes data from radar sites, ships, reconnaissance planes and ground observer posts throughout the country. The display consoles give a visual representation of the complete air defense situation. His prime responsibility is to keep the display consoles running.

8 pleasant hours a day

"I'm essentially my own boss and I'm encouraged to



Discussing block diagram in class

Testing a pluggable unit

Programming a control board

Adjusting console photo cell

. without a degree?

think for myself. For me, this is an ideal environment. What do I like best about my job? Trouble-shooting, I think. I enjoy being able to repair anything that isn't working properly. As a Field Engineer, I have opportunities to assume other engineering functions. For instance, while I have nothing to do with design engineering, I do suggest changes for review by the design engineers. I also rewrite engineering procedures."

Jim Pieratt's future

"There's plenty of room for me to grow at IBM. My next step up should be to Systems Engineer. This calls for more headwork. After that, if I display enough initiative, I may become a Group Supervisor."

Family, friends, recreation

Jim Pieratt, his wife and three-year-old daughter live in a pleasant ranch home, just a few miles from the site. Social life? "We've made quite a few friends here," he says. "Mostly among the IBM fellows and their wives. We play golf together."

Where do you go from here?

Can you look ahead, as Jim Pieratt does, and see yourself as a man on the way up? Maybe you should give some thought to IBM Federal Systems and the SAGE project program. Opportunities are greater than ever as the long-range program continues to grow in importance.

If you have a minimum of 3 years' technical schooling—or equivalent experience—you may be eligible for advanced training for 20 weeks as a Computer Units Field Engineer. While training, you receive full salary plus overtime pay and living allowance before assignment to a permanent location.

From then on, you can go as far as your abilities and ambition will take you. And, as you may already know, at IBM you receive company-paid benefits that set standards for industry today.

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Service Industry News

IN A SPIRITED contest for votes, "Mac" Metoyer of Kansas City, Missouri, was elected president of the National Alliance of Television and Electronic Service Associations (NATESA), at the recent annual convention. He succeeded Vincent J. Lutz of St. Louis, Mo. With a background of ten years of active participation in national, state, and local association work, including two years as NATESA's secretary general, Metoyer is noted for his energy in working toward objectives that he feels are in the best interests of the service industry.

Benny Benoit, dynamic association leader from New Orleans, La., was elected to the post of secretary general and Nelson Burns of Memphis, Tenn., was re-elected treasurer of the national service organization.

Members of the executive council elected to serve for the coming year include Irving Toner of Buffalo, N. Y., eastern vice-president; George Carlson of Jamestown, N. Y., eastern secretary; Cordell Britt of Nashville, Tenn., east central vice-president; Gerald Hall of Milwaukee, Wis., east central secretary; W. E. Johnson of Beaumont, Texas, west central vice-president; Leroy Ragsdale of Fort Smith, Ark., west central secretary; Winston Haines of Burlingame, Cal., western vice-president; and O. W. Andrews of Denver, Colo., western secretary.

The resolutions adopted by the delegates to the convention included the following:

The association urged "all service people to exercise selective buying and channel their buying power to those companies that are non-competitive."

"NATESA recognizes only the Electronic Industries Association standard warranty plan; namely, 90 days on all parts and tubes and one year on picture tubes. No labor warranty by factories is recognized."

The association urged all TV receiver manufacturers to "permanently and indelibly imprint serial and chassis numbers on all chassis and to issue a certificate of title for each set which is to accompany the set in all transactions."

One purpose of this resolution was to help put a stop to the growing number of set thefts.

Tulsa, Oklahoma, was selected as the site for the Association's annual Spring convention in 1960.

Unity: NATESA's Story

Rejection of the application by TSA of Detroit, Michigan for membership in NATESA was followed by a wave of commentary critical of NATESA for turning down the former group. (See "Service Industry News," September 1959, pp. 136 and 137.) In rebuttal NATESA has set forth its position *via* a release entitled "What Is Unity?" which has been circulated to local associations throughout the country. It is issued over the signature of executive director Frank Moch, against whom many charges have been leveled personally, growing out of the TSA rejection.

"The word unity is being bandied about more than ever (begins the statement), despite the fact that NATESA today has well over 100 affiliates and the fact that it has grown *every single month* since its birth . . . the only possible reason for this growth can be the fact that NATESA philosophies parallel those of honest, ethical service people across the nation."

Moch then charges that those outside NATESA who have spoken loudest about unity are the ones who have done the most, unsuccessfully, to destroy the unity represented by that national group. He further states that those within NATESA who have taken up the same cry are the ones who have been least successful in bringing new groups into NATESA to achieve unity.

On the background of the TSA attempt to gain membership, the release says, "Those of you who were at the Nashville meeting will recall the 'dramatic' announcement of TSA-Michigan's intention of affiliating . . . It was hoped that spontaneous and unthinking acceptance would be voted. You may or may not have heard of the maneuvering to give a special 'deal' to TSA-Michigan (Detroit). You did see the report that the TSA application was rejected."

The statement also points to the legal problems involved, raising the question as to whether the national office could have stepped in to maneuver the acceptance of TSA without violating constitutional limitations.

"Here is how this (the TSA application) was handled, and I can assure you that it follows specifically the constitutional provisions and that it follows exactly the same procedure followed for acceptance of your group as an affiliate. When the application was finally received, in view of the fact that we had the Michigan state affiliate who already had a Detroit affiliate, the application was submitted to TESA-Michigan. They turned down the application completely in accord with

their rights as a state affiliate. For this I have been maligned and libeled."

As to the reasons for the unfavorable decision on the application, the NATESA statement is accompanied by a copy of a letter to Frank Moch from John H. Stefanski, president of TESA-Michigan ("Service Industry News," October 1959, page 144). In the letter, Stefanski presents his version of association activities in Detroit and Michigan from 1954 on, questioning the actions and motives of TSA. Copies of this correspondence are available from NATESA's national office on request.

Moch also refers to two stories that have appeared in print in recent months: the rumor that TEA (Texas) was considering affiliation with NATESA and the story that ITTA (Indianapolis) had not received approval of its application for membership. He charges that these stories, both untrue, were put in circulation to create confusion. In view of the legal limitations placed on his role in handling the TSA application, Moch concludes, "I doubt if sincere officers and directors feel that the abuse heaped upon the executive director is fair and a part of the job."

TV Service Charges

Many dealers, in trying to adjust their service charges to a level that is compatible to the present costs of operating, look around for some standard of comparison based upon known costs of doing business. Some of the widest and most exhaustive surveys to determine the actual costs of performing home and shop service on TV sets have been conducted by dealers in the Detroit, Mich. area. Using the information from these surveys as the basis, Harold Chase of Detroit, Mich. recently compiled a new chart of "Average Labor Charges for Television Service and Repairs." The charges are based on a time rate of $6.00 per hour. Readers who would like to check their own charges against those listed in this chart may obtain a copy of it by sending ten cents to Hal Chase, *Chase TV Service,* 16311 Grand River, Detroit 27, Mich.

ETG of Boston Elects

Lawrence J. McEvoy was elected president of the Electronic Technicians Guild of Boston at their recent annual election. Officers named to serve with him include George Catavolo, vice-president; James Kelley, re-elected secretary; and Donald Cicolini, treasurer. The address of the association is: James H. Kelley, secretary, ETG of Boston, 236 Main Street, Woburn, Mass.

President McEvoy named the following members to serve as delegates to the Massachusetts state association: Warren Gagosian of Medford, state director; Hy Leve of Brighton and Ted deBruyn of Woburn, state delegates.

The members of the association report that one of the best affairs ever sponsored by ETG was that held in

June when more than 425 members and guests registered. It was cited as an impressive show of strength in favor of the ETG License Bill. Also during the same month, the association cooperated in a radio program designed to bring the proposed ETG license measure to the attention of the general public. President Larry McEvoy, George Catavolo, and Pat La Fauci served as members of a panel to answer questions telephoned in about the licensing plan, ETG, and the independent electronic service industry.

Mid-State ESDA Rating Plan

Wayne Prather, president of the Electronic Service Dealers Association of Mid-State Pennsylvania, announced that the Keystone-State organization will establish a customer rating plan as its fall project.

The program, intended to protect the members of the association, revolves around the compilation of a list of customers who are poor payers, so-called "dead-beats," and those who are generally antagonistic or abusive to service people. Pointing out that the information will be strictly for the 28 members of Mid-State ESDA, Mr. Prather emphasized that the program is not to be construed as a credit-information plan.

The mailing address of Mid-State ESDA is % Wayne Prather, president, 17th and Herr Streets, Harrisburg, Pa.

FRTSAP Developments

The Federation of Radio & Television Service Associations of Pennsylvania was recently informed by the state's sales tax department that sales taxes are applicable to in-warranty work performed by service firms on behalf of dealers, distributors, and manufacturers.

Until the present, most service firms were not charging taxes on work performed under in-warranty arrangements, assuming that the tax should be paid by the manufacturer, distributor, or dealer on both labor and parts.

Other developments in the Pennsylvania association include a demand to the *National Broadcasting Company* for equal time to answer the "charges" and "insults" said to have been made against the service industry by Alexander King on a recent Jack Paar Show.

The association delegates authorized officers to send a letter to the Pennsylvania Governor urging him to sign the "Wholesale Bill" which had been passed by both houses of the State Legislature. The "Wholesale Bill" is said to define operations of wholesale distributors in that the distributors must sell only to "people in the trade." The delegates also heard first reports on the review of a proposed state-wide service licensing measure now under consideration by member local associations. The bill, setting up the provisions for licensing radio, electronic, and television technicians, is being readied for presentation at the next session of the legislature. —30—

Are You "Alignment Happy"?

(*Continued from page* 47)

justified alignment are brought on by defective alignment equipment or lack of experience by the technician using that equipment. Here again, alignment checks *without adjustments* will help. In the case of defective equipment, curve checking of a number of sets, preferably including new sets known to give satisfactory pictures, will eventually prove even to the most trusting technician that something is adrift with his set-up or equipment. Surely every set cannot have the same defect. As for the technician seeking more experience in the use of alignment equipment: he will gain that know-how soon enough if allowed to check but *not adjust* the alignment curve of every set going through the shop.

