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RADIO-ELECTRONICS

OCTOBER 1955

TELEVISION · SERVICING · HIGH FIDELITY

HUGO GERNSBACK, Editor

In this issue:

Adding Feedback to Old Amplifiers

•

An FM Wireless Intercom

•

Build a Karlson Enclosure

•

Extend Your Ohmmeter Range

35¢ U. S. and CANADA

Radiophones for Small Craft

(See page 4)

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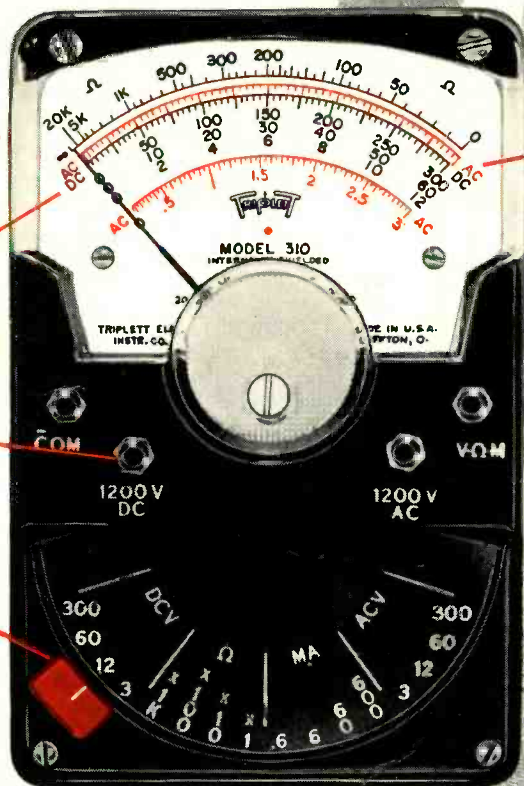

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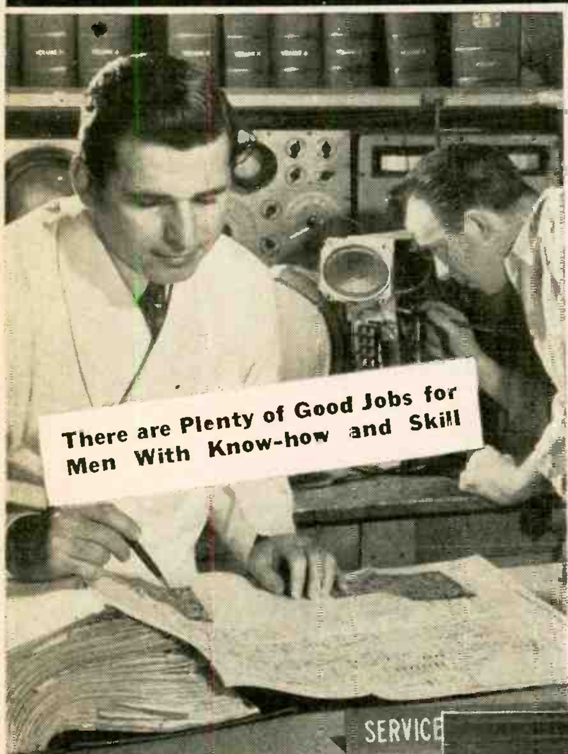

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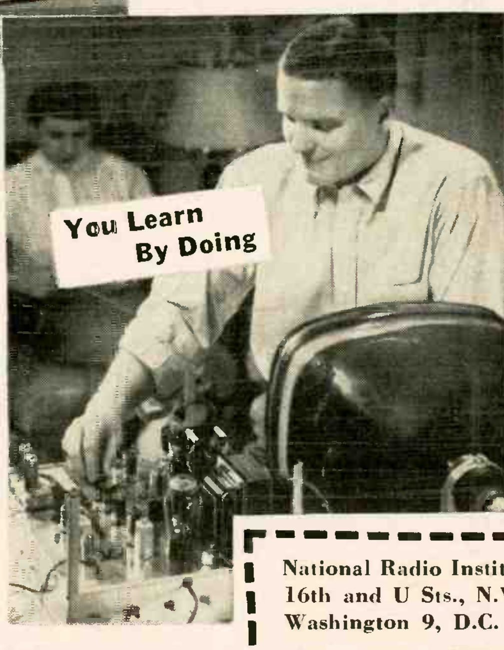

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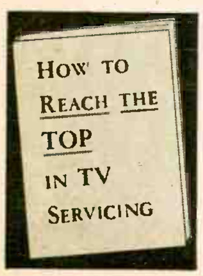

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GERNSBACK PUBLICATIONS, INC.

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ON THE COVER:

(Story on page 50) Barbara Brainard assists in a routine service check on ship-to-shore radiophone equipment.

Color original arranged by Phaostron Co., So. Pasadena, Calif.

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DEPARTMENTS

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the Radio month

TUBE RACKET CURB is aim of Philco plan which would offer service technicians 5 cents' credit for each worn-out tube turned in. In announcing this policy, James J. Shallow, general manager of Philco's accessory division, stated that discarded radio and TV receiving tubes are "being resold by unscrupulous concerns" to the public. It is estimated that this practice amounts to a $100 million take annually with the tubes being completely worthless in many cases.

Under the plan the service technician can bring to a Philco distributor any brand tube and receive his 5-cent credit toward the purchase of a new tube. The old tube will be destroyed in the presence of the technician. It is believed that industry-wide adoption of this plan would greatly reduce or eliminate the tube racket.

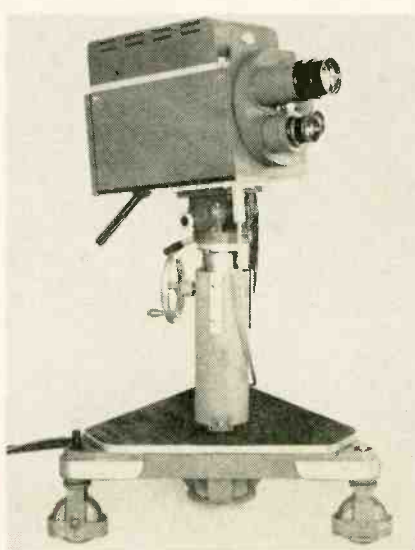
The racket practice generally consists of purchasing worn-out tubes for 1 to 3 cents, cleaning and relabeling them and selling them to dealers and technicians by mail at huge profits.

NEW COLOR TV SYSTEM, demonstrated recently at Gimbels' New York City store, may make closed-circuit store telecasting feasible by making it cheaper. The system, introduced earlier this summer by Du Mont under the name *Vitascan*, in effect reverses present TV camera methods. What appears to be a camera is a flying-spot light source, and the signals are picked up by devices that look like banks of lights (see photos).

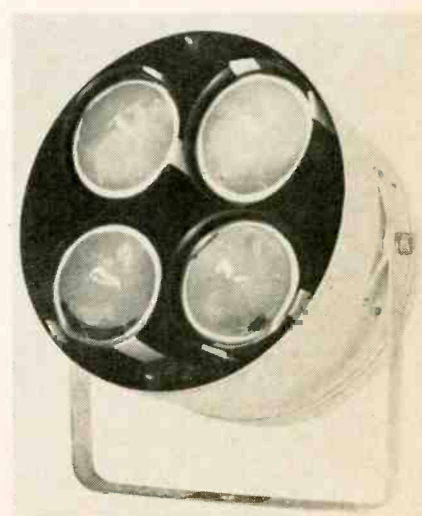
The principle of the flying spot is simple: instead of having a camera scan the object, a bright spot of light does so. A phototube pointed at the scene receives a signal proportional to the brightness of the spot being scanned. The principle was used in early black-and-white TV, but the camera was found more efficient. The story is different with color. Instead of three cameras combined in one unit and carefully registered with each other, all that is needed are "buckets" consisting of four photocells. Two of these are made sensitive to red light, one to green and one to blue.

Since ambient light cannot be permitted to reach the phototube clusters, the studio must be kept in darkness while the signal is being picked up. This could make it very difficult for the performers, but the problem is resolved by illuminating the area brightly with strobe lights during each vertical blanking period. Thus—due to persistence of vision—the studio is brightly lighted as far as the performers are concerned.

G. A. BRIGGS, British audio book author and manufacturer of the Wharfdale speaker, is coming to the United States. Encouraged by the results of two demonstrations of high-fidelity equipment in Festival Hall, London, he has engaged Carnegie Hall in New York City for a similar lecture–demonstration on Oct. 9 at 3 pm. Mr. Briggs states that his object is to show what can be done with high-fidelity equipment—rather than reproduce music absolutely true to life—and to provide an opportunity of listening to records under conditions free from room effects.



The camera-like mobile light source.



One of the "buckets" of phototubes.

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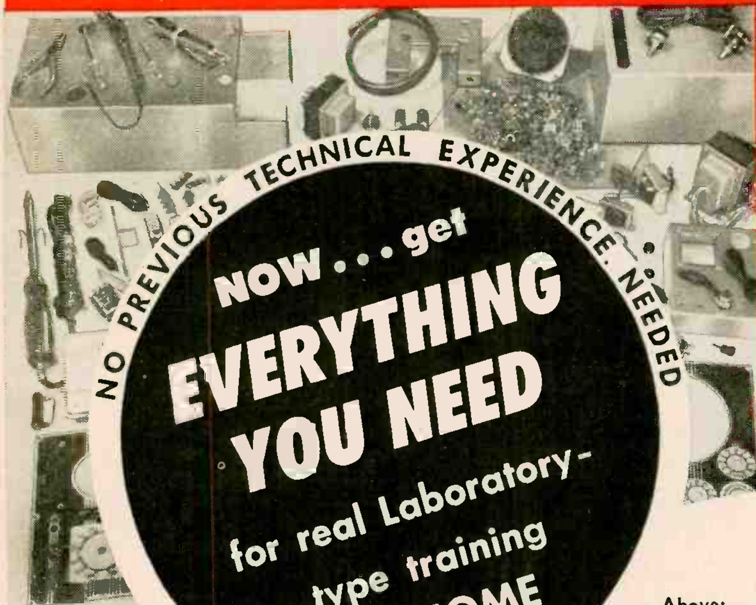

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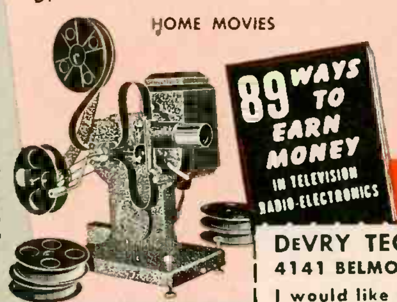

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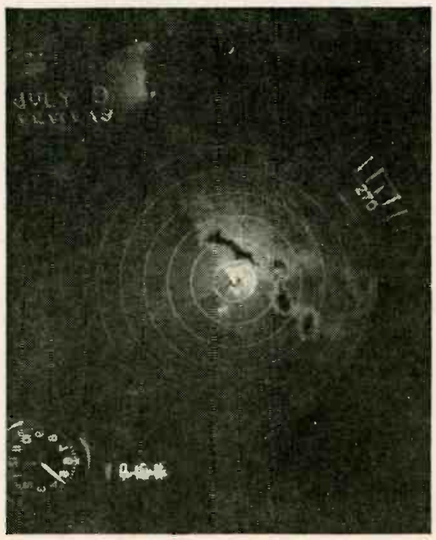
TEN NEW TV STATIONS have gone on the air since our last report:

KNTV	San Jose, Calif.	11
WTHS-TV	Miami, Fla.	2
WILL-TV	Champaign–Urbana, Ill.	12
WNDU-TV	Notre Dame–South Bend, Ind.	46
KSTF	Scottsbluff, Neb.	10
WFLB-TV	Fayetteville, N. C.	18
KFJZ-TV	Fort Worth, Tex.	11
WXEX-TV	Petersburg–Richmond, Va.	8
WHIS-TV	Bluefield, W. Va.	6
WJPB	Fairmont, W. Va.	35

WEEU-TV, Reading, Pa., channel 33, and WACH-TV, Newport News–Norfolk, Va., channel 33, have gone off the air. WTVH-TV has changed its call letters to WTVH, Peoria, Ill., channel 19. Canada's 28th station, CJON-TV, St. John's, Newfoundland, channel 6 has gone on the air.

WEATHER RADAR is being installed on all United Air Lines planes that will enable pilots to peer deep into thunderstorms, normally appearing as a dense mass, and to navigate through smooth



corridors (see photo) around the cores of storms. Designed primarily for weather mapping, the new C-band radar (5.5 cm) also gives pilots a clear picture of terrain features such as streams, mountains and shorelines. It will keep pilots informed of changing weather conditions as far as 150 miles ahead.

The radar equipment, made by RCA, has its antenna and gear mechanism installed in the plane's nose.

BELL SOLAR BATTERY installed in Americus, Ga., this past summer has

undergone its first practical test as part of the telephone system. The experimental unit, essentially identical to the model shown in the photo, supplied power to terminal equipment on rural telephone lines. The heart of the solar battery is a silicon disc that converts sunlight into electricity.

The model contains 432 discs, arranged in 48 units of 9 each. During daylight hours the solar battery powers terminal equipment directly and, at the same time, charges a storage battery to provide power for nighttime operation and periods of lowered sun intensity. The mounting permits the face of the battery to be tilted to the most favorable angle for maximum sun exposure.

TWO TELEVISION PROGRAMS on a single channel is a plan proposed by Paramount Pictures in their bid for FCC approval of pay-as-you-see TV. The Paramount plan, which does not use scrambling as part of their system, would show a photo advertising a motion picture on a given channel. When a coin is inserted, the continuous commercial would be replaced on the screen by the movie.

Dr. King, head of Telemeter's engineering department, a subsidiary of Paramount, indicated that the quality of the continuous commercial might be degraded as compared to the motion picture. He added, however, "Ultimately, I think it will be possible to send two full programs simultaneously on the same channel—our present use of the TV channel is very wasteful."

In its technical paper filed with the FCC, Paramount stated that its system is roughly similar to that of color TV transmission. By a system of frequency interleaving, signals of program A are dropped between those of program B. With a switching circuit, either set of signals can be selected.

NEW FREQUENCY RECORD for transistors has been set by the Bell Telephone Laboratories, with a junction tetrode transistor that oscillates at 1,000 mc (1,000,000,000 cycles) per second.

The new transistor is an n-p-n type in which the central p-layer has been made very thin, as a result of new production techniques. In the 1,000-mc transistors the layer is less than .0002 inch wide, 10 times narrower than was previously possible. A fourth electrode is also attached to this layer. It concentrates the current flow in only a part of the layer, making it electrically even smaller and narrower.

Telephone engineers are especially interested in the new transistors, since it may be possible to use them in the relay systems which now beam television programs and large bundles of phone conversations across the country. Previous transistor types could not be made to operate at the high frequencies used in such systems.

Commercial production of the at-present experimental transistors is scheduled to begin this year. END

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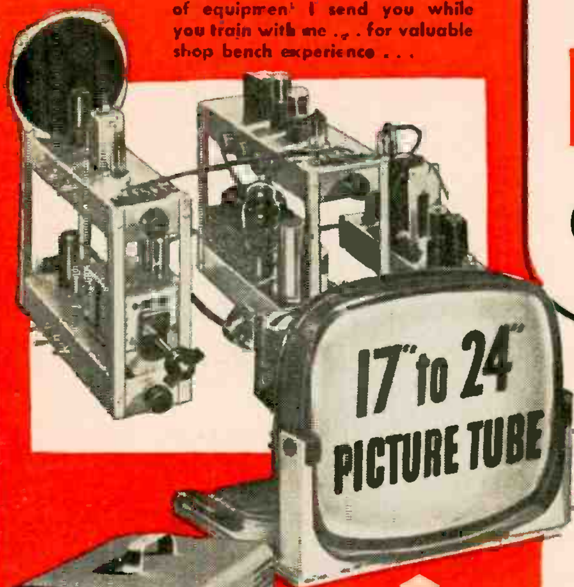

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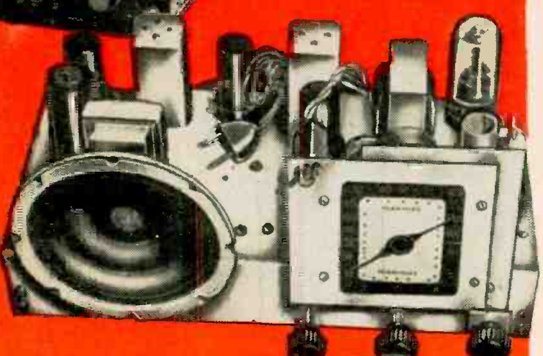

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Correspondence

TRANSISTOR SYMBOLS

Dear Editor:

I agree with Mr. Aisberg (June, 1955, page 14) on the need of standard symbols for transistors. They should be as simple as possible. I like the idea of putting a circle around the elements because transistors are encased in a material just as tubes are enclosed in glass or metal.

A small square or triangle could be inserted within the circle to indicate that there is no vacuum, as a small dot now indicates gas in a tube. [Why not simply enclose the transistor symbol in a square or triangle instead of this extra complication?—*Editor*]

A circle simplifies schematic reading —imagine TV schematics without circles around the tube elements, especially drawings that have been reduced!

T. L. BARTHOLOMEW
Bridgeport, W. Va.

LOUDSPEAKER ENCLOSURE

Dear Editor:

I was pleased to see Mr. Coates' article "A New Loudspeaker Enclosure" (June, 1955). His cabinet is similar in principle to one I built some months ago, but he has gone much farther with his muslin diaphragm.

While I am no expert on acoustics, I have not been content with expensive speakers and multiple-port cabinets. I remembered that years ago our console radio seemed to sound better when turned to face the wall.

I decided to rework my open-face phonograph cabinet. I removed the speaker mounting panel from the front and cut another from ¾-inch plywood to fit the back and put in an inexpensive 8-inch speaker. The speaker faces forward and protrudes out the back. The inside is lined with Fiberglas.

Performance has been very satisfactory; the bass response is smooth and sensitive to the lowest notes. On the treble end it is not shrill nor harsh and violins or trumpet solos stand out loud and clear.

Since Mr. Coates and myself agree that the open box type of enclosure gives pleasant listening, I feel that the complicated constructions and multiple-speaker systems are of no great advantage. My medium-priced 12-incher reposes on a shelf in the basement.

JOHN S. MCLEAN
Detroit, Mich.

ELECTRONIC EMPLOYMENT

Dear Editor:

As a person who has occasion to be

very close to employment problems in electronics, I feel Mr. Lane's treatment of the subject (July, 1955) was incomplete. He devoted a great deal of space to jobs employing a small segment of the nation's electronic technicians. Some of the biggest areas of opportunity were completely ignored.

He mentioned jobs such as technical writers, shipboard radio officers, etc., but did not bring out the fact that as of last June (1954) there were more than a half-million mobile transmitters in operation—excluding amateur, military and Government equipment. At the present rate of expansion that figure could easily reach the million mark within a year. Imagine how many FCC-licensed men will be needed in that field alone!

The installation and maintenance of electronic business machines (including computers) is rapidly drawing a great many men and the demand exceeds the supply. What about the airlines and their increasing demand for communications personnel? And the increased use of microwave equipment is another direction for electronically-minded men to move.

Mr. Lane should have dwelt less on minority groups and more on a complete coverage of the field.

G. O. ALLEN, *Vice President*
Cleveland Institute of Radio Electronics
Cleveland, Ohio

NOTE FROM DOWN UNDER

Dear Editor:

Here in Australia we are patiently waiting for our first TV broadcast. Allocations have been decided upon, and there will be one Government and two commercial stations in each capital city. In about a year we should be on the air. Americans will appreciate our feelings as you experienced a similar state of conditions.

RADIO-ELECTRONICS is highly rated in Australia and regarded as a *must* if one desires to keep abreast of the electronics field. Although we cannot yet follow along practical lines, articles on TV circuits, troubleshooting and antenna installations are very instructive and will be valuable for future reference.

Since the war we have followed the American trend in electronics. Tubes used here are, without exception, American types and circuits follow suit. Industry is fast waking up to automatic electronic control, and again these are mostly American products. I hope the above will be of some interest to your readers.

L. KAY
Charlestown, New South Wales
Australia

END

PSEUDO-HORN ANTENNAS

Dear Editor:

With regard to Mr. Julius Green's letter to the editor in the August, 1955, issue of RADIO-ELECTRONICS, we wish to add pertinent comments. Whether or

not the antenna referred to in the April issue of RADIO-ELECTRONICS is a true horn is an academic question. The gain-frequency characteristics of the antenna much more closely approximate those of a horn than of a dipole.

One advantage that a cut Yagi has is its rejection of signals at frequencies other than that to which it is tuned. However, if a broad-band Yagi is used, this advantage exists to a lesser degree. It should be pointed out that the pseudo-horn in Mr. O'Leary's article in the April issue has no tuned rejection of signals within itself. The rejection is limited to that of the front end of the TV set and the horn has high gain for "noise signals" as well as the wanted TV signals. There are many advantages, however, to the pseudo-horn, as constructed by Mr. O'Leary. One is that technically it is very easy to build and adjust. Very little adjustment of elements is necessary for proper impedance match and maximum gain, whereas in a Yagi these adjustments are critical and difficult to make without a completely equipped engineering laboratory. The area of space from which a Yagi can abstract signals is limited by the frequency to which it is cut, whereas the pseudo-horn does not have this limitation. This means that the total energy abstracted from space by a pseudo-horn can be very much greater than that by a Yagi.

In some communities where satisfactory signals are required regardless of cost, extremely large pseudo-horns have been constructed. They have given satisfactory TV reception where Yagis had failed completely. These large horns had higher gains than low-frequency Yagis and much higher gains than higher-frequency ones. Therefore, we feel that RADIO-ELECTRONICS readers would be well advised to try these horns in extremely low-signal areas.

GEORGE PRICE
BRUNO ZUCCONI
San Francisco, Calif.

TOUGH SITUATION

Dear Editor:

I am in complete agreement with Mr. H. M. Layden's comments (May, 1955) regarding screwdriver mechanics. I am the only service technician in a large rural area jampacked with screwdriver mechanics and can prove with facts, figures and case histories that every word of Mr. Layden's letter is true.

