ELECTRONICS WORLD

FEBRUARY, 1960

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RADIO & TV NEWS

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SPECIAL FEATURE

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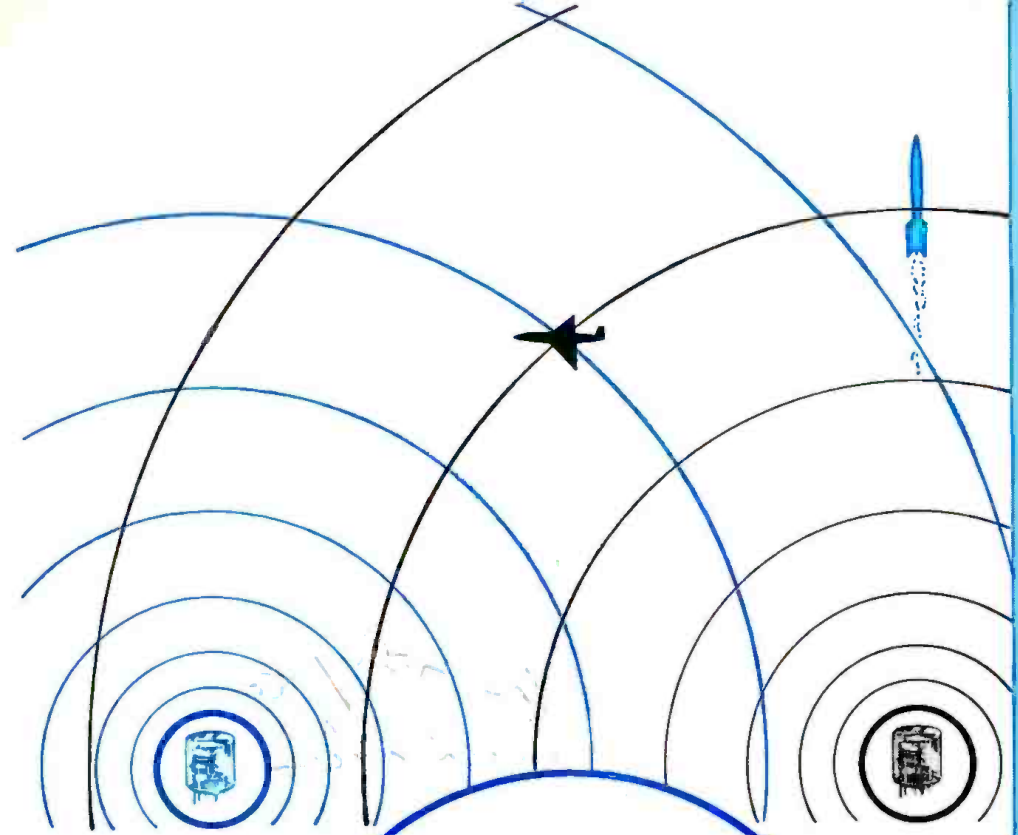
CONSTRUCTION DETAILS ON A TWO-METER TRANSISTOR TRANSMITTER

ROOM ACOUSTICS FOR STEREO

Part 2. Reverberation and Room Treatment



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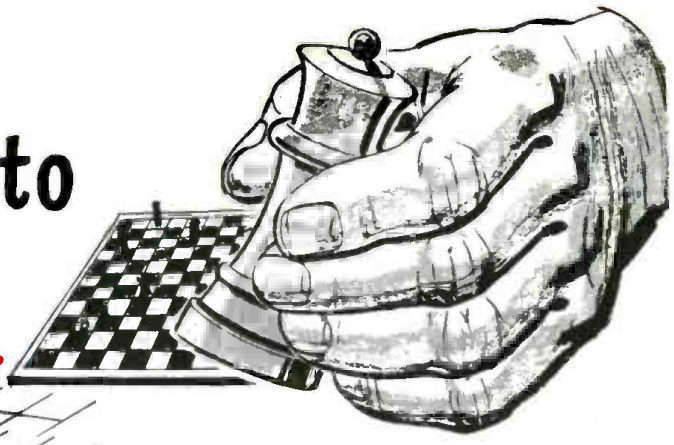

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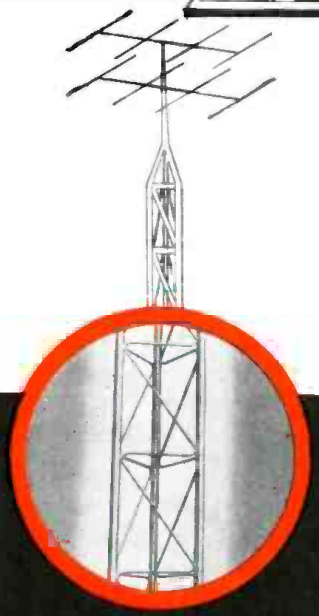

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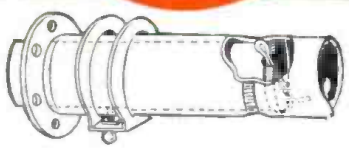

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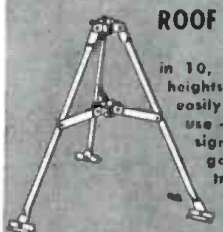

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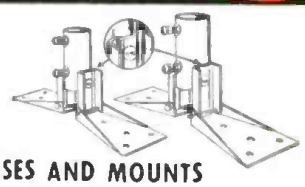

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ELECTRONICS WORLD

FEBRUARY, 1960

VOL. 63 ■ NO. 2

First in radio·television·audio·electronics

CONTENTS

Net Paid Circulation 242,396

SUBSCRIPTION SERVICE: Forms 3579 and all subscription correspondence should be addressed to Circulation Department, 434 South Wabash Avenue, Chicago 5, Illinois. Please allow at least four weeks for change of address. Include your old address as well as new—enclosing if possible an address label from a recent issue.

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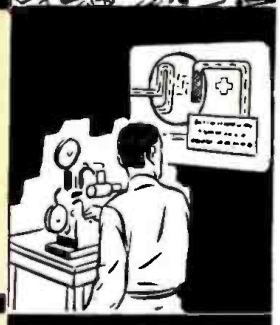

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...for the Record

By **W. A. STOCKLIN**
Editor

CITIZENS BAND CALLING FREQUENCY

WE KNOW that it is not quite proper to talk about one's successes or achievements, but we would like to take this opportunity to do just that. Every one of our readers should know that this publication has really "scooped" the entire field on the subject of the Citizens Band. Prior to September, 1958, the FCC had such stringent requirements on equipment and since operation was restricted to the not-very-useful 460-mc. band only a handful were actually sold and used. With the September FCC announcement many of the restrictions and limitations were removed and the 27-mc. band was assigned for Class D Citizens Radio service. In our March, 1959 issue we published an article with the new rules and regulations, along with a complete circuit diagram and construction details on a simple Class D Citizens Band transceiver. Its success and interest to everyone in the field is indicated by the number of companies that produced, virtually overnight, assembled versions and kits following the ideas presented in our article. In a little over one year approximately 70,000 licenses were granted and the FCC is continuing to process some 8000 more each month.

This is a fantastic story but we feel that more can be done to increase the usefulness of this band to all concerned. One of the major applications of this type of equipment is in the marine field. This does not mean that Citizens Radio equipment will take the place of the higher power, regular marine radiotelephone equipment. However, the lower cost of CB equipment will make it attractive to owners of small boats or even larger craft to augment the regular radiotelephone equipment. Unfortunately, and as a result of its tremendous growth, there has been no assignment of certain channels for calling and working as has been done on the other bands. For example, 2182 kc. has been designated as the calling (and distress) channel in the 2-3 mc. maritime radiotelephone band. As soon as contact is established, the operating frequency is shifted to 2638 or 2738 kc. These or other pre-arranged frequencies are then used to work the required traffic.

This has worked extremely well and obviously should set a pattern for Class D Citizens Band operators. Basically, we should have one channel for calling and another for handling communications. As a result of discussions with several manufacturers it seems that Channels 13 (27.115 mc.) and 15 (27.135 mc.) would be good choices to reserve for marine applications—13 being the calling frequency and 15 for continued communications. Since the industrial, scientific, and medical frequency is 27.12 mc., we thought it would be a good idea to select channels near this frequency (skipping one channel to allow for broad selectivity of some of the receivers used). Since the ISM frequency is normally cluttered with all types of interference it doesn't serve much purpose for land-operated equipment, particularly in metropolitan areas. As this type of interference is less troublesome in marine areas and is negligible on weekends, it would seem advisable to choose channels near this frequency.

One problem is that there are many single-channel units on the market today and they obviously cannot be used for two-channel operation as previously suggested. This is rather unfortunate but probably some lenience can be shown in permitting communications to be carried on Channel 13. This may work out for the time being when traffic is still light but we feel that in the not-too-distant future there will be such wide use made of these channels that there will be need for two-channel operation.

We understand that various manufacturers of Citizens Band equipment may get together shortly to discuss this very problem and should their conclusions differ from those suggested here we will report on it in next month's "For The Record." Should the industry fail to get together, it is our hope that all marine users of Class D Citizens Band equipment will work together to promote the use of Channels 13 and 15 as outlined herein.

Our appreciation to F. A. Genochio, *Karr Engineering Corp.;* Ed Manville, *Vocaline Co. of America, Inc.;* G. T. Wilde, *Multi-Products Co.;* and B. H. Ballard, Jr., *Apelco Sales Corp.,* for their thoughts on proper channel selection. —30—

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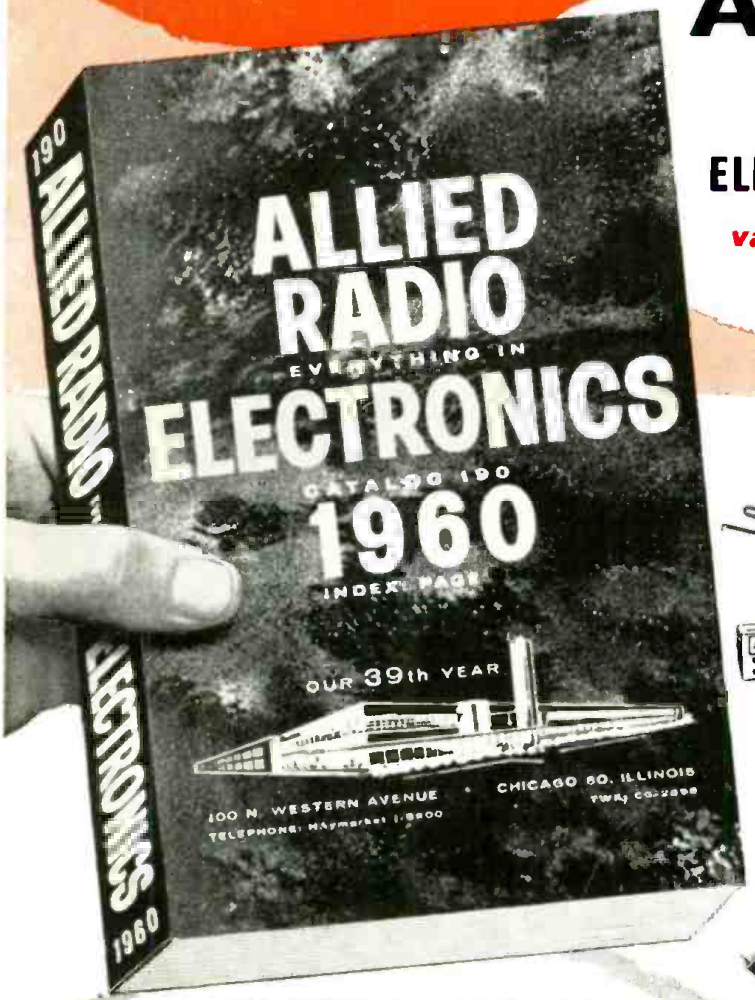

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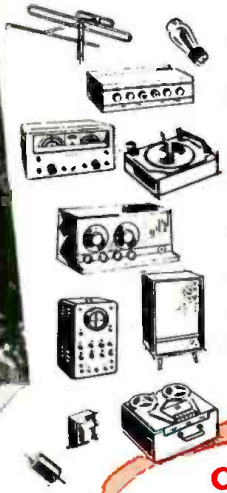

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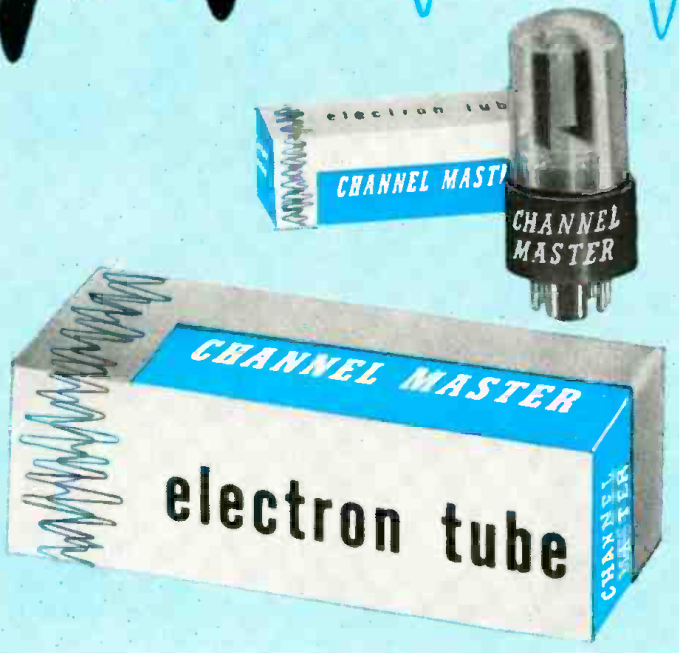

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Everett T. Bozard, 411 N. Wash. St., Alexandria, Va.	1st	12
Henry M. Best, 1003 Vermont St., Fremont, N. C.	1st	11
Harold V. Jones, P. O. Box 705, Alamogordo, N. M.	1st	13
Michael F. Aperio, 916 Townsend St., Chester, Pa.	1st	12
Earl A. Stewart, 3918 Modesto Dr., San Bernardino, Calif.	1st	14
Donald L. Leeburg, Box 1075, Anchorage, Alaska	1st	12
J. Milton Condit, 1312 N. 78th Street, Seattle, Wash.	1st	8
John R. Bahrs, 72 Hazelton St., Ridgefield Park, N. J.	1st	12
Richard Baden, 4226 - 37th St., N.W., Washington, D. C.	1st	12
James F. Stewart, 2618½ Prospect Ave., La Crescenta, Calif.	1st	12
Norman R. Cook, 130 Olive Street, Neodeska, Kans.	1st	12

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OUR OCTOBER ISSUE

To the Editors:

Just a line to compliment you on the publishing of "The Stereo Illusion" and placing it first in your October issue. The article was very enlightening and authentic. Dr. Harris knows how to write, and I certainly hope you will have more of his material in future issues.

BARNEY ASHTEN, VE7BK
Ganges, B. C., Canada

To the Editors:

I must compliment the editors of ELECTRONICS WORLD for putting out such a wonderful issue.

I would like to stress one point very strongly. In many of the articles it seems as though the authors have gotten too involved in the hi-fi field, and have forgotten what it is supposed to be. Just to remind some of you, the approximate definition of the term hi-fi is "faithful reproduction of live sound."

I have been involved in the hi-fi field for about three years, have listened to topnotch equipment only, and unfortunately, have forgotten how live sound really sounds. This summer I attended a live concert and was appalled to realize how much I had missed. Being used to listening to restricted response—even from the best components—I noticed how much my taste had changed, how my ears compromised to sounds not below 30 cps, not higher than 18,000 cps, and to the realization that the speaker was always there!

In my opinion, a compulsory prerequisite for any good hi-fi technician is to attend at least two good concerts a year in order to remember what high fidelity is trying to accomplish.

JEHUDA FRYDMAN
Sound Scription Service, Inc.
Montreal, Quebec, Canada

We concur with Reader Frydman's views that people in the hi-fi field should certainly know what live music sounds like.—Editors.

* * *

REBUILT PICTURE TUBES

To the Editors:

Your September issue contained an article on rebuilt picture tubes which, on the whole, is the best article on the subject I have seen. However, near the bottom of the first column on page 65, there appears a statement that corded ware (glass shells with surface ripples or irregularities on the face plate) is not ordinarily used in making new tubes. The natural question then is where did the rebuilder obtain the dud with a corded mark on the face plate if it was not used by the so-called tube manufacturer in the first place? The statement is, of course, incorrect as certain of the glass companies' molds developed this trouble when making certain types of bulbs long ago. Therefore, the original new tube manufacturer received the glass with cord marks and the original equipment was built with those tubes. I believe, though, that sometimes cord marks are accentuated by the cleaning process when the dud is being cleaned by a rebuilder before re-use.

MORRIS F. TAYLOR
Morris F. Taylor Co.
Manufacturers' Representative
Silver Spring, Maryland

Reader Taylor is to be congratulated on his alertness in noting what appears to be a contradiction in the article. His own conjectures as to how corded ware may become available to rebuilders is probaby correct. Some rebuilders also hint that corded glass shells are acquired in ways other than the salvaging of duds, but they are reluctant to divulge details.—Editors.

* * *

SERVICING COMMERCIAL EQUIPMENT

To the Editors:

Many of your magazine articles have been encouraging service men to take on more commercial equipment jobs.

I started servicing radios back in 1925 and am still in the business of servicing radios, TV sets, phonographs, and car radios. Many times customers ask me to service other equipment used by the medical profession and factories. Almost without exception I have had nothing but opposition. When I try to get parts or service information, I am treated very rudely by the factories and supply houses. I am treated much worse than I have ever treated a customer when he brings me a TV set to service with the parts in a sack.

As an example, I have a customer who brought me a sound and motion picture projector. I have attempted getting parts and service instructions for this machine for five months and have been blocked at every turn. I have written several companies and called some trying to get the information, but have been unable to get anything. What would you suggest in a case of this sort? After every such ordeal, I swear I will never accept any service job other than radio, TV, or phonograph.

LESTER BERRY
Berry's Radio & Television Service
Fairborn, Ohio

There is a great deal of validity in what you have to say about the difficulties in servicing commercial equip-

INTERNATIONAL'S

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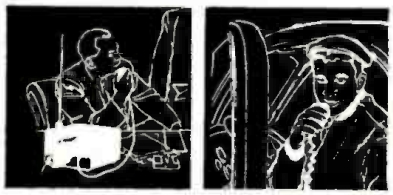
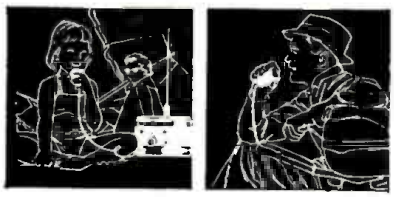


Home

Sports



Farm

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Five watts plate input. Crisp and clear full modulation. Series Gated automatic noise limiter. 2.5 audio output. Fifteen tube performance. The Executive has 10 tubes and 1 diode. Four tubes are multi-purpose.

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INTERNATIONAL

CRYSTAL MANUFACTURING COMPANY, INC.

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ment with respect to obtaining the cooperation of manufacturers. We are aware of this situation, but also believe that it is changing.

The manufacturers involved are reluctant, on the one hand, to entrust work on their equipment to outside technicians who are unknown quantities to them. On the other hand, they insist that such service is burdensome to them, and they would like to see it taken off their hands.—Editors.

* * *

SUBDIVIDED SPEAKER ENCLOSURE

To the Editors:

As a practicing chemist, I would like to call your attention to some inaccuracies that appeared in the article "Subdivided Hi-Fi Speaker Enclosure" in your November, 1959 issue.

Calcium chloride is referred to as "silica gel." Calcium chloride is water soluble while silica gel, chemically similar to sand, is not. Both are good desiccants, but there the similarity ends.

One other thing bothers me a little about your suggestion to increase the compliance of a cone by treating the edge with calcium chloride. Calcium chloride is mildly acidic by nature, and cellulosic materials (such as speaker cones) are degraded by acids. I believe this would shorten the life of a speaker, but only an experiment could determine how much. An organic desiccant such as glycerine or diethylene glycol might be better.

You have an excellent publication. I have subscribed for nearly 15 years, starting with RADIO NEWS, then RADIO & TV NEWS, and now ELECTRONICS WORLD. Your publication gives me just what I want, and the approach combines both the practical and the moderately technical.

ROBERT J. ATHEY
Wilmington, Delaware

Thanks to Reader Athey for setting us straight on our chemistry.— Editors.

* * *

OLD-TIME WIRELESS GEAR

To the Editors:

I was very interested in your article "Restoration of Old-Time Wireless Gear" in the November issue, chiefly because I once made a living operating some of the old-time receivers you mention. For example, the *Canadian Marconi* receiver shown on the upper right of page 63 was still going strong when I began operating in 1920 and (with the addition of a triode) continued for some years after I moved to the engineering department of *Canadian Marconi* in Montreal in 1923.

I remember one particular unit. I have forgotten the model but not the serial number—13! Six times this was sent back from a Canadian ship as dead. Five times it was thoroughly tested and found perfect. The sixth time, it came back on a Monday when the temperature was 15 below and the furnace at the old plant on William Street was slow to start. That square coilformer that drops over the variometer was the antenna coupler (later used as a tickler coil in a regenerative

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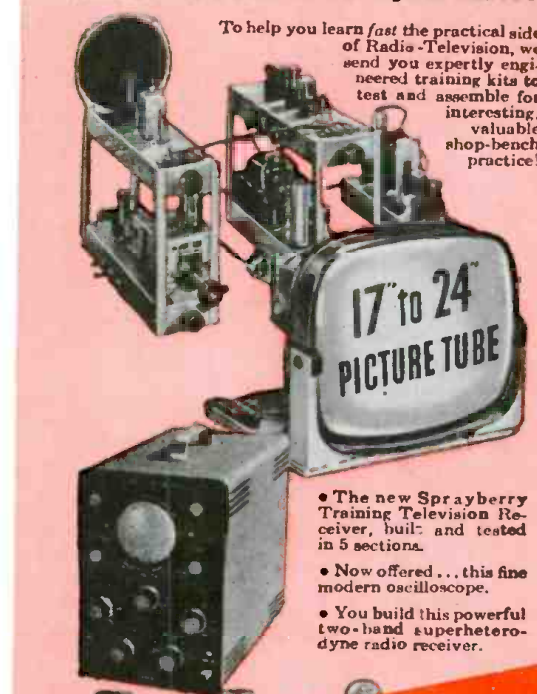

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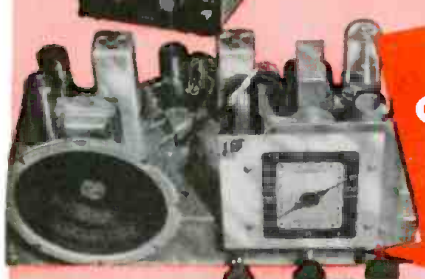

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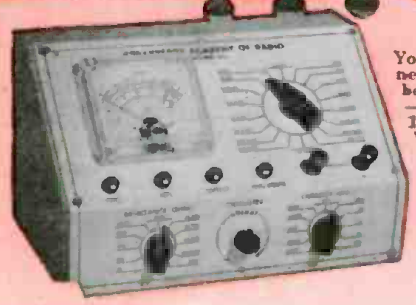

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circuit). A continuity check showed open circuit—until the room warmed up. A little detective work disclosed that each time the set was returned to the vessel, it stood on a cold wharf for some time before being taken aboard. If the operator had held off his test until the set warmed up and expansion brought the broken ends of wire back together, we might never have gotten the set back a second time.

H. F. SHOEMAKER, Manager
Radio College of Canada
Toronto, Canada

* * *

AUTOMATIC "TALK SQUELCHER"

To the Editors:

I have had some correspondence with readers who have had some difficulty with the automatic "talk squelcher" I described in the April, 1959 issue. The problems were insufficient sensitivity and relay chattering.

1. Adjust the relay, if possible, so that the moving armature is closer to the magnet pole; that is, so that the armature will not have as far to travel when the relay is energized. Then adjust the relay contacts so that they just "break" when the relay is de-energized. This will increase the sensitivity of the relay, and it should then operate at a lower setting of the pot.

2. If it is not possible to lower the sensitivity of the relay by adjustment of armature contacts, it will be necessary to modify the talk suppressor amplifier stage (V_1) to obtain higher gain and hence higher audio output voltage. At the same time this is done, it will be desirable to add a small filter network which will help to eliminate un-

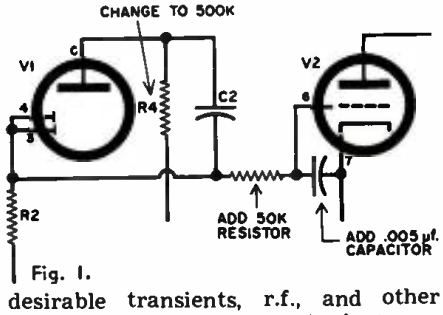

Fig. 1.

desirable transients, r.f., and other voltages which may otherwise be transmitted to the relay tube grid circuit.

3. If it is necessary to add the filter and to modify V_1, it can be accomplished as follows with reference to the schematic of the device (page 61, April, 1959 issue of ELECTRONICS WORLD) and the diagram in Fig. 1.

a. With the receiver disconnected from the a.c. line and the talk suppressor turned off, remove the plate resistor (R_4) from the talk suppressor amplifier (V_1) and replace it with a 1-watt resistor of 500,000 ohms.

b. Connect a ¼-watt or ½-watt, 50,000-ohm resistor in series with the grid of the relay tube (V_2) and the junction of C_2, R_2, and the diodes of V_1.

c. Connect a .005 µf. capacitor between the grid and cathode of V_2.

MARVIN L. GASKILL
Marlton, New Jersey

—30—

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TRANSISTORIZED CITIZENS BAND CONVERTER: Complete plans for building a single-channel crystal-controlled converter designed for use with any broadcast-band transistor receiver.

ROOM ACOUSTICS FOR STEREO: Variable sound absorption devices and special speaker setups are featured in Part Three of this four-part series. Learn how any audiophile can adapt these techniques for better listening!

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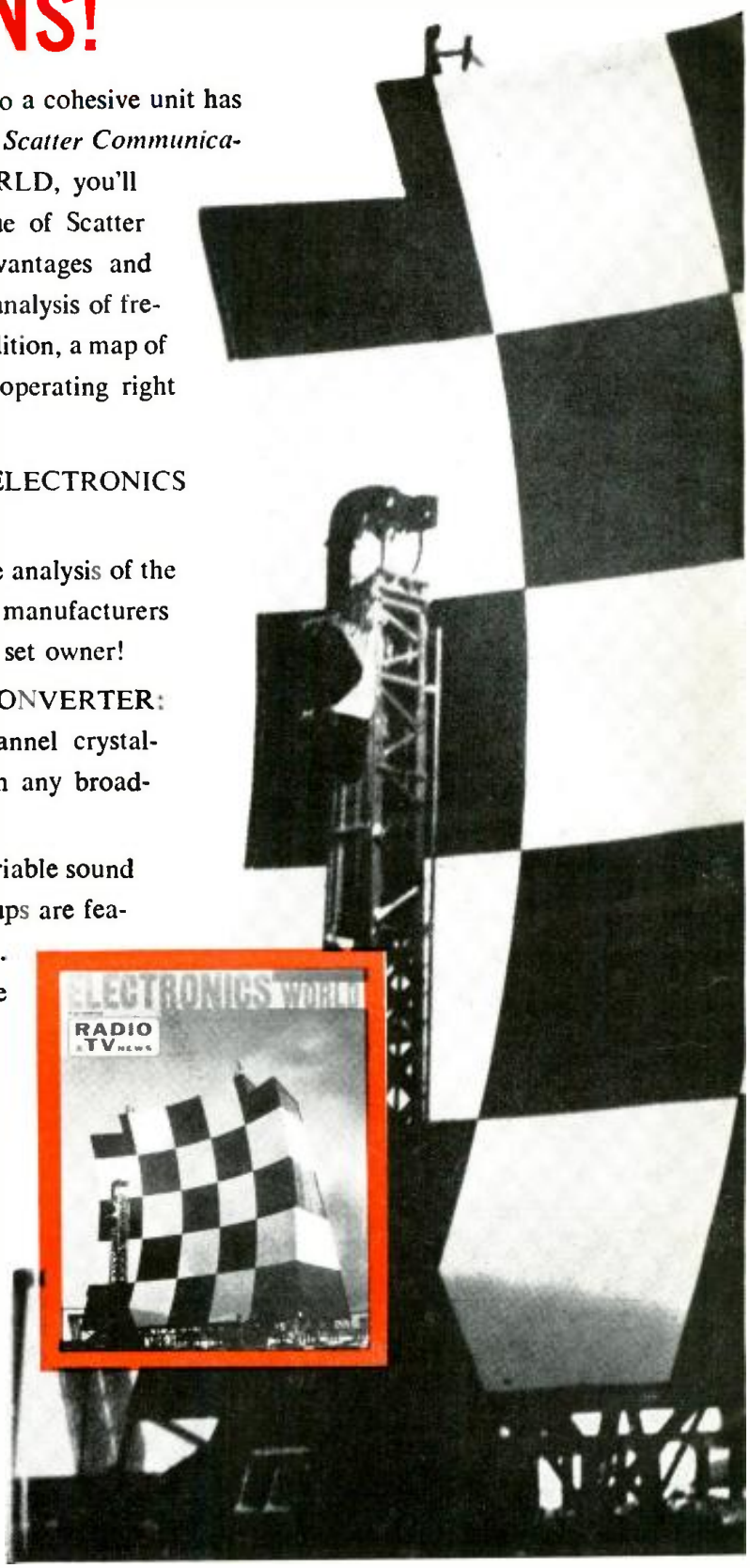

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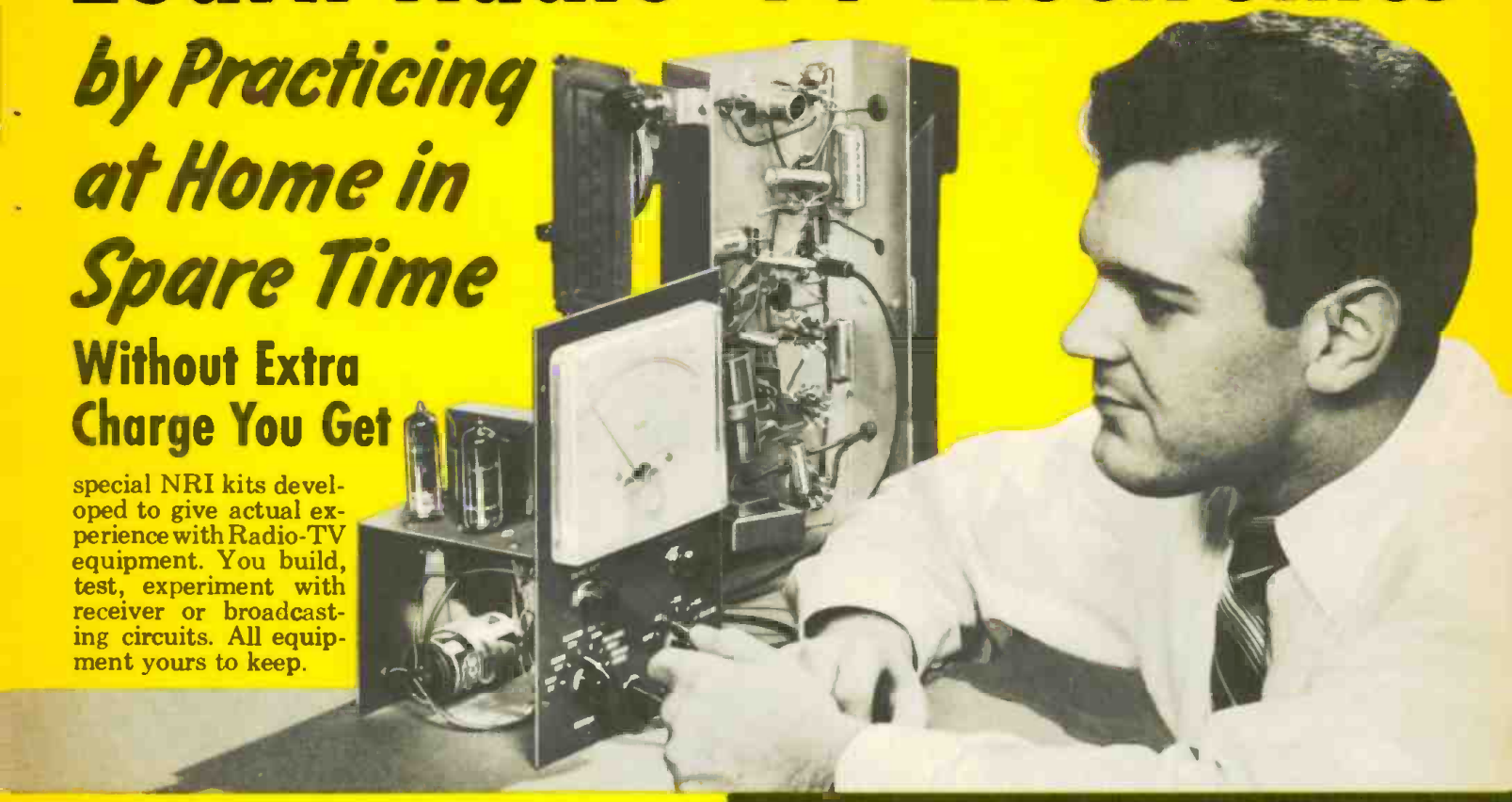

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"NRI changed my whole life. If I had not taken the course, probably would still be a fireman, struggling along. Now Control Supervisor at WRCA - TV." J. F. Meline, New York, N.Y.

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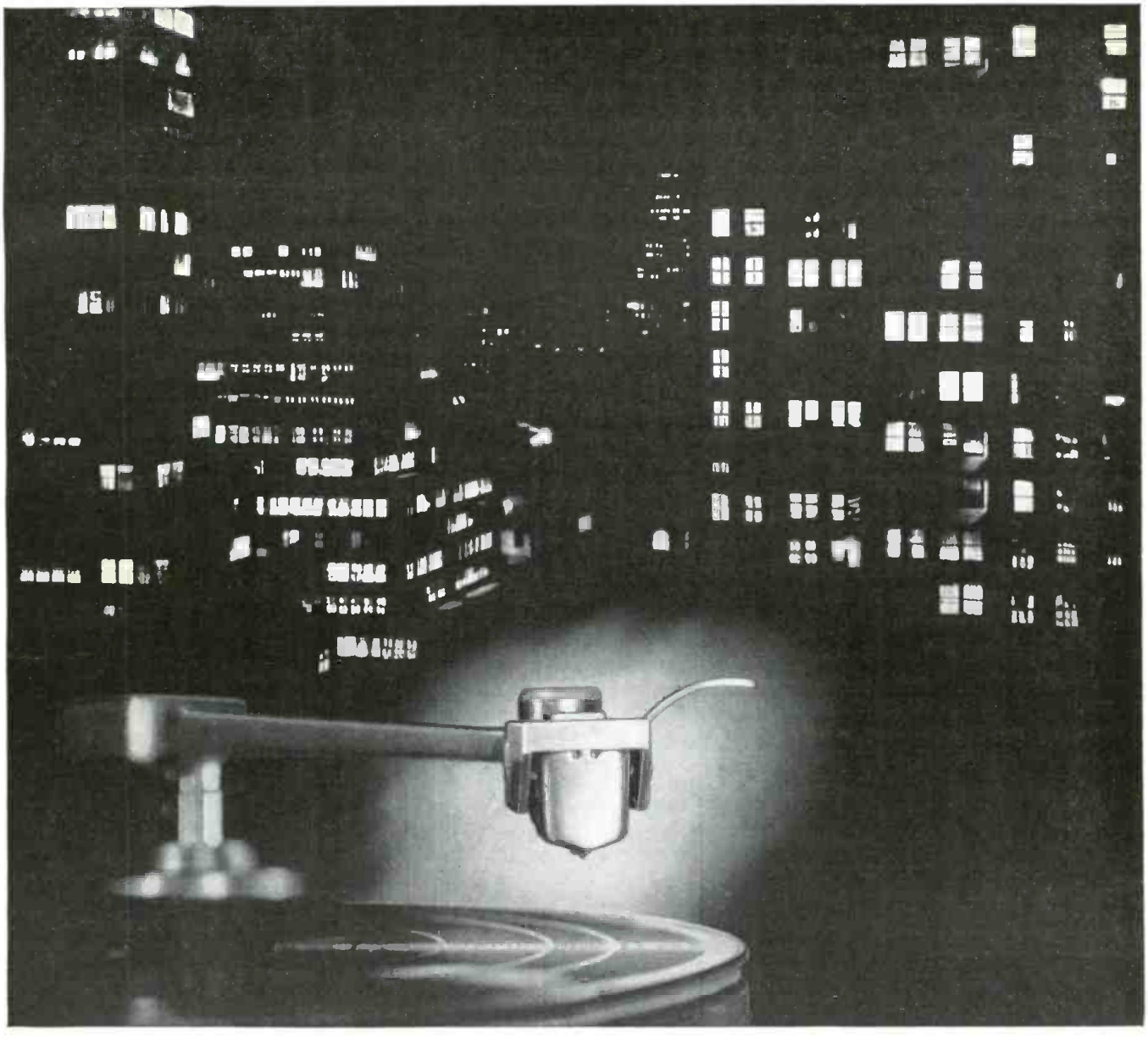

General Electric VR-22 Stereo Cartridge—Superior in the four vital areas

Stop to think for a moment of all the jobs required of a stereo cartridge: It must track, with utmost precision, in not one but two directions. It must separate the two stereo channels inscribed in a single record groove. It must perform smoothly in mid-range and at both ends of the audible frequency spectrum. And it must do all these things without producing noticeable hum or noise. Only a fantastically sensitive and precise instrument like the General Electric VR-22 can do all these jobs successfully.

General Electric's VR-22 is superior in the four vital areas of stereo cartridge performance: (1) **Compliance**—It tracks precisely, without the least trace of stiffness. (2) **Channel separation**—Up to 28 db for maximum stereo effect. (3) **Response**—Smooth and flat for superior sound from 20 to 20,000 cycles (VR-22-5), 20 to 17,000 cycles (VR-22-7). (4) **Freedom from hum**—The VR-22 is triple-shielded against stray currents.

Money-back guarantee: General Electric believes that once you hear the all-new VR-22 in the privacy of your own home, on your own equipment, you'll want this superb instrument for your very own. That's why we are making an offer virtually without precedent in the Hi-Fi field: Try the VR-22 at home for 10 days. If you don't agree that this is **the** stereo cartridge for you, return it to your participating General Electric dealer and the full purchase price will be cheerfully refunded.

VR-22-5 with .5 mil diamond stylus for professional quality tone arms, $27.95*. VR-22-7 with .7 mil diamond stylus for professional arms and record changers, $24.95*. Both are excellent for monophonic records, too. TM-2G Tone Arm—designed for use with General Electric stereo cartridges as an integrated pickup system, $29.95*. General Electric Co., Audio Products Section, Auburn, N. Y.

*Manufacturer's suggested resale prices.

GENERAL ELECTRIC

Spot News

Latest Information on the Electronic Industry

By ELECTRONICS WORLD'S WASHINGTON EDITOR

ARMED FORCES WANT MORE INVENTIONS—Hundreds of new ideas are still being sought by the Army, Navy, and Air Force, the National Inventors Council revealed recently. In a 48-page report, the governmental agency declared that the need for new technical developments was most acute, with requirements ranging from advancements in aeronautics, missiles, and weapons to blue-sky projects. Heightened interest in electronics was also prompting increased pleas for help. Commenting on the need for improved communication techniques, the Washington book pointed out that today's methods are not usable for the guidance of long-range missiles; they are not sufficiently effective for guiding a missile accurately to a distant target. We need a "new look" in techniques, they said; one that will extend global-contact ranges in the 1000-5000 mc. bands. There also appears to be a need for a method to eliminate radio noise, without distortion of the intelligible signal. Such improvements are important in missile projects, it was disclosed, since guidance and the accuracy of telemetered data are severely affected by noise. Today's systems either limit or dampen noise, or eliminate both the noise and intelligible portions. Also wanted by the Armed Forces is an electronic timer that will measure intervals from 0.1 microsecond to 0.9999999 second, to an accuracy of plus or minus 0.01 microsecond or better.

NEW MEDICAL-DENTAL TV OPTICAL SYSTEM DEMONSTRATED BY NAVY—An optical fiber probe linked to a closed-circuit TV system that permits dentists to view any part of the mouth, highly magnified—up to 35 times, on a TV screen, has been demonstrated at the U.S. Naval Dental School in Bethesda, Maryland. The probe consists of about 10,000 hair-like optical fibers bound together in a whip-like cable with a fingertip-size lens arrangement at the probing end. Each tiny fiber picks up light from a microscopic section of the surface in front of it and transmits a speck of light to the other end. The thousands of fibers provide a picture featuring thousands of light segments. The development, an Avco project, may eventually permit viewing of the interior of other body cavities, highly magnified and in color, Navy authorities noted.

AVIATION RADIO USE UP, FAA SURVEY REVEALS—More than 50 per-cent of all general aircraft now carry two-way radios, a Federal Aviation Agency survey has disclosed. The study noted that nearly 61 per-cent of the nation's 66,000 aircraft are carrying receiver-transmitters.

NEW MEDICAL EMERGENCY RADIO SERVICE IN OFFING—A 17-frequency medical emergency radio service available to physicians, hospitals, and emergency ambulance services for transmission of urgent messages, has been proposed by the FCC. Operating in the 152-162 and 42-50 mc. bands (using 13 and 4 channels respectively), the new medical block would shift allocations of highway maintenance, fire radio, police, and special emergency in the emergency spectrum, in accordance with the recent split-channel recommendations.

HIGH-POWER KLYSTRONS IN NIKE ZEUS ANTI-MISSILE SYSTEM—Klystrons, which can generate more power per wavelength than any microwave tube currently in use, will be placed in Nike Zeus, the Army's anti-missile defense system designed to track oncoming intercontinental ballistic missiles at longer ranges with greater certainty. The new tube, more compact than earlier models which measured up to 12 feet high, is one of several types developed for the Army by Sperry under a multi-million-dollar contract.

NEW LOW-POWER V.H.F. TRANSLATOR RULES PROPOSED—Standards for the licensing of new low-power v.h.f. TV translator stations are now being considered in Washington. Power outputs would be limited to 1 watt. However, those desiring greater powers—up to 100 watts—could ask to operate on the upper 14 u.h.f. channels, where interference possibilities are not so acute. The new rules would also forbid the use of co-channel boosters, which transmit on the same channels as the stations they pick up since they are, according to the Commission, unstable and capable of transmitting false and misleading signals when operated in the v.h.f. band. -30-

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three models... superbly styled... covering a wide range of applications

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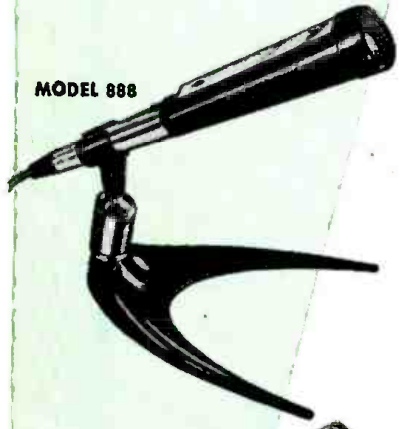

MODEL 788

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Most versatile performers in the microphone field are the Astatic Futura Series Dynamic Microphones—Models Metro 788, Tempo 888, and Vogue 988. Beautifully styled, encompassing the newest and most advanced principles in microphone engineering, each model is designed to outperform any other microphone in its price class.

Futura mikes are instantly convertible from hand to stand to lavalier use... offer many special features such as rugged, stable, fatigue-free Mylar diaphragm and, on the 888 and 988, the Cannon XLR-3 connector for instant detachment from cable ("Take the microphone to the cable.")

Model No.	Type	Response	Output	Impedance	Finish and Trim	Price
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888	Omni-Directional	50-15,000 cps	-56 DB	50, 200, Hi	Black and Chrome	110.00
988	Omni-Directional	40-20,000 cps	-58 DB	50, 150, 250	Black and Gold	150.00

NOTE — Exclusive Astatic impedance selector permits instant choice of impedance without special tools.

All three microphones come complete with lavalier and belt clip, 360° swivel adaptor for ⅝ #27 thread.

Twenty-foot, two-conductor, shielded cable supplied with each microphone.

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FROM WHAT YOU HEAR

ASTATIC MICROPHONES ARE A SENSATION ON ANY INSTALLATION

Within the Industry

FRED P. BEGUIN has been appointed head of a new engineering section at the *American Optical Company* in Southbridge, Mass. In his new post he will direct the efforts of the company in highly specialized areas of electro-acoustics.

Prior to his new appointment, Mr. Beguin was associated with *General Electric Company*. He joined that firm in 1950 as a project engineer in the television department. He then became audio consultant with the audio section of the company's radio receiver department.

More recently Mr. Beguin had been serving as technical specialist with the responsibility for technical sales of audio products to original equipment manufacturers in the Eastern region of the country.

* * *

FREDERICK R. LACK, former EIA vice-president and director and vice-president of *Western Electric Company* until his retirement in 1958, has been elected director of the Electronic Industries Association's engineering department.

Mr. Lack is a fellow of the IRE and is also a member of the AIEE, American Association for the Advancement of Science, the American Physical Society, and the Harvard Engineering Society. He was awarded the 1959 EIA Medal of Honor for his many contributions to the advancement of the electronic industry.

* * *

THOMAS E. GOOTÉE has climaxed a 17-year civilian-military career with the Army by accepting an executive post with *Page Communications Engineers,* a subsidiary of *Northrup Corporation,* located in Washington, D. C.

In his new post, Mr. Gootée will be assistant director of maintenance and operations for the firm which performs governmental and industrial global communications systems engineering, particularly in the fields of tropospheric, ionospheric, and scatter communications.

Prior to his Signal Corps and civilian government service, Mr. Gootée was a field engineer with *NBC.*

* * *

INSTITUTE OF HIGH FIDELITY MANUFACTURERS has named Milton D. Thalberg chairman of the nominating committee. Mr. Thalberg, president of *Audiogersh Corporation,* is also treasurer and a member of the Institute's board of directors.

In addition, four new general members have been elected. They are: *Brand Products Inc., Cletron Inc., DeWald Radio Inc.,* and *Telectrosonic Corporation.* * * *

WILLIAM N. LATSHAW has been appointed to the newly created post of advertising production manager for *Heath Company.* In this capacity Mr. Latshaw will assist Clifford M. Edwards, director of advertising, in the preparation of advertising for the firm's line of high-fidelity, marine, ham radio, and test equipment kits.

Mr. Latshaw comes to the company from *MacFarland, Aveyard Advertising Agency* where he was production manager. He was formerly art department manager for *Waldie & Briggs Advertising Agency.*

* * *

H. LESLIE HOFFMAN, president of *Hoffman Electronics Corp.,* has been appointed chairman of the Electronic Industries Association's spectrum committee for the fiscal year ending July 31, 1960.

Other members of the committee are: Robert C. Sprague, vice-chairman, *Sprague Electric Co.;* F. L. Ankenbrandt, *RCA;* R. S. Bell, *Packard Bell Electronics;* P. L. Chamberlain, *General Electric Co.;* W. P. Corderman, *Litton Industries Inc.;* D. G. Fink, *Philco Corp.;* I. J. Kaar, *Hoffman Electronics Corp.;* W. B. Lodge, *CBS;* D. E. Noble, *Motorola Inc.;* T. C. Rives, *Syra-*

JOHN R. (JACK) BINNS, honorary board chairman of Hazeltine Corp., died recently at the age of 75. A pioneer in the field of electronics, Mr. Binns won fame in 1909 for his life-saving role as a wireless operator during the first sea rescue by radio. He sent the distress signal and then guided the rescue ships following the collision of the steamships "Republic" and "Florida" at sea. A founder of the New York Newspaper Club, he was also a member of the Radio Club of America, Institute of Radio Engineers, and the Society of Naval Engineers, among other organizations.

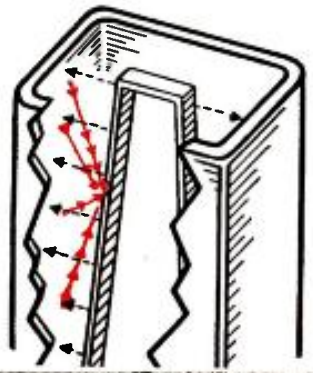
My new plates behave like plates... not filaments

(FORGET YOUR LOW-VOLTAGE RECTIFIER PROBLEMS)

HOW BACK EMISSION IS ELIMINATED

Back emission from overheated plate to filament causes most rectifier failures. Reverse current mounts . . . filament is stripped . . . overheats . . . burns out.

That's why the new CBS 5U4GB plates are of non-emissive material, are larger, and run cooler. These and many other advance engineered features make the new CBS 5U4GB the best you can buy. Here's typical proof. Dynamic "blast" tests brutally cycle the tube between 4 and 6.8 volts with 800 volts plate potential. Yet back emission is just measurable . . . less than one milliampere!



"My new plates don't heat up and start acting like filaments. They can't because my plate material is designed not to emit wrong-way electrons. So back emission can't build up and burn out my filament. And you aren't pestered with premature failures."

That is right. The new CBS 5U4GB offers you *total reliability* . . . proved in performance by leading TV and radio set manufacturers. You, too, can profit from the *total reliability* of CBS tubes. Just replace with CBS . . . always.

TOTAL RELIABILITY... proved in performance

Receiving, industrial and picture tubes
transistors and diodes
audio components
and phonographs

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

cuse University Research Corp.; P. F. Siling, *RCA Frequency Bureau;* D. B. Smith, *Philco Corp.;* Dr. W. R. G. Baker (*ex officio*), *Syracuse University Research Corp.:* and L. G. Cumming (*ex officio*), IRE.

* * *

U. S. DEPARTMENT OF COMMERCE, electronics division, Business and Defense Services Administration, has announced that first half 1959 shipments of electron tubes, semiconductors, and other principal electronic components increased more than 15 per-cent over the preceding six months. In addition, all were in excess of 30 per-cent above the comparable period during the year 1958.

This sharp rise, the greatest since the Korean War period, confirms employment trends and other general indicators of steadily growing electronics output during the past months.

Although all components shared in the upward movement, there were marked differences in their rates. Semiconductor shipments during the first half of 1959 were more than double those of the first half of 1958, while receiving tube shipments increased only 5 per-cent.

* * *

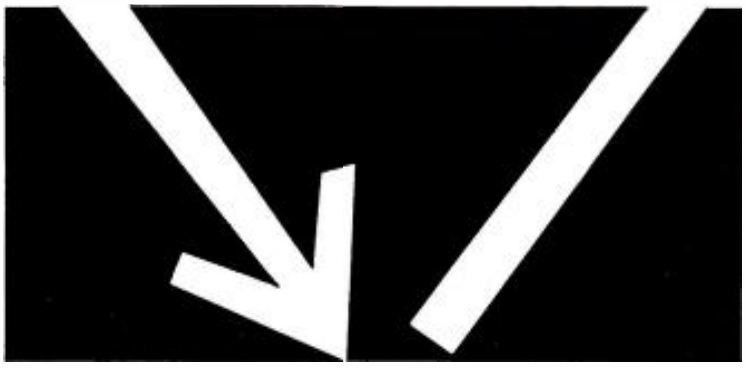
RADIO-TELEVISION TRAINING OF AMERICA is the new name of **RADIO-TELEVISION TRAINING ASSOCIATION.** Expansion of facilities plus the addition of new radio, television, and electronic courses has prompted this change of name. There will be no other changes in its administration . . . **ELECTRONIC RESEARCH ASSOCIATES, INC.** of Cedar Grove, N. J. has announced the acquisition of **ADVANCED ACOUSTICS CORPORATION** as a wholly owned subsidiary. The new subsidiary, formerly located in New York, will occupy new premises in Nutley, N. J. with its offices, laboratory, and production areas all under one roof . . . **FAIRFIELD ENGINEERING CORPORATION,** Springdale, Conn., and **COVE INDUSTRIES, INC.,** Norwalk, Conn., have announced that a merger of the two companies has been completed. Under the terms of the agreement the Springdale company will acquire the assets of the Norwalk firm, in exchange for *Fairfield* stock.

* * *

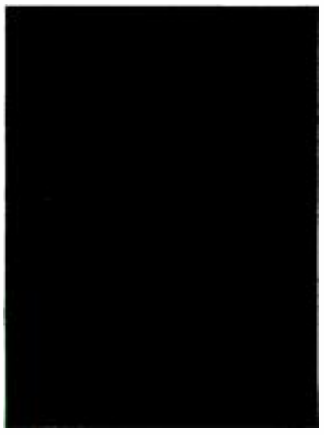
HASKEL A. BLAIR has been elected president of *University Loudspeakers, Inc.,* a subsidiary of *Ling-Altec Electronics, Inc.*

Mr. Blair began his career early in 1923. After forming the *Blair Radio Laboratories,* he worked on the development and manufacture of the first commercial resistance-coupled radio receiver. Under the name of *Blair Service Laboratories* he proceeded to further develop and manufacture amplifier lines for *Lafayette Radio, Federated Purchaser,* and other well-known mail order houses throughout the country.

In 1932 Mr. Blair joined *David Bogen*



HOW MUCH DO YOU KNOW ABOUT TRANSISTORS?



Attend the

Delco Electronics–One Week –Advanced Training School

No tuition charge
No laboratory fees
Textbooks supplied

Bring yourself up to date on transistors and other modern electronic equipment with personalized instruction at the Delco Electronic training school to be held soon at a General Motors Training Center near you. Classes are conducted by graduate engineers with special training in your field.

The Delco Radio diploma, awarded only to those who successfully complete the courses, will mean a great deal to you—*and* to your customers.

The Delco Electronics—One Week—Advanced Training Schools will be conducted in the General Motors Training Centers indicated below. One of them is near you. Register now through your local Delco Electronic Parts Distributor or write directly to Delco Radio Division, General Motors Corporation, Kokomo, Indiana, Attention: Service Manager.

COURSES OF STUDY OFFERED AT NO COST TO YOU:

❶ Transistor Fundamentals—complete coverage of transistor theory without the use of mathematics. ❷ Transistor Circuit Trouble-shooting—lecture and lab work analyzing defects in transistor circuits. ❸ Hybrid-type Automobile Radios—low voltage tube and output transistor circuits. Lecture and lab. ❹ Trouble-shooting procedures for dead or weak low voltage auto radios—factory developed techniques that are foolproof. ❺ Lecture and lab practice on "Signal Seeker" and "Wonder Bar" auto radio tuners and trigger circuits. ❻ Guide-Matic Headlamp Control (Autronic Eye)—lecture and lab. ❼ Twilight Sentinel Automatic Headlight Switch—lecture and lab. ❽ Garage Door Operators—lecture and lab work including the new Delco Radio all-transistor control units. ❾ Auto Portable Radios—lectures on circuitry of both 1959 and 1960 auto portable radios.

DELCO RADIO
DEPENDABILITY
RELIABILITY

DELCO ELECTRONICS TRAINING SCHOOL SCHEDULE

DATE	REGION 1	REGION 2	REGION 3	REGION 4	REGION 5	REGION 6
1-11	Philadelphia	New Orleans	Chicago			
1-18				St. Louis	Dallas	Salt Lake City
1-25		Atlanta	Detroit			
2-1	Union					
2-8				Omaha	Memphis	
2-15	Pittsburgh	Jacksonville				Los Angeles
2-22	Pittsburgh		Cincinnati			
2-29				Kansas City		
3-7	Tarrytown	Charlotte		Kansas City	Dallas	Portland
3-14			Cleveland			
3-21				Omaha	El Paso	
3-28	Boston	Atlanta				Los Angeles
4-4	Boston		Chicago	Minneapolis		
4-11				Minneapolis	Houston	
4-18	Union	Washington	Milwaukee		Houston	San Francisco
4-25		Washington				
5-2			Cincinnati	Omaha		Portland
5-9	Buffalo				Okla. City	
5-16		Atlanta	Detroit	St. Louis		
5-23						Los Angeles
6-6	Tarrytown		Chicago		Dallas	
6-13		New Orleans				San Francisco
6-20	Philadelphia			Denver		
6-27			Cleveland		Memphis	Salt Lake City

Company and in 1945 left to devote himself to the *Blair-Steinberg Co.*

* * *

CHARLES D. MANHART has been elected vice-president of *Daystrom, Incorporated* . . . **ABRAHAM B. COHEN** has been appointed president of *Electronic Research Associates, Inc.'s* newly acquired subsidiary, *Advanced Acoustics Corp.* . . . **LEWIS T. STEIN** has been promoted to product merchandiser, industrial components division of *Allied Radio Corp.* . . . **CURTIS A. HAINES** has been appointed vice-president, facilities and manufacturing planning of *Sylvania Electronic Systems.* In addition, **RALPH L. BLOOM** is now sales manager, radio and high fidelity, of *Sylvania Home Electronics Corp.* . . . *National Company, Inc.* has appointed **THOMAS M. STUART** to the position of technical liaison representative. Its subsidiary, *National Radio Co., Inc.,* has announced the appointment of **SYDNEY W. NATKIN** to the post of assistant general manager . . . *Tung-Sol Electric Inc.* has elected **EDWARD J. DANNEBERG** to the newly created position of vice-president for personnel . . . **E. M. HINSDALE** has been named chief engineer, *RCA* communications products department . . . The board of directors of *The Hickok Electrical Instrument Company* has elected **PAUL WILLOUR** vice-president-treasurer and **ROBERT L. PURCELL,** assistant secretary-treasurer . . . **WILLIAM H. KNOTH** has been named general sales manager of the *Mallory Battery Co.,* a division of *P. R. Mallory & Co. Inc.* . . . The appointment of **THOMAS S. KNIGHT, JR.** as sales manager for *General Electric Company's* receiving tubes, television picture tubes, and high-fidelity components has been announced . . . **JERRY MELTZER** has been named sales promotion manager for *Rek-O-Kut Company, Inc.,* and the *Audax Division* of this firm.

* * *

ELECTRONIC INDUSTRY SHOW CORPORATION has announced plans for a "double-header" educational program for the 1960 Electronic Parts Distributors Show. Detailed planning is now underway, with the Corporation's educational and program committee in charge. The committee is headed by Jack D. Hughes of *Littelfuse, Inc.* with Robert E. Svoboda of *Amphenol-Borg Electronics Corp.* as co-chairman.

Enhanced 1960 plans, based on last year's experience and on first-hand knowledge of areas where distributors feel education will help them in their own businesses, call for two separate seminars for distributor management and sales personnel. The two seminars will meet simultaneously in separate rooms on May 17 and May 18—in sessions combining talks, films, and special presentations. Participants will be assigned to non-competitive workshop groups sharing similar interests.

The distributor management seminar will cover such topics as sales and financial management, while the sales personnel seminar will explore selling techniques. —30—

How to Get a Commercial FCC License

do you know what an FCC license really can do for you in Electronics?

1 More income for you every week

2 A more interesting job in electronics

The average person spends over 50% of his waking hours on the job (or going to and from the job). Therefore doesn't it make sense to have a job that is really interesting and also pays well?

The chances are very good that if you are reading this magazine you can qualify for the really good jobs in electronics like those shown in the pictures at the left . . . and it won't take long to do it. Your past training and experience in basic electronics (such as radio and TV repair, armed forces electronics, ham operators, etc.) can be the foundation for a profitable career as an "across-the-board" electronics technician.

Whether you run your own shop or work for someone else, the real money, the interesting work, is available to the man who can effectively handle the more complex electronic gear. Home receiver repair can provide a good living, but it can't match the opportunities open to a skilled electronics technician.

The Career Information Material shown below will show you how you can qualify for a government certificate of competency . . . a commercial FCC License . . . and acquire a really fine technical education. Find out how your success with the FCC examination is guaranteed . . . or your money back.

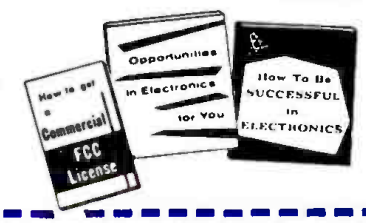
You will also find out which jobs require the FCC License . . . where technicians are needed . . . what a technician needs to know about electronics . . . and many other facts about opportunities for you in electronics.

It will cost you only the price of a postage stamp to get all the facts. If you are in any type of electronics work . . . or if you have had previous training or experience in electronics . . . you owe it to yourself to ask us to send you information on profitable careers in electronics.

CLEVELAND INSTITUTE OF ELECTRONICS

Desk RN-38, 4900 Euclid Ave. Cleveland 3, Ohio

1. Raytheon Manufacturing Company
2. Radio Corporation of America
3. Jupiter IRBM, Army Ordnance Missile Command
4. Collins Radio Company
5. Radio Corporation of America



free!

FIND OUT HOW:

1. **The new electronic devices can be handled by you**
2. **To solve the problems that will stump your fellow technicians**
3. **Training is Job Insurance when employment is tough to find . . . and more money for you when times are good**

CLEVELAND INSTITUTE OF ELECTRONICS

Desk RN-38, 4900 Euclid Ave., Cleveland 3, Ohio

Please send FREE Career Information Material prepared to help me get ahead in Electronics. I have had training or experience in Electronics as indicated below:

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

In what kind of work are you now engaged? _____

In what branch of Electronics are you interested? _____

Name _____ Age _____

Address _____

City _____ Zone ____ State _____

RN-38

NOW take another look at

NEW E-V MODEL 644

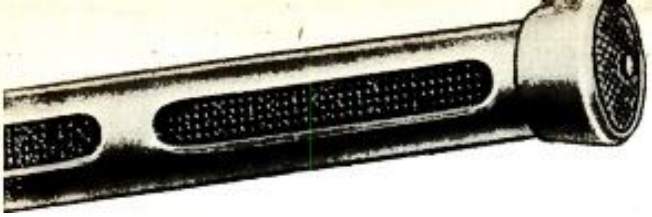
SOUND SPOT MICROPHONE • LIST $110.00

If you are in the commercial sound business, you have had your share of . . . "they couldn't be done" . . . jobs at one time or another in your business life. These jobs could not be solved because general purpose microphones just couldn't do the job. That, fortunately, is past history. E-V's new Model 644 ushers in a new era in the concept of microphone pick-up. So *take another look* and see how many of those "tough" jobs the 644 reclassifies to "simple and easy". Your local E-V distributor has all the details on the Model 644. Why not call him today or write Dept. 20N for our new Commercial Sound Catalog No. 132.