Even if a curve check indicates a genuine need for alignment, it should not necessarily be done if any decrease in gain would be involved. Remember, the customer is not watching an oscilloscope trace. He is watching a picture, often quite happily through a dirty glass with full, excessive contrast and near-full brightness. Scanning lines may be paired and blobs of snow bigger than the detail represented by a whole megacycle of bandwidth may flit unnoticed across the screen. To such a viewer, a nicely balanced curve may have meaning only with reference to the female form. Why spoil his fun by improving his picture at the expense of gain? With less gain he might not even have a picture unless you are able to improve the signal strength available at the antenna terminals. This is not to say that alignment should never be undertaken. However, the decision should not be made lightly.

Some knowledge of the service history and the general appearance of the chassis will often help in deciding whether or not to re-align. If it is apparent that the tuning slugs in the i.f. circuits have been adjusted previously, if components in the i.f. circuits obviously have been changed, and if the present signals are of sufficient strength to warrant it, alignment should be considered. There is also the matter of the customer's willingness to pay for an alignment job.

In any event, before proceeding with the alignment, a curve check should be made and tubes and other suspect components checked by substitution. Voltage readings should be taken and any defects in other parts of the set corrected. Tube shields and other metal screening should be installed as the designer intended them to be. Then, if you are sure of yourself and your equipment, the set may be re-aligned, according to the manufacturer's service information, to provide the best possible picture and sound along with satisfactory gain. Only in this way will both the technician and the customer be satisfied that the work was really necessary. —30—

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			Reg. Net	Rad-Tel Price
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	MAC 15—14.2 to 2.2		1.23	.61
	MAC 20—19.6 to 2.7		1.32	.66
	MFD	WV		
CORNELL DUBILIER	40.40.40	350.300.50		1.00
CORNELL DUBILIER	8	1000		2.95
CORNELL DUBILIER	60.40	500.500		.65
CORNELL DUBILIER	20	450		.15
SPRAGUE	10.10.10	450.450.450		.25
PHILCO	80.200.400	350.300.50		.45
PHILCO	10.100.10.100	475.300.300.25		.55
INDUSTRIAL	500	5 Non Polarized		.75
INDUSTRIAL	8.8.8	5		.10
CORNELL DUBILIER	.1	1600		.25
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BELDEN TEST PROBE CABLE. Type 8899. No. 18. Cotton wrap rubber over-all				ft. 2c
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SOLA Constant Volt Trans. 105/125V; output 7V; 20VA			16.00	6.95
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Type	Price	Type	Price	Type	Price	Type	Price
1AX2	.62	6AC7M	.96	6CG8	.77	12AV6	.41
1B3GT	.79	6AF4	.97	6CM7	.66	12AV7	.75
1S5	.51	6AG5	.65	6CN7	.65	12AX7	.63
1U4	.57	6AH6	.99	6CS6	.57	12AZ7	.86
1U5	.50	6AK5	.95	6CU6	1.08	12B4	.63
1X2B	.82	6AL5	.47	6CY7	.71	12BD6	.50
2AF4	.96	6AM8	.78	6DE6	.58	12BE6	.53
28N4	.60	6AN8	.85	6DG6GT	.59	12BH7	.73
3AL5	.42	6AQ5	.50	6DQ6	1.10	12BQ6GT	1.06
3AU6	.51	6AT6	.43	6DT6	.53	12BY7	.74
3AV6	.41	6AT8	.79	6J5GT	.51	12C5	.56
3BZ6	.55	6AU4GT	.82	6J6	.67	12CU5	.58
3BY6	.55	6AU6	.50	6K6GT	.58	12CU6	1.06
3CB6	.54	6AU8	.87	6L6	.84	12DQ6	1.04
3CF6	.60	6AV6	.40	6S4	.48	12F8	.66
3DT6	.50	6BA6	.49	6SK7GT	.74	12K5	.65
3V4	.58	6BC5	.54	6SN7GT	.65	12L6	.58
4BN6	.75	6BD6	.51	6T4	.99	12SA7M	.86
4BQ7	.96	6BE6	.55	6T8	.80	12SK7GT	.74
4DT6	.55	6BF6	.44	6U8	.78	12SN7GT	.64
4BZ7	.96	6BG6G	1.66	6V6GT	.54	12V6GT	.53
4CB6	.59	6BH8	.87	6W4GT	.57	12W6	.69
5AM8	.79	6BK7	.85	6W6GT	.69	17AX4	.67
5AN8	.86	6BN4	.57	6X4	.39	17BQ6	1.09
5AQ5	.52	6BN6	.74	6X8	.77	19AU4	.83
5AT8	.80	6BQ/CU6	1.25	6Y6G	.65	19BG6	1.39
5BK7A	.82	6BQ5	.65	8AU8	.83	19T8	.80
5BQ7	.97	6BQ6GT	1.05	8AW8	.93	25BQ6GT	1.11
5CG8	.76	6BQ7	.95	11CY7	.75	25C5	.53
5CL8	.76	6BR8	.78	12A4	.60	25CD6	1.44
5J6	.68	6BY6	.54	12AD6	.57	25CU6	1.11
5T8	.81	6BZ6	.54	12AF6	.49	25L6	.57
5U4GB	.60	6BZ7	.97	12AQ5	.52	35C5	.51
5U8	.81	6C4	.43	12AT6	.43	35Z5GT	.60
5V6	.56	6CB6	.54	12AT7	.76	50B5	.60
5X8	.78	6CD6	1.42	12AU6	.50	50C5	.53
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6AB4	.46	6CG7	.60				

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Are You Geared for Change?

(*Continued from page 52*)

hi-fi and stereo in many areas, FM offers countless opportunities for dealers who will seek the business aggressively. In many locations, the full benefits from FM broadcasts can be realized only through the use of an outdoor antenna. Any dealer who will develop a consistent promotion program on this type of equipment and do a conscientious job of satisfying his customers will add a substantial amount of pleasantly earned income to his business.

Service dealers located in good business areas with reasonable pedestrian traffic should study the possibility of retailing other types of merchandise, especially if they can allot adequate display area for it. Such items that relate to electronics are good, but anything at all is fair game for supplementary income, especially if it fills a demand not already being met by someone else in the vicinity. As an extreme case, greeting-card centers set up in spare corners of service shops have proved profitable, also improving the service business itself by creating more store traffic! In at least one such example of "diversification," the dealer's wife handles the greeting-card end of the business, leaving him free to conduct his service operation without distraction.

Hobby centers inside the shop, involving such items as model planes, boats, and trains, are magnets that draw local boys and men, particularly if a reasonable amount of window space is devoted to interesting displays. The tie-up with the hobbyist concerned with radio-controlled models or with electronics in general is something of a "natural." Many dealers who have been able to devote floor space and capital to such experiments have found that these added "departments" carry overhead for the entire shop once they are publicized and established.

In virtually every trading area, there are products or groups of products not carried by other businesses in the area for which a demand can be found. Discovering what they are and arranging for the space they must occupy are challenges to one's capabilities in business management. Remember this: it is easier and safer to add a side-line venture than to start an entirely new business.

The important point to keep in mind is that changes taking place in the handling of consumer electronic service are not simply affecting income of independent shops for the brief present: these changes are likely to have even greater impact as time goes on. To remain in business, the dealer must be constantly on the alert for activities which will re-inforce possible losses of income and help insure his ability to meet overhead and operating costs.

FM TRANSMITTER-RECEIVER

APN-1. 420 to 460 Mc Aircraft Radio altimeter equipment. Tubes: 4—955, 3—12SJ7, 4—12SH7, 2—12H6, 1—VR150. Complete with all tubes and mount. For 27 V DC. **$8.95**

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Original operating manual for above .....

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Conversion instructions for 110V 60 cyc AC 65c

BC-733 VHF 10-TUBE AIRCRAFT RECEIVER. 6-channel xtal control. Freq. 108.3 to 110.3 Mc. Dual filter range. Easily converted for tracking Sputniks! **$7.95**

Exc. used. Complete with tubes $8.95
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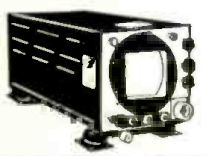

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FINE QUALITY NAVIGATIONAL EQUIPMENT

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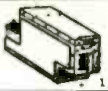

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110V AC Power Sup. Kit for above $9.75

ARC-5/T-23 TRANSMITTER

100-150 Mc Includes 2—832A, 2—1625 Tubes. BRAND NEW **$21.50**

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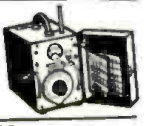

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6AG5	.35	6AC7	.55	815	2.15
12AT7	.45	6J6	.32	837	.85
12X4	.35	6BA6	.35	1625	.29
6AK5	.35	6AS6	.55	1629	.29
6C4	.25	SPECIAL PURP.		2013	.39
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6AL5	.33	807	.95	4X-150	5.95
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27 to 38.9 Mc F.M. Two preselected channels crystal controlled. 5 to 10 watts. Complete with speaker, tubes. Exc. Used **$11.95**

POWER SUPPLY for BC-620, 659, available for 6, 12 or 24 Volts DC. Specify $8.95

SCR-625 MINE DETECTOR

Complete portable outfit in original packing, with all accessories. Brand New **$22.50**

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DYNAMIC BOOM MIKE M-33/AIC. Low impedance, with mounting bracket for attachment to headsets. A REAL VALUE at **$3.95**

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DYNAMIC HANDMIKE, aircraft, made by Telephonics Corp. Press-to-talk switch on mike. BRAND NEW **$4.95**

HI-FI DYNAMIC HEADSET with Cushions

Freq. Range: 40-14000 CPS. No Distortion. BRAND NEW **$7.85**

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Model	Description	Excellent Used	BRAND NEW
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T-30	Carbon Throat Mike	$ .34	.74
T-45	Army and Navy Lip Mike		1.25
T-24	Carbon Mike		5.95
TS-9	Handset		3.88
RS-38	Navy Type	2.69	4.75