On only one point would I beg to differ. This is one shop where local tube pullers do not get the red-carpet treatment. I reserve a specialty for them called the meat-axe treatment.

Because of this situation, it looks more than likely that this area will be losing shortly its only legitimate service technician as it is impossible to maintain a profitable business when the gravy jobs are going elsewhere and all one has to work with are the headaches.

GORDON MCINTOSH
Crysler, Ont., Canada

L. C. Lane, B.S., M.A.
President, Radio-Television Training Association.
Executive Director, Pierce School of Radio & Television.

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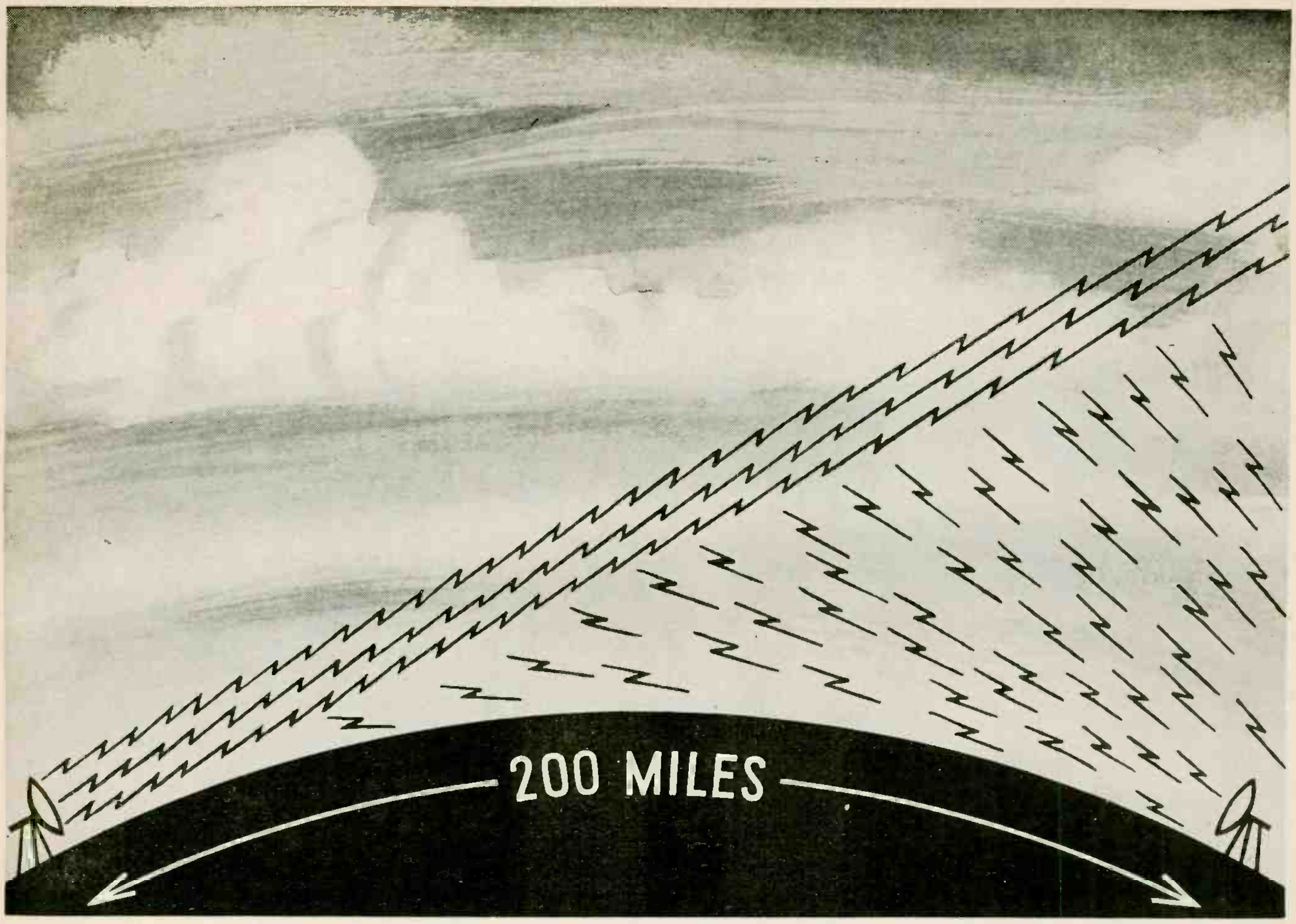
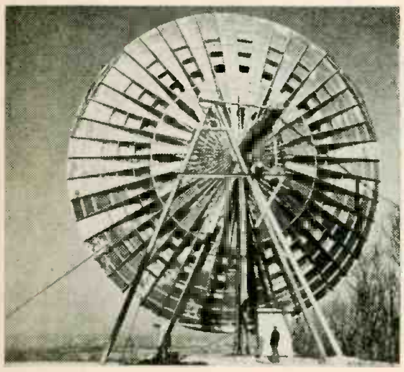


Highly schematic drawing illustrates the possible distribution of energy in ultra-high-frequency "over-the-horizon" transmission. The effect is similar to that of a powerful searchlight whose beam points into the sky. Light can be seen miles away from behind a hill even when the searchlight lens is invisible.

Something new on the telephone horizon



This experimental 60-foot antenna (rear view) photographed at Bell Laboratories in Holmdel, New Jersey, is designed for study of "over-the-horizon" phenomena.

Telephone conversations and television pictures can now travel by ultra-high-frequency radio waves far beyond the horizon. This was recently demonstrated by Bell Telephone Laboratories and Massachusetts Institute of Technology scientists using "over-the-horizon" wave propagation, an important recent development in the radio transmission field.

This technique makes possible 200-mile spans between stations, instead of the 30-mile spans used for present line-of-sight transmission. It opens the way to ultra-high frequencies across water or over rugged terrain, where relay stations would be difficult to build.

In standard microwave line-of-sight transmission, stations are so spaced that the main beam can be used. But now, with huge 60-foot antennas, and much higher power, some signals drop off this main beam as it shoots off into space. These signals reach distant points beyond the horizon after reflection or scattering by the atmosphere. The greater power and larger antennas of the "over-the-horizon" system permit recapture of some of these signals and make them useful carriers. The system will be a valuable supplement to existing radio relay links.

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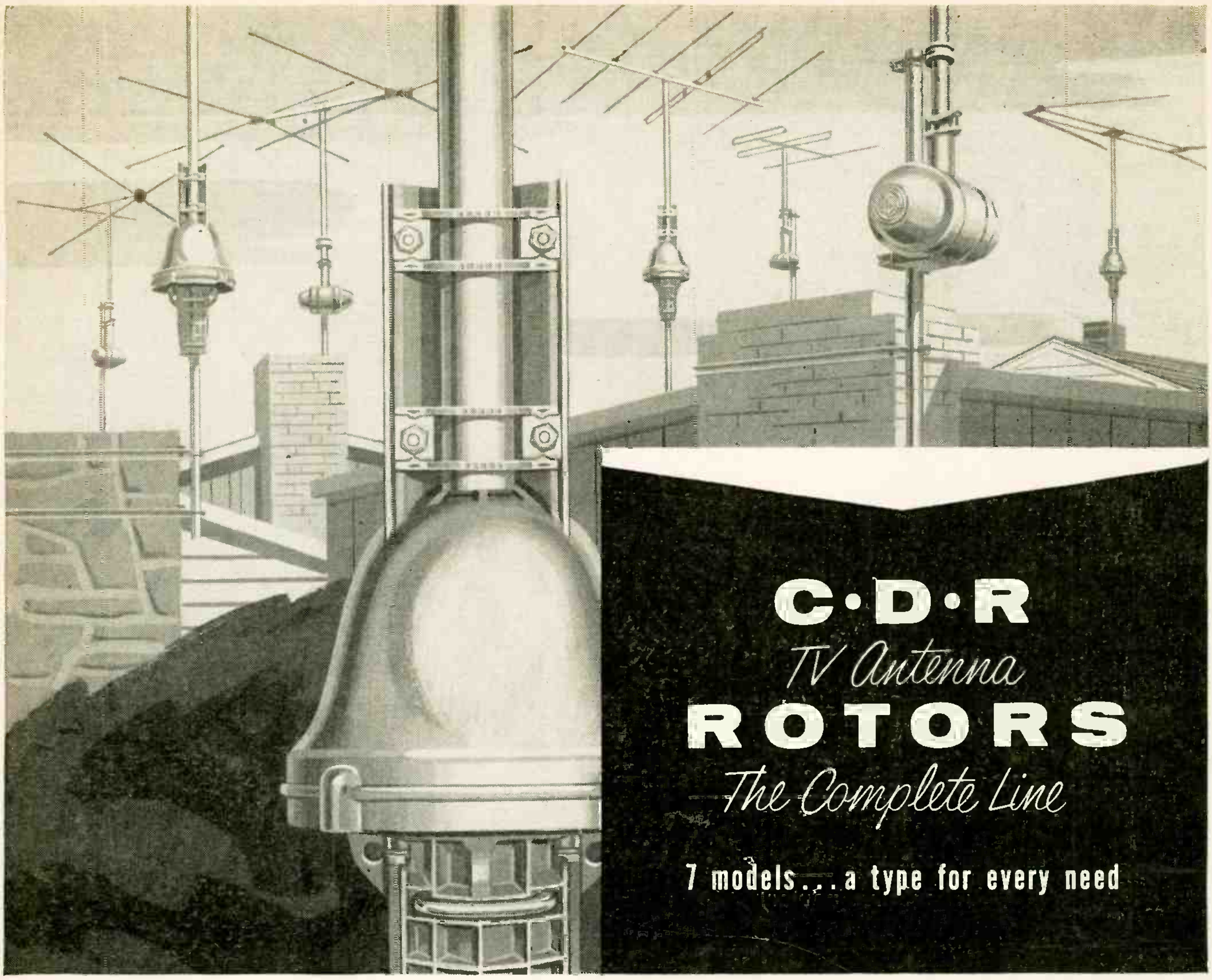

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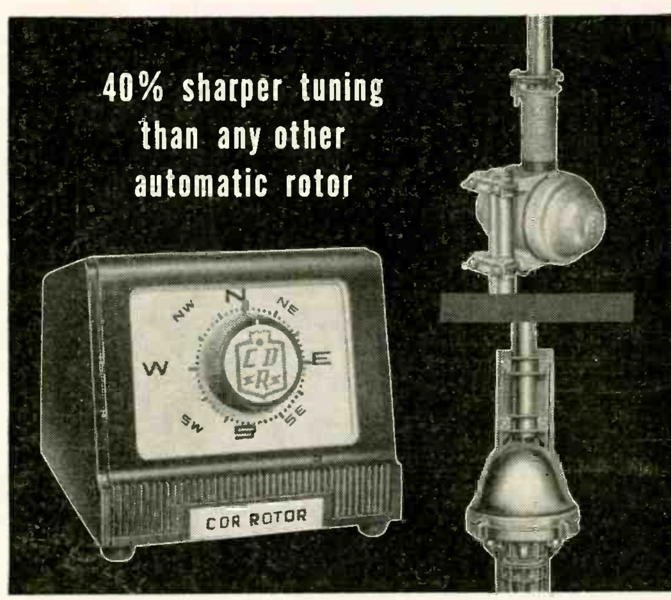

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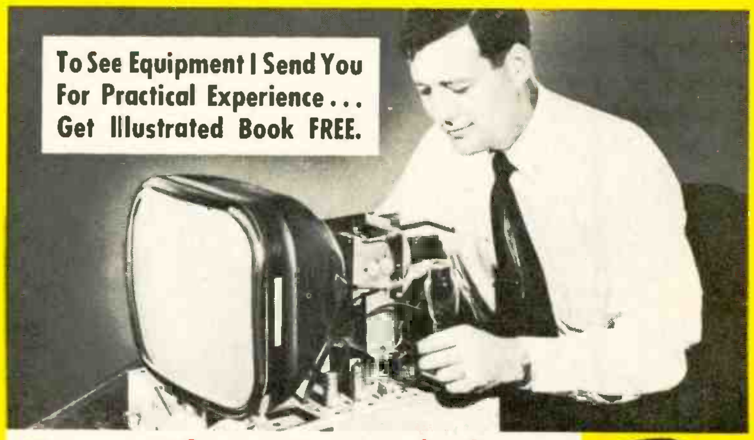

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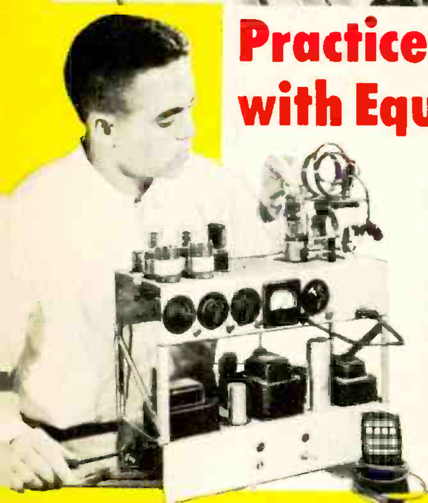

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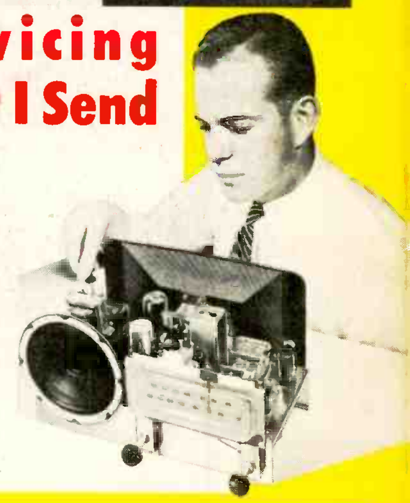

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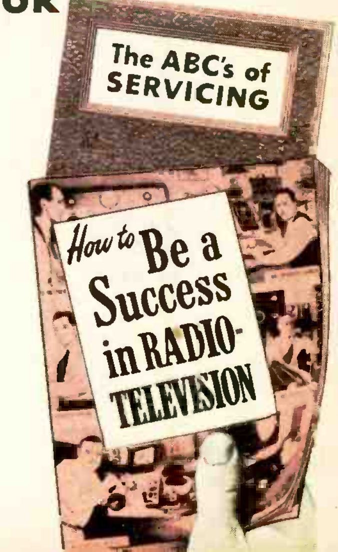

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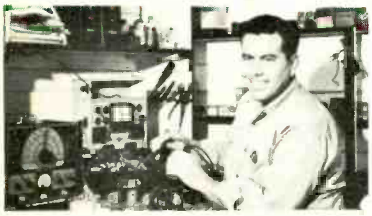

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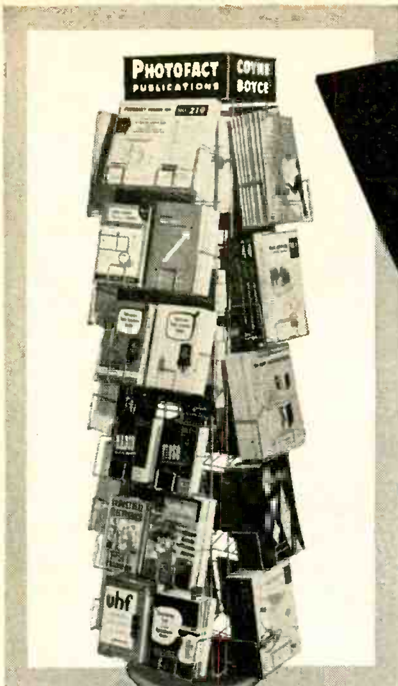

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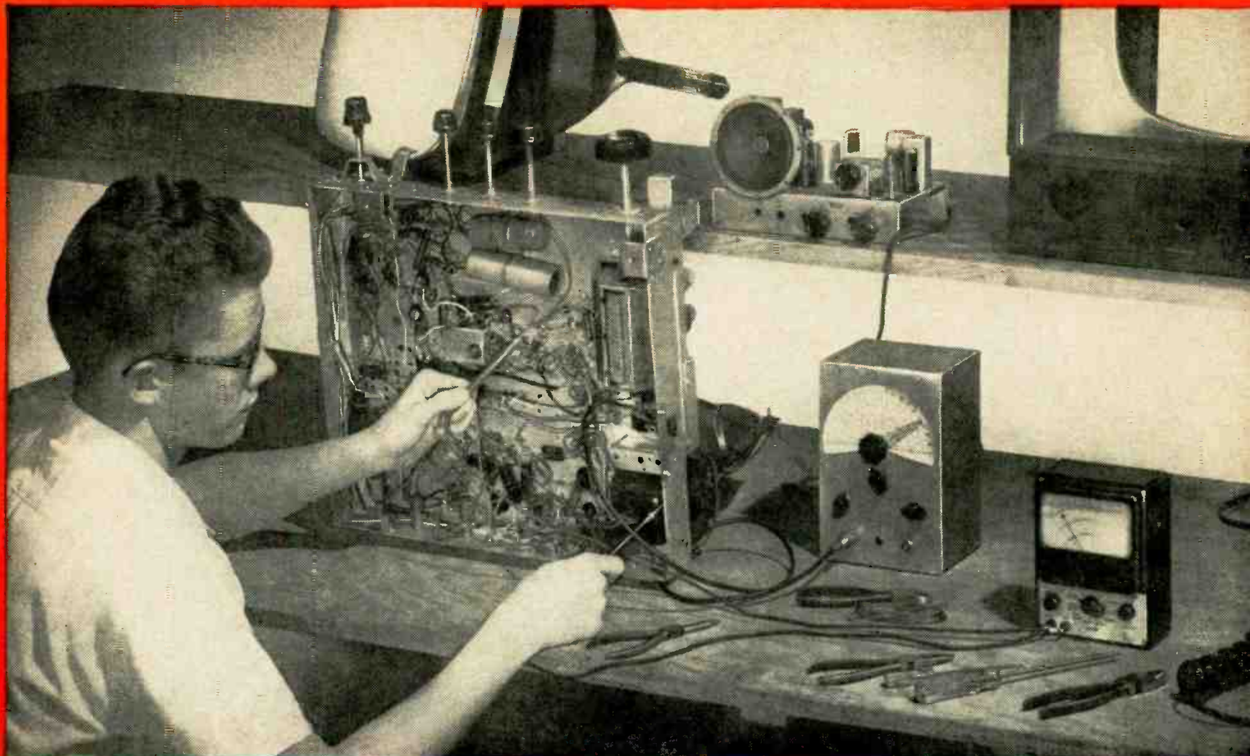

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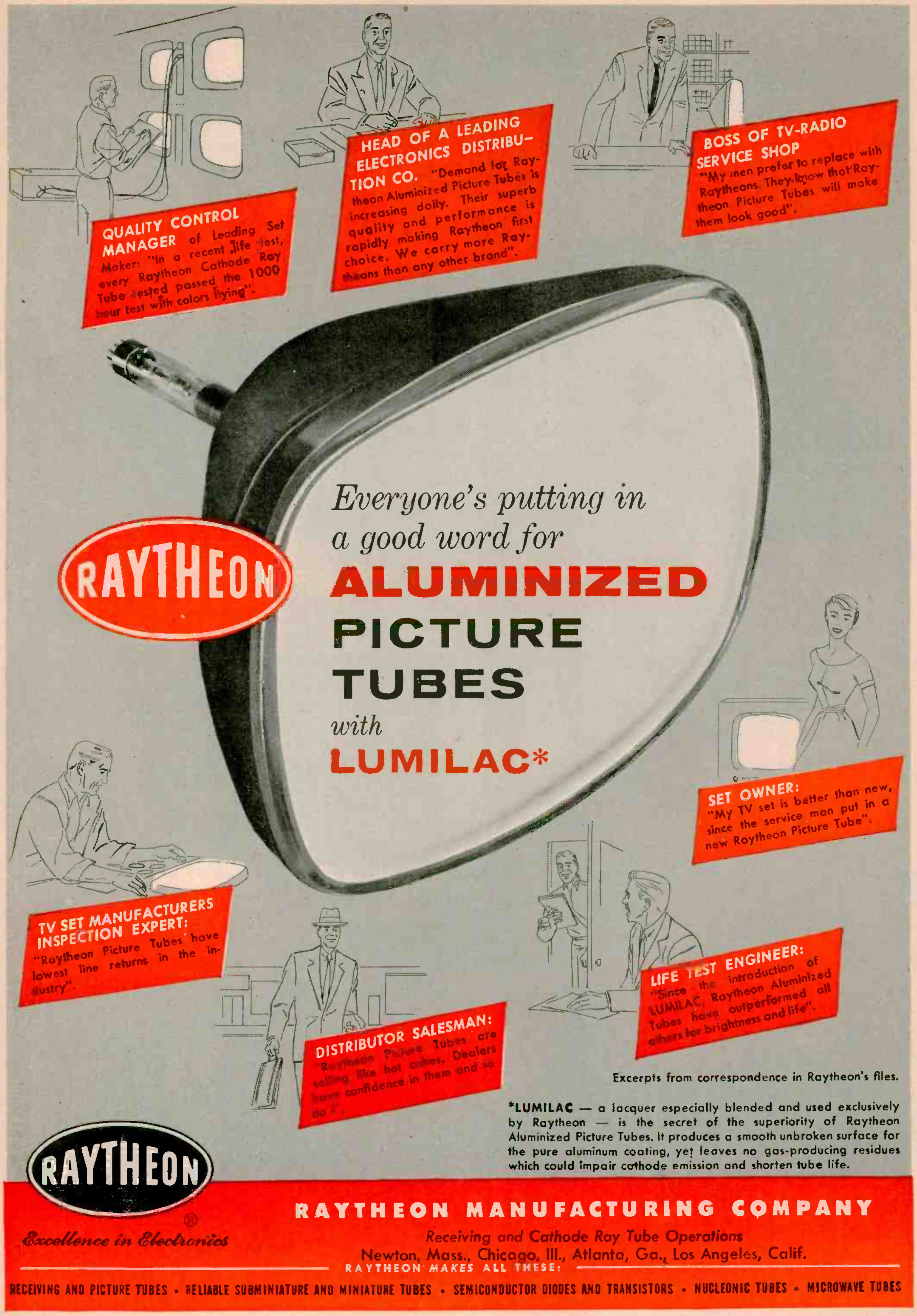
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FIELD REPORT NO. 5

Jack Livesay
Livesay's Music Co.
Roanoke Rapids, N. C.