Electro-Voice®

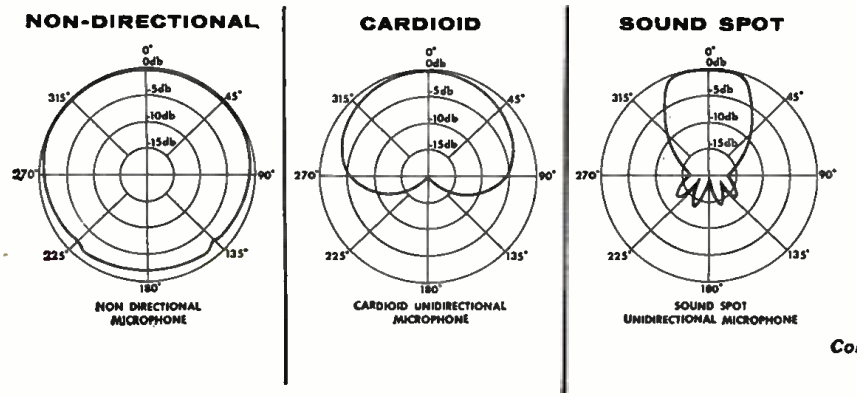
The New E-V Model 644 is in stock now at

ALABAMA
Birmingham — Forbes Distributing, 2600 3rd Ave.
ALASKA
Anchorage — Yukon Radio Supply, 645 "I" St.
ARIZONA
Phoenix — Culver Electronic., 231 N. First Ave.
Phoenix — High Fidelity Sound Systems, 1809 E. McDowell
CALIFORNIA
Burbank — Valley Electronic, 1302 W. Magnalia
Fresno — Dunlap Radio, 2617 Tulare St.
Hollywood — Hollywood Radio, 5606 Hollywood
Los Angeles — Kieruff Sound, 820 W. Olympic
Los Angeles — Radio Product Sales, 1501 S. Hill St.
Oakland — Elmar Electronics, 140 Eleventh
Pasadena—Audio Associates, 689 S. Fair Oaks Ave.
Pasadena — Dow Radio, 1755-59 E. Colorado
Pomona — Anderson-Maggs Electronic, 1095 E. 3rd
Sacramento — Dunlap Radio & TV, 1800 22nd
San Diego — Wrights House of Hi Fi, 5140 El Cajon
San Francisco — Columbia Music & Electronics, 1080-86 Market St.
San Francisco — San Francisco Radio, 1284 Market
San Francisco — Eber Electronics, 2355 Market St.
San Jose — Alca Paramount, 79 South Third
San Rafael — Catania Sound, 1541 Fourth St.
Santa Barbara—Channel Radio Supply, 18 E. Ortega
Stockton — Dunlap Radio, 27 North Brant St.
COLORADO
Denver — Fistells Electronic Supply, 1001 Bannock
Pueblo — L. B. Walker Radio, 100 N. Victoria
CONNECTICUT
Hartford — Dressler Electronics, 401 Trumbull St.
Hartford — Hatry of Hartford, Inc., 100 High St.
Meriden — Business Music, Inc., 99 Colony
Middletown — G. U. Reed, 143 Williams St.
Waterbury — The Bond Radio Supply, 439 W. Main
DELAWARE
Wilmington — W. S. Wilson Co., 405 Delaware
DISTRICT OF COLUMBIA
Washington — Commissioned Electronics, 1776 Columbia Rd., N.W.
Washington — Electronic Whlslr., 2345 Sherman,NW
Washington — Shrader Sound, 2803 "M" St., NW
Washington — Silberne Radio & Electronic Co., 3400 Georgia Ave., N.W.
Washington — U.S. Recording, 1121 Vermont Ave.
Washington — Wilson-Gill, 1 Thomas Circle, N.W.
FLORIDA
Jacksonville — Fidelity Sound, 1427 Landon Ave.
Miami — Electronic Equipment, 2701 N.W. 42nd
Miami — Electronic Supply, 61 N.E. 9th St.
Miami — Flagler Radio, 1068 West Flagler St.
Tampa — Thurow Distributors, 121 South Water
Winter Park — Laird Electronics, 803 Fairbanks Ave.
GEORGIA
Atlanta — Calhoun Co., Inc., 121 Forrest Ave., N.E.
Atlanta — Radio Television, 526 Plaster Ave., N.E.
Atlanta — Southeastern Radio Parts Co., 400 W. Peachtree St.
HAWAII
Honolulu — Precision Radio, 1160 South Kings St.
IDAHO
Boise — Robbies Radio & TV, 3801 Hill Rd.
ILLINOIS
Benton — Lampley Radio Co., 452 East Church St.
Broadview — Hi Fi Unlimited, 1303-05 Roosevelt Rd.
Chicago — Allied Radio, 100 North Western
Chicago — deHann HI-FI, Evergreen Shopping Plaza
Chicago — Newark Electric, 223 W. Madison St.
Chicago — Private-Tele-Communications, Inc., 1010 West Diversey Parkway
Chicago — Woodlawn Appliance, 1215 East 63rd
Jacksonville — Besco, 419 South Mauvaisterre St.
Peoria — Klaus Radio, 403 East Lake
INDIANA
Anderson — Seybert's, 1331 Main St.
Bloomington — Stansifer Radio — 1805 S. Walnut
Evansville — Ohio Valley Sound, 20 E. Sycamore
Fort Wayne — Warran Radio, 1716 S. Harrison
Fort Wayne — Workrite Intercommunication Systems, 5341 Gardenview
Indianapolis — Graham Electronics, 122 S. Senate
Indianapolis — Radio Distributing, 1013 N. Capital
Indianapolis — Warren Radio, 732 N. Capitol Ave.
Kokomo — Georges Electronic, 320 W. Superior
Peru — Clingaman Sound, 814 West Main
Richmond — Fox Electronics, 711 South Ninth
Rolling Prairie — Rolling Sound, Rural Route 1
South Bend — Colfax Company, 747 S. Michigan
South Bend — Industrial Sound Engineers, 531½ Eddy St., South
South Bend — Radio Distributing, 1212 S. High St.
Terre Haute — C. T. Evinger Co., 1216 Wabash
Wabash — Mark's Camera & Hi-Fi Shop, 14 Canal
IOWA
Council Bluffs — World Radio, 3415 W. Broadway
Des Moines—Radio Trade Supply, 1224 Grand Ave.
Iowa City — Woodburn Sound, 218 East College St.
KANSAS
Kansas City — D. Beatty Stereo Hi-Fi, 1616 W. 43rd
Wichita — Radio Supply Co., 115 Laura St.
Wichita — Stark-Suburban Sound, 807-09 South Woodlawn
KENTUCKY
Lexington — J. M. Hisle, 405 South Upper St.
Lexington — Radio Equipment Co., 480 Skain St.
Louisville — Universal Radio Service, 533 S. 7th St.
Paducah — Rawton TV & Sound Corp., 4815 Clarks River Rd.
LOUISIANA
New Orleans — Electronic Parts, 3622 Toulouse
MAINE
Bangor — Maine Electronic Supply, 494 Broadway
Portland — Maine Electronic Supply, 148 Anderson
MARYLAND
Baltimore — Henry O. Bermon, 12 E. Lombard St.
Baltimore — Industrial Electronics, 127 Light St.
Baltimore — Kann Ellert Electronics, 9 S. Howard
Baltimore — R. Selway Collmus, 627 N. Bend Rd.
MASSACHUSETTS
Boston — Cramer Electronic, Inc., 811 Boylston St.
Boston — DeMambro Radio, 1095 Commonwealth
Boston — The Louis M. Herman Co., 885 Boylston St.
Boston — Radio Shack Corp., 730 Commonwealth
Boston — Tape & Music Inc., 1026 Commonwealth
Boston — Trimount Coin Machine, 40 Waltham St.
Cambridge — Hi Fi Lab Electronic, 1077 Mass.
Springfield — Regent Sales, 999 Worthington St.
Worcester — Fred G. Walters Co., 1308 Grafton St.
MICHIGAN
Ann Arbor — Wedemeyer Electronic, 213-17 N. 4th
Battle Creek — Electronic Supply, 94 Hamblin Ave.
Detroit — Audio Equipment, 15747 Wyoming
Detroit — KLA Laboratories, 7375 Woodward Ave.
Detroit — Pecar Electronics, 11201 Morang Ave.
Detroit — Rissi Electronic Supply, 14405 Wyoming
Flint — Folsom's Commercial Sound Engineering, 1608 Albert St.
Grand Rapids — Radio Electronic Supply Co., 505 Jefferson, S.E.
Grand Rapids — Radio Parts, 542 Division, S.
Lansing — Offenhauer Company, 5019 W. Saginaw
Lansing — Tape Recording Industries, 3335 East Michigan Ave.
Muskegon — West Michigan Sound, 1932 Peck
Saginaw — Audio Communications, 1511 Janes
MINNESOTA
Minneapolis — Lew Bonn, 67 South Twelfth St.
MISSISSIPPI
Jackson — Swan Distributing, 342 North Gallatin
Tupelo — Pate Electronics, Highway 45 South
MISSOURI
Cape Girardeau — Seudekum Electronics, 2215 Broadway
Kansas City — Audio Communications, 1515 Baltimore Ave.
Kansas City — Burstein Applebee, 1012-14 McGee
Kansas City — McGee Radio Co., 1901 McGee St.
Kirkwood — Kirkwood Camera, 122 W. Jefferson
St. Louis — Ebinger Electronics, 2501 S. Jefferson
St. Louis — Gasco, Inc., Box 113, Lambert Field
St. Louis — Hollander & Co., Inc., 3900 W. Pine
St. Louis — Interstate Supply, 4445 Gustine
St. Louis — Phone Craft Co., 427 North Euclid
St. Louis — Van Sickle Radio Co., 1113 Pine St.
NEBRASKA
Omaha — J-B Distributing Co., 1616 Cass St.
NEW JERSEY
Camden — Radio Electric Service, 513 Cooper
Jersey City — Nidisco-Jersey City, Inc., 713 Newark
Mountainside — Federated Purchaser, 1021 Rte. 22
NEW YORK
Albany — Audio-Video Corp., 324 Central Ave.
Albany — Fort Orange Radio, 904 Broadway
Auburn — Dare Radio, 22 East Genesee St.



those "impossible" sound jobs!

compare polar patterns yourself



- Four times greater working distance than the best cardioids, depending on acoustics
- Greatly reduces feedback
- Retains "on-mike" presence despite extended working distance
- Excellent outdoors . . . less wind noise
- Priced low to fit most budgets
- Lasts a lifetime

Another better product for better sound from . . .

ELECTRO-VOICE, INC.

Commercial Products Division • Loudspeakers-Microphones

BUCHANAN, MICHIGAN

your Electro-Voice Microphone Headquarters

Binghamton — Stack Electronics, 25 State St.
Buffalo — Radio Equipment, 147 Genesee St.
East Meadow — South Service Engineers, 1778 Hempstead Turnpike
Elmira — Chemung Electronics, 403 East Third St.
Farmingdale, Long Island — Gem Electronics Distributors, 34 Hempstead Turnpike
Jamaica — Lafayette Radio, 165-08 Liberty Ave.
Mineola, Long Island — Arrow Electronics Inc., 525 Jericho Turnpike
New York — Airex Radio, 64 Cortlandt St.
New York — Goody Audio, 235 West 49th St.
New York — Harvey Radio, 103 West 43rd St.
New York — Heins & Bolet, 68 Cortlandt
New York — Hudson Radio, 37 West 65th St.
New York — Leonard Radio, Inc., 69 Cortlandt
New York — Magic-Vue Television, 323 E. 13th St.
New York — Milo Trading, 215 Fulton
New York — Recording Tape Co., 123 East 88th St.
New York — Sonocraft, 115 West 45th St.
New York — Terminal Radio, 85 Cortlandt
Rochester — Rochester Radio, 600 East Main St.
Syracuse — Brown Sound Equipment, 521 E. Washington
Valley Stream — Sam Goody Green Acres, Inc., 44 North Parking
White Plains — Westchester Electronic Supply, 602-610 Mamaroneck Ave.

NORTH CAROLINA
Asheville — Freck Radio & Supply Co., 38 Biltmore
Charlotte — Dixie Radio, 4131 Bryant St.
Gastonia — Stroup Hi Fi Center, 112 Green Drive
Winston Salem — Dalton Hege Radio, 938 Burke

NORTH DAKOTA
Fargo — Walter Electronic, 402 North P. Ave.

OHIO
Akron — Olson Radio, 69 West State St.
Akron — The Sun Radio Co., 110 East Market St.
Canton — Burroughs Radio, 2705 Fulton Rd., N.W.
Columbus — Associated Sound, 671 Dennison Ave.
Columbus — Electronic Supply, 134 E. Long St.
Dayton — Custom Electronics, 1918 S. Brown
Dayton — Srepco, Inc., 314 Leo St.
Lima — Hutch & Son, Roberts at Lenore
Marion — Servex Electronics, 220 N. Prospect
Massilon — M. H. Martin Co., 1118 Lincoln Way, E.
Steubenville — The D & R Radio Supply 221 S. 3rd
Toledo — Warren Radio Co., 1002 Adams St.
Zanesville — Thompson Radio, 110 South 6th St.

OKLAHOMA
Oklahoma City — Johnson Wholesale Electronics, 927 Northwest First St.
Oklahoma City — Trice Wholesale, 800 N. Hudson

OREGON
Portland — United Radio, 22 Northwest 9th
Salem — Universal Sound Corp., 1461 Capitol, N.E.

PENNSYLVANIA
Allentown — A. A. Peters, Inc., 231 North 7th St.
Allentown — Radio Electronic Service, 1313 Linden
Bethlehem — Buss Radio, 431 West Broad St.
Erie — Warren Radio, Inc., 1313-17 Peach St.
Harrisburg — D & H Distributing, 2535 N. 7th St.
Johnstown — Cambria Equipment, 17 Johns St.
McKeesport — McKeesport Electronics, 1661 5th Ave.
Philadelphia — Airtone, 1710 Sansom St.
Philadelphia — Almo Radio, 913 Arch St.
Philadelphia — General Sound, 3500 N. 9th St.
Philadelphia — Magnetic Recorder & Reproducer, 1533-35 Cherry
Philadelphia — Radio Electric Service Co., N.W. 7th and Arch Sts.
Pittsburgh — Cecil T. Hall Labs, 770 Washington
Pittsburgh — Radio Parts Co., 6401 Penn Ave.
Pittsburgh — Olson Radio Warehouse, 5918 Penn
Pottsville — Moyer Electronic, 330 N. Norwegian
Reading — George D. Barbey, Second and Penn Sts.
State College — Alvo Electronic, 103 S. Pugh
Wilkes-Barre — Shelborne Electronics, 169 N. Penn

RHODE ISLAND
Providence — W. H. Edwards, 92 Broadway
Providence — Gertz, Inc., 257 Adelaide Ave.

SOUTH CAROLINA
Charleston — Radio Labs, 475-477 East Bay St.
Columbia — Dixie Radio Supply 1628 Laurel St.

TENNESSEE
Knoxville — McClung Appliance, 310 Georgia, NE
Knoxville — Roden Electricol, 708 Central, N.W.
Knoxville — Smith Electronic, 301 E. Magnolia
Memphis — Bluff City Distributing, 234 East St.
Memphis — Glenn Allen Co., 1150 Union Ave
Memphis — Lavender Distributors, 180 S. Cooper
Memphis — W & W Distributing, 644 Madison Ave.
Nashville — D & N Dist., 113 19th Ave., S.
Nashville — Electra Distributors, 1914 W. End Ave.

TEXAS
Arlington — Audio Acoustics, 130 Fairview
Corpus Christi — Electronic Equipment and Engineering, 805 South Staples
Dallas — All State Distributing, 2411 Ross Ave.
Dallas — Southwest Radio, 1820 W. Horwood
Forth Worth — C. Herring Sound, 1705 7th St., W.
Fort Worth — Rae Gantt Sound, 12th & Throckmorton
Houston — Sound Equipment, 2506 Crowford
Lubbock — R & R Distributing, 1607 Avenue G
Lubbock — Sound Photo Sales, 2107 Broadway
Waco — Best Electronics, 324 North 18th St.

UTAH
Ogden — Carter Supply, 3214 Washington Blvd.
Ogden — Ballard Supply, 3109 Washington Blvd.
Salt Lake — Custom Sound by Poll, 1651 S. 11th
Salt Lake — Ballard Supply Co., 44 E. 6th St., S.

VIRGINIA
Arlington — Rucker Electronic, 1213 Wilson
Danville — Womack Radio, 513 Wilson
Newport News — General Supply Co., 4215 Huntington Ave.
Norfolk — Coin Electronics, 14th and Monticello
Norfolk — Electronic Engineering, 4201 Hampton
Norfolk — Priest Electronics, 6431 Tidewater Dr.
Norfolk — Radio Parts Dist'ng., 128 W. Olney
Norfolk — Radio Supply Co., 711 Granley St.
Richmond — Cottrell Electronics, 408 East Main St.
Roanoke — L. C. Hartman, 3236 Cove Rd., N.W.
Staunton — Southern Electronic, 818 Greenville

WASHINGTON
Everett — Pringle Radio, 2514 Colby
Seattle — Electricraft, Inc., 1408 6th Ave.
Seattle — Western Electronic Supply, 717 Dexter Ave.
Seattle — Pacific Electronic Sales, 1209 First Ave.
Tacoma — C & G Radio Supply, 2502 Jefferson Ave.
Tacoma — Wible Radio Supply, 2360 S. Fawcett Ave.

WEST VIRGINIA
Charleston — Chemcity Electronic Dist., 1637 4th
Charleston — Mountain Electronics, 708 Bigley Ave.
Parkersburg — Housfeld Radio Supply, 536 7th St.

WISCONSIN
Manitowoc — Harris Radio Corp., 115 N. Tenth St.

BRITISH COLUMBIA
Vancouver — D. Eldon McLennan, 1624 W. 3rd Ave.

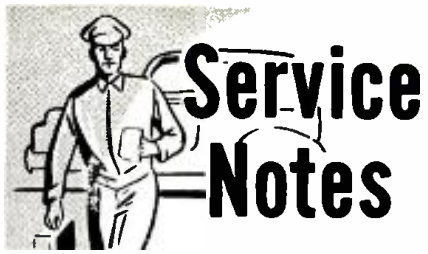
NEW BRUNSWICK
Moncton — Lewis-Price TV Radio, 330 St. George

ONTARIO — CANADA
Kitchener — MacDonald Electric, 307 Queen St., S.
London — C. M. Peterson Co., 575 Dundas St.
London — Provincial Electronic Supply, 641 York
Ottawa — Tower Productions, 278 Sparks St.
Scarborough — R. C. Kohnert, 73 Crockford Blvd.
Sudbury — Sonic Northern, 300 Elm St., East
Toronto — Electro-Sonic Supply, 540 Yonge St.
Toronto — Electro-Voice Sound Systems, 126 Dundas
Toronto — General Sound & Theatre, 861 Bay
Windsor — Adams Electronics, 2471 Ouelette Ave.
Windsor — C. M. Peterson & Co., 800 Howard Ave.

QUEBEC — CANADA
Montreal — Electric Labs, Reg'd, 7556 St. Hubert
Montreal — Poyette Radio, 730 St. James West
Montreal — Radio Service, 2022 McGill College
Quebec City — Crobel, Ltd., 790 Blvd. Chorest E.
Quebec City — George Latour, Inc., 1540 Third

MANITOBA — CANADA
Winnipeg — Dollard Recording Ltd., 138 Portage

EXPORT
New York — Telesco International, 36 W. 40th St.



ANDREA: INTERMITTENT SOUND

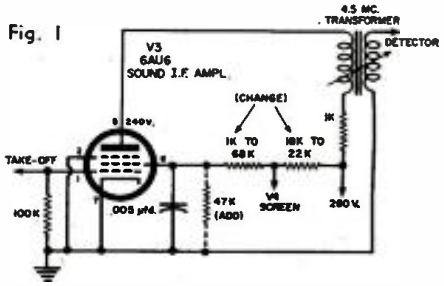
If sound output is intermittent on TV receivers using the VO-21 and VP-21 chassis, or if audio-output level fluctuates, the cause may lie either in the sound take-off transformer (Part No. SA-373) or the ratio-detector transformer (Part No. SA-374). Before deciding on the removal of either unit, the possibility of a poor external connection should be considered. Accordingly a hot soldering iron should be applied to the lugs of both transformers to make sure that coil wires have proper electrical connection to these lugs.

If the symptoms noted here develop after the receiver has been in use for a long while, and if sweating the connections and replacing the tubes involved do not remedy the condition, then one of the transformers is probably internally defective. If this is the case, it may prove to be more economical to replace both transformers at the same time than to attempt to determine which of the two is specifically defective. The cost of the extra transformer saves bench time.

OLYMPIC: BUZZ

Some TV receivers using the HE, HJ, JE, and JJ chassis may exhibit a tendency to annoying buzz in the sound when tuned to a relatively strong signal. If this should occur, it indicates that there is probably slight misalignment in the sound strip. While realignment is helpful, a minor revision of the circuit involving three resistors will render the receiver less sensitive to the long-term development of this symptom. As shown in Fig. 1, the 1000-ohm resistor connected to pin 6 of the sound i.f. amplifier (V_3, 6AU6) should be changed to 68,000 ohms. A 47,000-ohm resistor should be added between this point and ground. In addition, there is an 18,000-ohm resistor between the 280-volt line and the screen-grid

Fig. 1



circuits of both V_3 and V_4, the 6DT6 discriminator. This should be changed to 22,000 ohms, 2 watts. This revision applies to all HE and HJ chassis and some JE and JJ units. Late production

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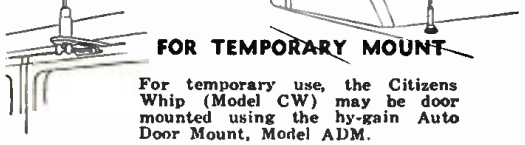
A careful antenna test range development program has resulted in a series of efficient antennas specifically engineered for the particular Citizens Band use involved. Each antenna is perfectly matched to 50 ohms. Rugged commercial construction design assures long, dependable service . . . These antennas are quick and easy to assemble and install in only a matter of minutes.

Mobile Use

ONE HOLE, EASY MOUNTING

Chrome plated, stainless steel telescoping whip extends to 73", down to 23" for easy garaging. Outperforms full length bumper mounted whip. Weatherproof, polyethylene enclosed, high efficiency base loading coil with exclusive "L" matching network. Universal swivel body mount.

Model CM $11.95



FOR TEMPORARY MOUNT

For temporary use, the Citizens Whip (Model CW) may be door mounted using the hy-gain Auto Door Mount, Model ADM.

Auto Door Mount

Complete with SO-239 receptacle for mounting model CW on door top of most autos for Mobile use. Easy, quick attachment.

Model ADM $4.95

Model CC-12. Coax cable kit for use with Model ADM and CW or CM. 12 ft. RG58U with soldered lugs one end, PL259 coax connector on other. $3.95

Close Range

FOR INDOORS, OFFICE-TO-OFFICE, ETC.

Citizens Dipole "Rabbit Ears" is portable with telescoping chrome plated whips (45" down to 15") with uniquely designed suction cup base for mounting on transceiver, wall, windows, etc. May be oriented either vertically or horizontally. Loading coils and "L" matching network enclosed in polyethylene. Six ft. RG58U coax cable.

Model CD $12.95

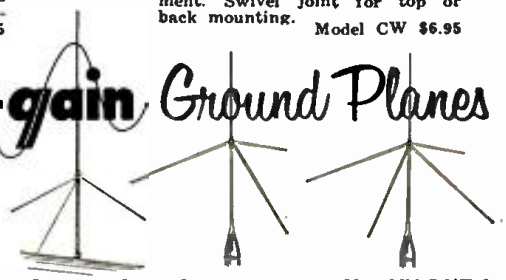
Citizens Whip;- chrome plated telescoping whip extends to 45", down to 15" for easy storage . . . Base loading coil enclosed in polyethylene cover. PL259 coax connector for simple screw-in attachment. Swivel joint for top or back mounting.

Model CW $6.95

Base Station Operation with the hy-gain Ground Planes

HIGH EFFICIENCY POINT-TO-POINT OR BASE STATION TO MOBILE

The Citizens Ground Plane is a complete kit and includes a ⅞" to ¾" telescoping aluminum radiator, three copper clad steel ground plane radials, screw hooks, 1½" dia. 3-foot mast and universal roof mount. The standard ground plane uses ⅝" dia. radiator and three radials. The Heavy duty ground plane is of rugged commercial construction with ⅞" to ¾" telescoping aluminum radiator and four radials. All are factory adjusted for perfect 50 ohm match and maximum efficiency.



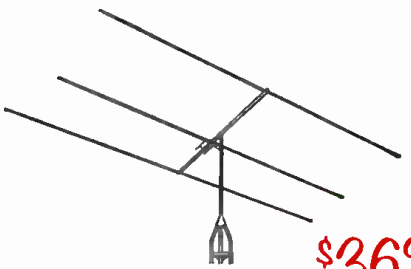
CITIZENS GROUND PLANE Model CGP	STANDARD GROUND PLANE Model SGP	HEAVY DUTY GROUND PLANE Model GP-1
$18.95	$19.95	$32.50

Extended Range Citizens Band Use

CITIZENS BEAM PROVIDES 8.5 DB GAIN; MULTIPLIES POWER 7 TIMES

3-Element Beam of commercial duty construction . . . light weight ⅞" to ⅜" OD aluminum elements and 2" OD aluminum boom. Completely factory preadjusted and beta-matched. Boom: 8 ft. Longest element: 16.5 ft. approx. Weight: 18 lbs. Positive grip U-bolt attaches to masts up to 1⅝" dia. May be rotated by any TV rotator. May also be mounted vertically for extended base-to-mobile coverage over approximately 180° arc.

Model 113-G



$36.95

Model CC-25 (25 ft.) or Model CC-50 (50 ft.) RG58U coaxial cable with PL259 coax connectors both ends. For use with ground planes or beam.

CC-25 $5.95 CC-50 $8.95

Model ADT Adapter, connects VHF coax plug type PL259 to automative type plug. $1.95.

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of the latter chassis incorporates the change.

WESTINGHOUSE CLOCK RADIO

Battery-operated clock radios H-685/6P8 may use two slightly different clock mechanisms. It is important to recognize this fact if the clock must be replaced, as a slight wiring change may have to be made. If the difference is not properly observed, clock noise (a ticking sound) may be reproduced in the transistor radio's loudspeaker following replacement. The clock used in late production is identified by a red dot on its rear cover. This dot does not appear on clocks used in earlier production.

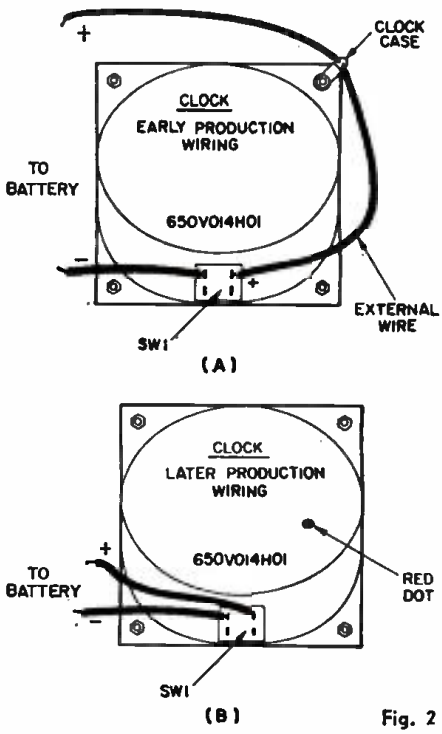

Fig. 2

Since either type of clock may be furnished as a replacement, the wiring for each of the two units should be kept in mind.

Wiring for the early production clock appears in Fig. 2A. As shown here, the clock case must be externally grounded (the positive side of the battery is ground). Late-production clocks do not require the extra ground lead (Fig. 2B), as the case has been grounded internally. Failure to make sure that the external ground is present when the earlier clock is used can produce the interfering sound of the clock's ticking in the loudspeaker. If the external ground already exists, neither clock should cause trouble.

MOTOROLA: VIDEO HUM

If a.c. in the picture persists despite tube changes and other normal corrective procedures, check the dress of resistor R_{12} (270,000 ohms) connected to the screen of the mixer-oscillator (5U8) in the tuner. It may be close to pin 4 (a heater connection) on the tube socket. Simply dressing it away from pin 4 should be a sufficient measure to eliminate the symptom. —30—

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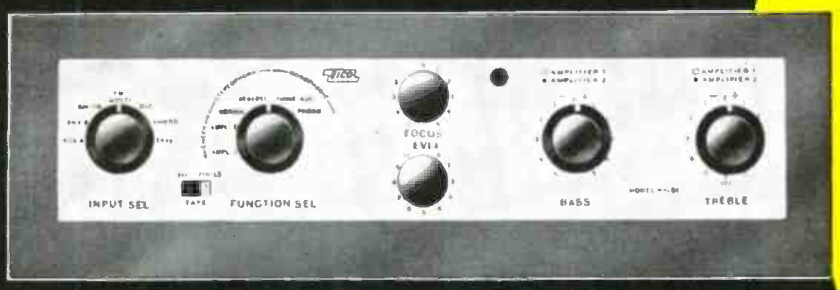
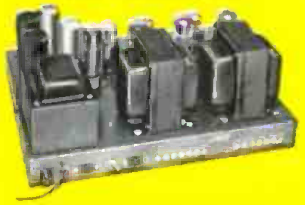


Stereo Amplifier-Preamplifier HF81

Stereo Preamplifier HF85



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

FM Tuner HFT90 FM/AM Tuner HFT92
AM Tuner HFT94

Stereo Integrated Amplifier AF4

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

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

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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.

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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. Kit $39.95. Wired $65.95 Incl. Cover & F.E.T.

New FM/AM Tuner HFT92 combines the renowned EICO HFT90 FM Tuner with excellent AM tuning facilities. Kit $59.95. Wired $94.95. Includes 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, ⅝" 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.

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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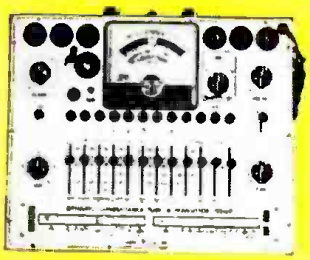

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A Tests all receiving tubes (picture tubes with adapter), n-p-n and p-n-p transistors. Composite indication of Gm, Gp & peak emission. Simultaneous selection of any one of 4 combinations of 3 plate voltages, 3 screen voltages, 3 ranges of continuously variable grid voltage (with 5% accurate pot.). Sensitive 200 ua meter. 10 six-position lever switches: freepoint connection of each tube pin. 10 pushbuttons: rapid insert of any tube element in leakage test circuit. Direct reading of inter-element leakage in ohms. New gear-driven rollchart. CRA Adapter $4.50.

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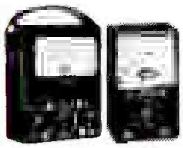

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Selecting and using a radio unit for Class D service. Complete listing of available equipment and important specs are included.

CITIZENS RADIO DIRECTORY

EVER SINCE the FCC established the Class D Citizens Radio Service in September, 1958, interest and activity in this new service has been growing by leaps and bounds. An article "Build This Citizens Band Transceiver" in our March, 1959 issue started the ball rolling for many hundreds of our readers, and for several equipment manufacturers as well, who wanted to get some gear operating on the new Citizens Band. A recent check with the FCC revealed that over 70,000 Citizens Radio authorizations have been granted, and applications are still coming in at the rate of over 8000 each month. By far the majority of these have been for Class D equipment. What is more, there are now over 48 manufacturers of this type of equipment.

What It Is

The advantage of the new Class D service is that no operator's license or license examination is required. The radio equipment must be licensed, however, but this is usually no more than a mere formality. The user need only fill out a simple form describing the intended use of the equipment, certifying that it meets the technical requirements, and indicating that he is familiar with the rules. The form is mailed to the FCC, Washington, D. C., which then acts on each application in turn. Because of the large number of authorizations being handled, there is usually a time delay of around 60 days before the authorization and call letters are issued.

Twenty-three channels have been assigned between 26.965 and 27.255 mc., which is the old 11-meter amateur band. Stations must use voice modulation only, and AM must be employed. A power limit of 5 watts (final amplifier plate input power) has been set for the transmitter.

Uses and Abuses

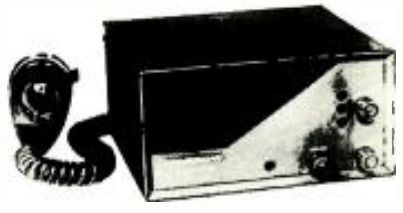
The Citizens Radio Service is intended for "private short-distance radio communications for personal or business use, limited to the minimum practicable transmission time." Citizens Radio units are now being used by business organizations to communicate with delivery trucks. TV service shops, department stores, laundries, dairies, and others can re-route their technicians or delivery men as required. Foremen in industrial plants or on construction projects can communicate with their workers even with considerable distance separating them. Farmers and ranchers can use Citizens Radio units to communicate with tractors, trucks, and other mobile units on the farm or ranch. Doctors and nurses may be paged directly in their cars with this equipment.

Citizen-users are installing units on pleasure boats in order to communicate with shore, with a nearby marina, and with other boats. Units have also been used on com-

Ray Jefferson Model 905 transceiver, manufactured by Ray Jefferson, Inc. Power requirements: 117 volts a.c. at 30 watts; other models available for 12 volts d.c. at 2.5 amps. or for 6 volts d.c. at 5 amps. Receiver: tunable superregenerative type with r.f. stage. Transmitter: 5-channel crystal-controlled type with 5 watts final plate input power. Units are normally supplied with single crystal for single-channel operation. Cabinet dimensions: 8⅛" x 6¾" x 8½"; weight: 12 lbs. Price: $99.50, including carbon micropnone.

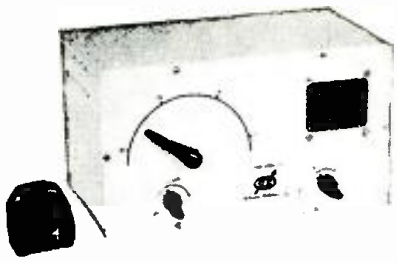
Utica "Town and Country" Model PT27 transceiver, manufactured by Utica Communications Corp. Power requirements: 117 volts a.c., 6 volts d.c., or 12 volts d.c. Receiver: single-channel fixed-tuned crystal-controlled superhet type with r.f. stage and two i.f. stages; noise limiter and squelch circuits are provided. Transmitter: single-channel crystal-controlled type with 5 watts final plate input power. Price: $159.50, including microphone.

Polytronics "Poly-Comm" PC-1 transceiver, manufactured by Polytronics Lab., Inc. Power requirements: 117 volts a.c. or 6 volts d.c.; also available for 117 volts a.c. or 12 volts d.c. Receiver: 4-channel fixed-tuned crystal-controlled dual-conversion superhet type with r.f. amplifier and three i.f. stages; noise limiter and squelch circuits are provided. Transmitter: 4-channel crystal-controlled type with 5 watts final plate input power. Units are normally supplied with one set of crystals for single-channel operation. Cabinet dimensions: 11" x 5" x 7½"; weight: 12¾ lbs. Price: $159.50, including carbon microphone.



Morrow Model 5W3 transmitter-receiver unit, manufactured by Morrow Radio Mfg. Co. Power requirements: 117 volts a.c. at 60 watts; models also available for 6 volts d.c. at 8 amps. or for 12 volts d.c. at 4 amps. Receiver: 3-channel fixed-tuned crystal-controlled superhet type with r.f. amplifier and i.f. stage; noise limiter and squelch circuits are provided. Transmitter: 3-channel crystal-controlled type with 5 watts final plate input power. Units are normally supplied with one set of crystals for single-channel operation. Cabinet dimensions: 9¼" x 4¾" x 8¾"; weight: 10½ lbs. Price: $179.50, including carbon microphone. (Note: Single-channel unit also available as Model 5W1 at $169.50.)

Apelco Model AR-9 transceiver, manufactured by Applied Electronics Co., Inc. Power requirements: 117 v. a.c. at 50 watts; also available for 12 volts d.c. at 5 amps. and 32 volts d.c. at 2.3 amps. Receiver: 5-channel fixed-tuned crystal-controlled superhet type with r.f. and i.f. stages; noise limiter and squelch circuits are provided. Transmitter: 5-channel crystal-controlled type with 5 watts final plate input power. Units are normally supplied with one set of crystals for single-channel operation. Cabinet dimensions: 9½" x 5¼" x 11½"; weight: 18 lbs. Price: $169.50, including carbon microphone.



Chickasha Model 1000-D transceiver, manufactured by Chickasha Electronics Inc. Power requirements: 117 v. a.c. at 35 watts, 6 volts d.c. at 7 amps., or 12 volts d.c. at 4 amps. Receiver: tunable superhet type with r.f. stage and i.f. stage; noise limiter and squelch circuits are provided. Transmitter: single-channel crystal-controlled type with 5 watts final plate input power. Cabinet dimensions: 12" x 7" x 6⅝". Price: $59.95 in kit form or $79.95 wired, with microphone.

Chickasha "Custom Dispatcher" transceiver, manufactured by Chickasha Electronics Inc. Power requirements: 117 volts a.c. at 35 watts, 6 volts d.c. at 7 amps., or 12 volts d.c. at 4 amps. Receiver: single-channel fixed-tuned crystal-controlled superhet type with r.f. stage and i.f. stage; noise limiter and squelch circuits are provided. Transmitter: single-channel crystal-controlled type with 5 watts final plate input power. Cabinet dimensions: 12" x 7" x 6⅝". Price: $69.95 in kit form or $89.95 wired, including microphone.

mercial craft on rivers and in harbors. Explorers and sportsmen have been using units to keep in touch with each other. Equipment may be used where regular communication facilities are not available or when wire facilities break down in an emergency.

Although there are many legitimate uses for the Citizens Radio Service, there have been some users who have gone overboard. Some look on the new service as an easy way to get on the air and have their own broadcasting stations. Space in the radio spectrum is far too valuable to be wasted by even a few capricious individuals who just want to "talk on the radio." If there is a real purpose for the communication, then personal use is perfectly in order. But just talking about the weather or a forthcoming social activity is taboo.

Then there are a few disgruntled amateurs who feel that the 11-meter band is still theirs, except with a limit on transmitter power. As a group, the hams have made many valuable contributions to radio communication, and many have worked hard to get the kind of amateur licenses they hold. Although we are very much opposed to the loss of any of the amateur frequencies, the fact of the matter is that 11 meters is simply not a ham band any more, and it must not be used as such. The calling of "CQ," attempts to work DX, or as many stations as possible are not permitted.

One good reason for the abuses is that the service is still fairly new and many of its users have not really learned its purpose. We feel that once it becomes clearly understood just what can and what cannot be done on the band, there will be a minimum number of rule violators.

Because of the fairly large number of rule violations at present, the FCC has been issuing quite a few violation notices. Being unable to answer some of these may result in loss of license. More serious violations may even carry fines or imprisonment.

COVER STORY

THIS MONTH'S COVER shows a number of representative examples of Class D Citizens Band transceiver units. Many of the important specifications of these transceivers are included in the following paragraphs. Note that each unit has been identified with a letter, and the description is keyed to the identifying letter.

(Photo by Bob Loeb)

A Heathkit Model CB-1 transceiver, manufactured by Heath Co. Power requirements: 117 volts a.c. at 35 watts; separate power supply needed for 6- or 12-volt battery operation. Receiver: tunable superregenerative type with r.f. stage. Transmitter: single-channel crystal-controlled type with 5 watts final plate input power. Cabinet dimensions: 9¾ x 8" x 6"; weight: 10 lbs. Price: $42.95 in kit form or $60.95 wired, including ceramic microphone.

B Johnson "Viking Messenger" transceiver, manufactured by E. F. Johnson Co. Also distributed by General Electric Co. Power requirements: 117 volts a.c. or 12 volts d.c.; also available for 117 volts a.c. or 6 volts d.c., and for 117 volts a.c. only. Receiver: 5-channel fixed-tuned crystal-controlled superhet type with r.f. stage and single i.f. stage; noise limiter and squelch circuits are provided. Transmitter: 5-channel crystal-controlled type with 5 watts final plate input power. Units are normally supplied with one set of crystals for single-channel operation. Cabinet dimensions: 7" x 5⅝" x 11⅜". Price: $139.75, including ceramic microphone.

C Knight-Kit "Custom" Model C-27 transceiver, manufactured by Allied Radio Corp. Power requirements: 117 volts a.c.; separate power supply needed for 6- or 12-volt battery operation. Receiver: tunable or single-channel fixed-tuned crystal-controlled dual-conversion superhet with r.f. amplifier and two i.f. stages; noise limiter and squelch circuits are provided. Transmitter: single-channel crystal-controlled type with 5 watts final plate input power. Cabinet dimensions: 12" x 5" x 12"; weight: 20 lbs. Price: $79.95 in kit form, including speaker-microphone.

D RME Model 4303 transceiver, manufactured by Radio Manufacturing Engineers, Inc. (division of Electro-Voice, Inc.). Power requirements: two self-contained 6-volt batteries. Receiver: tunable transistorized superhet with two i.f. stages. Transmitter: single-channel crystal-controlled transistorized type with 90 milliwatts oscillator input power. Cabinet dimensions: 9½" x 3¼" x 1⅞"; weight: ¾ lb. Price: $99.50, including speaker-microphone and built-in antenna.

E Vocaline "Commaire" Model ED-27 transceiver, manufactured by Vocaline Co. of America, Inc. Power requirements: 117 volts a.c. at 48 watts or 12 volts d.c. at 4.5 amps.; also available for 117 volts a.c. or 6 volts d.c. at 9 amps. Built-in transistor power supply is used with d.c. supply. Receiver: single-channel fixed-tuned crystal-controlled dual-conversion superhet type with r.f. amplifier and i.f. amplifier stages; noise limiter and squelch circuits are provided. Transmitter: single-channel crystal-controlled type with 5 watts final plate input power. Cabinet dimensions: 9¼" x 5¼" x 8¼"; weight: 11 lbs. Price: $179.50, including ceramic microphone.

F EICO Model 760 transceiver, manufactured by Electronic Instr. Co., Inc. Power requirements: 117 volts a.c. at 60 watts; also available for 117 volts a.c. or 6 volts d.c. at 9 amps and for 117 volts a.c. or 12 volts d.c. at 4 amps. Receiver: tunable superhet type with r.f. amplifier and two i.f. stages; noise limiter circuit is provided. Transmitter: single-channel crystal-controlled type with 5 watts final plate input power. Cabinet dimensions: 8½" x 6" x 9"; weight: 12 lbs. Price: $59.95 in kit form, including ceramic microphone. Also available factory-wired.

G RCA "Radio-Phone Deluxe" type CRM-P2B transceiver, manufactured by RCA Industrial Electronic Products. Power requirements: 117 volts a.c. at 40 watts or 12 volts d.c. at 3.4 amps.; also available for 117 volts a.c. or 6 volts d.c. at 6.8 amps. Receiver: tunable or single-channel fixed-tuned crystal-controlled superhet type with r.f. stage and two i.f. stages; noise limiter and squelch circuits (optional accessory) are provided. Transmitter: single-channel crystal-controlled type with 5 watts final plate power input. Cabinet dimensions: 7" x 9" x 5"; weight: 8 lbs. Price: $159.95, including speaker-microphone.

H Globe Electronics "Citizens Broadcaster" CB-100 transceiver, manufactured by Globe Electronics, Inc. Power requirements: 117 volts a.c. at 60 watts or 12 volts d.c. at 5 amps.; separate converter required for 6-volt d.c. operation. Receiver: 3-channel fixed-tuned crystal-controlled superhet type with r.f. amplifier and two i.f. stages; noise limiter and squelch circuits are provided. Transmitter: 3-channel crystal-controlled type with 5 watts final plate input power. Units are normally supplied with one set of crystals for single-channel operation. Cabinet dimensions: 13" x 3½" x 10½"; weight: 13 lbs. Price: $129.95, including ceramic microphone.

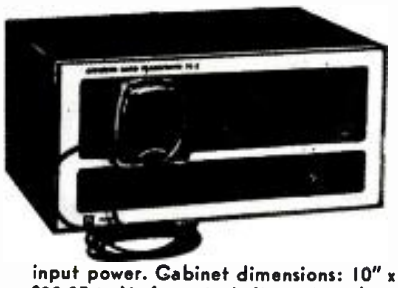
What About Range?

The prospective user of a Citizens Radio unit is sure to want to know just how much range he can get from the equipment he is going to buy or build. The question of how much distance can be covered cannot be answered simply. It depends on many factors, including transmitter power, type and location of the antenna, sensitivity of the receiver, and type of terrain.

Just about all Citizens Radio transmitters are operated with close to the maximum legal limit of 5 watts final input power. The power specified is actually d.c. plate input power to the final power amplifier. It is calculated by multiplying the plate voltage by the plate current. This does not mean that there will be 5 watts of r.f. power applied to the transmitting antenna. Some output circuits are less efficient than others so that in some cases only 1 watt or less of r.f. is available. With more efficient output circuits, as much as 3 or more watts of r.f. is produced. With a short, properly matched transmission line to the antenna, just about all this r.f. is applied to the antenna. But if the transmission line is long or is not properly matched, then only a portion of this power actually gets into the antenna to radiate a useful signal.

A far more important factor in getting long-distance coverage is the type and location of the antenna. Only one antenna is required per unit, since this antenna is switched from transmitter to receiver as required. A quarter-wave antenna for 27 mc. must be 8⅔-feet (nominally 9 feet) long, while a half-wave type is twice this length. Because such lengths are inconvenient for mobile use, it is common to use shorter whip antennas. These have loading coils inserted in them to increase their length electrically. Such loaded antennas are usually not as efficient in radiating a signal as antennas having the full quarter or half wavelength.

The matter of antenna location is very important. Very little signal will be radiated (or received) if the antenna is inside a house or inside a car. Much better performance will be obtained by a window, or better still, a roof mount-

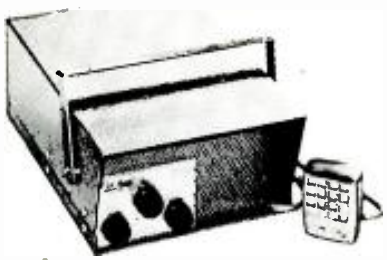


Knight-Kit "Standard" Model C-11 transceiver, manufactured by Allied Radio Corp. Power requirements: 117 volts a.c.; separate power supply needed for 6- or 12-volt battery operation. Receiver: tunable superregenerative type with r.f. stage. Transmitter: single-channel crystal-controlled type with 5 watts final plate input power. Cabinet dimensions: 10" x 6" x 8"; weight: 10 lbs. Price: $39.95 in kit form, including microphone. (Another Knight-Kit model appears in our cover story.)

Gonset "Citizens' Communicator" Model G-11 transceiver, manufactured by Gonset Div., Young Spring & Wire Corp. Power requirements: 12 volts d.c.; models also available for 6 volts d.c. or 117 volts a.c. Receiver: single-channel fixed-tuned crystal-controlled superhet type with r.f. stage and two i.f. stages; noise limiter and squelch circuits are provided. Transmitter: single-channel crystal-controlled type with 5 watts final plate input power. Cabinet dimensions: 6¾" x 5¼" x 6¾"; weight: 10 lbs. Price: $124.50, including microphone.

Gonset "Citizens' Communicator" Model G-12 transceiver, manufactured by Gonset Div., Young Spring & Wire Corp. Power requirements: 117 volts a.c. or 12 volts d.c. Receiver: 4-channel fixed-tuned crystal-controlled superhet type with r.f. stage; noise limiter and squelch circuits provided. Transmitter: 4-channel crystal-controlled type with 5 watts final plate input power. Units are normally supplied with one set of crystals for single-channel operation. Cabinet dimensions: 7" x 4½" x 10"; weight: 11 lbs. Price: $149.95, including microphone.

Multi-Elmac "Citi-fone" CD-5 transceiver, manufactured by Multi-Products Co. Power requirements: 117 volts a.c. at 30 watts or 6 volts d.c. at 5 amps.; also available for 117 volts a.c. or 12 volts d.c. at 2.5 amps. Receiver: 5-channel fixed-tuned crystal-controlled superhet type with r.f. amplifier and two i.f. stages; noise limiter and squelch circuits are provided. Transmitter: 5-channel crystal-controlled type with 5 watts final plate input power. Units are normally supplied with one set of crystals for single-channel operation. Cabinet dimensions: 8" x 4¼" x 11"; weight: 12 lbs. Price: $124.50, including ceramic microphone.



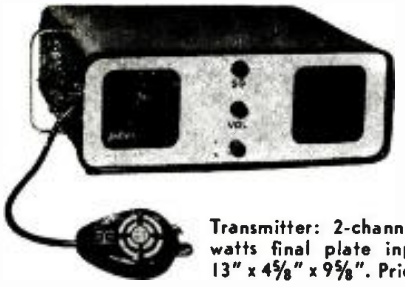
International Model KB-1 transceiver, manufactured by International Crystal Mfg. Co., Inc. Power requirements: 117 volts a.c. at 60 watts; also available for 117 v. a.c., 6 volts d.c., or 12 volts d.c. Receiver: tunable crystal-controlled dual-conversion superhet type with r.f. stage and i.f. stage; noise limiter and squelch circuits are provided. Transmitter: single-channel crystal-controlled type with 5 watts final plate input power. Cabinet dimensions: 8¾" x 6" x 10"; weight: 15 lbs. Price: $90 for a.c.-only model in pre-wired sub-assembly kit form.

EDCO "Unicom" 100-C transmitter-receiver unit, manufactured by Electronics Design Co. Power requirements: 117 volts a.c. at 100 watts; also available for 117 volts a.c., 6 volts d.c. at 16.7 amps., or 12 volts d.c. at 8.5 amps. Receiver: single-channel fixed-tuned crystal-controlled superhet type with r.f. amplifier and two i.f. stages; noise limiter and squelch circuits are provided. Transmitter: single-channel crystal-controlled type with 5 watts final plate input power. Cabinet dimensions: 11¼" x 10½" x 9½"; weight: 15 lbs. Price: $235.00 for the a.c.-only model.

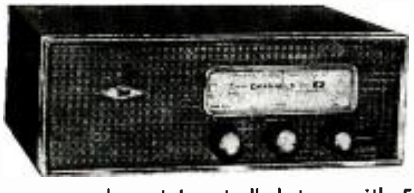
International "Executive" transceiver, manufactured by International Crystal Mfg. Co., Inc. Power requirements: 117 volts a.c., 6 volts d.c., or 12 volts d.c. Receiver: tunable or two-channel crystal controlled dual conversion superhet type with r.f. stage and i.f. stage; squelch circuits and noise limiter are provided. Transmitter: 3-channel crystal-controlled type with 5 watts final plate input power. Units are normally supplied with single transmitter crystal. Cabinet dimensions: 8½" x 5½" x 9½"; weight: 12 lbs. Price: $169.95.

Raytheon "Raycon" transceiver, manufactured by Raytheon Co. Power requirements: 117 volts a.c. at 50 watts; also available for 12 volts d.c. at 5 amp. and 32 volts d.c. at 2.3 amps. Receiver: 5-channel fixed-tuned crystal-controlled superhet with r.f. and i.f. stage; noise limiter and squelch circuits are provided. Transmitter: 5-channel crystal-controlled type with 5 watts final plate input power. Cabinet dimensions: 9½" x 5¼" x 11½"; weight: 18 lbs. Price: $179.50, including carbon microphone.

Transpace Model C-27A transceiver, manufactured by Transpace, Inc. Power requirements: 117 volts a.c. at 60 watts; adapters available for 6 volts d.c. at 9 amps. or for 12 volts d.c. at 4.5 amps. Receiver: 6-channel fixed-tuned crystal-controlled superhet with r.f. stage and two i.f. stages; noise limiter and squelch circuits are provided. Transmitter: 6-channel crystal-controlled type with 5 watts final plate input power. Units are normally supplied with one set of crystals for single-channel operation. Cabinet dimensions: 10⅛" x 4¼" x 9"; weight: 11 lbs. Price: $169.50, including ceramic microphone.



Tecraft "Falcon" transceiver, manufactured by Tecraft Sales Corp. Power requirements: 117 volts a.c., 6 volts d.c., or 12 volts d.c. Receiver: tunable or single-channel fixed-tuned crystal-controlled dual-conversion superhet type; noise limiter and squelch circuits are provided. Transmitter: 2-channel crystal-controlled type with 5 watts final plate input power. Cabinet dimensions: 13" x 4⅝" x 9⅝". Price: $144.95, including microphone.



Shell Model CB-12 transceiver, manufactured by Shell Electronics Mfg. Corp. Power requirements: 117 volts a.c. at 37 watts or 12 volts d.c.; also available for 117 volts a.c. or 6 volts d.c. Receiver: tunable superregenerative type with r.f. stage. Transmitter: single-channel crystal-controlled type with 5 watts final plate input power. Cabinet dimensions: 11½" x 4⅜" x 6¼"; wt.: 7½ lbs. Price: $79.95.

Regency Model CB-27 transceiver, manufactured by Regency Div., Industrial Development Engineering Associates, Inc. Power requirements: 117 volts a.c. at 50 watts; also available for 12 volts d.c. Receiver: tunable dual-conversion superhet with one oscillator crystal-controlled; noise limiter and squelch circuits are provided. Transmitter: 2-channel crystal-controlled type with 5 watts final plate input power. Units are normally supplied with one set of crystals for single-channel transmitter operation. Cabinet dimensions: 8¾" x 4½" x 6½"; weight: 9 lbs. Price: $124.95, including ceramic microphone.

ing on a house and a bumper or fender mounting on a car. The higher the antenna can be mounted, the greater will be the range covered. It is important that the antenna be no more than 20 feet above the structure on which it is mounted to meet one of the legal requirements for Citizens Band operation. Naturally, a mobile unit in a car parked in a valley would have far less effective range than the same unit would have when the car is atop a high hill. Antennas may also be mounted on towers or poles in order to increase range. Under these conditions, though, the antenna must not exceed the height of the tower. It is also possible to increase range considerably by the use of highly directional antenna arrays.

The characteristics of the receiver are also important in determining range. The more sensitive the receiver is, the greater the distance it will be able to pick up a signal of given strength. Highly selective receivers, although they do not actually increase the coverage range, make it easier to work with a signal that is interfered with by other signals on adjacent channels.

Finally, the type of surrounding terrain is important in determining range. Dense, heavily wooded areas tend to absorb r.f. energy and reduce effective range. On the other hand, clear open fields, or better still, a large body of water, will provide extended coverage.

All in all, a reliable range of 5 to 10 miles can be expected under fairly normal conditions. When communications are tried between two mobile units using short antennas, coverage of about 2 to 3 miles is usual. On the other

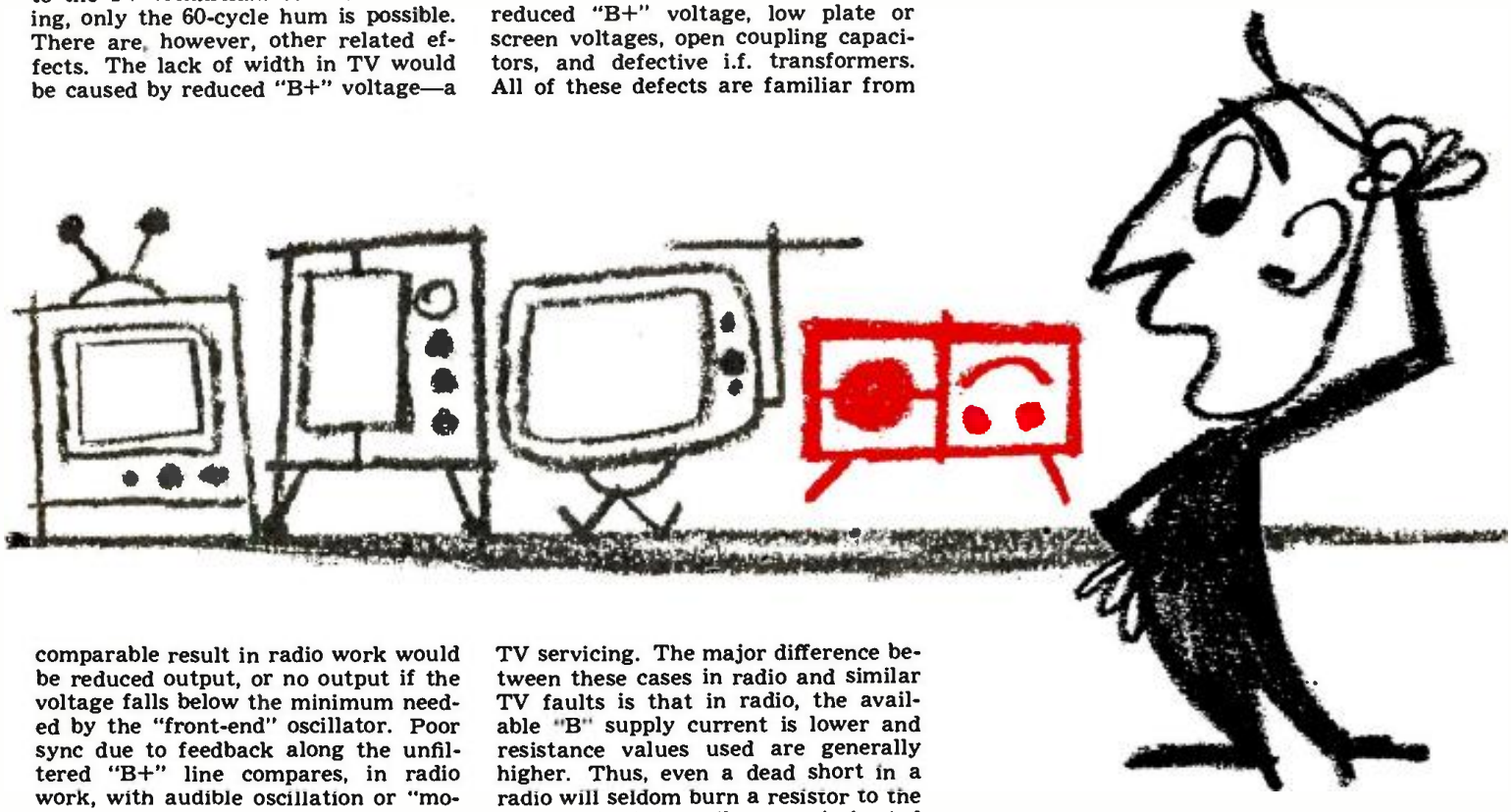
(*Continued on page* 139)

CITIZENS RADIO MANUFACTURERS

ACTON LABORATORIES, INC., 533 Main Street, Acton, Massachusetts
ALLIED RADIO CORP., 100 N. Western Avenue, Chicago 80, Illinois
APPLIED ELECTRONICS CO., INC. (APELCO), 213 E. Grand Avenue, South San Francisco, California
ARKAY, 88-06 Van Wyck Expressway, Richmond Hill 18, New York
CHICKASHA ELECTRONICS, INC., 828 Choctaw Avenue, Chickasha, Oklahoma
CITIZENS ELECTRONICS, P. O. Box 443, Laurelton, N. J.
DIXON ELECTRONICS, 13444 W. McNichols, Detroit 35, Mich.
DUNLAP ELECTRONICS, INC., 764 Ninth Street, Des Moines 14, Iowa
ELECTRONIC INSTRUMENT CO., INC. (EICO), 33-00 Northern Blvd., L.I.C. 1, N. Y.
ELECTRONICS DESIGN CO., 400 E. Cornell Street, Enid, Oklahoma
ESSCO C-B HEADQUARTERS, 58 Walker St., New York 13, N. Y.
GLOBE ELECTRONICS, INC., Div. of Textron Electronics, Inc., 22-30 South 34th Street, Council Bluffs, Iowa
GONSET DIV., Young Spring & Wire Corp., 801 South Main Street, Burbank, California
GROVE ELECTRONIC MFG. CO., 4103 W. Belmont Avenue, Chicago 41, Illinois
HALLICRAFTERS, 4401 W. Fifth Ave., Chicago 24, Ill.
HEATH COMPANY, Benton Harbor 15, Michigan
HERSHEL RADIO CO., 5249 Grand River, Detroit 8, Mich.
INTERNATIONAL CRYSTAL MFG. CO., INC., 18 N. Lee, Oklahoma City, Oklahoma
JOHNSON, E. F. CO., Waseca, Minnesota
KAAR ENGINEERING CORP., 2995 Middlefield Road, Palo Alto, California
KAY-TOWNES ANTENNA CO., Box 593, Rome, Georgia
LAFAYETTE RADIO, 165-08 Liberty Avenue, Jamaica 33, New York
LAKELAND ELECTRONICS, Warsaw Indiana
MAXWELL ELECTRONICS CORP., 229 Garvon Street, Garland, Texas
MORROW RADIO MFG. CO., 2794 Market Street, N.E., Salem, Oregon
MULTI-PRODUCTS CO., 21470 Coolidge Highway, Oak Park 37, Mich.
NUNAMAKER ELECTRONICS, 918 Sixth St., Portsmouth, Ohio
PEARCE-SIMPSON, INC., 2295 N.W. 14th Street, Miami, Florida
PHILMORE MFG. CO., INC., 130-01 Jamaica Avenue, Richmond Hill 18, New York
POLYTRONICS LAB., INC., 253 Crooks Avenue, Clifton, New Jersey
RADIO CORP. OF AMERICA, Radiomarine Products, Camden, New Jersey
RADIO MANUFACTURING ENGINEERS, INC., Div. of Electro-Voice, Inc. Washington, Illinois
RADIO SHACK CORP., 167 Washington Street, Boston 8, Massachusetts
RADSON ENGINEERING CORP., Macon, Illinois
RAY JEFFERSON, INC., 40 East Merrick Road, Freeport, L. I., N. Y.
RAYTHEON MANUFACTURING CO., Waltham 54, Massachusetts
REGENCY DIV., I.D.E.A. Inc., 7900 Pendleton Pike, Indianapolis 26, Indiana
SHELL ELECTRONICS MFG. CORP., 112 State Street, Westbury, L. I., New York
SPRINGFIELD ENTERPRISES (also ELCOLAB), P. O. Box 54, Springfield Gardens 13, New York
TECRAFT SALES CORP., Box 116, River Edge, New Jersey
TRANSPACE, INC., 12902 Foothill Blvd, San Fernando, California
U. S. ELECTRONICS, 7400 Jackson, Birmingham, Mich.
UTICA COMMUNICATIONS CORP., 19 S. LaSalle Street, Chicago 3, Illinois
VANGUARD ELECTRONIC LABS, Box 12, Hollis 23, N. Y.
VOCALINE CO. OF AMERICA, INC., Old Saybrook, Connecticut
WESTERN RADIO, Kearney, Nebraska
WIGHTMAN ELECTRONIC ENGINEERING CO., Easton, Maryland
WORLD RADIO LABORATORIES, 3415 W. Broadway, Council Bluffs, Iowa

Radio Service for TV Technicians

By KENNETH BRAMHAM



Would you rather tackle a TV set than a simple table radio? Your technique may need a little polishing.

VOLUMES have been written on the subject of TV servicing for the radio technician. The assumption is that the beginning TV service technician is first experienced in radio repairing, and is familiar with radio circuitry.

The trend in recent years, however, has been towards TV servicing itself as the primary field. As a result, we now have what might be described as a new generation of practical TV technicians, with little or no radio experience. For this growing number, a few hints on radio servicing and a comparison with TV work will be useful.

While a component failure causing trouble in a radio may be identical with a familiar TV fault, the effect can be quite different. Take the case of an open filter capacitor as an example: decreased width, poor sync, 60-cycle hum in the audio, and shading in the picture are all possible and familiar symptoms to the TV technician. In radio servicing, only the 60-cycle hum is possible. There are, however, other related effects. The lack of width in TV would be caused by reduced "B+" voltage—a comparable result in radio work would be reduced output, or no output if the voltage falls below the minimum needed by the "front-end" oscillator. Poor sync due to feedback along the unfiltered "B+" line compares, in radio work, with audible oscillation or "motorboating" arising from the same type of defect.

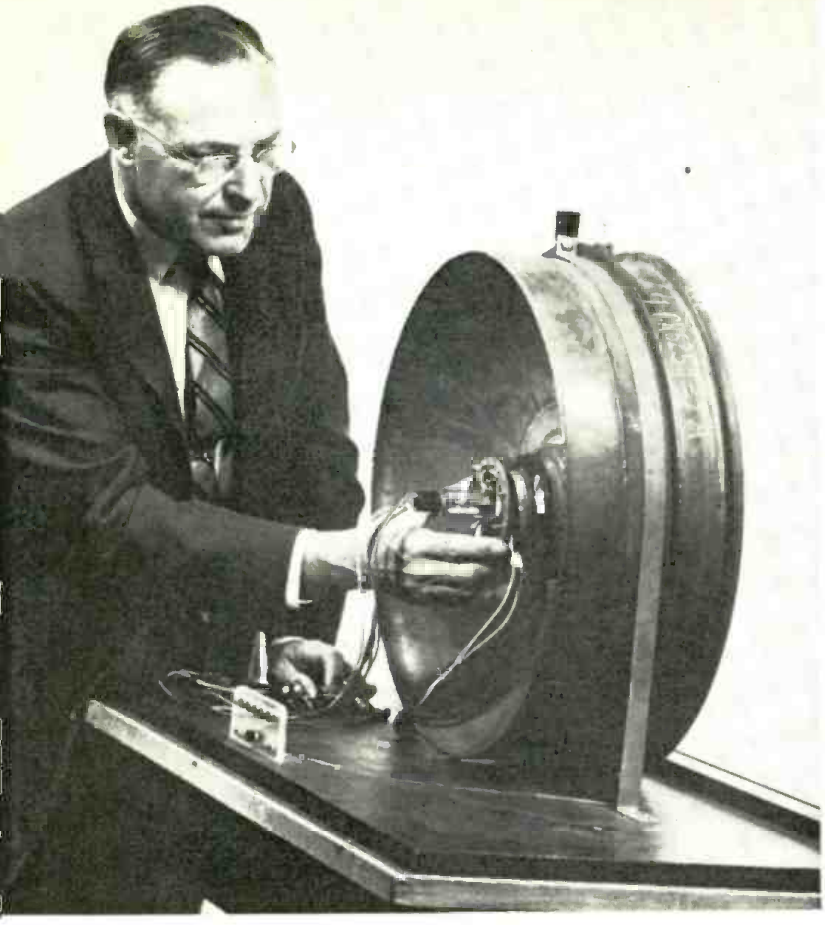
The very simple "B+" filtering used in small radios makes servicing relatively easy, with the most useful service instrument being a 10-μf. electrolytic capacitor, with good stiff leads, used to bridge out each filter capacitor section in turn. The usual electrolytic capacitor combination is made up of two "B+" filters, the smaller of the two being used at the rectifier or input end of the network, and a lower-rated cathode bypass capacitor, used in the power output stage. Thus it is possible that, while bridging a capacitor may indicate an open condition, the real trouble may be leakage between sections of the multiple unit. In either event, a complete multiple-electrolytic unit should be replaced when one section appears defective in preference to installing a replacement across the one section only.

Oscillation and motorboating are also caused by regeneration other than that of feedback on an inadequately filtered "B+" line. The most frequent offender is an open screen bypass capacitor, which allows an individual stage to oscillate. Again the technique of bridging out individual capacitors (with one known to be good) may be used. Alternatively the grid of each successive stage may be shorted out until the offending stage is located. Then the bypass capacitor in this stage may be bridged out as a final localization check.

Loss of contrast in TV compares in radio servicing with a loss of gain and sensitivity arising from comparable component failures. The most obvious cause of reduced gain is, of course, one or more weak tubes. Other causes are; reduced "B+" voltage, low plate or screen voltages, open coupling capacitors, and defective i.f. transformers. All of these defects are familiar from TV servicing. The major difference between these cases in radio and similar TV faults is that in radio, the available "B" supply current is lower and resistance values used are generally higher. Thus, even a dead short in a radio will seldom burn a resistor to the point where it is easily seen. A shorted screen bypass capacitor, for instance, may drop the screen voltage to zero without burning out the screen dropping resistor or seriously affecting the voltage available to other parts of the set. Fortunately, it takes very little time to check every plate and screen voltage in a small radio. It should be remembered, when checking these voltages, that a "B−" line is usually employed instead of the familiar negative chassis.

Perhaps the most useful "dodge" in radio servicing is that of signal tracing with a screwdriver or solder pick. Applying this "test instrument" to a grid should produce a click and 60-cycle hum in the speaker. Working from the output stage back to the r.f. section

(*Continued on page* 113)



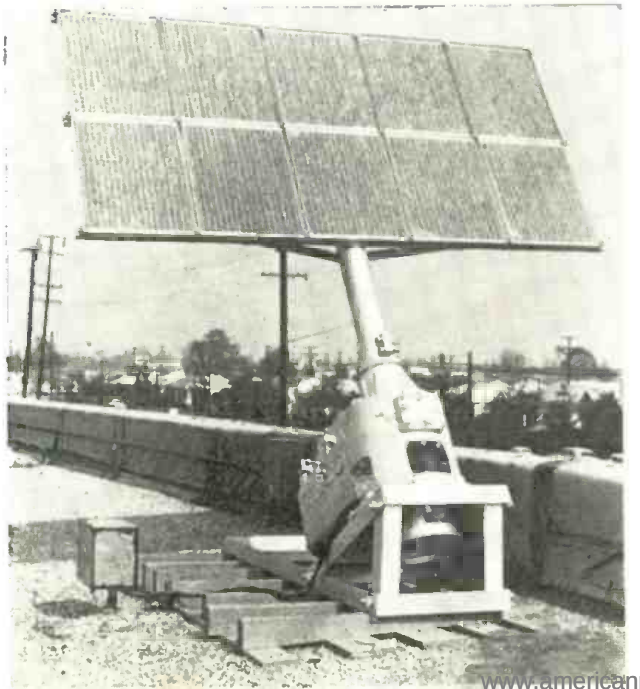
Recent Developments in Electronics

Inside-Out Picture Tube

A radically new type of thin picture tube that promises increased brightness, detail, and compactness in military and commercial radar systems is under development by *RCA*. The experimental tube, known as a reflected-beam kinescope, has a viewing surface 21 inches in diameter and a total length of only 10 inches. The phosphor screen is over the curved rear inner surface instead of at the tube face. The electron beam approaches the transparent face of the tube, which acts as an "electron mirror" to reflect the beam back to the phosphor. The new tube can display TV pictures but with only one-quarter the efficiency of conventional TV picture tubes.

Electronic Security System

Detection devices shown here are used with the new integrated building protection and security system introduced by *Minneapolis-Honeywell*. Included are fire and smoke detector heads, tamper-proof magnetic switches to windows, electronic noise and motion detectors, capacitance-type electronic fencing, and many others. Any of the devices can be tied in with the new system's centralized control console. In all instances of alarm, a guard at the console receives both an audible alarm (horn, buzzer, bell) and visual warning (push-button switch lights up).



Largest Solar Energy Converter

The world's largest solar energy converter, "Big Bertha," converts sunlight into electricity by means of over 7800 silicon solar cells, similar to those used to power instruments in U. S. earth satellites. "Big Bertha" was used recently for the first time to power a door-opening device during the dedication of the new $2-million *Hoffman* Semiconductor Center in El Monte, Calif. It has been installed permanently on the Center's roof to provide electricity for the Center's solar energy exhibits. The solar cells are attached to a 4- by 8-foot panel. An automatic tracking device keeps the panel faced toward the sun for maximum efficiency. Ten individual panels in the array can be connected in various combinations to provide 6 to 60 volts at currents from .5 to 5 amps.