HEADPHONES

Model	Description	Excellent Used	BRAND NEW
HS-23	High Impedance	$2.19	$4.65
HS-33	Low Impedance	2.69	4.65
HS-30	Low Imp. (featherwt.)	1.15	1.89
H-16/U	High Imp. (2 units)	3.75	7.95

TELEPHONICS—600 ohm Low Impedance HEADSETS. BRAND NEW, PER PAIR $3.25
CD-307A Cords, with PL55 plug and JK26 Jack ..... .99
Earphone Cushions for above—pair ..... .50

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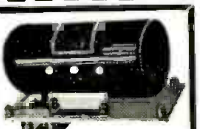

Input 12V DC. Output: 625 V DC @ 225 Ma. for press-to-talk intermittent operation. Shpg. wt. 14 lbs. OUR LOW PRICE **$6.45**

OTHER DYNAMOTOR VALUES: Type	Input	Output	Excellent Used	BRAND NEW
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DM-33A	28V 5A	575V .16A		
	28V 7A	540V .25A	1.95	3.75
DM-34D	12V 2A	220V .080A	4.15	5.25
DM-53A	28V 1.4A	220V .080A	3.75	5.45
DM-64A	12V 5.1A	275V .150A		7.95
PE-73C	28V 20A	1000V .350A	7.95	10.50
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Please include 25% Deposit with order—Balance C.O.D., or Remittance in Full. 50c Handling Charges on all orders under $5.00. All shipments F.O.B. Our Warehouse, N.Y.C. All Merchandise subject to Prior Sale and Price Change.

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11 CHANNELS
200-1500 Kc
2 to 18.1 Mc

$48.50 Complete with Tubes

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Exc. Used .....
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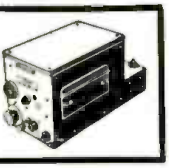
24V Dynamotor for ART-13 ..... 11.95

NAVY AIRCRAFT RADIO RECEIVER

CRV-46151(ARB). Communications receiver made by RCA. Complete coverage 195 to 9050 Kc in 4 bands continuous tuning. Complete with tubes and dynamotor, used $17.95
Like NEW $26.50

POWER SUPPLY for above, 110V AC, complete ready to plug in, wired $9.75

234-258 MC RECEIVER
AN/ARR-2



BRAND NEW 11-tube UHF Tunable Receiver with schematic. Only a few at this low price! Complete with tubes **$8.88**

SCR-274 COMMAND EQUIPMENT
ALL COMPLETE WITH TUBES

Type	Description	Used	Like NEW
BC-453	Receiver 190-550 KC	$14.50	$16.50
BC-454	Receiver 3-6 Mc	9.45	12.45
BC-455	Receiver 6-9 Mc	10.45	12.45
BC-456	Receiver Control Box	1.29	1.75

110 Volt AC Power Supply Kit, for all 274-N and ARC-5 Receivers. Complete with metal case. Instructions **$7.95**
Factory wired, tested, ready to operate $11.50

SPLINED TUNING KNOB for 274-N and ARC-5 RECEIVERS. Fits BC-453, BC-454 and others. Only **49c**

BC-457 TRANSMITTER—4-5.3 Mc. complete with all tubes and crystal. BRAND NEW **$7.85**
BC-458 TRANSMITTER—5.3 to 7 Mc. Complete with all tubes and crystal. BRAND NEW **$9.75**
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ARC-5 T-19 TRANSMITTER—3 to 4 Mc. BRAND NEW complete with all tubes & crystal **$8.85**

BC-456 Modulator ..... USED 3.45 NEW 5.95
BC-451 Transmitter Control Box .. 1.25 NEW 1.49
ALL ACCESSORIES AVAILABLE FOR COMMAND EQUIPMENT.

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20 TO 27.9 MC. **$14.95**
Like New .....

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

12 or 24V Dynamotor for Above Exc. Used $4.25 ..... Brand New $8.50
BC-683 same as above except 27 to 38.9 Mc. LIKE NEW **$23.50**

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1⅜" square x 2" long, ¼" shaft extends ½". 10,000 RPM. 24V DC. Input. Complete with fan **$2.19**

FL-5 FILTER **$1.19**

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3 Amp. Hour. BRAND NEW. 3⅝" x 1-13/16" x 2⅜". Uses Standard Electrolyte ..... Only $2.88

2 VOLT BATTERY "PACKAGE"

1—2V. 20 Amp. Hr. Willard Storage Battery $2.79
1—2V. 7 prong Synchronous Plug-in Vibrator 1.49
1—Quart Bottle Electrolyte (for 2 cells) 1.45
ALL BRAND NEW! Combination Price **$5.45**

Technical Books

"TRANSISTORS IN RADIO, TELEVISION AND ELECTRONICS" by Milton S. Kiver. Published by *McGraw-Hill Book Company, Inc.*, New York. 419 pages. Price $7.95. Second Edition.

The three years that have elapsed since the first edition of this book made its appearance have witnessed amazing progress both in the improvement of transistors themselves and in their application to a wider variety of circuits. Because of these many important changes, this volume represents a complete revision of the earlier text.

Written primarily for the service technician in radio and television, the text covers point-contact and junction transistors, transistor characteristics, amplifiers, oscillators, radio receivers, transistors in TV receivers and in electronic circuits, additional transistor developments, servicing transistor circuits, experiments with transistors, and transistor amplifier design.

A bibliography, test questions, and transistor data tables complete the text, making it a self-contained volume for the student and technician. Most readers of this magazine are familiar with Mr. Kiver's lucid style and will find in this volume the same clear-cut, thoroughly intelligible exposition which characterizes his other textbooks for practicing technicians. Extensive use of line drawings, graphs, cut-away diagrams, and photographs has eliminated the need for elaborate mathematical exposition.

* * *

"FUNDAMENTALS OF NUCLEAR ENERGY AND POWER REACTORS" by Henry Jacobowitz. Published by *John F. Rider Publisher, Inc.*, New York. 114 pages. Price $2.95. Soft cover.

Since the day is rapidly approaching when the electrical power in our homes will be generated by nuclear reactors (several pilot plant operations are already under construction by the utilities), the subject matter of this book is not as remote from our daily lives as might be expected.

This is an up-to-the-minute, not-too-technical discussion of the part the "peaceful atom" can play in our future. The author discusses the construction, principles of operation, cost, and power output of specific plants and covers experimental reactors which will serve as prototypes for commercial units of the future.

The text is lavishly illustrated with photographs, line drawings, cut-away views, and pictorial diagrams. Since the treatment is largely non-mathematical, the intelligent layman should derive as much benefit from this book as utility company personnel.

* * *

"CLASS 'D' CITIZEN RADIO 1959 CALL BOOK" compiled and published by *International Crystal Mfg. Co., Inc.*, Oklahoma City, Okla. 101 pages. Price $1.00. Soft cover.

This is Vol. 1, No. 1 of what the company expects to be a series of "call books" for the "Class D" service in the Citizens Band The material is presented in familiar "call book" format by zones and, in addition, information on Citizens Band channels, radio districts, hanging coax antennas, message codes, radio codes, and pertinent FCC regulations has been included.

Calls are listed in numerical order with the license holder's name, street address, city, and state following. Those now licensed in the "Class D" Citizens Radio Service will undoubtedly find this material extremely helpful in view of their assumed inexperience with radio procedures.

* * *

"BASIC ELECTRONIC TEST PROCEDURES" by Rufus P. Turner. Published by *Rinehart & Co., Inc.*, New York. 316 pages. Price $6.50.

The sub-title of this volume aptly describes its content — "a practical handbook for electronic technicians." The novice technician, who already knows the basics about test instruments, possibly from this author's companion volume "Basic Electronic Test Instruments," will find in the present text step-by-step instructions on the use of meters, scopes, bridges, distortion checkers, and many other instruments. A large number of typical test setups are illustrated and described, ranging all the way from how to measure line voltage with a meter to industrial measurements.

Readers of this magazine are familiar with the author's clear, direct presentation. As a further aid to students each chapter is followed by a complete summary and a large number of review questions and exercises. The text should be of great value to all who use basic electronic test instruments professionally, as a hobby, or those who want to learn to use these instruments properly and profitably.

* * *

"SCIENCE STUDY SERIES" published by *Doubleday & Company, Inc.*, Garden City, N. Y. Five volumes. 95 cents each. Paper bound.

This new and basic series of "handbooks" represents a unique and dra-

matic approach to the teaching and study of physics. Born as the result of a conference of scientists and educators meeting at MIT, this series is under the aegis of the Physical Science Study Committee of Educational Services, Inc. and published by *Doubleday-Anchor Books* and Wesleyan University working cooperatively.

Each volume is written by an authority in the field who is also endowed with that rare gift of enthusiasm for his subject plus an ability to transmit both his knowledge and his enthusiasm.

There are currently five volumes in the series—"The Neutron Story" by Donald J. Hughes, a senior physicist at the Brookhaven National Laboratory; "Magnets" by Francis Bitter, professor of physics and associate dean of the School of Science at MIT; "Soap Bubbles" by C. V. Boys, (Sir Charles—1855-1944); "Echoes of Bats and Men" by Donald R. Griffin, professor of zoology at Harvard University; and "How Old Is the Earth?" by Patrick M. Hurley, specialist in the history of the earth at MIT. The volumes are numbered 1 through 5 in the order listed.

It would be difficult to find a more worthwhile venture in the paperback publishing field than this series of books—the information is authoritative, vital, and interestingly presented. Illustrative material has been used unstintingly and math sparingly—making these volumes basic enough for the beginner but authoritative enough for the serious student of the subject. All concerned with this project are to be congratulated on their foresight and public-spirited interest in the dissemination of scientific knowledge.