We have an eighty-five foot test tower located at our Store for the purpose of comparing the different types of antennas on the market today. The reason we have selected the JFD Star-Helix all channel antenna above all others is that it has the best frequency response and highest gain on channels 2 through 13. Since the birth of the JFD Star-Helix we have installed over 600 Star-Helix and have never had a call back due to the fault of the antenna.

Paul Morrore
Morrore TV
Creston, Ia.

Most of my customers are out in the fringe area. We need a lot of gain to pull in the signal, most of all on channel 13. I used every new antenna that came out that was a fringe antenna, but nothing worked until I used the Super-Star Helix made by JFD. The Super-Star Helix is for me now. It's made me a lot of new customers.

Oliver Ewbank
Plaza Television
Topeka, Kan.

When the Star-Helix came out, we checked its performance as we do with all new antennas. The exceptional results of those tests have since been verified many times by users who are getting the sharpest, cleanest pictures possible. We know of numerous instances where the Star-Helix delivered excellent pictures at locations where three or four other antennas had failed.

Sam M. Patrick
Patrick TV & Radio Inc.
Orlando, Fla.

The JFD Star-Helix is the best antenna I've tried—and I've tried them all—that pulls in clear pictures on channels 8 and 13 from Tampa over 100 miles away. Also channel 4 from Jacksonville which is over 150 miles away. I also know that my Star-Helix customers are ready for Top-notch color reception when it comes their way.

Harry H. Rogers
Rogers Radio & TV
Lenox, Ia.

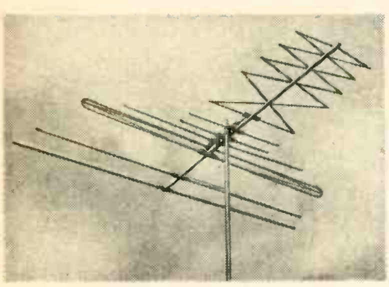
Channel 13 from Des Moines has been a big problem out my way. The other channels came in good but 13 was nothing but ghosts and interference. JFD made the Super-Star Helix and I tried it and now 13 comes in as bright as all the other channels. Now I'm using it in all of my installations.

John D. Sorrentino
East New York Appliance
Brooklyn, N. Y.

It sure surprised me. It's the first time I ever got compliments on the looks of my antenna installation. That trim inline build of the JFD Fire-Ball sure looks as good as it works. I don't have to worry about break-down from high winds or ice-loading either. It's got my vote.

Across the U. S. A. TV Dealers Acclaim these JFD Antennas...

Whether you buy the ultra-sensitive Star-Helix or the new Super-Star Helix or the remarkable Fire-Ball, you know the JFD antenna you install protects your reputation.



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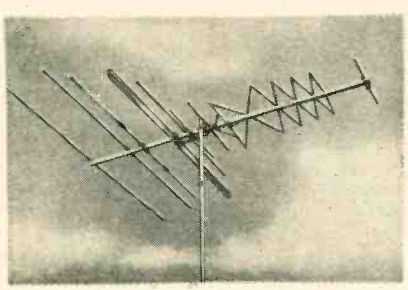

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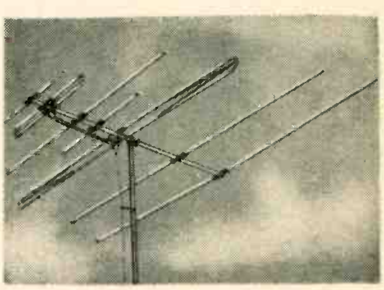

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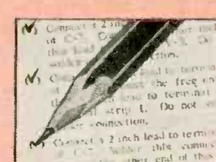

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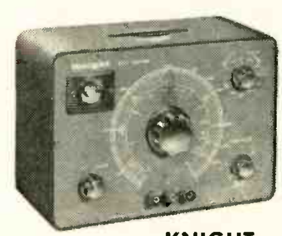

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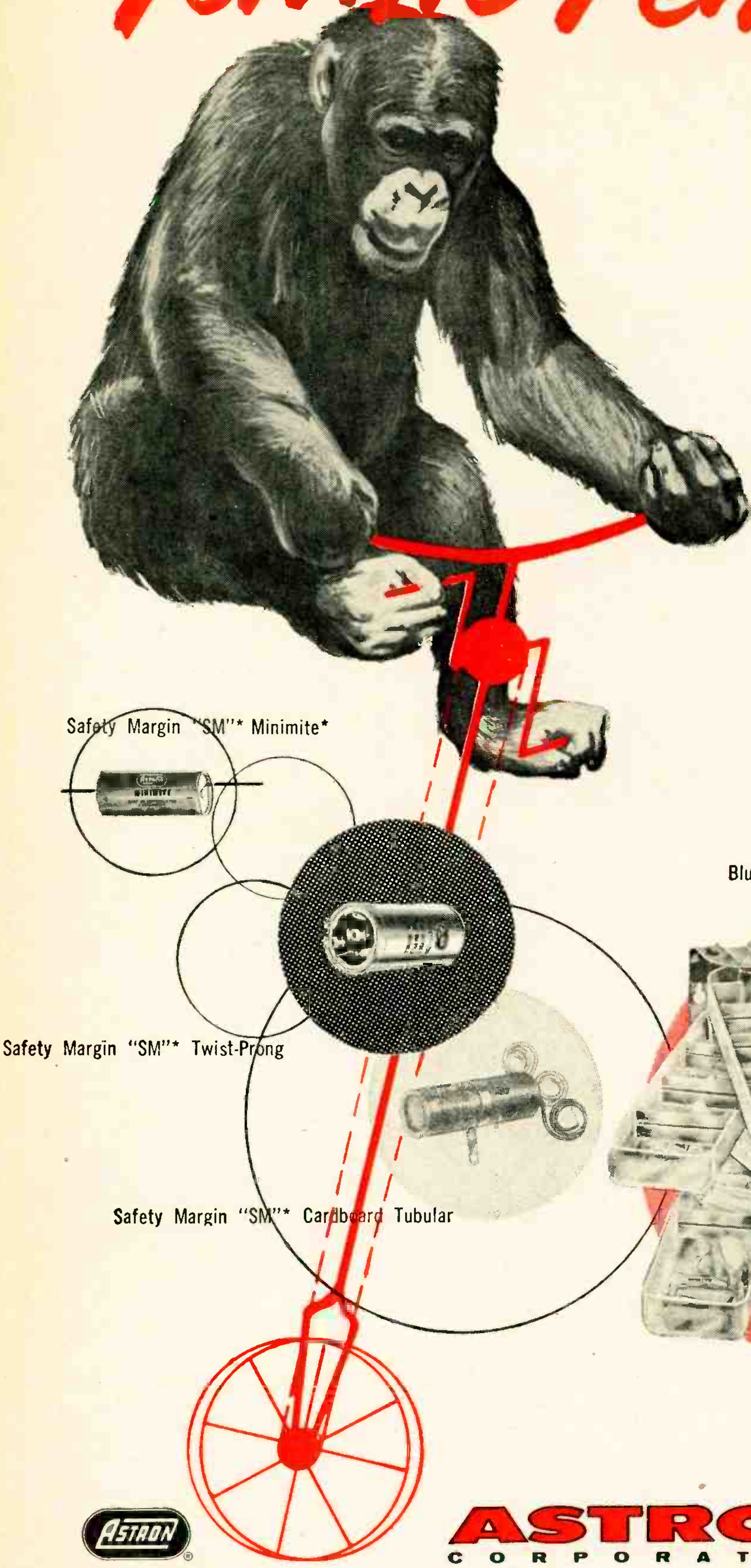

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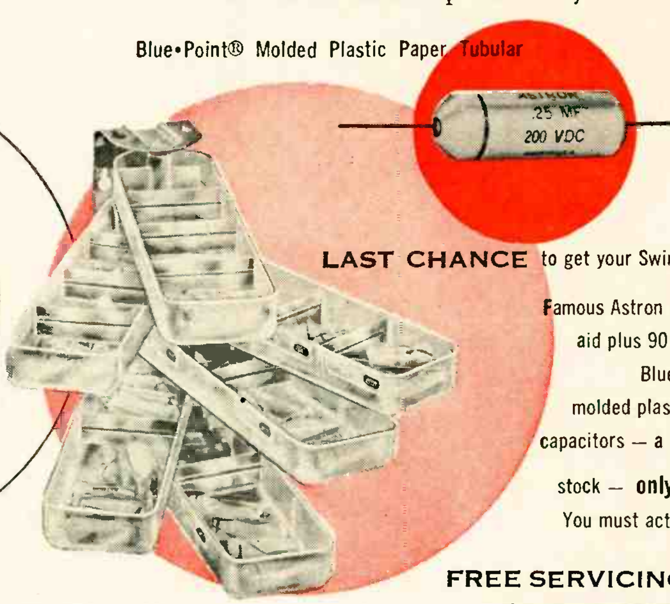

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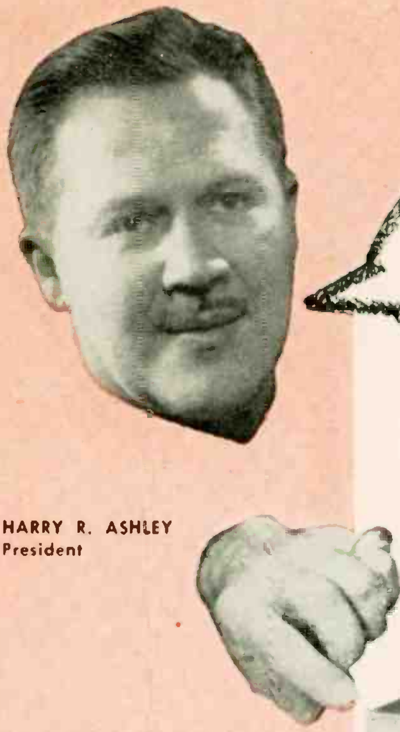

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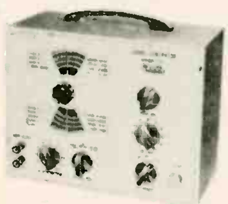

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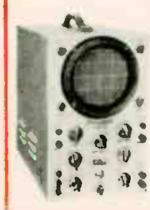

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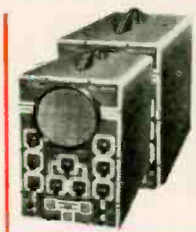

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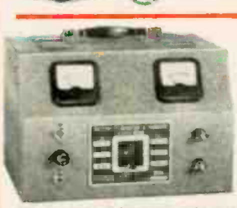

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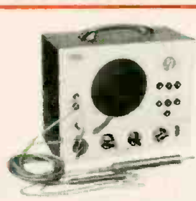

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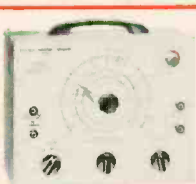

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ELECTRONIC ALARMS

. . . A new and lucrative business for technicians . . .

Sound Barrier. In Chicago, two burglars who broke into an electronics firm were startled when a booming voice said, "Good evening, gentlemen. We remind you that this place is electronically guarded. We suggest that you turn around and disappear." They fled emptyhanded when loudspeakers all over the building began shouting, "Burglars! Burglars! Call the police!"—*Time Magazine*

IN 1953, burglars entered 479,120 times and took over $78 millions in money and property in the United States. In 1954, this form of crime increased nearly 15%. It will be much higher in 1955.

These figures do not include auto thefts, daytime bank thefts or robbery. Only in about one out of four burglaries committed are the perpetrators convicted while convictions result in only about one out of six auto thefts and other larcenies.

The astonishing part of this sorry state of affairs is, not the crime, but the fatalistic apathy of our people who hardly lift a finger to protect themselves. Not only are householders and business establishments notoriousy lax in safeguarding their property, but even big banks. Thus, recently a New York City bank—one of over a dozen in a huge banking chain—was held up and robbed of over $300,000 in plain daylight. *Yet this huge banking institution, whose assets run into several billions of dollars, had never installed an alarm in any of its branches.*

What is wrong? The answer is: our business people have never been properly educated in the efficacy of modern electronic safety devices. Most people in the business world still think in terms of antiquated burglar alarms. Then, too, our technicians and electronic designers must be accused of not using sufficient ingenuity in devising up-to-date electronic safeguards that can fit ANY variety of conditions.

Obviously, you would not use identical equipment to protect a home, a garage, a jewelry store or a bank. Each demands different treatment. Thus, banks need *two* distinct types of alarms—one for daytime holdups, one for nighttime protection. Banks, too, frown on noisy alarms, which bank officials claim invites gunplay of trigger-happy holdup men. Yet there are literally hundreds of ways in which electronics can be used to give *silent* alarms without thieves ever knowing about it. Such alarms can summon police or guards who can nab the criminals before they reach their getaway car or when they emerge on the sidewalk. Holdup men can also be photographed by comparatively simple electronic triggering devices.

In homes, the mere entrance of a burglar can turn on all house lights, which will often effectively scare away the intruder. The device may also take his picture, too, unbeknown to him.

In jewelry stores—manned often by the proprietor only —*concealed* tear gas devices can be placed in or under the counter, directed upward to hit the burglar square in the face when the proprietor or clerk moves his foot in a certain manner. The same act could release an outdoor alarm that screams, "Burglar! Holdup! Police!" in a stentorian voice audible for blocks.

With some ingenuity, an unlimited number of such protective devices can be designed by any good technician. Some can be installed at reasonable cost. Other more elaborate ones—depending on requirements—may run into a good deal of money as, for instance, complex installations in banks.

Designers should, however, always appreciate the fact that the average burglar is not stupid—often he is most ingenious. He may not enter through a door or window. Thus, to give but one example, in our own building in downtown New York, burglars—always over a weekend—selected the premises of a manufacturing concern which makes gold emblems. Their establishment was raided several times in the past. The firm put up heavy iron grating on the door, with stout steel bars and excellent locks.

What did the burglars do? They left the door untouched, but hacked a large hole in the plaster wall, through which they entered. Invisible infra-red or ultrasonic rays criss-crossing the premises could have controlled a signaling device that would have brought the police on the run or set up a deafening outside alarm which surely would have routed the intruders.

Burglars, too—often suspecting an alarm system—will carefully disconnect the electric supply from outside of the premises, particularly in detached houses. If the alarm depends upon outside electric supply lines, it is thus put out of action. The remedy in this case would be a relay system that operates as soon as the outside current fails, switching on batteries, which in turn sound a loud, outside alarm.

The list is endless, but one thing is certain: with sufficient ingenuity, the burglar can be outwitted in most cases.

Yet that is not the moral: The main purpose of this article is to alert enterprising technicians, particularly service technicians, to embark upon one of the most lucrative endeavors — the business of making or installing electronic safeguards in their community. Such installations are not only profitable, *they also must be serviced and tested periodically.* The latter alone is an extra source of income.

Many such installations can use photoelectric equipment already on the low-price market. Others may require designing capacitance alarms, which have often been described in this magazine. The more elaborate, such as ultrasonic alarms, are available on the market in complete form.

It is essential that if you embark on such a venture, you must prepare some convincing literature to mail to your prospects. The average person, as we mentioned above, is skeptical—he must be convinced before he will place an order. That is why your printed appeal must be educational, explanatory and forceful. Reproduction of newspaper clippings of recent burglaries always helps, too.

Electronic safeguards and alarms is a coming business—GET IN ON THE GROUND FLOOR NOW! —*H. G.*

RADIO-ELECTRONICS will pay from $50 to $150 per article accepted on *Electronic Safeguards and Alarms*, depending on article quality, originality and novelty of such a device.

Dual-Frequency Crystal Calibrator

By RONALD L. IVES

Sawtooth-pulse oscillation identifies output of instrument

ABOUT 30 years ago, J. R. Pierce and others of the Bell Telephone Laboratories' staff demonstrated the usefulness of quartz crystals as frequency standards. Developed from these findings are the phenomenally accurate time and frequency standards now used by AT&T and the U. S. Bureau of Standards. Less widely publicized—but much more widely used—are the crystal calibration oscillators supplied as integral parts of many communications receivers made during the last 20 years.

A typical calibration oscillator consists of a quartz crystal, a vacuum tube and sundry components so connected and adjusted that the output consists of the fundamental frequency of the crystal and many of its harmonics. A conventional triode oscillator usually gives usable harmonics to about the 30th.

As the frequency spectrum has been expanded upward, harmonic generators have been added to calibration oscillators so that usable outputs beyond the 150th harmonic are now easily attainable.[1, 2, 3]

Identifying the calibration oscillator outputs has been a problem since the device was first used. It is virtually impossible to distinguish between a steady carrier from an outside source and the calibration oscillator output without some auxiliary identification.

Bliley attempts to produce an identifiable calibration signal by supplying the plate of an electron-coupled crystal oscillator from the first capacitor in the plate-supply filter. This produces an easily detectable 120-cycle modulation which, unfortunately, too closely resembles a TV picture signal or a poorly filtered "outside" oscillator.

Use of sawtooth-pulse oscillation to make calibration signals easily recognizable was suggested by Langford-Smith[4] more than 15 years ago, but nothing seems to have been done with the suggestion despite its apparent merit.

Required components for a workable pulse-identified calibration oscillator consist of a crystal oscillator, a harmonic generator, a pulser and a mixer.

Crystal oscillator circuitry

The crystal oscillator is a standard electron-coupled device using a dual-frequency crystal (Bliley SMC-100) with outputs at 100 and 1,000 kc. The circuit (Fig. 1) is substantially that recommended by the manufacturer—minor changes have been made to permit frequency switching with a grounded-armature relay. The 25-$\mu\mu$f trimmer sets the 100-kc frequency exactly, by zero-beating a harmonic with a WWV signal. None of the component values are at all critical, and only a major circuit defect will keep it from operating. If the SMC-100 crystal is not available, you can use a Valpey DFS or similar type with both crystals in parallel.

The harmonic generator consists of a nonlinear input device (1N34 diode) and a pentode amplifier, connected as in Fig. 2. Tube constants and component values are extremely uncritical and almost any reasonable values will work well.

Relative strengths of the various harmonics can be altered somewhat by changing the values of the coupling capacitors. The higher-frequency harmonics are favored by using small coupling capacitors. With conventional tubes, components and construction, outputs above 500 mc are rather undependable.

Probably the most satisfactory pulser which can be constructed from standard parts is the neon oscillator, a conventional relaxation oscillator, depending for its operation on the difference between the striking and extinction voltages of a gas tube. A basic circuit of a neon oscillator, with representative constants, is shown in Fig. 3. The general formula relating supply voltage, tube characteristics and component values is:

$$f = \frac{1}{2.303\ RC \log_{10} \left[\frac{E_b - E_e}{E_b - E_s} \right]}$$

in which:

f = frequency in cycles
R = resistance in megohms
C = capacitance in microfarads
E_b = supply voltage
E_e = extinction voltage of tube
E_s = striking voltage of tube[5]

it being assumed that discharge time—during which the tube conducts and the voltage across C falls from E_s to E_e—is very short relative to charging time, when the tube is nonconducting and the voltage across C rises from E_e to E_s.

The useful frequency range with this circuit and stock neon tubes is from about 60 to about 8,000 cycles and can be extended to include a range of from 10 cycles to 12 kc by hand-picking neon tubes and components.

The remaining working element of this calibration oscillator is the mixing device which permits amplitude modulation of the r.f. signals by the neon pulser. Theoretically, the modulating signal can be injected at almost any ungrounded point in almost any circuit. Practically, modulation of the crystal

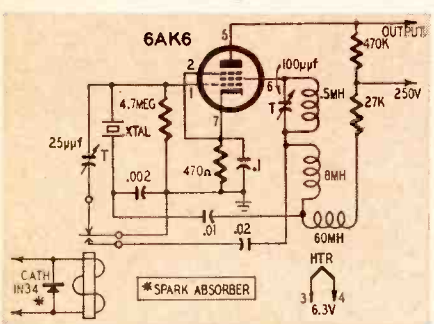


Fig. 1—Dual-frequency calibrator.

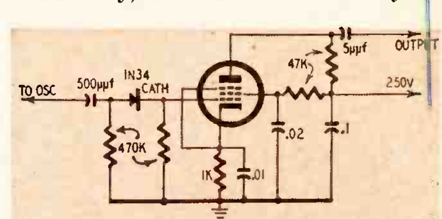


Fig. 2—A harmonic generator circuit.