◀ High Voltage for Satellites

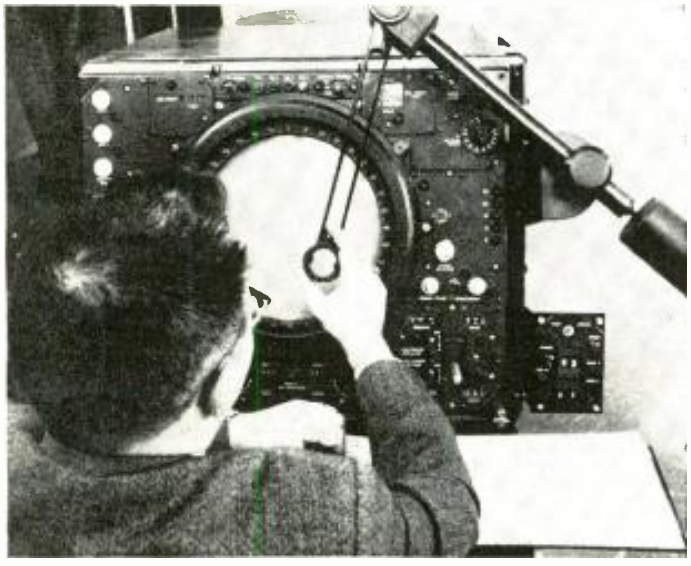
A ferroelectric converter, developed by *ITT* laboratories, can produce high voltages directly from the warming power of the sun or other heat source. Unlike solar cells, which depend on light to produce low-voltage d.c., the converter relies on temperature changes alone to produce high-voltage a.c. by means of special ceramic coatings.

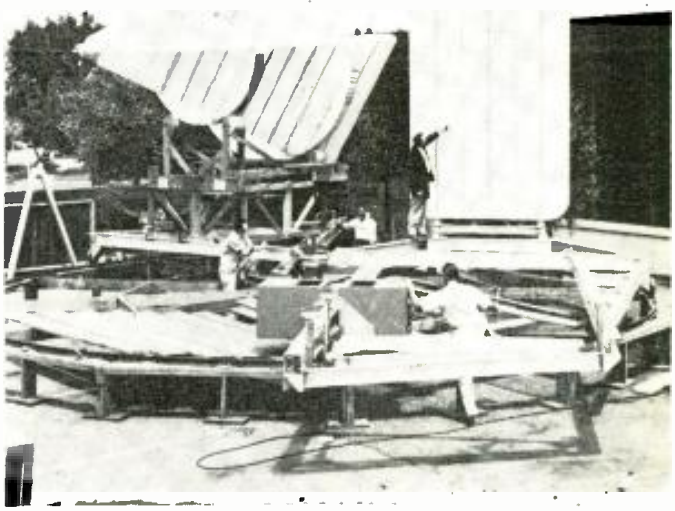
Countermeasures Antennas

Advanced antennas which meet the extremely wide band requirements for electronic warfare weapons are shown below. These were displayed at the formal opening of a major addition to *Sylvania's* Electronic Defense Laboratories at Mountain View, Calif. Antennas having a 30:1 bandwidth have been built here. ▼

Aircraft Identification System

New *General Instrument* device permits air traffic controller to pick out on radar screen any one "blip" within 200 miles and identify it exactly without communicating with plane's crew. Aircraft radar beacon sets up identifying numbers on indicator at right. ▼





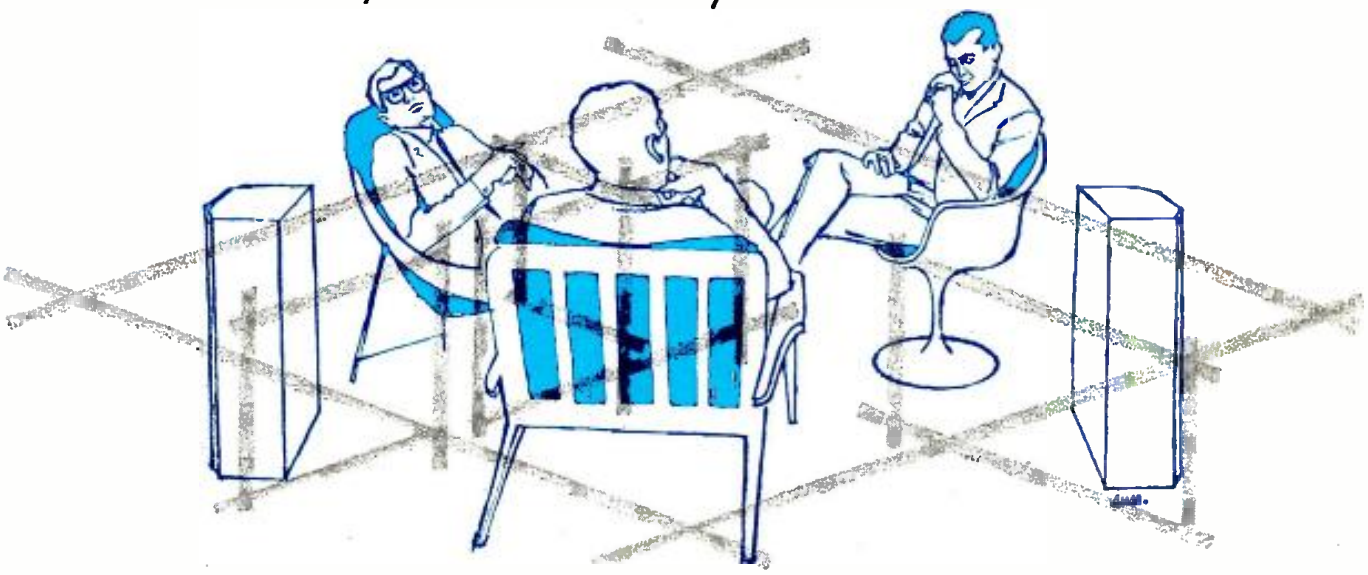
Power Generator Uses Rocket Exhaust ▶

This electronic system with no moving parts converts the heat of a rocket exhaust directly into electric power to run the steering controls and electronic equipment of the missile. System consists of *RCA* thermionic generator tube in the shape of a hollow cylinder which fits like a sleeve over the flame tube attached to a *Thiokol* solid-fuel rocket motor in a special test mount. Heat from the burning fuel is converted directly to electricity, which is carried through wire leads to measuring equipment used during tests.

Room Acoustics for Stereo

Part 2. Reverberation & Room Treatment

By **ABRAHAM B. COHEN** / Advanced Acoustics Corp.



How the optimum room reverberation is obtained and room resonances are controlled by the use of standard decorative and special acoustic materials.

ONE requirement for a good listening room is that it have the proper reverberation time—or liveliness—to simulate good concert hall conditions. Control of reverberation may be achieved by using standard home decorative materials and commercial sound absorbent tiles. By means of absorption tables covering architectural materials used in home construction, ordinary decorative materials, and commercially available acoustic tiles, it is fairly simple to calculate and "correct" a room to provide proper reverberation conditions.

Reverberation

A room in which sound is to be produced or reproduced, whether live speech and music direct from the piano sounding board or reproduced sound from loudspeakers (monophonic or stereo), must meet certain acoustical conditions if the sound is to be heard properly. A good "listening" room should have correct reverberation properties and generate a minimum of multiple echoes.

Analytically, reverberation is a measure of how fast a room will cause sound to be reduced to a certain level *after* the source of sound has ceased to emit its signal, *providing* the sound has been fully built up in and has "saturated" the room before the source was stopped. We naively state that reverberation is the quality of "liveness" of a room (to sound) but what is the actual mechanism of room acoustics that leads to reverberation?

In Fig. 7A let the loudspeaker in the corner generate a constant-frequency and constant-amplitude sound. The wavefront emerging from the loudspeaker builds out in a spherical shell of constantly enlarging radius. As soon as that first wavefront reaches a reflecting surface, as at point P1 on wall A-B, the wavefront will be reflected. This reflection travels outward from the wall just as if there were an additional actual sound source at wall A-B. Again the sound from this new source travels out in ever-increasing spherical fronts until it hits another surface like wall D-C from which it will again be reflected as if there were another sound source at P2 on that wall. Thus these reflections will continue until there are a great number of these reflected rays travelling through the room, as shown in Fig. 7B, producing a generally diffused sound condition throughout the room—*as long as the source continues to operate.*

When the source of sound stops, the diffuse reflections do not stop immediately because the sound that has left the speaker has a finite speed of travel. The sound will keep reflecting in a completely random manner, each reflection being successively weaker than the preceding one. The more absorbent the walls, the less sound power gets reflected and the quicker the sound dies out. When the sound dies out slowly, there is little absorption within the room, and the room would be termed "highly reverberant."

Reverberation, then, is correlated with time—how fast does the sound die out? This is a measure of reverberation—"time." Consequently, "reverberation time" has been defined as the time (in seconds) that a steady-state sound in a room decreases to 1-millionth (1/1,000,000) of its original intensity (after the source has stopped). See Fig. 8. In easier terms, when the intensity of the sound, *after the source has stopped,* decreases by 60 db, the time it took to drop to this level is the reverberation time.

Now, just what sort of reverberation time period should one expect of a listening room, especially one intended for stereo listening? In Part 1 of this series we noted that perhaps a shorter reverberation time for stereo might be desirable since the very essence of stereo itself "psycho-enlarges" the room. This question of optimum reverberation time cannot be answered by complete specifications down to the last decimal place. It is a variable, depending on room or auditorium size and the type of program material being presented. Studies have shown that while an auditorium sounds right—has an accepted reverberation time—for a full symphony orchestra, it may not have the proper reverberation for chamber music or voice.

Many studies have been made of music rooms, auditoriums, concert halls, churches, and similar structures to determine the acceptable range of reverberation times and these figures have been generalized in Fig. 9. While it would be nice to have an instrument at home which would enable us to check the reverberation time of our listening room against this sort of

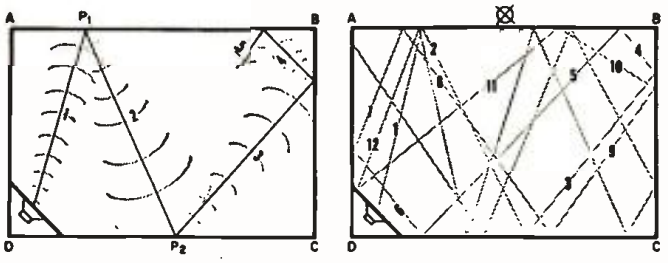


Fig. 7. When a sound source continues to operate, diffuse reflection builds up until the sound level reaches steady state.

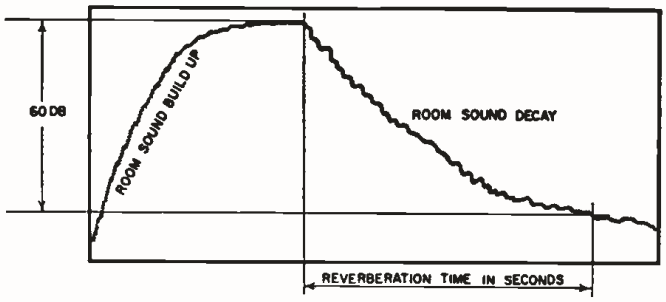


Fig. 8. Reverberation time is the time, in seconds, taken for steady sound to be reduced to a millionth of its original level.

chart, such equipment is quite expensive (for home use) and requires an experienced professional hand at the controls. For such non-critical conditions in the home it is possible to calculate the reverberation time of any room by measuring its physical size and applying information from the charts and tables to be discussed shortly.

In very simple form, $T = .05V/A$, where T is the reverberation time of the room (in seconds), V is the volume of the room (in cubic feet), and A is the *total* absorption of the room and its contents. V, the volume of the room, is no trouble to calculate. Total absorption may be judiciously estimated by reference to established tables which give the absorption coefficients of various materials used in the construction and decoration of the room. For purposes of this article, we must, of necessity, limit ourselves in listing absorption coefficients. What we

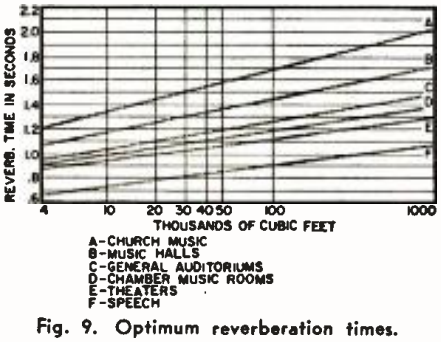


Fig. 9. Optimum reverberation times.

will do is list the more common household materials which may affect the acoustic conditions of our listening room and then work with these.

Table 1 itemizes such common household materials while Fig. 10 illustrates, in chart form, the absorption characteristics, as a function of frequency, of some representative commercial materials available for acoustical correction purposes. It will be observed that, in general, the softer the material, the more it soaks up the sound.

Another interesting item to be observed from Table 1 is that a given material can be arranged so that its absorption characteristic may be varied. Velours, for example, when hung flat, have much less absorption *per unit area,* as shown in Fig. 11 than, if we drape or "bunch" a length of velour into an area one-half its flat length. As Table 1 indicates, we practically double the absorption. This, then, is a basic principle by which highly absorbent surfaces are obtained . . . "amplify" a given absorptive area by providing a dimension *in depth* for more absorption.

Acoustical Tiles

Most of us are familiar with those off-white squares of "sound absorbent" material widely used on the ceilings of public buildings. Such materials are known as "tiles" in the trade. Fig. 13 shows some typical units of this type. The tiles are generally a foot square and may be obtained in several thicknesses—¾" being standard for home use. The tiles are made in a variety of materials and textures. Some are simply rough surfaces with "cracks" or fissures apparent on the surface while others are of the perforated variety, some with evenly spaced holes and some with randomly spaced perforations.

Although an inspection of Fig. 10 indicates that the absorption characteristics of these materials are roughly similar, the perforated variety has some advantages in absolute absorption, especially in the mid-frequency range, although the "curve" of absorption is not as smooth as for the unperforated type.

If such acoustic tile is to be applied for the purposes of reducing noise due to the human voice alone, as in restaurants and offices, then the perforated material, with its accentuated mid-frequency absorption (where most of the voice frequencies are found) is perhaps most suitable since the ear is especially sensitive in this area.

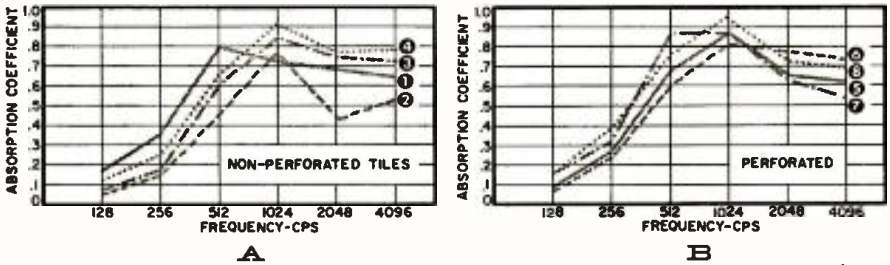
If, however, we wish to absorb a fuller range of sound than that of the human voice, then the fissured material is preferable because of the smoother absorptive curve, although more of the material may be required. Moreover, as far as the home is concerned, the fissured or sculptured material will fit in with the decor better and look less "industrial" than the perforated variety.

It is interesting to note that the rise in the absorption curve of these materials roughly coincides with the frequency range where the stereo differentiating effect takes place. In the region above 300 cps, spatial differentiation becomes effective and separate speakers reproducing these frequencies are necessary for proper spatial perspective. Thus the effectiveness of these sound absorbing materials roughly matches the frequency range where the stereo effect becomes discernible—making them eminently suited for acoustic adjustments and compensation for stereo reproduction.

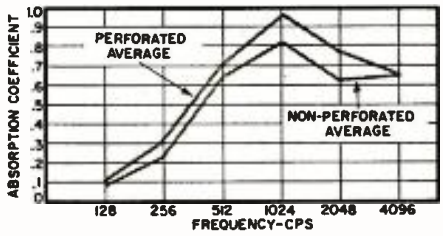
Determining Reverberation

To illustrate the application of the reverberation formulas in conjunction with the tables, let's choose a room with the typical dimensions shown in Fig. 12. In its bare, untenanted state, the room consists of a pine floor with the walls and ceiling of plaster, lime, and sand finish on metal lathing. The

Fig. 10. Average absorption characteristics of representative acoustic tiles.



CURVE	MANUFACTURER	COMPOSITION
1	INSULITE CO.	COMPRESSED WOOD PULP
2	ARMSTRONG CORK	CORK
3	NAT'L GYPSUM	COMPRESSED WOOD FIBERS
4	AMER. ACOUSTICS	CORK GRANS. & MINERAL BINDER
5	JOHNS-MANSFIELD	FELTED MINERAL FIBERS
6	CELOTEX CORP.	MINERAL FIBERS
7	OWENS CORNING	FELTED MINERAL FIBERS
8	ARMSTRONG CORK	CORK COMPOUND



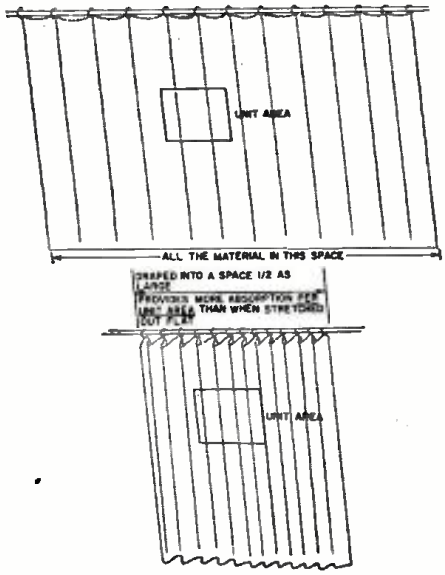
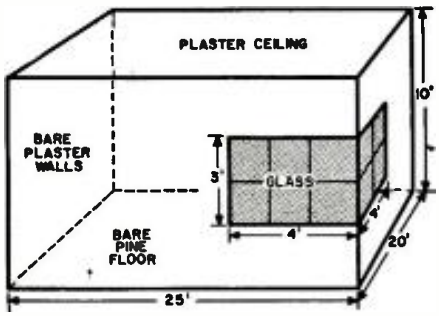


Fig. 11. Here is a simple method of changing the amount of absorption in a typical listening room, as required.

Fig. 12. This completely bare hard room will be too "live", while the room will be too "dead" if completely padded. Figures used are shown below.



	Surface	Sq.Ft. × Abs. Coeff. (512 cps)	= Total Abs.	
Completely bare room	Floor	500	.09	45
	Ceiling	500	.06	30
	Walls	876	.06	52.6
	(2 @ 25 × 10 = 500) + (2 @ 20 × 10 = 400) = 900 − glass (2 @ 3 × 4 = 24) = 876			
	Glass	24	.03	0.7
				128.3 units
	T = (.05 × 20 × 25 × 10) / 128.3 = 1.95 seconds			
Completely padded room	Floor (carpeted)	500	.37	185
	Ceiling (bare)	500	.06	30
	Walls (draped & assuming windows covered by drapes)	900	.55	495
				710 units
	T = (.05 × 5000) / 710 = .35 second			
Adjusted room	Floor (carpeted)	500	.37	185
	Ceiling (bare)	500	.06	30
	Walls (draped 1/5 of area)	180	.55	99
	Walls (bare plaster 4/5 of area)	720	.06	43
				357 units
	T = (.05 × 5000) / 357 = .70 second			

windows, of course, are of standard glass. We know intuitively how a loudspeaker would sound in this bare room, but just as a simple exercise to illustrate the use of our "mathematical tools," let us put down some numbers that will provide the figure of (de)merit for this room.

We are going to apply the reverberation formula ($T = .05V/A$) previously discussed, which relates room volume to total absorption. To get total absorption, we simply add up all the *absorption units* of all the surfaces of the room by *multiplying the areas of the various exposed surfaces by their respective absorption coefficients.* In simple cases such as this, the absorption coefficient for 512 cps is used. Thus, as indicated in Fig. 12, the floor has an area of 25' x 20' or 500 square feet. It is made of pine flooring which has an absorption coefficient of .09 (per square foot). Its total absorption is 500 x .09' or 45 *units*. The "units" for the walls, ceiling, and windows are figured in the same way on the basis of their areas and absorption coefficients. The absorption of the room totals 128 units and, as indicated in Fig. 12, the reverberation time becomes 1.95 seconds. Checking back to Fig. 9 we find that this reverberation time is far too long for proper definition of sound in a room this size (5000 cubic feet). The room will be too "live" which, of course, we knew from the start.

Now let's go to the other extreme and drape all the walls (using a drape which has an absorption coefficient of .55) and lay carpeting on the floor. The second tabulation, Fig. 12, shows that the total absorption will now be 710 units. Again applying our reverberation formula we get .35 second, which we can see from Fig. 9 is far too low—much too dead—which we also probably surmised from the excessive padding added to the room.

Somewhere between the completely live room (128 units) and the over-subdued room (710 units), there must be a happy medium. Without going through the calculations, but following the same general method, we find that if we drape only one-fifth of the area of each wall and carpet the floor we arrive at a total absorption of 357 units (per the third calculation of Fig. 12). This room, now re-adjusted to 357 units, yields a reverberation time of .70 second. Although this figure is a little on the low side, it will insure a reasonable acoustic "liveness."

The room should actually be a bit more on the live side because if you put a couple of upholstered settees in the room (at an absorption figure of 5 units each) and sprinkle generously with seven or eight human beings (4 absorption units each), the total absorption will be gradually increased to approximately 400 units which will tend to pull down the reverberation properties of the room to near the lower "acceptable" limit.

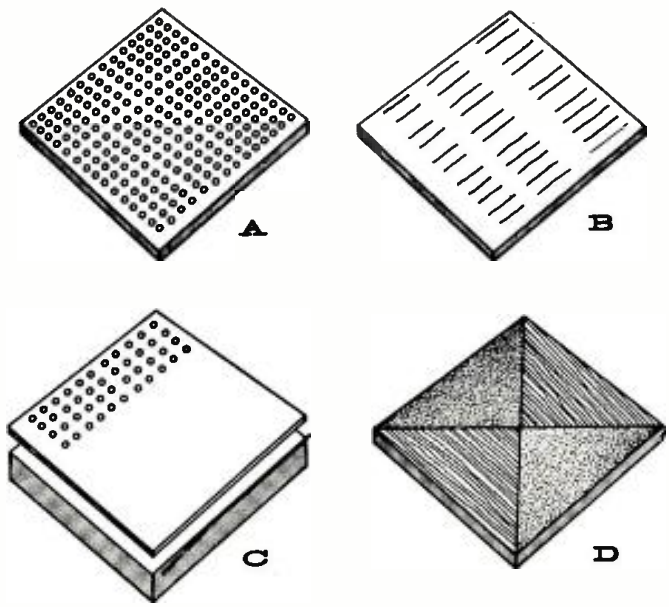


Fig. 13. Commercial acoustic tiles. (A) Soft fibers pressed into rigid, but acoustically soft mass with perforations to absorbent body; also with surface absorption. (B) Soft fibers pressed into rigid, but acoustically soft mass with surface cracked, or fissured, for added absorption. (C) Hard panel, such as Masonite, perforated and backed by thickness of absorbent material; no absorption by surface. (D) Same as (B) but with surface sculptured for decorative effect.

Altering the Room

As just demonstrated, much can be accomplished in the line of altering the reverberation of a room by judicious application of various household materials, especially those in the drapery category. Thus, for instance, if one were to hang draw drapes across the four walls of a room (of the dimensions of the one given in Fig. 12) and kept the floor linoleum-covered, as in a playroom, the room could measure from 2.5 seconds with the drapes completely retracted to .46 second with the drapes fully extended to cover the walls. With this type of arrangement, it would be fairly simple for the host to adjust his room to match the number of guests: For a lot of people—open the drapes and expose the walls; for an intimate soiree—draw the drapes. On the basis that each adult is equivalent to 4 absorption units, one could "calibrate" the drapery drawstring in units of number of guests.

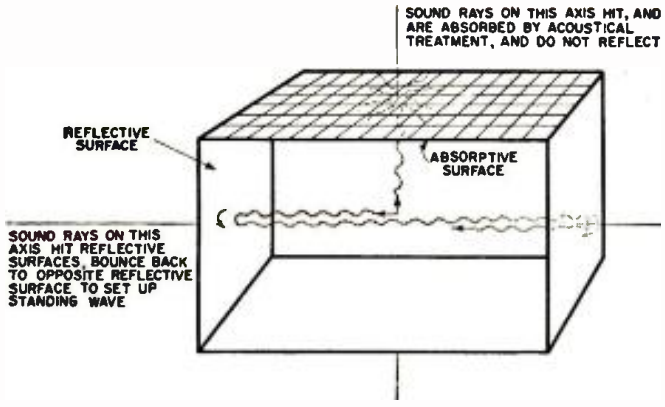


Fig. 14. Absorbent material on one surface will inhibit a resonance condition between that surface and the opposite one, but will not prevent resonance from being set up between the other room surfaces.

We may, of course, use materials which have been developed specifically for sound control, such as the acoustic tiles discussed previously. With these tiles we may control the room acoustics more accurately and with smaller areas of material than with conventional drapes, although combinations of tiles and drapes are practical. Tiles are especially useful when the room decor will suffer from an overabundance of drapery. Actually, the acoustic tiles may be quite decorative as well as functional and lend a clean, uncluttered look to the room. With the modern trend toward "airy" interiors, acoustic tile may actually prove a boon in maintaining this feeling while controlling room acoustics. Many such tiles (especially the perforated ones) can be painted to create interesting decorative effects.

One of the most important features of these tiles is that they enable us to treat ceilings as well as walls. Since the ceiling of a room comprises approximately one-sixth of the room's interior surface, it represents a good sized area which cannot be treated other than with tiles. The ceiling cited in our example, 25 feet x 20 feet with an absorption coefficient of .06 when bare has only 30 absorption units but when covered with fissured acoustic tiles its absorption becomes 375 units —more than enough to take care of the whole room without treating the other areas.

Undesirable Resonances

Although this method of adjusting room acoustics in one grand stroke is fine for general noise abatement, it is not the best approach to the problem of musical acoustics control. The reason for this is that there may be room resonances set up between the sets of untreated parallel walls which can produce quite disturbing effects to musical sounds reproduced within the room. Room resonances may occur when the dimensions of the room are close to the wavelength of the sound propagated in the room and are most prevalent in the low-frequency region.

When the air within the listening room is energized by a sound source, the volume of air enclosed by the walls, ceiling, and floor may be driven into resonance at frequencies which coincide with the wavelength or half wavelength separation of the walls. The very worst shape for a room, acoustically speaking, is a perfect cube because all axes are of equal length and the room is highly excitable acoustically and energetically resonant in all directions at the wavelength (and harmonics of it) which is equivalent to the spacing of the walls. In general, no room dimension should be close to a whole number ratio of another dimension. For normal living rooms, you may consider that if the dimensions of your room are in the ratio of 1:1.25:1.58 then your listening room will be reasonably immune to resonances between the three mutually perpendicular axes.

Although there is usually nothing we can do to the dimensions of our rooms, the statement of the condition, as given, is important in that it allows us to allocate our sound absorbent material intelligently. For instance, if there should be a strong resonant condition between two highly reflecting *walls*, then even large amounts of sound absorbing materials on the floor or ceiling will not affect that particular wall-to-wall resonance to any great extent. See Fig. 14. Thus the technique of treating the ceiling *only* is not the answer to adjusting the room for *music* purposes. We must distribute the "treatment" in random fashion to include all surfaces in order to minimize reflections along all three axes. If we thus distribute the treatment throughout the room, not only will we minimize room resonance but we will improve and equalize the general sound diffusion throughout the room—a condition of considerable importance for stereo.

Speaker & Listener Locations

One of the prime considerations in setting up a room for music reproduction—live or recorded—is that the sound source be located in a relatively "live" area so that the sound may be projected *into* the room. For monophonic applications, an undraped cor-

(*Continued on page* 106)

Table 1. Absorption coefficients per square foot of some common materials are shown.

	ABSORPTION COEFFICIENTS FREQUENCY (cps)					
FLOORS	128	256	512	1024	2048	4096
Linoleum on concrete	.02	.02	.03	.04	.04	.04
Pine flooring	.08	.09	.09	.10	.10	.09
Carpet on ⅛" felt	.11	.14	.37	.43	.27	.25
Cork slabs, polished	.08	.08	.08	.19	.20	.21
WALLS AND CEILINGS						
Brick wall, unpainted	.02	.02	.03	.04	.05	.07
Brick wall, painted	.01	.01	.02	.02	.02	.02
Poured concrete, painted	.01	.01	.01	.02	.02	.02
Wood veneer on 2 x 3 studs 16" on centers	.11	11	.12	.11	.10	10
Plaster on hollow tiles	.01	.01	.02	.03	.04	.05
Plaster lime, sand finish on metal lath	.04	.05	.06	.08	.04	.06
Pine wood sheathing	.10	.11	.10	.08	.08	.11
Window glass	.03	.03	.03	.02	.02	.02
WALL FURNISHINGS						
Cotton Fabrics 14 oz./yd. draped to ½ width	.07	.31	.49	.81	.66	.54
draped to ⅞ width	.03	.12	.15	.27	.37	.42
Velours 18 oz./yd. flat	.05	.12	.35	.45	.38	.36
draped to ½ own width	.14	.35	.55	.72	.70	.65
FURNITURE AND PEOPLE						
Upholstered mohair chair	2.5	3.5	4.5	4.5	4.8	5.0
All wood chair	1.8	2.0	2.4	2.4	3.8	2.5
Plastic covered chair	1.5	3.3	4.3	4.0	3.8	3.6
Child standing	1.8	2.2	2.8	3.8	3.5	3.5
Adult standing	2.5	3.5	4.2	4.6	5.0	5.0
Adult in upholstered chair	3.0	4.0	4.5	5.0	5.2	5.5
Woman in evening dress	1.8	2.0	2.3	3.6	3.6	3.5

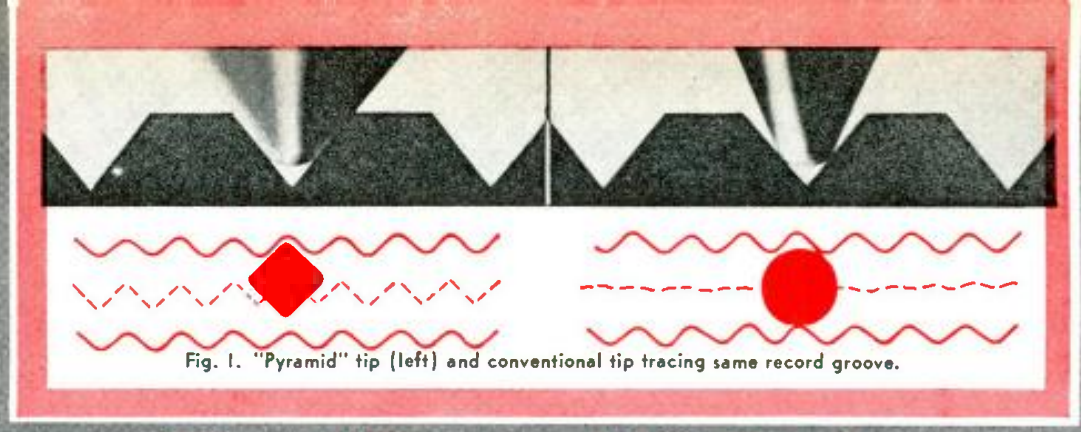


Fig. 1. "Pyramid" tip (left) and conventional tip tracing same record groove.

The "Pyramid" Stylus

By C. D. O'NEAL
Director of Electronic Research, Fidelitone, Inc.

New playback stylus tip shape is said to produce less distortion and noise, plus less record and stylus wear.

EDITOR'S NOTE: The announcement of a "Pyramid" playback stylus has produced quite a stir of interest in the industry. Attaining, with precision, the contour specified requires skilled craftsmanship and minute attention to detailed tip shaping. This will add to the cost somewhat, although it may be worthwhile if the performance of the new stylus comes up to expectations. More attention will also have to be paid to mounting and tracking accuracy, but the requirements are not so strict that they cannot be met with present-day equipment.

THE story of high fidelity is the story of pushing back limitations. With the advent of the single-groove stereo record, many new techniques and specialized equipment—all promising improvements in some unique way—made their appearance. From among these techniques emerged one basic new requirement which, on the whole, is not too well understood by the general public. This was the recommendation for a much smaller needle tip radius to be used with the new type of phonograph pickup.

The RIAA standards committee recommended a .0005-inch radius with a top limit of .0007 inch. Even though the .0005-inch radius is six times smaller than the stylus used to play 78's, it still introduces certain quality limitations in reproduction. Furthermore, such a diminutive size of point greatly limits the tracking force of the pickup with which it may be used.

These are some of the problems which caused *Fidelitone, Incorporated* to sponsor the development of the pyramid-shaped diamond stylus which is to be described.

The underlying principles relating to the reproduction of the stereo record (single-track variety) establish conditions which produce more distortion than the conventional monophonic type of lateral modulation. The limitation is not built into the record itself but is inherent in the playing back of these records using the same size needle tip radius. This, then, becomes the basis for making the point radius smaller so that distortion will not be increased over that experienced with mono discs.

It is not practical to market a round stylus with a radius smaller than .0005 inch because the problem of wear is almost insurmountable. The reason behind this is that reducing the stylus tip radius increases, conversely, the contact pressure per unit area of the stylus in the groove. This, of course, is providing the pickup weight remains the same. This contact force goes up in inverse proportion to the contact area or linear dimension squared. So the stylus tip change, from .001 inch

Fig. 2. Plan and sectional views of cutting and conventional hemispheric playback stylus in a laterally modulated groove.

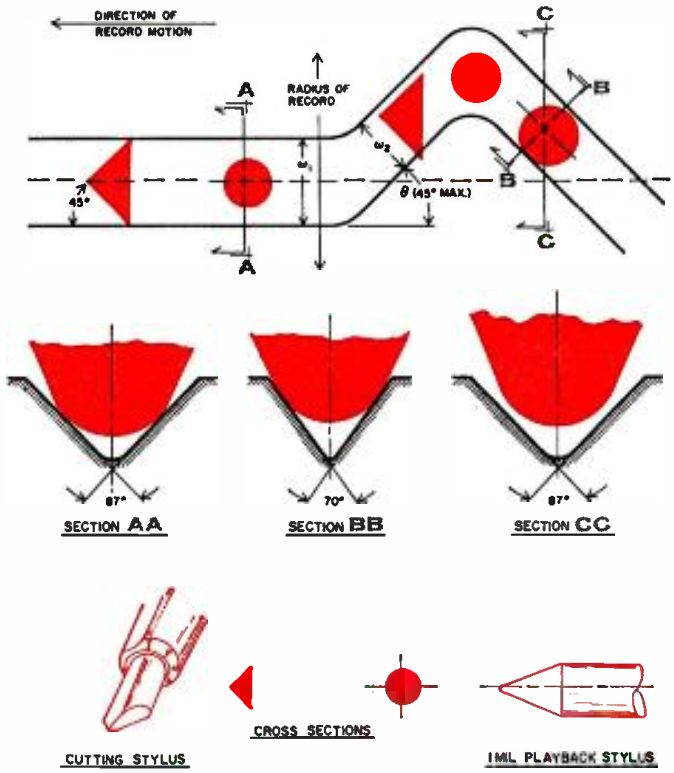
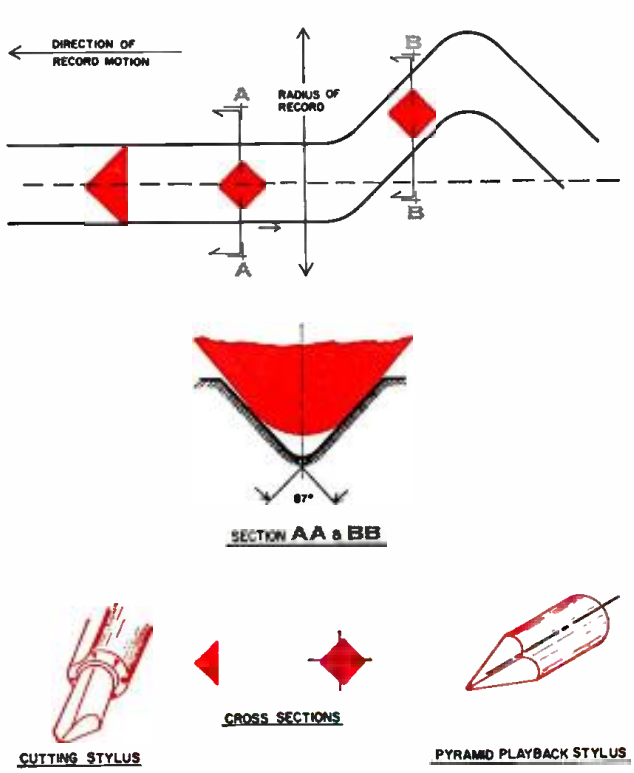


Fig. 3. Plan and sectional view of cutting and the new "Pyramid" tip playback stylus in a laterally modulated groove.



for monophonic microgroove to .0005 inch for stereo recordings, as recommended by the RIAA committee, means that pressure per unit area on the vinylite record increases four times with a concomitant increase in wear.

The only way to offset this wear is to reduce tone-arm tracking weight by one quarter. If a stereo pickup can be made to track at one gram where the monophonic version needed four grams, we are holding our own with regards to wear. Thus far, however, experience has shown that stereo pickups generally require a little more needle force, to make them work properly, than do monophonic cartridges.

What is needed, then, is a stylus which is designed to overcome the inherent weaknesses of the conventional hemispherical point. To get a better picture of the problem, it is first necessary to point out some stylus limitations.

Stylus Limitations

Basically, most distortion problems as well as wear arise because the groove is made with a triangular-shaped, sharp-edged cutter while the recording is played back with a smooth, rounded-tip needle. This seems logical enough since the sharp edges of the cutter are needed to cut and the smooth roundness of the playback

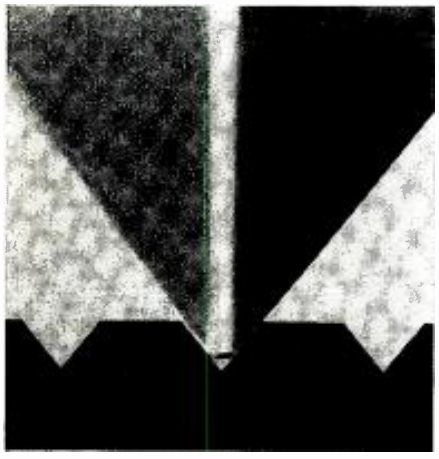


Fig. 4. Enlargement of new stylus in groove.

stylus is needed to follow the groove and avoid cutting.

Just as long as the formed groove remains straight, or nearly so, this premise holds true. The trouble comes when the cutting stylus is required to "wiggle" violently when recording high-level, high-frequency program material. This is when the sharp-edged cutting stylus, in its lateral gyrations, forms a groove of many changing dimensions in width and steepness of side walls (Fig. 2, Section BB). This stems from the shape of the cutter which is formed to provide a flat rather than a round cutting area and has a trailing 45 degree clearance angle which only follows the sharp flat front plane doing all of the work.

A round-tipped stylus tracing such a groove is lifted at narrow points in the groove (compare Section C-C with A-A in Fig. 2). At maximum excursion or "corners" of such modulation, the round stylus will again settle back into the groove in a normal manner. This up-and-down motion caused by a round-tipped stylus tracing heavy lateral modulation is known as "pinch effect." This "pinch effect" occurs to some degree twice each cycle for each recorded frequency on the disc. The greater the recorded modulation velocity, the greater this lift effect, up to the point where the modulation sine-wave equals 45 degrees, which should be the high limit created by the 45 degree trailing angle of the cutting stylus. The amount of lateral modulation needed to push the momentary groove angle up to 45 degrees depends on the frequency and the speed of the groove under the stylus. Such severe conditions are most often encountered near the inside grooves of the record. This is where the lower groove speed past the stylus can exactly equal the modulation velocities; thus satisfying the condition for a 45-degree sine wave.

Suffice it to say that reducing the contact radius on the stylus reduces the "pinch effect" in the groove up to the limit where the bottom radius in the groove equals the stylus radius tracing it.

Of even greater importance, however, is the way the stylus contact radius fits into the peak radii of the modulation or the "corners" as previously described. On lateral modulation (as exemplified by conventional monophonic recordings), when the contact radius of the reproducing stylus exactly equals the radius of the "corners" of the modulation, over 30 percent odd harmonic distortion is being generated. When this same condition occurs on stereophonic recordings, over 50 per-cent harmonic components are produced.

Here, again, we can understand why the smaller radius (contingent with satisfying the proper needle force per unit area) generates lower values of harmonic distortion. This re-enforces the RIAA recommendation of a .0005-inch radius stylus for stereo records.

We must also point out that harmonic distortion is aggravated by the recording equalization characteristic. It is a "velocity" rather than an amplitude effect. Pre-emphasis above 2000 cps (RIAA curve) will increase the value of generated distortion in this higher frequency region.

One additional point before concluding this discussion on "pinch effect" and that is the fact that it is possible to design monophonic pickups to have less sensitivity to vertical "pinch effect" motion. This is not possible with stereo pickups. Vertical movement of the stylus now has to be used so it is no longer possible to "dispose of it harmlessly." Each 45-degree movement found on the stereo recording can be divided into part lateral, part vertical. Where left and right channels contain identical program material (where the original sound originated from a central position) the lateral parts add and the vertical parts cancel. For sound coming from any other position, there is some vertical movement to represent its "location." Therefore, vertical "pinch effect" becomes even less tolerable.

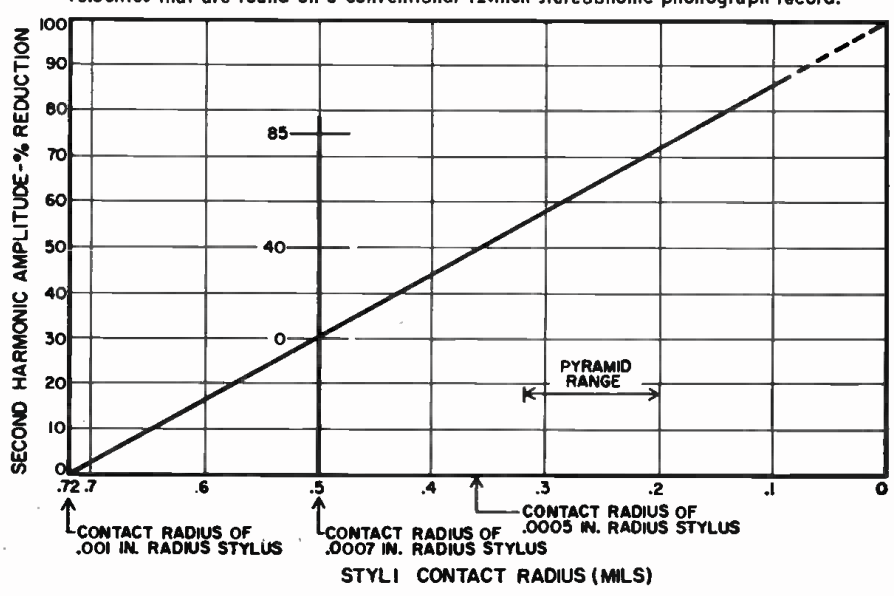
Now for a solution to these stylus limitations.

A Solution

If the playback stylus could be made the same shape as the cutter stylus, the problem could be solved. The alternative, which is commonly accepted, is to reduce the stylus tip radius, without changing record groove parameters. The groove, however, must be sharp enough in the bottom to prevent the smaller radius tip from touching bottom since this condition could be objectionable. Here, again, the limitation

(*Continued on page* 144)

Fig. 5. Average reduction in distortion relative to values generated by conventional 1-mil and .7-mil styli for maximum and normal modulation conditions and groove velocities that are found on a conventional 12-inch stereophonic phonograph record.



These preparations are invaluable, but you should know their limitations as well as their uses and how to pick the right one.

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

Know Your Electronic Chemicals

PART 1

WHENEVER we visit our electronic parts distributor, we pass a large display rack full of neatly labeled bottles and cans. Often there are several such shelves and it seems that the great variety of bottles, jars, and cans would be more suitable on the prescription counter of a drugstore. This array of chemicals appears bewildering mostly because of the many different names, types, and uses advertised on their labels.

Actually most of these chemicals fit into one of three main categories. They are usually cements, lubricants, or cleaners. Some of the cements may also serve as insulators, and some cleaners may contain a lubricant, but the three main categories still hold. A fourth "miscellaneous" category could be set up to cover such specialty items as enamel-wire stripper and non-slip compounds for dial cords. Paints and finishes are not properly "radio chemicals," since they are used even more widely in other industries and are also sold in painting supply and hobby stores.

Category one, glues and cements, ranges from such specialized types as Bakelite cement to such commonly used glues as rubber cement. Category two is made up of many different types of lubricants and, just as in the case of the cements, the selection of the right one for each job is extremely important. In category three we have included the different cleaners and solvents, and here the damage due to application of the wrong chemical can be considerable.

We would hardly solder a .001-μf. capacitor in place of a .1-μf. unit; the choice of the correct chemical can be just as important. Most of our readers are familiar with the system of electrical values and understand the difference between resistance, capacitance, and inductance, but relatively few also understand the basic chemical differences that determine the need for a particular glue, lubricant, or cleaner. This is not the place for a review of chemistry, but it is not necessary that one be a chemist in order to choose the right materials. The technician only needs to know a few fundamentals in order to pick the right compound for a particular job.

Properties of Cleaners

Obviously the most important property of any liquid that we use for cleaning is its ability to dissolve and remove the substance to be taken off. This depends to some extent on what the "dirt" is and from what surface we want to remove it. For example, if we want to remove a splash of paint, we may use a common paint thinner. However, if the offending spot rests on a plastic surface, this thinner could attack the plastic as well, producing an "etched" spot that may be as bad as the original paint spot, or worse.

The choice of a particular cleaner may be decided as much by the package as by the contents. For accessibility to some spots, a spray can with tube attached (A, B) may be necessary. Spraying over a more generalized area (C) may be preferred in other cases. A free fluid (D) that can be swabbed on may be the choice for other surfaces.

The term "cleaner" covers a wide variety of completely different preparations, chemically speaking, that are intended for different applications and are not interchangeable. Tuner cleaners (preceding page) are usually of the same type as general volume-control and contact cleaner (A and B, to the right). These two types are therefore generally interchangeable. Picture-tube and glass cleaners (C) are another group entirely. Other classes include preparations for cleaning the magnetic heads of tape recorders, paint-type thinners, and household detergents.

We can see that the first consideration is to match the cleaner or solvent to both the dirt and its base. Another important consideration is the volatility, toxicity, and flammability of a particular chemical: in other words, how dangerous it is to use. What precautions must we take? Unfortunately many cleaners and solvents suffer from one or the other of these limitations. The outstanding exceptions are soap and most household detergents. Strange as it may seem, a good detergent and warm water, properly applied, can perform a great variety of cleaning chores around a service shop. Many technicians prefer to use detergent or soap with warm water for cleaning picture-tube screens and face masks, although window cleaning fluid and the special "anti-static" preparations work very well.

In choosing cleaning agents for electronic service work, we must also consider their electrical properties, such as the advantage of cleaning a picture tube with a material that will reduce the static charge on the glass. This charge is responsible for attracting much dirt. In cleaning the contacts of a TV tuner, we want to make sure that the cleaner either leaves no insulating residue or else that the film left after the cleaner evaporates will be electrically conductive. A cleaning agent used to clean printed-wiring boards, on the other hand, should leave no film at all.

Most of the cleaners and solvents that are sold at electronic parts distributors are specifically designed to handle a certain job. We find cleaners for magnetic recording heads, contact cleaners, potentiometer cleaners, picture-tube glass cleaners, speaker-cone cement, solvents, and so on. Few service shops carry every one of these materials in stock and frequently one of these cleaners is called on to do a job for which it was not intended. Knowing some of the properties of a cleaner helps us decide if it is safe and worthwhile to apply a particular chemical.

Some cleaning agents, such as alcohol, are very inflammable and burn even at relatively low temperatures. Others give off fumes that may tend to become dangerous. A few leave "drying spots" behind as they evaporate. Most of these troubles are avoided by the specially prepared cleaners sold through electronic parts jobbers, but even there the wrong application can be troublesome.

We know of a service technician who used the thinner intended for polystyrene "dope" as an all-purpose cleaner. It worked well cleaning grease spots off a chrome-plated audio amplifier chassis. TV tuner contacts could also be cleaned with it. However, when he used it to clean the head of a tape recorder, trouble started. The felt pads that hold the tape against the head were soaked through with the thinner and, after a few hours, they fell off. New pads were glued on and the recorder was delivered. However, a few drops of glue had been used to lock the head alignment screws in place, and this glue was loosened by the thinner. Within a few weeks the recorder was returned by the unhappy customer because of "weak sound."

It was found that the head alignment was off. By that time the technician had a small stock of the most frequently used cleaners and other chemicals so that he could be sure that the right material was used each time.

Contact Cleaners

Probably 50% of all troubles in potentiometers, switches, and tuners are due to dirty contacts. It is therefore not surprising that a host of specially prepared cleaning agents is available just for this purpose. *General Cement's* "De-Ox-Id"; *Walsco's* "No-Ox"; "Quietrole"; *Electronic Chemical's* "No-Noise"; "Hush"; and a number of similar preparations are all specially designed to deal with the contact cleaning problem. They all operate effectively on contacts and potentiometers, but should *not* be used for cleaning glass, printed-wiring boards, or other exterior surfaces because they leave a residue.

Our readers may ask at this point what is so special about contacts that they require a particular chemical? Could we not use carbon tetrachloride or alcohol? The answer is that these simple cleaners could be used. For that matter, even soap and water would have some effect. However, to avoid deterioration of the contacts, a special preparation is better. Most switch and tuner contacts are either solid coin silver or are at least heavily silver plated. Silver oxidizes, as is apparent by the black coloring that develops on it. The oxidized film is a poor electrical conductor. When even small currents are switched through these contacts, some arcing is inevitable, and this promotes further oxidation. Eventually the contacts become intermittent.

In addition to the oxidation of the contact surface there is mechanical wear. If the contacts are lubricated to avoid this wearing process, the lubricant gets saturated with dust until a gritty mixture clings to the contact area. This actually accelerates wear. From this description we see that a cleaner should really do several jobs. It must dissolve the lubricant and wash away the dirt. Then it must be able to dissolve the oxidized coating. After that the contacts should be clean, and now lubrication is needed. Many of the prepared contact cleaners leave a film behind that serves to lubricate the wearing surfaces. To maintain good electrical contact, this film should be conductive.

Irrespective of the type of cleaner used, the applicator is important. Never, never, under any circumstances should contacts be scraped with a metal instrument. Scraping can not only remove dirt and oxide but can also damage the silver plating and wreck the wearing surface. The same goes for the practice of using sandpaper. This habit stems from the early days of electricity when copper contacts were used. In practically all electronic switches, silver or (on more expensive

items) rhodium contacts are used: these should be cleaned only with chemicals. The best way of applying a cleaner is by using a fine artist's brush, cleaning tissues held in tweezers or—the simplest—"Q-Tips" (cotton pads wound on small wooden sticks).

The most effortless way to clean TV tuner contacts is to apply the cleaning agent without removing the chassis. This is often possible if we use one of the special cleaning agents that is available in a spray can, with a special nozzle or injecting needle. The cleaning agent is sprayed directly into the contact area and, since the agent contains a conducting lubricant as well as a cleaner, noisy contacts are usually "quieted down." In a similar manner, noisy volume controls can be cleaned by forcing the liquid cleaner in through the shaft bearing. Whenever such a "quickie" method is used, it is important that the contacts be moved in both directions to clean and lubricate all surfaces properly. A TV tuner should be switched through all channels at least four or five times, and a potentiometer should be turned at least as often, from one extreme of its rotation to the other.

Basic Cleaners

The technician who is a long way from a well-stocked parts supplier and who finds himself suddenly out of the needed cleaning agents can resort to a number of common cleaning materials that can be adapted to fill almost any need. Some of these are to be found in most homes so that when a house call is made, one can sometimes obtain them from the efficient housewife (poor practice, of course, except in an emergency).

A list of some of these cleaners with their recommended use in electronic work is shown in Table 1. Remember that, unlike the preparations obtainable through a regular electronic supply house, the strength and purity of these items is usually unknown. They may therefore be unsuitable for a particular use. A review of these common cleaning agents shows that most of them are suitable only for general cleaning of chassis, picture tubes, and cabinets. The specific requirements for contact or potentiometer cleaners are not met by any one of them. Two items, gasoline and paint thinner, are not recommended for electronic work because they are dangerous and not really suitable for any application. Both have a tendency to leave a film that often contains chemically active residues.

Most rubbing alcohol is simply denatured alcohol with possibly some aromatic ingredient added. This can be used for cleaning off grease. Occasionally the alcohol is mixed with mint or other oils, and the latter can then leave undesirable residues. It is usually safest to try a questionable cleaner out first on a sample spot, a small area not normally visible, or on a piece of dirt scraped from the area we want to clean. If the reader finds himself without a good contact cleaner he can use alcohol or carbon tet to remove the dirt first, provided that the contacts are accessible enough to be wiped with a "Q-Tip" or similar wiper. Then a mild silver polish can be applied carefully and quickly removed. This takes care of the oxidation—but it is important that *any* residue of the silver polish be completely removed. This can be done either by rinsing the area with water and drying it off with air pressure, or by using alcohol again. Next, the contacts should be lubricated, but never with machine or household oil. In the absence of a good contact lubricant, "Crisco" or a similar vegetable shortening can be used in an emergency. Be careful not to use too much and apply the shortening only to the contact area.

Such "homey" cures may come in handy when a noisy TV tuner is encountered, but they cannot be used easily on a potentiometer. Unless we are willing to disassemble the pot, the only remedy, short of replacing it, is to use one of the specially prepared cleaners. Most of these chemicals are sold with either a long, thin nozzle or needle with a pressure can, or else a special plastic nozzle that fits over the shaft is provided. These applicators help to get the cleaner directly to the moving contact area where the trouble really is.

Table 1. Many chemicals that do not have to be purchased as special preparations are useful. They are listed here, with applications and limitations.

CLEANER	DISSOLVES	USE ON	REMARKS
Acetone	Lacquer, paints, grease	Chassis, contacts, glass	Attacks some plastics, leaves slight film
Alcohol	Grease, oils, rosin	Chassis, contacts, plastics, solder joints, recorder heads	Inflammable, leaves very slight film
Ammonia	Grease, grime	Chassis, picture tubes, glass, plastics	Use only in mild solution in warm water
Benzene	Grease, oil, wax	Chassis, only some plastics (use sparingly)	Inflammable, some fumes
Carbon tet	Grease, oil, wax	Chassis, glass, plastics, non-waxed parts	Toxic fumes, leaves film, extinguishes fire
Detergents	Grease, grime	Plastic cabinets, glass, picture tubes	Use only mild solution in warm water
Gasoline	Grease, oil, some paints	Not recommended for electronic work	Inflammable, fumes
Lighter fluid	Grease, oil, wax, rosin	Chassis, plastics, contacts, solder joints	Inflammable, leaves visible film
Paint thinner	Paint, grease, wax, oils	Not recommended for electronic work	Inflammable, fumes
Silver polish (water soluble)	Oxidation	Silver contacts	Apply lightly and remove residue before lubricating
Turpentine	Grease, oil, wax, paint	Chassis, glass, some plastics	Inflammable, leaves film
Window cleaner	Grime, dust	Glass, plastics	Some types leave a light film

Recording Head Cleaners

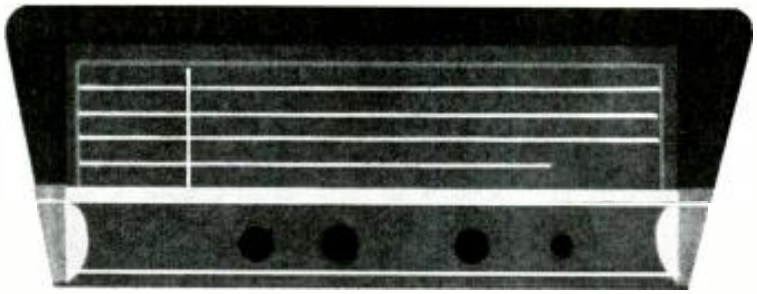
A whole group of special-purpose preparations is available for cleaning magnetic recording heads. Here the cleaning agent must remove the iron-oxide deposits that collect at the head and should leave a lubricating film to reduce tape wear. At the same time, the cleaner should not be damaging to the felt pads or the cement that holds them. It should not attack the plastic material of the recorder case, the epoxy which is usually part of the head, nor should the film left by the cleaner be harmful to the tape itself.

Magnetic head cleaners offered by parts jobbers under various tradenames all fulfill these requirements. Some cleaners like *E. L. Hern's* "X-Sol," are available with a cotton wick that can be inserted into the tape mechanism and pulled through just like the recording tape. This makes for a very simple yet effective cleaning procedure. The wick is squeezed out automatically when it is returned to the bottle and, after a while, the collection of iron oxide at the bottom of the bottle signals that it is time to get another bottle.

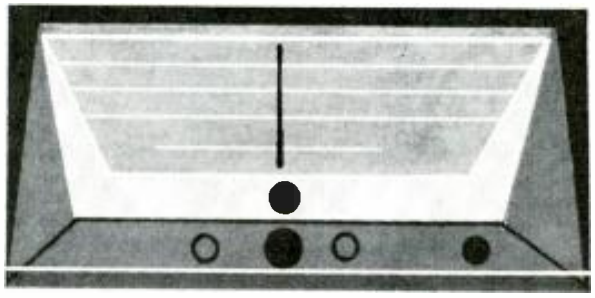
Conclusion

A little understanding of the basic chemistry of cleaning agents is helpful for anyone who services electronic equipment. Common household cleaners can be used for some jobs and can often serve, in a pinch, when the right chemicals are not available. The specially prepared cleaners still give the best results. For switches, tuners and any other contacts, a special contact cleaner that also deposits a lubricating film should be used whenever possible. For noisy potentiometers, a special cleaner and applicator are a necessity. For cleaning the delicate and expensive heads of magnetic tape recorders, only a prepared magnetic head cleaner should be used.

(Concluded next month)



Simple Improvements For Short-Wave Receivers



By
JOHN A. KIRK
W3CRB

Inexpensive circuit changes to increase the performance of many low and moderately priced communications sets.

THE performance of many low- and moderately priced communications receivers can often be improved by simple, inexpensive modifications. It is the purpose of this article to describe a few of these modifications for which the need is widespread.

Series Antenna Capacitor

For amateur c.w. operation of a low-priced (no r.f. stage) communications receiver using a longwire antenna, a variable series antenna capacitor is a valuable aid. The usual antenna coil design in such receivers will give good results with a short antenna but produces effective antenna overcoupling with a longwire. Blocking and frequency pulling by strong, undesired adjacent-channel signals make evening operation a nightmare. However, the longwire is very desirable from the standpoint of DX reception, particularly in the daytime.

The solution to the antenna coupling problem on receivers such as the *Hallicrafters* S-38, *National* SW-54, and *Heathkit* AR-3, is the installation of a variable series antenna capacitor of approximately 140 micromicrofarads. When severe interference occurs, the capacity may be reduced to the point where the signals become clear and distinct. Retuning then permits copying of signals which, in many cases, would have been lost in QRM. As capacity is reduced, the effective antenna coupling is reduced, r.f. selectivity increases, image ratio is improved, and strong signal amplitude reduced to an acceptable level at the mixer grid. While the addition of a series variable capacitor is not as beneficial to the more expensive, r.f.-stage-equipped receiver, it will nevertheless be found very worthwhile even with such equipment.

Typical series variable capacitor installations are quite simple to make. The capacitor employed is a 140-$\mu\mu$f. air trimmer with one end plate bent over at the tip so that at full mesh the capacitor may be shorted to make direct contact from the antenna to the receiver's antenna terminal. Each antenna trimmer of the receiver should be peaked near the high-frequency end of its respective band with the series variable capacitor at approximately half mesh when using a longwire antenna. Then, in the presence of strong, undesired adjacent-channel signals, if the series variable capacity is reduced, the r.f. tuning sharpens and is peaked for optimum performance. At full or nearly full mesh, due to the effective antenna overcoupling, receiver r.f. trimmer alignment is broad and non-critical in most normal operating conditions.

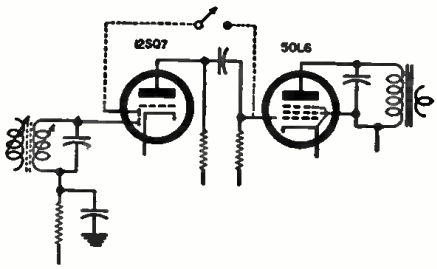
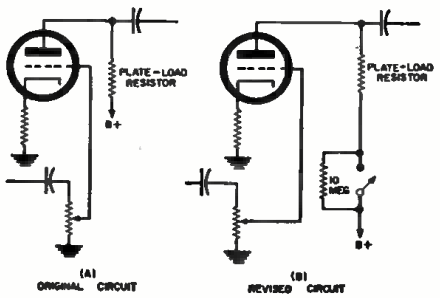


Fig. 1. Noise limiter for S-38 receiver.

Fig. 2. Audio limiting for the SX-24.

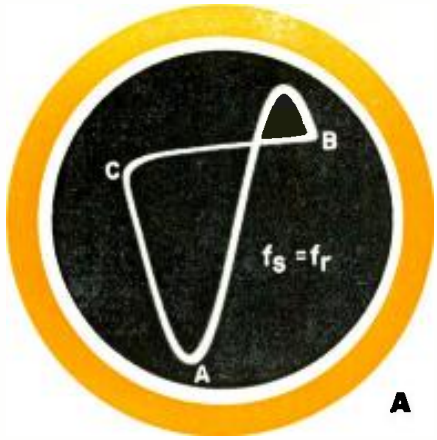


Amplitude Noise Limiter

While an effective noise limiter is a very useful feature on any communications receiver, many of the lower-priced sets do not incorporate one. Noting that the *Hallicrafters* S-38B had its 12SQ7 diodes paralleled, it was decided that one of these tubes could be put to better use as a noise limiter (especially after it was found that receiver performance was unaffected if one diode was disconnected). Since the "send-receive" switch is never used by the operator of this particular receiver, a "no-cost" modification was possible. The two leads of the "send-receive" switch were removed, soldered together, taped, and dressed down near the chassis. The lead connecting the 12SQ7 diodes together was clipped and the diode (pin 5) thus isolated was connected to one contact of what was the "send-receive" switch. The other switch contact is connected to the grid of the 50L6 (pin 5). When the switch is closed (placed in the "receive" position), the diode is connected to the 50L6 grid. Limiting occurs with signals even smaller than 0.1 volt at the 50L6 grid. Refer to Fig. 1 for the simple circuit modification.

If it is desirable to retain the "send-receive" switch function, an ordinary toggle switch may be mounted at some convenient place on the receiver panel and wired as described. Where the receiver does not have an unused diode which can be employed as a noise limiter, a 6C4 tube may be added under the chassis. Pins 5 and 6 are tied together permitting the grid and plate to act as a diode plate and cathode pin 7 connects to ground. On series filament a.c.-d.c. receivers, filament pins

(*Continued on page* 145)



A

Fig. 1. Oscilloscope displays obtained (A) when sweep rate (f_s) and resonant frequency of the tank (f_r) are equal, (B, C) when f_s is a subharmonic of f_r, and (D) when f_s is greater than f_r.

The Scope as a Resonance and LC Tester

By A. A. MANGIERI

Test flybacks, check resonance, measure inductance or capacitance with two resistors and your scope.

THE MODERN oscilloscope is regarded by many as the most versatile of test instruments. Few people claim to know all the uses to which it may be put. New uses are always being suggested. The possibility of measuring resonance with the oscilloscope was investigated because a convenient method of checking low-frequency tanks, in the range of 1 to 200 kilocycles, was needed. Popular devices normally used to measure resonant frequencies, like grid-dip meters, do not generally extend below 300 kc. As for unknown values of an inductance or capacitance, they can be found by resonating them against known components.

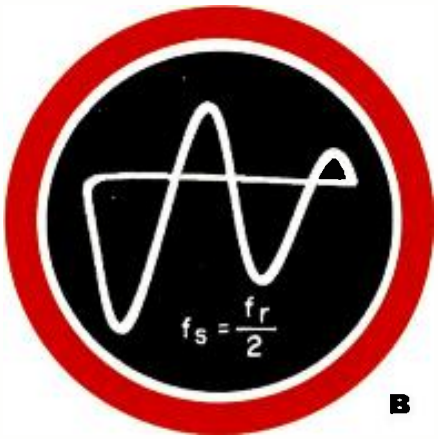
The method worked out was that of exciting a parallel connection of L and C with the saw-tooth output from an oscilloscope. Circuit connections for the technique are shown in Fig. 2. The saw-tooth voltage (E_1) is applied to the LC network and an output voltage (E_2) is taken from the tank for application to the vertical input of the oscilloscope. Isolation resistors R_1 and R_2 are not critical: values anywhere from 50,000 to 250,000 ohms are satisfactory.

Theory of Operation

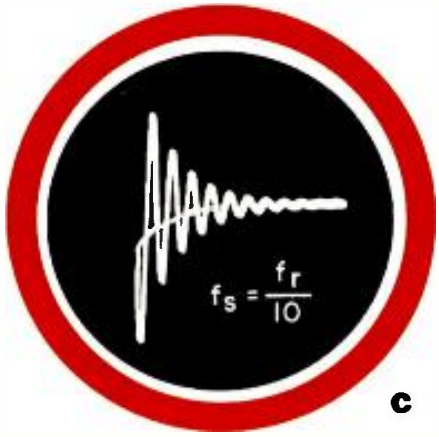
A saw-tooth wave is an excellent source of a broad band of frequencies. In addition to its fundamental, it contains a sequence of usable odd and even harmonics of progressively smaller amplitude. The parallel LC circuit will exhibit a characteristically high impedance at its single frequency of resonance.

We may understand behavior of the circuit if we first think of the saw-tooth wave, E_1, as a pulse that shock-excites the tank circuit. This results in a damped, transient oscillation, E_2. The frequency of oscillation is determined by the LC tank and the damping by the "Q" of the circuit.

We will call the fundamental sweep frequency or repetition rate of the saw-tooth waveform f_s and the resonant frequency of the LC circuit f_r. If the sweep-frequency controls of the scope are adjusted so that these two are equal ($f_s=f_r$), the oscilloscope pattern will resemble Fig. 1A, displaying one cycle of oscillation. If the sweep frequency is one-half the resonant LC frequency ($f_s=f_r/2$), a two-cycle display (Fig. 1B) results, with the second cycle smaller in amplitude than the first. With f_s much lower than f_r ($f_s=f_r/10$), the damped oscillation of Fig. 1C results. If the sweep frequency should differ from the resonant frequency in the other direction—that is, if f_s should be greater than f_r, the waveform collapses as shown in Fig. 1D.

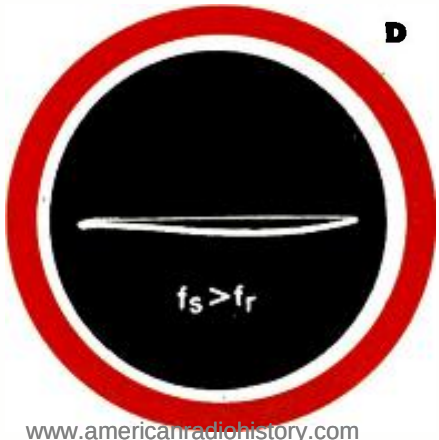


B



C

D



If f_r is unknown, how can we determine when sweep frequency f_s is correctly set to it? This is done simply by adjusting the sweep frequency while observing point A in Fig. 1A. This point will extend and retract vertically as we sweep through the resonant frequency. The point of maximum extension (maximum pattern height) occurs when $f_s=f_r$. Similarly, when we sweep f_s gradually through $f_r/2$, point A exhibits like behavior, but with reduced amplitude. During normal adjustment, point A will also seem to move from side to side, and the retrace line (B-C) will move up and down. These effects reflect the gradual shifting of phase between E_1 and E_2.