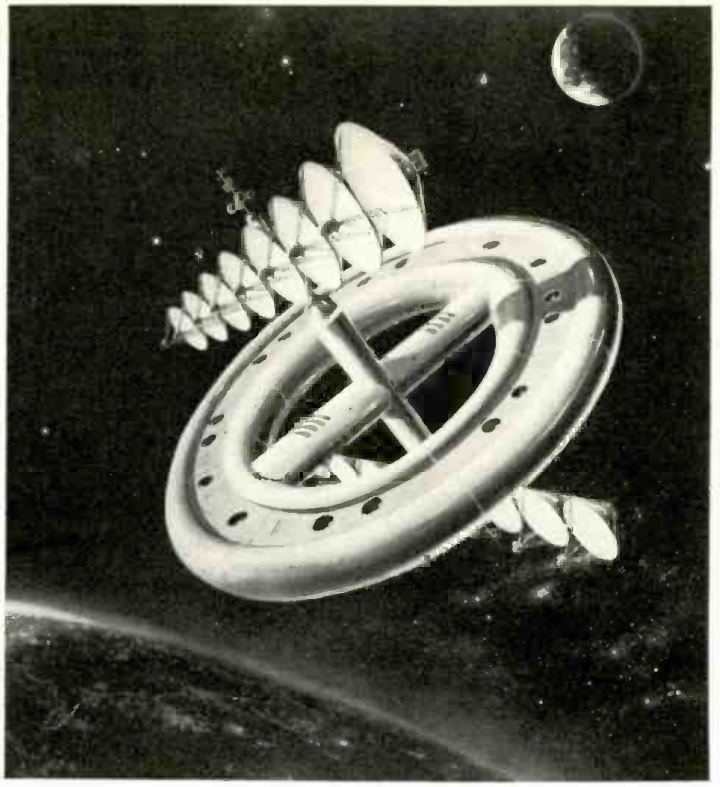
* * *

"RADIOTELEPHONE LICENSE MANUAL" by Woodrow Smith. Published by *Editors and Engineers, Ltd.*, Summerland, Calif. Price $5.00. Second Edition.

This manual is designed as an aid to those preparing for FCC license examinations covering basic radiotelephone and advanced radiotelephone tickets. It doesn't supplant standard texts on theory but does indicate the scope of the examinations and the areas on which the prospective licensee should concentrate his study efforts.

The text is divided into four chapters and an appendix. The chapters coincide with the "Elements" in the FCC exam and cover basic law, basic operating practice, basic radiotelephone, and advanced radiotelephone. The appendix includes useful formulas, radio mathematics and calculations, plus logarithm and decibel tables.

The material is presented in question and answer form for succinctness and to give the student a "feel" for the actual examination. The answers are brief and explanatory material is accurate but concise. For further exposition on any particular point, the student should consult standard engineering texts. Diagrams of circuits called for have been included. —30—



RCA's version of manned satellite that would hover far above the earth.

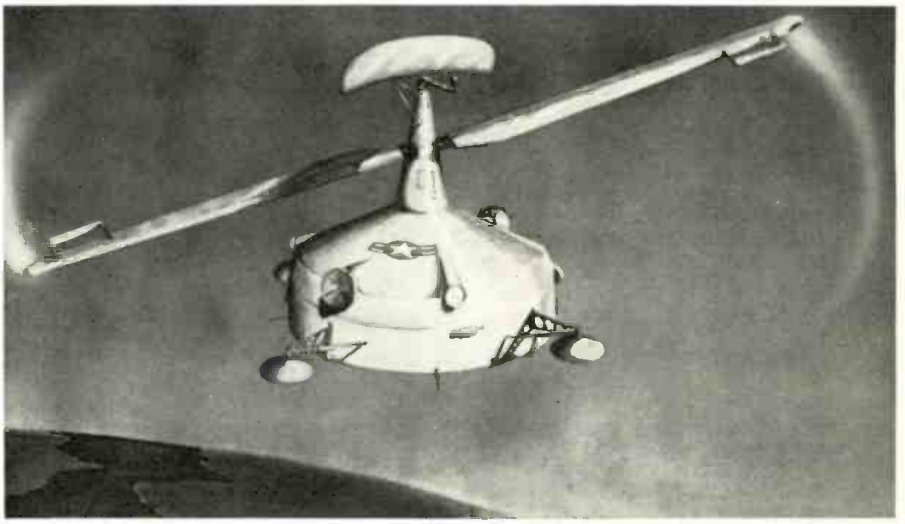
Space Platforms for the Future

Both manned and unmanned communications sky stations are now on government and on company drawing boards.

COMMUNICATIONS space stations of the type shown above—based on actual plans developed by engineers of *RCA*'s Astro-Electronic Products Div. —may become future "orbital post offices," relaying messages around the world by microwave radio. The satellite would remain in fixed orbit at 22,000 miles altitude, with antennas beamed at receiving and transmitting stations on earth. A network of three or four such stations may ultimately link all of the world's major cities with live television and microwave radio communications.

Shown below is a sky station proposed by *Raytheon Company's* Government Equipment Div. that would be powered by microwave energy beamed from the ground and then converted into heat energy in the satellite itself. The company has been awarded an Air Force study contract to spur the development of efficient forms of power conversion techniques. In addition to the radar antenna, the artist's conception also shows a number of relay antenna dishes that would be employed for long-range microwave communications. —30—

Raytheon's sky station would be unmanned and powered by microwave energy from earth.



Preserving & Cooking Food

(*Continued from page* 40)

Surprisingly enough, the technician called to service a microwave oven will not be confronted by an immensely complex device. The only essential test equipment is a voltohmmeter such as any radio and TV technician already owns. The service manual of the *Raytheon* "Mark III" unit shows a series of troubleshooting steps which will appear really easy to anyone accustomed to following TV service procedures. Most troubles are either magnetron failures, which can be determined by d.c. current or 60-cps voltage measurements, as indicated by the monitoring points in Fig. 9, or else poor contacts, broken leads, etc., which ohmmeter tests will show up quickly. Probably the most time-consuming part of servicing would be the disassembly of the power transformers and electromagnets because they contain a liquid cooling jacket. Fortunately, these parts are rarely the cause of trouble.

Routine servicing includes replacement of the air filters, defective or jammed interlock repair, adjustment or replacement of timers and burned out indicator lights, and fuses.

Conclusion

As mentioned at the beginning of this article, the "miracles" produced by the impact of electronics on the food industry will not be sudden but we can look forward to steady progress. Irradiation of food will soon move out of the laboratory and will probably first be used to meet the needs of our Armed Forces. Like many other uses of electronics which were pioneered by the Services, irradiation of foods will eventually be accepted by industry and, while the progress will be slow, the day will come when irradiated bread and many other items make their appearance in our daily diet. At first there will be competition among frozen, canned, and irradiated foods, but eventually the most economical method for each particular food will win out. While fresh irradiated fruits may be better than frozen or canned ones, beer should still be served cold, beans canned, and ice cream . . . irradiated?

The effect of microwave cooking is much easier to foretell. Since our ladies will enjoy even greater freedom from the "hot stove," they will be able to relax more and therefore continue on their merry road to "full emancipation." There is a bright side, too. It will take no longer to prepare a nice roast than it takes to cook frankfurters—so we can anticipate an occasional improvement in our diets. Our technically minded readers may face a new hazard though. They may have to fix, not only all the other household appliances, but "put a new tube in the oven" from time to time.

—30—

Printed Boards

(*Continued from page 51*)

circuit tracing. From the beginning, set manufacturers had some awareness that a service technician would need some sort of aid to guide him through the impossible labyrinth deposited on the board. Earliest attempts involved pictorial aids included with the service data, like the one shown in Fig. 3, which the technician was required to correlate with the "blind" board. While this approach had its shortcomings, the use of numbered and lettered coordinates running along the top, bottom, and sides of the pictorials is noteworthy. This is the same technique used for pinpointing exact locations on conventional road maps—and the comparison is prophetic.

The pictorial aid is valid and still used, but it now plays second fiddle to identification directly on the boards themselves. In Fig. 4 we see a portion of the top or component side of the *RCA* board that corresponds to the pictorial aid in Fig. 3. For clarity, Fig. 4 is shown with no components mounted. All actual wiring occurs on the underside of the panel, but the conductive paths have been faithfully transferred to the top in ink to facilitate tracing. In addition, the same numbers that identify components, tubes, and key circuit points on the schematic (such as C_{502}, R_{519}, E, G, L_{501}) are clearly printed beside the actual parts.

G-E does things a little differently. Fig. 1 is the lower right-hand portion of the board shown at the center of the cover, with no components mounted. Identification in bright yellow indicates tube types (6CB6, 6BZ6). Point-to-point circuit connections, instead of following the twisting paths below the board, are shown as direct, straight lines. Ground points are indicated by triangular symbols. Other important connections ("B+"1) and key test points (Roman numerals, such as "III") are marked to correspond with the service data. The fainter indications in Fig. 1 are in-plant production markings in white, to be ignored by the technician.

The *Westinghouse* answer to the problem of "reading" the board (Fig. 2) is based on another distinctive approach. All components are mounted on one side of the board. Everything else—this includes actual wiring as well as all identification—is on the other side. The protective, insulating overcoating on the conductive paths is in bright green for easy tracing. All other connections, components, and key points are shown *schematically* in yellow, nonconductive ink. Conventional symbols for resistors, capacitors, and coils are used, and actual values are printed beside them. Actual tube type numbers and functional pin connections are marked, instead of arbitrary code numbers. In other words,

you will not find such markings as V_1 or "pin 2." Instead you see "3CS6" or K (cathode) or G_1.

On the *Motorola* board, partially shown in the lower right-hand corner of the cover, little reliance is placed on readable symbols. Although conductive paths are on both sides of the board, the complete labyrinth of connections is duplicated in brightly colored ink on each side. Combinations of four colors are used in a code based on the EIA color coding system. With filament, plate, ground, and other types of connections dramatized in this way, we have still another way of getting across an idea of what is going on in a circuit, simply by glancing at the board that carries that circuit.