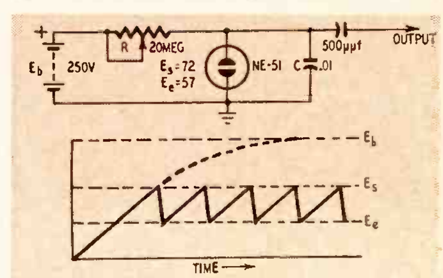
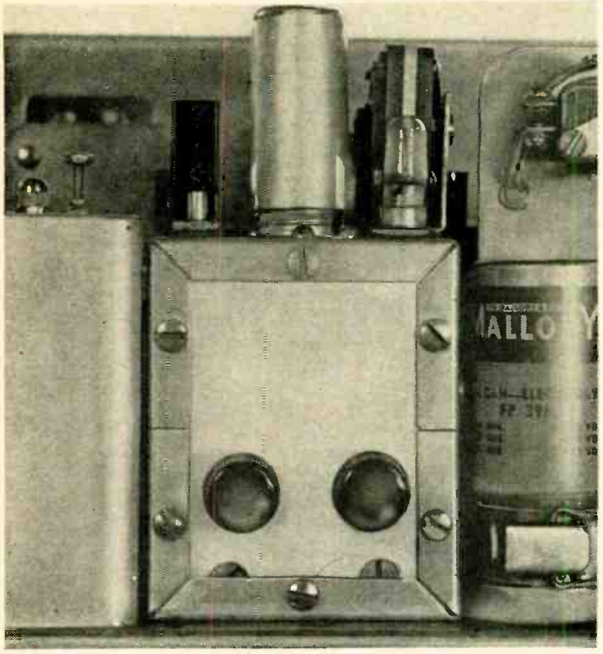
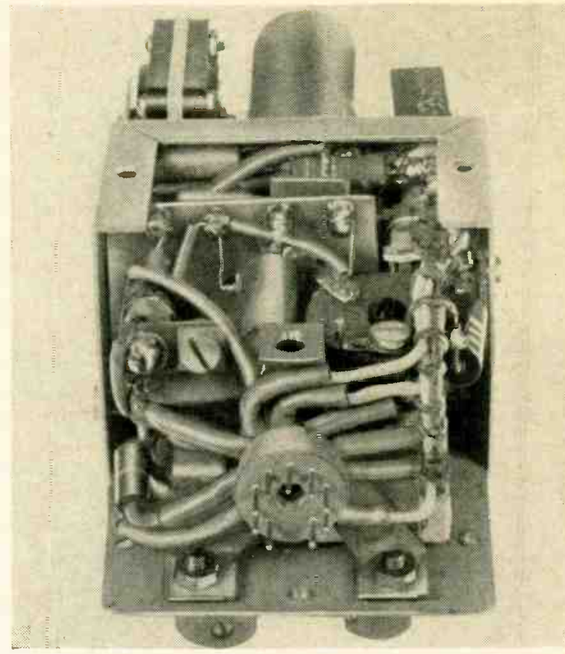


Fig. 3—Circuit of neon oscillator.



The complete oscillator as installed in a receiver.



An internal view of pulse-identified oscillator.

oscillator is undesirable as it tends to frequency-modulate the output, causing the higher harmonics to merge. The cleanest performance was obtained with a pentagrid converter (6SA7, 6SB7-Y, 6BE6), the first grid being coupled to the neon oscillator through a capacitor, the third grid to the crystal oscillator by a 1N34 and a small coupling capacitor.

The final circuit of the pulse-identified calibration oscillator is shown in Fig. 4, with pertinent values. The tube lineup consists of a 6AK6 electron-coupled oscillator, a 6BE6 harmonic generator and mixer, a NE-51 neon oscillator. Rather tight shielding and extremely good circuit isolation were essential to prevent spurious responses. For convenience in servicing, the crystal calibrator was designed as a plug-in unit, all connections being brought out to a noval plug on the base. Pin numbers are circled in Fig. 4, and pins 2 through 7 are bypassed to ground, with respect to r.f., by a .02-μf capacitor from socket pin to ground directly under the chassis.

Construction details

Available space for the calibration oscillator in my receiver was 2¼ x 2¾ x 5½ inches. The case decided upon consisted of the covers of two ICA No. 29435 Flexi-mount aluminum cases which formed the top, bottom and ends of the case, and two pieces of .050-inch sheet steel, 2⅝ x 3⅛ inches, which form the front and back panels (see photos). The bottom was strengthened by inserting a piece of .050-inch steel to prevent warping when the holding screws were tightened.

To insure mechanical and electrical oscillator stability, all components were mounted rigidly with liberal use of tie points and terminal strips, all of which are firmly bolted to the case. A 100,000-ohm resistor was wired in series with the 20-megohm tone control to prevent neon tube burnout if the knob is turned too far toward the low-resistance (high-frequency) end.

The noval plug, through which all connections except ground are made, is supported by a small steel spider (see photo) bent from .050-inch stock and bolted to the front and back panels. Ground connections are made to the case, grounded to the receiver chassis by two holding screws.

The top side arrangement and construction are fairly straightforward. The tube sockets should be spaced so that the shields do not conflict, and the 25-$\mu\mu$f trimmer must be insulated from the case by a pair of fiber washers. When the trimmer is undergoing adjustment, the oscillator is operating at 100 kc and the trimmer shaft is grounded through the relay so that this "hot rotor" connection does not introduce a hand-capacitance problem.

The crystal mounting bracket is insulated from the case top by a thin sheet of Micarta, and its holding screw by a fiber washer. The NE-51 is mounted in a standard bayonet socket, pushed through a ⅜-inch rubber grommet. This, in turn, fits a ½-inch hole in the case top. The inner terminal of the socket is held under one of the tube socket mounting screws, giving rigid support and electrical grounding at the same time.

The space available in the receiver did not permit installing the calibrator close to the panel where a crystal-frequency selector switch could be mounted with short leads so a relay was substituted for the switch. I used a Price type 1035-1 relay made especially for radiosonde applications and available only through surplus sources. You can substitute any d.c. relay that will fit into the available space. Potter & Brumfield Super-Midget relays will fit in the same space. A 3-volt supply is not essential. I supply my relay through a half-wave selenium rectifier connected to the heater circuit with a 500- or 1,000-μf 6-volt electrolytic for a filter.

The auxiliary crystal shown in the photos is not an electrical part of the calibrator. It is used in a b.f.o. circuit and is mounted on the calibrator chassis for space reasons only.

Traditionally, the calibration oscillator is coupled to the antenna terminal of the receiver through a gimmick. This permits its use not only as a frequency checker, but also as a test oscillator for occasional touching up of receiver alignment. This method of coupling is very

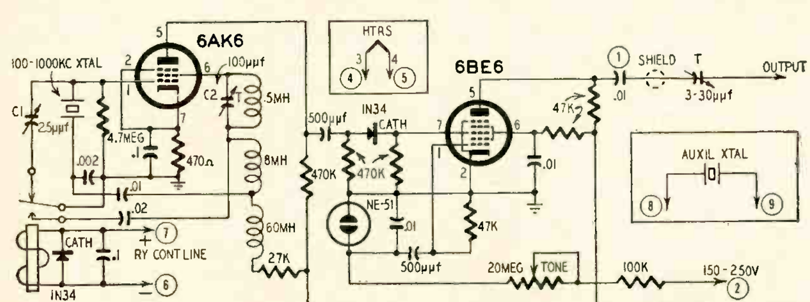
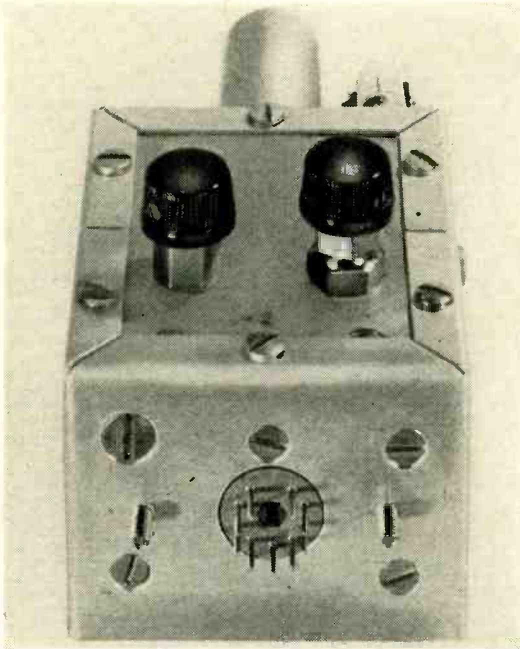
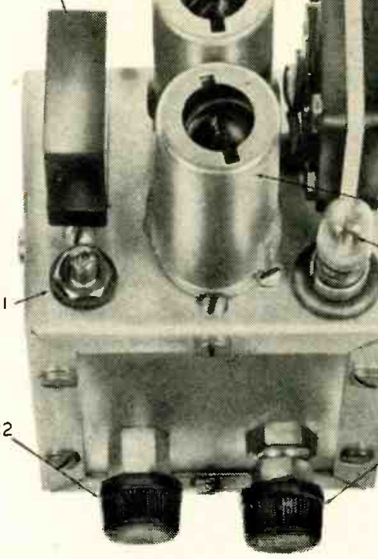


Fig. 4—Schematic diagram of the neon-pulsed calibration oscillator circuit.



Bottom view shows the output plug.



Top view shows the major components.

satisfactory so far as the receiver is concerned, but produces interference in neighboring receivers. A more satisfactory coupling method is by a gimmick to the first r.f. grid, on the grid side of the bandswitch. A mixer tube for the first r.f. stage would be even more satisfactory were the tube noiseless.

Adjustment and operation

Adjustment of the calibration oscillator consists of setting the tone to suit the operator, the screen trimmer for optimum operation on 1000 kc and zero-beating the 100-kc oscillator with WWV.

With the receiver and oscillator on and warmed up center any convenient calibrator harmonic in the i.f. passband by using the S meter or a v.t.v.m. between the a.v.c. line and ground, and then turn on the pulser. The NE-51 in the calibrator should now light, and a musical note be heard in the speaker. Adjust this to suit the operator's taste by varying the 20-megohm rheostat.

With the calibrator set for 1000-kc output (relay in up position), tune in the highest-frequency harmonic that will indicate on the S meter and adjust the screen trimmer (100 $\mu\mu$f in Fig. 4) for maximum output. This will be at the highest S-meter reading.

Next, with the calibrator off, tune in WWV on the receiver and center the signal in the i.f. passband. Set the calibrator for 100-kc operation (relay armature in up position), turn on the calibrator but not the pulser, and observe the signal. A heterodyne squeal, modulated by the WWV modulation, should be heard and will change in pitch as the crystal trimmer (25 $\mu\mu$f in Fig. 4) is adjusted. The desired setting is zero cycles when the WWV carrier is not modulated (during the long breaks in the announcement intervals). The setting is correct if a slight adjustment of the trimmer in either direction brings back the heterodyne.

Finally, vary the coupling between the calibrator and the receiver, adjusting it to the amplitude most suitable to your personal taste and operating habits. It is good practice to keep the calibration oscillator signal at a relatively low amplitude to minimize Miller-effect detuning and possible receiver overload.

Calibration oscillators are widely used for checking receiver calibration, for minor realignment work and for indexing the main tuning dial on receivers equipped with electrical bandspread. The calibration oscillator produces a signal at each 100 (or 1000) kc from the crystal fundamental to the limit of the frequency multiplier.

To index for bandspread operation, zero the bandspread dial, set the main dial to the desired band and turn on the calibration oscillator. Adjust the main dial for maximum signal, then lock it. The bandspread dial calibration will now be at optimum accuracy and settings can be recovered within the mechanical limitations of the receiving equipment.

Because of the multiplicity of harmonics in the audio output of this calibrator, the calibration signals are unlikely to be removed by a tunable audio filter. The audio fundamental can be filtered out, but the higher harmonics will be passed, and the operator's ear will reinsert the filtered-out fundamental.[6]

The calibration oscillator here described has been in operation for more than 5,000 hours at the time of writing. No exact information on expected tube and component life can be given because all the original components are still in service. Both tubes test good, even though they have been used more than five times the nominal 1,000 hours' service cited for most military and aeronautical applications. The only other component likely to fail is the relay, designed for radiosonde service, where a maximum of less than 1,000 operations is usually expected. After considerably more than 10,000 operations the relay is still in perfect condition.

Parts for calibration oscillator

Resistors: 1—470, 1—27,000, 3—47,000, 1—100,000, 3—470,000, 1—4.7 megohms, ½ watt; 1—20 megohms, potentiometer.

Capacitors: 2—500 µµf, 1—.002 µf, 4—.01 µf, 1—.02 µf, 2—0.1 µf; 1—25 µµf, 1—3-30 µµf, 1—100 µµf, trimmers.

Miscellaneous: 1—6AK6, 1—6BE6, tubes; 2—shields for tubes; 2—sockets for tubes; 1—NE-51 and socket; 2—1N34 (or equivalent); 1—crystal (Bliley SMC-100 or other usable combination) and holder; 1—choke, 500 µh; 1—choke, 8 mh; 1—choke, 60 mh; 1—relay, s.p.d.t. (Price 1035-1); 1—chassis (see text); 1—length of shielded wire.

Estimated tube life, based on experience with other equipment, is about 7,000 hours for the 6BE6 and the 6AK6, and more than 10,000 hours for the NE-51. Probable life of the relay in this type of service is 100,000 operations, after which, by replacing a cheap spring, it should be good for another 100,000. All other components, if initially of good construction, chosen with an adequate margin of safety and not mishandled during construction, are substantially immortal and will probably outlast the receiver in which the calibrator is installed. END

REFERENCES

[1] See instruction sheets supplied by manufacturers of calibration crystals such as *Bliley Crystal Type SMC-100*, Bliley Electric Co., Erie, Pa.

[2] "The Secondary Frequency Standard," *Radio Amateur's Handbook*, 31st edition, 1954, pp. 467–468.

[3] R. L. Dawley (editor), *Radio Handbook*, 13th edition, 1951, pp. 609–610.

[4] F. Langford-Smith, *Radiotron Designer's Handbook*, 3rd edition, 1940; 4th edition, 1952, p. 1261.

[5] Discussed fully in Rider & Uslan's *Encyclopedia on Cathode-Ray Oscilloscopes and Their Uses*, 1950, pp. 218–222.

[6] This is the so-called synthetic bass effect. See F. Langford-Smith, *Radiotron Designer's Handbook*, 4th edition, 1952, pp. 616, 676.

A VOLTAGE-MEASURING ELECTRONIC SWITCH

Instrument features use as an oscilloscope calibrator

By WILLIAM AUSTIN

THE electronic switch makes it possible to observe two signals simultaneously with an oscilloscope by switching the scope input rapidly between one and the other. Extending this principle, an instrument can be designed which will also act as on oscilloscope calibrator with the advantage that the voltage of any portion of a signal can be measured, independently of the vertical gain setting, while the signal is on the screen.

The circuit of the instrument is shown in the diagram. A semisquare wave is generated by V1, a cathode-coupled multivibrator. This circuit produces a symmetrical waveform and can be synchronized, an advantage which will be explained later. Two frequency ranges are provided, covering roughly 50 to 700 and 700 to 8,000 cycles. V2 is a phase inverter and amplifier which also clips the wave tops, producing a flat-topped square wave which is applied to the grids of V3.

V3 and V4 have common cathode circuits. When one half of V3 is cut off, the corresponding half of V4 operates normally while its other half is cut off due to the large voltage drop across the cathode resistor. Assume the grid bias to be the same on both halves of V4 so that each draws the same plate current during its operating period. If a signal is applied to both grids, it will be switched from one half of V4 to the other at the repetition rate of the square wave. Since both halves of the tube have a common plate load resistor, the signal will appear across this resistor uninterrupted and can be observed with an oscilloscope. Now, if the bias of one grid is changed with respect to the other, the signal will separate vertically on the screen and will be seen as two signals, one above the other, each being made up of short dashes. Their length and number will depend on the switching rate.

Any two signals of the same frequency or a multiple can be observed this way. If a signal is applied to only one grid and the bias is equal, the signal will appear with a dashed line through its zero axis, and changing the relative bias will cause this line to move up or down with respect to the signal.

Since the position of this line with respect to the signal is proportional to grid voltage, we have a means of measuring the peak voltage or the voltage of any portion of the signal in which we are interested. This is done by varying the bias with a potentiometer having a scale calibrated to correspond with the voltage difference between the grids. For example, if a signal having a peak amplitude of 2 volts is applied to one grid, it will take a 2-volt change in the relative bias between the grids to make the reference line move to the peaks of the signal. The potentiometer has a scale calibrated in volts so we are able to read this 2-volt peak amplitude of the signal on the scale. Amplifier stage V4 will invert signals fed to it. This means that if the oscilloscope normally shows signals with positive peaks up, they will be down when using the electronic switch. So to measure the positive peak voltage, the reference lines moves down to align with the bottom peaks of the signal.

Voltage regulator tube V5 provides a constant 150 volts which is applied to the grid returns of V4 through a resistance bridge containing two potentiometers. One of the potentiometers is calibrated from 0 to 3 volts and the other is used to balance the circuit so that when the calibrated potentiometer is in the zero position, the voltage difference between the grids is zero. The grids are also maintained about 2 volts positive above ground to avoid excessive bias due to the large cathode resistors. A d.p.d.t. switch permits reversing the voltage difference on the grids for measuring either positive or negative with respect to zero. This switch could be eliminated by making the potentiometer read zero in the center, but the scale would be more crowded and less readable.

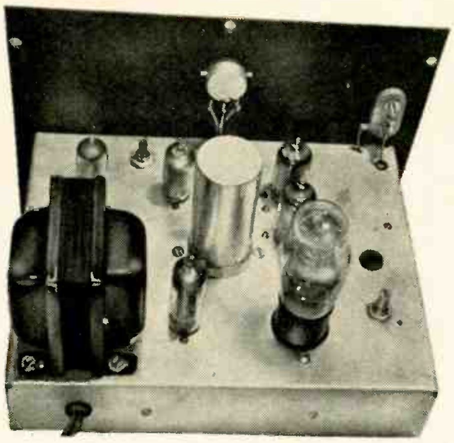
Input A has a three-step attenuator with a resistance of 1 meghom. Each step multiplies the dial by 10, making it possible to measure voltages up to 300. The attenuator is frequency-compensated for good transmission of pulses and irregular wave forms; the compensation circuit is simple but effective. Only one variable capacitor is necessary for its adjustment. The 10-$\mu\mu$f capacitor is disconnected in the first position where the grid is connected directly to the signal source. This tends to keep the input capacitance constant at all three settings.

This input is used for the signals which are to be measured. Input B uses only a simple 1-megohm potentiometer. This input—being continuously variable—can be used to set two signals to the same amplitude for comparison.

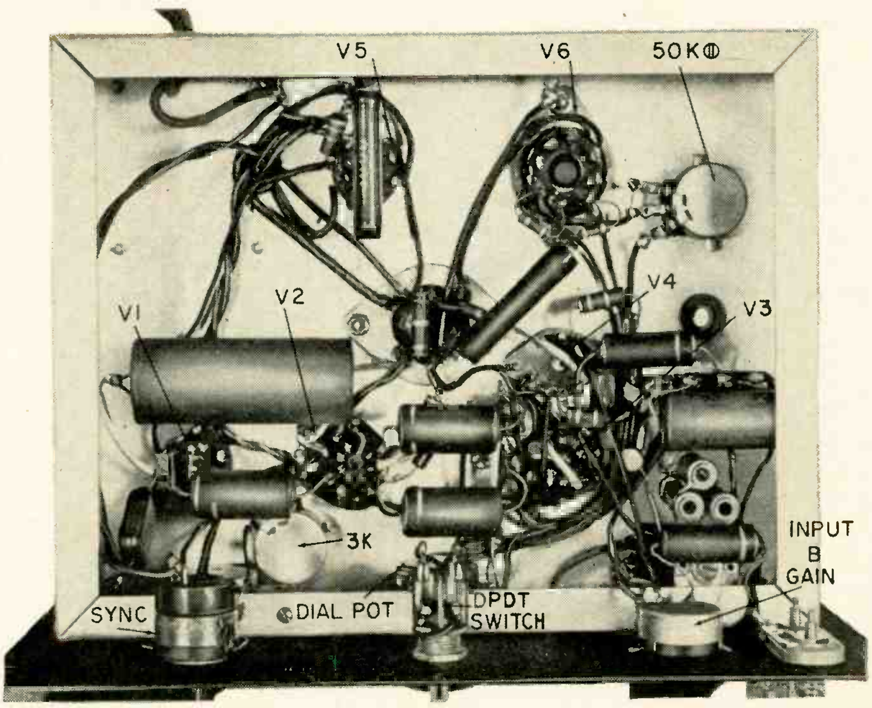
Construction and calibration

The instrument is housed in a 10 x 8 x 7-inch utility box. Any layout arrangement can be used which will keep stray capacitance to a minimum, especially in the portions where square waves are involved. In the interest of small size, metallized paper coupling capacitors were used. The two 4-μf electrolytic capacitors which bypass the grid returns of V4 must be separate units. A dual-section capacitor is not satisfactory here because the capacitance between sections will cause coupling between the two inputs. The multivibrator stage should be thoroughly decoupled from the rest of the circuit. This is the reason its plate supply has a separate capacitor.

The dial (see photo) was made by applying several coats of white enamel



Top-chassis view shows major parts.



Closeup view of underchassis layout.

around the edge of an aluminum disc held to the panel by the nut which holds the potentiometer.

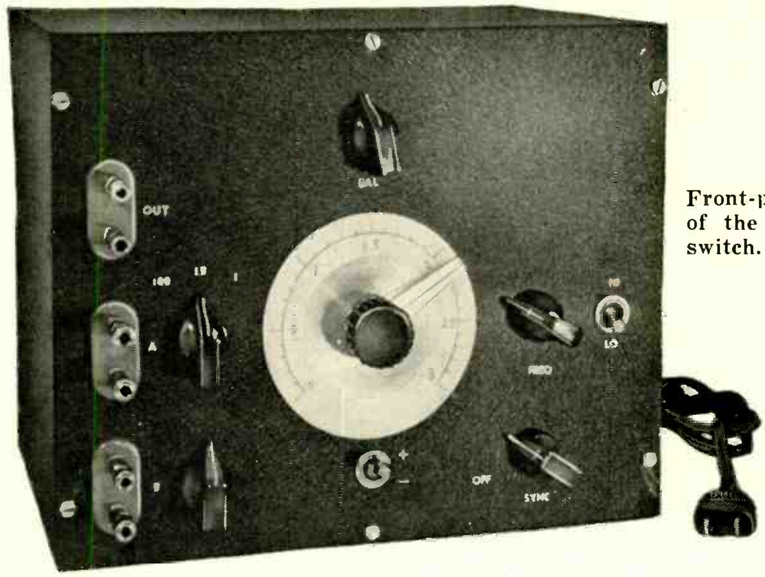
The calibration marks and figures on the enameled portion were made with india ink. A plastic pointer was attached to a knob to complete the dial assembly.

Calibrating the instrument is relatively simple. Connect a v.t.v.m. on its lowest d.c. range between the grid returns of V4 (from one 4-μf capacitor to the other) and set the dial potentiometer a little above the fully counterclockwise position. Adjust the other 50,000-ohm potentiometer for a zero voltage reading. Clockwise rotation of the dial will now cause the voltage to rise to a little over 3 at full rotation. Whether the voltage goes positive or negative depends on the v.t.v.m. connection and the position of the d.p.d.t. switch. The dial can now be marked in 0.1-volt increments as indicated by the meter. With the scope connected to the output a square wave should be seen, variable in amplitude by either the dial or the 500-ohm cathode balance potentiometer. The latter should be adjusted for zero square-wave amplitude with the dial on zero. Turn the vertical gain of the scope up when making this adjustment.