Calibration

To apply the technique, we must obviously calibrate the sweep frequency controls of the oscilloscope. Where the fine-frequency control is not marked with a subdivided scale, a dial plate with a hundred divisions may be fixed in place behind it. An audio or other low-frequency oscillator may be used. Connect the oscillator output to the vertical terminals of the oscilloscope and, for each frequency at which calibration is made, adjust the scope controls to obtain a single-cycle display.

During calibration, keep the sync-amplitude control of the scope adjusted to its lowest usable setting. This prevents excessive "pulling" of the sweep frequency and permits the greatest possible accuracy. During actual resonance and *LC* tests, the sync-amplitude control is set to zero. Despite the fact that the multivibrator of the scope's sweep generator will be free-running with no sync, its stability will be adequate in most cases. Nearly all oscilloscopes today, including some less expensive ones, use some form of voltage regulation, insuring a reasonable amount of frequency stability.

Arbitrary markings rather than actual frequencies should be marked on the scope panel. Actual calibration frequencies should be plotted on graph paper. In this way, a separate curve for each position of the coarse frequency control can be made up, and all curves may be plotted on the same reference sheet. Semi-log graph paper was found to be most practical.

Resonance Testing

To determine the resonant frequency of a parallel circuit, connect it to the oscilloscope as shown in Fig. 2, and adjust sweep frequency to obtain a single-cycle display while maximizing pattern height. Resonant frequency may then be read from the calibration curve.

Conversely, to adjust an *LC* circuit to a particular frequency, set the scope controls to that frequency and manipulate the value of either *L* or *C* to produce the characteristic pattern. The direction in which the parallel combination is off may be determined by comparing the shape of the initial pattern observed with those in Fig. 1.

One practical application of the method has been in testing flyback transformers, by measuring their self-resonant frequency. With the TV receiver de-energized, connect the high end of the flyback transformer to the oscilloscope through the two isolation resistors, as shown, and connect the low end of the transformer to the scope's ground terminal. This self-resonant frequency will vary considerably from one type of set to another, depending on design of the transformer itself and differences in circuit loading. It will help to record the normal frequency for each type of circuit design encountered for later comparison.

In testing the flyback circuit of a suspected receiver, moderate deviation from the normal frequency may be expected due to manufacturing tolerances. However circuit defects, such as open or shorted windings and cracked or loose cores, will result in a marked change in inductance and therefore a large change in resonant frequency. Is it also possible, as in other flyback testing techniques, to unload the transformer gradually by disconnecting associated components one at a time to localize a defect.

Measuring Capacitance

We can determine the value of an inductor or capacitor in a tank circuit if the resonant frequency and the value of the other component in the *LC* combination are known. Of the two methods available for measuring capacitance, the greater accuracy and simplicity of one of them makes it the strongly preferred technique. In addition to one (or more) inductor chosen as a standard reference, it relies on calibration against several known capacitors. A capacitor decade box or a sequence of other accurate capacitors will serve.

Using the arrangement of Fig. 2, each of the capacitors is connected in turn across the reference inductor. The value of the latter need not be known exactly. With each capacitor, the scope's f_r is adjusted to equal f_r. A sheet of graph paper is then used to record the position of the sweep-frequency controls for each known value of capacitance, and a curve may be plotted from these individual readings. Calibration in terms of sweep frequency is not necessary.

To measure an unknown capacitor, connect it across the reference inductance in the test circuit and adjust the sweep frequency for resonance. The value of *C* may then be found by direct reference to the calibration curve. Neither the sweep frequency, the exact value of the inductor, nor any other characteristics of the latter need be taken into account once it has been chosen as the standard. Experimentation shows that a choke of about 60 millihenrys can be used to measure capacitance from 100 $\mu\mu$f. to .1 μf. High-"*Q*" inductors are preferred.

The alternative method of measuring *C* uses the curves already plotted for resonance tests along with the known inductor already noted. In addition, the familiar formulas involving reactance and resonance will have to be used for calculation of values. Even here, the paperwork can be simplified by using a reactance slide rule. One such inexpensive unit is made by *Shure Brothers, Inc.* Nevertheless, the technique must take into account additional factors that will not be involved in the first method described for measuring capacitance. For example, the reference inductor will have a certain amount of distributed shunt capacitance across its terminals, rendering it self-resonant at some frequency. This capacitance, C_o, is across any external capacitor that may be in parallel with the inductor.

If the inductance is known to start with, C_o may be found by determining the self-resonant frequency and using the formulas or the reactance slide rule. To measure an unknown capacitor, connect it in parallel with the inductor in the test circuit and find f_r. From this frequency and the known value of *L*, the value of *C* may be worked out or read on the reactance calculator. From the value thus obtained, C_o should be subtracted. Circuit "*Q*" also can be a factor if an attempt is made to use an inductor over too wide a range of capacitance values. If circuit "*Q*" is much less than ten, considerable error can result. For a particular inductor, it is wise to limit the values of *C* that are used to measure over a range that insures a circuit "*Q*" of ten or more. The latter factor may also be calculated with the reactance slide rule.

Measuring Inductance

Capacitors of known value will obviously be needed to determine the inductance of unknown coils, and such factors as "*Q*" and C_o are also important. However a simple method with few pitfalls does exist.

First find the self-resonant frequency, f_o, of the unknown inductor. Next, shunt sufficient known capacitance across this inductor so that f_r for the combination is about one-tenth of f_o. Under these conditions, C_o will be small compared to *C*, so that the former will not cause significant error. Also, circuit "*Q*" will generally be above ten. Using f_r and the added shunt capacitance as the known quantities, the inductance can be found using the formula $L=1/4\pi^2 f_r^2 C$ or from the reactance calculator.

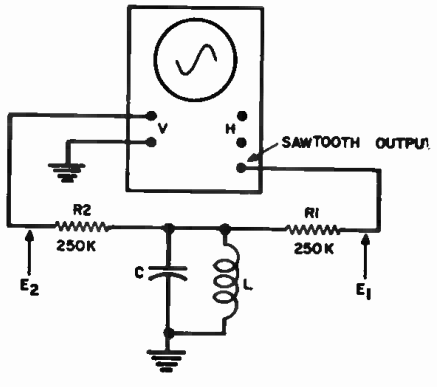
Summary

The measurement of low-frequency parallel-resonant circuits and of capacitance, using the methods recommended here based on appropriate calculation curves, are straightforward and reliable. Measurements involving more than one step and the calculator (or formulas) will also be found useful to those who have no other suitable equipment for making such checks.

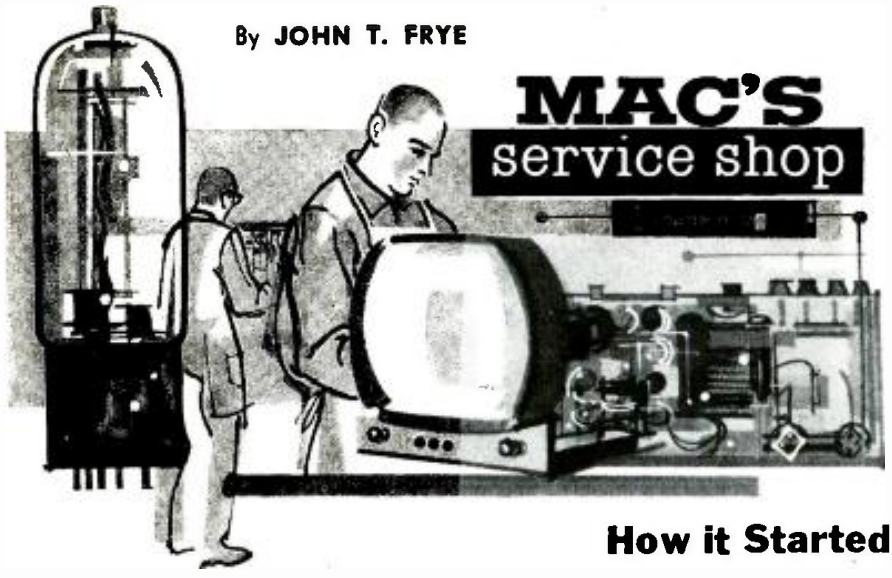
Accuracies will obviously not approach those obtainable by producing nulls on the bridges in laboratory-quality equipment. However, there is a question as to how much accuracy is actually needed. Most measurements made by the methods described here fell within five per-cent.

A final word of caution: some types of inductors with powdered-iron cores are quite non-linear, inductance varying with applied voltage and frequency. These should be avoided as reference inductors. No simple correction factors will compensate for the errors they introduce. As to capacitors, paper and mica units show relatively small changes in value even at higher frequencies and also have high "*Q*." —30—

Fig. 2. Connections from circuit being measured to the scope are very simple.



By JOHN T. FRYE



How it Started

"HEY, that's pretty old reading material, isn't it?" Barney remarked as he came into the service shop to find Mac, his employer, deeply intent on one of several age-yellowed, newspaper print magazines spread out on the service bench in front of him.

"Right you are," Mac replied. "A fellow in Peru ran across these the other day, and last night he brought them over and gave them to me. There are nine copies of *Radio Digest Illustrated,* a weekly radio magazine, dating back to October, November, and December of 1923. They present a fascinating picture of this business we are in when it was just a pup with its eyes hardly open yet. Remember that KDKA had started the whole broadcasting business only three short years before when, on the night of November 2, 1920, it came on the air with the returns of the Harding-Cox presidential election. KDKA began transmitting on 833 kilocycles with a whole fifty watts of power."

"Who was listening?" Barney wanted to know.

"The people the magazine calls 'hams,' 'listeners-in,' or 'radiophans' almost interchangeably. You've got to remember that when radio was first discovered it was looked upon as a scientific marvel and a means of communication. Commercial stations 'communicated' by means of high-powered spark transmitters; experimenters and radio amateurs, fascinated by the 'scientific marvel' aspect, toyed around with radio just to see what they could learn about it and do with it in the same way 'rocket societies' play around with rockets today. When some of these experimenters and hams started using radiotelephony instead of radiotelegraphy, they began to entertain each other or anyone listening by playing phonograph records or musical instruments, singing, reading poetry, etc. Right then and there the idea of radio as a means of *entertainment* began to bud. As to who was listening in 1923, the magazine says this:

" 'Radio has divided itself into two distinct groups of broadcast listeners, those who buy a complete set and those who purchase the parts and put them together in a way that suits their fancy. . . . The class who build their own sets are in a majority. . . . When radio came, the man on the street found that he could make his own apparatus at a saving in cost and have a lot of fun doing it'."

"What kind of sets were they using?"

"Well, look at this advertisement for a *Crosley* Model X-J for only $65—but remember those were *big* dollars, son. It is a one-stage t.r.f., detector, and two stages of audio affair. 'Local interference can be easily tuned out and far distant stations quickly and clearly heard,' it is claimed—although I'm not quite sure what 'quickly heard' means. According to the magazine the crystal set was still holding its own pretty well against the more expensive and complicated vacuum-tube receiver. Tubes advertised were the WD-11, WD-12, C-300 or UV-200, C-301 or UV-201, C-301A or UV-201A and the 'New UV-199.' What's more, you could have any of these tubes repaired and 'guaranteed to work like new' for charges varying from $2.75 to $3.50. Since a new tube cost from five to seven dollars, this was an enticing offer.

"The majority of listeners still used earphones as this girl from the *Vanities of 1923* is doing in the picture. Proof is contained in this story headlined *'Radio Ear' is New Pain for Listener.* 'Tight headphones bring on the affection,' the story explains. 'A sharp, shooting sensation in the head is a symptom. Doctors suggest loosening up on headphones.' One assurance is given of benefit from radio headsets, however: 'Youths of this generation will never have as protruding ears as some of their older brothers'."

"I'll bet those radiophans had lots of troubles," Barney hazarded.

"They did that. The magazine confesses: 'With so many constantly varying items in and about a radio set, it is amazing that more trouble is not traced to them directly. There is the "A" battery which tapers off as it is used; there is the detector tube that gradually loses its sensitivity; there is the outside grid leak that is changed by atmospheric conditions; and finally there are the four contact prongs on the vacuum tube that attract dust and dirt and are continually subjected to corrosion.'

"Interference was a problem, too, as you can see from this Letter from a Reader: 'Regarding . . . the subject of spark interference on or around 450 meters, I really hate to start in on this subject, for I get so exasperated every time I mention it. On long-distance work it is enough to drive one crazy to have nice concerts from Los Angeles, New York, Philadelphia, etc., all mussed up by that confounded dot-and-dash stuff. What do folks think of radio when you tune in a nice concert and then have one of those spark fellows slip in with his machine gun noise and gum up the works?' "

"Was he talking about hams?"

"Not necessarily. An editorial in the same issue suggests: 'Some listeners-in keep complaining that amateurs interfere with broadcasting. They do not actually know who is interfering. Half the time it is probably ships which are sending or shore stations handling regular commercial work. What these "knocking" listeners-in should do is to learn to read code so that they can identify the senders'."

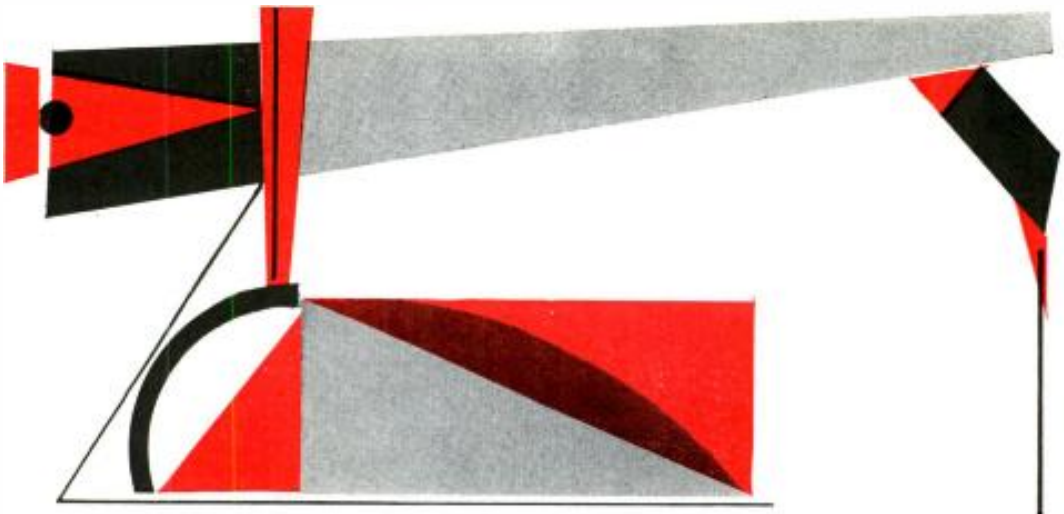
"Guess my TVI trouble ain't so bad after all!" Barney said with a grin.

"Of course the antenna was a constant field for experiment and a cause of annoyance," Mac continued. "Doesn't this advertisement for a gadget that obviously uses the light line for an antenna sound hauntingly familiar? 'Cold winter nights won't find you on the roof fixing the aerial, removing snow and sleet, exposing yourself to sickness, if you use Antenella.' "

"I see fading really bugged the boys back there," Barney observed. "Here is one guy, chief radio operator and announcer of a broadcast station, who claims he has found the 'real cause' of fading. It's so simple. Fading is caused by power fluctuations in the power line supplying the transmitter!"

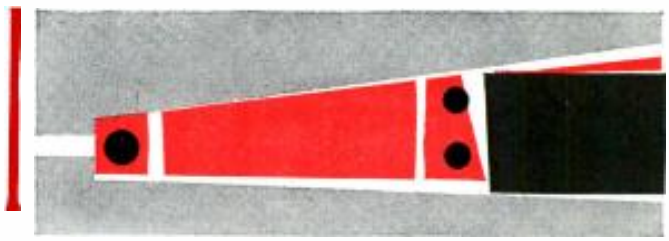
"It would have been nice had it been that simple; but a story in another of those magazines comes lots closer. It says tests carried out through the joint efforts of the Bureau of Standards and the American Radio Relay League in 1920-1921 point to the fact that 'uneven air' and variations in the Heaviside layer are somehow tied in with fading radio signals. Incidentally, all anyone has to do to be convinced of the heavy debt modern radio, television, and electronics owes to the radio amateurs is to leaf through these magazines and see what an active, important part they were playing back there in the very beginning. Here they are holding a Wouff Hong initiation at a hamfest at Atlanta on December 27th, 1923. Here Fred Schnell, 1MO, traffic manager of the ARRL,

(*Continued on page* 146)



Low-Noise Transistor Preamp

By **DAVID R. STEELE**
Ampex Corporation



Construction of simple, well-designed phono preamp for magnetic cartridges that can be built for under $15.

FOR the past decade, the serious record enthusiast has been plagued by problems involving equipment associated with magnetic cartridges. Foremost in this classification is the preamplifier. Commercial or home-made, they have been traditionally beset with microphonics, hum, and other noises that must be suppressed at every turn. This is a never-ending battle that has become more expensive and elaborate as the dynamic range of LP records has been steadily increased. It is now both simple and economical to overcome these problems with a low-noise transistorized preamplifier. Due to the nominal power requirement, it is feasible to use batteries, an excellent source of hum-free supply voltage. Transistors are non-microphonic, making mechanical precautions necessary. Transistors provide an economical approach to a low-noise, high-quality preamplifier.

It is universally accepted that it is the responsibility of the preamplifier to increase the output of the low-level magnetic cartridge and to provide correct equalization to complement the recording characteristic. These are both simple tasks. However, they must be performed without injecting any perceptible noise or distortion into the system. The preamplifier described herein accomplishes this at a total cost of less than $15, including batteries.

This is not intended to be a general-purpose unit. It is designed to do just one job and to do it as well as is technically possible. It should be evaluated on the same basis as any other preamplifier, namely noise, distortion, transient response, and accuracy of equalization. Naturally, the better these figures are, the better the preamplifier. But before any actual design work can be done, it is necessary to know exactly what this preamplifier is expected to do in terms of measurable performance.

These specifications represent desired performance. If subsequent investigation proves them extravagant or unattainable, they may be tempered with reality in the final specifications. Nevertheless, they provide a visible goal at the outset of the development and a yardstick by which its success may be measured upon completion. In this case, the following "wishing list" was compiled: Input impedance: 100,000 ohms; Output: 500 ohms or less; Gain: 35 db mid-frequency (to provide approximately 1 volt r.m.s. output); Distortion: less than 0.2 per-cent harmonic measured at maximum operating level +6 db; Equalization: RIAA ±2 db (RIAA tolerance); Noise: 80 db down from maximum operating level measuring all components in a band of 0 (d.c.) to 20 kc.

If this last specification seems unnecessarily detailed, it should be remembered that the signal-to-noise ratio is most informative when the frequency range of the measured noise is known. Unless otherwise specified, this might be taken only as the noise in the frequency range of interest, in this case, 30 cps to 20 kc. Unfortunately, noise components below 30 cps can be just as offensive to the rest of the system as those above. Therefore, it is felt that the noise measurement should be taken down to d.c.

Other desirable features include good transient response and fast overload recovery. Primarily, this goes to minimize the effect of dropping the stylus into the lead-in groove. It should be immune to stray fields generated by motors and transformers. The preamplifier should be compact and self-powered so that it may be installed close to the tone arm. It should operate reliably at temperatures up to 150°F. It must not use any special, selected, or unduly expensive components.

In consideration of the foregoing requirements, the design philosophy of a two-stage, direct-coupled feedback amplifier followed by a common collector stage, also direct-coupled, is very attractive. This configuration has definite advantages in that:

(*a*) Equalization can be accomplished in a single voltage feedback loop.

(*b*) The series feedback thus produced will elevate the input impedance.

(*c*) Temperature stabilization can be accomplished by a separate d.c. feedback loop.

(*d*) The common-collector output stage will provide a low-impedance output and isolate the equalizing network from the load.

Since the preamplifier is to be battery powered, it is practical to arrange the supply with two identical batteries to provide positive and negative voltage with respect to the mid-point, which is grounded, serving as a "0" voltage reference. The base of the input transistor is conveniently placed at ground potential due to the very low d.c. resistance of the cartridge. The base current of the first stage does flow through the cartridge, however, this is only about 2.5 microamperes and has no perceptible effect on the performance of the cartridge.

Circuit Employed

Referring to the schematic, Fig. 1, an absence of coupling capacitors will be noted. The direct coupling is responsible for the excellent overload recovery and low-frequency transient response. It is also responsible for the temperature stability, through the d.c. feedback loop between the input and output emitters. This method of temperature stabilization avoids the use of current-consuming divider networks at the base of each stage, resulting in considerably less battery drain than would otherwise be experienced.

For discussion purposes, the amplifier can be divided into three sections. The forward-gain path, the signal-feedback loop, and the d.c.-feedback loop. The forward-voltage gain is provided by V_1 and V_2, which are used in the common-emitter configuration. V_3, an emitter-follower, provides current gain, reducing the output impedance. A 2N-324, a high-*beta*, low-noise transistor, was selected for V_1. In order to obtain the desired d.c. distribution throughout the amplifier, it is necessary to use an *n-p-n* transistor for V_2. Type 2N169A was selected for this position. V_3, the output stage, is not at all critical. Another 2N324 is used here, reducing the number of different types required. These types are manufactured by *General Electric*. No difficulty should be encountered in the substitution of other types as long as they are electrically similar. Most manufacturers publish reliable cross-reference data, which can be used in the selection of other types. The parts list includes some alternate types that have been tried and found satisfactory. The use of an "economy" transistor in the V_1 position is not recommended, as this might degrade the noise figure of the preamplifier.

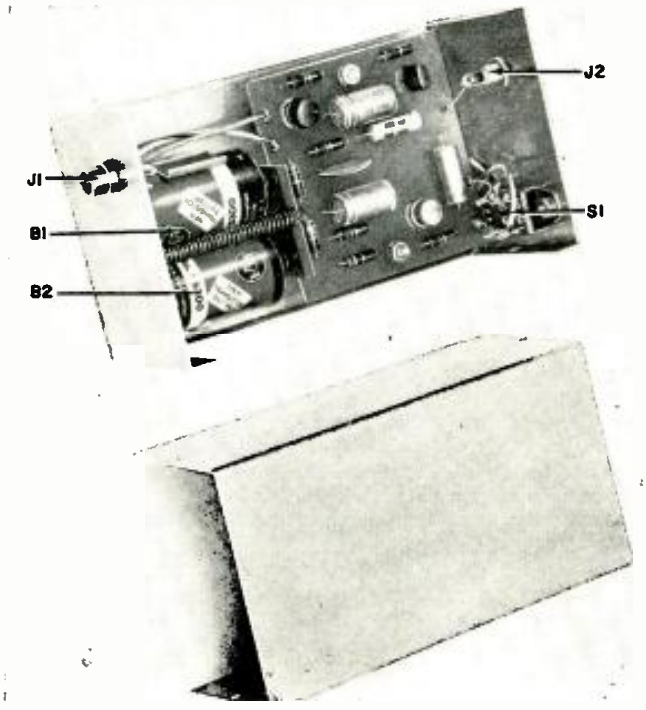
Signal feedback of a negative voltage characteristic is obtained from the collector of V_2, and developed across R_2, the unbypassed portion of the V_1 emitter resistance. This series feedback configuration raises the input impedance of the preamplifier to a value that prevents loading a high-impedance magnetic cartridge. Equalization is obtained through the use of a frequency-discriminating network in this loop. R_4, C_2, and C_3 are selected to produce the RIAA characteristic. R_4 and C_3 determine the low-frequency turnover point and C_2 determines the high-frequency roll-off. Naturally, the feedback is at its minimum at the top of the low-frequency rise. However, at this point there is still approximately 15 db of feedback through this loop.

The d.c. feedback loop includes the emitter-follower. It returns the d.c. component of the output to the input stage emitter. Any shift of d.c. operating points due to temperature, transistor characteristics, etc., would, without this over-all loop, produce a change in the d.c. voltage at the V_3 emitter. If this change is applied, in proper phase, to the input of the amplifier, the situation will be self-correcting, as it is in this case. The temperature stabilization realized in this manner is quite effective. Referring again to the schematic, it will be observed that C_1 is used to filter the signal out of the d.c. loop. This is necessary, since the signal feedback loop is "inside" the d.c. loop. Signal voltage appearing in the d.c. loop would tend to nullify the action of the equalizing network.

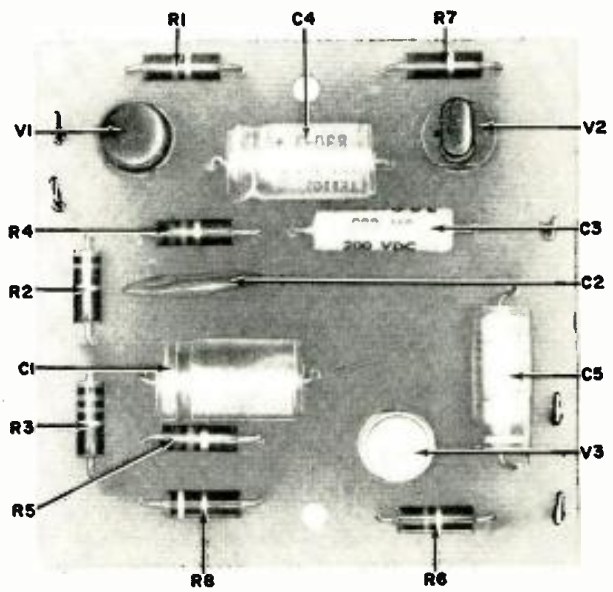
The capacity of C_1 is chosen so that, in conjunction with R_5, low-frequency feedback occurs in this loop. Actually C_1 and R_5 have been selected to permit feedback starting at 30 cps and increasing as frequency decreases. This serves to control the subaudible response of the preamplifier. It provides feedback in the region where the signal feedback loop has ceased to function. Three important benefits are derived from this feature. It is generally conceded that it is desirable to attenuate the response of the system below the range of interest to reduce turntable rumble and changer thumps. It reduces the possibility of low-frequency instability, and, most important, it greatly reduces the 1/F or flicker noise produced by transistors.

At first glance, the value of C_1 may

Inside view showing the placement of the two batteries used.



Circuit board on which transistors and other parts are mounted.



seem unusually large. To avoid confusion, it should be pointed out that R_5 is in series with an amplifier having an open loop gain of about 60 db, therefore, the effective resistance of R_5 is 27,000/1000 or 27 ohms. Nearly all LP recordings available today require the RIAA curve for correct reproduction and this is why the RIAA curve was built into this preamplifier. It is conceivable, however, that some users will desire other equalization, or perhaps several different switchable curves. Inasmuch as all of the equalization is accomplished by one network between two points, a single-pole rotary switch can be used to provide as many equalization positions as desired. If a curve having a 500 cps turnover and no high-end roll-off is desired, common to 78 rpm records, C_3 is changed to .02 μf. and C_2 is omitted. A capacitive reactance chart or nomograph is useful in determining the appropriate values to produce a particular curve. A general consideration that should be kept in mind is that the amount of equalization must always be less than the amount of feedback determined by R_4. Thus, if the turnover frequency is moved up, it should be done by decreasing the capacity of C_3 and decreasing the resistance of R_4, otherwise, the low-frequency rise may flatten out prematurely. By making C_3 very large (10 μf. or more) and omitting C_2, the response may be made essentially flat.

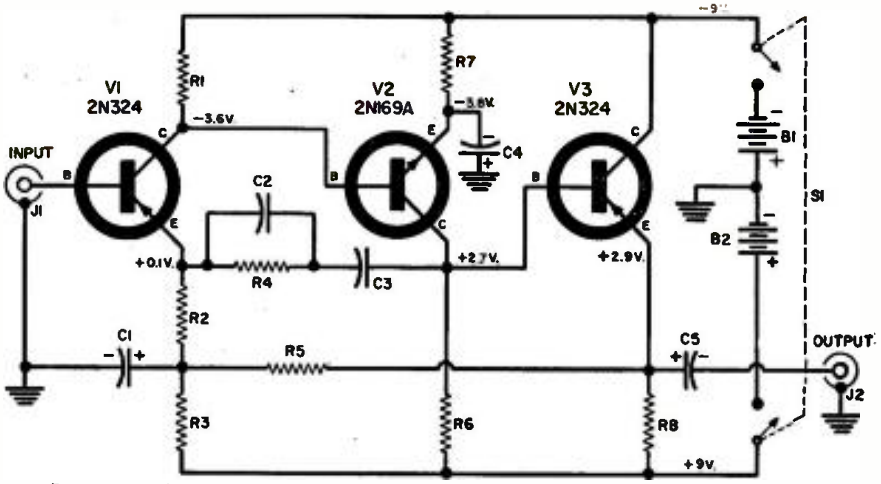
Input Impedance	120,000 ohms
Output Impedance	90 ohms
Gain	35 db @ 1000 cps
Distortion	0.17% @ 2 v. r.m.s. output (measured at 1 kc.)
Noise	—85 db, all components d.c. to 20 kc.
Equalization	RIAA
Output Level	Approx. 1 v. r.m.s.
Operating Temperature	165°F

Table 1. Listing of preamp specifications.

Performance specifications of the preamplifier are given in Table 1 and the response in Fig. 2. All of the original specifications have been met and, in some cases, exceeded. The only maintenance required—in fact the only maintenance possible—is the replacement of batteries when required. The exact battery life is, of course, dependent on how much the preamplifier is used. A good procedure is to check the voltage every three months or so, and discard the batteries when they measure less than approximately 6 volts.

Layout & Construction

The physical layout and construction shown in the photographs are intended primarily as examples. Parts placement and lead dress are not at all critical. In the event the builder elects to forego sockets for the transistors, the usual precautions regarding soldering should be observed. The use of a d.p.s.t. relay connected to the turntable motor may be used to turn the preamplifier off and on. No doubt several possible innovations will occur to the reader. The "chassis" is 1/16" Fiberglas, but any of the common insulating materials will be satisfactory. The connecting terminals were made by bending a loop in the end of No. 20 tinned wire. The completed preamplifier is housed in a homemade aluminum box. It is recommended that this preamplifier be enclosed in some kind of a metallic shield.



R_1—15,000 ohm, ½ w. res.
R_2—330 ohm, ½ w. res.
R_3—33,000 ohm, ½ w. res.
R_4—18,000 ohm, ½ w. res.
R_5—27,000 ohm, ½ w. res.
R_6—10,000 ohm, ½ w. res.
R_7—8200 ohm, ½ w. res.
R_8—3900 ohm, ½ w. res.
C_1—250 µf., 3 v. elec. capacitor (see text)
C_2—.0039 µf. disc ceramic capacitor
C_3—.022 µf., 200 v. capacitor
C_4—100 µf., 6 v. elec. capacitor
C_5—1 µf., 6 v. capacitor
S_1—D.p.s.t. switch
B_1, B_2—9-volt battery (RCA VS300 or Burgess P6M)
J_1, J_2—Phono jack
V_1—"p-n-p" transistor (G-E 2N324, 2N508 or RCA 2N175)
V_2—"n-p-n" transistor (G-E 2N169A, RCA 2N585, Sylvania 2N214, or General Transistor 2N446A)
V_3—"p-n-p" transistor (G-E 2N324, 2N321, 2N508, 2N190, or RCA 2N109)

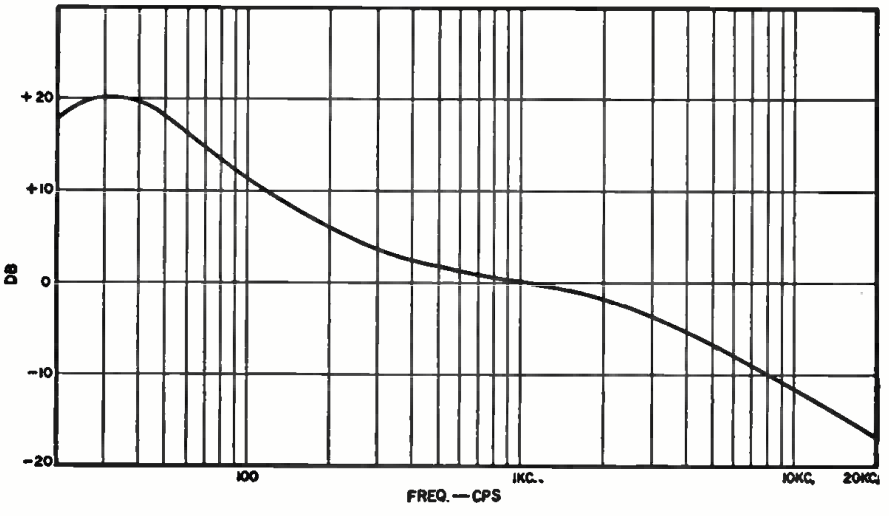
Fig. 1. Total cost of the three transistors used in this circuit runs about $6.50.

The d.c. voltages shown on the schematic were measured with a v.t.v.m. and also with a 100,000-ohm-per-volt multimeter. All readings should be ± 1 volt. The d.c. stability may be checked by connecting a voltmeter between V_3 emitter and ground. V_1 is then heated by holding a soldering iron in close proximity. The voltage will decrease. When it drops to about +1 volt, remove the soldering iron and grasp V_1 between thumb and forefinger. It should feel decidedly hot. The voltage at the V_3 emitter should return to normal rapidly as the heat is dissipated by the fingers.

Installation and Use

It is desirable to mount the preamplifier close to the turntable or changer, keeping the lead from the cartridge short. The higher impedance magnetic cartridges are sensitive to cable capacity. Since the preamplifier is not connected to the a.c. line, the possibility of ground loops in the system is slight. If encountered, the solution is merely to avoid connecting the preamplifier box to ground except by the shields of the input and output leads. It is preferable that the following amplifier have a volume control preceding the first stage, otherwise there is a possibility that the preamplifier will overdrive it, causing distortion. The simplest solution in this case is to insert a fixed attenuator between the preamplifier and the main amplifier. —30—

Fig. 2. Response curve of preamp shows how closely it follows RIAA characteristics.



De-Bugging the Horizontal Oscillator

By **WARREN J. SMITH**

Phil George gets more bench tips from Harry, this time on horizontal woes.

THE FACT that small defects can be more difficult to pinpoint than the larger, more dramatic ones has been proved many times on the service bench.

The broad troubleshooting procedures that serve for the majority of likely faults need some additional, refined techniques when it comes to the tricky defects or circuits. Without these refinements, a bench man can find himself enmeshed in some obscure fault for hours. Phil George had good reason to appreciate the meaning of this point:

Harry Gridleak had just buttoned up the FM tuner and was beginning to write up the repair ticket when he spotted Phil mumbling to himself. "What's got you all worked up, Phil?" he asked. "You run into a tough one?"

"I'm afraid so." Phil replied. "If you have a minute to spare a poor, lost soul, come over here and take a look at this portable. It's about to bug me!"

Harry wrapped up his own job and then joined Phil at the bench. "What seems to be the trouble?" he wanted to know.

"Horizontal tearing. Like a lot of other portables, this one uses a multivibrator oscillator with only one frequency adjustment—a slug in the ringing coil. To make the set hold sync, I have to screw the slug all the way in. Even then, it shows a tendency to tear out every so often."

"Make any circuit checks?" Harry asked.

"Are you kidding. I've checked out or substituted for just about every component in the circuit. After isolating the trouble to the oscillator, I plugged in a new tube. That didn't clear up the trouble, so I began checking out voltages, then components, one at a time.

"And what did you find?" Harry wanted to know.

"That's just it—nothing! I figured something must have gone haywire in the frequency-determining networks because sync holds at the extreme setting of the ringing coil. Yet, after checking out every one of these (here Phil pointed successively to each of the components set off with a broken-line circle in Fig. 1), I'm right back where I started nearly an hour ago."

"How about the input grid, Phil? Get an a.c. reading on the v.t.v.m.?"

"Now why should I check the input grid for a.c.? The only voltage that could be there is bias or correction voltage from the a.f.c. circuit trying to hold the oscillator in sync—and it checks out okay."

"Want to make a little bet?" Harry ventured. He sounded very confident.

Phil didn't spend much time thinking over the offer: "Make it coffee and you're on."

Harry nodded, wheeled the scope over to Phil's bench, and clipped its leads into the first grid of the 6CG7. After a few deft adjustments, he got a pattern on the scope screen. "Good grief!" Phil exclaimed. "That's about the meanest-looking signal I've seen on a d.c. grid. What is it?"

"It's a combination of 60- and 15,750-cps signals," Harry replied. "The noise-filter network is defective."

"Bypass the fancy jargon, Harry. Give it to me straight."

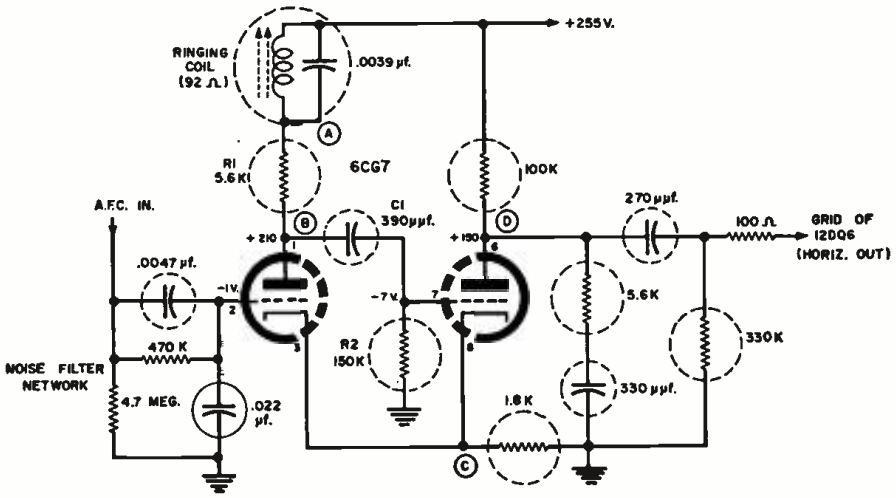
"Sure. That means the grid bypass capacitor (.022 μf., in the solid circle of Fig. 1) is probably open. Why don't you try replacing that one?"

"Well doggone; why didn't I think of that?" Phil asked himself. Then he tacked in a new capacitor and fired up the portable. As it came to life, he glanced up at the scope screen: the unwanted signal was gone. After readjustment of the slug in the ringing coil, horizontal sync on the set held tightly. "That's another 'oak-leaf cluster' for you, Harry. You were right again. How did you figure it?"

"I made an educated guess on this one, my young friend. It wasn't so difficult to do after the preliminary work you had done. The input grid of the multivibrator is essentially grounded for a.c. by the noise-filter network. This prevents any random signal that may be heading for the grid, where it could upset oscillator operation, from getting there. Since the tearing was at random and you had eliminated everything else that could affect the operating frequency of the oscillator, there was just about no other conclusion left. Any more questions?"

"Yep. You once showed me a procedure to use in isolating trouble that might involve either the a.f.c. circuit or the horizontal oscillator. (see "Tame TV Dogs with Technique," ELECTRONICS WORLD, July 1959). The idea was to save time by doing things systematically. Now take a case like this one, where isolation went right down to the oscillator. Is there a procedure that

Fig. 1. Harry checked circled components in this multivibrator to no avail.



comes in here? I sure could use one."

"There definitely is, Phil. For top-notch efficiency, any circuit defect should dictate the use of a set procedure. The horizontal multivibrator is no exception. You could have saved about fifty-five minutes of your last hour, in all probability, if you had started out the right way."

"You must be ribbing me, Harry," Phil insisted. "How in the world could I pinpoint the trouble in only five minutes?"

"Well, once you got as far as isolating the trouble to the multivibrator, there are a couple of preliminary quick-checks you should have made right away. In this case, you would have had to go no further."

"All right, then; what are these quick-checks, as you call them?"

"The first is to short out the ringing coil with a jumper to determine whether it is misadjusted or defective. You see, Phil, the ringing coil is actually nothing more than a resonant network to stabilize the operation of an oscillator that is already working: the coil and capacitor simply force the plate current and voltage in the first triode to follow what is essentially a sine waveform. So, if all the other components are within tolerance, the multivibrator should still operate on frequency with the ringing-coil network shorted out."

"And if it doesn't?"

"Then you know the multivibrator itself is off frequency—and you can tell in which direction, too, by the effect on the picture. If it flops over so that the diagonal lines slant upward to the left, the multivibrator is running too slow; if the lines swing upward to the right, the oscillator's too fast."

"I can see that; but how would it have helped me to know?"

"Well, you certainly wouldn't have wasted all that time substituting a new ringing-coil network or cranking the slug."

"But I still wouldn't have pinpointed the trouble, Harry."

"No; but remember that we still have a second quick-check that comes in here. You measure the d.c. grid voltage and check for the presence of a.c. Any a.c. voltage at this point indicates a defective noise-filter network, while excessive d.c. voltage means the multivibrator is unbalanced."

"I begin to see the outlines of what you call a correct approach," Phil said. "But suppose that our trouble wasn't a.c. on the grid. Where would we go from there?"

"Check out the coupling network between the triode stages. Measure the value of the plate (R_1 in Fig. 1) and grid (R_2) load resistors; and substitute for the coupling capacitor (C_1). The free-running frequency of the multivibrator is determined primarily by the time it takes that coupling capacitor to discharge through the grid resistor, so even small changes in value here could result in an off-frequency output that the a.f.c. circuit may not be capable of counteracting. After eliminating

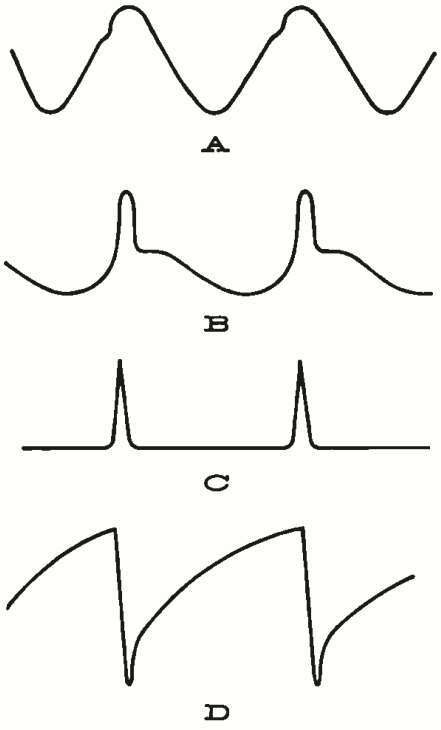


Fig. 2. These waveforms occur at correspondingly lettered points in Fig. 1.

this network, we have only the fairly simple waveforming and coupling networks in the output to contend with, and they can be checked out quickly. With a scope, you can check through for correct waveforms in very little time. (Normal waveforms in Fig. 2 are lettered to correspond with the points at which they should appear in Fig. 1) Get it?"

"Got it. I guess we're just about ready to head for Joe's Cafe and the 'big payoff.' Before we do, though, how about helping me get this other set out of the way?" Phil asked nonchalantly.

"What, *another* one?" Harry exclaimed.

"Aw; it shouldn't be tough for an old pro like you. This is the last one to be repaired and I don't want to spend the rest of the day on it," Phil wheedled. He was using the right approach.

Harry answered, "All right; what are the symptoms?"

"The picture shimmies all over the screen. It looks like horizontal instability, but it isn't. First I tried new tubes in the tuner, i.f. strip, sync, a.g.c., and horizontal-oscillator circuits, but that got me exactly nowhere. I thought it might be a.g.c. trouble, so I went off in that direction first. Sure enough, clamping the a.g.c. voltage with a fixed external bias cured the shimmy. Then I went through the a.g.c. circuit with a fine-tooth comb, but I couldn't find a thing wrong. The a.g.c. filters all check good. The voltages and signals in the a.g.c. keyer all look normal. Now there almost has to be something wrong with that doggone a.g.c. circuit. My only question is—where?"

"Did you try replacing the horizontal-sweep output tube?"

Phil's tone of voice betrayed his surprise. He asked, "Why in tarnation should I replace the horizontal-output tube?"

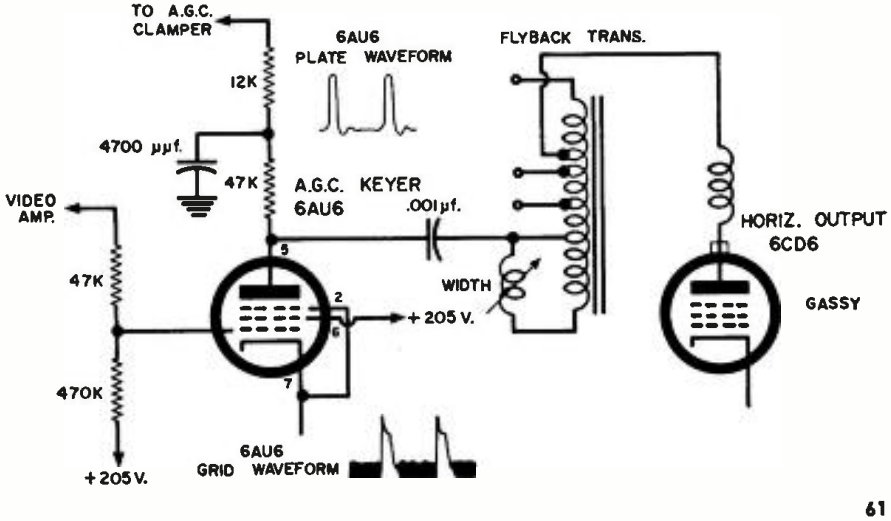
"Keyed a.g.c. circuits can get involved in the most peculiar kinds of trouble, Phil. Once you run into something like a gassy horizontal-output tube resulting in mistiming of the plate pulses at the keyer, you don't easily forget it. You don't wind up asking why in tarnation you should replace the output tube."

"Come to think of it, Harry, I can see the possibility. If the timing of the plate pulse at the keyer (Fig. 3) doesn't match the timing of the grid pulse, then the stage isn't conducting when it should be. This means a.g.c. output voltage would be low. Sync pulses would be overamplified or distorted in the i.f. system. That could easily cause sync instability."

While Harry stood patiently by, Phil replaced the 6CD6 and then plugged in the cheater. The picture came up clear and steady, and stayed that way. Phil had only one terse comment: "Simple defects—but, man, can they be tough."

Harry only grinned and said, "Let's go get that cup of java." -30-

Fig. 3. A keyed a.g.c. circuit can be upset by a horizontal-output defect.



Type N Carrier Telephone System

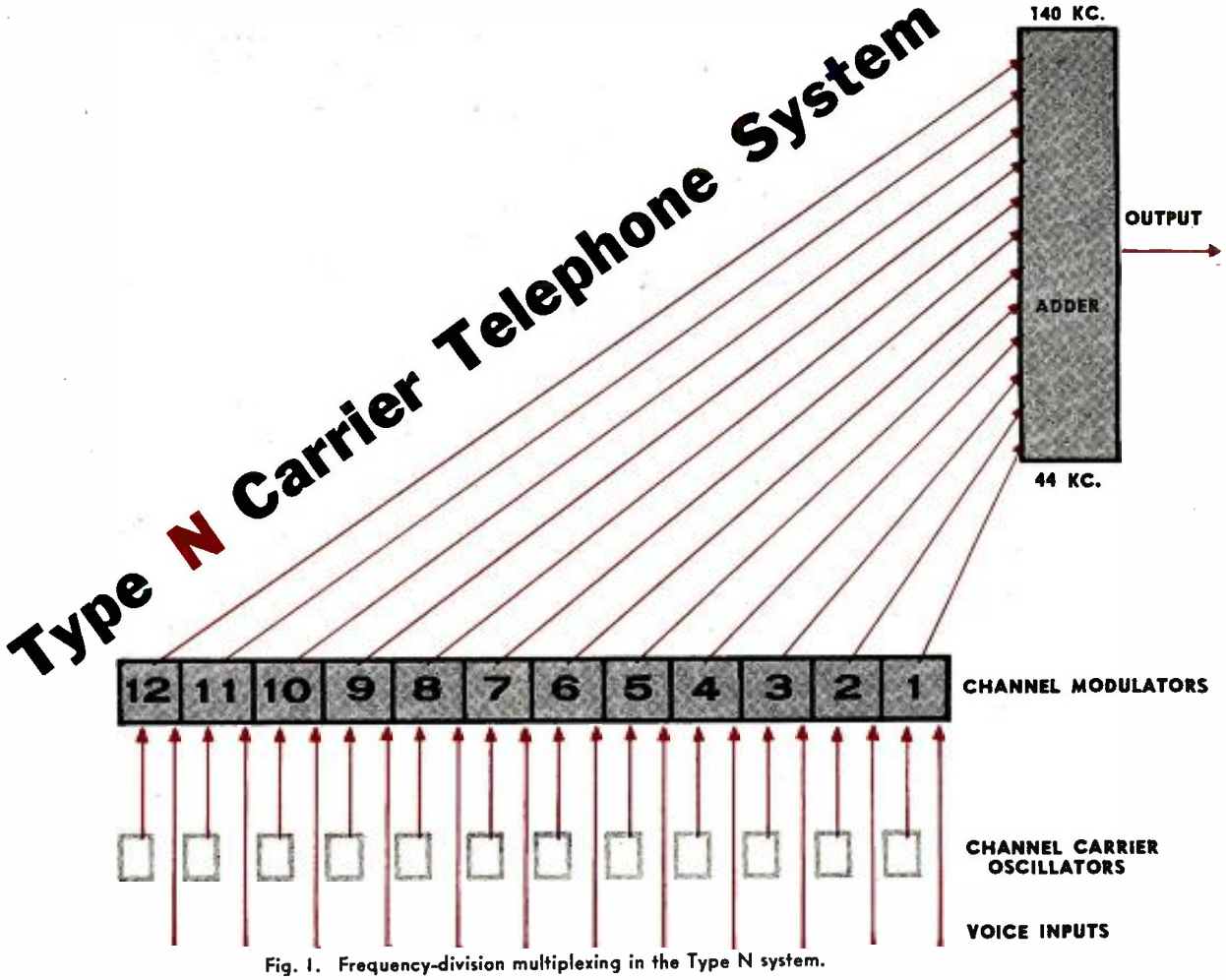


Fig. 1. Frequency-division multiplexing in the Type N system.

By RONALD B. TIPTON

Techniques and circuits employed to permit a single pair of conductors to handle 12 2-way voice channels.

EVER since 1918 when the first carrier system was put into service, the *Bell System* has been introducing and applying progressively newer versions as they were needed and developed. The first system, designated Type A, has been succeeded by more sophisticated techniques, each of which has been labeled with a letter of the alphabet. In this article the Type N carrier system is described.

A Carrier System

First, what is a carrier system? In this connotation the term "carrier system" refers to frequency-division multiplexing using open-wire lines, cable pairs, or coaxial cable as the transmission medium. The *Bell System* also employs carrier systems using radio links as the transmission medium but these will not be considered in this article.

"Frequency-division multiplexing," as the term is employed here, is that process of taking several voice channels occupying a band, say from 250 to 3100 cps, and using these voice channels to modulate channel-carrier oscillators—the frequencies of the oscillators being spaced to "stack" the voice channels, leaving a suitable guard space between each channel. For the Type N system, this process is diagrammed in Fig. 1.

The advantages to be gained from such a system are obvious. Without the system a pair of conductors and separate repeater amplifiers would be required for each voice channel. By multiplexing, many channels can be transmitted over a single pair of wires and can be amplified in one wide-band repeater amplifier.

Let us consider the Type N system because the techniques involved are representative of many of the systems in use and because some of its features are of particular interest.

At the end of World War II when material was again available for consumer products and services, the demand for telephone facilities of all types swamped the various operating companies. Much of this demand was for the so-called "short-haul" service, that is, distances from 15 miles to a maximum of about 200 miles. The problem involved was basically an economic one: the high cost of additional equipment for single voice channels in the quantity required *versus* the almost equally high cost of the then-in-use long-distance carrier equipment. It was apparent that a practical solution involved the development of an economical carrier system specifically designed for short-haul use and applicable to existing transmission lines. The result was the Type N carrier system. The various points of this system will be described and then discussed in some detail.

System Description

The N system is designed to provide twelve two-way voice channels on two pairs of non-loaded cable in two frequency bands, one between 44 and 140 kc. and another between 164 and 260 kc. (Since attenuation and phase shift are functions of frequency in a practical transmission line, series inductance is placed in the line to lessen this effect. This process is called "loading." Obviously, a line without such loading is a "non-loaded" line.) It uses the different bands for transmission in opposing directions. It is a double-sideband system with the carrier being transmitted. The system employs miniaturized equipment and makes use of devices known as "compandors" and a

technique known as "frequency frogging" to improve the system at minimum expense.

The twelve voice channels are evenly distributed through a frequency band of 96 kc., allowing 8 kc. per channel. The voice band is limited to a range of 250 to 3100 cps by a bandpass filter in the terminal equipment. Since double-sideband transmission is used, 6200 cps of each channel is required for the voice band. A signalling or dialing frequency is provided at 3700 cps in each channel, putting another "line" in the spectrum at the channel-carrier frequency, ± 3700 cps. This channel "filling" is indicated in Fig. 2 and, as can be seen, still leaves a guard space between channels.

Transmitting the carrier provides several advantages. It avoids the added expense and complication of requiring accurate channel-carrier supplies at both the receiving and transmitting terminals. Of course, channel-carrier supplies are required at both terminals but they do not have to be maintained to accuracies of only a few cycles-per-second as would be the case with suppressed-carrier transmission. The presence of the carrier also allows gain control in the repeater without transmitting a "pilot frequency" (a steady carrier transmitted over the system for gain regulation). Because this circuit functions much like the automatic volume control in a radio receiver, it needs the carrier to regulate gain according to the carrier's average value.

No. 16, 19, 22, or 24 gauge conductors can be used with the Type N system. Repeater spacing is nominally 8 miles for 19 gauge and 6 miles for 22 gauge. Where geography or other physical limitations determine repeater spacing, they can be located closer together—the missing line attenuation being used up in a "span pad" at the repeater.

Since repeaters are placed wherever convenient, which is usually in the open on a pole, they as well as the transmission lines are subjected to extreme temperature variations. The loss in the conductors is also a function of their temperature and hence the repeater gain must be adjusted to compensate for this temperature-caused variation. Thermistor control elements in the repeater feedback circuit accomplish the regulation.

Use of Compandors

The word "compandor" is a coined expression derived from the words "compressor" and "expander." The compandor consists of a volume compressor at the sending end of the line and an expander at the receiving end. The compressor provides a gain dependent upon the amplitude of the voice signal applied to it. The expander provides a variable loss which is also dependent on the amplitude of the applied signal. The compandor action on a steady tone is shown in Fig. 3.

What benefits are to be derived from using the compandor? There is always a certain amount of noise on the transmission line, some of it arising from the thermal agitation of electrons in the conductor, some picked up from the atmosphere, and some added by the equipment connected to the line. In the compressor a low-amplitude voice signal is amplified and transmitted at a higher level to override the noise on the line.

Higher voice signal amplitudes need less amplification to maintain the same signal-to-noise ratio. High signal amplitudes are attenuated to help prevent crosstalk between lines. "Crosstalk" is the term used to designate the coupling of energy between parallel lines due to the field produced by one line cutting the field of the other line. Lower transmission amplitudes result in lower intensity fields and hence less crosstalk.

The noise voltage present on an idle line receives the full 28 db attenuation in the expander hence customers are not bothered by a noisy line when neither is talking.

The time-constants of the compandor are chosen for a fast attack of about 3 to 5 milliseconds and a slower release of about 10 times the attack time. This proportion allows the compandor to follow the syllabic speech rate. If the attack were too slow, a high-amplitude speech burst would not receive the proper attenuation and would overload the system. Similarly, too slow a release would allow noise to be audible at the ends of the syllables.

The use of the compandor also offers the following advantages: Operation is possible to a frequency of 260 kc. without the need for far-end crosstalk balancing; repeaters can be spaced about 40 per-cent farther apart than would be possible without the compandor because of crosstalk and line noise; the compandor also makes possible the use of more economical repeater circuitry and transformers since the dynamic range to be handled is narrower—30 db with the compandor as compared with 60 db without it. See Fig. 3.

To avoid degrading the noise advantage of the compandor, the 3700-cps signal frequency is added after the compressor at the sending terminal and removed by filters before the expander at the receiving terminal. Thus the compandor is left to operate only on the voice signals.

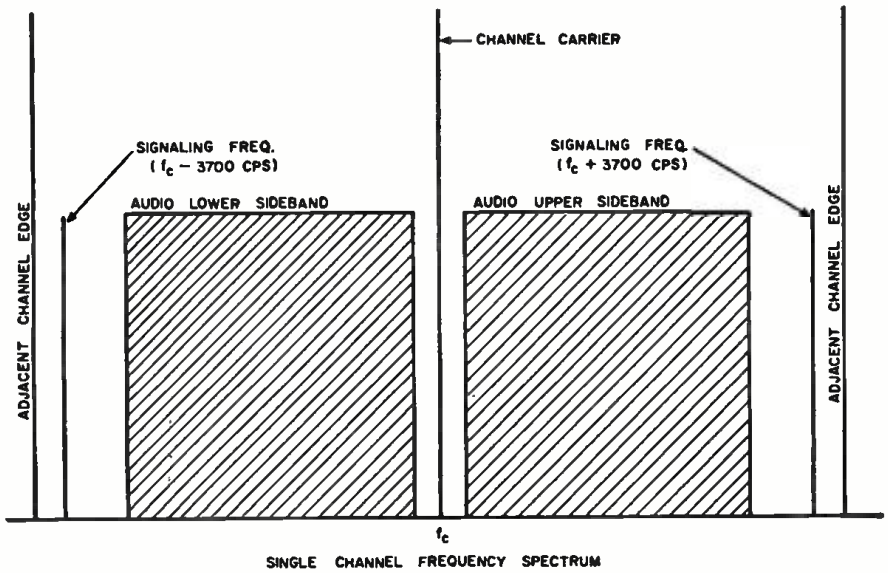


Fig. 2. The over-all frequency spectrum for one of the voice channels is shown.

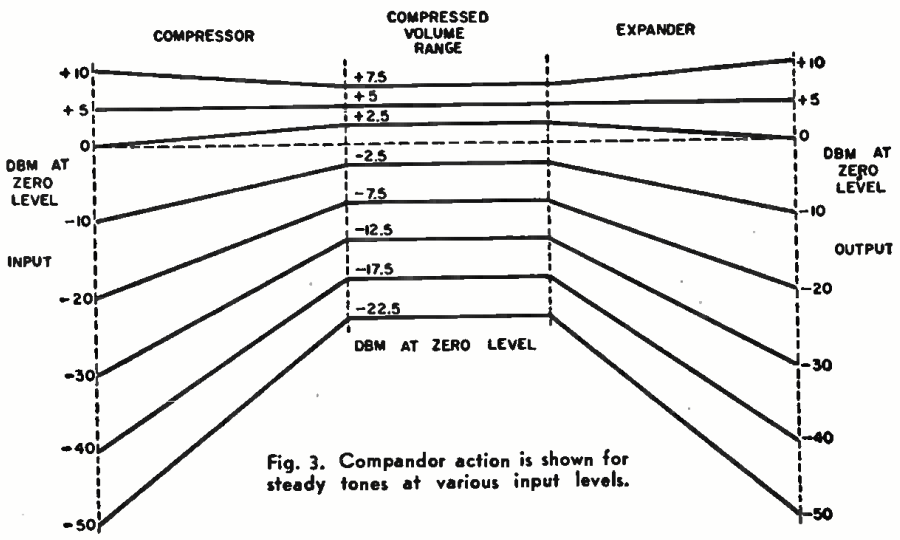


Fig. 3. Compandor action is shown for steady tones at various input levels.

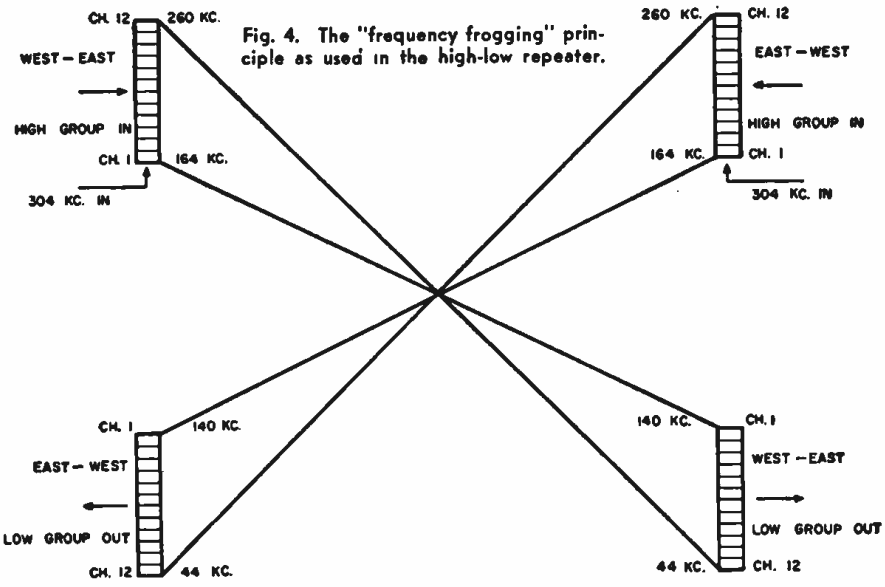


Fig. 4. The "frequency frogging" principle as used in the high-low repeater.

Since many of the lines that were wanted for the Type N system were not originally designed for carrier operation, the compandor keeps the volume on the line contained between the limits acceptable for these lines.

Frequency Frogging

With "frequency frogging," the output of a repeater is always at a frequency different from the input. For a high-low repeater this is illustrated in Fig. 4. A high-low repeater is one in which the incoming channels are in the high-frequency band (164-260 kc.) and the output is in the low band. A high-low repeater is always followed by a low-high repeater which, in turn, is followed by another high-low unit. The number of repeaters and whether the terminal equipment is high- or low-band must, of course, be determined on the basis of compatibility.

Both the incoming channel groups are mixed with a 304 kc. crystal-controlled signal. Taking the "difference frequency" results in the groups being interchanged or "frogged" in frequency. Selecting the proper sideband after mixing is accomplished by means of filters in the repeater amplifier—a block diagram of which is shown in Fig. 5.

The technique of frequency frogging allows the use of less filtering equipment at the repeaters by eliminating crosstalk around the repeaters. Known as "interaction crosstalk," this results from the output of a repeater being fed back into the input.

In addition to eliminating interaction crosstalk, the channels are inverted in passing through the repeater, that is, the high channel in one line section becomes the low channel in the next line section. Since line attenuation increases with frequency this inversion tends to keep line losses more nearly constant across the twelve voice channels. Repeater gain is also a function of frequency. A curve showing the sum of low-high and high-low repeater gains appears in Fig. 6A as well as a curve of the sum of two cable section losses which appears in Fig. 6B. It can be seen that these curves compensate closely. The residual difference in slopes is easily compensated in the repeater feedback circuit.

Deviation equalization is required at about every tenth repeater to compensate for the mismatch between repeaters and the line.

Although for many applications even the Type N system does not provide adequate facilities for the ever-increasing public demand for telephone service and increased channel systems such as the Types O and ON have been developed to meet these needs, the Type N system is the "father" of short-haul systems in use today.

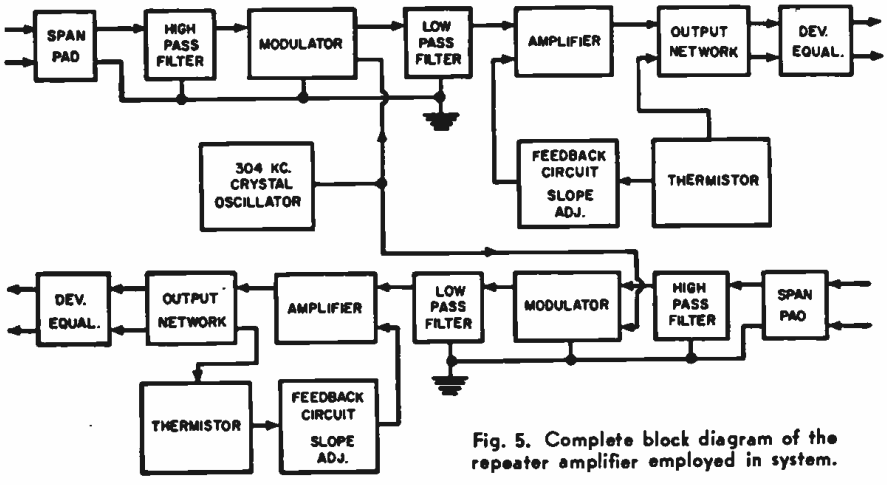
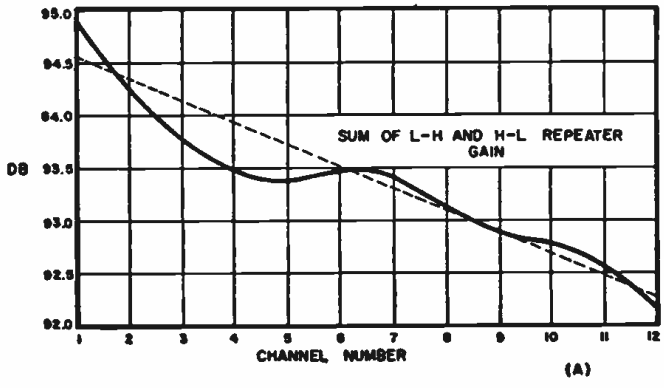


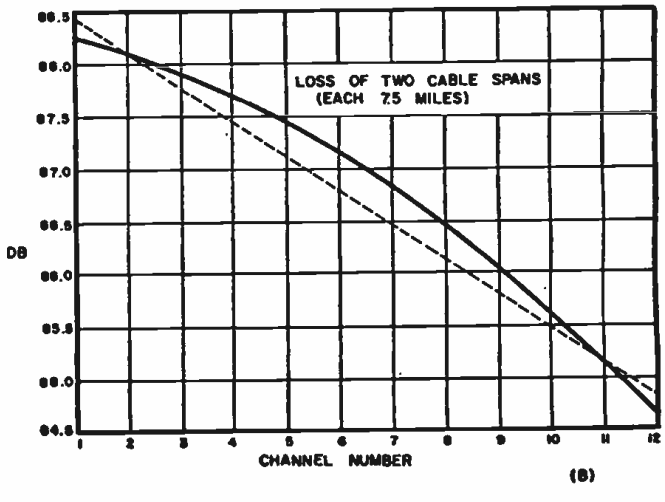
Fig. 5. Complete block diagram of the repeater amplifier employed in system.