Most of the basic methods used for making the printed panels directly convey information have been covered with the four examples chosen. Samples from other manufacturers show variations of the techniques described. For example, the component-and-information side of a *Philco* board uses a system similar to that of *RCA*. However, in addition to component numbers, many key points are designated with such legends as "tuner," "vertical sync," or "2nd detector."

The effect of the new look, whatever its specific nature, is hard to overestimate. The final decision must be left to time, but those who make the most optimistic predictions might turn out to be right. Instead of being almost impossible to service, the coded panels —or the "road-map" boards, as many manufacturers are calling them—may indeed turn out to be easier to work with than conventional hand-wired chassis.

Because component and board mounting have been worked out anew with the problem of accessibility in mind, some claim it is now possible to reach, check, and replace all or most components without removing chassis from their cabinets. The "good, old" sets were never like this.

Because so much information that, in the past, could only be found in separate service data is now right on the panels, it should be possible to do far more work than was once feasible without so much as referring to a schematic. Some manufacturers give actual percentage figures on how much can be done, either in the cabinet or without auxiliary data, on their designs. Such figures as "80%" or "90%" may raise the eyebrows of the conservative-minded, but they appear frequently. In any case, the general methods have been laid down for convenience and speed in servicing that were unheard of a few years ago, and the "new look" is only beginning.

At this point, the technician may begin to feel a little grateful that no one has succeeded—yet—in getting *all* of the necessary data inside the set to the extent that supplementary information can be eliminated altogether. After all, some remaining challenge to individual ingenuity is still appreciated. —30—

Transistor Radio Circuits

Part 1. Initial installment of a series that will analyze circuits widely used in automobile and portable receivers covers the r.f. amplifier.

EDITOR'S NOTE: *This material on transistor circuits, appearing here and in subsequent issues, is being reproduced with the kind permission of the* Delco Radio Division *of* General Motors Corporation. *Although originally prepared and distributed to those servicing* Delco *auto radio receivers, much of the information is also applicable to other types of transistorized radios and we believe it worthwhile to present this material to our readers.*

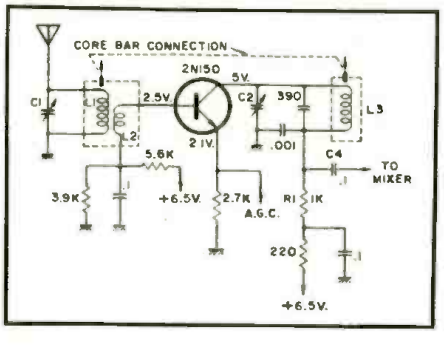
TRANSISTORS employed in automobile radio receivers are generally divided into two major groups—low-power junction transistors and high-power junction types. Low-power transistors of the *n-p-n* and *p-n-p* variety are useful in the following applications: r.f. and i.f. amplifiers, oscillators, mixers, detectors, audio preamps, a.g.c. amplifiers, and trigger stages. High-power transistors, referred to as "power transistors," are usually of the *p-n-p* type and are to be found in such circuits as: single-ended class A audio output stages, push-pull class AB audio output stages, and square-wave oscillator circuits utilizing transistors in place of the vibrator.

R. F. Stage

Fig. 1 shows a typical transistorized r.f. stage. The purpose of this stage is to amplify the small signal voltages received at the antenna and to discriminate between wanted signals and unwanted ones (images). The amount of selectivity obtained depends primarily upon the "*Q*" of the tuned circuits used and the signal amplification is primarily dependent upon the transistor and how it is operated.

The transistor is a 2N150 low-power unit of the *n-p-n* variety, connected in a common-emitter configuration. This means that the emitter element is common to both the input and output circuits. In the input circuit the untuned tickler winding, L_2, inductively couples the signal from the parallel-tuned antenna circuit. L_1-C_1, to the transistor base. A step-down ratio between L_1 and L_2 is used to match the high impedance of the antenna circuit to the low impedance of the transistor input.

Fig. 1. This "n-p-n" r.f. amplifier uses a common-emitter configuration.



"Forward bias" voltage is obtained for the transistor by a voltage divider network in the base circuit, consisting of a 3900-ohm and a 5600-ohm resistor connected in series across a 6.5-volt line. The voltage at the base connection between these two resistors is approximately 2.5 volts, derived from simple bleeder current through the resistors and a small amount of base current which flows.

A positive voltage on the base of an *n-p-n* transistor attracts electrons from the emitter and causes collector current to flow. Since both the collector current and a small base current must return through the emitter circuit, a voltage drop is produced across the 2700-ohm emitter resistor. In vacuum-tube circuits, a similar resistor in the cathode circuit is commonly known as a "self-biasing resistor." Here, the voltage drop across the resistor reduces the forward bias between base and emitter. In transistor circuits, the emitter resistor is more commonly referred to as a "stabilizing resistor" since it tends to control collector current due to its influence on emitter voltage. Although the emitter is positive with respect to ground, it is negative with respect to the base and a .4-volt forward bias exists on the input diode. However, this bias is further reduced on strong stations by the a.g.c. voltage which is coupled to the emitter. As the a.g.c. line swings positive, the emitter voltage increases and reduces the gain of the stage—sometimes to the point of completely cutting off collector current and allowing the signal to pass through only by inter-electrode capacitance within the transistor. This is true on very strong signals at which time it is desirable to keep the sensitivity of the receiver at a low level.

The collector is biased in the "reverse direction" by a positive 5 volts and collector current variations are introduced through the r.f. coil L_3 and the collector resistors. Powdered iron cores tune L_2 and L_3 through the same frequency range by their physical connection to a common core bar. The tuned parallel-resonant collector tank circuit allows the 2N150 to "see" a high output impedance and the *RC* signal-coupling network R_1 and C_4 lets the input of the following stage see the proper low impedance.

(*To be continued*)

CALENDAR of EVENTS

OCTOBER 29-30

Fifth Annual Electron Devices Meeting. Sponsored by Professional Group on Electron Devices, IRE. Shoreham Hotel, Washington, D. C. Dr. John A. Hornbeck, Bell Labs, Murray Hill, N. J., technical program chairman.

NOVEMBER 3-5

Mid-America Electronics Conference. Sponsored by Kansas City Section of IRE. Municipal Auditorium, Kansas City. Program details available from MAECON, 5109 Cherry St., Kansas City 10, Mo.

NOVEMBER 4-6

National Automatic Control Conference. Sponsored by PGAC, PGIE, Dallas Section ISA, and AIEE. Sheraton-Dallas Hotel, Dallas, Tex. Program information available from George Axelby, Westinghouse, Box 746, Friendship Airport Station, Baltimore, Md.

NOVEMBER 5-6

Eighth Annual Instrumentation Conference. Sponsored by School of Engineering, Louisiana Polytechnic Institute, Ruston, La. Papers and exhibits. Contact Institute for program.

NOVEMBER 9-11

Radio Fall Meeting. Sponsored by IRE and EIA. Syracuse Hotel, Syracuse, N. Y. Virgil M. Graham, % EIA, 11 W. 42nd St., N. Y. C., program chairman.

Fourth Instrumentation Conference. Sponsored by PGI of IRE. Atlanta, Georgia. Details from W. B. Jones, Jr., Georgia Tech, Atlanta 13, Ga.

NOVEMBER 10-12

Twelfth Annual Conference on Electrical Techniques in Medicine and Biology. Sponsored by AIEE, ISA, and PGME of IRE. Sheraton Hotel, Philadelphia, Pa. Dr. L. E. Flory, RCA Labs, Princeton, N. J., for program details.

NOVEMBER 11-13

Sixteenth National Meeting. Sponsored by Operations Research Society of America. Huntington-Sheraton Hotel, Pasadena, Calif. Technical sessions and panel meetings. Contact Sidney I. Firstman, % The Rand Corporation, 1700 Main St., Santa Monica, Calif., for program information.

NOVEMBER 16-19

Conference on Magnetism and Magnetic Materials. Sponsored by IRE, AIEE, APS, AIM, and ONR. Sheraton-Cadillac Hotel, Detroit, Mich. Program information from J. E. Goldman, Scientific Lab., Ford Motor Co., Box 2053, Dearborn, Mich.

NOVEMBER 17-19

1959 NEREM Meeting. Sponsored by Region 1 of IRE. Boston Commonwealth Armory, Boston, Mass. Program information from Dr. Gardner A. Norton, % Avco, Lawrence, Mass.

Manufacturers' Literature

"THYRATRONS ARE DIFFERENT"

CBS Electronics, Parker Street, Newburyport, Mass., has a new technical bulletin entitled, "Thyratrons Are Different," written by Bud Tomer. Known as PA-223, the bulletin is available from the company's advertising service at the above address.

Author Tomer explains the mechanism of ionization, describes the "critical characteristic" curve, and discusses the effects of temperature on ionization time and tube life.

Installation precautions are also given.

PARTS SELECTOR CATALOGUE

Ram Electronics Sales Company, 600 Industrial Avenue, Paramus, N. J., has issued a new 36-page catalogue of electronic component service replacements and technical information for the electronic technician. This brochure is available without charge by writing direct to the company.

The new two-color, illustrated parts selector guide features the latest in up-to-date listings of the firm's components. It includes details on i.f. coils, power and audio transformers, filter chokes, as well as a great deal of technical information and "service hints" that are extremely useful to the electronics technician.

AUTOMATION AGE "SPOOF"

Audio Devices, Inc., 444 Madison Avenue, New York 22, N. Y., has acknowledged the age of automation with a collection of cartoons illustrating the effect of electronics on life today.

Particularly appropriate for those involved in the computer and telemetry fields, the booklet may be obtained at no charge by writing to the firm.

Reprinted from leading periodicals, the booklet is tersely entitled, "A Study of the Unique Influence of Space-Automation Technology on the Present-Day Environment with Special Attention to its Implications for the Behavioral Sciences."

AUTO RADIO COIL GUIDE

J. W. Miller Co., 5917 South Main Street, Los Angeles 3, California, is offering a complete 20-page auto radio coil guide which lists every auto radio coil in use and quickly identifies each item for replacement.

Available through the firm's distributors or by writing to the company, this catalogue (No. 260) provides the technician with a cross-reference of 1000 part numbers from 45 manufacturers to the company's equivalents.