This cathode potentiometer was mounted on the front panel because its adjustment was found to be somewhat critical. Slight changes in circuit constants and even jarring the instrument will affect the balance noticeably. Having the control on the panel makes it easy to reset. For a symmetrical waveform, the resistance in the cathode circuit of V1 is about 2,000 ohms. It varies somewhat with different tubes, so a 3,000-ohm potentiometer was used. This control, mounted on the chassis near V1, can be set by watching the output square wave on the scope and setting the control for best symmetry.

The easiest way to adjust the attenuator is to feed a 10-kc or higher square wave to input A with the scope connected to the output. The 10-kc signal can be seen as will be explained later. Adjust the 180-$\mu\mu$f trimmer for the best square wave on all three switch positions. The signal, of course, should not look any better than it does when fed directly to the scope. It is possible, in making this adjustment, to over-compensate the attenuator in an attempt to make up for deficient high-frequency response in the scope vertical amplifier. If the adjustment is made so that the signal looks the same at all three settings, there is little likelihook of this.

To observe signals of 1,000 cycles or less, use the high switching rate which will give the dashed pattern. For signals of higher frequency, use the low range and turn up the sync control, the amount depending on the amplitude of the signal at the input. When the multivibrator is synchronized with a submultiple of the signal, a stationary pattern can be obtained without the dashed effect. For example, if the signal frequency is 4,000 cycles and the scope sweep is the same, one cycle of the signal will be seen. If the switching rate is 2,000 cycles, one cycle of the signal will occur during each half of the switching cycle. Actually, only every other cycle of the signal occurs on the screen, but persistence of vision will make it appear continuous. In this example each cycle of the signal is followed by a blank trace, making the reference line we can use for measuring. If desired, the signal could be fed to both inputs. Now the signal appears twice on each half of the switching cycle, either superimposed or separated vertically, depending on the setting of the dial. As the signal frequency increases, the submultiples on the low-frequency switching range get closer together so there are numerous points on the frequency control at which the pattern will be stationary. In fact, at 10 kc and higher, a stationary pattern can be obtained at practically any setting of the control by turning up the sync a little. At intermediate signal frequencies there is some instability when the dial is turned to near maximum because the scope horizontal sweep tends to synchonize with both the signal and the switching square wave. In some cases, it may be necessary to make a few readjustments between the scope sync and horizontal frequency controls.



Front-panel view of the electronic switch.

Parts list for electronic switch

Resistors: 1—1,000, 1—12,000, 1—22,000, 1—33,000, 1—68,000, 1—470,000 ohms, 3—1 megohm, 2—4.7 megohms, 1/2 watt; 2—1,800, 3—10,000, 1—33,000, 1—47,000 ohms, 1 watt; 1—1,000, 1—2,000, 1—6,000 ohms, 10 watt; 1—10,000, 1—90,000, 1—900,000 ohms, 1%.

Potentiometers: 1—500, 1—3,000, 2—50,000 ohms (one a high-quality unit—Ohmite CU-5031 or equivalent); 1—1 megohm (linear); 2—1 megohm (audio, one with on-off switch).

Capacitors: 1—10, 1—500 μμf, 1—.001, 1—.005, 1—.01 μf, mica or ceramic; 3—0.1, 3—0.25 μf, 450 volts, metallized paper; 2—4 μf, 450 volts; 1—20 μf, 450 volts; 1— 30-30-20 μf, 450 volts.

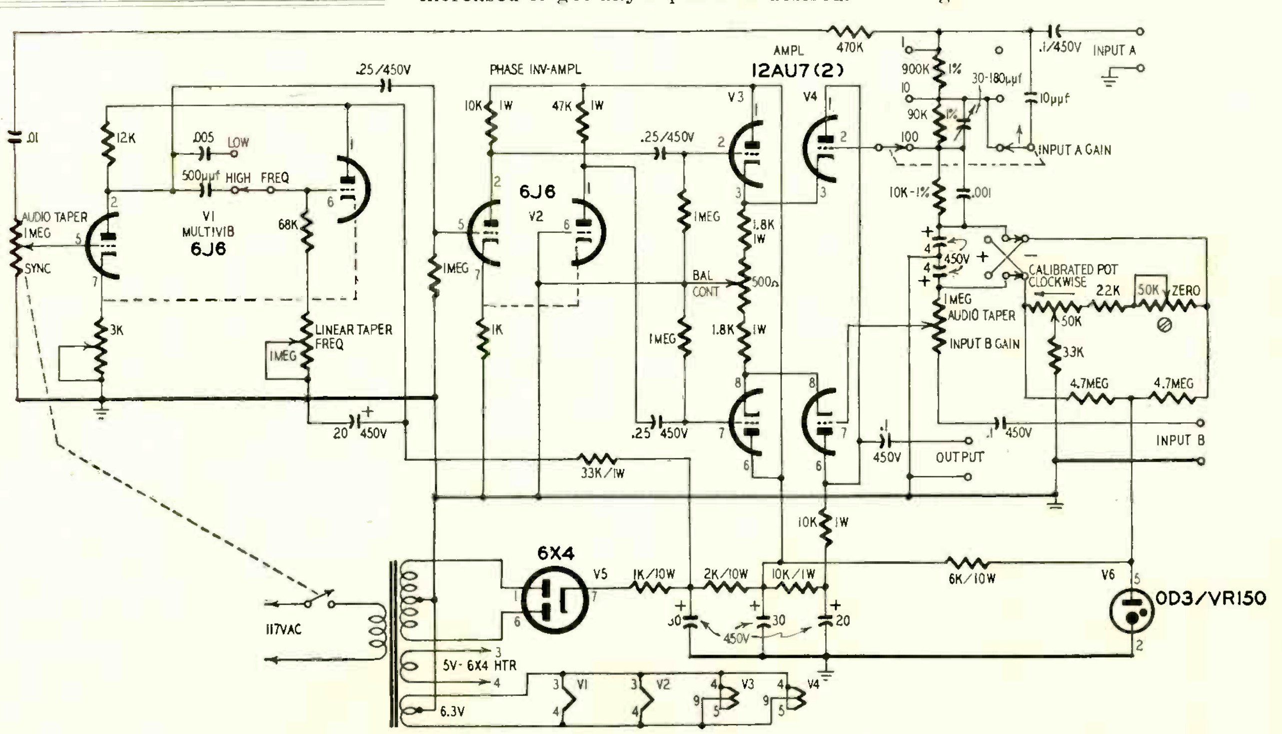
Miscellaneous: 2—6J6, 2—12AU7, 1—6X4, 1—0D3/VR-150; 3—7-pin miniature sockets; 2—9-pin miniature sockets; 1—octal socket; 1—s.p.d.t. switch; 1—d.p.d.t. switch; 1—2-pole 3-position switch (Mallory 3223-J or equivalent); 1—power transformer, 650 volts c.t. @ 55 ma, 5 volts @ 2 amps, 6.3 volts @ 3 amps (Stancor PC-8407 or equivalent); 1—chassis and cabinet; 3—twin jacks; 1—dial (see text); 5—knobs; 1—line cord.

The voltage gain in V4 is about 3. This low gain is due to the low value of plate load resistance and to degeneration in the cathode circuit. Lack of gain here is of no consequence however because the vertical amplifier of the scope contributes all the gain necessary. About 4 volts peak signal can be applied to the grids before any serious distortion occurs. To determine whether an excessive signal exists, it is necessary only to turn the dial to maximum.

If the reference line will not reach beyond the peaks of the signal, turn the attenuator to the next lower range and increase the scope vertical gain to restore the signal to the same size on the screen. When observing two signals that cannot be separated enough with the dial, the vertical gain can be increased to get any separation desired.

The output of this instrument can be used for square-wave testing over its range with the peak amplitude variable to about 9 volts with the calibrated dial. When the scope vertical gain is turned up, a spike or overshoot may be seen at the leading edges of the square waves. This is caused by coupling via the grid-cathode capacitance in V4 and can, of course, be eliminated by turning both gain controls to the minimum setting.

Many uses can be found for this device in radio and TV servicing. For instance, in tracing through the sync circuits of a TV receiver, it is very convenient to be able to see the sync pulses at verious points and measure their amplitude without disconnecting the scope to substitute a calibrating voltage. END



Complete schematic diagram of the voltage-measuring electronic switch.

. . . *an accessory for your* SIGNAL GENERATOR

Used with calibrated signal generator, unit takes guesswork out of design of r.f. tuned circuits

By DAVID JOHN LEWIS, W1SLE

MOST amateurs and experimenters spend a good deal of time working with tuned circuits. Only a few have the specialized and often expensive instruments needed for more than a cut-and-try approach. Impedance bridges, Q meters and the like are just not practical investments for the nonprofessional.

This accessory, designed primarily for measuring small inductances and capacitances usually found in radio-frequency circuitry, will also function as a grid dip meter over the entire range of the signal generator with which it is used. No modifications or alterations of the signal generator are required. Construction is simple and inexpensive.

The accessory (see schematic) is essentially a crystal receiver coupled to the signal generator through a small capacitance. Variable capacitor C1 is calibrated in 10-$\mu\mu$f steps from minimum to maximum capacitance. Coil L_x is connected across terminals J1, J2. A high-frequency germanium diode is used as a detector. The r.f. source must be modulated to provide a signal in the headphones.

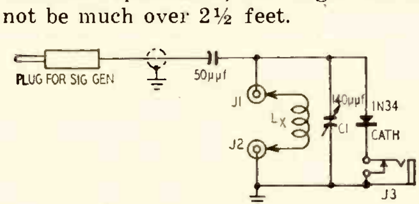
When measuring inductance the unknown coil and C1 are connected in parallel to form a tuned circuit. The resonant frequency of this tuned circuit can be measured by tuning the signal generator for maximum tone output at the headphones. Since the capacitance of C1 is known, it is then a simple matter to compute the inductance of the coil from the formula $L = \frac{1}{4\pi^2 f^2 C}$. To eliminate the necessity for mathematics, however, a small chart is used to convert the signal generator readings in megacycles directly into microhenries.

To measure capacitance, connect a coil of arbitrary inductance across the test terminals in parallel with the capacitor under test. Set C1 at minimum capacitance and tune the signal generator, as in the measurement of inductance, for peak output. At this point remove the unknown capacitor. This will detune the circuit and to bring the output back to a maximum it will be necessary to advance C1. The capacitance this adjustment adds to the circuit is equal to the unknown capacitance and can be read directly from the scale on C1. The largest value of capacitance that can be measured will be equal to the difference between the minimum and maximum capacitance of C1.

A set of plug-in coils covering the desired ranges will be required when the instrument is used directly to measure the resonant frequency of coil and capacitor combinations. With the correct coil across the terminals, set the signal generator for output somewhere in the frequency range of the circuit to be tested. Tune C1 for maximum volume. If the external circuit is now loosely coupled to the coil on the accessory and tuned to the signal generator frequency, there will be a marked drop in volume. Since both the signal generator and the accessory must be tuned to the same frequency, it is not conveniently possible to tune the signal generator for the dip rather than the circuit being measured. For many applications, however, such as calibrating wavemeters, adjusting filters, etc., this is not too important.

Construction and calibration

A standard utility box measuring 3 x 4 x 5¼ inches is used for a cabinet. The variable capacitor, phone jack and test terminals are mounted on the cover. The r.f. input lead enters the cabinet through a rubber grommet, near the terminals. The r.f. leads should be kept short to minimize stray inductance and capacitance. The input lead is a standard coaxial instrument cable with a plug to fit the signal generator output jack. Since these cables have a fairly high internal capacitance, its length should not be much over 2½ feet.



Schematic of signal generator accessory.

A National FWG terminal strip was used for the test terminals. A pair of short test leads can be plugged in the banana jacks at the top, while a coil is held in the holes at the bottom of the binding posts when making capacitance measurements. The terminal strip also serves as a socket for the "grid-dipper" coils.

The scale on C1 should be calibrated in terms of absolute capacitance across the test terminals. Often this will be helpful in determining the capacitance needed to resonate with a given coil at a desired frequency. A bridge is convenient for this calibration if you have access to one, but it is not essential.

One simple method of calibrating the instrument, for example, would be to connect an inductance of known value across the terminals. The signal generator would be tuned as in inductance measurements to find the resonant frequency of the circuit. With the inductance and frequency known, the capacitance will be easy to compute. The capacitance across the terminals for as many positions of C1 as desired can thus be established.

No matter how the instrument is calibrated, it is important that it be completely assembled and connected to the signal generator when the job is finished. Otherwise, the true capacitance will not be obtained. When the plates of C1 are wide open, the capacitance across the test terminals should be about 9 $\mu\mu$f.

The grid dip meter coils are wound 1 inch in diameter. The coils for the two highest frequency ranges are self-supporting. On the lower ranges, the coils are wound on pieces of 1-inch Bakelite tubing and fastened in place with coil dope. No special plug-in arrangement is used; the leads from the coils are stiff enough for support when clamped in the binding posts.

The coil dimensions given (Table I) will cover the most important amateur frequencies. Extra coils can be wound to give any deired coverage. Any one of the coils can be used when making capacitance measurements.

Table II, converting the signal generator readings from megacycles to microhenries, will be correct when the

TABLE I
COIL DATA FOR ACCESSORY

Frequency MC	Construction: Turns	Wire	Wound
3.3– 6.5	20	No. 22 enamel	close
6.3–11.5	10	No. 22 enamel	close
11.5–19	6	No. 18 d.c.c.	close*
16 –30	3	No. 14 d.c.c.	close*

*Self-supported

TABLE II
FREQUENCY CONVERSION
(With 100-$\mu\mu$f capacitance)

Inductance (μh)	Freq. (mc)	Inductance (μh)	Freq. (mc)
2	11.5	60	2.10
5	7.2	65	2.0
10	5.1	70	1.92
15	4.15	80	1.80
20	3.6	90	1.70
25	3.2	100	1.62
30	2.95	150	1.32
35	2.73	200	1.15
40	2.55	250	1.02
45	2.40	300	0.93
50	2.29	400	0.81
55	2.17	500	0.73

capacitance across the inductance is 100 μf, and C1 must be set to this value when the chart is used. For the sake of convenience the chart can be glued to the side or back of the chassis. If you wish, a more complete chart can easily be made from a capacitance, inductance, frequency nomograph. (See *ARRL Handbook*, 1955 edition, page 534.)

The accessory can be used separately from the signal generator as both an absorption type wavemeter and a modulation monitor, if desired. A rough calibration in terms of megacycles on the scale attached to C1 would be useful in this connection.

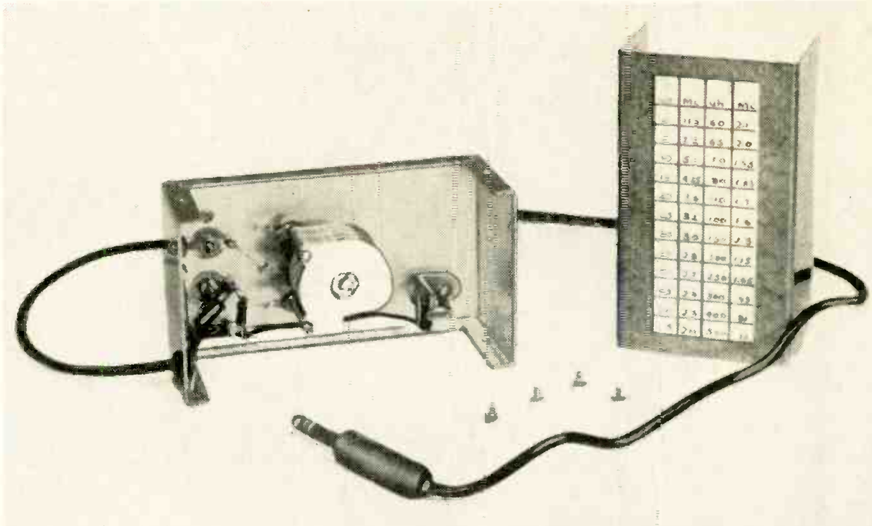
Here are a few suggestions for using the accessory. Remember that the accuracy of inductance measurements can be no greater than the accuracy of the calibration on the signal generator. Furthermore, the distributed capacitance present in the coil being measured will have an effect on the results. Don't expect the precision possible with a bridge.

Parts for signal generator accessory

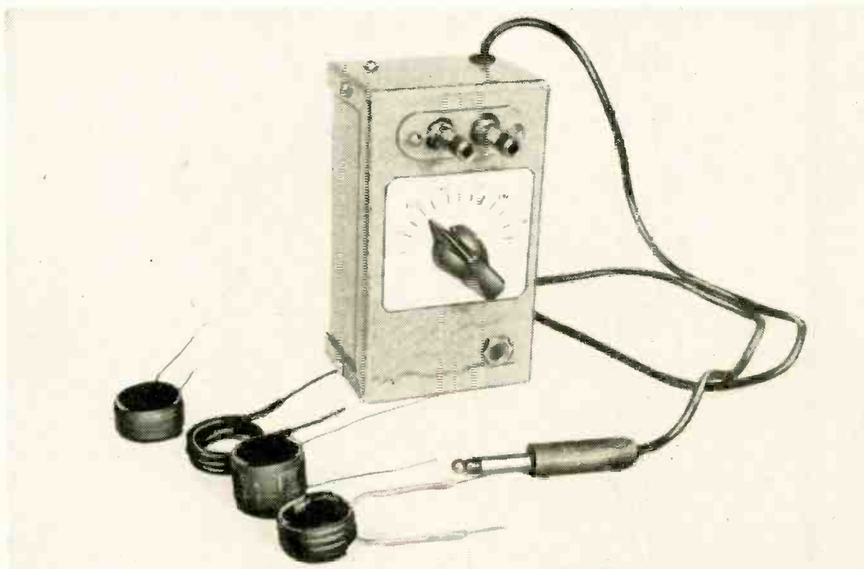
1—50-$\mu\mu$f capacitor; 1—140-$\mu\mu$f capacitor, variable; 1—terminal strip (National FWG or equivalent); 1—closed-circuit phone jack; 1—plug to fit signal generator output jack; 1—IN34 (or any high-frequency crystal detector); 1—chassis; coils (see Table I).

When using the unit as a grid dip meter, it is advisable to couple the coils as closely as possible to locate the general vicinity of the dip. The coupling can then be decreased to the point where the change in volume is just barely noticeable as the unknown circuit tunes through the signal generator frequency.

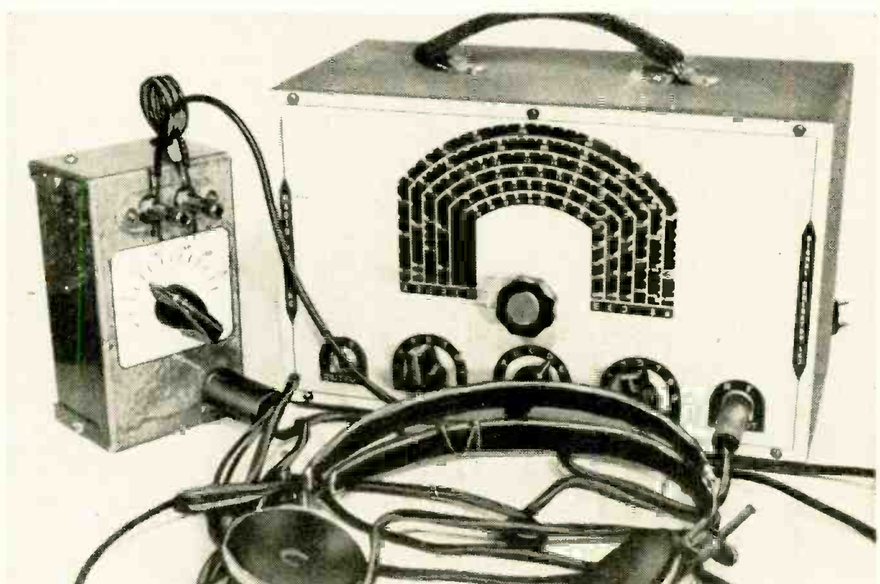
The range of capacitance measurements can be extended by adding a small mica capacitor in parallel with the unknown capacitor when C1 is not large enough to retune the accessory. The capacitance of the extra capacitor is then merely added to the increase read from the scale on C1. END



Underchassis view shows parts layout.



Front view of accessory with coils.



The accessory set up for use. The coil shown covers range of 16 to 30 megacycles.

By DONALD H. ROGERS*

EXTEND THE RANGE OF YOUR Ohmmeter

Modification permits wide range of resistance measurements

THE usefulness of almost any ohmmeter can be increased with a simple, easily built range extender.

Most ohmmeters use one of the two circuits shown in Fig. 1. In the series version (Fig. 1-a) the battery, meter and some resistance are connected in series between the test leads. The circuit is open until an unknown resistor is connected across the leads. This completes the series circuit, the current flow depending upon the battery voltage and circuit resistance. The meter reads full scale with the leads shorted. (The zero adjustment is made to an exact full-scale reading.)

The meter will read half-scale when the test probes are connected to an external resistance equal to the internal resistance of the ohmmeter. *This half-scale reading is the true criterion of the sensitivity of the instrument.* Any ohmmeter, regardless of sensitivity, reads from zero to infinity. But, when the internal resistance is equal to the external resistance, the current will be half the full-scale value and will show the reading at which the scale is most spread out and therefore most useful.

(The above method is accurate for practically all purposes for which a meter would be required in radio-TV service work. But it is worth noting that a slight error is introduced, because the resistance of a meter with a shunt connected across it is lower than that of a meter alone. This error is usually less than 1%. Where more accurate calibration is necessary, refer to the article "Meter Resistance Measurement" on page 100 of the May 1955 issue of RADIO-ELECTRONICS.—*Editor*)

The other circuit, the shunt version shown in Fig. 1-b, shows exactly the same action in reverse. In it the circuit is closed all the time, and full-scale current flows through the meter except when an unknown resistance is connected across the test leads. Lower values of unknown resistance shunt more of the current, the meter reading zero when the leads are shorted. In this circuit also, we get a half-scale reading when the external resistance is equal to the internal.