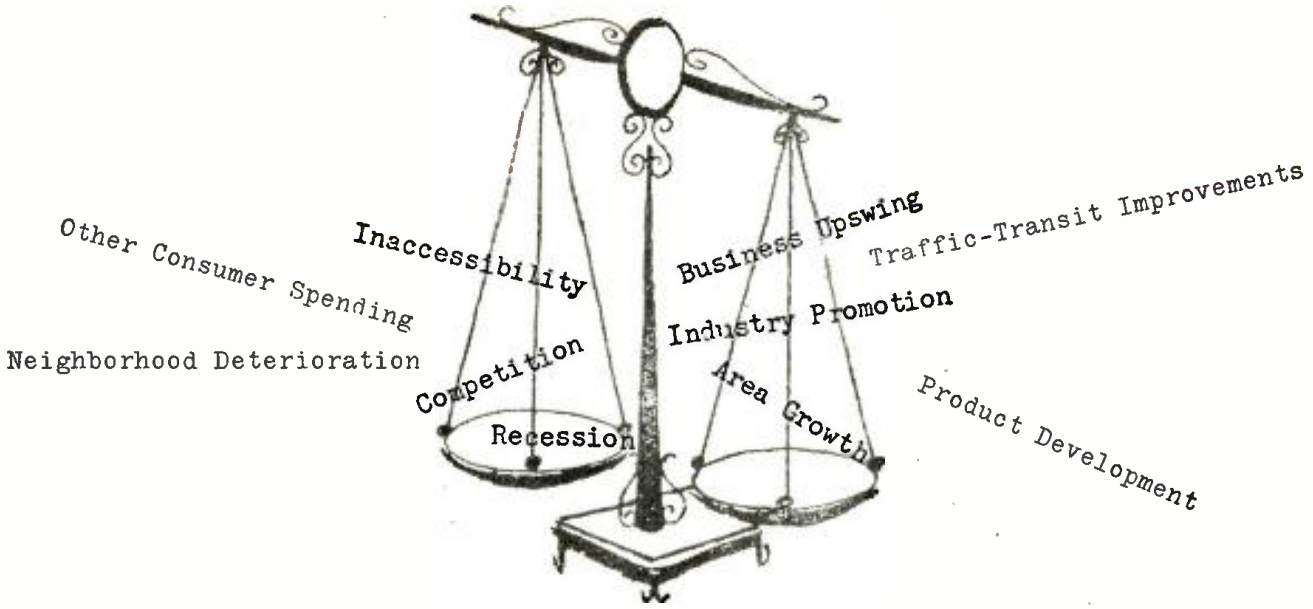
Acknowledgement

The author wishes to thank John K. Beins of the Toledo (Ohio) Long Lines Department of *American Telephone & Telegraph Company* for his assistance in preparing this article. -30-

Fig. 6. (A) The sum of the low-high and the high-low repeater gains in the carrier system. (B) Curve of the sum of losses that exist along two cable spans which are each 7.5 miles long.







Estimating Your Business Potential

By **ERNEST W. FAIR** / **Determining your income for the year ahead doesn't have to be all guesswork.**

"WHAT I WOULD give to know how much business we can expect to do next year!" How many shop owners have said something like this at one time or another? Unfortunately, the crystal ball that comes up with complete and infallible answers has not quite been perfected yet.

However, by carefully weighing certain factors that have passed the test of time, one can come quite close in arriving at an estimate. These factors do not speak in exact dollars and cents, but they can give the shop owner a fairly accurate picture of whether he may expect better or worse business in a period just ahead and, to some extent, the degree of such change.

There are many specialists in the fields of economics and statistics who derive their incomes from the ability to anticipate trends in business and industry. The indicators they employ in reaching their decisions can be used, to a great extent, by the individual owner of a small business.

Area growth. Your trade area may have become stabilized in the recent past and may no longer be subject to growth in the immediate future. It will be important to recognize this. However, if such growth is happening before your eyes and is certain to carry into the near future—increased industrial or residential construction or improved transportation facilities, for example—it is some assurance that your service area and business can grow.

On the other hand, an examination may indicate actual decline in the area. If so, the probability should be faced. In this, as in all other factors, you are wasting your time if you are not completely honest with yourself. Try to avoid coloring the situation with excessive optimism or pessimism.

The state of competition. Even though an increase in the total available business appears probable, your share of it will depend on what other similar businesses in the area will be doing. Are existing competitors becoming more active? Are they enlarging or modernizing their shops, or adding new technicians or trucks? Also, if the pattern of area growth is making new shop locations available, your competitors may increase in number. It is often possible to find out what types of business are scheduled for the new facilities, and every effort should be made to do so. Heavier competition need not mean a decline in your own business. However you can only decide how to counteract it by determining where and how it will come.

New developments. New products or significant changes in old ones have important bearing on possible increases in business. There are many reasons for keeping up with every phase of activity in electronics, no matter how unrelated it may seem, and this is one of the most important reasons. Of course, routine improvement in shop equipment, material, and supplies can have some effect in increasing total business, but the real possibilities for greater income exist when new fields are opened up for sales and service. Being alert enough to take advantage of such possibilities can make the difference between a good year and a mediocre one.

The financial status of customers will have a profound effect on your own potential. A general sag throughout the nation will be felt by you in one way or another. A prolonged strike in your specific area, involving an industry on which many people depend for their livelihoods, may mean a retrenchment for several months in the future, even after the strike has been settled. Understanding these conditions is useful. For example, the impact of a recession could be relieved with the proper strategy, to some extent. The possibility of saving money by repairing old sets rather than replacing them could be promoted.

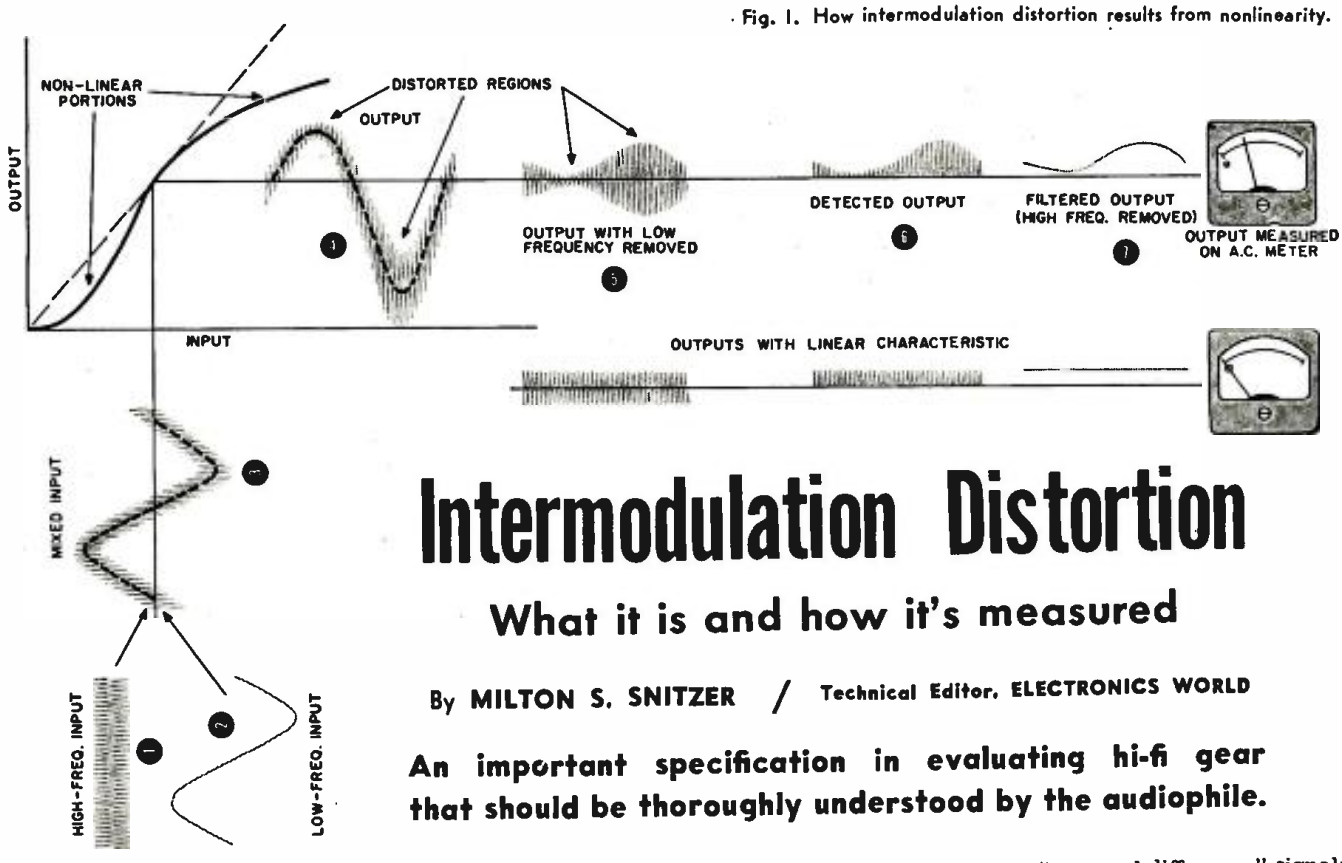
The activities of industries outside of electronics may have a great effect on your volume, and should therefore be watched. Suppose, for example, that the automotive industry is known to be readying a stepped-up drive for sales in the coming year, based on promotion of design changes. This may mean that some of the consumer money that would ordinarily go to you will end up, along with other money withdrawn from other types of spending, in buying new cars. One industry's gain may be another's loss.

Thus any appraisal of your own future and your own industry must take into account the fact that you are in competition with hundreds of other types of business for customers' dollars, not just with your direct competitors. Do you or your industry have anything "special" to offer (hi-fi, stereo) to counterbalance the enticements of other industries competing for a greater share of consumer spending? Are there any outside industries that promise to grow stronger, attracting more consumer attention in the year ahead?

Changes in buying and spending habits, related to the point just mentioned, can have profound effects. Customer

(*Continued on page* 107)

Fig. 1. How intermodulation distortion results from nonlinearity.



Intermodulation Distortion

What it is and how it's measured

By MILTON S. SNITZER / Technical Editor, ELECTRONICS WORLD

An important specification in evaluating hi-fi gear that should be thoroughly understood by the audiophile.

THE earliest and still most common method of checking distortion in hi-fi gear is by the use of a single input frequency in a harmonic distortion check. (See "Harmonic Distortion —What It Is and How It's Measured" in our November, 1959 issue.) Although this method is easy to use and readily duplicated, it may not tell very much about how an amplifier would handle a somewhat more complex input. For example, if we were to apply a mixture of two input signals, one at a low frequency and the other at a high frequency, and we were to check how the amplifier handles these simultaneously and what interactions there are between them, then we would have a better indication of how the even more complex speech and music signals would be handled. This is exactly what we do when we measure intermodulation distortion (IM).

There is currently some disagreement on the value of an IM measurement. There are many in the field who feel that a total harmonic distortion (THD) test made over the entire frequency range adequately describes the amplifier's distortion performance. Following this reasoning, recent standards have been set up for THD measurements but *not* for IM measurement. Despite this, a good many manufacturers quote IM distortion figures so it is important to understand these figures and how they are obtained.

How IM Is Produced

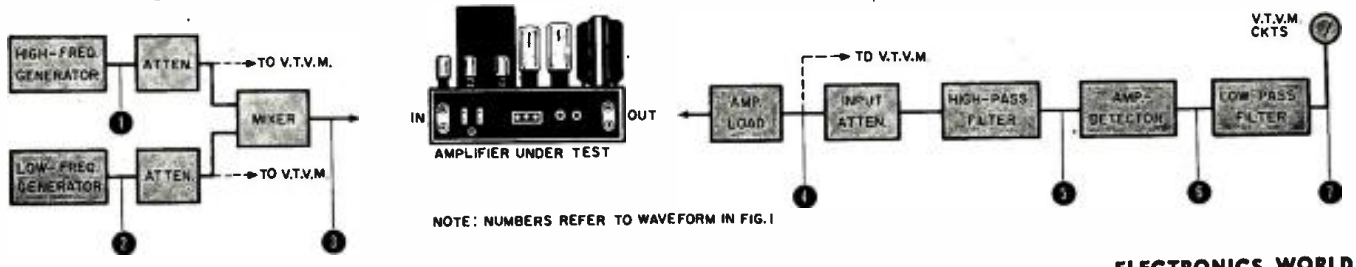
When two different frequencies are applied to a perfectly linear device (one whose output varies directly in accordance with the input), then the output of the device contains only these two frequencies. On the other hand, when there is any non-linearity, one of the signals is changed or modulated by the other. (See Fig. 1.) When this modulation takes place, additional sideband frequencies are generated just as they are in the modulated stage of a radio transmitter. These additional sideband frequencies are *not* harmonically related to either of the original frequencies. For example, if a large 60-cps signal is combined with a small 6000-cps signal in a non-linear device, the additional frequencies of 5940 (6000−60) cps and 6060 (6000+60) cps are formed. What is more, harmonics of the original two frequencies combine with each other to produce still more "sum and difference" signals. None of these additional signals was present originally, so that we have now introduced distortion.

The amount of this distortion is the r.m.s. sum of all these added sideband signals expressed as a percentage of the modulated signal. In the example just given then, if the square root of the sum of the squares of all the sideband frequencies is 0.1 volt and the amplitude of the 6000-cps signal alone is 5 volts, then the IM distortion is 2 per-cent.

Audible Effects

There are two audible effects of IM distortion: one of these is the result of the amplitude modulation that occurs and the other is the result of the unharmonically related added frequencies. Assume you are listening to a Bach Chorale with the sopranos being accompanied by a loud, bass passage on the organ. If your equipment has high IM distortion, the voices may have an unpleasant, "fluttery," and unclear sound because these high frequencies are being amplitude modulated by the low-frequency tones of the organ.

Fig. 2. Functional block diagram of IM analyzer. Waveforms at various points in the instrument are shown in Fig. 1.



NOTE: NUMBERS REFER TO WAVEFORM IN FIG. 1

In addition to this effect, any time that you listen to any combination of tones, or even a single tone that is anything but a simple sine wave, the added frequencies due to IM distortion introduce a roughness or harshness that seems to "muddy up" the original tones. Any added frequencies, whether harmonically related or not, constitute distortion. But when these frequencies are not harmonically related, then the audible effects are quite unpleasant.

Limits of IM

In measuring IM distortion it is common to apply to the equipment under test a large low-frequency signal along with a small high-frequency signal. The usual ratio between the two amplitudes is 4 to 1 (12 db). Low frequencies in common use are 40 cps, 60 cps, 100 cps, and 150 cps; high frequencies in common use are 3000 cps, 4000 cps, 6000 cps, and 15,000 cps.[1] Depending on which frequencies are used, and their related amplitudes, different IM distortion figures will be obtained. Therefore, it is important to state just what frequencies and amplitudes are used in a given test when specs are quoted. It is also important to state the power level at which the measurement is made.

The amount of IM distortion that should be present in top-quality hi-fi equipment has been the subject of much discussion. According to one authority[2] the following arbitrary grouping is given:

AMPLIFIER	IM
Very high-fidelity (lower test freq., 40 cps)	Less than 2%
High-fidelity (lower test freq., 40 cps)	Less than 4%
Good fidelity (lower test freq., 60 cps)	Less than 8%
Fairly good fidelity (lower test freq., 60 cps)	Less than 20%

Recently the *Heath Co.* has set up its own standards for IM distortion limits on power amplifiers. Its groupings, using test frequencies of 60 and 6000 cps at a 4:1 ratio, are as follows:

AMPLIFIER	IM
Professional	1% or less
High-fidelity	2% or less
Utility	3% or less

In our own lab-tested reports as well as in the specifications quoted by a large number of companies in the field, an IM distortion figure of 1 per-cent is used. If we find that an amplifier will not produce its full rated output power at 1 per-cent IM, then we down-rate the unit. Admittedly this is an extremely strict specification to meet but we feel that it is fair provided all units are subjected to the same criterion.

IM Compared with THD

In general, when an amplifier has low intermodulation distortion, it also has low total harmonic distortion (THD). When the IM is high, so is the THD. However, it must be remembered that these two methods of measuring distortion are quite different, so it is logical to expect that the percentage figures for IM and THD will not be the same.

The relation between IM and THD in a hypothetical amplifier is shown in Fig. 3. These curves are fairly typical. Note that at low power outputs (up to about 11 watts in this case) the IM distortion is less than the THD, as measured at the extremes of the frequency range to be covered (say 20 or 20,000 cps). At 10 watts output, the IM of this particular amplifier is 1% while the THD is 2%. It is quite accidental that these two figures, which we use as our own standards, occur at the same power level. But observe what happens at the higher power levels. First, the IM goes upward a little more suddenly than does THD. For this reason, many feel that the IM measurement is a much more sensitive indication of amplifier overload. Second, the two distortion curves cross each other so that the value of the IM becomes higher than the value of the THD.

If the harmonic distortion measurements are made at the mid-frequencies (400 or 1000 cps), our amplifier is seen to produce much less THD. Under these conditions, it is not uncommon for the value of THD to be less than the value of IM at all power levels. In the case of our hypothetical amplifier, an output power of 13 watts is produced at a THD of 2 per-cent. At this power level, the IM is close to 8 per-cent, or almost 4 times as great.

It is quite possible to have a totally different relation between IM and THD than is shown in Fig. 3. The design of the amplifier being checked, and particularly how it overloads, may change this picture markedly.

IM Analyzers

Although IM distortion can be measured with separate audio generators, filter circuits, oscilloscope or meter indicators, common practice is to combine many or even all the functions needed into a single instrument. This instrument may be called an IM analyzer. A block diagram of all the functions performed by such an instrument is shown in Fig. 2.

(*Continued on page* 142)

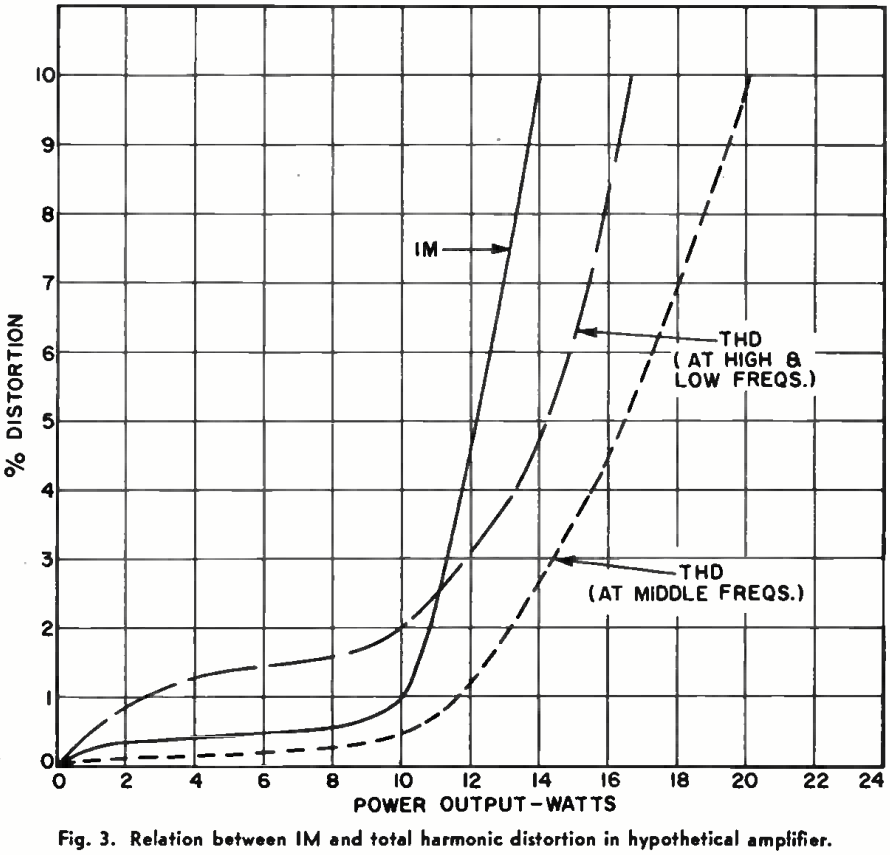
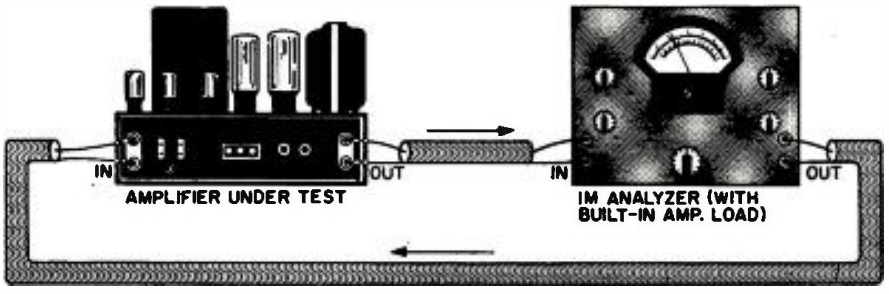
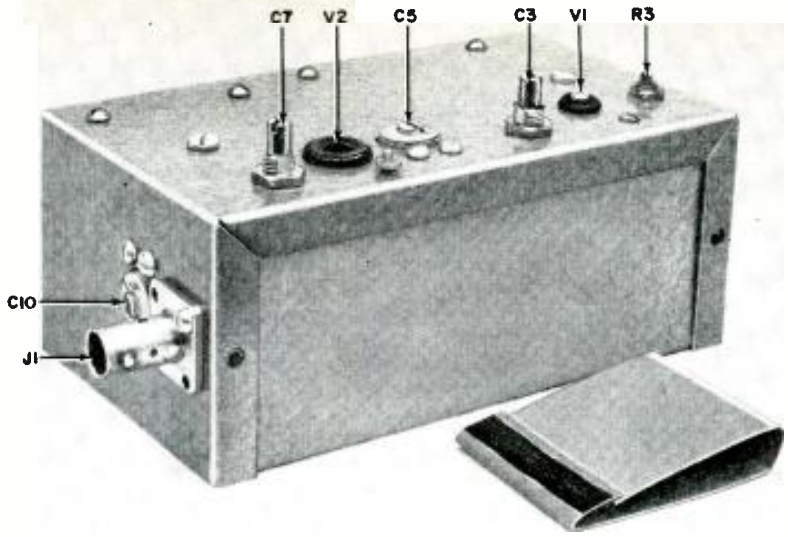


Fig. 3. Relation between IM and total harmonic distortion in hypothetical amplifier.

Fig. 4. Test setup employed for checking IM distortion of a high-fidelity amplifier.



[1] This method is the one specified by the Society of Motion Picture & Television Engineers.
[2] "Radiotron Designer's Handbook" Fourth Edition—edited by Langford-Smith.



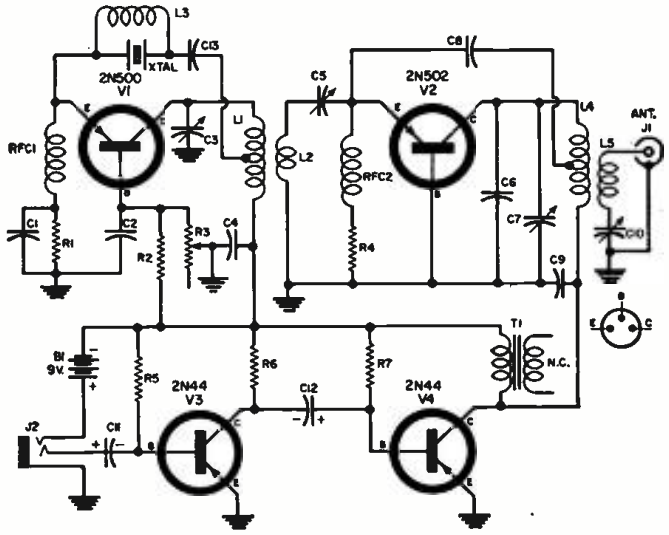
A 9-volt battery runs this 144-mc. transistorized v.h.f. amateur transmitter.

Two-Meter Transistor Transmitter

By **DONALD L. STONER, W6TNS**

Two micro-alloy-diffused type v.h.f. transistors are used in this 20-mw. battery-operated ham transmitter.

Fig. 1. MADT transistors are used in the r.f. portion of this transistorized rig.



R_1—220 ohm, ½ w. res.
R_2—22,000 ohm, ½ w. res.
R_3—5000 ohm miniature pot (see text)
R_4—100 ohm, ½ w. res.
R_5—1 megohm, ½ w. res.
R_6—4700 ohm, ½ w. res.
R_7—270,000 ohm, ½ w. res.
C_1, C_2, C_4, C_9—.001 µf. button capacitor
C_3—1.8-8.7 µµf. variable capacitor (E. F. Johnson 9M11 or equiv.)
C_5—3.5-12 µµf. trimmer (Centralab 827B)
C_6—4.7 µµf. disc ceramic capacitor
C_7—1.5-5 µµf. variable capacitor (E. F. Johnson 5M11 or equiv.)
C_8—3.3 µµf. disc ceramic capacitor
C_{10}—7-35 µµf. rotary trimmer (Centralab 827D)
C_{11}, C_{12}—20 µf., 10 v. miniature elec. capacitor
C_{13}—.001 µf. disc ceramic capacitor
RFC_1, RFC_2—40 t. #36 en. wound on 1 megohm, ½ w. res. (see text)
J_1—BNC style antenna connector (Amphenol)
J_2—Three-circuit mike jack
T_1—Plate-to-speaker trans. (Triad TY-44X or equiv.)
Xtal.—72.05 mc. fifth overtone crystal (International FA-9)
L_1—7¾ t. #20 silver-plated wire, ¾" dia., spaced dia. of wire, 16 turns-per-inch (Air Dux 616, see text)
L_2—4½ t. #20 silver-plated wire, ¾" dia., spaced dia. of wire, 16 turns-per-inch (Air Dux 616, see text)
L_3—20 t. #32 en. wound on 1 megohm, ½ w. res. (see text)
L_4—4½ t. #16 silver-plated wire, ½" i.d. spaced dia. of wire
L_5—3 t. #16 silver-plated wire, ½" i.d. spaced dia. of wire
V_1—"p-n-p" transistor (Philco 2N500—oscillator)
V_2—"p-n-p" transistor (Philco 2N502—buffer/doubler)
V_3, V_4—"p-n-p" transistor (2N44 or 2N217—speech amplifier and modulator)
B_1—9-volt mercury cell (RCA VS312)
1—Aluminum chassis, 2⅛" x 5¼" x 3" (LMB TF-780)

IT WAS just about three years ago that I built my first transistor oscillator circuit. It was a so-called "wireless microphone" that operated at the high end of the broadcast band. I remember thinking at the time that it delivered a tremendous amount of power (probably less than one milliwatt) and at such a high frequency too!

Times have certainly changed. Since then manufacturers have developed "drift," MADT, and MESA high-frequency transistors. It is not at all uncommon to read about a transistor that will deliver a very respectable amount of power at 750 mc. The wide acceptance of these new types is slowly but surely driving the price down to the experimenter's level. Increased production will soon bring the cost down within the reach of everyone.

The *Philco* 2N500 and 2N502 MADT (micro-alloy-diffused type) high-frequency transistors were selected for this two-meter transmitter as a reasonable compromise between performance and price. The 2N500 will set you back about $10.90 while the 2N502 (oscillates to 750 mc.) sells for $12.40. You can obtain much more power output by using the new MESA transistors but their price tags run into the $30-$40 class. A pair of *Philco* 2N588's (also MADT type) can be substituted and they cost only $6.00 each. However, the power output will be somewhat lower with this type.

The Circuit

The schematic for the two-meter transistor transmitter is shown in Fig. 1. The 2N500 and 2N502 are both employed in a common-base circuit which appears to produce more power output near *alpha* cut-off. The 2N500 is used as a fifth overtone crystal oscillator with the feedback path between the collector tuned circuit and the emitter. The emitter choke, RFC_1, provides a low impedance path for the emitter current but effectively blocks the r.f.

Resistor R_1 prevents the stage from going into thermal runaway. The stage is biased by connecting the base to the junction of a voltage divider across the battery. Capacitor C_{12} blocks the d.c. while inductance L_3 neutralizes the crystal and holder capacity (more about this later). Tank circuit L_1 is tuned to the fifth overtone frequency of the crystal, in this case 72.05 mc., with C_3.

Output from the oscillator drives the buffer/doubler through L_2 and C_5. In effect, this is a series-tuned circuit with a low impedance between emitter and ground. This stage is self-biased with r.f. drive. Whenever a positive half cycle arrives at the emitter, the stage conducts. During the negative half cycle period, it "rests," producing true class C operation. Any attempt to apply bias to the 2N502 will reduce the power output! Resistor R_4 provides emitter stabilization and the r.f. choke, RFC_2, functions the same as in the oscillator section. Although this stage is driven with 72-mc. energy, the collector circuit is tuned to the second harmonic, or 144 mc., with C_7 and L_4. A small 3.3-$\mu\mu$f. disc capacitor is connected between L_4 and the emitter to provide a small amount of regeneration, which enhances the doubling action. The size of this capacitor can be adjusted empirically for maximum power output. The output coil, L_5, couples r.f. to the antenna and capacitor C_{10} is used to tune out the link reactance.

The modulator system is ultra-simple and by no means optimum. It served the purpose for contacts and demonstrations but does suffer from the "leave well enough alone" philosophy. There is excessive gain and talking any closer than one foot from the mike produces overmodulation. In addition, core saturation and voltage loss occur in T_1. Quite possibly a push-pull collector-to-speaker transformer would produce better modulation (naturally the speaker winding would not be used). Either 2N44's or 2N217's can be used equally well in this circuit. No matter which transistors are used, R_6

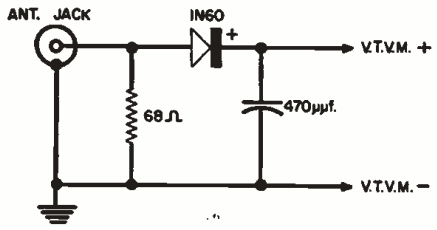


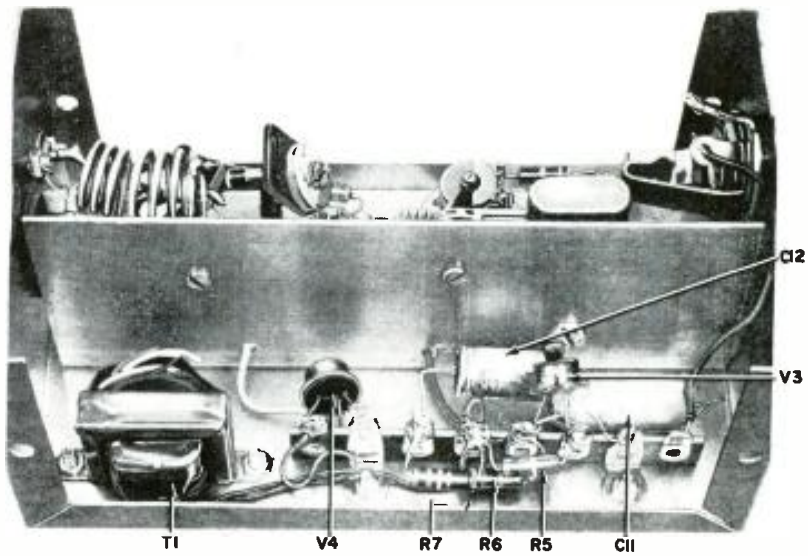
Fig. 2. Detector load may be 50-75 ohms.

should be adjusted for 1 ma. collector current in V_3 and R_7 should be set so that V_4 draws about 2 ma.

Construction

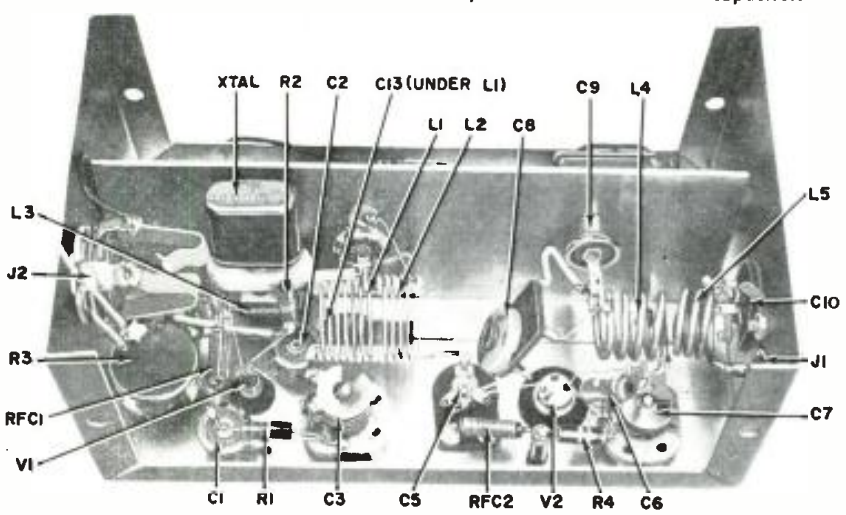
The first step in the construction of the unit consists of winding the r.f. chokes and coils. Both RFC_1 and RFC_2 were wound on tiny powdered iron forms that look like ¼-watt resistors. Half-watt resistors, used as forms, have been substituted with no change in performance or drive. The only requirement is that these chokes be self-resonant at 72 mc. with the leads extended. The exact number of turns is relatively unimportant, but keep the winding neat and avoid scramble winding.

Coil L_3 is very important! If it is not resonant at the correct frequency, you will never tame the oscillator. When made as described, the oscillator will be "rock solid," as the saying goes. Wind L_3 as instructed in the parts list. Clip the leads to ⅜", solder to the crystal holder, and insert the crystal. Couple a grid-dipper to L_3 and measure the resonant frequency. It should be about 5% *higher* in frequency or somewhere between 75 and 77 mc. The meter may show a bit of "gyration" at 72 mc., but there should be a solid dip at the higher frequency. The idea of this coil is to neutralize the crystal and holder capacity. If the coil were not in the circuit, the crystal would look like a small capacitor and the 2N500 would oscillate at whatever frequency L_1 and C_3 were tuned to. When properly tuned, the path looks like a high impedance, except at the 5th overtone crystal frequency. Coils L_1, L_2, L_4, and L_5 are wound with silver plated wire. Whether this increases the circuit efficiency or not is problematical. The books all say that it *should!* The silver-plated "Air Dux" is a standard item, or you can have regular tinned wire plated at the local silversmith.



Audio portion of the 2-meter transmitter. The transistors are supported by means of their leads; no sockets are employed. Either 2N44 or 2N217 types can be used.

The r.f. portion of the transmitter. The rig was properly tuned up with the variable capacitors in the positions shown. C_8 was replaced later with a fixed capacitor.



The layout does not seem to be critical and the circuits are very stable with the straight-line construction used. A small potentiometer should be used as there is some crowding at this end of the chassis. If you like, you can substitute a 4700-ohm, ½-watt resistor for the pot as most 2N500's work best with the pot wide open, anyway. I find it handy, however, for impressing people with how low into the microwatt region they can still receive my signal. The mike jack really belongs on the other side of the divider. I must confess I placed it there to fill up a hole! The

(*Continued on page 82*)

By JOHN POTTER SHIELDS

Basic information and construction details on "debugged" circuits used to detect presence of people or objects.

The Capacitance Relay

THE capacitance relay was developed a number of years ago and, since that time, has received a moderate amount of attention from both experimenters and industry. Innumerable circuits have been developed—many of which have been very successful. Unfortunately, many experimenters who have tried either to develop their own versions or build up commercial circuits have obtained unsatisfactory results. It is the purpose of this article to describe the various "bugs" that may be encountered in the design and construction of capacitance relays and outline several novel, but thoroughly "de-bugged," circuits with which the writer has had success.

Applications

Capacitance relays are quite versatile and, unlike "electric eyes," require no light beam source. They are not directional as are most photoelectric setups and since no light beam is needed, the presence of a capacitance relay alarm can remain undetected by an intruder. For example, suppose you want to signal the entry of a person through a doorway. All that is needed here is a length of wire strung around the door frame. Very fine wire can be used and the control unit placed out of sight, making the installation virtually undetectable.

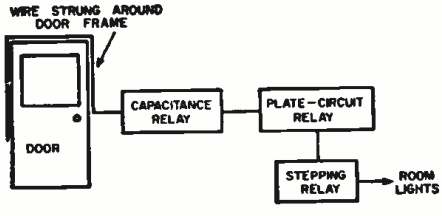
An installation of this type can also be used to count the number of people or objects passing through a given area, such as an interior doorway or entrance to a building. An installation made by the author is shown in Fig. 1. The wire was strung around the door frame to act as a sensing element. The plate-circuit relay was used to actuate a stepping relay. When a person entered the room, the capacitance relay was tripped, closing the plate relay. This sent a current impulse to the stepping relay, causing it to advance and turn on the room lights. When the person left the room, the capacitance control was again tripped, the relay advanced another step, and the room lights were switched off.

Capacitance relays may also be used to count objects on conveyor belts, in chutes, etc. They are especially useful in places where fumes or dust-ladened atmosphere would quickly cloud the optical system of a conventional photoelectric setup.

Perhaps the most popular use of capacitance relays has been in store window displays. You may have seen setups where a model train or other animated device was set in motion when a bystander placed his hand near a metal plate or wire on the window. Another possible use for capacitance relays is in the industrial field. As an example, the relay could be used to protect the operator of a punch press, drill press, etc. In operation, a wire "sensing probe" could be arranged so that when the operator's hands were in a dangerous area around the machine, it would be automatically shut off.

Now that we have explored some of the applications for capacitance relays, let's take a look at their design and construction. Possibly one of the biggest headaches for the builder of a capacitance relay is that of stability.

Fig. 1. Installation made by the author.

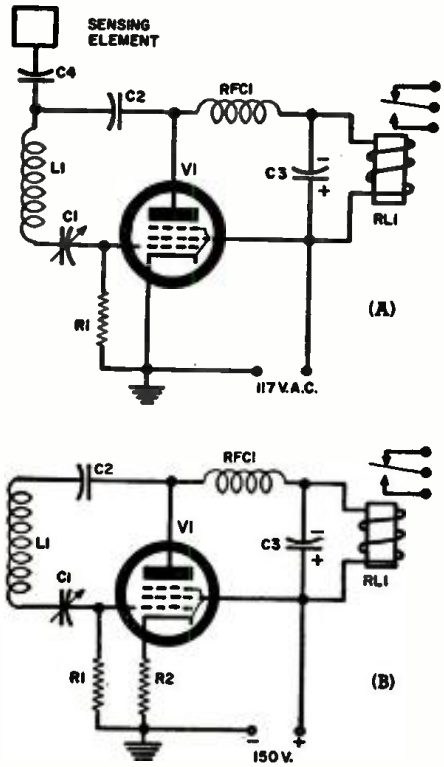


Many a constructor will find that after he has finished and adjusted his relay it will not retain its initial setting. There are several ways of handling this problem and these will be covered later. Now let us consider the basic circuit.

Basic Circuit

Fig. 2A is a schematic of one of the commercial capacitance relays. There is at least one manufacturer who has developed a special coil for this circuit. Circuit operation is quite simple. The trimmer, C_1, is adjusted so that enough feedback voltage is available to permit the circuit to oscillate feebly. In this condition a negative grid voltage will be developed by the tube which will hold the plate current at a low level. When an object approaches the "sensing element" the circuit will be "loaded down" causing it to cease oscillating. When this occurs, the plate current will rise due to the lack of negative grid voltage and the plate circuit relay will close. So far, so good—but—perhaps you have tried to use this circuit with a d.c. plate-voltage supply and found the results unsatisfactory. The reason for this is that with a d.c. plate supply, once the oscillator stops oscillating due to the loading provided by an object approaching the sensing element, it stays stopped. If you will notice, the original circuit probably called for an a.c. plate voltage supply. The reason for this is that with an a.c. plate supply the oscillator will be conducting — hence oscillating — once on every positive half cycle. When the oscillator is loaded to the point where it ceases to oscillate, it will be shocked back into an oscillating condition when the loading is removed by the next positive half cycle of plate voltage.

A d.c. plate supply can be used for



R1—100,000 ohm, ½ w. res.
R2—1000 ohm, ½ w. res. (Fig. 2B)
C1—160-500 μμf. mica padder
C2—500 μμf. mica capacitor
C3—10 μf., 50 v. elec. capacitor
C4—.001 μf., 600 v. mica capacitor
L1—10 mhy. air-core r.f. choke
RFC1—2.5 mhy. r.f. choke
RL1—S.p.d.t. relay, 5000-ohm coil (Potter & Brumfield LM5 or equiv.)
V1—6AQ5, 6V6, 50L6, etc. tube

Fig. 2. (A) Circuit of commercial capacitance relay. (B) Circuit with d.c. supply. Sensor, blocking capacitor are not shown.

the capacitance relay, as indicated in Fig. 2B. A resistor is connected between the cathode of V_1 and "B—". With this resistor in place the d.c. plate current flowing through V_1 will cause a voltage drop across the resistor, making the cathode more positive than the grid. This makes the grid effectively negative with respect to the cathode. Now, when the oscillator is loaded by an object approaching the sensing element, the circuit will not cease to oscillate entirely due to the fact that the grid of V_1 is being held slightly negative with respect to its cathode and can therefore "bounce back" to its original oscillating condition after the loading has been removed. This cathode resistor also tends to stabilize the oscillator with respect to temperature and line voltage variations.

Fig. 3 is a practical circuit incorporating the foregoing features. It is a highly sensitive and stable device employing two tubes—a 6J5 oscillator and a 2050 thyratron relay tube. If desired, the tubes' miniature counterparts, a 6C4 and 2D21, can be used. As will be noted, the oscillator stage in this relay is essentially the same as the one shown in Fig. 2B. The 2050 was used to increase the sensitivity of the circuit. In the circuit of Fig. 2B, the relay is inserted directly into the oscillator plate circuit while in the modified circuit of Fig. 3 the relay is in the plate circuit of the 2050 thyratron.

The 2050 is a very interesting tube. Like all thyratrons, it possesses certain properties not shared by the more popular vacuum tube. A thyratron's plate current will remain completely cut off until its control grid is made more positive than the cathode. When this occurs, the gas in the thyratron will suddenly ionize, causing a rather heavy flow of plate current. Once the thyratron has been ionized, the control grid loses all control over the flow of plate current. It is similar to the operation of a s.p.s.t. switch, *i.e.*, "go or no-go." The advantage of this feature is that a very slight voltage differential on the control grid will cause the tube to change from a non-conducting to a conducting state. The 2050 is connected to the grid of the oscillator stage through an isolating resistor and its cathode is connected to the movable arm of a pot which is connected between "B+" and ground. This is the "sensitivity" control.

The adjustment of the "sensitivity" control potentiometer is quite critical and must be done carefully if the capacitance relay is to operate satisfactorily.

The proper adjustment procedure is to set the potentiometer to such a point that the thyratron *just* does not fire with no object near the sensing plate.

Now, when the oscillator is loaded down by the approach of a body to the sensing element, the oscillator grid voltage will drop, causing a corresponding drop in the negative grid voltage on the 2050. This will make the grid less negative with respect to the cathode of the 2050, causing it to fire and closing the plate circuit relay. If great sensitivity is not required, the pot can be adjusted so that the 2050 cathode is somewhat more positive than the negative grid voltage from the oscillator. The sensitivity of this circuit is excellent. For example, with a six-foot length of hookup wire strung around a door frame, a person of average height, standing four feet from the doorway, will trip the relay.

Recently the author was asked to develop a lightweight, portable, and extremely stable capacitance relay. The resulting circuit is shown in Fig. 4 and is somewhat similar to the one shown in Fig. 2B but powered by a six-volt, vibrator-type power supply. If desired, a combination-type power transformer can be used to provide operation on both 6 and 117 volts. Several such transformers are available commercially from most parts jobbers.

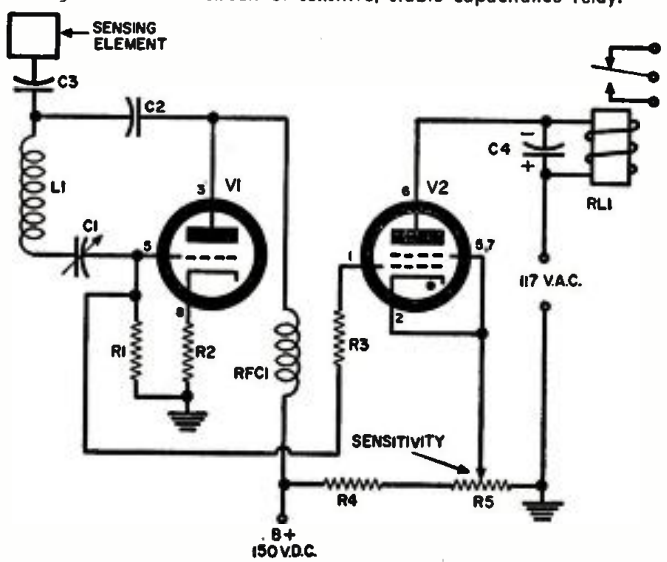
The sensing element for the portable capacitance relay consists of one of the metal panels from the *Bud* cabinet which was used to house the device. The metal panel is insulated from the case itself by two ceramic stand-off insulators. The unit is powered by four 6-volt batteries that have been connected in parallel.

This portable capacitance relay was designed for use in a steel mill. The crane operator placed the unit some distance down the crane runway with the contacts of the plate-circuit relay connected so that as the crane trolley approached, the operator could be alerted by means of a warning bell. Other possible uses for this portable capacitance relay include intrusion alarms, portable counter applications, annunciators, etc.

Another Circuit

Another rather unusual capacitance relay is shown in Fig. 5. Here it was desired to have the sensing element

Fig. 3. Practical circuit of sensitive, stable capacitance relay.



R1—33,000 ohm, ½ w. carbon res.
R2—1800 ohm, ½ w. carbon res.
R3—4700 ohm, ½ w. carbon res.
R4—68,000 ohm, 1 w. carbon res.
R5—20,000 ohm, 1 w. linear-taper pot "Sensitivity")
C1—160-500 μμf. mica padder
C2—500 μμf. mica capacitor
C3—.001 μfd., 600 v. capacitor
C4—10 μf., 50 v. elec. capacitor
L1—10 mhy. air-core r.f. choke
RFC1—2.5 mhy. r.f. choke
RL1—S.p.d.t. relay, 5000-ohm coil (Potter & Brumfield LM5 or equiv.)
V1—6J5 or 6C4 tube (see text)
V2—2050 or 2D21 thyratron (see text)

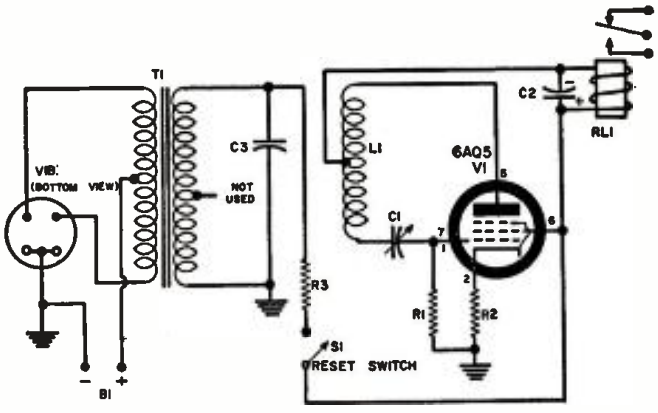


Fig. 4. Complete schematic diagram and parts listing for the lightweight, portable capacitance relay unit with vibrator supply described by author. The metal panel sensing element was connected through a blocking capacitor to the high side of coil L_1.

R_1—10 megohm, ½ w. carbon res.
R_2—47 ohm, 2 w. carbon res.
R_3—15,000 ohm, 10 w. wirewound res.
C_1—160-500 μμf. mica padder
C_2—10 μf., 50 v. elec. capacitor
C_3—.008 μf., 1600 v. paper capacitor
Vib.—6-volt vibrator
T_1—6-volt vibrator transformer
L_1—456 kc. oscillator coil (Meissner 14-4034 or equiv.)
S_1—S.p.s.t. toggle switch ("Reset")
RL_1—S.p.d.t. relay, 5000-ohm coil (Potter & Brumfield LM5 or equiv.)
B_1—Four 6-volt "A" batteries (wired in parallel)
V_1—6AQ5 tube

some distance from the actual device. In order to avoid stray pickup from the lead, a shielded connecting cable had to be used. This ruled out the basic circuit shown in Fig. 2B as the shunt capacitance of the connecting cable would contribute too much additional capacitance. The circuit of Fig. 5 overcomes this problem as follows: Two oscillators, operating at a rather low frequency, approximately 100 kc., are used and their outputs fed into a mixer stage. The output from the mixer stage is fed into a low-pass filter, the output of which is applied to the grid of the 2050 or 2D21 thyratron. One oscillator is fixed-tuned and the other is made variable by means of the trimmer, C_2. The sensing element and its shielded cable are connected across the tuned circuit of the variable frequency oscillator. The shunt capacitance of the shielded cable, together with the distributed capacitance of the oscillator coil and associated wiring, determine the variable frequency oscillator's operating frequency. The length of the shielded cable will naturally be the major single frequency determining element. In operation, the variable frequency oscillator is so adjusted that with no object near the sensing element, it will be 1000 cps above the frequency of the fixed frequency oscillator.

There are *two* possible adjustments here. One is where the variable frequency oscillator is set 1000 cps *below* the frequency of the fixed frequency oscillator and the other is where the frequency is set 1000 cps above. The latter setting is the correct one. Thus, when an object approaches the sensing element, the capacitance of the tuned circuit of the variable frequency oscillator will increase, lowering its frequency, causing the output or "beat frequency" obtained from the mixer stage to decrease in frequency. Since a low-pass filter stage is connected between the mixer and thyratron relay stages, the voltage applied to the thyratron grid will increase with a corresponding decrease in the output frequency from the mixer. When this voltage becomes great enough, the thyratron will fire, closing the plate-circuit relay. The same thyratron biasing scheme is used in this circuit as was used in that of Fig. 3. As will be noted, the resultant beat frequency is applied directly to the thyratron grid without benefit of rectification. No improvement was noted when the signal was rectified before being applied to the thyratron grid.

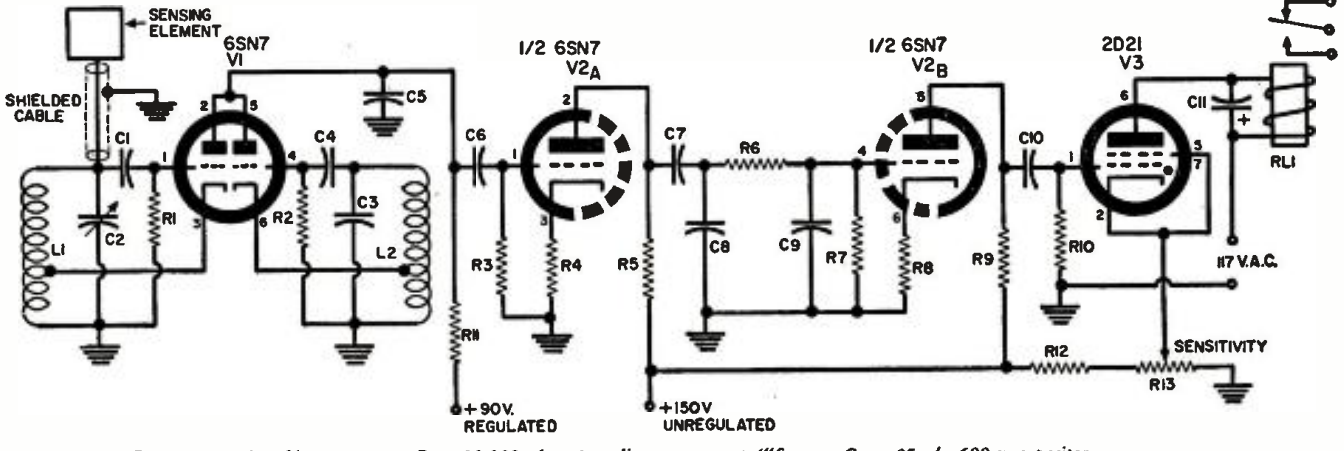
Construction

Now for a look at some of the "bugs" that can crop up in the construction of capacitance relays. For example, let's consider the construction of the relay just described. In a device of this type, proper mechanical construction is extremely important. Mechanical rigidity is of utmost importance. The chassis should be of fairly heavy gauge material and, if a panel is used, it should be firmly attached to the chassis. All components should be securely fastened to the chassis and/or panel, paying particular attention to those components in the tuned circuits.

Voltage regulation is recommended and, along these lines, the author has found that a small NE-2 neon lamp makes an excellent and inexpensive voltage regulator tube. When constructing several units using the circuit of Fig. 5, the author employed a 100 kc. crystal oscillator as the fixed-frequency oscillator.

There are many other circuits, of course, that could be used in assembling a capacitance relay but space precludes describing all of them. The ones covered in this article are those that the author has actually constructed, tested, and "de-bugged." They really work, so don't hesitate to try any, or all of the circuits, should you have need for a capacitance relay. —30—

Fig. 5. An unusual capacitance relay circuit built by author in which sensing element was some distance from actual device.



R_1, R_2—47,000 ohm, ½ w. res.
R_3, R_7—470,000 ohm, ½ w. res.
R_4—2200 ohm, ½ w. res.
R_5, R_6—100,000 ohm, ½ w. res.
R_8—150,000 ohm, ½ w. res.
R_9—4700 ohm, ½ w. res.
R_{10}—68,000 ohm, ½ w. res.
R_{11}—82,000 ohm, ½ w. res.
R_{12}—68,000 ohm, 1 w. res.
R_{13}—20,000 ohm, 1 w. linear-taper pot ("Sensitivity")
C_1, C_4—500 μμf. mica capacitor
C_2—160-500 μμf. mica padder
C_3—300 μμf. mica capacitor
C_6—.001 μf., 600 v. capacitor
C_8—.01 μf., 600 v. capacitor
C_7, C_8, C_9—.02 μf., 600 v. capacitor
C_{10}—.05 μf., 600 v. capacitor
C_{11}—10 μf., 50 v. elec. capacitor
L_1, L_2—456 kc. oscillator coil (Meissner 14-4034 or equiv.)
RL_1—S.p.d.t. relay, 5000-ohm coil (Potter & Brumfield LM5 or equiv.)
Cable—RG/62U shielded coax.
V_1, V_2—12AU7 or 6SN7 tube
V_3—2050 or 2D21 thyratron

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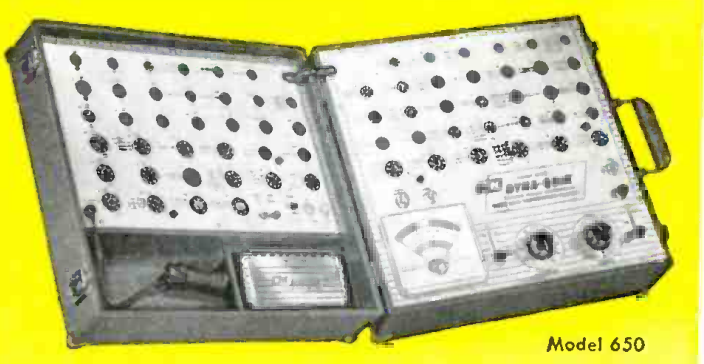

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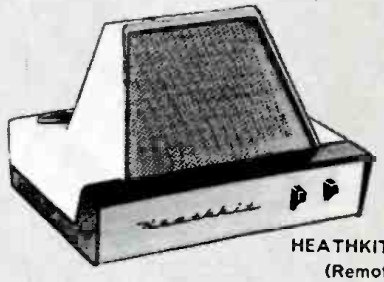

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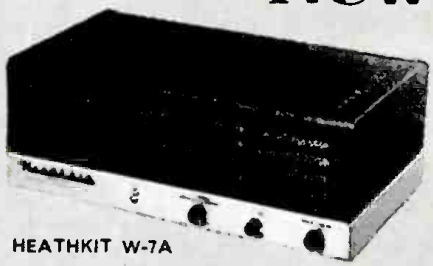

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NOTE THESE OUTSTANDING SPECIFICATIONS—Power output: 14 watts, Hi-Fi; 12 watts, Professional; 16 watts, Utility. **Power response:** ±1 db from 20 cps to 20 kc at 14 watts output. **Total harmonic distortion:** less than 2%, 30 cps to 15 kc at 14 watts 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.

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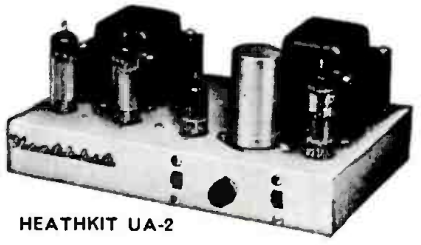
"UNIVERSAL" 14-WATT HI-FI AMPLIFIER KIT (UA-2)

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 13¾" 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.

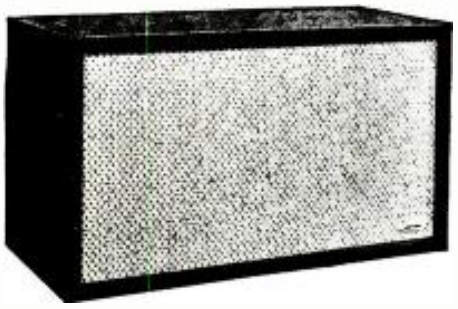
TR-1AH SPECIFICATIONS—Frequency response: 7.5 IPS ±3 db 40 to 15,000 cps; 3.75 IPS ± db 40 to 10,000 cps. **Signal-to-noise ratio:** 45 db below full output of 1 volt/channel. **Harmonic distortion:** less than 2% at full output. **Bias erase frequency:** 60 kc (push-pull oscillator).

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 11⅜" 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:** 200 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:** 7⅜" H. x 4¾" W. x 4⅜" D.

HEATHKIT RF-1

$27.95

PREASSEMBLED AND ALIGNED BANDSWITCH/COIL ASSEMBLY

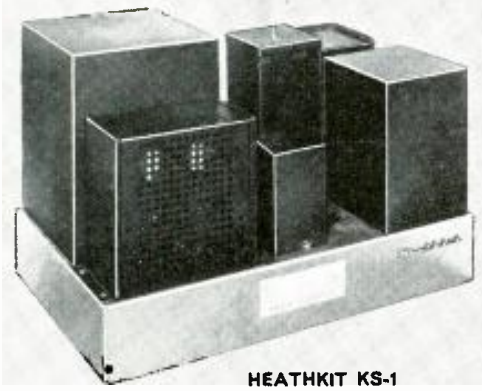
RF SIGNAL GENERATOR KIT (RF-1)

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:** 17¼" 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 11⅝" 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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a subsidiary of Daystrom, Inc.

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(PLEASE PRINT)

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- ☐ Freight
- ☐ Best Way

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

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

Transistor Transmitter

(*Continued from page* 69)

crystal holder and capacitors C_4 and C_9 are also mounted on the partition. All adjustments, except C_{1n}, come out the top of the chassis. A stand-off tie-point is used at the junction of RFC_2 and R_4, along the side of V_2. A BNC-style antenna connector was used, but you can use a type that suits your antenna installation. The r.f. transistors are held securely in place by inserting them in grommets. This eliminates lossy sockets and still holds the transistors firmly. Use extreme care when soldering to the transistor leads—grasp the lead you are soldering with a pair of needle-nose pliers to conduct heat away from the transistor.

Over on the audio side of the chassis you will find that the transistors are mounted by their wire leads. In fact, all the audio components are mounted on an eight-lug terminal strip. The modulation transformer, T_1, is at the end of the strip opposite transistor V_3.

The entire unit is powered by a 9-volt mercury battery mounted in the other half of the chassis box. It is secured with a small aluminum clip and when the box is assembled the battery lies just above (or below, depending on your point of view) the audio transistors.

Alignment

You may have noticed that this two-meter transistor transmitter has no metering jacks. The emitter and bias resistors in the oscillator circuit were chosen so as not to exceed any of the transistor ratings, whether the circuit is oscillating or not. The 2N502 cannot be damaged because the oscillator simply will not deliver enough power to run the buffer/doubler out of ratings. During the initial tests, or if you run the transistors at a higher collector voltage (you can go as high as 15 volts), a meter in each emitter lead is recommended. It should be pointed out that the efficiency of the transmitter will increase considerably at higher collector voltages but, I am a coward and don't like to play with high voltage!

Let's fire up the oscillator first. Disconnect the lead between L_2 and C_5 to disable the buffer/doubler. Apply power to the oscillator only. It should draw between 2 and 3 ma., depending on the setting of C_3. When the circuit is oscillating you should be able to detect a weak second harmonic on a two-meter receiver. When you touch L_1 (to kill the oscillation), the collector current should drop noticeably. Coil L_1 should resonate with C_3 meshed from ⅛ to ⅓.

Reconnect C_5 and apply power to the 2N502. Adjust C_2 and C_5 for maximum collector current (about 2 ma.). Build the r.f. detector probe shown in Fig. 2 and connect it to the input of a v.t.v.m. The crystal will rectify the r.f. signal across the 50- to 75-ohm load resis-

tor and provide a relative indication of power output. All the transmitter adjustments should be made for maximum indicated voltage on the v.t.v.m. If everything is working properly, the meter will read between 0.3 and 0.5 volt d.c. This corresponds *roughly* to about 5 mw. power output and indicates an efficiency of 25%—not bad for a doubler operating at that collector voltage. It is very difficult to measure the exact power output because some power is "lost" in the crystal.

Performance

When transmitting with an antenna connected, you should have some provision for detecting the amount of power radiated by the antenna. As with the dummy load, tune all adjustments for maximum power output.

You will find that you can do some rather amazing things with this "little bomb." When connected to a twin four-beam antenna, it was possible to contact stations in Corona, California about 27 miles away. The signals were very readable and the enthusiastic ham gave me a report of 5-9 plus, plus,—what ever that is! It certainly indicates that the rig can cover a great distance, under the right conditions.

On c.w. this transmitter should be capable of some rather startling feats. For this mode, transformer T_1 should be shorted and the emitter of V_2 keyed.

-30-

AUTOMATIC TUNER CLEANING

By KEN RAINS

EVERY so often, it becomes necessary to clean the contacts of most Standard Coil tuners to maintain satisfactory performance. This periodic task can become quite annoying, but it can be avoided with a simple measure.

To keep the tuner contacts clean, simply wrap a small strip of soft cloth around the coil strip (or strips) for any one unused channel, as shown, and replace the strip or strips in their original position. Then saturate the cloth with contact cleaner. Whereas such a cleaner, as normally applied, will dissipate fairly rapidly, the cloth acts as a wick, retaining the cleaner for longer periods.

No special measures need be taken to bring about the cleaning action. Rotation of the tuner drum during normal use will clean away grease and dirt, keeping the contacts continuously clean.

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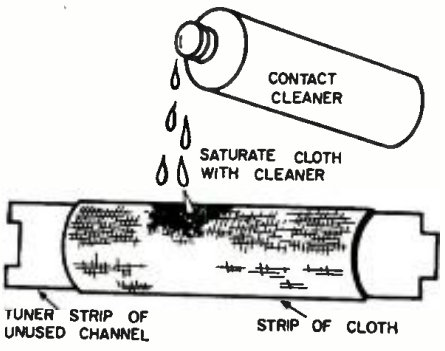
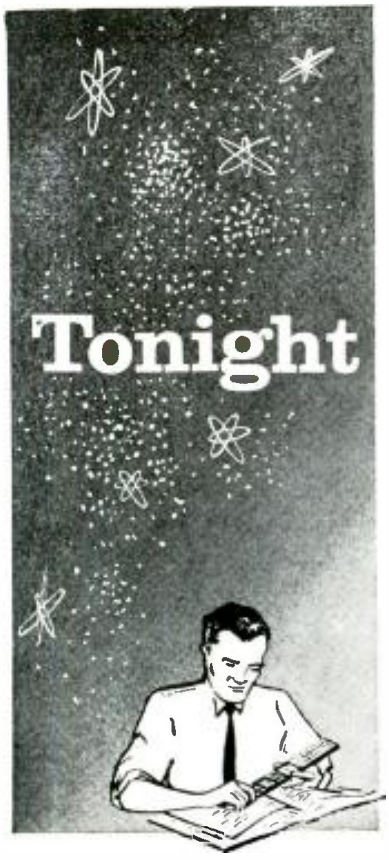
"Self-cleaner" for Standard Coil tuner.





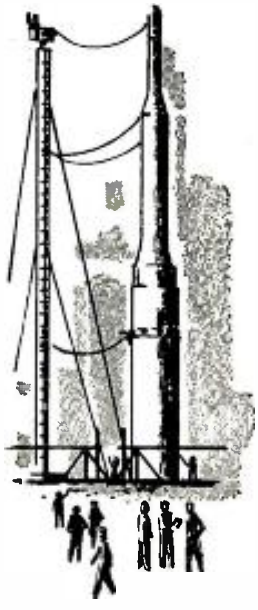
20,400 people can study advanced electronic engineering technology via CREI.

Growth of the electronics industry is not automatic assurance of your own prosperity. You need advanced, modern electronics education to advance yourself. 20,400 CREI students know this—and are taking appropriate action. Can you?

The electronics industry is now fifth in volume among American industries. In 1958 total sales and services exceeded $13 billion, up about tenfold in a decade. Growing electronics applications in automation, instrumentation, industrial electronics, aeronautical electronics, guided missiles, servo-mechanisms, computers, astronautics and telemetering **point to equally rapid future growth.**

But the entire field of modern electronics is changing. **Industry** growth does not always mean individual growth. Companies actively seeking men with modern technological knowledge are simultaneously firing mediocre men.

CREI students (more than 20,400 are currently enrolled) keep pace with the electronics industry and are eagerly sought by employers who offer solid opportunities for rapid advancement.



Paul S. Lewis, Jr., a research assistant in an AEC-sponsored nuclear physics research program — and a CREI student — writes, "Like most large-scale physics projects, this machine (a proton accelerator) is largely electronic. The need for electronics technicians on basic scientific research projects will no doubt continue to grow."

Charles E. Lawson, another CREI student, brings out another point: "The fact that I am enrolled with CREI caused enthusiasm on the part of my employer (Wright Airborne Electronics). A former student of CREI is now chief engineer for the company."

CREI is now in its 34th year. 1958 marked the start of CREI Atomics, a division of CREI devised to meet the need for advanced home study education in nuclear engineering technology. 1958 also marked the opening of our European Division, bringing advanced professional electronic education to Western Europe.

Since 1927 we have directed technical education of thousands —as individuals and in groups— in electronics engineering technology. We developed the first civilian pilot course for radio mechanics for the Army Signal Corps in 1941, supplied 300,000 texts to the U. S. Navy in a special course for radio technicians in the South Pacific in 1943, trained hundreds of technicians during World War II for the Signal Corps. We co-founded the National Council of Technical Schools, which first established scholastic and business standards for the technical school field. We were among the first three technical institutes whose curricula were accredited by the Engineers' Council for Professional Development. In 1946 we instituted the group training programs used by companies representing the cream of the electronics and aviation industries.

What does this record of achievement mean to you as a CREI student? It means that industry and the Armed Services alike respect CREI men. It means that your CREI diploma is a door-opener. Significantly, Help Wanted ads often specify "CREI education or equivalent required." Our Placement Bureau, which helps graduates and advanced students find more desirable positions, is always available to CREI men. While no placement guarantees will be made by CREI or any other reputable institution, for many years the demand for CREI graduates and advanced students has far exceeded the supply.

CREI HOME STUDY ADVANTAGES.