The text includes specifications and prices on intermediate frequency transformers, r.f. coils, chokes, and other related items.

SEMICONDUCTOR DEVICES

Transitron Electronic Corporation, 168-182 Albion Street, Wakefield, Mass., has a new condensed catalogue of semiconductor devices—TE-1340A.

The brochure provides a rapid reference source and features a listing of all basic silicon and germanium products in the company's line. Package photos of the various components accompany accurate data charts which supply information regarding the actual range of performance of each device.

A description of the component type underlines the significant features as they relate to various aspects of individual application.

1960 ALLIED CATALOGUE

Allied Radio Corp., 100 N. Western Ave., Chicago 80, Ill., has announced the release of its 1960 general catalogue of electronic parts and equipment. It is available free upon request direct to the company.

The 444-page catalogue, which includes 232 pages in rotogravure and 4-color covers, lists over 40,000 items. The company's line of "Knight-Kits" is illustrated and described in a 64-page. 2-color rotogravure section.

A full presentation of the latest stereophonic high-fidelity equipment in all leading makes is shown, including such items as amplifiers, tuners, speakers, enclosures, cartridges. record changers, recording and playback decks, and add-on components for conversion of conventional systems to stereophonic sound. Stereo records. tapes, and tape recorders for professional and home use are also covered.

The catalogue also offers a television and amateur radio section, and listings on transistors. tubes, television antennas, Citizens Radio transceivers, intercom units, electronic counters. rectifiers, transformers, accessories, and technical books.

OTS TRANSISTOR CATALOGUE

Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C., has published a revised edition of its catalogue of technical reports on transistors (CTR-310 Transistors). Copies may be ordered from the Department at a cost of 10¢ each.

The catalogue lists 146 technical reports on transistors available to industry through the facilities of OTS, in some cases in printed form and in others in photocopy or microfilm.

The reports are the result of research by the Army, Navy, and Air Force between 1949 and June, 1959.

RCA SEMICONDUCTORS

RCA, semiconductor and materials division, Somerville, N. J., has released its revised and expanded edition of the booklet entitled, "*RCA* Semiconductor Products." It is available at a cost of 30¢ through the firm's semiconductor

products distributors or by sending payment direct to the company at the Somerville address.

The new 40-page edition contains technical data on the company's germanium and silicon transistors and silicon rectifiers. Maximum ratings, typical operating characteristics, and dimensional outline are given for each type.

Also included in this booklet are a section on transistor theory, an interchangeability directory which lists over 1100 type designations of 29 different manufacturers, and a section on circuits containing 37 schematic diagrams illustrating some of the more important applications of transistors and silicon rectifiers.

RAYTHEON BROCHURE

Raytheon Company, industrial tube division, 55 Chapel Street, Newton 58, Mass., has released a new brochure which describes the firm's welded assembly technique for high density packaging of electronic components. Free copies are available from the company. Contact Mr. Wesley J. Davis, Dept. 2528, at the above address.

The six-page booklet describes the new technique, which was developed by the company's industrial tube division working with Massachusetts Institute of Technology's instrumentation laboratory. It details the savings in space, weight, and power consumption made possible with welded assemblies and shows how their reliability and mechanical ruggedness make them particularly adaptable to installations in data processing equipment, computers, and airborne electronic systems.

G-E TUBE HANDBOOK

General Electric Company's electronic components division, Owensboro, Kentucky, is offering a new edition of its receiving tube and television picture tube handbook, "Essential Characteristics," at a price of $1.00.

This 260-page book contains a total of 1392 receiving and special-purpose tube types and 399 television picture tube types. A new section lists the domestic near-equivalents of 95 foreign tubes for ready reference by service technicians.

The handbook also includes classification charts for quick and convenient reference to tube families that are available for specific classes of service. Outline drawings and configurations are keyed to each type, giving designers essential dimensions. Characteristic curves are given for 13 basic families of receiving tubes.

Still featured is the popular comb binding which permits keeping the book flat on desk or workbench and the inclusion of pertinent basing diagrams on each page.

BATTERY CHARGERS

Terado Company, 1068 Raymond Avenue, St. Paul 8, Minn., is offering a catalogue sheet which illustrates and describes the firm's new battery chargers.

The four-color sheet covers details on the company's Model 50180 high power charger and the Model 50181 super charger for cars, boats, and tractors.

Write direct to the manufacturer for further details.

"SILCAD" BATTERIES

Yardney Electric Corp., 40-50 Leonard St., New York, N. Y., has issued a technical brochure on "Silcad" batteries entitled, "The Battery For You . . . Wherever Long Life, Maximum Power and Minimum Space and Weight Are Required."

The six-page booklet supplies extensive data on physical and electrical characteristics of the cells, as well as numerous graphs comparing performance of this system with that of other types of batteries.

For additional information, contact the company at the above-mentioned address.

TRANSISTOR HANDBOOK

Allied Radio Corp., 100 N. Western Ave., Chicago 80, Ill., has published a new 64-page handbook entitled, "Understanding Transistors" by Milton S. Kiver. Priced at 50¢, the handbook is available direct from the company.

Beginning with a discussion of the properties of germanium, the opening sections of the book clarify important basic theory and provide a solid foundation for the succeeding chapters. Some subjects covered include atoms and molecules, electrons and holes, current flow, junction transistors, drift and tetrode transistors, surface barrier transistors, basic transistor amplifier circuits, power amplifiers, r.f. and i.f. amplifiers, transistor oscillators, silicon transistors, etc.

Many additional transistorized circuits, with a detailed explanation of each, are also included. There are over fifty diagrams and illustrations. —30—

AUDIO-VISUAL AIDS TO SCIENCE EDUCATION

SIX new audio-visual aids to science education have just been produced by Bell Telephone Laboratories, and they are being made available without charge to educational institutions and professional groups through local Bell Telephone Co. offices.

The aids include 16-mm. sound films on "Crystals—an Introduction," "Brattain on Semiconductor Physics," and "Submarine Cable System Development." Also available are filmstrips with record narration on "Zone Melting" and "The Formation of Ferromagnetic Domains." Finally, a record album consisting of two 33⅓ rpm discs on "The Science of Sound" is available.

The training aids, which have been double-checked for technical accuracy and proper educational values, have been produced to complement regular lectures in science and engineering. If the record album is an example of the quality and excellence of the other aids, then we would not hesitate to recommend them as valuable adjuncts to training courses dealing with the subjects covered. —30—

What's New in Radio

MULTI-PURPOSE TESTER

Sencore of Addison, Illinois has announced the release of its new SS105 "Sweep Circuit Trouble-Shooter"—an

instrument specifically designed to pinpoint sweep troubles in both horizontal and vertical circuits.

The new unit, according to the company, is actually a "6-in-1" instrument, serving as a universal horizontal oscillator, horizontal output cathode-current checker, universal deflection yoke, dynamic flyback transformer checker, voltmeter, and universal vertical oscillator. Checking cathode current in the horizontal output stages is greatly simplified by an easily replaceable roll chart which gives all necessary pin, current, and voltage data. An adapter socket eliminates the need for breaking connections.

The instrument weighs only four pounds and measures 7" x 6" x 3½". It is currently available at electronic parts distributors.

"POLY-COMM" CLASS D SET

Polytronics Laboratories Inc., 253 Crooks Ave., Clifton, N. J. is now offering a 4-channel Class D Citizens Band transceiver in a choice of two dual-voltage models.

The circuit features a super-sensitive, dual-conversion 10-tube superhet receiver which incorporates fast-acting

adjustable tube squelch circuit, delayed a.g.c., floating series-gate-type noise limiter, and full 2 watts of audio.

A unique electronic changeover circuit switches from transmit to receive without use of relays by actuation of

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You can still get this brand new

STEREO-MONOPHONIC TEST RECORD

produced by the editors of ELECTRONICS WORLD

...and enjoy top performance from your hi-fi system!

Special to our readers for only...

The demand for this new, trouble-shooting test record has been, and still is, stupendous! So great, our original pressing quickly sold out! However, we've just received a new supply—and are prepared to fill your order by return mail. If you already have this wonderful disc, get several more as Christmas gifts for hi-fi-minded friends. If you haven't already ordered one, we urge you to join the tens of thousands whom it has helped achieve top hi-fi reproduction. By all means, *fill in and return the coupon below, right now!*

Here are some of the questions this record will answer for you!

- ✓ *How good is my stylus? Is it worn? Will it damage my records?*
- ✓ *What about my stereo cartridge? Does it have enough vertical compliance so that it won't ruin my expensive stereo records?*
- ✓ *Is my turntable running at the right speed? Is it free of rumble, wow, and flutter?*
- ✓ *What sort of standing waves do I get in my listening room?*
- ✓ *Are my speakers hooked up correctly? Are they phased properly, and is the correct speaker connected to the right stereo channel?*
- ✓ *How perfectly is my system equalized?*
- ✓ *What about separation? Is it adequate?*

You'll get on-the-spot-answers to these and many other questions when you use this Stereo-Monophonic Test Record. It's the *most complete test record* of its kind—contains the widest range of essential check-points ever incorporated into *one* test disc! And, best of all, you need no expensive test equipment when you use this record! Just listen and get the thorough results you want—*all checks can be made by ear!*

As a man who is seriously interested in hi-fi, you can immediately see the extraordinary 2-way value you get from this special test record. First, it guides you in evaluating the quality of reproduction your equipment now produces. Second, it specifies the adjustments necessary to get the best recorded sound you have ever heard! Add up the advantages! Check the special low price! This is easily the best value of the year for everyone who owns a hi-fi system—either monophonic or stereo!

Special Features of ELECTRONICS WORLD 7" Stereo-Monophonic Test Record

- Four bands for stereo checks only—plus three bands for checking stereo or monophonic equipment!
- Made of top-quality virgin vinyl for long wear!
- Specially-reinforced center resists wear!
- Delivered in special polyethylene envelope—dust and dirt are sealed out!
- Fully guaranteed!