In Fig. 1-a the internal resistance is equal to the total resistance of the battery, meter and variable resistor. In Fig. 1-b it is the value we see looking in through the test leads and is equal to the parallel combination of the meter resistance and the series combination of battery and rheostat resistance.

To increase the sensitivity of the series circuit add more battery voltage and more internal resistance so that you still get a full-scale reading when the leads are shorted. You can make up this battery and resistance in a separate package, convenient to handle and use.

Although it is less obvious, the same thing is true of Fig. 1-b. In both cases the improvement will be proportional to the increase in voltage and resistance.

The first step is to examine the ohmmeter. Determine which circuit it uses, the battery voltage on the highest scale and the half-scale ohms reading. This is the point where the meter movement shows half-deflection. For a 10-times increase in sensitivity, 9 parts more each of voltage and resistance must be added in the same proportions. For an increase of 100 times, 99 parts more of each.

In a vacuum-tube ohmmeter using the shunt circuit, the meter is a v.t.v.m. of relatively infinite resistance, and the calculation may be made directly from the battery voltage and the internal series resistance.

Building the extender

The simplest sort of range extender is shown in Fig. 2. It is intended for use with an ohmmeter using a 4.5-volt battery and shunted 1-ma meter, and having a mid-scale sensitivity of 3,600 ohms. The addition of a 3,000-ohm potentiometer or rheostat, a 31,000-ohm resistor and 40.5-volt battery (in series-

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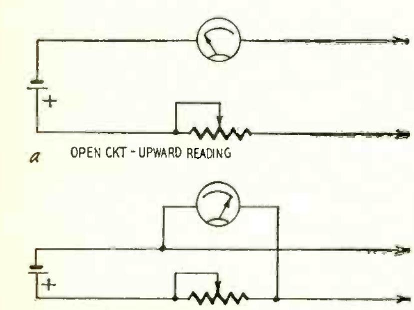


Fig. 1—Two basic ohmmeter circuits.

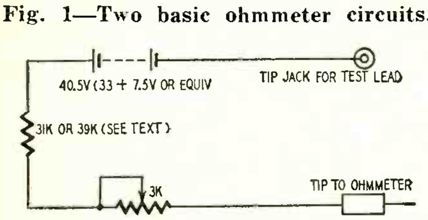


Fig. 2—Simple type of range extender.

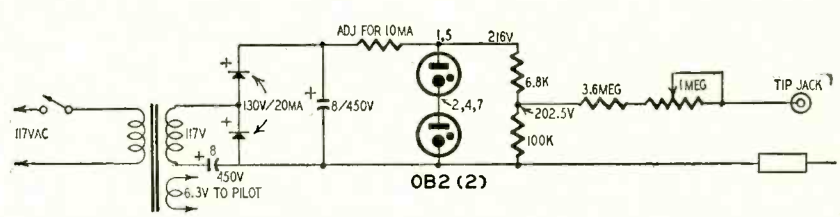


Fig. 3—Electronic range extender supplies exact voltage from the a.c. line.

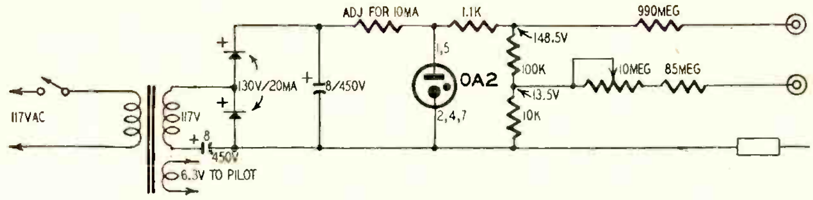


Fig. 4—A range extender for making insulation resistance measurements.

aiding) provides a 10-times increase in sensitivity, to a mid-scale reading of 36,000 ohms. The total voltage and the total resistance of the circuit are now each 10 times as high. For the probably more common series type ohmmeter the resistance should be 39,000 ohms, and the constants will have to be varied for instruments using other meters, battery voltages, etc. For example, the resistance values would be doubled with the same voltage if the meter were a 500-μa type, and an ohmmeter with a 1.5-volt battery would be multiplied 10 times by adding an external voltage source of 13.5. With a 1-ma meter, this would mean about 12,000 ohms fixed resistance and a 3,000-ohm potentiometer in series. Multipliers for ohmmeters with unknown internal circuits can be found by experiment, being careful not to use too much battery or too little resistance at the start. A little time spent changing resistors may save an expensive meter.

In Fig. 3 we have a more elaborate version of the same model, with an electronically regulated power supply, providing a 10 times increase in sensitivity for an ohmmeter using a 50-microampere movement, a 22.5-volt battery and having a mid-scale sensitivity of 450,000 ohms. The required 202.5 volts is obtained from a tap on a bleeder across the regulated 216-volt drop provided by a pair of 0B2's in series.

The extender shown in Fig. 4 provides multipliers of 10 and 100 for an instrument such as the Heathkit V-6, having the circuit of Fig. 1-b, with a 1.5-volt cell, 10 megohms of series resistance and a virtually infinite impedance meter circuit. Since this instrument has a mid-scale sensitivity of 10 megohms the extender provides 100 and 1,000 megohms and can be used for reading to at least 10,000 megohms. It is connected so that it bucks the internal battery of the ohmmeter and the meter reads downward when the leads are shorted.

Here the supply voltage is 9 times and 99 times the original 1.5 volts. The resistors are in proportion, which produces the proper ratio of 1.5 volts to 10 megohms. No zero adjuster is used on the highest scale; instead, series resistors are selected so that the short circuit reading will be approximately correct. In fact, the rheostat may be omitted from any of the circuits shown if they are adjusted carefully and if the original ohmmeter has a good range of zero adjustment.

Above 100 megohms we rarely deal with the resistance of conductors. We usually measure the resistance of insulators that have significant voltage and temperature coefficients. Surface moisture also enters, particularly as dirty surfaces often carry perspiration salts from handling as well as other substances which draw moisture from the air. Consequently, insulation resistance measurements cannot be compared, repeated or even specified except in terms of test voltage, ambient temperature and atmospheric humidity. And even then, a repeatability within 5% or 10% is good.

In building the unit of Fig. 4, the tip jacks must be well insulated by locating them in a panel of good insulating material like polystyrene, with an inch or two of creepage path to metal. A range switch must be specially designed; ordinary switches have too little clearance and may even have cracks between laminations to hold films of moisture or dirt. Special resistors are required, such as the S. S. White Dental Manufacturing Co. type 65X. A variable zero adjustment is not too easy to make, but the zero can be brought slightly on-scale by adding series 10- or 22-megohm resistors at the supply end where they are easier to insulate. Insulators and resistors should be handled with clean gloves and care to avoid fingerprints and scratches. END

IMPROVED MOTOROLA TYPE TESTER FOR SERIES-STRING TV TUBES

On page 131 of the October, 1954, issue we reprinted, from *Motorola Service News*, details of a tester for detecting shorts, gas and leakage in the more common types of tubes used in TV r.f. and i.f. circuits. Motorola has now described a modification to permit similar tests on the new series-string 600-ma tubes.

The modified diagram is shown. An extra socket is added for the 2AF4 and any new types that have the same heater, cathode and grid pin connections. An adjustable 10-ohm, 50-watt resistor and a selector switch have been included for adjusting the heater voltage. Taps are set as indicated on the

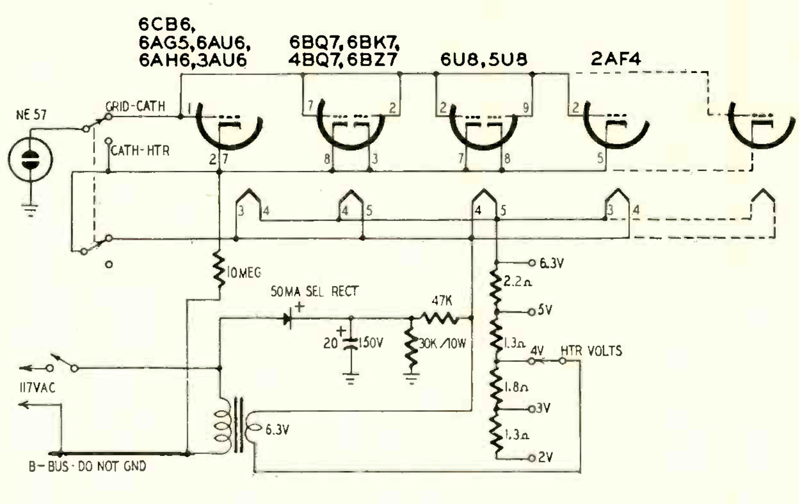


diagram. The dashed lines show how other sockets can be added for testing future types that do not have heater, cathode and grid connections corresponding to existing types.

The B supply is a half-wave transformerless type connected to the power line with a 50-ma selenium rectifier delivering the d.c. voltage. The common negative bus is carefully isolated from the metal case to minimize shock hazard and to prevent shorts should the case contact a hot chassis or a grounded object.

When the d.p.d.t. switch is in the GRID-CATHODE position, a fairly high d.c. voltage is applied between the grid and cathode. The neon lamp glows when the tube is gassy, when it draws grid current or when leakage or a short between grid and cathode is 30 megohms or lower. Switching to CATHODE-HEATER applies the d.c. voltage between heater and cathode. A leakage path of 2 megohms or less between these elements causes the lamp to glow.

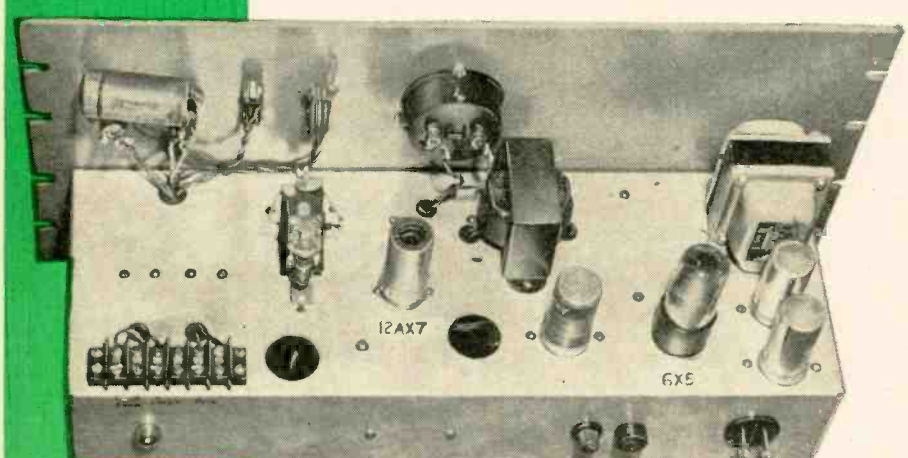
Connect a resistor of about 40 megohms between the grid line and B minus if the lamp glows slightly on good tubes when the d.p.d.t. switch is set to GRID-CATHODE. END

Failure-proof
CONELRAD ALARM

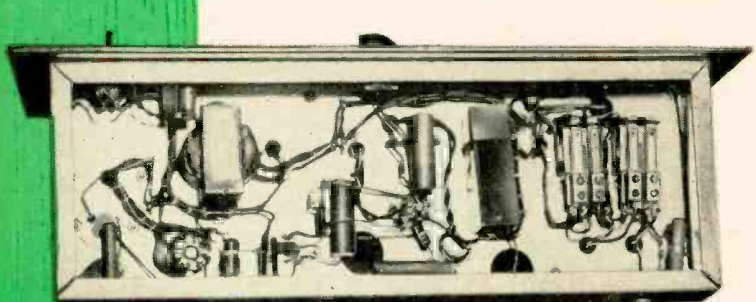
CONtrol of ELectromagnetic RADiation is an important civil defense measure. Here is a very reliable alarm system

By HAROLD SCHAAF*

The front panel of the Conelrad alarm.



Top and rear-chassis view of the alarm.



Underchassis view—alarm relays at right.

PERHAPS the most widely used Conelrad alarm consists of a single tube with a control relay in series with one of the current elements of the tube. The tube is biased to cutoff by a.v.c. voltage from a receiver. The relay is not energized, because no current is drawn by the tube. If the tube burns out or the power supply fails there is no warning, because there is no relay action. Such a system cannot be considered reliable, since it can go out of order without the operator knowing it.

Another system adds a thyratron tube to control the relay. Here again the same conditions prevail. In addition, thyratrons go flat rather quickly in spite of current limiting. They are also unstable when used with small voltages unless well regulated power supplies are used.

Some versions of both the above systems are rather insensitive and require a large a.v.c. voltage to work properly.

With these points in mind we at WRFD built an alarm that uses high-vacuum tubes only, is sensitive, operates with all relays energized when a.v.c. is applied and alarms if the tube heaters burn out or the power supply fails.

Since a.v.c. voltage was considered the best means of triggering an alarm, an a.v.c.-biased trigger tube was retained. To operate a control relay in the energized position when a.v.c. voltage is present, a d.c. amplifier was added following the trigger tube. It was also felt that relays in the warning circuits should operate in the energized position so there would be an indication in case of trouble in their circuits. A series-heater dual triode was used so that burnout of either heater section would affect current in the control tube and operate the relay. An overcurrent relay and resistors and capacitors of higher power and voltage ratings than any encountered in the circuit completed the features needed to make the alarm failure-proof.

Several d.c. amplifiers were checked for operating characteristics. We finally settled on a variation of a circuit

* Chief engineer, WRFD, Worthington, Ohio

which has been used as a d.c.-controlled a.c. amplifier. The variation is excellent for relay operation as the plate current of the second tube can be varied over a rather wide range by altering the d.c. bias on the first tube.

The schematic of the final version of the alarm is shown in Fig. 1. All relays are shown with a.v.c. applied to the input. It uses a 12AX7 tube, in which the heater sections are connected in series.

The first section of the tube is used for a.v.c. triggering. The second section is for control, to operate a relay which in turn operates the alarm indicator relays. The a.v.c. voltage is fed to the input potentiometer which adjusts the operating point of the alarm. A filter follows the potentiometer to remove audio interference and noise. Capacitor C1 can be varied in size to obtain a time delay so that momentary loss of the key station signal will not operate the alarm. The a.v.c. voltage is then fed to the grid of the trigger tube and biases it toward cutoff. As its plate current drops to a low value, the voltage drop across R2 approaches zero. Since the grid of the control tube is connected to one end of this resistor through R1 and the cathode of the control tube is connected to the other end of the same resistor, the voltage difference between the grid and cathode approaches zero. Current then flows in the control tube plate circuit, energizing the control relay in the circuit.

As the a.v.c. voltage drops, the trigger tube loses its bias and starts to draw plate current. This causes a voltage drop across R2. Since this voltage drop is in series with the grid circuit of the control tube, it causes the grid to go more negative and the plate current to approach zero, causing the control relay to de-energize. Circuits following this relay are then deactivated to give alarm.

A milliammeter and an overcurrent relay are also inserted in the plate circuit of the control tube. The milliammeter is used to adjust the plate current to the desired operating value. The overcurrent relay activates the alarm circuits in case the plate current should rise to an abnormal value. This would be the case if the B voltage divider opened above the cathode tap or if the tube developed an internal short. The overcurrent relay is adjusted to operate at a value between the pull-in current of the control relay and the tube current with the B voltage divider opened.

The control tube plate current *vs.* trigger tube grid voltage curve is smooth (Fig. 2) from saturation toward cutoff. We adjusted the control relay to pull in at 1.5 ma and to release at 1 ma, the center of the curve. It can be seen that a rather small a.v.c. voltage applied to the grid will operate the alarm. The curve can be shifted along the y-axis by varying the value of R2. It will maintain its slope over a

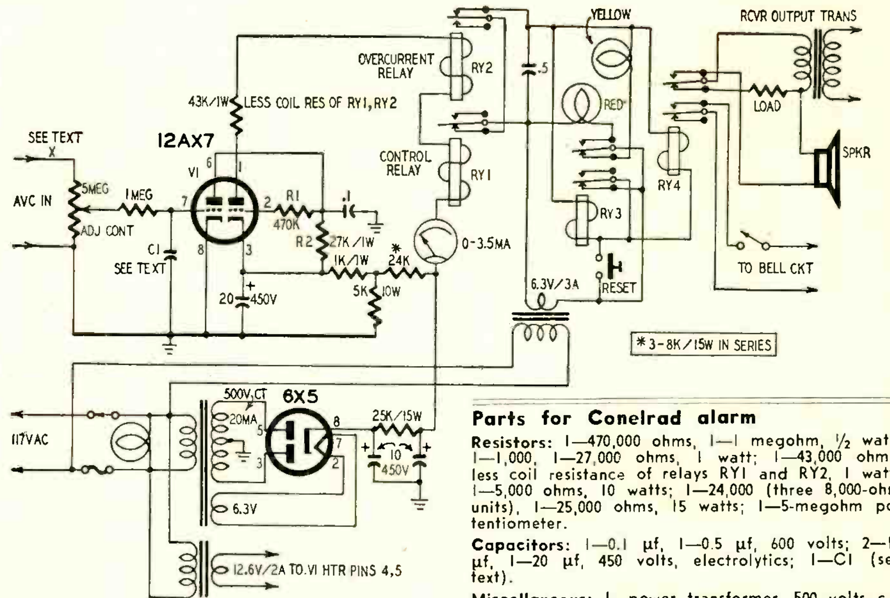


Fig. 1—Schematic diagram of the failure-proof Conelrad alarm system.

rather wide range of shift. If the a.v.c. developed by the key station is so high that the input potentiometer has too small an adjustment range, a series resistor of a few megohms may be inserted at point X on the diagram.

Adjusting the alarm

Advance the input potentiometer until the control relay pulls in. Then adjust it for some value of current between the the release current of the relay and the knee of the current curve, allowing for normal variations of the a.v.c. voltage. Since we are in a fairly strong signal area, we adjust ours to run halfway between the pull-in and release currents. Loss of a.v.c. will allow the control relay to release and trip the alarm circuits. We have marked the current values on our meter for easy reset and for use as a check on the overall performance of the alarm.

The warning indicators following the control relay are types that suit our specific needs. There are any number of variations that may be used. A yellow pilot lamp shows when the a.v.c. is holding the relays energized. When the alarm is tripped, a red pilot lamp shows, the receiver output is transferred from a load resistor to a loudspeaker and a bell circuit is energized. The same indications are given when internal trouble develops. A lockout circuit is used through the contacts of one of the warning circuit relays. This is necessary to keep the alarm from resetting with each application of a.v.c. Manual reset is required once it has tripped.

We experimented with an automatic sequencing alarm and reset for this unit. However we felt manual reset was better since less circuitry is involved and power interruption at the wrong time in a sequencing circuit could render it useless. Before putting the alarm into operation we subjected it to a series of failure conditions that might occur. Indication was given for all of them. Since being put into operation it has worked perfectly.

Good grounding and a shielded line from the a.v.c. bus are necessary. The 6X5 should be mounted vertically. Horizontal mounting is permissible, however, if pins 3 and 5 are in the horizontal plane. No other precautions need be used in constructing the alarm.

The parts list shows the components we used. Although it may seem there are more transformers than needed, we had part of them in stock and used what we had. Some of their functions could easily be combined. The relays can be of any make so long as they operate in the current ranges of the circuit.

We also built an alarm using a 12AU7 tube which works equally well. It requires higher a.v.c. voltage and has greater plate current in the control tube. The same circuit configuration was used with changes in some of the component values to account for the difference in tubes. END

Parts for Conelrad alarm

Resistors: 1—470,000 ohms, 1—1 megohm, ½ watt; 1—1,000, 1—27,000 ohms, 1 watt; 1—43,000 ohms, less coil resistance of relays RY1 and RY2, 1 watt; 1—5,000 ohms, 10 watts; 1—24,000 (three 8,000-ohm units), 1—25,000 ohms, 15 watts; 1—5-megohm potentiometer.

Capacitors: 1—0.1 µf, 1—0.5 µf, 600 volts; 2—10 µf, 1—20 µf, 450 volts, electrolytics; 1—C1 (see text).

Miscellaneous: 1—power transformer, 500 volts c.t. @ 20 ma, 6.3 volts @ 1.5 amps (Triad R-3A or equivalent); 1—filament transformer, 6.3 volts @ 3 amps (Merit P-2946 or equivalent); 1—filament transformer, 12.6 volts @ 2 amps (Merit P-2959 or equivalent); 1—6X5; 1—12AX7; 1—octal socket; 1—9-pin miniature socket; 1—relay (RY1), surplus type BK-7B, s.p.d.t. 4,000 ohms, adjustable sensitivity; 1—relay (RY2). 10,000 ohms, s.p.d.t, 3.2 ma. 5-ampere contacts (Potter & Brumfield LM5, adjusted for 3 ma, or equivalent); 2—relays (RY3, RY4), d.p.d.t., 6 volts a.c. (Potter & Brumfield KR11A); 1—milliammeter, 0–5 ma (or 3.5-ma meter from surplus BC-442-A antenna relay unit); 1—switch, push to make; 1—s.p.s.t. switch; 3—pilot lights and assemblies; 1—fuse and holder; 1—terminal strip; 1—shield for 12AX7; 1—jack for receiver input, 1—power cord; 1—chassis and panel.

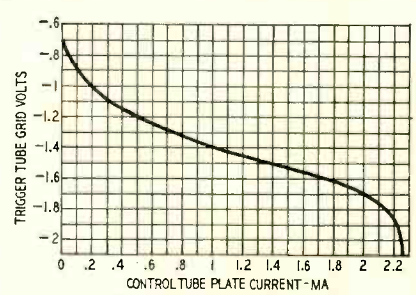


Fig. 2—Control tube characteristic.