Technical education is accomplished on your own time, during hours chosen by you. You waste no time in travel. You have plenty of time to do your best. Your work is under the supervision of a regular staff instructor who guides your progress step by step. Courses are prepared by experts, presented in easy-to-understand form, kept up to date by periodic revision. Experience in more than three decades of home-study teaching, during which time we have corrected and commented on many hundreds of thousands of examinations, enables us to anticipate questions in our lesson material and minimize troublesome points.

CREI STUDENTS are professional electronics engineers and technicians, all over the world and in every phase of electronics, about one-third military, the rest civilian. Their median age is 28. In 1958 they devoted approximately 1,572,456 hours to 104,831 lesson texts, answered (and were individually graded upon) 1,048,310 searching questions and engineering problems. They studied electronics engineering technology—transistors, microwaves, forward scatter, computers, servomechanisms, radar, electronic navigational devices, and the entire field of modern electronics. New students enrolled during the year are on the missile ranges of Vandenburg AF Base and Cape Canaveral. They are at Alamagordo and China Lake, at SAC bases around the world. They are in the research laboratories and manufacturing plants where the latest electronic equipment is designed and produced. They maintain electronic equipment for United Air Lines, and Trans-Canada Air Lines. They share in electronics at All America Cables and Radio, Inc., and The Martin Co. They work for USIA (Voice of America) and Columbia Broadcasting System, for Gates Radio and Federal Electric, to name but a few. All of the firms mentioned offer their personnel CREI technical education under company plans. CREI men are found by the hundreds among field engineers of major electronic manufacturers. They're across the world and across the street. They're men you'll compete with—to gain or hold your place in the electronics profession.

QUALIFICATIONS FOR CREI.

College degree is not essential. If you have had basic electronic education, practical experience in electronics, and a high school education, you can probably qualify. A good way to find out: Use the postage-paid card. It will bring you the free 54-page book which has launched thousands on their advanced careers: "Insurance for Your Future in the New World of Electronics." Tuition is reasonable and may be paid monthly. It takes just one $10-a-week raise to repay your investment in CREI education and leave you a substantial bonus the first year. Available to veterans under GI bill.

LATEST CREI COURSE:

Now added to CREI's variety of courses in Electronic Engineering Technology is *Automation and Industrial Electronic Engineering Technology.* Complete course covering all electronic phases of automation. Special emphasis on theory, functioning and applications of servomechanisms and computers. Also noteworthy—lessons on machine control, instrumentation, data processing and telemetry.

Residence School in Washington, D. C. for those who can attend classes. Day and evening classes start at regular intervals. Qualified graduates earn AAS degree in 27 months. Electronics experience not required for admission.

Capitol Radio Engineering Institute

Founded 1927

ECPD-Accredited Technical Institute Curricula

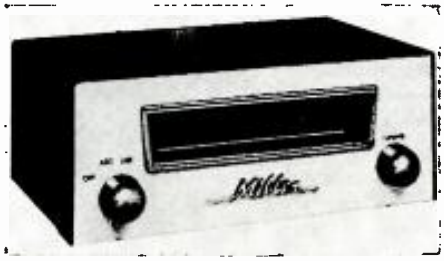
Dept. 1102 G
3224 16th St., N.W. **CC**
Washington 10, D. C.

Hi-Fi-Audio Product Review

FM TUNER

J. W. Miller Company, 5917 S. Main St., Los Angeles 3, Calif. is now offering a moderately priced FM tuner which features a tuned r.f. stage, ultra-stable permeability tuning, and dual limiters.

The oscillator stage of the Model 580 is completely shielded to maintain radiation well below FCC requirements.



The tuner has a.f.c. with defeat control and cathode-follower audio outputs which can be FM multiplexed.

A six-tube unit, it is designed for a tuning range of 86 to 110 mc. Frequency response is 15 to 25,000 cps with distortion less than 0.5% at the 2-volt output.

The unit measures 9" x 4" x 7" and is available in black and white with gold trim or brown and white with gold trim. Literature is available on request.

CHANNEL MASTER TURNTABLE

Channel Master Corp., Ellenville, N. Y. has added a 4-speed professional turntable with transcription tone arm to its line of stereo hi-fi components.

The Model No. 6652 is said to exceed NAB (formerly NARTB) performance standards for wow, flutter, and rumble. The turntable is of heavy cast aluminum with weight concentrated in the rim to provide a smooth flywheel effect. The rotor of the specially designed 4-pole motor is electronically balanced and the motor shielded to prevent hum and keep out dust. A new suspension and mounting system permits the turntable to operate in complete electrical and mechanical silence.

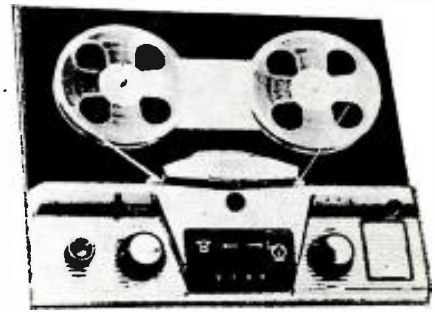
The unit features a built-in, illuminated, easy-to-read stroboscope which gives the listener a continuous speed check during operation. The turntable will handle records at 16⅔, 33⅓, 45, and 78 rpm. There is a vernier fine speed control which permits the user to "tune" his records to the same pitch as musical instruments.

The turntable comes equipped with its own transcription tone arm and features a stereo wired plug-in head to accommodate all popular stereo and mono cartridges. Write the manufacturer for a copy of a data sheet giving full specifications and prices.

ARKAY STEREO TAPE DECK

Arkay International, Inc., 88-06 Van Wyck Expressway, Richmond Hill 18, N. Y. has added the *Arkay/Harting* MS-5 stereo tape deck to its line of audio components.

The heart of the unit is its combination magnetic tape head, for record and playback of optional stereo or monophonic tape. The ultra-short gap employed assures maximum response from extra-long-playing half-track or quarter-track tape. A separate erase head is coupled with an automatic interlock to prevent accidental erasure.



The oversize capstan, ½" in diameter, provides for constant tape speed and virtually eliminates wow, flutter, and distortion, according to the company. Vertical tape control is achieved by means of an all-metal tape guard. Double-shoe brakes provide instantaneous stops with no tape stretch.

Frequency response is 30 to 16,000 cps ±2 db. The deck provides speeds of 7.5 and 3¾ ips. Rewinding speed is 110 seconds for 1200 feet. The unit includes a recording level indicator, precision digital tape counter, push-button operating controls, and features instant drop-in loading.

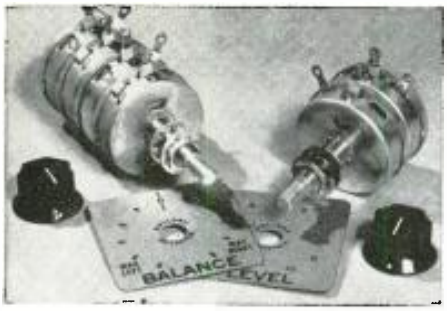
For illustrated literature and complete specifications, contact the company.

MALLORY CONTROLS

P. R. Mallory & Co., Inc., has recently introduced two new series "L" controls which have been especially designed for audio applications.

The "LL" pad provides single-knob adjustment of both channels in a stereo

system for perfect balance. It is of dual tandem design and can be used as a stereo balance or master volume control for low-level, low-impedance audio



circuits. It includes two separate "L" pads mounted in piggy-back arrangement and operated by a common shaft.

The "LA" control was designed as a level control for monophonic equipment and features an extra long bushing to facilitate easier mounting through modern speaker cabinets without need for special extension bushings.

Both controls are so designed that as the gain on volume to the speaker is varied, the impedance between the control and the amplifier will remain constant, eliminating distortion due to impedance mismatch.

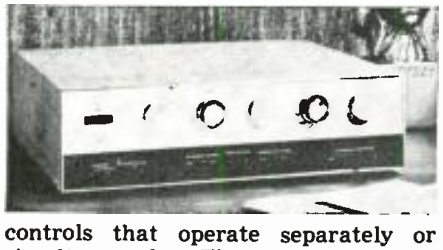
Additional details are available from the firm's distributors or from the Distributor Division of the company at P. O. Box 1558, Indianapolis 6, Ind.

60-WATT STEREO AMP

Allied Radio Corporation, 100 N. Western Ave., Chicago 80, Ill. is now marketing a deluxe 60-watt stereo amplifier as the "Knight" KN-760.

This unit delivers 30 watts per channel on stereo and 60 watts in the mono mode with a peak rating of 152 watts. It features a "stereo separation" control for continuously variable adjustment of channel separation and a loudness-contour switch for compensation at three different listening levels.

The amplifier incorporates precision bridge-T scratch and rumble filters and concentrically clutch-mounted tone



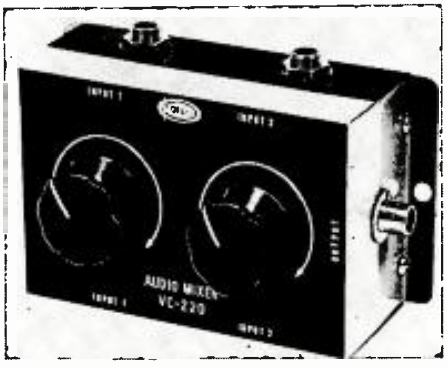
controls that operate separately or simultaneously. The circuit employs the newly developed 6L6GC output tubes which are combined with extra-heavy output transformers for extended response. To permit filling the "hole-in-the-middle" a blended third output is provided for connecting an additional speaker, if desired.

Response is ±.5 db at 60 watts over the range of 25 to 20,000 cps. Harmonic distortion is less than .75% at full rated output while IM distortion is less than 2% at 30 watts per channel. Hum and noise are 74 db below full rated output for tuner and auxiliary inputs.

The amplifier comes completely assembled in a vinyl-clad case which measures 4⅜" x 15¾" x 15⅛". It is catalogued under Stock No. 92 SU 434.

DUAL AUDIO MIXER

Olson Radio Corporation, 260 S. Forge St., Akron, Ohio is now offering a dual audio mixer unit, the Model VS-



220, which is designed to be used with any amplifier, tape recorder, or system to control any two audio sources.

The unit connects to the microphone or phono input and handles input and output impedances of 500,000 ohms. Dual input jacks take either standard ¼" phone plugs or *RCA*-type phono pin plugs. The output terminates in *RCA*-type phono pin jacks.

The unit is housed in a cabinet which measures 4" x 2⅝" x 1⅝".

NEW AUDIO TUBE

The Receiving Tube Department of *General Electric Company,* Owensboro, Ky. has registered a new audio tube, the 7355, which is designed to fill the gap getween the 6V6 and the 6L6 and provide economical hi-fi equipment in the 20- to 30-watt range.

This new midpower tube is an octal-based beam pentode which incorporates the company's new five-ply bonded metal plate. With 18 watts plate dissipation per tube possible, a pair of 7355's is rated to deliver 28.5 watts with 2 percent harmonic distortion without feedback in a class AB_1 push-pull high-fidelity amplifier.

Maximum ratings include: plate, 440 volts; screen, 400 volts; screen dissipation, 2.5 watts continuous and 5 watts on speech and music peaks; and cathode current, 100 ma. The 6.3-volt heater draws 0.8 amp.

AUDIO CONTROL CENTER

Ampex Audio, Inc., 1020 Kifer Road, Sunnyvale, Calif. has recently released a new stereo audio control center as its Model 403.

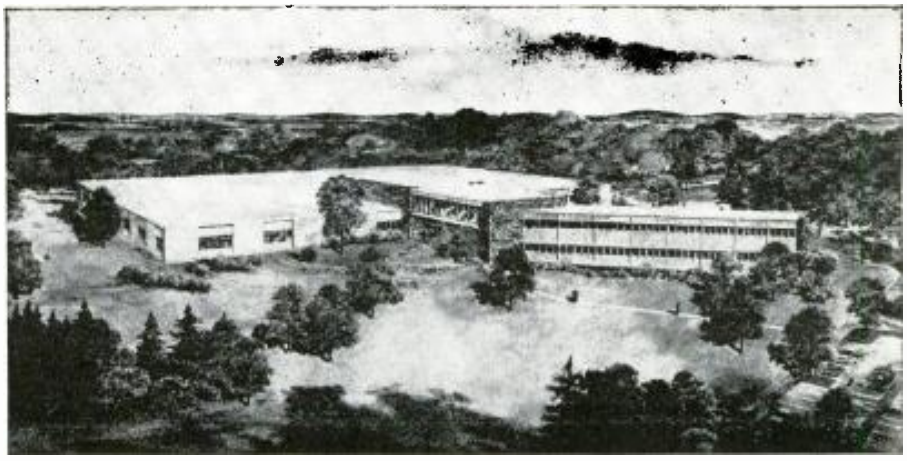
Push-button selection insures proper matching, equalization, and balance for the input signals from tape, records, FM-AM tuner, TV tuner, microphone, or other external sound sources. The unit is designed to be used with any quality audio system.

Separate controls for bass and treble response permit individual adjustment, as desired, with a maximum boost or

cut of approximately 15 db. Two loudness controls, one for each channel, are mounted on concentric shafts and friction-coupled to permit setting and maintaining uniform calibration and balance of audio levels. A push-button control is provided for reversing left and right channels.

Available uncased for built-in installations or with a hardwood cabinet (walnut finish or unfinished) for open

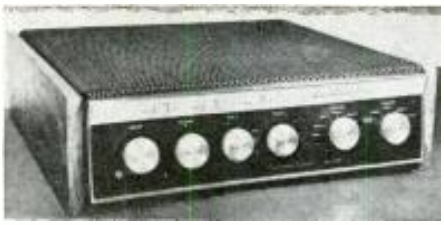
Clevite Transistor Products is building a new plant in Waltham, Mass. which will provide 165,000 square feet of manufacturing, laboratory, and office space and employ approximately 1500 persons. Completion is set for late spring or early summer. Air-purification and temperature control systems will afford a plant atmosphere of hospital operating room standards. Decontamination locks will enable employees to remove dirt from shoes and change into lint-free clothing before entering key work areas. In all laboratory and production areas, power lines and process liquids and gases will be channeled through a subfloor network. The new plant will be located along Route 128, a superhighway artery feeding the Boston area.



or shelf mounting, the unit measures 4½" x 14⁵⁄₁₆" with 9" required behind panel. A data sheet giving complete specifications is available on request.

TRANSISTORIZED STEREO GEAR

Transis-Tronics (TEC), Inc., 1650 21st. St., Santa Monica, California has announced production of an all-transistor high-fidelity stereo amplifier and



preamp which provides 25 watts per channel on stereo (50 watts peak) and 50 watts on mono (100 watts peak).

The Model S-25 has provision for all possible sources of stereo FM multiplexing, stereo AM sideband tuning, and stereo TV, as well as stereo AM-FM. The unit is designed to operate from either a 12-volt battery power supply or 115-volts a.c.

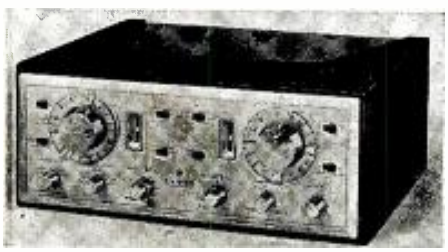
Specifications include response 20 to 20,000 cps ±1 db at 25 watts; harmonic distortion less than 0.8%; hum 100 db below full output; RIAA equalized low-level phono, high-level phono, NAB equalized low-level tape playback, low-level microphone, high-level tuner, and two high-level auxiliary inputs; and 4-, 8-, and 16-ohm outputs on each channel.

The company is offering this new equipment with a two-year unconditional guarantee of materials and workmanship. Write the manufacturer direct for further details and price.

TUNER/AMP COMBINATION

H. H. Scott, Inc., 111 Powdermill Road, Maynard, Mass. is now offering a new stereo tuner/amplifier combination, the 399.

The new instrument combines two preamplifiers, two 20-watt power amplifiers, an AM tuner, and an FM tuner



on a single chassis. All that is needed for a complete stereo component system are two speakers. A phonograph can be plugged into the back if desired.

The circuit features separate tone controls on each channel for speaker matching to room acoustics; a phase reverse switch on the front panel; third-channel output; and sensitive AM and FM front ends. Other features include a special non-magnetic chassis, d.c. heaters on all preamp tubes, and a 10 kc. bridged-T AM whistle filter. There are more than 30 separate controls located on the front panel for

the maximum operational flexibility.

Full technical details are available from Dept. P of the company.

ELECTRONIC ORGAN KITS

Schober Organ Corporation, 2248 Broadway, New York 24, N. Y. is now offering two electronic organ models in easy-to-build kit form, the "Concert" and the "Consolette."

The "Concert" model meets the specifications of the American Guild of Organists while the "Consolette" offers the user a full-range organ which is smaller than a spinet. It has two 61-note keyboards, 22 stops, and 13 pedals yet measures only 38 inches wide.

Both organs are available as a series of kits so that the builder may purchase and assemble his instrument at his convenience and to meet his budget. A 10-inch LP demonstration record which shows the quality of performance of both models is available for $2 which is refunded with the first order for a kit.

A booklet describing the two organs is available without charge on request.

AUDIO CATALOGUES

TELEFUNKEN BROCHURE

Audio Fidelity Professional Products Inc., 770 Eleventh Ave., New York 19, New York, U. S. distributor of *Telefunken* professional products, announces the availability of a six-page brochure covering the firm's line of microphones, amplifiers, tape recorders, disc playback equipment, loudspeakers, and general accessories for use by the broadcasting, motion picture, radio, recording, and television industries as well as other electronic areas where sound reproduction in communications is involved.

The publication pictures and describes each of the units in considerable detail. Those in professional recording fields are invited to write the U. S. distributor for a copy of the brochure.

MICROPHONE TIPS

Shure Brothers, Inc., 222 Hartrey Ave., Evanston, Ill. has prepared a new booklet entitled "The Microphone in Public Address Systems" which it will forward without charge to interested persons.

The eight-page booklet has been written for businessmen, educators, entertainers, recording enthusiasts, and all others who have occasion to use a microphone. Contents include a description of a p.a. system's components, tips on buying or improving a system, and facts on the uses and limitations of the basic types of microphones.

Also covered are rules of microphone technique and a list of common microphone usage problems and solutions.

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Heath Company, Benton Harbor, Michigan has announced the withdrawal of the Model SA-1 14-14 watt stereo amplifier which was announced on pages 89-90 of our January issue. This unit will be replaced by a dual 25-watt amplifier which will be designated as the Model AA-50.

A BABY'S "DIAPER ALARM"

By C. M. SWEET, VU2CT

OFTEN small babies are left in discomfort when busy mothers fail to notice that a "change" is required. Here is an absolutely safe and easily built alarm which automatically announces, in a pleasant, audible tone of adjustable pitch, when the baby is in need of attention.

The unit is in two parts—(1) the alarm box proper which houses an adjustable audio-frequency oscillator of the low-power transistor type that operates from a 1½-volt flashlight battery. This energizes a PM speaker. The oscillator is connected via a convenient length of twin-lead to (2) a moisture-sensitive contact pad. This pad is placed in the baby's crib above the usual protective waterproof sheet but below the folded napkin or pad of absorbent material which is changed.

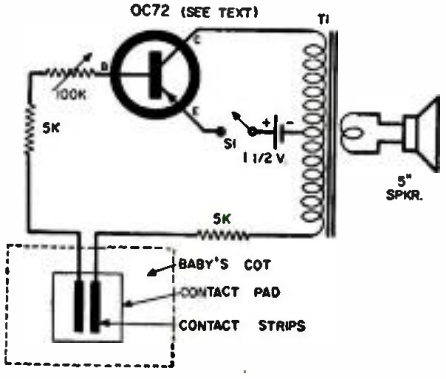
Although the author used a Philips OC72 transistor, any low-power audio transistor, such as the Raytheon CK722 or G-E 2N107 can be substituted. Also any PM speaker output transformer having a tapped primary with impedance of 400 ohms or more will do. The designer's intention was to limit the current in the contact pad circuit to a maximum of 50 μa. and in the collector circuit to about 15 ma.

In operation, when the switch is turned on and the absorbent cloth touching the contact pad is moistened, the input circuit is completed. Now the transistor oscillates due to feedback between the two sections of the primary winding of the transformer which are coupled, respectively, to the input and output circuits. The pitch of the note thus produced in the loudspeaker is adjusted by varying the 100,000-ohm pot. A fairly high note is preferable as it is more audible; in addition, current consumption is reduced as the oscillator frequency is increased. If too much moisture collects between the contact strips, they should be wiped dry when the diaper is changed.

The contact pad consists of two flat metal strips, each 10" long and ¼" wide, sewed onto a 12" x 6" pad of waterproof or plastic sheet. The strips should be separated ⅛" and connected to the alarm unit by a 10-foot length of twin-lead.

Considering the small amount of time and cash required to build this alarm, the results are truly gratifying. —30—

Circuit diagram of a safe "moisture" alarm unit which produces pleasant audible tone.



HOME-BUILT POWER-LINE REGULATOR

By **A. V. J. MARTIN**
Carnegie Institute of Technology

Ferro-resonant a.c. stabilizer uses rewound transformer, capacitor, and resistor. Delivers 0.5 amp. at 117 volts.

IRREGULAR power-line voltage is a common plague affecting not only the technician in his laboratory but the customer at home. Picture size variation and unstable pictures are two common effects of varying line voltage. In addition, most precision instruments, like generators, are often sensitive to supply voltage variations and for maximum accuracy should be fed stabilized a.c.

Ferro-Resonant Stabilizer

The so-called ferro-resonant a.c. stabilizer is probably the simplest of all the means which have been devised to keep power-line variations within reasonable limits. A number of commercial versions of the device are available, most of them involving highly sophisticated circuitry, with attendant bulk, weight, and high price.

Basic Principle

Basically, a ferro-resonant circuit comprises a capacitor and inductor, as shown in Fig. 1. The inductor saturates and its inductance value is not a constant but a function of the applied current or voltage. Such an inductor is said to be "non-linear." Fig. 2A shows the voltage V_C across the capacitor and the voltage V_L across the non-linear inductor as functions of current.

Since the capacitor and inductor are connected in series, the current is evidently the same through the capacitor and the inductor, but the voltages V_C and V_L are opposite in phase. Consequently, the total voltage V across the series combination is given by the difference between V_C and V_L and has been plotted in Fig. 2B. It is seen that V goes down to zero for some value of current, just as it would for some value of frequency in a standard series-resonant circuit, hence the name "ferro-resonant" circuit, which has nothing to do with any "resonance"

The rewound transformer and the capacitor are mounted atop a small chassis.

of the usual kind that is ordinarily discussed.

As it stands, Fig. 2B represents the ideal case when there is no power consumption. If there is power consumption, the zero point P shifts upward and does not give zero voltage any more. The resultant curve is represented in Fig. 2C. The almost horizontal part of the curve has a slope which depends on the power consumption—becoming more horizontal as the power consumption increases.

A variant of the circuit uses a parallel connection of the capacitor and inductor with similar results. It can be seen that these ferro-resonant circuits are highly sensitive to changes in current or voltage. They are extensively used as the basis of different arrangements to provide relatively stabilized voltages or currents.

The non-linear inductor can just as well be the primary of a transformer and this has been put to good use in the stabilizer that is described in the following text.

Fundamentally, then, stabilization can be obtained with a single capacitor and a single inductor and nothing forbids us to use only these two necessary components, as indicated in Fig. 3. This diagram represents the basic ferro-resonant stabilizer. It seems hard to beat for simplicity and economy, although this stripped-down version works well.

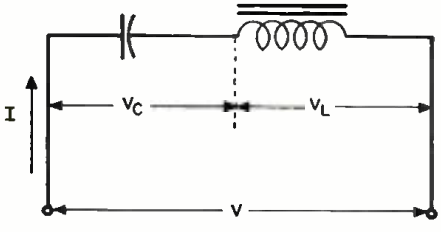
Resistor R is a refinement added to provide a discharge path for the capacitor when the stabilizer is switched off. The capacitor then discharges through the primary of the transformer and the resistor, whose value is not at all critical—it can run anywhere between 50,000 and 500,000 ohms. The capacitor can be of any non-polarized, *i.e.*, non-electrolytic, type. For example, paper or oil capacitors are suitable. For the standard power-line voltage, the capacitor should be rated at least 600 volts.

Any value of capacitance can be obtained at will by paralleling several capacitors but it is simpler and more economical to choose a design leading to a standard value of capacitance. Care must be exercised, however, because the tolerances are very wide for capacitors. Unless a precision component is purchased (and they are costly) the best way is to actually measure the capacitance. No precision measurement is necessary, however, since discrepancies up to 10 or even 20 per-cent can be adjusted during the final tune-up.

Components

The only non-standard element is the transformer.

The core laminations will be stacked transformer fashion, that is, with no air-gap and with alternate orientations. The core cross-sectional area, S, will be evaluated with the help of the expression: $S = k\sqrt{P}$ where P is the



◀ Fig. 1. Basic ferro-resonant circuit.

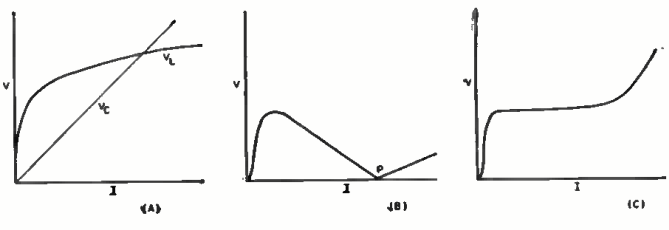


Fig. 2. (A) Individual and (B) total voltage. ▶ (C) Effect of load.

wanted power in va., *e.g.*, the product of the regulated voltage, V_2, in volts by the load current, I_2, in amperes. S is obtained in square centimeters. k is a coefficient depending on the quality of the laminations. For the standard low-grade *armature* steel (28 sheet gauge, .0155 inch thickness, .625 pound per square foot) or for the next better grade, *electrical,* in the same dimensions, k should be about 1.

For the better grade *dynamo* steel, in the same dimensions or in the more common 29 sheet gauge, k should be 0.9.

The primary winding will have a number of turns, N_1, given by the formula: $N_1 = 40\ V_1/S$ where V_1 is the nominal power-line voltage.

Similarly, the secondary winding will have a number of turns, N_2, given by the expression: $N_2 = 30\ V_2/S$.

The correct wire gauge to use is determined by the current through the wire. The primary current will be taken as $I_1 = P/V_1$ and the secondary current as $I_2 = P/V_2$.

Reference to a wire table will indicate what size wire to use, bearing in mind that the current density should not exceed 2.5 amperes per square millimeter. If no wire table is available, dividing the current by 2.5 will give the wire cross-section in square millimeters.

Once the wire size is known, a good precaution is to check that the laminations opening or window is large enough to contain the two windings and the insulation.

For powers up to 100 va., the capacitor should not be smaller than 4 μf. For power between 100 and 250 va., the capacitor should not be less than 8 μf. in value. Keeping this restriction in mind, the capacitor value in microfarads is given by: $C = 1.5 + (P/6)$.

It can be seen that the preceding restriction precludes the design of stabilizers for powers lower than 15 va. As previously pointed out, the capacitor value given by the equation above will probably be an awkward number. The nearest standard value will have to be adopted.

This, and the fact that all of the formulas given are empirical, indicates that the calculations will provide only an approximate design. In all cases, final adjustment will have to be made to insure optimum results. Luckily, such an adjustment is not too critical. The easy way to proceed is to be prepared for it by including several taps in the primary winding, as well as some amount of overwinding so as to provide leeway in both directions.

A practical satisfactory minimum arrangement is to provide two taps at 25% and 12% of the total number of turns before the end of the winding. Then, the primary is overwound 25% with a tap at 12%. The adjustment consists of connecting the capacitor to the tap providing the best regulation.

Practical Design

An example of design will show how to proceed. For example, a stabilizer

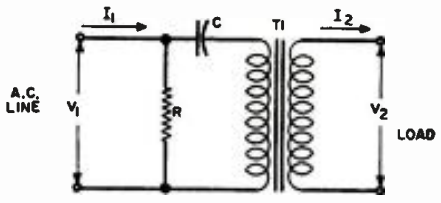


Fig. 3. Basic circuit with transformer.

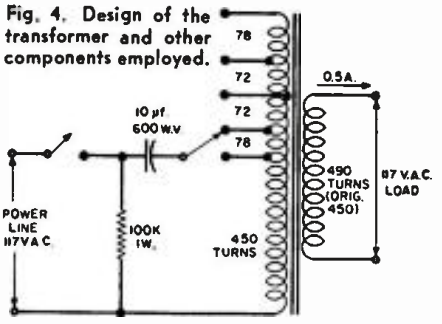


Fig. 4. Design of the transformer and other components employed.

was desired to provide a maximum current, I_2 of 0.5 amp at a stabilized voltage, V_2, of 117 volts. The power is: $P = 117 \times 0.5 = 58.5$ va., which rounds off at 60 va.

It was desired to use available laminations, with a center limb 1 inch wide. The only trouble was that nobody had any idea of the quality of the steel. Consequently, it was assumed to be good grade material and a k of 1.0 was chosen in the hope that final adjustment could correct for any eventual discrepancy. Luck was with us . . .

The cross-section of the core thus becomes: $S = 1.0 \times \sqrt{60} = 7.75$ square centimeters. A 1¼" thick stack of laminations will give a cross-section of $2.5 \times 3.1 = 7.75$ square centimeters with a good enough approximation.

The primary winding would then have: $N_1 = (40 \times 117)/7.75$ or 600 turns, nominally, but to allow for adjustment we shall wind 750 turns with taps at 450, 528, 600, 672, and 750 turns.

For a primary current of 0.5 amp. and a current density of 2.5 amps. per square millimeter, the primary wire will have a cross-sectional area: $S = 0.5/2.5$ or 0.2 square millimeter, which corresponds to No. 24 AWG.

The secondary will have: $N_2 = (30 \times 117)/7.75$ or 450 turns and will use the same wire size.

Finally, the capacitor value is: $C = 1.5 + (60/6)$ or 11.5 which would normally round off at 12 μf. However, several available oil and paper capacitors were measured and one 10 μf. unit turned out to be 11.8 which was nearer the actual value than was hoped for or indeed desired.

The stabilizer was then built according to the diagram of Fig. 4 and tests were made by connecting high-power resistors across the secondary. The tap which provided the best results was the tap at 528 turns.

With the help of a "Variac," the primary voltage was varied and the secondary voltage under load measured. The resulting regulation characteristic is plotted in Fig. 5. It shows a secondary voltage variation of no more than 3.5 volts, *e.g.*, 3 per-cent for a primary voltage variation of ± 24 volts which is practically 40 per-cent. The actual output voltage was not 117 volts originally because of the design approximations. This was immaterial but was easily remedied by suitable adjustment of the number of secondary turns, that is, by adding 40 turns to the existing 450.

Note that the stabilizer should preferably be used under full load. The hardest regimen is the "no-load" condition.

Advantages & Drawbacks

The main advantages of the simple ferro-resonant stabilizer are economy and ease of design. It can be built and made to work without difficulty and will provide regulation sufficient for most practical purposes without critical adjustments. In addition, the design is inherently about as rugged as could be and is practically trouble-free for life.

The picture is not all rosy, however. For one thing, the design becomes more approximate as the power increases and as the transformer increases in bulk and weight. The temperature rise is somewhat high and easily reaches 70 degrees C in the windings.

The magnetic field around the transformer is intense and precludes installation near any field-sensitive device such as a high-gain amplifier, electromagnetic measuring instrument, or magnetic deflection tube.

The output voltage bears only a faint resemblance to the familiar sinusoid. In other words, the waveform is strongly distorted. This is not too important when the stabilizer feeds a transformer, which is the common case, but may become a drawback in special circumstances.

Finally, the regulator is frequency sensitive. A frequency variation of 1 or 2 per-cent will give rise to an output voltage variation of 2 or 3 per-cent.

All in all, these drawbacks are not serious in a vast number of practical applications. If such is the case, the ferro-resonant a.c. voltage stabilizer will provide year after year of reliable service at small initial cost and with virtually no maintenance. —30—

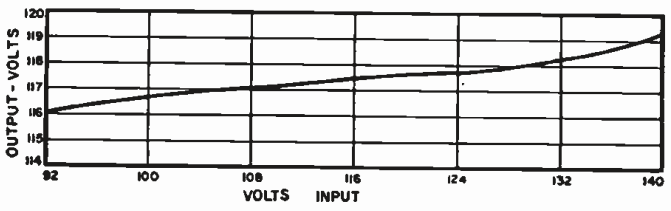


Fig. 5. The excellent stabilization characteristics of the circuit are shown here. For a change of input voltage from 92 v. to 140 v., output is between 116 v. and 119.5 v.

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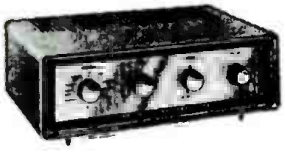

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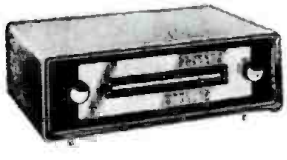

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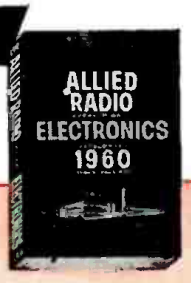

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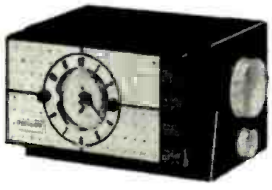

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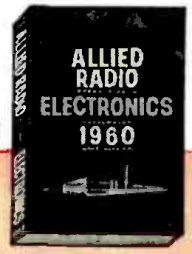

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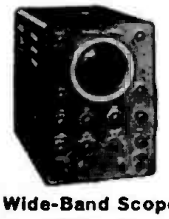

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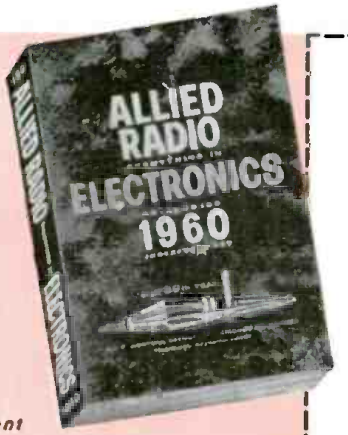

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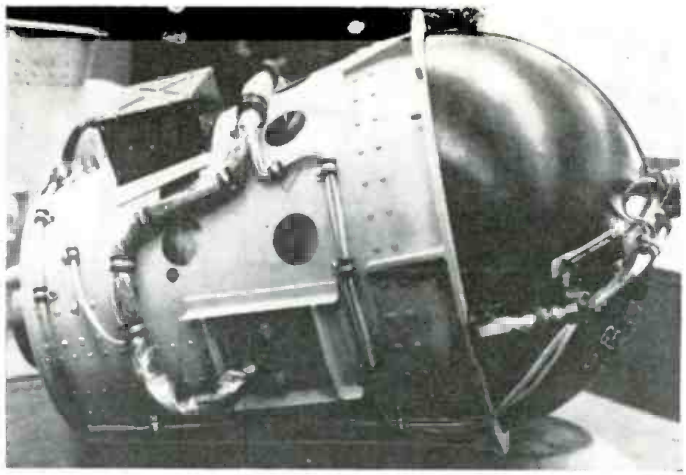

Instrumentation portion of missile nose cone. Plastic recovery capsule is shown fitted into cone rear at right. Sphere is jettisoned before impact.

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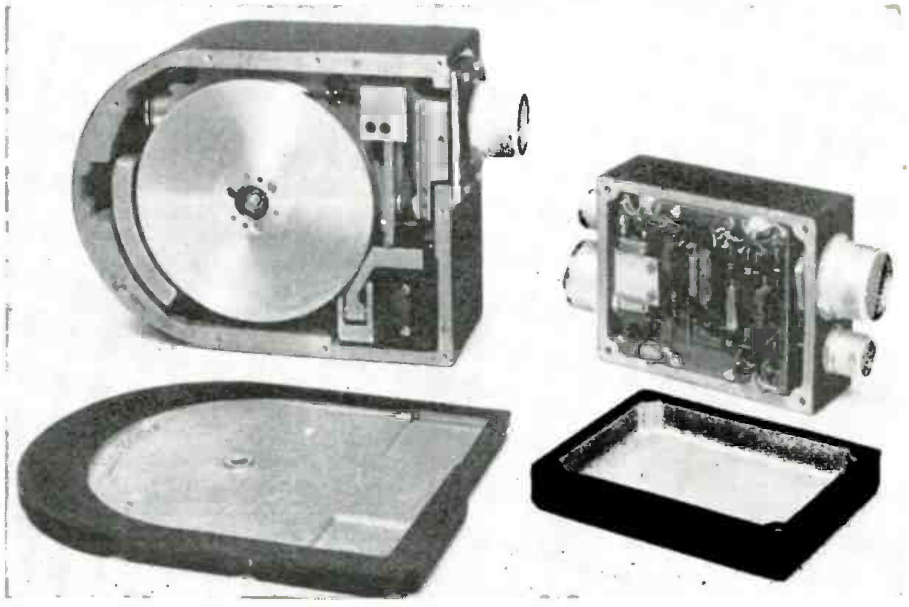
The diminutive recorder, produced by *Ampex Corp.*, stores all data to be telemetered from the nose cone during flight. Such data includes temperature, pressure, stress, acceleration, and deceleration information. When radio communication is interrupted, the recorder continues to capture the vital information and will play it back when radio communication can be resumed. For example, when the missile re-enters the atmosphere, it is surrounded by a layer of hot, ionized air which prevents transmission. The recording system allows data to be acquired during this critical time.

The complete system weighs 20 pounds and occupies less than one-fifth cubic foot. It has a frequency response from 300 to 100,000 cps, and will record two tracks on 1400 feet of quarter-inch tape at 60 ips. Potted subminiature tubes and silicon transistors are used in the two record and reproduce amplifiers. —30—

Complete tape transport assembly (left) and the separate electronics unit.



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1B3	.95	5T8	.86	6BG6	2.25	6J5	.70	12AX4	.95
1S5	.60	5U4G/GB	.75	6BH6	.70	6J6	.60	12AX7	.65
1T4	.55	5U8	.75	6BH8	.90	6K6	.80	12B4	.70
1U4	.45	5V6	.55	6BJ6	.65	6L6	1.15	12BA6	.60
1U5	.55	5Y3GT	.55	6BK5	1.40	6S4	.60	12BD6	.60
1X2A/B	.95	6AB4	.55	6BK7A/B	.90	6SA7	.80	12BE6	.60
2AF4	1.00	6AC7M	.90	6BL7	1.55	6SC7	.80	12BH7	.80
3AF4	1.05	6AF4	1.05	6BN6	.75	6SK7	.75	12BQ6	1.10
3AL5	.46	6AG5	.65	6BQ5	.70	6SL7	.90	12BY7	.80
3AU6	.55	6AG7M	1.25	6BQ6	1.10	6SN7	.85	12C5	.60
3AV6	.45	6AH4	1.30	6BQ7A	1.10	6SQ7	.85	12CU5	.60
3BN6	.75	6AH6	1.35	6BR8	.95	6T4	1.00	12CU6	1.10
3BU8	.75	6AK5	.85	6BU8	.70	6T8	.95	12DQ6	1.10
3BY6	.60							12F8	.65
3BZ6	.60							12K5	.70
3CB6	.60							12L6	.65
3CF6	.65							12SA7	1.00
3CS6	.60							12SK7	.85
3DT6	.55							12SN7	.90
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3S4	.65							12V6	.55
3V4	.70							12W6	.75
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5AN8	.85							25L6	.85
5AQ5	.55							25W4	1.10
5AT8	.85							35C5	.65
5AU4	.95							35L6	1.00
5BK7	.90							35W4	.50
5BQ7	.98							35Z5	.70
5CG8	.85							50C5	.70
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6AM8	.85	6BY6	.60	6V6	.80		
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6AQ5	.55	6BZ7	1.10	6W6	.95		
6AS5	.90	6C4	.50	6X4	.45		
6AT6	.55	6CB6	.70	6X5	.65		
6AT8	.85	6CD6	1.70	6X8	.85		
6AU4	1.00	6CF6	.70	6Y6	.95		
6AU5	1.75	6CG7	.65	8AU8	.90		
6AU6	.65	6CG8	.80	8AW8	.95		
6AU8	.90	6CL6	1.35	8CG7	.65		
6AV5	1.60	6CM7	.70	10DE7	1.15		
6AV6	.55	6CN7	.70	11CY7	.75		
6AW8	.90	6CQ8	1.35	12AD6	.55		
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6BA6	.65	6CS7	1.15	12AQ5	.56		
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6BC8	1.10	6CU6	1.10	12AT7	.76		
6BD6	.65	6CY7	.75	12AU6	.60		
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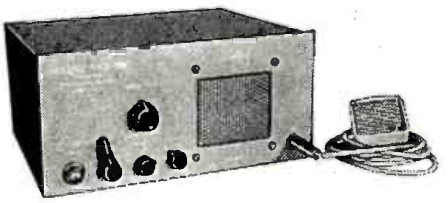

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Transistor Radio

Part 4. The audio preamp stage and the audio output stage are covered in this i...

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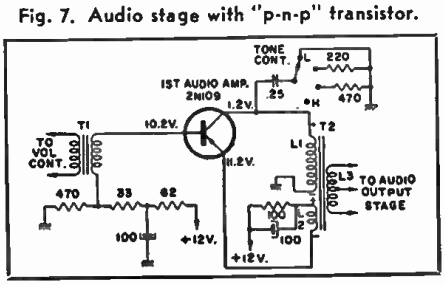
Audio Preamplifier

An audio preamplifier stage is required whenever the detector output is not sufficient to drive the audio stage properly. The amplifier in Fig. 7 employs a 2N109 *p-n-p* transistor which is in the medium-power class, having higher current amplifying characteristics than the low-power transistors used for r.f. and i.f. amplification.

The emitter is connected, through transformer winding L_2 and a 100-ohm resistor, direct to the 12-volt supply. The proper base-emitter forward bias is obtained by a series of voltage divider resistors in the base circuit which keep the base less positive than the emitter (necessary for biasing a *p-n-p* transistor in the forward direction). The collector is connected to ground through transformer winding L_1 which keeps the collector negative with respect to the other elements for maximum attraction of holes from the emitter. All of these voltages set the d.c. collector current of the transistor to about 5 ma. of current through L_1, with no signal applied. Then as signal is applied through input transformer T_1, the base voltage and current are changed at the audio rate. This causes corresponding increases and decreases in collector current through L_1, but of larger magnitude due to the amplification characteristics of the transistor.

The amplified signal currents in L_1 induce a voltage in secondary winding L_3 and also a small voltage in the primary winding L_2, which is connected to the emitter. The voltages shown are induced during the part of the cycle when the collector current is increasing and it can be seen that the voltage in L_2 is degenerative by the way it is connected to the emitter and would try to oppose or cancel some of the original current change. This minimizes distortion since the higher... monics which cause dis... duce more voltage in ... winding and this has the ef... celling the distortion frequen... the output of this stage.

Fig. 7. Audio stage with "p-n-p" transistor.



The 100-ohm emitter resistor ... 7 is self biasing and stabilizes d.c... lector current, keeping the transi... operating at the best point for mi... mum distortion. The 100 μf. capacito... across this resistor prevents the resis... tor from causing audio degeneration by providing a low-impedance path for bypassing the audio signal. However, d.c. current changes, such as those caused by an increase in transistor temperature, are restrained due to the voltage drop across this resistor.

The tone of the receiver is often controlled in this stage. In Fig. 7 the tone is varied by a four-step control connected to the collector of the transistor through a .25-μf. coupling capacitor. The control varies the amount of resistance in series with the capacitor to ground. The smaller the value of resistance, the more efficient will be the bypassing characteristic of the capacitor. Since the higher frequencies are more easily bypassed by the capacitor than lower ones, the control has the effect of "shorting" the high-frequency audio signals to ground.

With the control set at stop "L," a maximum amount of high-frequency audio is shorted to "ground" and the tone appears to be low. As the arm is moved clockwise, greater amounts of resistance are added to reduce the effect of the tone capacitor and the higher frequency audio signals remain in the collector circuit, causing a higher tonal response in the receiver.

Single-Ended Output Stage

Fig. 8 shows an audio-output stage employing a 2N173 high-power *p-n-p* transistor in a class A, common-emitter circuit.

Forward bias is developed across the 10-ohm resistor in the voltage divider network consisting of 10-ohm and 130-ohm resistors and the 60-ohm potentiometer. By adjusting the potentiometer, the voltage drop across the 10-ohm resistor can be varied and since this resistor is connected between the base and emitter of the transistor, the voltage developed across it determines the amount of forward bias between these two elements.

The method normally used to make the bias adjustment is to insert an ammeter in series with the ground connection to output transformer T_2 and adjust the bias control until a specified reading of collector current is obtained. A typical value of 930 ma. is shown in the circuit but this specifi-

cation will vary greatly with the transistor and circuit used. This sets the d.c. operating point for the transistor and determines power output as well as the amount of distortion present. The signal induced in the secondary winding of T_2 is in series with the base connection to the voltage divider and therefore fluctuates base voltage and current at the audio rate.

Small current changes in the base circuit are greatly amplified by the transistor and produce much larger collector-current changes in transformer T_3. The energy in T_3 is then coupled to the speaker from a point on the transformer which matches the speaker voice-coil impedance. The 150-ohm resistor across the output transformer protects the transistor from a high surge of back voltage which will occur if the voice-coil winding should open or is disconnected during operation.

Since the collector current in this circuit is near 1 amp and transformer

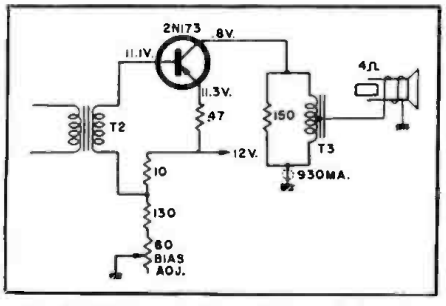


Fig. 8. High-power "p-n-p" is used class A.

T_3 has a d.c. resistance of about 1 ohm, the collector voltage developed is about 1 volt. This voltage will give an indication of whether or not the transistor is drawing current because no collector voltage would be produced if it were not conducting.

The .47-ohm emitter resistor stabilizes collector current and prevents a possible runaway condition due to transistor heating. As temperature increases during operation, the transistor resistance drops which causes it to draw more current. But this produces a change in voltage across the .47-ohm resistor, which adjusts the bias and opposes the original current change. Temperature is also controlled by mounting the transistor tightly to a suitable chassis which acts as a heat sink and absorbs much of the heat. To prevent the transistor case and collector from being grounded, the heat sink chassis will usually be insulated from the main chassis in some manner.

(To be continued)

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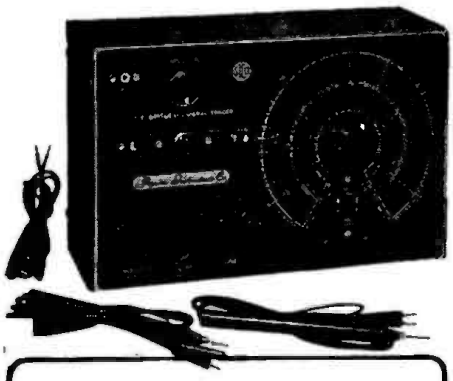

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D.C. CURRENT: 0 to 1.5/15/150 Ma. 0 to 1.5/15 Amperes.
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THE MODEL TV-50A comes absolutely complete with shielded leads and operating instructions.

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★ Tests all tubes, including 4, 5, 6, 7, Octal, Lock-in, Hearing Aid, Thyratron, Miniatures, Sub-miniatures, Novals, Subminars, Proximity fuse types, etc.
★ Uses the new self-cleaning Lever Action Switches for individual element testing. Because all elements are numbered according to pin-number in the RMA base numbering system, the user can instantly identify which element is under test. Tubes having tapped filaments and tubes with filaments terminating in more than one pin are truly tested with the Model TW-11 as any of the pins may be placed in the neutral position when necessary.
★ The Model TW-11 does not use any combination type sockets. Instead individual sockets are used for each type of tube. Thus it is impossible to damage a tube by inserting it in the wrong socket.
★ Free-moving built-in roll chart provides complete data for all tubes. All tube listings printed in large easy-to-read type.

NOISE TEST: Phono-jack on front panel for plugging in either phones or external amplifier will detect microphonic tubes or noise due to faulty elements and loose internal connections.

EXTRAORDINARY FEATURE

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3. Press down the quality button—

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- 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

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- 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.

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Room Acoustics for Stereo

(*Continued from page 47*)

ner of the room is perhaps the best "projector" area of the room. Many articles have recommended locating the loudspeaker in a corner so that the corner can act as a three-sided horn *feeding* the room. Too little mention is made, however, concerning the acoustic condition of the walls and floors of these "desirable" corners. If the walls and floors are heavily draped and carpeted, as shown in Fig. 15A, the corner would be of very little use. The need for a live backing area behind the sound (Fig. 15B) is dictated by the need for throwing the sound forward—just as is done by an orchestral shell (Fig. 15C). Therefore, absorption techniques that are to be applied should be in the general listening area, with a minimum in the sound generating area.

Putting the absorbent material in the listening area serves to reduce unduly strident echoes from live surfaces (removed from the original source) which by reflectively interfering with the direct sound will cause confusion at the listener's ear. In this connection we must also realize that the closer one sits to the source of the sound, the less effective are the surroundings. This effect is especially noticeable in very live rooms. If one were seated close to a hard plaster wall and the sound source is 20 feet away, there would be considerable interference introduced by reflections off the wall. On the other hand, if the walls were heavily draped then the ear would receive very little reflected sound and its major acoustic stimulus would be direct sound from the speaker. We must, therefore, strive for a balance between direct and reflected sound so that while we hear the performance in front of us, we get some general diffuse sound from around us to "liven" the performance.

Summary of Principles

Summarizing the various principles outlined for any good listening room—whether for live music, reproduced monophonic or stereo, we have:

A. The room should have an absorption characteristic which will provide a reverberation time of from .75 to 1.25 seconds.

B. The sound absorption material used to achieve this reverberation figure should be distributed throughout the room rather than be concentrated in one area.

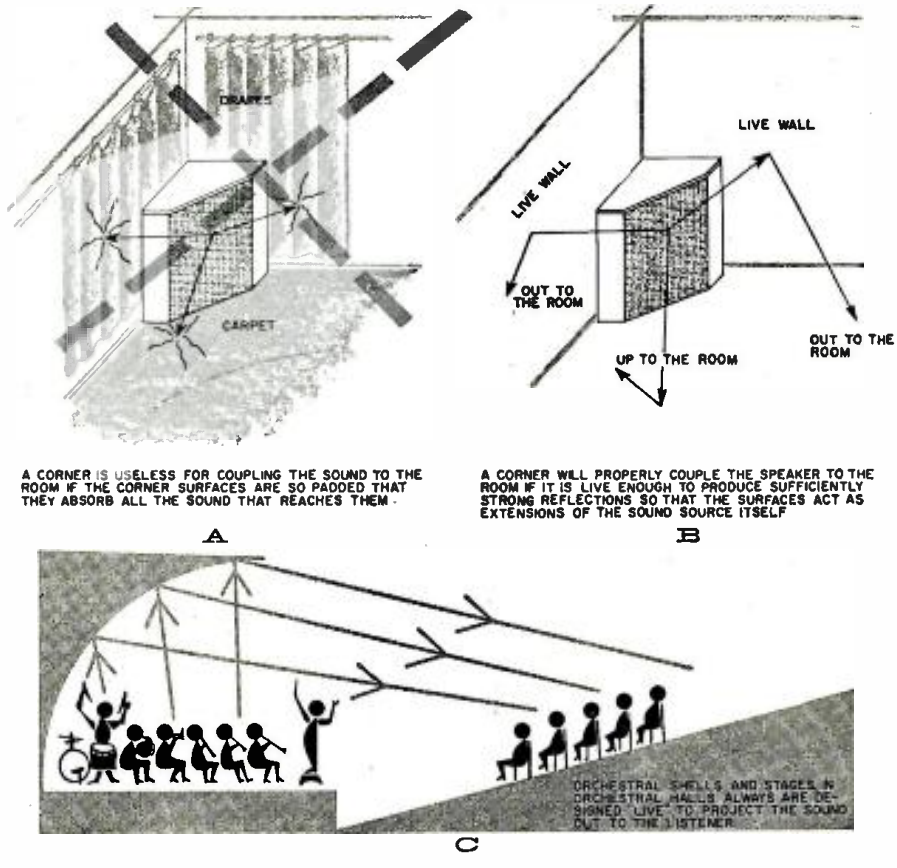
C. Large, hard parallel reflecting areas should be avoided as they lead to multiple reflections and resonances.

D. The sound source should be located in a comparatively "live" area of the room.

E. The listener location should not be adjacent to either a hard reflective surface or a totally absorptive surface since in neither case will the listener receive the proper proportion of reflected-to-direct sound in keeping with accepted reverberation practice.

(To be continued)

Fig. 15. Speaker placement should be such as to provide proper "live" coupling.



Estimating Your Business

(*Continued from page 65*)

attitudes toward types of businesses, aside from the products or services involved, do change. There may be a tendency to patronize either larger or smaller shops. A growing preference for either more service or more self-service may be evident. Establishments that look impressively expensive or streamlined may be attracting more—or less—public confidence than modest, more personalized businesses. There should be constant awareness of the need for changing the character of the service shop based on unmistakable trends in other businesses, whether they be groceries or drug stores.

The general outlook. One of the most difficult factors to assess is what the year ahead promises in general. However, there are always indicators to watch in such areas as business and politics.

An election year, for example, usually has a certain psychological impact. There is generally a feeling of increased confidence on the part of the public that is associated with prosperous conditions. The plan for a centennial, fair, or other such attraction that will be felt in your area also has a stimulating effect.

Industry-wide plans for the year ahead, aside from new things to sell, can have a local effect that should not be ignored. Special promotional activities should be watched. Is your local association planning a campaign? Does your distributor have something in the fire that will influence your own business? Are any manufacturers preparing to stage drives? No activity in your own field when there is some in other areas may reduce your income. Broad activity evident along more than one front in your own field can mean a good lift as compared to what other fields will experience.

The profit ratio. Aside from actual increases or decreases in volume, your success in the year ahead will depend on how much it costs to keep your business going. Are there any price rises in the offing for parts and components? Is your rent going up? Is your own pricing structure realistic with respect to overhead? You could be making less money while doing more business.

In addition to the factors mentioned, which would apply to most shops, there are others that would be specific and peculiar to each firm. For the most reliable estimate of tomorrow's business, your own alertness in recognizing any factor that may have some bearing is indispensable. Overlooking one or making an estimate too hastily may throw the picture out of focus. However the care required in drawing up a useful advance evaluation is well worth the effort. Readiness to meet the future will make you stronger than reliance on last-minute, ill-considered response to the unexpected. —30—

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● RESPONSE 17-21,000 CPS ± 1 DB (at normal listening level) ● UNIQUE "BLEND" CONTROL ● PREMIUM EL86 OUTPUT TUBES ● 50 WATTS MONAURAL—25 WATTS EACH STEREO CHANNEL ● CLUTCH-OPERATED VOLUME CONTROL ● SEPARATE BASS & TREBLE CONTROLS

A completely new stereo high fidelity amplifier with a high quality of reproduction, remarkable versatility and new distinctive styling. Full range of controls include a unique "blend" control for continuously variable channel separation—from full monaural to full stereo, 4-position Selector, Mode, Loudness and Phasing switches plus outputs for 4, 8 or 16 ohm speakers. Harmonic distortion less than 0.25%, IM distortion less than 1%. Hum and Noise 74 db below full output. Assembly is simple—no special skills or tools required. Complete with deluxe cabinet and legs, all parts, tubes and detailed instruction manual. Shpg. wt., 26 lbs.

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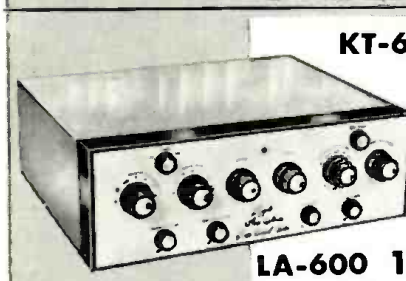

KT-600

IN KIT FORM **79.50**

LA-600 134.50
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PROFESSIONAL STEREO CONTROL CENTER

● RESPONSE 5-40,000 CPS ± 1 DB ● UNIQUE STEREO & MONAURAL CONTROL FEATURES ● PRECISE "NULL" BALANCING SYSTEM ● CONCENTRIC INPUT LEVEL CONTROLS

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KT-310

IN KIT FORM **47.50**

LA-310 72.50
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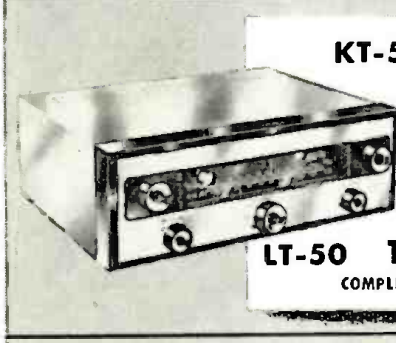
STEREO/MONAURAL POWER AMPLIFIER KIT

● 36 WATT STEREO AMPLIFIER—18 WATTS EACH CHANNEL ● EMPLOYS 4 PREMIUM-TYPE 7189 TUBES ● 2 PRINTED CIRCUIT BOARDS FOR SIMPLIFIED WIRING ● RESPONSE BETTER THAN 35-30,000 CPS ± ½ DB AT 18 WATTS ● LESS THAN 1% HARMONIC OR IM DISTORTION

A superb basic stereo amplifier in easy-to-build kit form. Unit may be used with a stereo preamplifier to provide two 18 watt stereo channels or, at the flick of a switch, as a fine 36 watt monaural amplifier. Controls include 2 input volume controls, Channel Reverse switch and Monaural-Stereo switch. Dual outputs for 4, 8, 16 or 32 ohm speakers. Input sensitivity .45 volts per channel for full output. Tubes are 2-6AN8, 4-7189, GZ-34 rectifier. Size 10-9/16" d x 5¼" h x 13¼" w. Complete kit with cage, all parts, tubes and detailed instruction manual. Shpg. wt., 22 lbs.

KT-310 WX Stereo Power Amplifier Kit ..... 2.00 Down ..... Net **47.50**

LA-310 WX Stereo Power Amplifier, wired and tested ..... 5.00 Down ..... Net **72.50**



KT-500

IN KIT FORM **74.50**

LT-50 124.50
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FM-AM STEREO TUNER KIT

● 11 Tubes (4 dual-purpose) + Tuning Eye + Selenium rectifier provide 17 tube performance ● Multiplex Output for new Stereo FM ● Armstrong Circuit with Dual Limiters and Foster-Seeley Discriminator ● Extreme Sensitivity and Wide Frequency Response.

A precision engineered, highly stable tuner—perfect for lifelike stereo FM-AM broadcast reception, FM reception and/or AM reception. Features separate tuning and volume controls for AM and FM. Magic eye on AM and FM, plus automatic frequency control on FM for accurate tuning—stations are "locked" in. Other deluxe features include cathode follower outputs and 5-position Function Selector. Efficient, broadband circuitry on AM with built-in antenna. FM section features include 2 microvolts sensitivity for 30 db quieting, frequency response 20-20,000 cps ± ½ db and full 200 KC bandwidth. Two printed circuit boards make wiring simple—even for such a complex unit. Complete kit includes all parts, deluxe cabinet and detailed instruction manual. Size is 13¾" W x 10⅜" D x 4½" H. Shpg. wt., 22 lbs.

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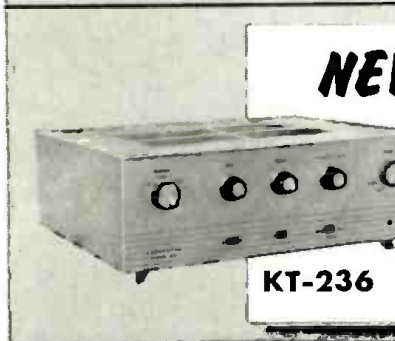
LT-50 WX Same as above, wired & tested ..... 5.00 Down ..... Net **124.50**



NEW!

KT-236

IN KIT FORM **52.50**

LAFAYETTE 36-WATT INTEGRATED STEREO AMPLIFIER KIT

● 36-WATTS MONAURALLY—18 WATTS PER CHANNEL ● FREQUENCY RESPONSE 15-30,000 CPS ± 1 DB ● UNIQUE "BLEND" CONTROL ● CONCENTRIC CLUTCH-OPERATED VOLUME CONTROL ● DUAL CONCENTRIC BASS AND TREBLE CONTROLS ●4-EL84 TUBES IN PUSH PULL

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LA-250


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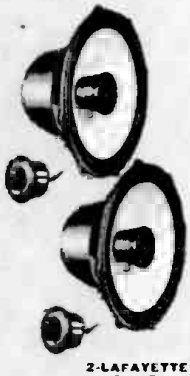
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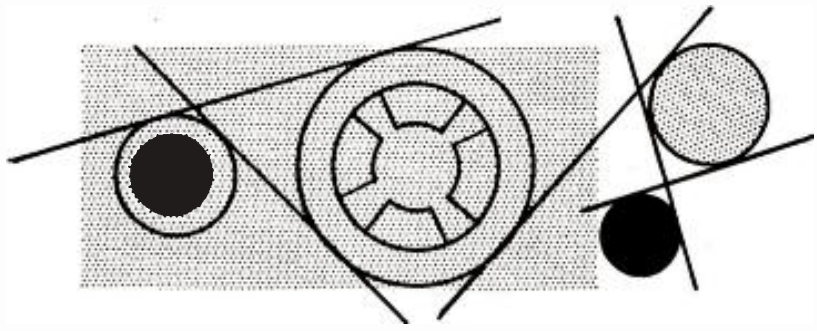
How To Make Better Tape Recordings



Some simple tips and techniques that can be used to get the best results from your tape recorder.

EDITOR'S NOTE: *The following material was abridged from an article by Warde Adams, Jr., field representative and pioneer recording specialist for Orr Industries, manufacturers of "Irish" brand magnetic tape.*

A MODEST cash investment and a moderate expenditure of your time spent in practice will enable you to make better tape recordings and add new dimensions to the scope of your recorder.

The first step is to become thoroughly familiar with your recorder. Read the operating manual that came with the machine. Read it through from cover to cover—then read it through again. Be sure you understand how your machine operates and know what each switch, button, or knob will do. It is important that you know how to operate your instrument and what makes it work.

Next, practice with your recorder until you know all of its functions intimately. Try your hand at all types of recording in order to gain experience and become familiar with the machine's potentialities.

With experience, you will find yourself instinctively picking a recording site where extraneous noise is minimum. The room itself may not be acoustically ideal but if not so originally you will soon discover how much the over-all sound can be improved by the judicious addition of carpeting and draperies.

Mike Placement

Correct microphone placement is extremely important. Every type of recording requires a different microphone technique—which can be determined only by experiment. It would be helpful if we could say "Here's where a mike belongs for guaranteed results"—but things just aren't that simple in most cases.

Try to avoid hand-holding the microphone. Mike stands, both floor and table models, are preferable due to their flexibility. Many inexpensive stands, suitable for home use, are commercially available.

A microphone stand is essential for recording groups. Adjust the height of the stand to the average height of the group. Have the "artists" remove their shoes since the scuffling of shoe leather, especially on an uncarpeted floor, will ruin the recording. Vibrations in the floor will reach the microphone through the stand. Professional recording studios spend hundreds of dollars for mike stands with elaborate shock mounts to prevent such transferral of vibration. The best the home recordist can do is to see that the stand rests on carpet and is steady.

Remember that most mikes furnished with home recorders are somewhat directional so take advantage of this characteristic to help keep extraneous noises out of the recordings that you make.

To record your own speech, the mike should be placed at mouth level and from 6 to 12 inches away, as a general rule. Test recordings should be made to determine the proper distance for the mike and the volume control setting on the recorder. Remember—even professionals tend to increase their vocal output as a recording progresses so make allowances for this phenomenon. When recording groups, test tapings should be made for each member of the group.

Don't place the microphone on the same table with the recorder or on a piano, radio, or TV cabinet. It may pick up motor noise from the recorder or cabinet resonance from the piano or TV. Before placing the mike on a table remove ash trays or decorative accessories which might be resonant to certain tones from musical instruments or voices.

For informal recordings, crystal microphones of the type usually supplied with the recorder will do an acceptable job. You will, however, get much better results with a dynamic microphone. These are available in a wide range of prices.

When experimenting, determine the proper setting for the volume control. If you "overload" a tape (record at too high a volume level) you will get distorted reproduction of the original sound. If the record level is too low, the effective dynamic range of the recording will be decreased and, when the playback volume is increased to compensate for this, the inherent noise

of the recorder will rise by the same amount. Once you have determined a good average level setting, try to keep all your recording levels within this range. However, if you are recording a program with wide dynamic range, such as music that starts softly and builds up to a crescendo, you may need to make occasional adjustments in the volume.

Many recorders have one or more neon bulbs or a "magic eye" tube which functions as recording level or volume indicator. While these devices are satisfactory in many cases, a vu meter is preferable because it gives a more accurate indication of signal level.

For timing, your recorder should have an index counter or program indicator. If you are recording several selections on one reel of tape, the indicator will enable you to locate any portion of your recording quickly and accurately. A mechanical counter which measures tape footage is the preferred type.

Miking and Mixing

To avoid feedback, place the microphone so that the sound from the speaker is not directed toward it. Keep the mike away from audible hum fields such as those produced by fluorescent lamp ballasts and the like.

Remember, your microphone is a delicate instrument. It should receive the same care you would give a fine watch.

You can increase your recorder's versatility by mixing the sounds from several microphones. This will give you better control over the balance among the various sound sources you are recording. Some recorders have built-in mixers. If yours does not, inexpensive, tubeless mixers are available as are the more expensive amplifier-type units.

Selecting a Tape

Tape recordists should become thoroughly familiar with the various types of tape and their applications. Tapes are made on two bases—cellulose acetate and "Mylar," *DuPont's* polyester film. "Mylar" is tougher, stronger, and more resistant to extremes in temperature and humidity than the acetate type. Recordings that are to be preserved for years should be made on "Mylar" base tapes.

The basic industry standard is 1200 feet of 1½ mil tape on a 7-inch reel and 600 feet on a 5-inch reel. Longer tapes are now available, on standard reels, from some manufacturers.

Beware of so-called "bargains" in unbranded tape or "manufacturers' seconds." If you want a quality recording, always buy a recognized brand tape. You can depend on a brand-name tape because every reputable tape manufacturer will stand behind his product with a comprehensive guarantee.

Recording Speeds

The recordist should also become

familiar with recording speeds. Most home recorders will have at least two speeds—usually 3.75 and 7.5 ips. These figures indicate the speed at which the tape passes the recording or playback head.

While the speaking voice alone may be recorded acceptably at 3.75 ips, it is advisable to record music, both vocal and instrumental, at 7.5 ips. Most professional recording is done at 15 ips, but few home recorders are designed to operate at this speed. Some home recorders will have a 1⅞ ips recording speed and this should be used for office dictation or for recording informal discussions, committee meetings, and the like.

Erasing and Storage

Previously recorded material on the tape is automatically erased during the next recording by means of the erase head which is located just in front of the recording head. Saturated tapes, or tapes recorded at too high a level, may be difficult to erase—using the erase head found on many inexpensive recorders.

Small models of the professional "degausser" are now available for home use. They will usually do a satisfactory job of erasing if used according to instructions.