Don't miss out—Order your Test Record for just $1 now!

This Stereo-Monophonic Test Record has been produced as a service for readers of *Electronics World*. You can be sure that it comes as close to perfection as is humanly possible, because the editors have poured their accumulated know-how into this project for a period of many, many months. You may obtain a copy at the special reader-price of just $1.

If you wish to order several test records for gifts, check the appropriate box in the coupon below for immediate shipment. Fill in and mail the coupon, together with your check ($1 per record) *today!*

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Please send me_____tests records at $1 each. My money order or check for $_____ is enclosed. I understand that you will pay the postage and that each record is fully guaranteed.

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the press-to-talk button on the carbon mike. The microphone has a hang-up clip on the front for mobile applications. A separate microphone preamp virtually eliminates all background or wind noise. Separate oscillator and a straight-through plate-modulated final yields a minimum of 2.5 watts output to any 52- or 72-ohm resistive antenna load. There is a built-in carrier and modulation indicator.

Available for 6-v.d.c./117-v.a.c. or 12-v.d.c./117-v.a.c. operation, the transceiver comes equipped with a crystal for one channel while other channels may be activated by plugging in additional crystals. Customers should specify channel and desired power supplies when ordering.

A specification sheet on the "Poly-Comm" will be supplied by the manufacturer on request.

RCA SCOPE KIT

The Electron Tube Division of *Radio Corporation of America,* Harrison, N. J. is now offering a new portable oscilloscope in both kit and factory-wired form.

The WO-33A is designed for lab technicians, hobbyists, hams, and experimenters. The kit contains simple step-by-step instructions, laminated circuit board construction, and oversize drawings. Components, keyed to their proper location, are mounted on one side of the circuit board and solder connections are made on the other side.

On narrow-band position for the vertical amplifier, sensitivity is 3 mv. per inch and bandwidth within −3 db from 20 to 150,000 cps. On wide-band position sensitivity is 100 mv. per inch and bandwidth within −3 db from 5.5 cps to 5.5 mc.

The 3-inch scope is small, lightweight, compact, and truly portable. It weighs 14 pounds and measures 6½" wide, 8¾" high, and 10¼" deep.

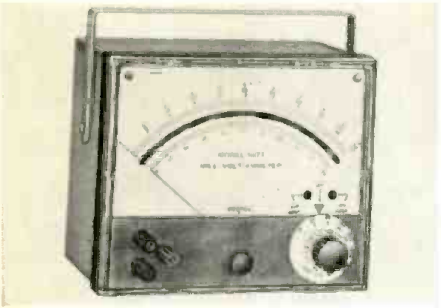
COMPACT MV./AMMETER

Weston Instruments Division of *Daystrom, Incorporated,* 614 Frelinghuysen Ave., Newark 12, N. J. has announced the availability of a single, compact electronic millivolt/ammeter which boasts zero-drift comparable to that of PM moving-coil instruments.

The Model 1477 is designed for the measurement and amplification of a wide range of d.c. currents and voltages from 10 to 1000 microamperes and 1 to 1000 millivolts. The instrument is a true d.c. meter with essentially zero-power drain from the source being measured combined with power-gain sufficient to supply 1 ma. output to drive its own indicating meter and external load of 5000 ohms or less. Since zero-drift is dependent only on a position of the galvanometer coil, long-time drift can be maintained to less

than 2μv. after a few minutes' warm-up time.

This new instrument uses no mechanical switches or choppers and is designed with a special electronic servo-



amplifier whose high gain, coupled with full feedback, provides accuracy and stability without the adverse effects resulting from variations in line voltage or frequency, condition of amplifier tubes, and other such variables.

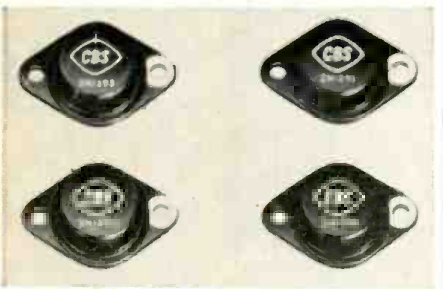
Full details on the Model 1477 electronic millivolt/ammeter will be supplied by the manufacturer on request.

"COMPLEMENTARY" TRANSISTORS

The first in a series of complementary *n-p-n—p-n-p* power transistor lines has been announced by *CBS Electronics'* Semiconductor Operations.

These complementary pairs of transistors permit new circuit design economies. They eliminate input and output transformers in push-pull circuits to save money and space while providing improved frequency response, according to the company.

This planned line of "pairs" is the result of consumer demand. The *n-p-n* transistors have electrical characteristics identical to those of their *p-n-p* counterparts. The pairs feature high



voltages—up to 100 volts—for audio, control, voltage-regulation, servo, and computer applications.

All types in the line have a maximum collector current of 3 amps, a minimum large-signal current gain of 30, and a maximum thermal resistance of 3 degrees C per watt.

Complete technical data on this new series is available from the Information Services of the company at 100 Endicott St., Danvers, Mass. Ask for Bulletin E-355.

SIGNAL TRACER—GENERATOR

Electronic Measurements Corporation, 625 Broadway, New York 12, N. Y. is now marketing a combination signal tracer and generator as its Model 802.

In the absence of a signal, the unit

generates its own signal for audio, i.f., or r.f. testing. The Model 802 also incorporates a noise locator circuit for checking noisy components and uses a magic-eye tube for visual detection and a speaker for aural detection of the

signal. In addition, provisions are made for using the instrument as a substitute speaker or amplifier. It can be used for checking and comparing magnetic, ceramic, and crystal cartridges.

The instrument is transformer-operated for safety and high efficiency. It uses separate high-gain r.f. and low-gain audio input channels and generates an audio signal of approximately 400 cps for testing audio systems. It also generates a modulated signal of 455 kc. for testing i.f.'s in radios using this i.f. frequency.

The Model 802 comes complete with a shielded crystal demodulator probe and two shielded audio probes. It is available in either wired or kit form. It measures 10" x 7" x 5" and weighs 7½ pounds.

PLASTIC "EXTENDER" FREE

Electro Chemical Corporation of Jersey City, N. J., is offering users of its "No-Noise Volume Control" and "No-

Noise Tuner-Tonic" a free bonus in the form of a 5-inch plastic extender for use with these aerosol packaged products.

The extender, which fastens to the top of the spray can, has a push-button assembly. It is ideal for pin-point applications of the liquids and does not cause shorts. This free premium is available through jobbers.

SHARP CUT-OFF TETRODE

Westinghouse Electric Corporation has recently introduced a new high-frequency, sharp cut-off tetrode for use as the r.f. amplifier in v.h.f. television tuners.

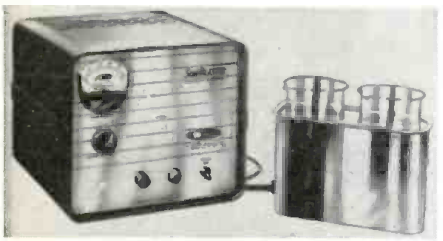
Designated as the Type 6EV5, its high transconductance and high input impedance at 200 mc. makes it suitable for use in i.f. amplifiers and other

v.h.f. applications. The new tube is very similar in construction to the 6CY5 but has higher available gain and lowered noise figure as the result of its high input impedance, high transconductance, and low value of screen current. Under typical operating conditions—plate voltage of 250 volts d.c. and screen voltage of 80 volts d.c.—the new tube has a transconductance of 8800 μmhos for a plate current of 11.5 ma. and a screen current of 0.9 ma.

For full information on this new tetrode, write the company at P.O. Box 2099, Pittsburgh 30, Pa.

SMALL ULTRASONIC CLEANER

The NARDA Ultrasonics Corporation, 625 Main Street, Westbury, L.I., New York has recently introduced a



new, low-cost multi-purpose "SonBlaster" ultrasonic cleaning unit which can handle two different jobs at the same time.

The Series 400 ultrasonically agitates the contents of two 400 ml. Pyrex glass beakers. This permits the washing and rinsing of parts simultaneously, using two different solutions at the same time.

The new "SonBlaster" consists of an ultrasonic generator, Model G-401; a transducerized ultrasonic tank, Model NT-401; and two 400 ml. Pyrex glass beakers. Items to be cleaned or processed may be placed in separate beakers or directly in the tank itself. The device operates from a standard 117 volt, 50-60 cps line and draws no more current than an electric light bulb.

The company suggests its use in cleaning delicate products and parts including dentures, dental instruments, contact lenses, gears, relays, potentiometers, miniaturized components, radioactive lab apparatus, semiconductors, timing mechanisms, etc.

Write the manufacturer direct for additional details and price.

NEW TUBE FOR SSB

The Electron Tube Division of *Radio Corporation of America,* Harrison, N. J. is now offering the first beam-deflection tube specifically designed for balanced-modulator, balanced-mixer, and product-detector service in single-sideband communications equipment.

The *RCA*-7360 will make possible simplified, low-cost circuitry with improved performance for single-sideband and double-sideband, suppressed-carrier communications equipment, according to the company.

The unique deflection systems of the tube makes it suitable for use in low-distortion audio-fader circuits, remote

Coming in December Electronics World:

JAMMING

Secret Warfare in Electronics!

Jamming could save your life! The old art of deceiving an enemy's radio or radar system looms as one of the most important defensive weapons in our arsenal.

In next month's exciting ELECTRONICS WORLD article "Electronic Countermeasures"—you'll get authoritative, important answers to such problems as false range information... decoy missiles ...misleading radar echoes... plus a complete historical survey that will show you how electronic counter-measures saved thousands of lives and helped bring us victory in World War II.

You'll also enjoy such important December ELECTRONICS WORLD articles as:

- **LET'S LEGALIZE AMATEUR PHONE PATCHES**—A prominent telephone company official tells you how the now illegal phone patch could be legalized—to the benefit of all concerned.
- **DIELECTRIC HEATING**—Find out how this important process is now being used to package goods, prepare plywood, bake foundry cores, mold boats, make plastic bags, produce many other varied products for home and industry.
- **BUILD YOUR OWN STROBE ANALYZER**—Complete construction details on an unusual and versatile strobe unit that can be used to "freeze motion". It's helpful in looking for causes of vibration in equipment, checking turntable motors, and performing many other important jobs.
- **BALANCING YOUR STEREO SYSTEM**—Here are complete instructions that make a handy guide for matching the acoustic output of your stereo channels.