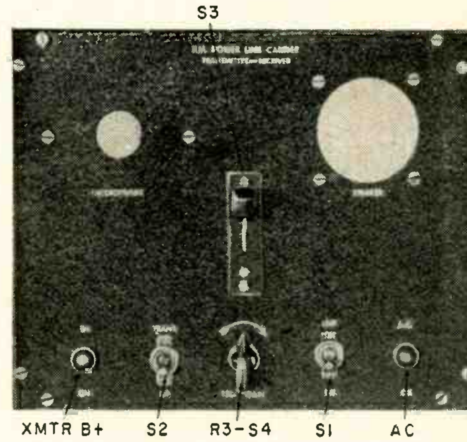
FM

WIRELESS INTERCOM

By J. P. NEIL

An easy-to-build power line carrier system

Front panel view of wireless intercom.



INTERCOM systems are many and varied. Included are some commercial power-line carrier types, but these have certain limitations—inability to pass through watt-hour meter circuits, strictly transceiver operation, line-noise interference. I know of no FM system of the power-line carrier type. This article describes a relatively simple FM power-line carrier transmitter–receiver with a number of important advantages: reduction in line noise; separate transmitter and receiver in the same cabinet permit monitoring only or receiving only when required; carbon mikes give better pickup than speakers used as microphones; lever control switch permits push-to-talk or steady-on operation effective up to several hundred feet beyond meter circuit.

The FM wireless intercom lends itself to many applications. Typical are: monitoring unattended offices or stores; monitoring children's playrooms and bedrooms; adjusting antennas at set and antenna simultaneously.

Circuitry

A schematic diagram of the transmitter, receiver and power supply is shown in Fig. 1. The transmitter consists of a 12AT7 grounded-grid speech amplifier with the microphone in series with the cathode of V1-a. V1-b is a grounded-cathode amplifier with printed-circuit R-C coupling to the reactance modulator, a 6BE6 capacitively coupled to a 6AG7 electron-coupled oscillator. The oscillator in turn is capacitively coupled to the line at point A.

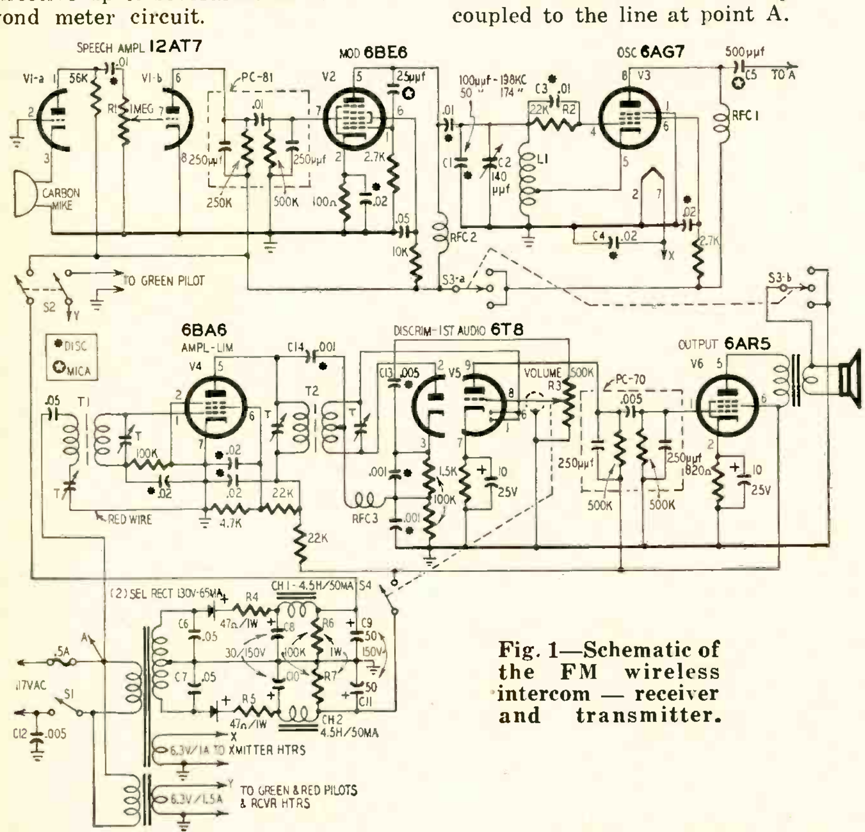


Fig. 1—Schematic of the FM wireless intercom — receiver and transmitter.

With the exception of bypass capacitors which are not too critical, all components are optimum values, determined from extensive experimenting. C4 must be connected from the "hot" side of the heater to ground *at the oscillator socket*. The oscillator coil consists of a J. W. Miller No. 4537 r.f. (four-pie, 2.5-mh, 200-ma) choke, with the cathode of V3 (*carefully*) connected at the junction of the first and second pies above ground. All leads should be kept short as possible. Switch S2 is in series with the transmitter B plus; S3-a controls only the oscillator stage.

The receiver is conventional except that it uses a single 6BA6 combined r.f. amplifier–limiter and a 6T8 as a combination discriminator–first audio. The 6AR5 output stage is biased to draw less than half its normal plate current, insuring low drain. As with the transmitter portion, printed-circuit R-C coupling is used. The trimmer capacitor originally across the primary of T1, the r.f. input transformer must be disconnected and very carefully wired in series with the primary and connected to chassis ground. S3-b is wired to short the voice coil during transmission. If transmitting and receiving on the same frequency, a switch may be inserted to remove receiver B plus during transmission. S4 is a s.p.s.t. switch on R3, in series with the receiver B plus. The output transformer is a universal type, connected for 14,000 ohms impedance.

The system used here makes it possible to use an inexpensive power transformer rated at only 250 volts c.t. at 25 ma, with a 6.3-volt 1-ampere filament winding. This winding is wired to the transmitter heaters only from point X. An additional small transformer provides the filament supply for the receiver tubes and pilot bulbs from point Y and is located in front of CH1, CH2, on top of the chassis. The 250-volt winding of the power transformer is split to give two separate 120-volt d.c. outputs by use of half-wave selenium rectifiers.

Capacitors C6, C7 and resistors R4,

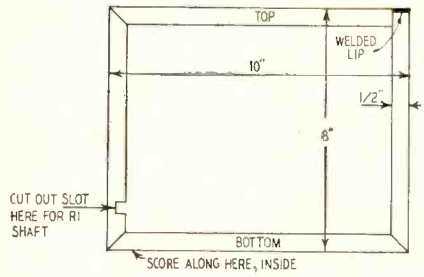


Fig. 2—Layout of intercom cabinet.

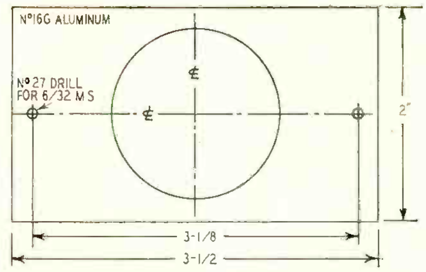


Fig. 3—Layout of microphone clamp.

R5 are, respectively, voltage and current surge-limiting components. C8, C9 and C10, C11 are dual 30–50-μf 150-volt tubular electrolytics. This high capacitance gives good voltage regulation without tube regulators. The value is not critical, but a total of at least 80 μf is recommended to keep the hum down to about 0.1%. Resistors R6, R7 discharge the filter capacitors.

Construction

A 10 x 8 x 7-inch aluminum utility box serves as a cabinet (Fig. 2) for the complete unit. A slight alteration is necessary so it will accept the 7 x 9 x 2-inch aluminum chassis, with respect to the 7-inch depth. The cabinet is of one-piece construction with separate back and front panels. The welded junction of the box should be at the top, so the bottom will be uniform and plane. Using a heavy knife blade, the bottom front and rear folded lips should be scored heavily along the inside seams. The lips should then be bent back and forth till they break off and the edges filed smooth and touched up with black lacquer. With the chassis in place attached to the front panel, it will be flush at the front of the box and projecting about 1/16-inch at the rear.

Major parts should be laid out as shown in the photos. Chokes CH1, CH2 are surplus microphone filters that were on hand. The companion unit used two Stancor No. C-1706 chokes in the same positions. When mounting the chokes and transformers, they should be placed so that adjacent coils are at right angles to each other where possible. All miniature sockets except that of V6 are shielded. V6 is the saddle type. R1 is located along the center line between V1 and V2. A slot must be cut in the left-hand lip of the cabinet as shown in Fig. 2. The shaft of R1 should be cut off to about ¼-inch and slotted. Then drill a matching ¼-inch hole in the side of the box to permit external screwdriver adjustment. S3 should be mounted positive upward, spring-return downward.

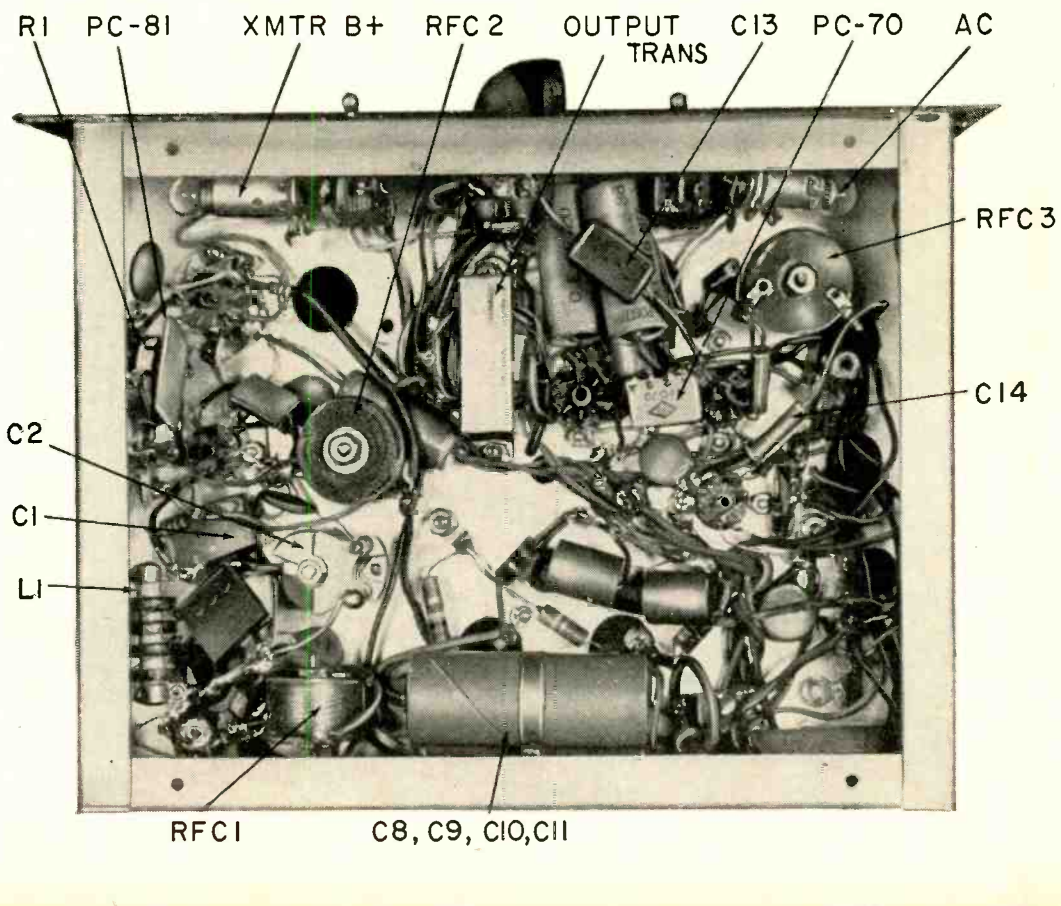
Most of the minor components are visible in the underchassis photo. Note particularly the locations of the r.f. chokes (mounted on 1½-inch 6-32 brass machine screws), L1 and its associated capacitors C1 and C2. C3 and R2 are wired from the top lead of L1 down to pin 4 of the octal socket. This lead of L1 is extended to the stator of C2 by a piece of No. 14 tinned bus wire. The lower strap lead of L1 connects directly to the rotor lead of C2. C1 is wired between the two leads of L1. The r.f. output capacitor C5 is mounted between one lug of RFC1 and a single-lug terminal strip, the mounting lug of which is soldered to pin 1 of the V3 socket. A lead from this strip is then run to point B on the fuse holder, along the rear bottom lip of the chassis.

The filter capacitors are strap mounted. These straps are bent so they can be attached to a common screw in the center of the rear edge of the chassis, with one capacitor staggered above the other. Selenium rectifiers can be placed on the side of the chassis or any convenient place.

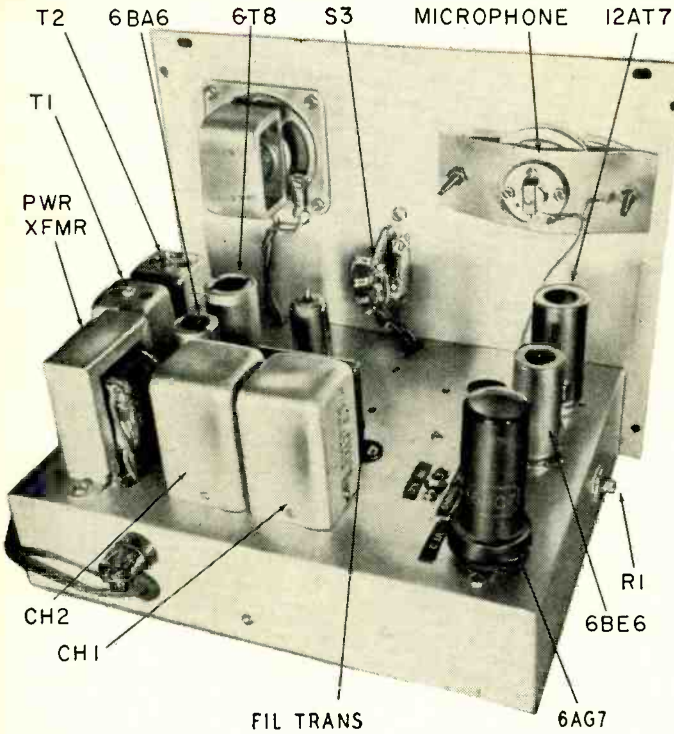
The panel components are mounted straightforward. The clamps for attaching the carbon mike capsules are from 16-gage aluminum (Fig. 3). A hole is cut out of the center just large enough to fit over the projecting ring on the back of the capsule. Although surplus mikes will do, Western Electric type F-1 or T-1 units are much better. Grill cloth is placed in front of both microphone and speaker. A piece of aluminum window screen is positioned between the 2-inch PM speaker and the grille cloth to protect the cone.

Transmitter adjustments

The transmitter section can be adjusted without instruments, by guess-



Underchassis view of the wireless intercommunicator.



Rear view shows major components. Unmarked tube next to the 6T8 is the 6AR5.

work, if necessary. However, an oscilloscope and an audio generator reaching to the 175-kc region should be used if at all possible. The two companion units are set to operate on 174 and 198 kc, respectively, merely because they were easy decal combinations for chassis marking. Actually, any two different frequencies between about 150 and 205 kc may be chosen as long as the two carriers are at least 20 kc apart. Deviation is narrow, amounting to only about 2 or 3 kc.

To adjust the transmitter using the above instruments, connect the audio generator output to the horizontal plates of the scope and the vertical plates to a pair of leads. The "hot" vertical lead is loosely coupled near the oscillator circuit under the chassis, the other lead connected to the chassis. An external ground should be used during this process but is not required for normal operation. Also connect the external sync terminal of the scope to the "hot" vertical terminal.

Set the generator to the desired frequency and adjust the vertical and horizontal scope gains to give a pattern of sufficient size. Oscillator tank capacitor C2 should then be varied very slowly until a circle pattern is obtained. If a circle cannot be obtained, set C2 first at minimum, then at maximum and at each position vary the generator to obtain a circle, noting the extreme limits. Should a circle be out of these limits for a given carrier, C1 may be wrongly marked and should be changed. In the event no vertical gain can be obtained, check for r.f. voltage with an a.c. v.t.v.m. at the hot end of L1. There should be 30 or more volts at that point and at least 50 volts r.f. at the 6AG7 plate. If there is no r.f. output, check the cathode current, which should be 14 to 18 ma. A current of only 2 or 3 ma indicates no plate load, hence C5 or C12 may be open. If there is no cathode current at all, check the continuity of L1 in both directions from the cathode tap. An "open" will likely to be indicated.

As a double check for r.f. output, a v.t.v.m. across the line terminals will show an increase of 2 or 3 volts if all is well. In checking with the scope, the circle pattern at resonance is very sharp and does not remain stationary for more than a moment at a time. Thus, a quick shifting of a cycle or so is of no consequence.

Turn R1 to maximum clockwise (full gain) and readjust the oscillator frequency slightly to its correct value. To check deviation place an earphone, fed with a 1,000-cycle note, close to the mike. The circle on the scope should change to a fuzzy square. Detune the generator about 1 to 2 kc higher and lower than the center frequency. A new circle should be obtained at each extremity, though not as sharp as with no modulation (that is to say, the circle pattern may be somewhat broad or fuzzy). If no instruments are available, C2 can be set at about one-third mesh for the higher-frequency carrier and at about two-thirds for the lower.

Receiver

Receiver adjustment can be carried out by ear or with an a.c. v.t.v.m. connected across the voice coil of the speaker. As in the above deviation check, impress a tone into the microphone of the transmitter in the companion unit. With the receiver gain at maximum start tuning each trimmer in succession until the tone is heard, gradually reducing the gain as it becomes too loud, until all are peaked. If voice reproduction is poor when the two units are separated by at least 30 feet or more, the trimmers can be repeaked to give best results. Transmitter deviation can be reduced by setting R1 of the sending unit a little less than maximum.

The rectifier outputs should be approximately 150 volts d.c. no load and around 120 volts d.c. loaded at C9 and C11.

Operation

Regardless of the purpose for which this equipment is being used, S2 and S4 should be in the "off" positions when not in use and S3 in neutral. S1 should always be turned on first and S2 and S4 only after a delay of at least 15 seconds. With selenium rectifiers, the plate voltage would otherwise be applied before the heaters have warmed sufficiently.

When used as an ordinary intercom S2 and S4 must both be "on" (after the warmup period). The push-to-talk (downward) position of S3 should be used for this purpose whenever possible to conform with normal practice. In situations requiring monitoring only, the transmitter B plus (S2) of one unit and the receiver B plus (S4) of the other are used. Full duplex operation is not feasible due to acoustic feedback if both transmitters and receivers are on together. This is another reason for muting the speakers. Due to the sensitivity of the microphones, a low voice level should be used when speaking close to them. Conversely, with S3 in the upward position (positive on), one can talk into the unit from some distance away. In the event of severe line noises, reversing the line plugs may help. END

Parts list for wireless intercom

Resistors: 1—100, 1—820, 1—1,500, 2—2,700, 1—4,700, 1—10,000, 3—22,000, 1—56,000, 3—100,000 ohms, 1/2 watt; 2—47, 2—100,000, 1 watt; 1—500,000 ohms (with switch), 1—1 megohm, potentiometers.

Capacitors: 1—25 μμf, 1—C1, (100 μμf for 198 kc, 150 μμf for 174 kc), 1—500 μμf, mica; 3—.001, 2—.005, 3—.01, 6—.02 μf, disc; 4—.05 μf, tubular; 2—10 μf, 25 volts, electrolytic; 2—30, 2—50 μf (use dual 30-50 tubulars), electrolytic; 1—140 μμf, variable (Hammarlund APC-140 or equivalent).

Miscellaneous: 1—input transformer T1, 175-kc input i.f. transformer (Miller 162-K1 or equivalent); 1—r.f. transformer T2, 175-kc full-wave i.f. output transformer (Miller 612-K3 or equivalent); 1—universal output transformer, 14,000-ohm primary, 4 watts (Stancor A-3823, Merit A-2900 or equivalent); 1—power transformer, 250 volts c.t. @ 25 ma, 6.3 volts @ 1 ampere (Stancor PS-8416 or equivalent); 1—filament transformer, 6.3 volts @ 1.5 amperes; 2—chokes, 4.5 h @ 50 ma (Stancor C-1706 or equivalent); 1—12AT7, 1—6BE6, 1—6AG7, 1—6BA6, 1—6T8, 1—6AR5, tubes; 2—7 pin, 2—9 pin, miniature sockets; 1—7-pin saddle type socket; 1—octal socket; 1—s.p.s.t. switch; 1—d.p.s.t. switch; 1—2-pole 2-position lever switch (Centralab 1467 or equivalent); 3—r.f. chokes, 60 mh; 1—coil (L1), 2.5 mh, 4 pie (Miller 4537 with strap leads or equivalent); 2—6.3-volt 150-ma pilot lamps and assembly; 1—1-ampere fuse and holder (1/4-ampere sloblo can be used); 2—selenium rectifiers, 130 volts, 65 ma; 1—printed circuit, Centralab PC-70; 1—printed circuit, Centralab PC-81; 1—2-inch loudspeaker; 1—carbon microphone capsule (Western Electric F-1 or T1, or surplus types); 1—chassis, 7 x 9 x 2 inches aluminum; 1—cabinet, 10 x 8 x 7 inches; 4—tube shields.

A.C. *Supply circuitry*

By L. B. HEDGE

SINCE most of our listening, viewing and test equipment is a.c.-operated, the power-line connection is a common element in most electronic design. Its function is to get electrical energy from the power line into the electronic unit with reasonable safety and efficiency and to bring in or let out a minimum of energy not useful in powering the device (noise, extraneous radiation, etc.). These objectives are straightforward and simple and not difficult to achieve. But a tendency to follow established practice has had some strange effects on what might be called the "back end" of a.c.-powered electronic equipment design.

Fig. 1-a shows a typical a.c. input circuit with a balanced filter for suppressing incoming noise and outgoing radiation. More elaborate variants of this basic scheme are shown at Fig. 1-b, c. Each of these arrangements has a nice symmetrical look. Since the power-line connection is usually made with a plug which may be inserted into the power outlet receptacle either way, this symmetry is deceptively appealing.