Splicing is easily accomplished by the "free-hand" method, using a pair of scissors or a razor blade, but be sure your "tools" are demagnetized before you bring them near the tape. Use a "degausser" for this operation, not a permanent magnet. *Caution:* Dual-track tape cannot be conveniently edited since when you cut out sections of one track you also delete portions of the second track that is recorded.

Tape may be stored at room temperature. Best storage conditions are at a temperature of around 70 degrees F and a humidity of from 40 to 60 percent. Keep tapes away from excessive heat and dampness. Recorded tape may be stored in its original cardboard box or in metal or plastic containers. Mark and label each tape for future reference and easy filing.

Do not store tape near electrical appliances or motors which may generate magnetic fields. If stored in cabinets in or near your hi-fi system, keep the tapes away from power amplifiers, loudspeakers, and magnetic microphones.

Recorded tapes should always be left on the take-up reel for storage. Tape wound at slow speed will have a much more uniform wind from the standpoint of tension and stack. If the tape is wound too tightly, it will distort due to the extreme pressure. Be sure the tape is wound evenly. If any edges are left sticking out of the stack, the tape may be damaged in handling.

Stored recorded tapes should be rewound at least once every six months and, preferably, once every three months. Rewinding is necessary to relieve any tension due to improper winding which could result in permanent distortion of the film base.

If all the above suggestions are followed, you will get the greatest amount of pleasure and profit from your recorder. Above all, don't be afraid to experiment and make mistakes. Each recording session will teach you something new. One unique advantage of a tape recorder is that you erase mistakes simply by re-recording. —30—

Allied Radio's Fall Amateur Radio Course drew a record-breaking enrollment which includes nine father-son teams, numerous husband and wife combinations, as well as a complete father-mother-son unit. Over 160 students took the training to pass the FCC examinations for the Novice Amateur operator license. The course, which is offered without charge by Allied as a service, covers a period of 14 weeks. Classes meet one evening a week. Students are instructed in sending and receiving code. Lectures cover basic radio theory. Keys, headphones, and other practice materials are supplied by the company for classroom use. Instructors George Bercos, W9WOV, and Joe Huffman, W9BHD, of Allied are in charge of lectures and practice sessions.

Radio Service for TV Techs

(*Continued from page* 41)

should make this indication louder, as each stage provides amplification. Thus absence or reduction of gain can be pinned down to an offending stage: such a stage will not contribute its share of increase in the loudness of the click and the hum. After such localization, it is usually easy, with such conventional techniques as voltage measurement and capacitor bridging, to determine the defective component. This method of "wet-finger" circuit tracing is also useful in TV work, but is less frequent with TV technicians who are used to handling elaborate service equipment than with the "old-timers" of radio servicing.

Intermittent faults, in radio as in TV, are the most elusive. The most common intermittent condition is that caused by one of the half-dozen or so coupling and bypass capacitors. Time and money can often be saved by replacing all the possible offenders. This is, in fact, routine in some shops, whenever a chassis is pulled.

"Front-end" oscillator circuitry, as used in small AM radios, is very different from that used in TV tuners, a heptode or pentode mixer-oscillator taking the place of the triode oscillator and triode or pentode mixer. Servicing this circuit, however, is not very different. A negative voltage at the oscillator grid still indicates that the oscillator is working and loss of output may still be caused by failure of the mixer section of this stage. Since few components are used, the interdependence of oscillator and mixer-amplifier often makes substitution the fastest method of fault finding. Partial oscillator failure may occur: the resultant loss of higher-frequency stations compares with the loss in TV of channels 7 to 13.

The technician who is experienced in looking for visible defects will have little trouble adapting to radio (or any other) servicing. Dry solder joints, leaking electrolyte, and cracked printed wiring are common to any kind of servicing. Also extra-bright tube filaments still indicate a possible short in a filament string, and a glowing output-tube screen still suggests loss of plate voltage due to an open output transformer. All these will be familiar to the experienced TV technician.

Printed wiring is hardly a novelty to the TV technician: he may have had far more experience with this kind of chassis than have most radio technicians. The same unsoldered joints, dirty tube sockets making poor contact, and broken printing are encountered, but printed boards used in radio are generally not so well mounted as their TV counterparts and, consequently, suffer more externally caused damage. Little difficulty will be experienced with printed boards. A start made on radio sets that use this type of chassis makes an easy introduction to the radio repair business. —30—

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- Deep brushed long lasting etched aluminum panel
- Matching cover protects instrument face — snaps on and off instantly.

SPECIFICATIONS OF VT-1 and VT-10

- **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
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- **RF** — Peak reading demodulator supplied for use on all DC ranges
- **Zero Center** — available on all DC volt ranges with zero at mid-scale
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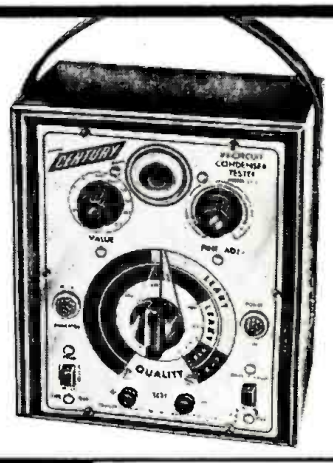

in-circuit checks:

- ✓ 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
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See for yourself at no risk why thousands of servicemen all over the country selected CENTURY test equipment above all others. Send for instruments of your choice without obligation . . . try them for 10 days before you buy . . . only then, if satisfied, pay in easy-to-buy monthly installments — without any financing or carrying charges added.

Housed in hand-rubbed oak carrying case — complete with MULTI-HEAD

Model CRT-2 **$57.50** Net

TERMS: $13.50 within 10 days. Balance $11 monthly for 4 months.

Model CRT-2 CRT TESTER-REACTIVATOR

TESTS, REPAIRS and REACTIVATES

- ***ALL BLACK AND WHITE PICTURE TUBES (including 110° tubes)*** . . . from 8" to 30", whether 12 pin base, 8 pin base, 14 pin base . . . and the very latest 7 pin base.
- ***ALL COLOR PICTURE TUBES*** . . . Each of the red, green and blue color guns is handled separately.

CHECK THESE EXCLUSIVE FEATURES

- **THE MULTI-HEAD** (Patent Pending) . . . **A SINGLE PLUG IN CABLE AND UNIQUE TEST HEAD** —A tremendous advance over the maze of cables and adapters generally found with other testers.
- **WATCH IT REACTIVATE THE PICTURE TUBE** — You actually see and control the reactivation directly on the meter as it takes place. This allows you for the first time to properly control the reactivation voltage and eliminates the danger of stripping the cathode of the oxide coating. It also enables you to see whether the build-up is lasting.
- **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.
- **UNIQUE HIGH VOLTAGE PULSE CIRCUIT** — Will burn out inter-element shorts and weld open circuits with complete safety to the picture tube.

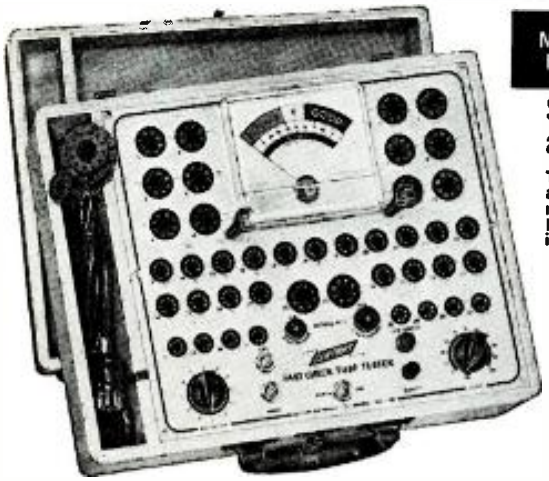
THE CRT-2 DOES ALL THIS RIGHT IN THE CARTON, OUT OF THE CARTON OR IN THE SET

TEST
- For quality of every black and white and color picture tube, employing the time proven dynamic cathode emission test principle.
- For inter-element shorts and leakage up to one megohm. Separate short test provided for each element in the picture tube.
- For life expectancy.

REPAIR
- Will clear inter-element shorts and leakage.
- Will weld open elements.

REACTIVATE
- The "SHOT" (high voltage controlled pulse) method of reactivation provided by the CRT-2 will restore picture tube to new life in instances where it was not possible before. 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 also improve definition, contrast and focus greatly and add longer life to the picture tube.

- **VISUAL LIFE TEST** — Enables both you and your customer to see the life-expectancy of any picture tube right on the meter . . . helps eliminate resistance to picture tube replacement when necessary.
- **SPECIAL LOW SCREEN VOLTAGE TUBES** — Will handle new type picture tubes with special low voltage of approximately 50 volts.
- **SEPARATE FILAMENT VOLTAGES** — including the very latest 2.35 volt and 8.4 volt types as well as the older 6.3 volt types.
- **NEW 'SF' PICTURE TUBES** — Accommodates the different base pin connections of this new type picture tube.



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Model FC-2 **$69.50** Net

TERMS: $14.50 within 10 days. Balance $11 monthly for 5 months.

Model FC-2 FAST-CHECK TUBE TESTER

Simply set two controls . . . insert tube . . . and press quality button to test any of over 900 tube types completely, accurately . . . IN JUST SECONDS!

The FAST-CHECK enables you to cut servicing time way down, eliminate unprofitable call-backs and increase your dollar earnings by selling more tubes with very little effort on your part. You make every call pay extra dividends by merely showing your customer the actual condition and life expectancy of the tube. The extra tubes you will sell each day will pay for the FAST-CHECK in a very short time.

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 900 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, 0Z4s, 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 900 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 • Deep brushed 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.

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Please print clearly

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City.....State.....

TROUBLESHOOT YOUR OWN V.T.V.M.

By DAVID R. ANDERSON

Time lost while this key unit is being repaired on the outside can be costly. You can do a quick job yourself with sectional analysis and isolation.

WHENEVER you turn to look at someone working in electronics, you are also likely to see a v.t.v.m. Especially in the case of the service technician, it is a constantly used and valuable instrument. Although he is quite likely to have at least one other meter in addition, failure of the v.t.v.m. generally leaves him in a tight spot. Despite the fact that actual work on this instrument is not a customary thing for its owner, he can greatly simplify the task of troubleshooting by dividing the v.t.v.m. into sections and checking each individually, or only those sections in which trouble is indicated.

The v.t.v.m. can conveniently be broken down into four principal sections: the bridge circuit, together with its power supply; the d.c. multipliers; the a.c. multipliers, including the a.c. rectifier; and the ohmmeter section.

The bridge circuit is the heart of the instrument. Other sections simply serve to process and apply a proper voltage to the input grid of the bridge for measurement. A typical bridge is shown in Fig. 2. With no voltage at the grid of the input triode the tubes are balanced out so that the same amount of current flows through each one. The "Zero Adjust Pot" is used to establish this condition, since there may be some imbalance inherent in the tubes or circuit components.

Since current through one triode equals that in the other and since the cathode resistors are equal, the voltage at point *A* will equal that at point *B*. No current will thus flow through the meter because it is connected between these two equipotential points. When an applied input signal throws the bridge out of balance, there is a voltage difference between points *A* and *B*, and a current flows through the meter, deflecting the latter in proportion to the imbalance, which is in proportion to the applied voltage.

There are other versions of the bridge circuit than the common one illustrated. For example, the meter movement may be connected between a point in the plate circuit of one triode and a like point in the other triode. However, fundamental operation is the same and the approach to isolating faults is also similar.

Let us assume, to deal with a not unusual defect, that we cannot zero the meter with the adjusting pot provided for that purpose. The cause of this abnormal degree of imbalance could lie in either of two directions. There is either a defective component in the bridge itself, or a defect in some other section is allowing an undesired voltage to leak to the input of the bridge. Shorting the grid to ground will tell us which way to look. Since this removes any stray voltage from the input grid, the trouble must lie in the bridge itself if zero adjustment still cannot be achieved.

With this additional localization, finding the point of defect is relatively simple if it is in the bridge, as only a few possibilities exist. Tube substitution will either remedy the situation or eliminate that component from suspicion. A voltage check at the triode plates narrows things down even more.

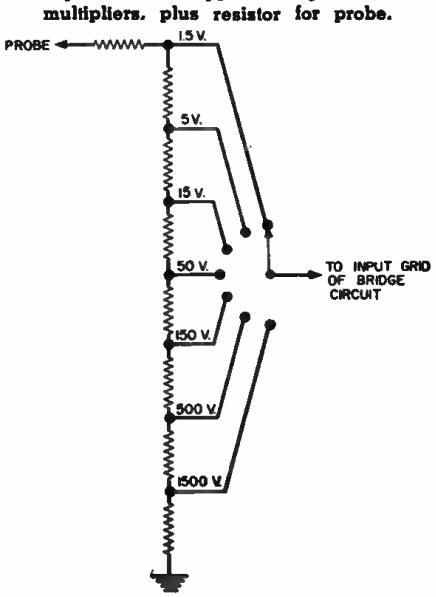
A high plate voltage indicates an open condition or excessive resistance in the cathode circuit of Fig. 2. With this indication, only three possibilities remain: either of the cathode resistors or the potentiometer. An ohmmeter should then provide the final answer.

If plate voltage is low, a short or leakage in the cathode circuit, or low output from the simple power supply, is probably responsible. Again, only a few components, all of which may be checked easily, are involved.

The purpose of capacitor C_1 is to filter out any a.c. that may reach the input grid. If C_1 opens, erratic readings result. If it shorts, any voltage applied to the input of the bridge will be bypassed, and reading will not be possible on any scale.

The d.c. multipliers, shown in Fig. 1, are switched into the circuit when the function switch of the v.t.v.m. is set to read d.c. voltage. In effect, they form a voltage divider that is tapped by the range switch, which applies voltage from the proper tap to the input grid of the bridge circuit. If trouble appears on one or more d.c. ranges but not in other functions, the multipliers may be checked with an ohmmeter for an open or shorted resistor.

Fig. 1. Switch-tapped string of d.c. multipliers, plus resistor for probe.



When the meter is set to read d.c., a calibration pot for this function, shown in Fig. 2, is also switched into the circuit in series with the meter by the function switch. If the pot is open, no readings will be possible at all. If the pot changes value appreciably or shorts, calibration will not be possible. The latter procedure consists of adjusting the pot to provide an accurate reading when a d.c. voltage value is applied. Calibration is performed, of course, after zero adjustment has been properly made. Since much switching is done in the d.c. and other functions, the switches themselves may be involved in many faults. The switches will be discussed later.

Although all circuits used for measuring a.c. are roughly similar, there is quite a bit of specific variety among them. The multipliers may be quite similar to those used for d.c. readings. However, Fig. 3 shows a commonly used variation in which the set of multipliers is broken up into two sections with the a.c. rectifier between the sections. The resistors before the rectifier protect this tube against voltages that exceed its ratings, becoming effective in dropping the input voltage, in this case, when it exceeds 150 volts. Multipliers for ranges below this value only are located after the rectifier. Purpose of the rectifier is to convert the a.c. voltage being measured to a d.c. voltage that can be applied to the bridge circuit and meter movement.

There are also several types of rectifier circuits used in v.t.v.m.'s, with the a.c. scales on the meter face calibrated to show equivalent r.m.s. values. The rectifier shown actually measures peak-to-peak voltages. It is a form of voltage doubler that measures the peak values of the positive and negative half-cycles of the input voltage and adds these together. A v.t.v.m. using this rectifier may also have a scale for reading peak-to-peak voltages. The converted r.m.s. scale will be accurate only for sinusoidal a.c. voltages.

Also switched into the circuit along with the a.c. multipliers is the balancing network shown in Fig. 3, con-

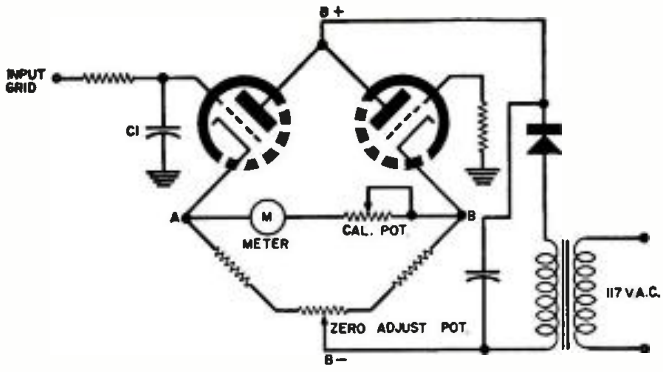


Fig. 2. The bridge, heart of the v.t.v.m., and its power supply. The version shown is typical but variations exist.

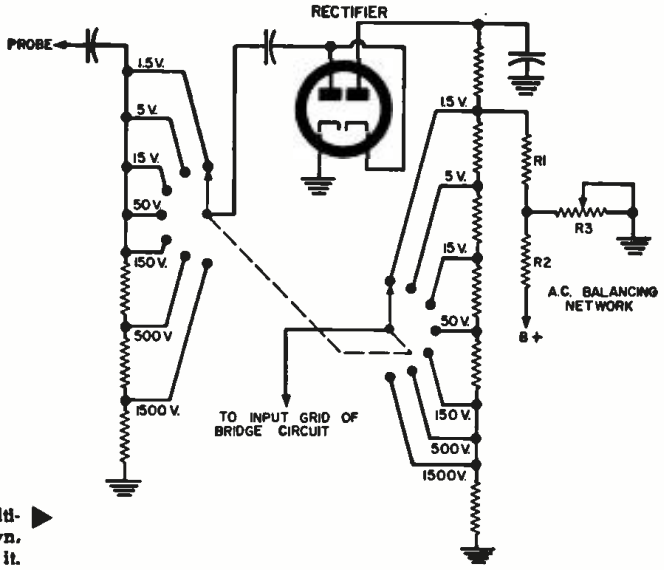


Fig. 3. The a.c. multipliers and rectifier. The multiplier string is often broken into two sections, as shown, with higher taps ahead of the rectifier to protect it. ▶

sisting of R_1, R_2, and R_3. Due to contact potential, some current will flow through the rectifier even when no voltage is being applied for measurement. Small as this current is (it may be less than a microampere), it flows through the large resistance of the multipliers to ground, and a voltage drop occurs across this divider.

Switching from the input of the multipliers to the grounded end will cause a change in the voltage applied to the input grid of the bridge. This, in turn, causes the meter pointer to move off zero when the a.c. voltage range is changed. To prevent this shift, a small variable voltage is tapped off the power supply to buck out the voltage due to contact potential. There are other methods for counteracting a.c. shift, but they can be identified if we keep in mind the fact that the principle is the same: the voltage due to contact potential must be balanced or bucked out in some fashion.

As with the d.c. multipliers, the a.c. multipliers, whether they appear before or after the rectifier, can be easily checked for open resistors, changes in value, or shorting. Substituting a new rectifier will eliminate the old one as a possible source of trouble.

When the meter is set to read a.c., a calibration pot, as shown in Fig. 2, is also used, but the a.c. calibration pot is not the same as the one used to calibrate d.c. Selection of the proper potentiometer is usually accomplished by the function switch, which also puts the correct set of multipliers in the circuit.

A common fault in the a.c. function that does not exist for others is the inability to obtain a.c. balance. This may be caused by a rectifier whose contact potential is abnormally high, and therefore cannot be bucked out, or a bucking voltage that is too low. Changing the tube and checking the bucking voltage will show where such trouble lies.

The ohmmeter section of the v.t.v.m. is shown in Fig. 4. A battery is used to apply voltage to the string of resistors. A single, 1.5-volt cell is commonly used, although higher voltages are sometimes found. Note that, when the ohmmeter function is not used, the top of the resistor string is not returned to ground. Thus the battery is not loaded and the full 1.5 volts, or whatever battery voltage is used, is available at any tap on the divider. When the meter is set to read ohms, full battery voltage is therefore applied to the input of the bridge on any range, as long as the probe is not connected to the external resistor that is to be measured. To indicate this full voltage, the meter pointer should read full-scale, on ohms, or infinity. The "ohms adjust" pot, which is switched into the position of the calibration pot shown in Fig. 2, is adjusted to give this full-scale reading before any resistance measurement is attempted.

When the external resistor to be measured is connected between the probe and ground, it is in series with one or more resistors in the string (depending on the range chosen), the entire combination appearing across the battery. Thus the external resistor forms a voltage divider with the selected range resistor(s). Since the input of the bridge taps this voltage divider, the drop from full battery voltage will cause the meter pointer to swing down from infinity or full-scale indication in proportion to the resistance being measured. Shorting the probe to ground removes all voltage from the input of the bridge and should produce a zero-resistance reading. This zero adjustment is also checked before resistance readings are attempted.

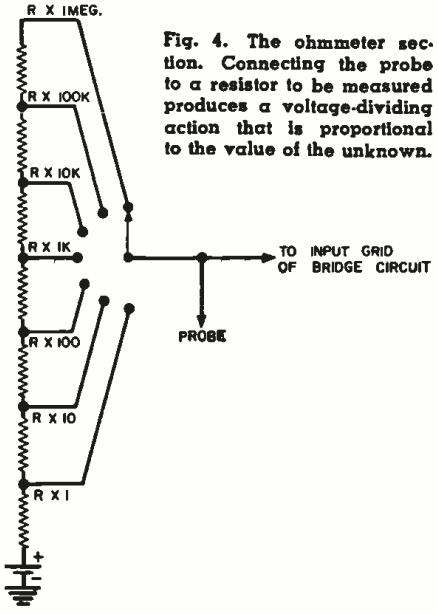


Fig. 4. The ohmmeter section. Connecting the probe to a resistor to be measured produces a voltage-dividing action that is proportional to the value of the unknown.

Inability to obtain full-scale adjustment generally indicates a weak battery. However, a change in value of a resistor in the string or of the "ohms adjust" pot may also be the cause. No movement of the meter pointer indicates an open condition in one of the resistors or the pot.

Of necessity, the various sections of the v.t.v.m. are chosen or connected together through a series of switches. To simplify the troubleshooting, the switches should also be analyzed. They are best broken down into functional switch sections, without too much regard as to which sections are ganged together on the same switch, so that each section can be considered separately.

Of the five functional sections generally found, one connects the probe to the proper set of multipliers for the type of measurement desired. Another switch section connects the output of the multipliers being used to the input of the bridge. A third section connects the proper calibration or "ohms adjust" potentiometer in series with the meter. This section usually also has a position for reversing the connections to the meter so that negative instead of positive d.c. voltages can be read without changing external probe connections. The sections already mentioned are usually associated with the function selector.

The fourth section selects the proper taps on the a.c. or d.c. voltage multipliers and the fifth chooses the desired tap on the string of "ohms" resistors.

(*Continued on page* 121)

New Tube Tester Data

Additional listings for the charts of five Sylvania tube testers: Models 137, 139, 140, 212, and 220.

MODELS 137, 139, AND 140

TYPE	A	B	C	D	E	F	G	TEST
6EM5	6.3	0	4	0	4	026	23	Y
	6.3	0	6	0	4	024	23	Y
6EW6	6.3	0	—	0	4	36	32	V
12AF3	12.6	0	3	0	4	—	17	Y
12DS7	12.6	0	—	0	3	67	37	X
	12.6	0	—	0	1	—	84	T
	12.6	0	—	0	4	—	84	T
12DT5	12.6	0	4	0	4	026	24	Y
	12.6	0	6	0	4	024	24	Y
12DV7	12.6	0	5	0	3	7	76	T
	12.6	0	5	0	2	—	63	X
	12.6	0	5	0	5	—	63	X
				Special Test				
12ED5	12.6	0	5	0	3	26	20	X
	12.6	0	2	0	3	56	20	X
17DE4	12.6	0	7	1	3	—	17	Y
18FW6	12.6	0	—	0	4	36	33	W
18FX6	12.6	0	—	0	5	3	59	X
	12.6	0	—	0	4	64	33	V
18FY6	12.6	0	—	0	3	3	47	T
	12.6	0	—	0	4	—	55	T
	12.6	0	—	0	5	—	55	T
32ET5	35	0	5	0	3	26	24	Y
	35	0	2	0	3	56	24	Y
36AM3	35	0	6	0	4	—	18	Y
	35	0	6	2	4	—	18	Y
7199	6.3	0	—	0	2	067	64	W
	6.3	0	—	0	1	5	20	W

MODELS 212 AND 220

TYPE	A	B	C	D	E	F	G	K
6EM5	6.3	4	56	17	5	013Z	9	7
	6.3	4	35	17	5	016Z	9	7
6EW6	6.3	3	4	67	4	16SU	5	2
12AF3	12.6	4	25	12	4	Z	9	1
				Use External Adapter				
12DS7	12.6	4	5	25	5	37SU	6	8
	12.6	4	5	39	5	T	1	8
	12.6	4	5	39	5	T	9	8
12DT5	12.6	4	56	19	5	013Z	9	7
	12.6	4	35	19	5	016Z	9	7
12DV7	12.6	4	159	37	5	7T	6	8
	12.6	4	589	44	5	T	2*	1
	12.6	4	589	44	5	T	3*	1
12ED5	12.6	3	45	15	4	26V	7	1
	12.6	3	24	15	4	56V	7	1
17DE4	19.0	7	8	11	8	Z	5	3
18FW6	19.0	3	4	45	4	16Z	5	7
18FX6	19.0	3	4	40	4	067T	5	2
	19.0	3	4	30	4	1X	6	2
18FY6	19.0	3	4	35	4	1T	7	2
	19.0	3	4	40	4	T	6*	2
	19.0	3	4	40	4	T	5*	2
32ET5	35.0	3	24	18	4	56Z	7	1
	35.0	3	54	18	4	26Z	7	1
36AM3	35.0	3	46	12	4	Z	5*	7
	35.0	3	46	12	6	Z	5*	7
7199	6.3	4	58S	50	5	037Z	2	6
	6.3	4	56	15	5	9Y	1	8

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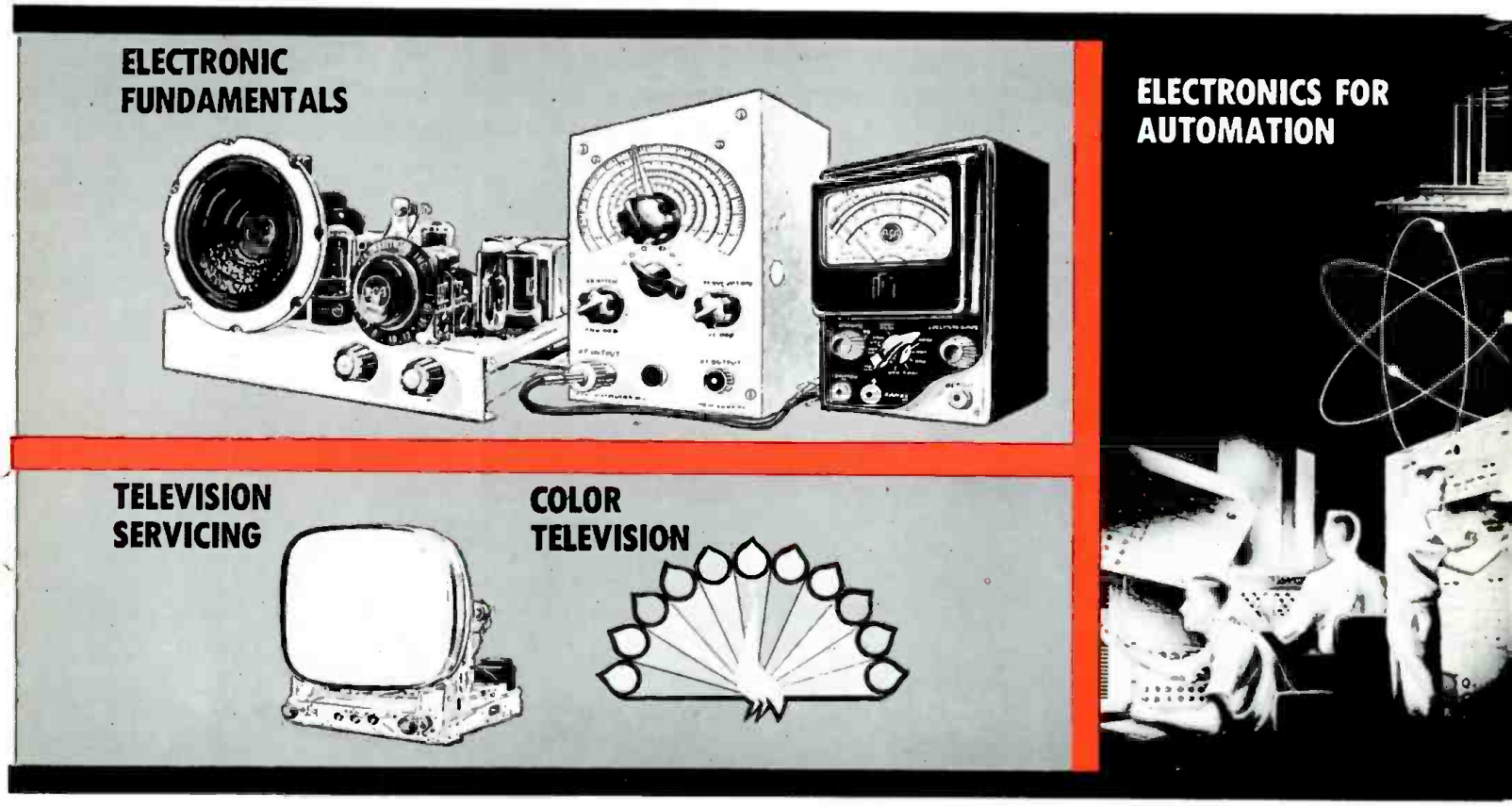

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Troubleshoot Your V.T.V.M.

(*Continued from page* 117)

These sections are associated with the range switch.

The principal problems in which switches become involved are leakage and dirty or worn contacts. Dirty or worn contacts can generally be detected by visual inspection, with the large number of contacts involved in all switch sections being the chief difficulty to this check. However, the technique of isolating a defect to a particular portion of the v.t.v.m. circuit, already described, reduces the number of contacts to be inspected to a reasonably small number. With this narrowing down, it is relatively simple to check the few contacts that may be involved. Conventional methods for cleaning or repairing a contact or contacts thus found to be faulty may then be followed.

As for leakage through switch sections in the voltage-measuring functions, a comparison v.t.v.m. known to be good and a source of fairly high voltage can be used. A thousand volts, or as close to it as may be obtained, should be used. The v.t.v.m. known to be operating properly is connected across the voltage source, and the reading is noted. This meter is left connected and the v.t.v.m. suspected of leakage is then connected across the source in addition. If this causes a significant drop in the voltage reading on the v.t.v.m. known to be good, then excessive loading by the suspected instrument is probable, and a leaky or shorted switch is the likeliest cause.

This still leaves several switch sections probably involved, but further localization is possible: the input to the range switch on the suspect unit is clipped off and the test is repeated. If the loading effect is still noted, the function switch should be investigated for leakage; if the loading effect disappears, the range switch is probably at fault.

Calibration of a v.t.v.m. may be performed with sufficient accuracy by using materials generally available in every service shop. The filament transformer of a tube checker is an excellent source of variable a.c. voltage. Fresh batteries offer an accurate source of d.c. If multiplier resistors are correct in value, calibration on one range should be enough to bring the instrument up to tolerance on all ranges.

For troubleshooting purposes, the basic philosophy has already been stated: isolation to a specific section is essential in that it reduces the components possibly involved to a small enough number so that they may be individually checked without much inconvenience. This, plus a general understanding of the instrument's circuitry, is sufficient to enable the rapid and fairly simple detection and correction of the faults most likely to be encountered. —30—

New Audio Test Report

LAB TESTED
ELECTRONICS WORLD

"KNIGHT" SHELF-TYPE SPEAKER SYSTEM

THE advent of stereo has brought with it a rash of shelf-type or bookshelf speaker systems. The compactness of these systems makes it very convenient to tuck away a pair of the units in a moderately sized listening room. The big problem with a compact enclosure has been its performance compared to a larger, more space-consuming enclosure. Much effort has been expended by manufacturers in getting the maximum possible quality of reproduction from these compact units—and with various degrees of success. The better systems use specially designed loudspeakers in acoustically matched enclosures. The best results obtainable compare quite favorably with many larger systems, some of which may not represent an optimum design.

A recent entry in the field of shelf-type speaker systems is *Allied Radio's* "Knight" KN-3000 shown here. In its 2-cubic foot volume, there is a special high-compliance 12-inch woofer along with two Janszen-designed push-pull electrostatic radiators. The radiators are each 6 inches square and are capable of producing useful output from 700-1000 cps up to the upper frequency limit of human hearing. In this system, the crossover frequency is around 2000 cps. The two high-frequency units are mounted in such a way as to improve the high-frequency dispersion of the system.

The special woofer, with its ceramic magnet, uses die-cast aluminum rings to weight the apex of the cone. Because of the increased mass and high compliance, the resonant frequency of the unmounted woofer is only about 25 cps. When mounted in its 2-cubic foot enclosure, this resonance rises to about 55 cps.

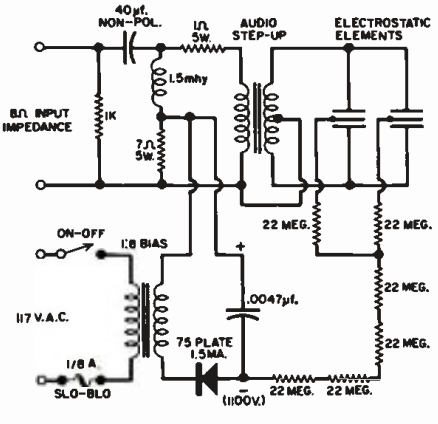
The enclosure itself, measuring 26½" wide by 14" high by 13" deep, is made

of ¾" stock, finished on four sides so that it can be used either horizontally or vertically. No ducts or ports are employed and the cabinet is lined on three sides with half-inch fiberglass. Mounted inside the enclosure on the back panel is the crossover network and the 1100-volt power supply for the electrostatic speakers (see diagram below). No high-frequency level control is provided as this would upset the impedance characteristics of the system. Instead the outputs of both high- and low-frequency sections have been matched for flattest response. Any desired adjustments can be made easily with the amplifier tone controls.

The over-all acoustic response of the system was measured (on axis) in an anechoic room and it was found to be within about ±3 db from 47 cps to around 10 kc. (except for a narrow dip just above 7 kc.) with respect to a common reference level. Measurements taken about 15 degrees off axis showed high-frequency response within ±3 db out to about 17 kc. Actual low-frequency performance of the system would be even better when used near a room wall or particularly in a live corner. Also, listening in a live room and at various positions would result in substantial output up to and beyond 20 kc. High-frequency distortion measurements were also taken and a comparison was made with a high-quality 8-inch cone speaker. The latter had a total harmonic distortion ranging from 1.8 to 5.6 per-cent in the frequency range 1000 to 10,000 cps. A single unselected electrostatic radiator was checked and distortion ranged from .16 to .5 per-cent in the same frequency range. These measurements were taken at a power input level of 3 watts, although the KN-3000 will readily handle 50 watts of musical program material.

A listening test of the new system disclosed the clean, transparent upper mid-range and highs associated with high-quality electrostatic speakers. The bass may be a little thin for some ears unless the system is placed in a corner. In general, the over-all per-

Fig. 1. Schematic diagram of the crossover network and 1100-volt power supply for the electrostatic radiators in system.



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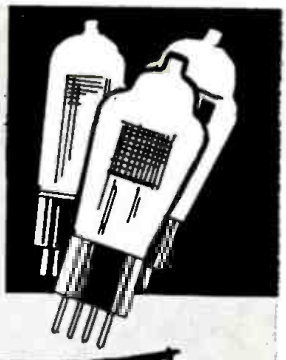

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OZ4	3BC5	6AB4	6BA6	6CL6	6S8GT	7B5	12AT7	12SJ7	38
1A7GT	3BN6	6AC7	6BC5	6CM6	6SA7	7B6	12AU6	12SK7	39/44
1B3GT	3BZ6	6AF4	6BC8	6CM7	6SD7GT	7B7	12AU7	12SN7GT	41
1C6	3C86	6AG5	6BD6	6CN7	6SF5	7B8	12AV6	12SQ7	42
1C7	3Q4	6AH4GT	6BE6	6CQ8	6SF7	7C4	12AV7	12V6GT	43
1F4	3S4	6AH6	6BF5	6CR6	6SG7	7C5	12AX4GT	12W6GT	45
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
1T4	5AV8	6AS5	6BQ7	6F6	6V6GT	7H7	12BH7	19T8	75
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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formance of the two-way system, which costs $129.50, is good with a minimum amount of tone coloration and a maximum amount of presence.

DUAL 4-WATT STEREO AMPLIFIER KIT

ONE of the simplest of all integrated stereo amplifiers that we have seen to date is *EICO's* Model AF-4. Not only is the design and construction simple, but it provides about the lowest power output, 4 watts per channel, that is available in component design. The unit consists of two single-ended amplifiers with 27 db of negative feedback in each channel.

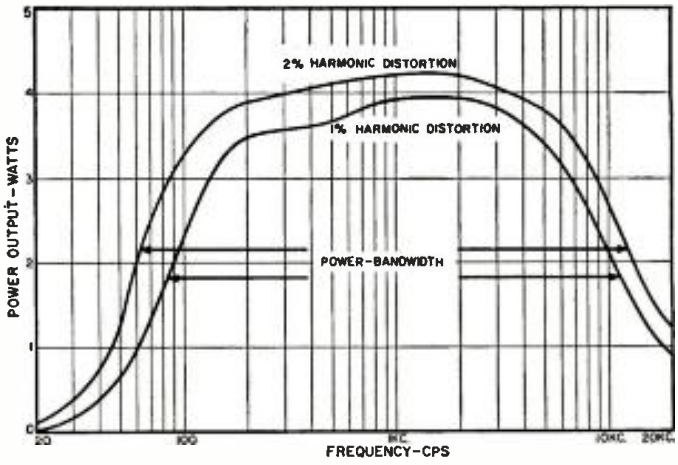
Neither we nor the manufacturer refer to this unit as a truly high-fidelity design, but it does provide a good quality of reproduction for its price. It is ideal for the youngster, for the novice kit builder, or for the economy minded.

It features separate stereo pairs of inputs for ceramic or crystal cartridges and stereo tape. Note that this unit is not sensitive enough for use with magnetic cartridges. Inputs are also provided for AM and FM tuners and an FM multiplex adapter. In addition to these features, it also includes a switch to parallel both power amplifiers to provide 8 watts output. A separate power amplifier could then be used to drive a second stereo speaker system.

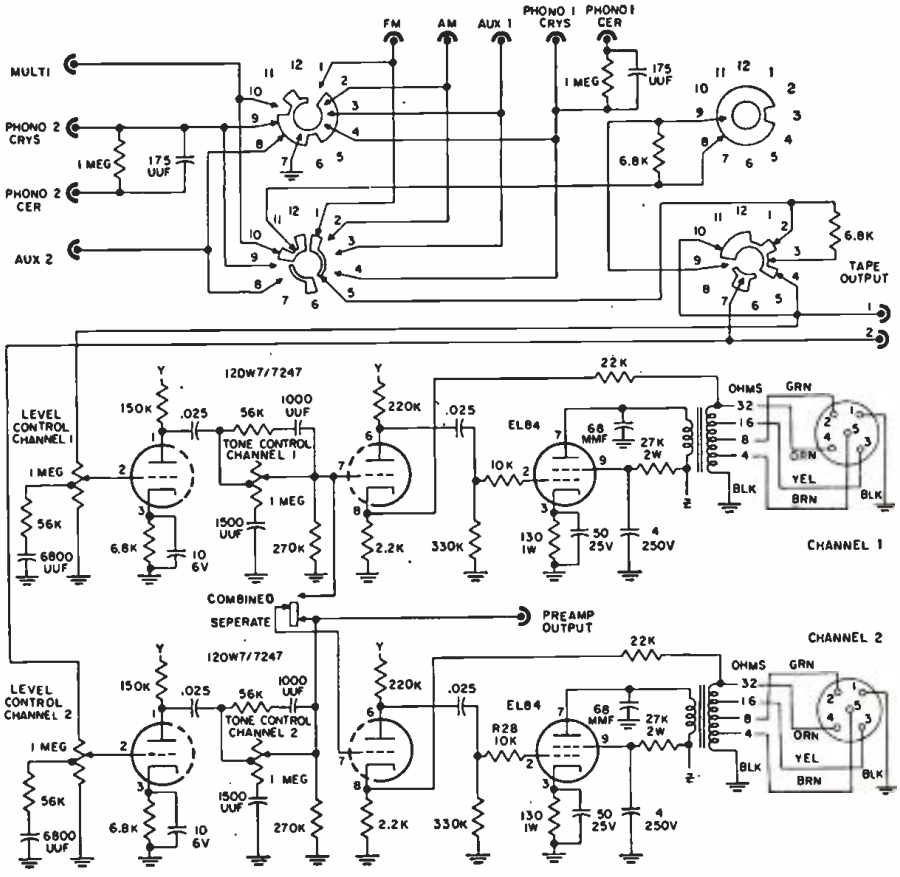
Our lab results are as follows:

Sensitivity: (for 4 watts output at 1000 cps). Crystal and all low-gain circuits, .113 volt; ceramic input, .275 volt.

Frequency response: + 1 db, −0 db



Response curve of the EICO Model AF-4 stereo amplifier. The unit is rated 4 watts power output per channel and is designed for those not requiring true hi-fi.



Schematic diagram of the AF-4 dual stereo amplifier. The conventional power circuit, using an EZ-81 full-wave rectifier tube, is omitted.

The AF-4 4-watt stereo amplifier.

from 30 to 15,000 cycles per second.

Bass control: In view of circuit simplification, only bass attenuation is provided, −11.7 db at 30 cps.

Treble control: Only treble attenuation is provided, −15 db at 15 kc.

Loudness control: Although no separate loudness control is provided, the design incorporates a loudness control circuit that provides about 6 to 8 db bass boost at low levels.

Harmonic distortion: To conform to the standards set up by the Institute of High Fidelity Manufacturers, we have included power output curves taken at 1% and 2% total harmonic distortion. Note that these are power response measurements and do not represent the frequency response of the unit. The input signal was not kept constant but adjusted to produce a constant level of distortion in the amplifier output.

Another standard set up by the Institute is that of power-bandwidth taken at the −3 db points. This amplifier could be rated as a 4.2-watt unit at 2% distortion from about 62 cps to 13 kc. It could also be rated as a 3.9-watt unit at 1% distortion from about 85 cps to 12 kc.

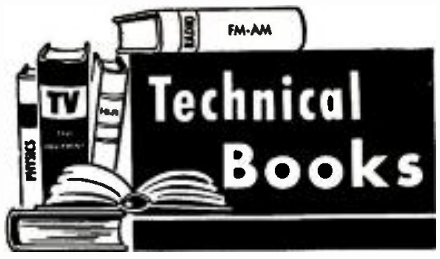
Channel separation: At 1000 cps, 37 db.

Hum: (from 2 watts output). All low-gain circuits, −61 db for shorted input and −46 db for open-circuit input; ceramic input, −46 db for shorted input and −36 db for open-circuit input.

IM distortion: The Institute of High Fidelity Manufacturers has omitted, at least for the time being, IM distortion measurements from its new standard on amplifiers. There is a legitimate reason for this as can be seen in this example. On this particular unit the IM distortion measured at 2 watts was 4.4% and at 3 watts it was 13.2%. These figures are extremely high compared to the 1% figure which we have used as our standard in the past. The figures obtained in this case are not truly indicative of IM distortion alone, however.

In view of the reduced bass response of this amplifier, the IM distortion characteristic, when using 60 and 6000 cps at a 4:1 ratio, is found to be abnormally high as it combines the effect of the amplifier's low bass response. If we had used 100 and, say, 5000 cps the IM distortion measurement would have been more reasonable.

The price of the unit is $38.95 in kit form and $64.95 wired. —30—



"101 WAYS TO USE YOUR SIGNAL GENERATOR" by Robert G. Middleton. Published by *Howard W. Sams & Co., Inc., Indianapolis.* 117 pages. Price $2.00. Soft Cover.

This is a companion volume to the author's books on using the sweep generator, oscilloscope, the v.o.m. and v.t.v.m. The format is identical to the previous "101 Ways" books and covers equipment checks, antenna tests, AM-FM receiver tests, TV receiver tests, component tests, and miscellaneous applications.

The text material is lavishly illustrated with schematics, block diagrams, and photographs with commentary held to a minimum. Each "Way" has sections covering the equipment needed, the required connections, the procedure to be followed, and an evaluation of the results obtained by means of the tests.

We believe that amateurs, experimenters, and hobbyists will find this book almost as useful as the professional radio and television technician for whom it was originally prepared.

* * *

"BASIC ELECTRONICS" by Van Valkenburgh, Nooger & Neville, Inc. Published by *John F. Rider Publisher, Inc.,* New York. 123 pages. Price $2.90. Soft binding. (Vol. 6 in series).

This is a companion volume to the five-volume "course" on basic electronics and has been prepared to permit individuals, schools, and industrial programs to upgrade their training to expand into areas of semiconductors, transistors, and frequency modulation (fields not covered in the first five volumes).

As was the case with the "Basic Electronics" course, the text uses the "picture" approach. The text material on each page carries with it a specially conceived illustration which amplifies and clarifies the discussion. The first half of the book deals with semiconductors and transistors while the second section covers the fundamentals of frequency modulation—including both transmitters and receivers.

Those who have completed the "Basic Electronics" course represented by the first five volumes will find this a welcome and instructive extension of the original material.

* * *

"SIMPLIFIED RADIO SERVICING BY COMPARISON METHOD" by M. N. Beitman. Published by *Supreme Publications,* Highland Park, Ill. 46 pages. Price $1.50. Soft binding.

This handbook is intended to help technicians speed repair jobs by eliminating aimless and time-consuming prodding of radio chassis. The text outlines simple tests which may be made to obtain electrical, visual, and other reactions from radio parts and circuits and explanations how to determine if the indications thus secured are "normal" or "abnormal."

The first section of the book covers symbols and abbreviations; practical electrical facts; resistors, capacitors, coils; reading schematics; the mechanical parts of the radio; printed circuitry; vacuum tubes and transistors; etc. The balance of the text covers specific circuits including screen-grid t.r.f. sets, small a.c.-d.c. receivers, small superhets, a.v.c., vibrator power supplies, early and modern auto radios, battery portables, combination portables, transistor portables, and test equipment.

A handy index at the back of the book guides the user to the pertinent circuit or component that comparison testing has indicated at fault. —30—

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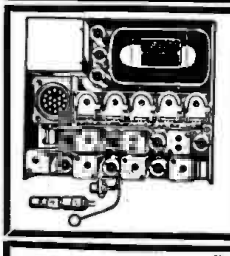

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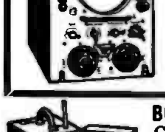

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$48.50 Complete with Tubes

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Earphone Cushions for above—pair..... .50

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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	5.50
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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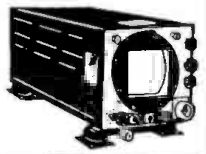
51 Vesey St., New York 7, N. Y.

ASB-5 'SCOPE INDICATOR



BRAND NEW, including all tubes, together with 5BP1 'Scope Tube. Originally used in Navy Aircraft RADAR equipment. Easily converted for AC operation.
VALUE $250.00!
OUR LOW PRICE... **$16.95**

ARC-5/R28 RECEIVER

2-meter Superhet. 100 to 156 Mc in 4 crystal channels. Complete with 10 Tubes. BRAND NEW **$24.45**
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**
SPECIAL OFFER! Limited quantity ARC-5/T23 xmitters. Excellent Used, less tubes..... $5.95
MD-7 MODULATOR for T-23, complete with 4 tubes. LIKE NEW..... **$9.95**

ARC-5 MARINE RECEIVER-TRANSMITTER

Navy Type Comm. Receiver 1.5 to 3 Mc BRAND NEW with 6 tubes..... **$16.95**
Navy Type Comm. Transmitter 2.1-3 Mc BRAND NEW with 4 tubes and Xtal **$12.45**
MODULATOR for above, new with tubes..... $5.95

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

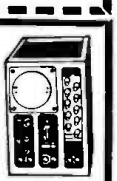
ALL COMPLETE WITH TUBES

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-450	3-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**
BC-459 TRANSMITTER—7-9.1 Mc. complete with all tubes and crystal. **$13.95**
ARC-5/T-19 TRANSMITTER—3 to 4 Mc. BRAND NEW complete with all tubes & crystal **$10.95**
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.

BC-603 FM RECEIVER



20 TO 27.9 MC. **$12.95**
Used.....
Like New $14.95
BRAND NEW.....$16.95
Convert to 20-50 Mc., and A.M.! (See CQ Sept. '58).
10 Channel, pushbutton tuning or continuous tuning. Complete with speaker, tubes, squelch.

12 or 24V Dynamotor for Above Exc. Used $4.25.....Brand New $5.50
BC-683 same as above except 27 to 38.9 Mc. Used **$23.50**
Brand New $27.50

AC POWER SUPPLY FOR BC603, 683
Interchangeable, replaces dynamotor. Has On-Off Switch. NO RECVR. CHANGE NEEDED. Provides 220 VDC @ 80 Ma. 24VAC @ 2 Amps..... $10.49
Complete 240-page Technical Manual for BC-603, 604 .....$2.95

BC-604 TRANSMITTER—Companion unit for BC-603 Recvr above. With all tubes.
BRAND NEW..... **$10.95**

BC-684 TRANSMITTER—Companion unit for BC-683 Recvr above. Complete with all tubes.
Like NEW..... **$7.95**
BRAND NEW..... **$12.95**

POWER SUPPLY for BC-620, 659, available for 6, 12 or 24 Volts DC. Specify..... **$8.95**

BC-659 TRANSMITTER & RECEIVER

27 to 38.9 Mc. F.M. Two preselected channels crystal controlled. 5 to 10 watts. Complete with speaker, tubes. Exec. Used..... **$11.95**
Less tubes, exec. used.....$7.95
Antenna for BC-659. Telescoping 20" to 8-Ft.....$2.95

WILLARD 6-VOLT MIDGET STORAGE BATTERY

3 Amp. Hour. BRAND NEW. 3⅝" x 1-13/16" x 2¾". Uses Standard Electrolyte .....Only $2.95

2 VOLT BATTERY "PACKAGE"

1—2V. 20 Amp. Hr. Willard Storage Battery. Model #20-2. 3" x 4" x 5½" high..... $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**

Service Industry News

NOTEWORTHY developments this month include the fact that the impact of the manufacturer-propelled campaign to "Buy American" is being felt on the service level and another fact that is something of an oddity: two highly regarded officials of an important east-coast association have resigned their offices—to the satisfaction of their supporters.

The latter puzzler obviously needs further clarification—so we'll hold you in suspense for a while. As to the first point, association officials are far from showing the unanimity expressed by the EIA in urging a virtual boycott of Japanese (and other foreign-made) electronic products to preserve the American economy. The "Hoosier Test Probe," organ of IESA of Indiana, says, "If the American standard of life is to be maintained, each of us must do our part. That foreign car or truck you purchase tends to steal pay from your customer, the auto worker. Likewise, when you sell foreign-made products to your customers, that many sales are lost to American business." Note is taken of the argument that the domestic economy, if it is forced to compete against other economies with lower standards of living, runs the risk of a similar lowering.

The Electronic Assn. of Mo., in its "TEAM News," does not take a final stand on the issue, but does note the existence of arguments on the other side of the fence. It points out the possibility that it may be important for us, in our own interests, to give needed support to the economies of other countries by acting as their customers. The healthy stimulus that outside competition can provide is also mentioned: "U. S. manufacturers talked vaguely for ten years or more about the 'coming' vest pocket radios. Only since foreign competition has put a burr under their tail have U. S. manufacturers made any effort to build them . . . Small, economical, foreign cars also pointed out a potential market which American motor car builders had ignored."

Another interesting point in this dispute is the ambiguous position in which some domestic manufacturers find themselves. On the one hand, they urge that finished products brought in from abroad be shunned in favor of their own competitive merchandise. On the other hand, how many of them are using foreign-made components (transistors, capacitors, etc.) in their "American-made" units? Like "TEAM News," we have no final answer.

Resignations in ESFETA

New York's Empire State Federation has seen the resignation, in rapid succession, of two high-ranking officers: Bob Larsen, president, and George Carlson, secretary. While both have been very active, neither action reflects strife within ESFETA or a weakening of that organization. Larsen was simultaneously serving as president of ESFETA and of its local affiliate (RTGLI) on Long Island. In addition, he is now devoting most of his efforts to what he considers the most important project before the service industry in his state; the development of an acceptable licensing law that will have a good chance of being passed by the state legislature and the maintenance of close contact with state officials to the end that such a law will indeed be passed. Feeling that he could not do full justice to all three responsibilities at once, he let the ESFETA presidency go.

George Carlson has dropped out for somewhat similar reasons. His election as NATESA's eastern secretary left him with too much for one man.

Newly elected ESFETA officers include Irv Toner of Buffalo, president; Bob Henderson of Long Island, vice-president; O. Capitelli of New York City, recording sec'y.; and Mel Cohen of northeastern New York, corresponding sec'y.

NCFEA Technician Training

The North Carolina Federation of Electronic Associations, in cooperation with the State Educational Department, is in the midst of an extensive campaign to make sure that TV service technicians are adequately trained and to issue cards to those found qualified.

Ed Kemp of NCFEA (right) issues certification card to Joseph Warren. On hand are Kenneth LaRue (left), NCFEA head, Bruce Roberts, a director of education program, and instructor Jim Hornaday.

Any full-time service technician may take a qualifying test on a voluntary basis. If he passes (he may try a second time, if he fails the first test) he receives a card certifying him as a "TV serviceman." If he cannot pass, he may enter a "journeyman" course of instruction, following the successful completion of which he receives the card.

There is also an advanced course, including color TV. Successful completion entitles the student to a card certifying him as a "TV technician." The cards are expected to help the public identify competent men and also assist those who may be seeking employment or employees. North Carolina technicians interested in the program should contact local Directors of Vocational Education or L. L. Leathers, chairman of the NCFEA Educational Committee, 221 Southerland St., Durham, N. C.

Miami Robbery

With the onset of the winter season, a new wave of break-ins and thefts is striking the Miami area, as it did last year. *George's Radio & TV Hospital* of that city suffered a loss of about $4000, only part of which was covered by insurance. The thieves chose Saturday night to break into the back door, pull up a truck, and make off with an extensive stock of new car radios, a tube caddy, test equipment, and electric drills.

Similar waves of thefts, giving the appearance of systematic technique, have occurred in parts of Indiana, Texas, and other areas of the country. TV receivers are also taken on these forays, many of the sets belonging to customers. The thieves have been showing quite a bit of judgment in the value of the equipment they have been taking or leaving behind. The uptrend in robberies gives greater urgency to the demands by service associations that set manufacturers begin stamping serial numbers and other identifying markings in such a way that they cannot be removed easily. The present difficulty in tracing stolen equipment encourages highjacking.

Service Fees

President Lou Ristau of TSA of Northeastern New York is urging the recommendation of a minimum fee of $5.50 for a service call. He gives some impressive statistics to show that anything less must be unprofitable. Some west-coast groups are urging minimum fees of $7 and $7.50.

ARTS Officers

The last semi-annual meeting of Associated Radio and Television Servicemen, Chicago, Ill., voted in a new slate of officers as follows: Joseph Ehlinger, chairman; Harold Mueschen, vice-chairman; Yuki Minaga, secretary-treasurer; and Delmar Kotrba, sergeant-at-arms. Carried over from last year were Anthony Mallin as historian and Stephen Jacyna as press representative. -30-

RCA TUBE TYPES

RCA, Electron Tube Division, Commercial Engineering, Harrison, N. J., has issued a revised edition of its list of preferred tube types for new equipment design. A free copy of this pamphlet, No. PTL-501G, may be obtained from the company on request.

This revised and expanded list covers entertainment types, including TV picture tubes; vacuum types for r.f. and a.f. power applications; vacuum types for pulsed-power applications; "Special Red," voltage-regulator, glow-discharge, and computer types; thyratrons, power rectifiers, oscillograph tubes, storage tubes, phototubes, and photoconductive cells; broadcast camera and television studio types; and industrial television types.

NEWARK ELECTRIC CATALOGUE

Newark Electric Company, 223 West Madison Street, Chicago 6, Ill., is now distributing its new "1960 Industrial Electronics Catalogue," No. 70. Free copies of the catalogue are available through the firm's branch at 4747 W. Century Blvd., Inglewood, Calif., or at the main office in Chicago.

Geared specifically to the industrial user, the catalogue features wide range of quantity price breakdowns. The entire book is fully illustrated and contains comprehensive descriptions of all listed items. A separate "Product" and "Manufacturer" index facilitates easy, faster reference to any specific item listed.

SWITCHING TRANSISTORS

Sylvania Electric Products Inc., 1100 Main Street, Buffalo 9, N. Y., has published a new booklet entitled, "Medium and High Speed Switching Transistors." Copies may be obtained direct from the company.

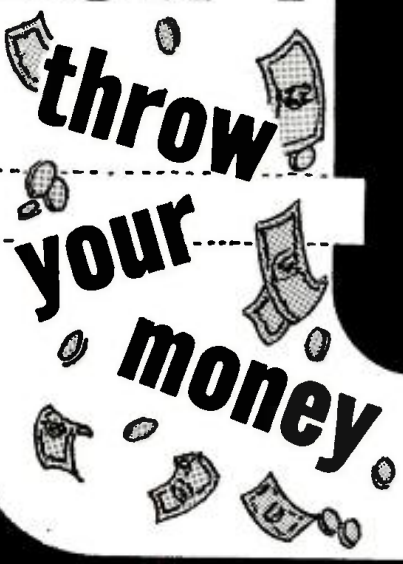
The 24-page booklet lists maximum ratings and electrical characteristics for all *p-n-p* and *n-p-n* medium and high speed types in the firm's switching transistor line. It also contains nine transistor switching time measurement circuits, diagrams illustrating mechanical specifications and connections, and a section on transistor switching time requirements.

SERVICING TRANSISTORS

CBS Electronics, 100 Endicott Street, Danvers, Mass., is making available a new bulletin entitled, "Servicing Transistor Equipment." It may be obtained through the firm's transistor and tube distributors or direct from the company's Information Services.

Written by Robert "Bud" Tomer, the bulletin recommends tools and equip-

DON'T throw your money down the drain . . .



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___	0Z4M	.79	___	4BA6	.51	___	6AN4	.95	___	6CD6	1.42	___	7A8	.68	___	12AU7	.60	___	12DL8	.85	___	17L6	.58
___	1AX2	.62	___	4BC5	.56	___	6AN8	.85	___	6CF6	.64	___	7B6	.69	___	12AV5	.97	___	12DM7	.67	___	17W6	.70
___	1B3GT	.79	___	4BC8	.96	___	6AQ5	.50	___	6CG7	.60	___	7Y4	.69	___	12AV6	.41	___	12DQ6	1.04	___	19AU4	.83
___	1DN5	.55	___	4BE6	.54	___	6AR5	.55	___	6CG8	.77	___	8AU8	.83	___	12AV7	.75	___	12DS7	.79	___	19BG6	1.39
___	1G3	.73	___	4BN6	.75	___	6AS5	.60	___	6CM7	.66	___	8AW8	.93	___	12AX4	.67	___	12DZ6	.56	___	19T8	.80
___	1J3	.73	___	4BQ7	.96	___	6AT6	.43	___	6CN7	.65	___	8BQ5	.60	___	12AX7	.63	___	12EL6	.50	___	21EX6	1.49
___	1K3	.73	___	4BS8	.98	___	6AT8	.79	___	6CR6	.51	___	8CG7	.62	___	12AZ7	.86	___	12EG6	.54	___	25AU4	.87
___	1L6	1.05	___	4BU8	.71	___	6AU4	.82	___	6CS6	.57	___	8CM7	.68	___	12B4	.63	___	12EK6	.56	___	25BQ6	1.11
___	1LA6	.69	___	4BZ6	.58	___	6AU6	.50	___	6CU5	.58	___	8CN7	.97	___	12BA6	.50	___	12EZ6	.53	___	25C5	.53
___	1LC6	.79	___	4BZ7	.96	___	6AU7	.61	___	6CU6	1.08	___	8CX8	.93	___	12BD6	.50	___	12F5	.66	___	25CA5	.59
___	1LN5	.59	___	4CB6	.59	___	6AU8	.87	___	6CY5	.70	___	8EB8	.94	___	12BE6	.53	___	12F8	.66	___	25CD6	1.44
___	1R5	.62	___	4CS6	.61	___	6AV6	.40	___	6CY7	.71	___	10DA7	.71	___	12BF6	.44	___	12FM6	.45	___	25CU6	1.11
___	1S5	.51	___	4DE6	.62	___	6AW8	.89	___	6DA4	.68	___	11CY7	.75	___	12BH7	.73	___	12K5	.65	___	25DN6	1.42
___	1T4	.58	___	4DK6	.60	___	6AX4	.65	___	6DB5	.69	___	12A4	.60	___	12BK5	.70	___	12SA7M	.86	___	25EH5	.55
___	1U4	.57	___	4DT6	.55	___	6AX7	.64	___	6DE6	.58	___	12AB5	.55	___	12BL6	.56	___	12SK7GT	.74	___	25L6	.57
___	1U5	.50	___	5AM8	.79	___	6BA6	.49	___	6DG6	.59	___	12AC6	.49	___	12BQ6	1.06	___	12SN7	.67	___	25W4	.68
___	1X2B	.82	___	5AN8	.86	___	6BC5	.54	___	6DQ6	1.10	___	12AD6	.57	___	12BY7	.74	___	12SQ7M	.73	___	25Z6	.66
___	2AF4	.96	___	5AQ5	.52	___	6BC7	.94	___	6DT5	.76	___	12AE6	.43	___	12BZ7	.75	___	12U7	.62	___	35C5	.51
___	2BN4	.60	___	5AT8	.80	___	6BC8	.97	___	6DT6	.53	___	12AF3	.73	___	12C5	.56	___	12V6GT	.53	___	35L6	.57
___	2CY5	.71	___	5BK7A	.82	___	6BD6	.51	___	6EU8	.79	___	12AF6	.49	___	12CA5	.59	___	12W6	.69	___	35W4	.52
___	3AL5	.42	___	5BQ7	.97	___	6BE6	.55	___	6EA8	.79	___	12AJ6	.46	___	12CN5	.56	___	12X4	.38	___	35Z5GT	.60
___	3AU6	.51	___	5BR8	.79	___	6BF6	.44	___	6EB8	.94	___	12AL5	.45	___	12CR6	.54	___	17AX4	.67	___	50B5	.60
___	3AV6	.41	___	5CG8	.76	___	6BG6	1.66	___	6H6GT	.58	___	12AL8	.95	___	12CU5	.58	___	17BQ6	1.09	___	50C5	.53
___	3BA6	.51	___	5CL8	.76	___	6BH6	.65	___	6J5GT	.51	___	12AQ5	.52	___	12CU6	1.06	___	17C5	.58	___	50DC4	.37
___	3BC5	.54	___	5EA8	.80	___	6BH8	.87	___	6J6	.67	___	12AT6	.43	___	12CX6	.54	___	17CA5	.62	___	50EH5	.55
___	3BE6	.52	___	5EU8	.80	___	6BJ6	.62	___	6K6	.79	___	12AT7	.76	___	12DB5	.69	___	17D4	.69	___	50L6	.61
___	3BN4	.63	___	5J6	.68	___	6BK5	.80	___	6S4	.48	___	12AU6	.50	___	12DE8	.75	___	17DQ6	1.06	___	117Z3	.61
___	3BN6	.76	___	5T8	.81	___	6BK7	.85	___	6SA7GT	.76												
___	3BU8	.78	___	5U4	.60	___	6BL7	1.00	___	6SK7GT	.74												
___	3BY6	.55	___	5U8	.81	___	6BN4	.57	___	6SL7	.80												
___	3BZ6	.55	___	5V6	.56	___	6BN6	.74	___	6SN7	.65												
___	3CB6	.54	___	5X8	.78	___	6BQ5	.65	___	6SQ7	.73												
___	3CF6	.60	___	5Y3	.46	___	6BQ6GT	1.05	___	6T4	.99												
___	3CS6	.52	___	6AB4	.46	___	6BQ7	.95	___	6T8	.80												
___	3CY5	.71	___	6AC7	.96	___	6BR8	.78	___	6U8	.78												
___	3DE6	.62	___	6AF3	.73	___	6BS8	.90	___	6V6GT	.54												
___	3DK6	.60	___	6AF4	.97	___	6BU8	.70	___	6W4	.57												
___	3DT6	.50	___	6AG5	.65	___	6BY6	.54	___	6W6	.69												
___	3Q5	.80	___	6AH6	.99	___	6BZ6	.54	___	6X4	.39												
___	3S4	.61	___	6AK5	.95	___	6BZ7	.97	___	6X5GT	.53												
___	3V4	.58	___	6AL5	.47	___	6C4	.43	___	6X8	.77												
___	4AU6	.54	___	6AM8	.78	___	6CB6	.54	___	7AU7	.61												

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ment for servicing transistor sets. It describes current and voltage measurements and includes a section on balancing output transistors.

Special precautions necessary when servicing transistor equipment are explained; they cover the use of ohmmeters and variable power supplies, the importance of test voltage polarities, and the dangers of testing by shorting circuits.

The author also covers transistor signal tracing and offers some practical hints on the use of high-power transistors.

RADIO SHACK HANDBOOK

Radio Shack Corp., Boston 17, Mass., is offering a semiconductor engineering guide keyed to the needs of both the engineer and the purchasing agent. Copies may be obtained by writing direct to the company, I & G Division.

The book includes two listings of the semiconductors of nine manufacturers: in sequence by parameter and function —the first such composite listing available to the industry—and a list by transistor and diode type number. Also included is a section of dimensioned mounting diagrams.

The 24-page handbook was prepared by the technical service department, Industrial and Government Division. Through revised semiconductor data and prices issued regularly, customers will have up-to-date information.

ZENER DIODE HANDBOOK

Motorola Inc., semiconductor products division, 5005 E. McDowell Rd., Phoenix, Arizona, has released a comprehensive, 130-page manual covering basic theory, design characteristics, and applications for zener (voltage limiting) diodes. Copies of the handbook are available for $1.00 from any of the company's semiconductor distributors throughout the country. Further information may be obtained from Dept. ZDH, at the above address.

This new handbook, the first of its kind, is intended to serve as a guide in the use of this component. Chapter headings include: "Characteristics of Silicon Zener Diodes," "Design Considerations," "Regulated Power Supplies," "A. C. and D. C. Amplifiers," and "Specifications and Testing Methods," among many others.

The book also contains numerous schematic drawings, tables, and curves, all based upon actual circuits that were designed and tested by the firm's engineers. References that have appeared in previous literature have been checked and incorporated to make this handbook as complete as possible.

Design engineers, hams, and hobbyists will find the book an excellent reference as well as a good introduction to a relatively little-known electrical component.

SECO BROCHURE

Seco Manufacturing Company, 5015 Penn Ave., South, Minneapolis, Minn., has released a pocket-sized brochure which provides full details and specifications on the company's complete line.

Fully illustrated, this attractive 2-color folder also gives prices on all units. Free copies may be obtained by writing to the firm and requesting Form No. M-CO99.