All of these features are coming your way in December ELECTRONICS WORLD—typical of the coverage you'll enjoy month after month in the world's most authoritative technical electronics magazine. Subscription rates will go up January 1st, so take advantage of the present low rates to bring ELECTRONICS WORLD to your door every month. Subscribe today!

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switching of studio and high-fidelity equipment, and other applications in which isolation of control voltage and signal voltage is required. The tube is capable of operation up to at least 100 mc.

This nine-pin miniature features balanced push-pull output with single-ended input; high gain and large output-signal voltages; self-excited operation; stable balance with life over a wide range of temperatures; high input impedance, 60 db carrier suppression in balanced-modulator service, and 40 db oscillator-signal suppression in balanced-mixer service.

Full specifications on this tube are available from the company's tube distributors.

CRT REJUVENATOR-TESTER

B&K Manufacturing Co., 3726 N. Southport Ave., Chicago 13, Ill. is now offering a new, completely self-contained CRT cathode rejuvenator and tester as its Model 440.

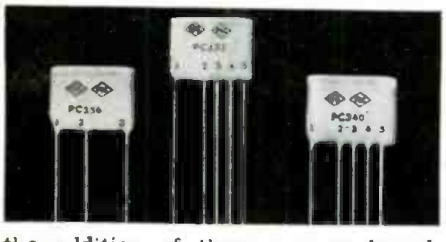
This new model is completely integrated. It tests and rejuvenates all black-and-white and color picture tubes at the correct filament voltage from 1 to 12 volts, including 110-degree tubes with 2.34, 2.68, 6.3, and 8.4 volt filaments. The unit tests and rejuvenates each gun of color picture tubes the same as black-and-white.

Testing and rejuvenating can be performed with the picture tube in the set. The Model 440 checks leakage, restores emission and brightness, repairs inter-element shorts and open circuits, life-test checks gas content, and indicates picture quality by means of grid cut-off readings.

The unit is housed in a leatherette-covered carrying case. A data sheet on this new service equipment will be supplied by the manufacturer on request.

PACKAGED CIRCUITS FOR TV

Centralab, Division of *Globe-Union, Inc.*, Milwaukee, Wis. has announced



the addition of three new packaged electronic circuits for replacement applications in television receivers.

Designed primarily for *RCA* and *Philco* sets, the new units are the No. PC-336 retrace suppression circuit, the No. PC-337 phase comparator circuit, and the No. PC-340 a.g.c. voltage divider.

There are an estimated 500,000 tele-

vision sets now in the field incorporating PEC circuits as original equipment.

TUBE FOR HYBRID RADIOS

The Electron Tube Division of *RCA*, Harrison, N. J. has just introduced a new twin-diode—power tetrode which has been especially designed for hybrid auto radio receivers operating directly from 6-cell storage battery systems.

The 12DS7-A is a multi-unit of the 9-pin miniature type containing two diodes and a high-perveance power tetrode of the space-charge-grid type in one envelope. Used in hybrid receivers operating from 12-volt batteries, the diode units are used for AM signal detection and automatic volume control while the tetrode unit serves as the driver for the transistorized power-output stage.

The 12DS7-A is unilaterally interchangeable with the 12DS7. —30—

OLDEST ASTATIC MIKE

ASTATIC CORP., Conneaut, Ohio is staging a world-wide contest to unearth the oldest Model D-104 microphone owned by an amateur operator. The contest is open to licensed hams only.

First prize is a working model D-104 cast in sterling silver, mounted for use or display as a trophy. In addition, the winner will receive his choice of either a standard model D-104 or a model 10-D or 10-C, all equipped with stand.

The D-104 has been made for 25 years. Contestants should send the serial number of their D-104, name, call letters, and address to "Astatic D-104 Worldwide Contest," The Astatic Corp., Conneaut, Ohio. The deadline is midnight December 1st. Winners will be announced in April. —30—

W. E. HOLDS "OPEN HOUSE"

WESTERN ELECTRIC, the manufacturing "arm" of the Bell System, recently held a week-long "Open House" at its Allentown Works to permit the press to inspect its 783,900 square feet of manufacturing facilities.

This modern manufacturing center makes tubes, switches, control units, transistors as well as serving as a research center for improving products used by the Bell System.

The plant has been in operation at Allentown since 1946 and now employs 3400 with 200 additional Bell Labs' resident personnel. The installation includes a manufacturing building, office quarters, and power and gas houses, and a service building. —30—

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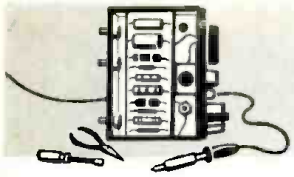

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STOP TV commercials, complete plans for remote control $1.00. Kittymack, Box 34EW, Monclova, Ohio.

FREE Fluorescent Bargain Catalog—Fixture kits, Fixtures, Circlines, Parts. Shoplite, 650N Franklin, Nutley 10, New Jersey.

FM TUNERS, 88-108 megacycles, 4 tubes complete, $14.95. Grutmans, 1 E. 167 St., N.Y.C. 52, N. Y.

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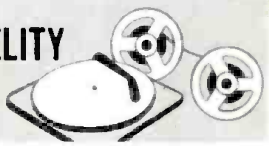

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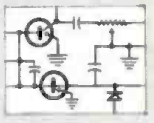

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NOVEMBER 1959

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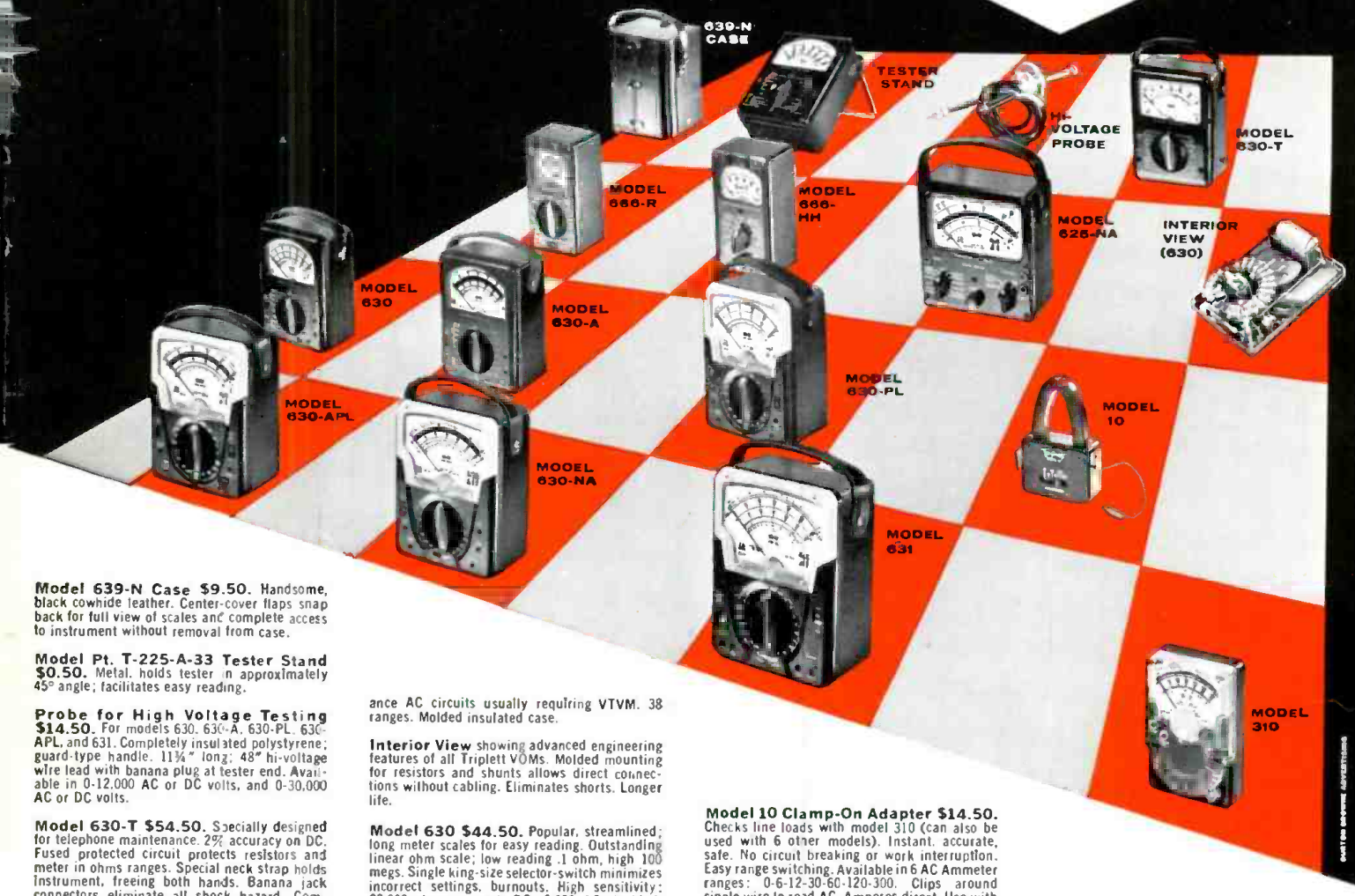

Model 639-N Case $9.50. Handsome, black cowhide leather. Center-cover flaps snap back for full view of scales and complete access to instrument without removal from case.

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Model 630 $44.50. Popular, streamlined; long meter scales for easy reading. Outstanding linear ohm scale; low reading .1 ohm, high 100 megs. Single king-size selector-switch minimizes incorrect settings, burnouts. High sensitivity: 20,000 ohms per volt DC; 5,000 AC. Molded, fully insulated case.

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