COMPONENTS BULLETIN

National Radio Co., Inc., 37 Washington St., Melrose 76, Mass., has announced the availability of a new catalogue covering dials, drives, and mechanisms. Purchasing agents and engineers may request this new brochure by writing to the company and asking for Bulletin 59-6.

The new 8-page, two-color catalogue describes and gives specifications on an assortment of dials, rim and planetary drives, and vernier mechanisms, all available from regular stock.

EIA STANDARDS

Electronic Industries Association has issued four new recommended standards. Copies may be obtained through the EIA Engineering Department, 11

Sylvania Electronic Tubes, a division of Sylvania Electric Products Inc., was named winner of the 1959 annual "NATESA Friends of Service Management" plaque. The award is made annually to companies which, in the judgment of NATESA, have rendered extraordinary service to the industry. This is the ninth consecutive year Sylvania has received the plaque. Present at the ceremony were (left to right) Frank J. Moch, executive director of NATESA; Donald W. Gunn, vice-president-sales for Sylvania; Matthew D. Burns, president of Sylvania Electric Tubes; Mac Metoyer, president of NATESA; and Harold H. Rainier, Sylvania distributor sales manager.

West 42nd Street, New York 36, N. Y.

RS-152-A "Land-Mobile Communication FM and PM Transmitters (25-470 mc.)." This is a revision of RS-152 from Standards Proposal 613. 80¢ each.

RS-226 "Television Picture Area—35mm. and 16mm. Motion Picture Film." This is a re-affirmation of Standards TR-136 and TR-137. 25¢ each.

RS-227 "One-Inch Perforated Tapes." This is new material from Standard Proposals 588, 577, and 544. 25¢ each.

RS-228 "Fixed, Tantalum Electrolytic Capacitors (Polarized)." This is new material from Standard Proposal 609. $1.65 each.

REPLACEMENT BROCHURE

G-C Electronics Co., division of *Textron Inc.*, 400 South Wyman St., Rockford, Illinois, is presenting a new 16-page illustrated catalogue giving complete cross-reference information on replacement knobs for leading makes of television sets. Copies of the catalogue may be obtained without charge from the company.

According to the firm, the brochure lists 97 different knobs—on-off, volume, fine tuning, channel selector—for various manufacturers. Information on colors, original parts numbers, set model numbers, and prices is included.

CAREER BROCHURE

Transitron Electronic Corporation, 168 Albion St., Wakefield, Mass., has published a brochure entitled, "You . . . and *Transitron*." It is designed to be of interest to graduate engineers seeking opportunities in the field of semiconductors.

Engineering categories are described as fundamental research, applied research, advanced development and development, design, factory follow-up, manufacturing or industrial, quality control, home sales, application, and field sales or service.

Photographs introduce the reader to the general environment of the firm. In addition, the brochure devotes space to a pictorial description of the suburban New England area in which the company is situated.

TUBE TESTERS

CBS Electronics, a division of *Columbia Broadcasting System, Inc.*, has made available a new "Tech Tips" bulletin, PA-500, entitled, "The Final Authority." It is available through distributors of the company's tubes.

Written by "Bud" Tomer, the booklet tells why the design of a universal tube tester is impractical, if not impossible. According to the author, ". . . tube testing is a very complicated business in spite of the popular notion to the contrary."

The pitfalls of relying on "universal" testers as the final authority to indicate whether a tube is good or bad are explained in considerable detail in this new bulletin. —30—

By
BERT WHYTE

CERTIFIED RECORD REVUE

LAST month I reported on the progress that stereo is making and the change that is gradually taking place in American listening habits. On the whole it was an encouraging report, but unhappily it now becomes apparent that all is not sweetness and light and there is a very somber side to this story.

This is being written at the prime merchandising and sales time of the year and although hi-fi is no longer quite as seasonal as in years past, most companies will admit that the Christmas season constitutes a very healthy portion of their year's business. This year, according to a variety of sources, Christmas business was very "spotty." Some companies enjoyed boom sales with others falling far short of their anticipated goals. What is the reason? Steel strike? Creeping recession? Well, friends, it would be foolish to say the steel strike did not have any effect, but it is certainly not the prime reason for the falling off in sales. It appears that package manufacturers are taking the brunt of these sales setbacks, although some component manufacturers are also feeling the pinch.

In the record business, the situation is described by some as "chaotic." The recent investigations into disc jockey bribery, more commonly known as "payola," have thoroughly shaken public confidence, especially coming on the heels of the TV quiz scandals. A lot of people are really getting hurt in this confused period. *Westminster*, whose early LP's were audio landmarks for quality and who in subsequent years gained an enviable reputation among knowledgeable record enthusiasts, is a bankrupt and although frantic attempts are being made to pull it out of the fire, it may prove fruitless.

In my opinion, this whole mad situation can partially be attributed to some of the reasons outlined, but I think a more honest evaluation is that the public has been bombarded with reams of sales propaganda extolling the merits of stereo and then on finally being exposed to it, the whole thing did not meet expectations . . . just was not "as advertised." And the blame lies not just with the playback equipment, but with the recordings as well.

I have been shocked by the number of people . . . just "man in the street types" . . . who have quite vehemently stated that they thought stereo was "for the birds." These people had either purchased some junk equipment and then had compounded the sin by playing records whose over-all quality, let alone stereo attributes, was appallingly bad. An even larger percentage of these people had never arrived at the purchasing stage, having been repulsed and disillusioned by what they heard demonstrated in their local appliance and department stores. Apparently, the same individual who was victimized in the "hi-fi" days when he bought his "$69.50 hi-fi," is much more discriminating than the average package manufacturer believes, when it comes to stereo . . . evidently it is not enough to furnish him with two rudimentary amplifiers and speakers and a cheap stereo pickup.

Poor old John Q. has been oversold . . . he has been so propagandized that he approaches stereo with the preconceived notion that this is the supreme listening experience. And I bave seen the situation grow more complex when some people tell me that they have stereo systems (I should more properly say "sets") but that they prefer to play mono recordings on these sets!

While it is true that a bad recording will sound poor on the best component system and worse still on a bad one, it is unfortunately true that a good recording will also sound poor on a bad set. The worst part of this situation is that even with some of the more expensive packaged stereo outfits, the quality is marginal and under the demonstration conditions which usually prevail . . . poor acoustics, poorly maintained equipment, sales people either inadequately trained or trained not at all, and a choice of demo records that would give an audiophile a heart attack . . . it is no wonder there is a sales problem.

However, another point to be noted in this sales crisis is that despite these problems, a great deal of stereo is being sold. It is just that, with the expenditures of advertising money, the manufacturers expected a far greater return. Naturally the degree of sales loss (if it can be called that) varies greatly with individual companies . . . but obviously some companies have gotten into hot water by spending too much on advertising and merchandising without adequate product quality to support these expenditures. The lesson they are learning may be a bitter one, but they have no one to blame but themselves.

In the record end of things, there is also much public confusion, as many do not know the limitations of their equipment and thus blame the lack of satisfaction on the recordings they buy. And certain advertising practices of some record manufacturers lead the buyer "up the garden path" by implying that cost differentials have nothing to do with record quality. There are good cheap records and there are bad expensive records but, by and large, "you gets what you pays for." Everyone likes a bargain, but it seems to me a poor bargain to buy a recording just because it is cheap. All recordings should be bought on individual merit.

The economics of the record business are a pretty stable affair. It costs so much to record, press, advertise, and distribute. The profit margins, while comfortable, do not allow for extreme cuts or price wars. If quality is to be maintained a record bas a certain minimum price at which it can be sold . . .

below this figure something has to suffer and it is almost always the quality—whether this be the sound quality, the material from which the record is made, what kind of wear can be expected, etc. It is also obvious that it is a great deal cheaper to record the "Braunschweiger Symphony of Lower Slobbovia conductd by Otto von Ersatz," than it is to record the Philadelphia Orchestra conducted by Eugene Ormandy.

And so the sorting out process continues . . . and the confusion of the public still must be resolved, if record and equipment sales are to progress and begin to reach anything like their potential. I believe the key to this is in taking an honest and realistic viewpoint of the stereo business, in giving the public stereo equipment sensibly engineered whatever the price range, and in advertising these products sanely and factually rather than with the ad agency's flights of fancy. Above all, *some effort,* however difficult it may be, should be expended in making certain that the people selling this equipment have at least had sufficient training to properly operate and demonstrate the models their store carries, and that they be taught a simple, honest, and factual explanation of stereo, which they can understand and which they can impart to a customer. This education, however simple it may appear, can win more people to stereo than all the fancy advertising money can buy.

The proof of the pudding in this is that those people who so shocked me with their disdain of stereo, "flipped" when I exposed them to some real stereo of good quality. One chap was positively astonished and wouldn't believe that a stereo disc was capable of such high quality. I had to play the discs of a number of companies for him and while he noted and appreciated stereo as never before . . . his education had already begun, since he also noted that there were quality differentials among the various discs.

I emphasize that this was strictly a lay person with no background or training in music or high fidelity. Perhaps of most importance was the fact that while he realized that I was playing the discs for him on top quality equipment and that lesser equipment would afford less enjoyment, he also stated that he now realized that a high quality disc was the prime requisite in stereo reproduction. Given this known quality, he would be enabled to choose more intelligently the stereo equipment he felt he could afford.

So there is the lesson stereo manufacturers would do well to learn . . . instead of moaning about the sales picture, do a little education . . . give the public a break and the sales will take care of themselves.

HOLST

THE PLANETS

Vienna State Opera Orchestra with the Vienna Academy Chorus conducted by Sir Adrian Boult. Westminster Stereo WST14067. Price $5.95.

Quite some years ago, Sir Adrian and *Westminster* created quite a sensation with a spectacular mono recording of this work. Now the same combination has given us a stereo "Planets" that must be accorded the same huzzahs. Boult gives us a majestic sweeping performance, that is very thrilling. Although many may prefer Stokowski's supercharged rocket-fueled reading, this is closer to the intent of the work and is certainly more idiomatic.

Boult probes the dynamic extremes of the score considerably aided by some superb stereo engineering. Here you will find excellent directivity, a fine exactitude in aural positioning of the instruments, a front-to-back sense of depth that is most realistic.

The over-all sound is very clean and this applies even in the biggest climaxes. Brass

sound is ultra-sonorous, especially in the "Jupiter" section, and throughout is some terrific percussion of great impact. The wordless chorus is nicely picked up in the final section and adds to the "mystic" impression of the work. Don't miss this one.

TCHAIKOVSKY
MARCH SLAV
POLONAISE
EUGEN ONEGIN WALTZ
FRANCESCA DA RIMINI
Minneapolis Symphony Orchestra conducted by Antal Dorati. Mercury Stereo SR90201. Price $5.95.

Potboilers all, to be sure but, boy, this pot is sure boiling over! This record is strictly for sound enthusiasts and Tchaikovsky buffs. The performances are all very good without gaining real distinction . . . the main thing here is the vast outpouring of hugely sonorous stereo sound. *Mercury* has really outdone themselves on this one. The brass growls and shrieks—high register and low—the strings work themselves into a fine frenzy in "Francesca" and there are monstrous bass drum thumps and much other percussion that is staggering in its power! The 60-watt amplifier and multi-woofer boys will have a ball here!

SIBELIUS
SYMPHONY NO. 2
London Symphony Orchestra conducted by Pierre Monteux. Victor Stereo LSC2342. Price $5.95.

This might, at first, seem an odd combination. However, Monteux shows his versatility by turning in a performance which must rank with the best to be found on records. There may be some who will quibble and state that his approach is too lyrical and in this there is probably some justification. For purists, Monteux's Sibelius lacks the sense of power and is less disciplined than the readings of such as Ehrling or Paul Kletzki. But, after all, it is a romantic symphony albeit with a heroic finale and what better man than Monteux to clearly delineate all the marvelous color and the final detail of orchestration that is so much a part of Sibelius' writing.

As with most of his recordings with the London Symphony, he elicits some of their very best playing and, technically, *Victor* always seems to achieve a better-than-average sound with this orchestra. Stereo-wise this has excellent directivity and each instrument is clearly highlighted and most articulate. The excellent acoustics of Walthamstow Town Hall in London contribute to the sense of depth and spaciousness.

The recording itself is very clean and has fairly wide dynamics with my only reservation a slightly over-heavy bass line. If you like your Sibelius in the most romantic fashion, with none of the stern character of the North with which so many other conductors try to imbue this work—this recording is for you.

WALTON
FACADE SUITES #1 & #2
LE COCQ
MAM'ZELLE ANGOT (Ballet Suite)
Royal Opera House Orchestra conducted by Anatole Fistoulari. Victor Stereo LSC2285. Price $5.95.

Here is a recording that should certainly keep your feet tapping and your soul full of high spirits. Both the Walton and the Le Cocq works are breezy, racy, sort of tongue-in-cheek orchestral expositions that have no particular pretentions and, above all, are very great fun.

Of course, there are probably many people who would like to have Dame Edith Sitwell make a new recording in stereo, with her reciting or doing whatever fantastic thing it is she does with her voice, the inimitable madness of her poetry. On the other hand, there are just as many people who consider her monotonous droning voice merely an obfuscation and wish she would get out of the way of the music. At any rate, this is about the best recording of the musical aspect of this work at present and is much to be preferred to the recent Kostelanetz version.

"Mam'zelle Angot" is one of those mad mixed up French pieces which seem to combine the writings of half-a-dozen or more composers. But the orchestration and the mood it engenders is very frothy and effervescent. it's a harmless little thing and should be enjoyed by almost everyone except old curmudgeons and communists.

Fistoulari is an old ballet hand and his performances are properly paced and neatly scaled and reflect an intimate knowledge of both scores. Very good stereo sound here too, with the recording perhaps a shade too reverberant for some tastes but in spite of this, a very clean recording with excellent transient response, especially in the high percussives which abound in these works.

GRIEG
PEER GYNT SUITE #1
SYMPHONIC DANCES
ELEGIAC MELODIES
Halle Orchestra conducted by Sir John Barbirolli. Mercury Stereo 90164. Price $5.95.

Sir John has a very straightforward way with these Grieg pot-boilers . . . no nonsense, no individualistic ideas on tempi, no mannerisms intrude on the music. The result is very acceptable after so much "interpretation" at the hands of other conductors. *Mercury's* superb stereo makes this the "best yet" recording of these works. Everything is beautifully clean, in fact the level of distortion here is virtually non-existent. The directional and depth aspects are fully realized and dynamic range is impressively wide.

There is some very powerful percussion in "Peer Gynt" and the "Symphonic Dances" which will be the delight of sound aficionados. Highly recommended.

STRAUSS, RICHARD
ALSO SPRACH ZARATHUSTRA
Vienna Philharmonic Orchestra conducted by Herbert von Karajan. London Stereo CS6129. Price $5.95.

This is Herbert von Karajan's debut on the *London* label and an event eagerly anticipated. The recording has been highly touted in England as a veritable *tour-de-force* in matters of sound, ranking along with *London's* fantastic "Das Rheingold."

Well, friends, I dunno what happened to the recording that was sent to me, for rarely have I been so disappointed. There are some interesting moments and some nice clean tympani shots, but outside of that, I found this one of the dullest sounding stereos ever issued by *London*. I can't understand or believe that it was intentionally recorded in that fashion. First of all the recording is at an astonishingly low level, and while wide dynamics are strived for, the whole thing is shifted in scale or perspective so that the *pianissimos* are just faint whispers. And mind you, this is at a volume setting designed to give some weight to the *fortes*. The result is that unless you possess the very top quality preamp and amplifier you will be inundated by hum and hiss in the quiet passages. My system is dead quiet, but at the level mentioned for the *fortes*, then the normally quiet *London* surfaces are heard *above* the *pianissimos!* It is beyond me . . . next time I am in England I'll get a copy over there and see if there is any difference.

Karajan's performance is good but doesn't generate the power and excitement of the

Fritz Reiner version. Of course, the sound problem may contribute to this feeling.

SCHUMANN
SYMPHONY #1 ("SPRING")
MANFRED OVERTURE
Cleveland Orchestra conducted by George Szell. Epic Mono LC3612. Price $3.98.

This follows hard on the heels of Paray's recent *Mercury* recording and is interesting in that despite national backgrounds, one of which would favor a Schumann recording and the other supposedly not, the end result is remarkably similar. Szell stays close to the score and employs no mannerisms and everything proceeds just about the way it should. Paray has the slightly lighter touch and Szell the greater sonority. The *Mercury* has a cleaner over-all sound, but lacks the better acoustics and stronger bass line of this recording. Fine playing from the Clevelanders.

SMETANA
MA VLAST (Symphonic Poem Cycle) Vienna Philharmonic Orchestra conducted by Rafael Kubelik. London CS2202. Two discs. Price $11.90.

This is a hugely proportioned work in six sections which are given descriptive titles. From this is derived the lovely "Der Moldau" and "From Bohemia's Meadows and Forest." It is an intensely nationalistic piece and as you might expect a perfect vehicle for Kubelik's talents. He has done this before on a *Mercury* record with the Chicago Symphony and this new version is almost untouched as to his interpretation.

I made one of the earliest stereo recordings on that occasion and one of the problems to cope with was the acoustics of Orchestra Hall, which usually are so apropos for most music. The "Sarka," "Tabor," and "Blanik" sections of this work are as thickly scored as you are likely to find and they created textural difficulties. *London* does not entirely escape this problem, but the stereo helps out quite a bit as it did in my recording.

The *Mercury* was a fine sound despite the problems but now must give way before this stereo version. There are some huge sounds in this work, especially in "Sarka" and "Tabor." "Tabor" has nice, big, clean tympani and great weighty brass and ultra-sonorous contrabassi. Here again *London* is essaying an extraordinary wide dynamic range and once more I make the comment that although this is at a higher level than the "Zarathustra," the *pianissimos* are still so low as to be masked a bit by surface noise. But this is minor in the over-all sonic impact which is considerable. Kubelik's performance is completely authentic and should go unchallenged for a long time.

SCHUMANN
ADAGIO AND ALLEGRO FOR HORN
HAYDN
TRUMPET CONCERTO IN E FLAT MAJOR
MOZART
FLUTE CONCERTO #2 (K. 314)
Edmond Leloir, horn; Paolo Longinotti, trumpet; and Andre Pepin, flute with L'Orchestre de la Suisse Romande conducted by Ernest Ansermet. London Stereo CS6091. Price $5.98.

This is a wonderful recording, with the prize piece being Haydn's incredible "Trumpet Concerto." This has always been a challenge to any virtuoso and Longinotti acquits himself nobly. Even in the stratospheric reaches of the score he is very steady and his attacks are beautifully precise. The other soloists are equally distinguished and give thoroughly refined readings, which are lovely to hear.

Ansermet is quite satisfactory in this (for him) unusual role and his accompaniments are sympathetic. Fine stereo sound throughout, and a low bow to the trumpet. —30—

Sound on Tape

By BERT WHYTE

NOT much news or review material this month, although some classical four-track finally showed up. Everything seems fairly quiet in the tape world with the impetus of four-track seemingly slowed a bit . . . probably a seasonal thing, however.

In another development, *Minnesota Mining* has announced a new type of tape cartridge which, in some clever way, combines the cartridge and reel concepts. *But,* and I really flipped at this information, the tape to be used is ⅛ inch wide and is to operate at a speed of 1⅞ ips. Gadzooks! The ⅛ inch tape is said to permit a tighter wrap and thus closer contact with the recording or playback gap, with subsequent improvement in frequency response. Total frequency response was not given.

Well, I have a lot of respect for the very smart boys up at *3M,* but this one sounds like a dilly. I am really going to be from Missouri on this one. If it is to be used for speech or some such, why, no comment—but if this is ultimately intended to furnish playback of music, I can't envision it being used for anything other than low-fi background stuff. Classical music? That is another question and I would view such a development with a very jaundiced eye. I don't say that it can't be done, but it sure is going to take some doing to inscribe sufficiently high frequencies and maintain a good enough signal-to-noise ratio to please the serious audiophile.

MUSIC FROM "FOR WHOM THE BELL TOLLS"

Ray Heindorf and Orchestra. Warner Bros. 4-channel Stereo BST1201. Price $7.95.

Now here is a unique side of Ray Heindorf—that of a good movie music man. He is an old hand at this trade and knows how to suffuse any score with the proper drama and expression. "For Whom The Bell Tolls" is, of course, the music from the great picture of the same name. It is typical of its genre, a strange admixture of powerful programmatic material with "love theme" and other devices which some find just too ultra-saccharine and cloying to the musical palate. It goes without saying that to listen to this music without having seen the picture is to add another burden to its acceptance.

The score is well played and equally well recorded. Balances within the orchestra are correct and all is quite clean and projects very well. The frequency range is broad and the dynamics somewhat less than you would expect. Directional and depth effects are nicely handled in the felicitous acoustics. Even on my big system there was no discernible cross-channel modulation and, at good room-filling level, the tape hiss was reasonably unobtrusive.

SAINT-SAENS SYMPHONY #3

Detroit Symphony Orchestra conducted by Paul Paray. Mercury 4-channel Stereo STC90012. Price $7.95.

This is the first classical from a major company I have received in the four-track stereo format. If this is a forerunner of what we can expect from a major company in this medium, then we are off to a good start. This is the first four-track stereo that I can say, without reservation, is able to compete on even terms with the older two-track. It is noticeably free from distortion and, played at a good room-fillling level, the background hiss was roughly equivalent to that usually found on two-track. Frequency response was excellent at both ends of the spectrum.

It may interest you to know that the very low-frequency organ passages in the first movement, at about 30 to 50 cycles, came through with startling clarity and volume . . . better than on the stereo disc I have on hand of this same recording.

All else is very articulate and the brass and strings have a brightness which signifies that the highs are well and truly being reproduced. Good as the stereo disc is, there is no denying the tape its superior separation. The stereo effects are much more pronounced.

Of the performance, I covered this in this recording's initial issue and suffice it to say, this is Paray's meat and the reading extraordinary. So I can wholeheartedly recommend this to all but those who are very cranky about hiss. There is nothing I like about hiss either and it existed on two-channel at about the same level. Nobody seems to be able to do anything about it, so we will all just have to learn to live with it.

I hope that a few more classicals will arrive before next month and we will have to wait and see if there is any improvement. —30—

Citizens Radio Directory

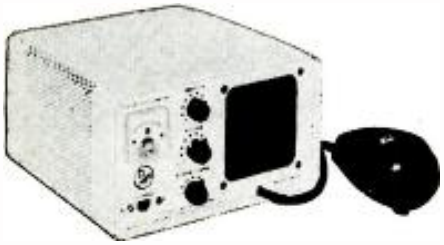
(*Continued from page 40*)

hand, if one or both of the antennas are directional and are on a high hill or mountain, distances on the order of 20 to 50 miles are possible. Under unusual ionospheric conditions when the skip is right, signals have been heard for several thousand miles. However, this type of operation is not reliable nor is it the type of service for which Citizens Radio was intended.

Features of Radio Units

You can buy a single Citizens Radio unit for as little as $40 in kit form or you can pay over $200 for an elaborate factory-wired unit. Remember that you will need two such units to set up a communications link. Also, most units require separate antennas which will add at least $5 to $10 for each unit for a simple whip to as much as $30 to $100 for each unit for more elaborate and directional antennas. What is more, some units require separate power supplies for mobile operation. This could add $5 to $10 or more for each unit. All in all, the least expensive link involving two stations would cost around $100. If you are con-

Arkay "Sky Vox" Model SQ-9 transceiver, manufactured by Arkay Radio Kits., Inc. Power requirements: 117 volts a.c. at 60 watts or 12 volts d.c. at 5 amps. Receiver: 3-channel fixed-tuned crystal-controlled superhet type with r.f. amplifier and i.f. amplifier stage; noise limiter and squelch circuits are provided. Transmitter: 3-channel crystal-controlled type with 5 watts final plate input power. Units are normally supplied with one set of crystals for single-channel operation. Cabinet dimensions: 11¼" x 5½" x 8½"; weight: 12 lbs. Price: $89.95 in pre-wired sub-assembly kit form, including microphone.



Kaar Model TR-326 "D Phone" transceiver, manufactured by Kaar Engineering Corp. Power requirements: 117 volts a.c.; also available for 12 volts d.c. and for 6 volts d.c. Receiver: 2-channel fixed-tuned crystal-controlled superhet type with r.f. stage; noise limiter and squelch circuits are provided. Transmitter: 2-channel crystal-controlled type with 5 watts final plate input power. Units are normally supplied with one set of crystals for single-channel operation. Cabinet dimensions: 8¾" x 5" x 8"; weight: 10 lbs. Price: $170, including microphone.

Philmore Model TC-11 transceiver, manufactured by Philmore Mfg. Co., Inc. Power requirements: 117 volts a.c. at 35 watts; also available for operation at 6 volts d.c. at 5 amps. or 12 volts d.c. at 3 amps. Receiver: 3-channel fixed-tuned superregenerative type with r.f. stage. Transmitter: 3-channel crystal-controlled type with 5 watts final plate input power. Units are normally supplied with one crystal for single-channel operation. Cabinet dimensions: 10" x 4⅛" x 10⅞"; weight: 11 lbs. Price: $39.95 for 117-volt model in kit form, including ceramic microphone.

World Radio Model EC8K transceiver, manufactured by World Radio Laboratories. Power requirements: 117 volts a.c. at 35 watts; separate power supply needed for 6- or 12-volt battery operation. Receiver: tunable superregenerative type with r.f. stage. Transmitter: single-channel crystal-controlled type with 5 watts final plate input power. Price: $39.95 in kit form.

sidering a large number of more elaborate units with directional antennas, the system cost may be in the thousands of dollars.

Most of the units we have encountered are *transceivers*. This means that some of the tubes and circuits are used for both transmitting and receiving. The most common arrangement is to use the audio tubes as microphone amplifier and modulator while transmitting and as the audio voltage amplifier and power output tube while receiving. In addition, the power rectifier is used for both transmitting and receiving. By making some of the circuits do double-duty in this way, the manufacturer is able to cut down on the size of the unit and the number of circuits used.

Power requirements are very modest, running between about 30 to 60 watts from the 117-volt a.c. line for most units. The d.c. requirements are also quite reasonable, and most of the units draw no more current from the car's or boat's storage battery than would be drawn by a conventional auto broadcast receiver.

Receivers in use are either superregenerative types or superhets. They may either be tunable over the entire band or fixed-tuned to one or more channels. The superregenerative receiver is quite simple and much sensitivity can be obtained in the single detector stage used. On the other hand, the superregenerative detector is quite broad in its tuning and it radiates a signal that could produce harmful interference. To overcome these effects, the detector is preceded by an r.f. amplifier.

Superhet receivers used in the Citizens Radio units are either ordinary single-conversion or double-conversion types. R. f. stages are usually included for added selectivity and anywhere from one to three i.f. stages are used for high sensitivity. Noise limiters, particularly useful in reducing ignition noise interference, are common in these superhets. Also, squelch circuits, which quiet the receiver completely when there is no signal coming in, are widely used. Many of these are adjustable to control the amount of squelch. Too much squelch cuts down the sensitivity of the receiver, while insufficient squelch is not effective in reducing no-signal noise.

The transmitters are fixed-tuned to one or several channels. The circuit is a conventional crystal oscillator, which must be held to within a .005 per-cent frequency tolerance of one of the

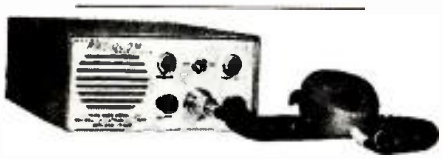
Acton Model TCV-271 transmitter-receiver, manufactured by Acton Laboratories Inc. Power requirements: 117 volts a.c. at 45 watts or 12 volts d.c. Receiver: single-channel fixed-tuned crystal-controlled dual-conversion superhet with r.f. and i.f. stage; noise limiter and squelch circuits are provided. Transmitter: single-channel crystal-controlled type with 5 watts final plate input power. Cabinet dimensions: 12" x 4" x 6"; weight: 9 lbs. Price: $179.95, including carbon microphone. (Model TCV-2 is also available with a tunable receiver and 3-channel transmitter at $189.95.)

Radio Shack Model CBK-1 transceiver, manufactured by Radio Shack Corp. Power requirements: 117 volts a.c. at 35 watts; separate power supply needed for 6- or 12-volt battery operation. Receiver: tunable superregenerative type with r.f. stage. Transmitter: single-channel crystal-controlled type with 5 watts final plate input power. Price: $39.95, including crystal microphone.

Citizens Radio channels. This is followed by a power amplifier stage. Simpler units use a single dual-purpose tube for both functions.

The units are fairly small in size and light in weight so that they can be moved easily or readily installed in autos or boats.

Many of the transceivers employ ceramic microphones which, unlike some crystal types, are not affected by heat and humidity. Some of the units use rugged carbon microphones and few use the built-in loudspeaker as a dynamic microphone when transmitting. Push-buttons on some of these microphones are used to transfer the function of the unit from transmitting to receiving. In other cases, switches are mounted directly on the operating panel to perform this function.



Maxwell "Radiocom" Model 27C-1 transceiver, manufactured by Maxwell Electronics Corp. Power requirements: 117 volts a.c. at 60 watts; also available with transistor power supply for 12 volts d.c. at 4.5 amps. or for 6 volts d.c. Receiver: single-channel fixed-tuned crystal-controlled superhet type with 2 r.f. stages and single i.f. stage; noise limiter and squelch circuits are provided. Transmitter: single-channel crystal-controlled type with 5 watts final plate input power. Cabinet dimensions: 7 1/8" x 3 1/2" x 11 1/4"; weight: 6 lbs. Price: $159.50, including carbon microphone.

Radson Model RT-70 transceiver, manufactured by Radson Engineering Corp. Power requirements: 117 volts a.c. at 50 watts. Receiver: single-channel fixed-tuned crystal-controlled superhet with r.f. stage and two i.f. stages; noise limiter is provided. Transmitter: single-channel crystal-controlled type with 5 watts final plate input power. Cabinet dimensions: 9 1/2" x 6" x 4"; weight: 9 lbs. Price: $149.95, including carbon microphone. (Model RT-75 is also available for 6 or 12 volts d.c. at $159.95.)

Wightman "We-Phone" Model WE-PT1 transmitter-receiver, manufactured by Wightman Electronic Eng. Co. Power requirements: eight self-contained 1 1/2-volt batteries. Receiver: single-channel fixed-tuned crystal-controlled transistorized superhet with r.f. stage and two i.f. stages; noise limiter circuit provided. Transmitter: single-channel crystal-controlled transistorized type with 100 milliwatts oscillator input power. Cabinet dimensions: 9 3/4" x 3 1/2" x 2 3/4"; weight: 2 1/4 lbs. Price: $149.50, including speaker-microphone and built-in antenna.

Pearce-Simpson Model CBD-1 transceiver, manufactured by Pearce-Simpson, Inc. Power requirements: 117 volts a.c. or 12 volts d.c. Receiver: single-channel fixed-tuned crystal-controlled superhet type; noise limiter and squelch circuits are provided. Transmitter: single-channel crystal-controlled type with 5 watts final plate input power. Cabinet dimensions: 7" x 4 5/16" x 10"; weight: 10 lbs. Price: $159.50, including carbon microphone.

Since the user may purchase his antenna from a manufacturer other than the one making his transceiver, he should check that the antenna fitting is the proper mate for the connector on the transceiver. If it is not, it will be necessary to change the antenna fitting so that a proper connection may be made.

With the very wide selection of Citizens Radio units available, most of which are illustrated and described in this article, our readers should have no trouble in picking a pair that will meet all their requirements. —30—

CALENDAR of EVENTS

FEBRUARY 3-5
1960 Winter Convention of Military Electronics. Sponsored by Institute of Radio Engineers. Biltmore Hotel, Los Angeles. Details from IRE, 1 E. 79th St., New York 21, N. Y.

FEBRUARY 10-12
Solid State Circuits Conference. Sponsored by PGCT, AIEE, and University of Pennsylvania. University of Pennsylvania, Philadelphia. Program information from T. R. Finch, Bell Telephone Labs, Murray Hill, N. J.

FEBRUARY 11-13
First Annual Convention. Sponsored by Electronic Representatives Assn., Drake Hotel, Chicago. Information from ERA headquarters at 600 S. Michigan Ave., Chicago 5, Ill.

FEBRUARY 16-18
First National Symposium on Non-Destructive Testing of Aircraft and Missile Components. Sponsored by Southwest Section of SNT, Inc., and Southwest Research Institute. Hilton Hotel, San Antonio, Tex. W. E. Cory, General Chairman, Southwest Research Institute (Unclassified), 8500 Culebra Road, San Antonio, Texas.

Intermodulation Distortion

(*Continued from page 67*)

Two stable audio generators are used, one of these produces the low frequency and the other produces the high frequency required for the test. In some instruments these frequencies are adjustable, in others they are fixed. The two signals are then fed into attenuators for isolation and for adjustment of the amplitude ratio (usually 4 to 1). Some units permit the user to switch internal v.t.v.m. circuits in at these points to measure the relative amplitudes of the two audio signals. After suitable mixing, the combined signal is applied to the input of the amplifier to be tested.

The amplifier is terminated in an output load resistor. Some IM units even have such loads built in for limited power use. The v.t.v.m. is then switched across this load so that the output power may be monitored. It is common to operate the amplifier "wide open," and simply keep increasing the mixed input signal until rated power output (or whatever power output level is desired) is obtained. See Fig. 4.

In this regard, it is important to use the same peak output voltage as would be obtained under single-frequency conditions, since it is usually at the voltage peak that distortion is generated. If the amplifier is delivering 4 volts of low frequency and 1 volt of high frequency at the same time, its total output voltage would be 5 volts. The distortion would be equivalent to that produced by a 5-volt signal. The power that should be produced by such a signal is E^2 (5^2, or 25) divided by the load resistance. On the other hand, the true power (as indicated by a voltage measurement taken across the load) is only 4^2 plus 1^2 (16 +1, or 17) divided by the load resistance. This means that the indicated power output must be multiplied by 25/17 (or 1.47) when testing for IM under these conditions to obtain an *equivalent sine-wave output power*. Hence, if the voltage measures 8 volts across an 8-ohm load, the true power is 8 watts, but the equivalent sine-wave output power is 1.47×8, or 11.8 watts.

The amplifier load signal is then applied through an input attenuator to a high-pass filter. This circuit removes the large-amplitude, low-frequency signal and passes on the high frequency. If the amplifier under test has IM distortion, the amplitude of this high-frequency signal will vary, perhaps as shown at the upper waveform No. 5 in Fig. 1. If the amplifier has no IM distortion, the amplitude will be constant, as shown in the lower waveform.

The high-frequency signal is then amplified and detected. (See waveform No. 6.) After detection, the signal is fed to a low-pass filter which removes the high-frequency ripple. Now the amplitude variation shows up clearly as a low-frequency signal (upper waveform No. 7). Had there been

no IM distortion, the output here would be pure d.c. The remaining low frequency, representing the distortion, is then applied to the a.c. v.t.v.m. circuits for measurement. Since this meter had previously been adjusted for full-scale reading with the undistorted high-frequency applied, it will now read directly the percentage value of the intermodulation distortion.

IM distortion measurements, taken in accordance with any standard method such as the one described, allow an important specification to be quoted for evaluating high-fidelity equipment.

—30—

Canada Puts Limit on R.F. Interference

By J. E. KITCHIN

Inspector, Telecom. Dept. of Transport

AUDIO noises have been well tabulated in the past but how does one set a tolerable limit for radio-frequency noise? A recent Canadian Department of Transport regulation (known officially as SOR 59-116 by the Queen's Printer, Ottawa, Canada) has defined radio-frequency noise as any electrical disturbance "produced by any mechanical, electrical, or other device" and capable of being received on a radio receiver.

The regulation refers specifically to r.f. generators in the ISM industrial bands, in which the amount of r.f. energy produced is without limitation. However, any r.f. generator in those bands must not have any emission outside of the band in excess of 25 microvolts-per-meter at a distance greater than one-thousand feet from the r.f. generator. A provision is also made that if r.f. generators are operated on any frequency outside the ISM bands the limit shall be 15 microvolts-per-meter at 1000 feet.

Allowance is also made for higher power industrial equipment (over 5 kw.) and high-frequency arc welding equipment where it is not practicable to apply the limits mentioned above. In these cases the field intensity is restricted to ten microvolts-per-meter at a distance of one mile from the industrial equipment.

It is also interesting to note that these measurements must be made on field strength meters of a make and type approved by the Department of Transport, or by meters having an equivalent standard of measurements. Field-strength meters must be adjusted to read the "quasi peak" values of field strength and the prescribed antenna system is a horizontally polarized dipole seven and a half feet high for measuring the frequencies above 25 mc.

Any records of measurements made to ensure compliance with the regulation must be kept for three years and be available to Inspectors of the Department of Transport. It must also be remembered that, as usual in such regulations, the provision is made that in certain cases or circumstances suppression may be required by the Department at values lower than those specified in the regulation.

—30—

The "Pyramid" Stylus

(*Continued from page 49*)

due to pressure per unit area must be taken into account.

What is needed, then, is a stylus designed to fit all existing microgrooves but shaped in such a way as to minimize "pinch effect" while fitting into all "corners" of the recorded modulation. *Fidelitone's* solution to this problem is the "Pyramid" stylus.

In order to understand how the "Pyramid" works, assume the stylus is ground into a pyramidal shape rather than in the form of a cone with a spherical tip. Each of the four ridge edges created by the four converging sides are rounded gently and highly polished to remove "cutting" edges and minimize friction. Consider further that the polished ridge edges of pyramid shape are formed so as to approximate the included angle of the cutter stylus. The "Pyramid" stylus thus formed is precision mounted on the needle in such a way as to cause the ridge radii to engage the side walls of the groove in the same horizontal and vertical fashion as the cutter stylus was when it formed the original groove.

Such a design permits the pyramid shape to maneuver all the sharp turns and reach into all the sharp corners the way the cutter stylus does. (Fig. 3 shows the way a "Pyramid" will trace the groove of Fig. 2 while Fig. 1 is a pictorial comparison of the two needle shapes tracing a single-tone, high-frequency groove.) Fig. 4 is an enlarged end view of the "Pyramid" showing its projection in the groove.

When such a stylus shape traces a groove, whether modulated or unmodulated, only the ridge corners of the "Pyramid" will touch the side walls of the groove, up to the maximum condition of 45 degrees inclination of groove modulation. The sides are constantly changing in proximity to the side walls but, like the cutter, they are always just following behind without interference. Throughout all this range of motion the stylus rides on an "even keel," not rising, but always in intimate gliding contact with groove side walls. Of course, the "Pyramid" corners must not have sharp cutting edges. They are rounded into contact radii much smaller than any round tip radius thus far proven practical.

One's first reaction is that such reduced radius values would also greatly reduce the contact area to the groove, thus requiring impossibly low needle pressures. The solution to this dilemma lies in the fact that the shape and mounting permits the stylus to follow the groove's contour farther up the walls of the groove than is possible with the round one.

The round stylus, to minimize pinch effect, must touch the groove walls as near to the bottom as possible. The farther up the side walls the contact radius extends, the greater will be the undesirable distortion effects. See Fig. 5.

The "Pyramid" stylus, on the other hand, is shaped so that its engagement area is a continuous line that can extend all the way up the groove's wall without affecting its tracing dimension (fore and aft) in the slightest. Thus no increased pinch effect nor decreased groove translation results. Hence it is possible to increase the contact area of the "Pyramid" to values equivalent to much larger spherical stylus areas. To be specific—a .0002 contact area of a "Pyramid" is greater than the contact area of a .0007 spherical point. This has been proved by record and stylus wear tests. It is therefore recommended that a working radius of .0002 on a "Pyramid" not be operated at greater than 6 grams needle force and a .0003 radius not exceed 10 grams needle force. When making this comparison consider that a .0005 round tipped stylus should operate at a 4-gram maximum needle force. The "line contact" of the "Pyramid" also results in a noticeable reduction in background noises, commonly referred to as "scratch noise." While this characteristic came as sort of a surprise, it is completely logical since the extended "line contact" area distributes forces up along the vinylite groove side walls, which will average out any molecular irregularities to be found at concentrated points.

Another bonus resulting with this new stylus is a noticeable reduction in needle drag, which greatly improves the so-called tangential distortion found with some pickup designs. This is a design weakness permitting motion of the needle in the fore and aft direction during the tracing of heavy modulation.

Manufacture and Mounting

Everything looks rosy in theory. Now, how is such a stylus to be made and how can controls be set up for its mounting? These big questions took nearly two years to resolve because no stylus is worthy of so much special handling unless it is made of diamond. To produce such a stylus requires careful molecular orientation of each stone before grinding. Only the softer molecular planes can be ground away which leaves the ridges which contact the groove side walls coincidental with the hardest molecular plane of the diamond. This requirement is also a condition for optimum wear. After the stone is properly processed and highly polished, it still requires precision mounting in its needle. The rotational horizontal orientation of the stylus in its needle mounting must be selected for maximum performance conditions to be met on the inside grooves of the record, where stylus performance is most critical.

The "Pyramid" diamond stylus needle should not only be viewed in the light of its longer service life and the longer useful life of costly recordings but in the improved reproduction possible by its use. —30—

Improvements for S.W. Sets

(*Continued from page 53*)

3 and 4 may be connected in the filament string either between the 2nd detector and i.f. amplifier tubes or between the i.f. amplifier and mixer tubes.

Audio Limiter

When the broadcast-band tuning range of a *Hallicrafters* SX-24 was extended to 460 kc. for ship radio reception, the need for additional noise limiting became apparent. The original audio noise limiter of the receiver does an excellent job on auto ignition at high frequencies and on certain other types of interference, however, it could not cope with the powerful blasting by the local harbor shore station if receiver sensitivity and audio gain were set for distant ship reception.

Numerous noise limiter circuits were tried and the simple scheme finally adopted was found to possess dual virtues. It is not only satisfactory in the reduction of blasting but very effective in the reduction of QRN. On many occasions when QRN would render 80-meter c.w. operation an annoying task, merely throwing in this limiter permits comfortable reception.

The limiter circuit consists of a 10-megohm, ½-watt resistor paralleled by a toggle switch, connected in series with the original plate-load resistor of the first audio stage. When the switch is closed, the receiver operates normally since the 10-megohm resistor is not in the circuit. When the switch is open, the 10-megohm resistor is part of the plate-load resistor and limiting occurs. (See Fig. 2.)

Narrowing Audio Response

So well known is the principle of improving receiver selectivity by narrowing the frequency response of the audio system that many communications receivers employ audio filters. The local oscillator stability of the low-priced communications receiver is rarely sufficient to permit the use of an audio filter. However, the addition of a tone control will be found quite advantageous under certain operating conditions (such as for the attenuation of an interfering c.w. signal at a very high beat-note frequency).

The layout of the S-38B presents a problem in mounting a tone control on the front panel. A thorough investigation under actual operating conditions showed that a worthwhile improvement in c.w. selectivity can be achieved by the simple addition of a .005-μf. bypass capacitor from the plate (pin 6) of the 12SQ7 audio amplifier to the chassis (close to the tube socket). No other value of capacitance or circuit position produces the same improvement in performance. In addition, this modification does not impair the audio quality of speech or music and results in improved signal-to-noise ratio.

Many hams occasionally enjoy listening to ships at sea on 600 meters and above. It is not a difficult task to extend the tuning range at the low end of the broadcast band to include frequencies to 460 kc. if an erroneous dial calibration can be overlooked. When an attempt is made to tune to 455 kc. (the usual receiver i.f.), the receiver will naturally take off in overall oscillation and no signals can be heard.

Extending BC Band

When there is sufficient room in the tuning coil assembly, a separate toggle switch may be placed in each r.f. compartment near the broadcast-band coil. The toggle switch handles are ganged together by a piece of insulating rod which may be run through the panel and equipped with a control knob. When the switches are closed, each connects a capacitor from the "hot" end of its broadcast coil to ground.

Unfortunately, there is insufficient room in the *Hallicrafters* SX-24 to make the installation just described. An attempt was made to mount switches and capacitors above the tuning gang. While performance was satisfactory on the broadcast and ship bands, the stray capacity thus introduced made it impossible to obtain proper alignment on the high-frequency bands. The arrangement finally adopted consisted of three 230-$\mu\mu$f. capacitors; one connection of each soldered to the tuning gang frame. A small alligator clip on the other lead of each capacitor permits clipping one to each of the tuning-gang lugs for ship reception. When ship reception is not desired, the alligator clips can be connected to any convenient point on the tuning-gang frame.

The *Hallicrafters* S-38 layout permitted a somewhat neater arrangement. A toggle switch (d.p.s.t.) was mounted between the oscillator coil bank and the antenna coil bank and its handle is accessible through a hole in the bottom cover. Both switch arms are connected to the chassis. A 172-$\mu\mu$f. capacitor (a 150 $\mu\mu$f. paralleled by a 22 $\mu\mu$f.) is connected between the "hot" end of the broadcast oscillator coil and one end of the switch contact. A 200-$\mu\mu$f. capacitor is connected between the "hot" end of the broadcast antenna coil and the adjacent switch contact. These capacitor values were selected to satisfy the following requirements: (1) The broadcasting tuning range extended down to 460 kc.; (2) Tracking excellent at 500 kc. (600 meters); and (3) Progressive mistrack from 500 kc. to 460 kc. (Having no r.f. stage, the low-priced receiver has a much lower i.f. rejection ratio than larger sets. The resultant tendency to oscillate as the receiver is tuned toward 460 kc. is offset by the intentional mistrack.)

There are undoubtedly a number of other simple modifications similar to those described here that will suggest themselves to the users of the various communications receivers under their particular operating conditions. —30—

Mac's Service Shop

(*Continued from page 56*)

is hearing Leon Deloy, 8AB, for the first trans-Atlantic reception on the short-wave band of 100 meters. This story tells about relaying a message by hams from coast-to-coast in an hour and twenty-five minutes, and this one tells of the McMillan expedition at the North Pole being picked up by an amateur."

"Wonder what those broadcasting stations were like?"

"Well, here is a description of WBZ's new 1000-watt transmitter described as one of the finest in the country. It uses 'four 250-watt oscillator and five 250-watt modulator tubes. A modulation meter and control rheostat has also been added so that the operator can listen to the programs and gauge their modulation'."

"I'll bet there were some far-out applications of radio back there."

"You're right. Here is a picture of a German *schutzman*, or police officer, carrying a portable radio for receiving orders from headquarters. The radio is about eighteen inches square with four exposed tubes sticking out the top. The poor devil is wearing earphones under his steel helmet, and a loop antenna at least four feet square is strapped to his back. The accompanying text says disorders in Germany are frequent and that the officer carries this cumbersome equipment so that he may know when his presence is needed. He's going to be in great shape to quell a riot when he arrives on the scene in that rig. Another story says that in New York City an undertaker operates a hearse equipped with a radio amplifier and loudspeaker. As the vehicle enters the cemetery, chimes, hymns, and funeral music are played. Finally, look at this headlined story about a radio device just invented by a Canadian physician that will diagnose human ills."

"Here's one for the book!" Barney exclaimed: "'Wired Service Corporation, located on Staten Island, is carrying to 500 residents of the island a six-hour program daily, to be increased when the service is extended to New Jersey. Upon payment of a certain sum, your set is installed and the programs come in.' Pay-Wired-Wireless away back there!"

"You'll find lots of familiar names in those old magazines. Herbert Hoover, Secretary of the Commerce Department that licenses radio stations, says broadcasting needs an overseer. It was to get one in the form of the F.C.C., of course. Here is a picture of a younger, heavier, hairier Arthur Murray giving an over-the-air dancing lesson. Charles Chaplin tells a reporter how frightened he was at his first radio broadcast. This strikingly handsome man is the visiting Prince of Wales who is described as an ardent radiophan. Coolidge's address to Congress is believed to have been heard

by a million and a half people. And Steinmetz dies on the morning of October 26, 1923."

"What do the magazines say about us service technicians?"

"Not much, as such. Most of the listeners, having built their own sets, also repaired them. The magazine gives instructions on how to build sets and also a lot of helpful hints, such as how to connect earphone jacks in series so that more than one person can hear, how to sandpaper tube prongs to insure better contacts, and how to employ earphones as a meter multiplier resistance so that the low-scale 'A'-battery meter can also be used to test the 'B'-batteries. I'll bet that was good on the earphones!

"And then there is this story headlined: '*Hook-ups Galore*. There are circuits everywhere. There are so many that a good radio electrician may wander into a store to buy a switch knob and actually hasten away in blushing ignorance'." Mac looked across at the metal file cabinets that contained around 2000 radio and TV diagrams and mused aloud, "I wonder what that radio electrician would think today.

"But they were trying hard to guess the future," he continued. "Some of the guesses were good, some not. Here the manager of WGR is saying seeing by radio is not far distant. And there is something sadly familiar about this editorial that declares: 'Radio-controlled mechanical devices, electrically operated, will exercise an influence difficult to foretell. Ten years and a new war will develop radio and make its uses so far-reaching. . . . that another world war will be impossible.' But listen to this: 'The near future will see small, compact, and portable radio receivers . . . in every home. There will be no outside antenna, no complicated wiring, and no batteries in the ideal foolproof set soon to be sought by up-to-date householders who will demand radio service just as they do telephone service today.' Some of the wise ones knew they were going to need us."

"This is more fun than looking through a family album," Barney declared as he leafed through the magazines.

"I think it's more than amusing," Mac said soberly. "Examining the past is the best way to understand the present and guess the future. That's why we study history. Personally, when I look back at this crude beginning of the electronic industry and realize how far and how fast it has come in thirty-seven years, I feel a little awed but very, very proud of being a part of it."

"Yes," agreed Barney with unwonted solemnity, "it is a sobering thought. Even in my scatter-brain fashion I am impressed by the fantastic contributions that the early hams made to the advance of radio every time I rattle a key and talk to some amateur half way around the world. The progress in our field is really staggering—I am glad I 'belong.' " —30—

What's New in Radio

MOBILE SOUND SYSTEMS

Lawrence Incorporated, P.O. Box 5106, Seven Oaks Station, Detroit 35, Mich. has announced the development of a new line of transistorized mobile sound systems which has been tradenamed "Road-Commander."

Designed primarily for police, fire, and civil defense work, the system includes a mobile amplifier (Model RC-1225) which can be operated from an automotive 12-volt system and supplies 25 watts audio output; and RC-100 flat contour speaker which is suitable for roof mounting on vehicles using roof lights; and the RC-101 concealment speaker for installation on unmarked cars or fender mounting. In addition, the system includes a microphone and microphone hanger.

Upon written request, the manufacturer will supply complete details on this system and the name of the nearest franchised dealer.

ALUMINUM MASTING

JFD Electronics Corporation, 6101 Sixteenth Ave., Brooklyn, N. Y. has announced production of a new series of lightweight, corrosion-proof aluminum masts for the service trade.

The company notes that such masts offer absolute elimination of rust, staining, or corrosion; high tensile strength of 45,000 lbs. per square inch; 66% less weight than steel; protective corrugated board packing which permits convenient warehousing; and a non-slip fitted-joint lock for positive stacking of sections.

The masts are available in 5, 7½, and 10 foot lengths, 1¼" o.d., .042 (19 gauge) sections in natural silver or gold anodized aluminum.

NEW SILICON RECTIFIERS

The Rectifier Division of *Sarkes Tarzian, Inc.,* 415 N. College Ave., Bloomington, Ind. has recently developed a new silicon rectifier that is designed to be used as a replacement for the 866 series of rectifier tubes.

The Type S-5130 is capable of operating at a full inverse peak voltage of 10,400 volts under all conditions and carries a d.c. current rating of 300 ma. with choke input and 240 ma. with capacitor input.

As a companion rectifier at lower cost, where a full 10,400 volts is not required, the company offers the S-5343 rated at 6400 peak inverse volts and 300 ma. d.c. This type will replace 816 tubes as well as 866's at reduced voltage.

For a data sheet on these new units, write the manufacturer direct. For quantities less than 500, local distributors can supply either rectifier.

UTILITY TABLE

Holly Electronics, 112 W. Colorado, Pasadena, California has recently introduced a new utility table which has been specifically designed for service applications.

The Model 12A1 has an adjustable open top for under-chassis repair and is designed to accommodate most TV and radio chassis. The table is 30" high x 24" square and is mounted on swivel casters. All joints are rigid with special locknut joints. Douglas fir is used throughout.

The table is tested to withstand 250 lbs. It is shipped direct from the manufacturer unassembled. Write the company for price and additional details.

"TRANSFILTER" CIRCUIT

Clevite Electronic Components, 3405 Perkins Ave., Cleveland 14, Ohio has developed two new "Transfilters"

which are said to cut at least 50 cents off the over-all parts cost of a conventional *LC* filter circuit in transistor portable radios.

The new models can be used for i.f. stages of AM radios. They permit the replacement of a double-tuned i.f. transformer and two single-tuned i.f. transformers by a single-tuned i.f. transformer and one each of the TF-01A and TO-01A "Transfilters."

The TO-01A is an interstage coupler providing impedance coupling between the first and second i.f. transistor stage. It combines the functions of impedance transformation and frequency selection of the i.f. frequency.

The TF-01A is an emitter bypass frequency selective element also resonant at 455 kc. In combination with the TO-01A, it gives the receiver's i.f.

stage selectivity comparable to that obtained by the four tuned stages in the original circuit.

The company emphasizes that although the new units replace functions of i.f. transformers in the receiver circuit the new components are not direct replacements. Slight circuit modification is required. Write the company for complete details and full specifications.

TUBE ANALYZER

American Scientific Development, P.O. Box 109, Redlands, California is now offering an electron tube analyzer, the Model ETA 100B, which has been designed for tube and electronic equipment manufacturers, and those requiring positive evaluation and/or matching of vacuum tubes.

The new unit measures true plate and screen current and transconductance at precise voltages specified by the tube manufacturer or at voltages

chosen by the circuit designer. The gas and leakage test, applied to every electrode, is continuously variable to 10 megohms. The unit determines the firing point of thyratrons, regulation of gaseous voltage regulators, and forward and reverse current of small dry-disc rectifiers and diodes.

The unit supplies continuously variable d.c. voltage for output circuits from 0 to 100 volts at 50 ma. It is housed in a portable hardwood carrying case.

Write the manufacturer for additional details and price.

ELAPSED TIME INDICATOR

Sela Electronics Company, 545 West End Ave., New York 24, N. Y. is currently offering a compact, low-cost elapsed time indicator which has been tradenamed the "Selachron."

Suitable for applications as diverse as checking the wear on phonograph styli and timing rented machinery and

equipment operation, the unit has no moving parts and is designed for direct wiring into devices for straight-scale reading of total operation time.

Models are available for equipment or devices operating on 6-, 12-, 115-volt a.c. or d.c. and total elapsed time readings of 100, 500, 1000, and 10,000 hours. Other voltage or time span combinations are available on special order.

CAPACITOR KIT

The Sprague Products Company, North Adams, Mass. has just announced a new kit of silvered mica capacitors which has been especially assembled for replacement applications in electronic servicing.

The "MK-1 Sampler" kit consists of an inventory of 40 silvered mica units in the seven most popular ratings, packaged in a handy reusable plastic box. The capacitors are made of carefully selected, electrically graded mica, are molded in low-loss phenolic, and impregnated for moisture resistance and long life. Capacitance ratings (marked on each unit) range from .0001 μf. to .001 μf. ±5%, 500 volts. The compartmented box has a diagram on its lid to show at a glance where each rating is located and its list price.

The new "Sampler" is currently available at all of the company's parts distributors.

CD ELECTROLYTICS

Cornell-Dubilier Electric Corp., South Plainfield, N. J. is now in production on a line of miniaturized can-encased aluminum-foil electrolytics which are being marketed as "Electomites."

The new units are designed for electronic equipment where compactness, light weight, moderate cost, and high electrical-mechanical dependability are required. They are especially suitable for personal radio receivers, portable wire and tape recorders, portable record players, electronic timing devices, and similar industrial and consumer products.

The new units are available in can sizes from 3/16" x ½" to ⅜" x 1½". Operating temperature range is −20 degrees C to +85 degrees C; 3 volts to 150 volts working.

Bulletin No. 533A, containing complete technical data on this new line, is available from the manufacturer upon written request.

REPLACEMENT SHAFTS

Eastern Jewel Corp., Rego Park 74, N. Y. has announced the availability of an exact replacement fine-tuning shaft for *Standard Coil* TV tuners.

Designated as Part No. TS4, the new unit is made in an extra long length so it can replace the original defective part in any TV set from A to Z (*Admiral* to *Zenith*). The shaft is aluminum and is easily sawed to the exact length needed.

The TS4 is designed to be continuously rotatable a full 360 degrees and has no stop. The dielectric wafer is made thin enough to pass through the conducting metal plates of the tuner which avoids the necessity for deforming the plates during installation.

Further details are available on request from the manufacturer.

TRANSISTOR MOUNTING KITS

Motorola Semiconductor Products Division, 5005 E. McDowell Rd., Phoenix, Ariz. has introduced power transistor mounting kits which provide the necessary hardware to mount all power transistors in the industry-standard TO-3 and TO-5 package.

With these mounting kits, Types MK-10, MK-15, and MK-20, power transistors can be mounted electrically isolated from a chassis or heat sink while excellent heat transfer characteristics are maintained.

Hardware in these new kits includes a transistor socket, front and back mounting templates for hole drilling guides, two #6 mounting screws and insulating washer, and complete mounting instructions.

Write Dept. PMK of the Division for complete details. —30—

MARS SCHEDULES FOR FEBRUARY

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 February.

Feb. 3—"Application of Quartz Crystals in SSB Filters" by W. E. Benton, Western Electric Company.

Feb. 10—"Design Philosophy of A Modern SSB Transceiver" by Chuck Carney, Collins Radio Company.

Feb. 17—"Harmonic and Intermodulation Distortion in High-Fidelity Amplifiers" by Milton Snitzer, Technical Editor, Electronics World.

Feb. 24—"High-Power Transmitter Stations" by Herbert C. Hawkins, U. S. Army Signal Development Laboratory, Fort Monmouth. —30—

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50 (right)	General Cement
51 (left)	Electronic Chemical Corp.
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90	Clevite Transistor Products
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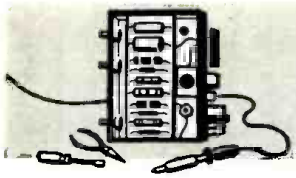

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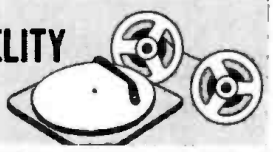

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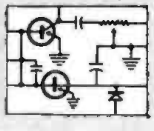

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FEBRUARY 1960

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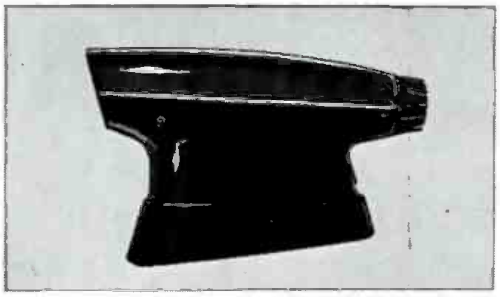
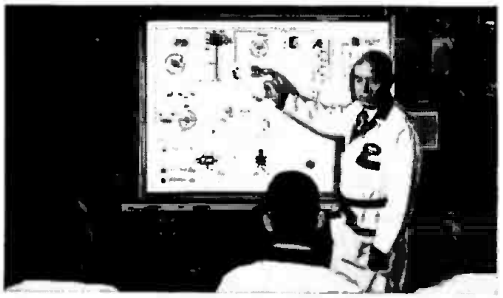
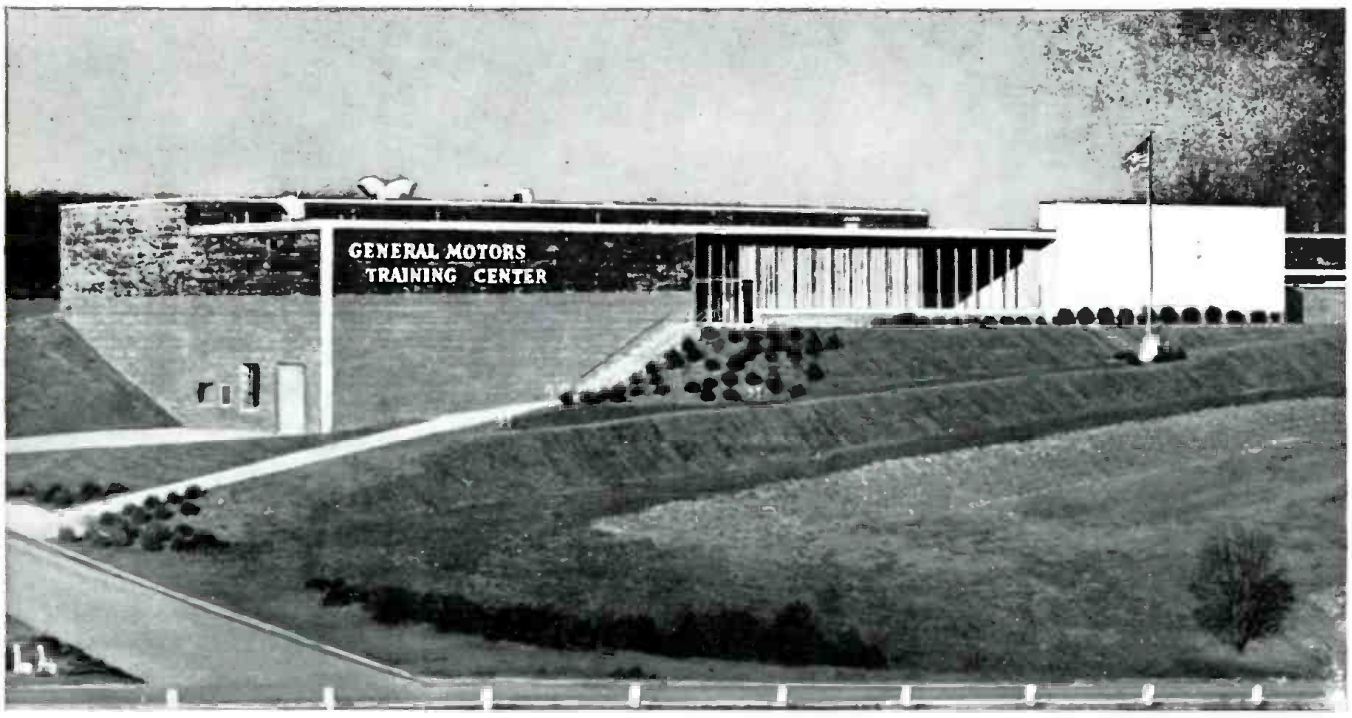


Jumbo-size operational panel of Guide-Matic circuit puts all parts out front for better, more efficient instruction.





GUIDE LAMP DIVISION

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REDUCE DAMPER TUBE CALLBACKS

Here are some important facts about damper circuits

In the *transformer-coupled* circuit, Figure 1, the damper cathode is connected to the "low" (Boost) side of the sweep-output circuit. The voltage difference between cathode and ground is usually less than about 600 volts.

In the *direct-drive* circuit, Figure 2, and in the *auto-transformer circuits*, Figures 3 and 4, the damper cathode is connected to a "high" point in the sweep-output circuit. The peak voltage difference between cathode and ground may be several thousand volts.

Because the damper cathode is "above ground" by several hundred to several thousand volts, care must be taken to prevent voltage breakdown between heater and cathode in the damper tube. Two basic methods are used:

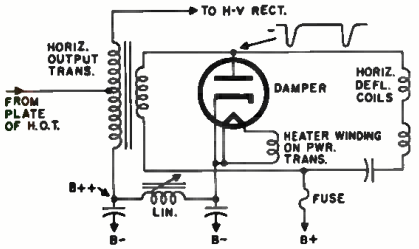

Figure 1. Transformer-coupled horizontal-output circuit. Note that the damper tube heater is connected to the cathode.

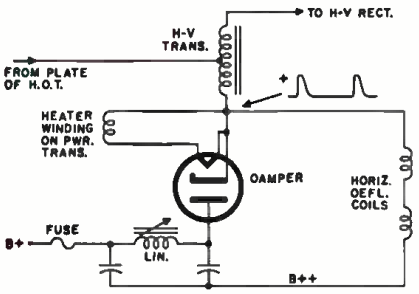

Figure 2. Direct-drive circuit. In some variations of this circuit, a capacitor is connected between heater and cathode in place of the direct connection. The capacitor serves to reduce the pulse-voltage difference between heater and cathode.

In one method, shown in Figures 1, 2, and 3, heater is connected to cathode. This connection eliminates voltage difference between heater and cathode, but it also makes the damper tube heater circuit "hot" with respect to ground. For this reason it is necessary to use a separate secondary winding on the power transformer just for the damper heater. This winding, and its connecting leads, must be insulated to withstand the peak voltage difference between cathode and ground.

In the circuits of Figures 1, 2, and 3, if the damper heater winding becomes grounded, or arcs to ground, high current will flow from B+ to ground through the damper tube, and the fuse will blow. Correction of this trouble usually requires costly and time-consuming replacement of the power transformer.

The second method, shown in Figure 4, takes advantage of the fact that modern damper tubes, such as the RCA-6AX4-GTA, 6AU4-GTA, and 6DE4, are designed to withstand high-amplitude positive pulse voltages between heater and cathode. These RCA tubes make it possible to ground the damper heater circuit, and for this reason, the damper heater may be connected to the regular 6.3-volt-ac grounded-heater circuit, thus eliminating the need for an additional high-voltage-insulated secondary on the power transformer.

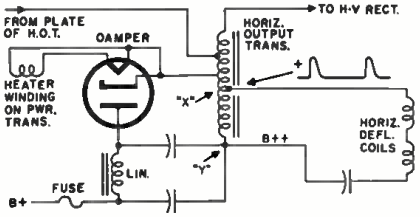

Figure 3. Auto-transformer circuit in which the damper tube heater is connected to the cathode. In some variations of this circuit, the heater is connected to a lower-voltage tap, "X" or "Y", in order to make the heater negative with respect to the cathode, and to reduce the shunting effect of the heater-circuit capacitance.

From a servicing viewpoint, the second method has definite advantages:

In the circuit of Figure 4, if the insulation between heater and cathode should break down, high current will flow from B+ to ground through the damper tube, and the fuse will blow, but the trouble can be corrected easily, quickly, and inexpensively by installing a new RCA damper tube. This is a lot easier and cheaper than installing a new power transformer!

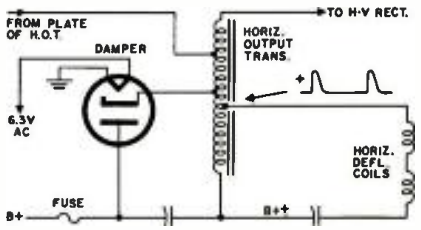

Figure 4. Modern auto-transformer circuit in which the damper tube heater is grounded. Tubes such as the RCA-6AX4-GTA, 6AU4-GTA, and 6DE4, which are designed to withstand high peak pulse voltage between heater and cathode, are required in this circuit.

Momentary arcing, or flashover, in a horizontal output tube or damper tube may be "self-correcting", that is, the flashover may not occur again. But the momentary flashover results in a heavy surge of current which will blow the conventional type of fuse. You can eliminate such unnecessary fuse failure by using RCA "chemical" fuses in the horizontal-output circuit. Three varieties, RCA Stock Nos. 104295, 105041, 105042, are available at your RCA distributor.

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