Virtually all 117-volt power supply lines in this country are connected to 117/234-volt, grounded-center, three-wire distribution circuits. Most industrial and many home power lines bring the 234-volt three-wire line into the meter and customer distribution center and provide 117-volt power outlets from both "sides" of the three-wire system (Fig. 2).

This three-wire, grounded-center system provides, at the 117-volt level, an unbalanced supply line—one side of the line is grounded. This ground connection is insured by a connection, on the customer side of the meter, between the common center line and the cold water line of the building. The metallic conduit system—if metallic conduit is used—is also connected to this grounded center line.

When the unit shown in Fig. 1-a is connected to the power line, this results in one of the alternative situations shown in Fig. 3. The chassis is maintained at an a.c. potential of approximately 58.5 volts above ground by the capacitive voltage divider of the filter when the switch is closed. With the connection shown at Fig. 3-b the chassis potential goes up to 117 volts when the switch is opened or the fuse blows. If two devices with Fig. 1 type "back ends" are plugged into outlets fed from opposite sides of the supply line, the two chassis will come up with a 117-volt difference of potential between them. If they are plugged in as in Fig. 3-b, this potential will rise to 117 volts when one switch or fuse is opened and to 234 volts when both units are "off" (Fig. 4).

These discrepancies are disconcerting and may be dangerous. Although the impedance of the capacitor filters of Fig. 1 is likely to be high enough at 60 cycles to prevent a large current flow through them, you can pick up a nasty shock by touching two chassis connected as shown in Fig. 4—especially if both of the units are turned off!

If these two units are, for example, a signal generator and an oscilloscope, the 60-cycle current flowing in an interconnecting "ground" lead may well introduce a troublesome 60-cycle signal at the scope. If a scope is not part of the setup, the spurious signal may appear as an unsuspected contribution to a meter reading or a hum which is credited to more conventional causes.

The key to a rational correction of these anomalies of conventional "back-end" design lies in the use of polarized power plugs. These plugs are obtainable from electrical supply houses or they can be easily and economically provided by simple modification of standard plugs (see "Polarized Power Plugs for the Experimenter," January, 1953). With the wide blade of the power plug connected directly to the power unit of the device, and the switch and fuse in the lead to the narrow blade, the switch and fuse will provide real protection (Fig. 5). With the power supply wiring now realistically unbalanced, the filter systems of Fig. 1 may be modified (Fig. 6-a, b) to provide the same filtering action without raising the a.c. potential of the chassis. The conversion is easily and quickly made on existing equipment—the unbalanced filter in no sense complicates a new design.

A special word is in order regarding the scheme shown in Fig. 1-b: *don't do it!* Fusing both leads to a grounded-center power supply connection is an invitation for unsafe failure—a short to the chassis which blows the fuse in the ground lead will leave the chassis hot with a solid connection through the short! END

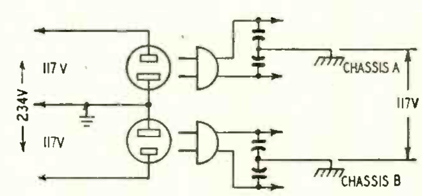


Fig. 4—Balanced filter can produce large voltages between two chassis.

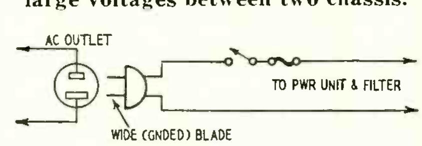


Fig. 5—Switch and fuse are in hot lead.

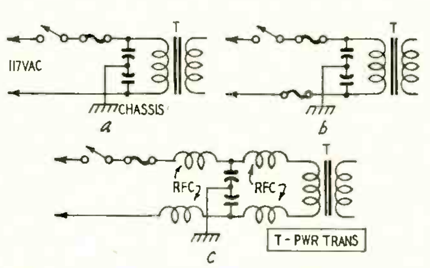


Fig. 1—Diagrams show common variations in standard power-line filters.

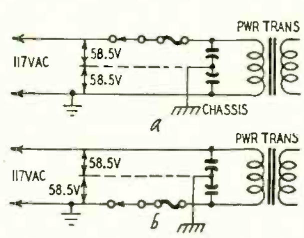


Fig. 3— Diagrams show how balanced filter places chassis above ground.

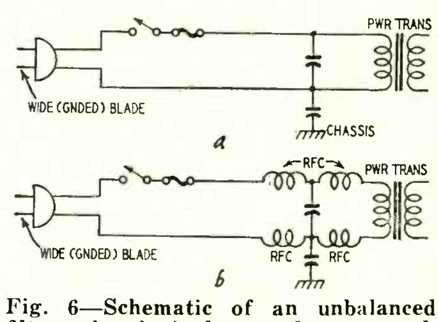


Fig. 6—Schematic of an unbalanced filter—chassis is bypassed to ground.

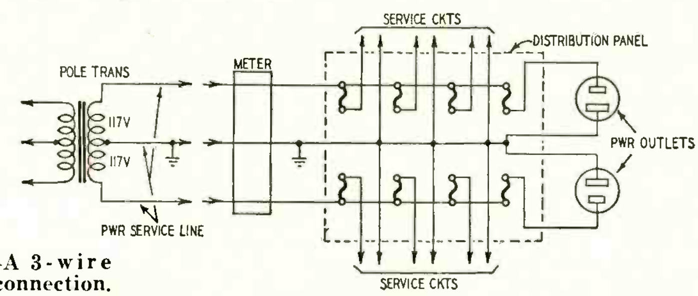


Fig. 2—A 3-wire service connection.

COVER FEATURE

RADIO

COMMUNICATIONS

SHIP TO SHORE

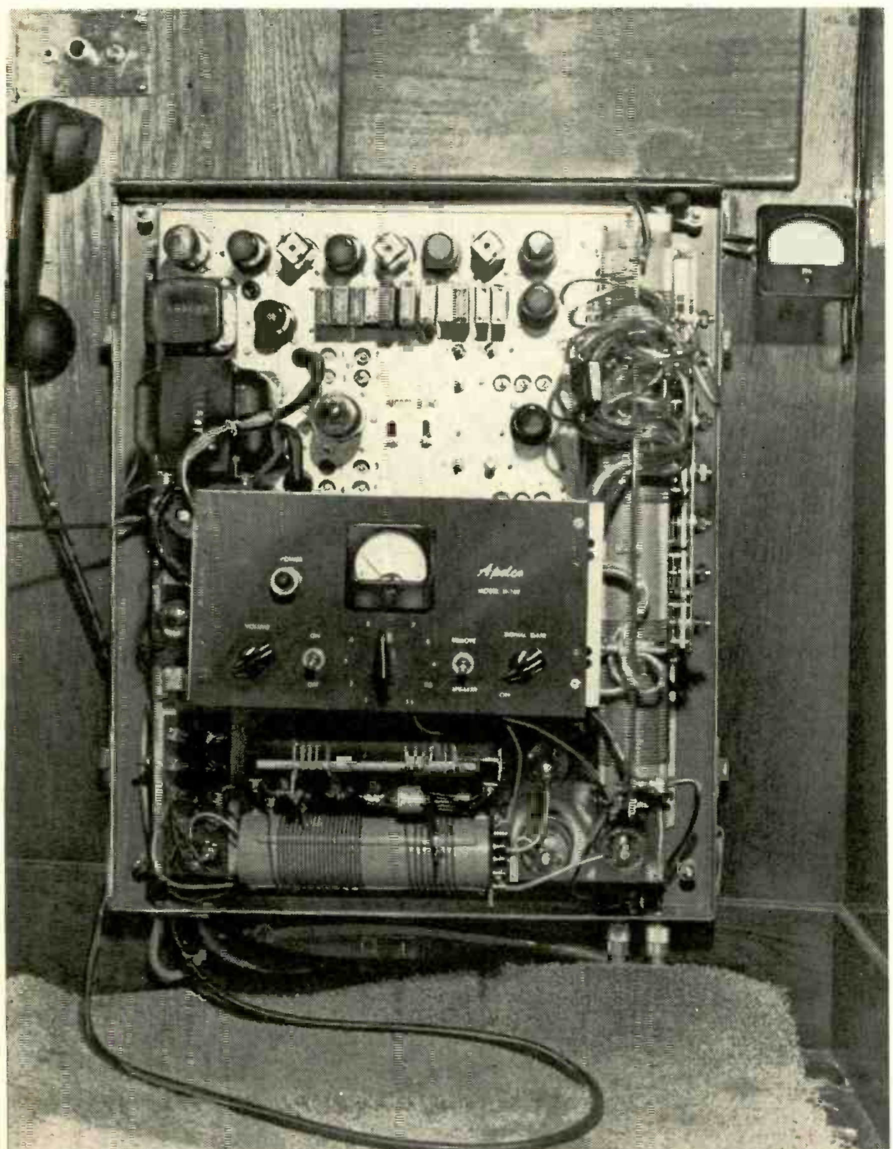
The radiotelephone story: applications, regulations, equipment

By SIDNEY S. KONIGSBERG*

RADIO people whose business or interests are not primarily in the marine field are often surprised to learn the important role of the radiotelephone on pleasure and commercial craft of all types.

*President. Applied Electronics Co., San Francisco.

From the smallest power cruiser to the most pretentious sea-going yacht, from the lowly harbor barge to the speedy, long-ranging tuna clippers, all are radio-equipped. Significantly, none but the largest boats employ radio operators with first- or second-class commercial operators' licenses. Radiotelephone (voice) is used predominantly, the design of the equipment being such that nontechnical people with easy-to-obtain third-class licenses can operate it without difficulty.



Topside view of the Apelco H-160.

Radiotelephone operation on any boat is not to be considered in the hobby class. It is important, functional, vital. It can, and often does, offer a craft in distress the only means of summoning aid. The effectiveness of small-boat radiotelephones in this regard is pointed up by a recent, nationally publicized news item. Many readers will recall the story of the false distress signals which sent the Navy and Coast Guard on a futile, costly search covering a very wide area. Apprehension and prosecution of the guilty parties followed in due course. However, the story's pertinence to this discussion lies in the effectiveness of the illicitly used boat radiotelephone equipment in summoning aid. Had the emergency been a real one, lives and property would surely have been saved.

A business man comfortably relaxed on his boat in the Florida Keys can, with his marine radiotelephone, speak to his office in New York. It is necessary only that the radiotelephone-equipped boat be within range of the nearest land station maintained by AT&T.

Marine operators answer the call from the vessel and patch the signal into land-line telephone circuits. Conversation thereafter proceeds in the same manner as a conventional telephone call with this exception: it is impossible for both parties to speak at the same time. The boat equipment operates on a press-to-talk, release-to listen basis.

The ability to converse directly with parties on shore is of extreme value to many commercial boat operators. Fishing fleets in particular use the radiotelephone to exchange spotting information on schools of fish, to inform shore canneries as to tonnage of catch, to arrange refrigeration, etc. The marine radiotelephone has come of age, evolved from a cumbersome, uncertain-in-operation curiosity to the present-day dependable, streamlined package.

Design problems in equipment for

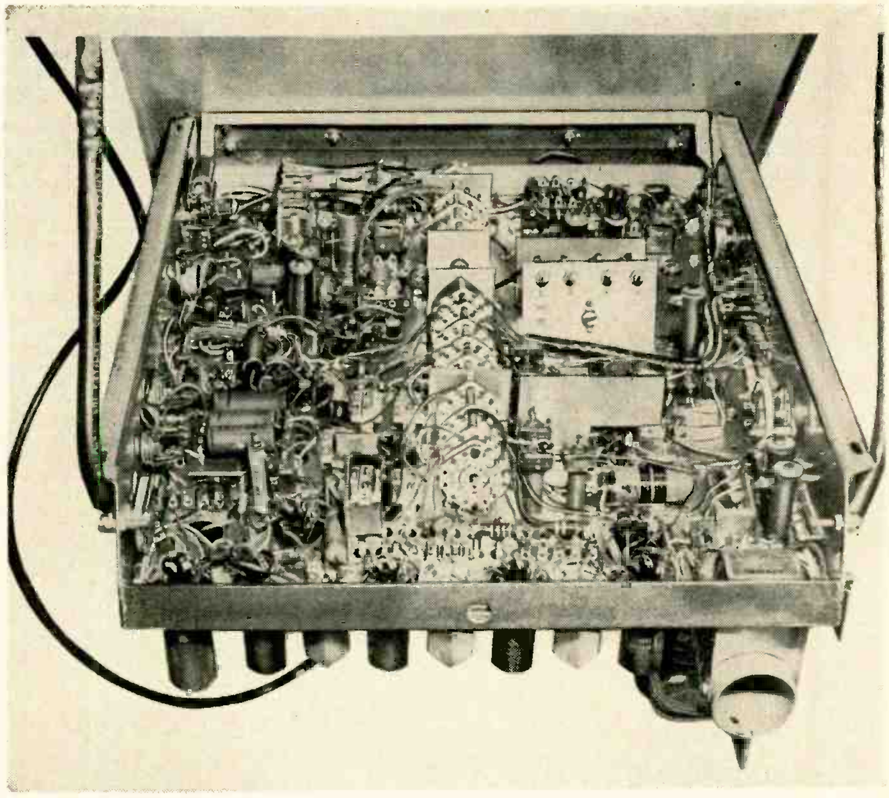
marine service are unique. For example, a typical installation operating from a 12-volt power source must be capable of functioning from between 10 to 16 volts. As mentioned, radiotelephone equipment is usually operated by nontechnical personnel having only an FCC third-class radiotelephone operator's license. The laws governing this type of service require that the equipment design must be such that the operator cannot make interior circuit adjustments. He is permitted merely to turn the primary power on or off, set the channel selector switch to the desired frequency and actuate the press-to-talk button on the microphone. In other words, the equipment must be foolproof, tamperproof and must be pretuned by a duly licensed technician.

No restrictions are imposed on receiver operation however. Most present-day equipment contains a multirange tunable receiver which includes the standard broadcast band. In addition, the receiver high-frequency oscillator is generally quartz-crystal-controlled, the operator automatically selecting the correct receiving channel when setting the master selector switch to the desired transmitting channel.

The frequency of operation may vary widely depending upon the type of boat and the cruising radius over which reliable communication is required. In addition to those on the Great Lakes, the telephone company has stations geographically arranged to provide overlapping coverage of the entire United States coastline. For example, on the East Coast there are stations in Boston, New York, Norfolk, Charleston and Jacksonville; on the Gulf, stations in Tampa and Galveston; on the Pacific Coast, San Pedro, San Francisco, Astoria and Seattle. These various shore stations have sufficient transmitting power and antenna systems for adequate reception by boats at substantial distances. The need for equivalent transmitting range from the boat is minimized by installation of telephone receiving stations at interim coastal points.

Many such stations operate with efficient directional antennas. Additional, and important, frequency channels provide for a general boat-to-boat calling frequency at 2182 kc. After establishing contact on this channel both boats shift frequency to 2638 or 2738 kc for further communication. Of great importance to the boat owner is the fact that the 2182-kc frequency is continuously monitored by the U. S. Coast Guard and thus serves as an emergency channel for ships in distress.

Where the cruising radius of a boat is limited to U. S. coastal waters, the required ship-to-ship, ship-to-shore and distress frequencies are encompassed within the frequency range from 2000 to 3000 kc (except in the Great Lakes area). Another group of telephone stations provides high-seas, extended-range, ship-to-shore radiotelephone communications.



Underchassis of the Apelco H-160.

The Apelco H-160 installed in the craft shown in the cover picture, has a total of 11 channels, some of which may extend as high as 18,000 kc. Therefore this equipment is sufficiently versatile to provide coastal or long-range ship-to-shore (telephone-company) operation by using the higher-frequency channels. It is not unusual to communicate several thousand miles on daily scheduled transmissions from boats so equipped.

In small-boat radiotelephone service numerous technical problems exist for the design engineer.

Power input in this equipment is limited both by FCC regulations and by the amount of current that can be drawn practically from a storage battery. Transmitters with inputs to approximately 50 watts are feasible from a 6-volt battery source. Higher powers, to 200 watts input, normally call for 12- 32- or 110-volt d.c. installations. With power inputs necessarily restricted and with antenna length dictated by the size of the craft, it is highly important that the equipment be as electrically efficient as possible. This is particularly true with regard to the final amplifier plate and output loading circuits.

Radiotelephone circuits

Marine transmitters of the above type always use precision, low-drift quartz crystals for maintaining frequency accurately. Rigid FCC regulations forbid self-controlled oscillator operation. A typical crystal-controlled oscillator circuit is shown in Fig. 1. This is a modified Pierce type in which no tuned L-C circuit is required. All crystals switch in on the master selector switch.

Buffer amplifiers are used in all but the smallest transmitters. Since the operator has no control over the interior circuits and no "touch up" is possible, it is important that drive to the final amplifier be sufficient at all times on all frequency ranges. This points up another consideration—the need for avoiding marginal adjustments. The buffer amplifier must receive adequate grid drive from the oscillator, use tubes with ample extra plate dissipation and supply proper drive to the amplifier even when its own tuned L-C circuits are not exactly "on the nose." In a word, safety factor—extra margin—must be everywhere in marine radiotelephone equipment.

The final amplifier tubes and output circuitry are of great importance for a number of reasons. When operation is in the 2000–3000-kc range, the average length of antenna that can be used usually represents only a frac-

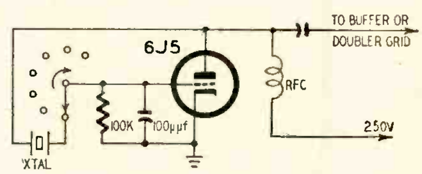


Fig. 1—Modified Pierce oscillator

tion of a quarter-wavelength at the lowest end of the operating range. All such antennas are necessarily of the Marconi type operating against a ground plate. It is necessary to load these antennas to a quarter-wavelength by adding suitable values of base inductance. (This procedure may be compared to an amateur automotive mobile installation operating in the 3500-4000-kc range and using a whip antenna.) A short antenna of this type looks electrically like a small capacitor (high capacitive reactance) in series with a small resistance. Generally speaking, the shorter the antenna compared to a quarter-wave-length at a given frequency, the smaller its capacitance, the higher its capacitive reactance and the lower its radiation resistance.

The transmitter output circuit must operate to transform the proper load impedance for the output tubes to the very low antenna base resistance (perhaps less than 5 ohms). This in itself may impose some knotty loading problems. The output circuit must also provide sufficient inductance to cancel the capacitive reactance introduced by the short antenna. In extreme cases the value of the loading inductance may be very large, making it mandatory that the "Q" of the loading inductor be very high if excessive losses are to be avoided. $\left(Q = \frac{2 \pi f L}{R} \right)$ Heavy-duty, space-wound inductors are used in the Apelco model H-160 (see photo).

Since there is a definite limit to inductor Q's that can be practically obtained in a compact transmitter, the trend is toward special antennas using built-in loading. Essentially, these are vertical antennas with built-in center-loading inductors above which are mounted flexible top whips for added height and additional (and desirable) top capacitance. Antennas of this type present a higher base load resistance to the transmitter and require much less base-loading inductance. They (or other base-loaded antennas) are precisely resonated by the technician for each channel, with proper taps being brought to the master range switch.

While many different types of output circuits are used by different manufacture, virtually all of them fall into two basic categories: First, some configuration of a conventional L-C tuned circuit to which the antenna is either tapped or inductively (link) coupled. These circuits may or may not use a supplementary loading inductor. Second, a pi-network output circuit using either single or double output sections. A single channel of a typical Apelco final amplifier and output circuit is shown in Fig. 2.

The output circuits in marine radiotelephone equipment are also called upon to provide a high degree of rejection to second-and higher-order harmonics to comply with current and proposed FCC regulations. In this regard, high-C circuits with direct, low-impedance harmonic paths to ground or harmonic traps are often used. Harmonics may be reduced further by bias and drive adjustments which provide class-C operation and r.f. plate current flow over approximately 120° of the input signal. Special circuits similar to pi–L combinations are used in some equipment. These circuits provide more than the required amount of harmonic rejection, are uncritical and insure output impedance matching to all conventional marine antenna types.

As mentioned, all equipment of the type discussed is pretuned, the initial tuning being done at the time of installation by a duly FCC-licensed marine service technician. Each channel is individually set up for resonance and for proper loading with the common antenna. Amplifier resonance is obtained through taps which change the inductance by adjustments of individual variable capacitors which are switched in parallel with a fixed value of inductance for each channel. Actual tune-up is not normally a difficult process, particularly when a center-loaded vertical antenna is used.

The technician requires equipment for measuring frequency and modulation and a means of checking harmonic suppression. He also requires an accurate test instrument for indicating all d.c. currents and voltages. The cover photograph shows the technician and his winsome assistant using a multimeter manufactured by Phaostron.

Amplifier loading is indicated both by d.c. plate current rise and by maximum r.f. current in the antenna. Most higher-power transmitters have a d.c. milliammeter on the front panel. Some equipment has a flashlight bulb in shunt with the antenna circuit wiring to indicate antenna current and modulation. Panel r.f. ammeters are rarely used in present-day equipment inasmuch as over the frequency ranges in use the indications are nonuniform.

Modulation systems have not been discussed since for the most part they are entirely conventional, using high-level plate modulation. Carbon microphones are generally used because of their ruggedness and freedom from adverse affects of humidity.

Almost all marine radiotelephones use full press-to-talk control. Depressing a button on the microphone housing actuates relays which apply transmitter B power to r.f. and a.f. circuits, switch common antenna from receive to transmit and mute the receiver.

The receivers, part of most marine radiotelephones, will not be discussed here since with a few notable exceptions they are conventional. An interesting and functional feature in the H-160 is the "signal-gate" circuit which mutes background noise in the absence of incoming signals. For the benefit of those who might find it useful in their mobile receivers, this circuit is shown in Fig. 3.

Space limitations in the average boat make it essential to minimize all equipment dimensions. This can be seen in the photos which show the vertical chassis type of construction used in the H-160. The chassis and housing are arranged for bulkhead mounting. Maximum accessibility is assured since the outer housing can be removed without disturbing the main control subpanel which remains attached to the chassis. The technician's job is further simplified by a removable side panel which permits touchup of tuned circuits after the cabinet is in its final position. END

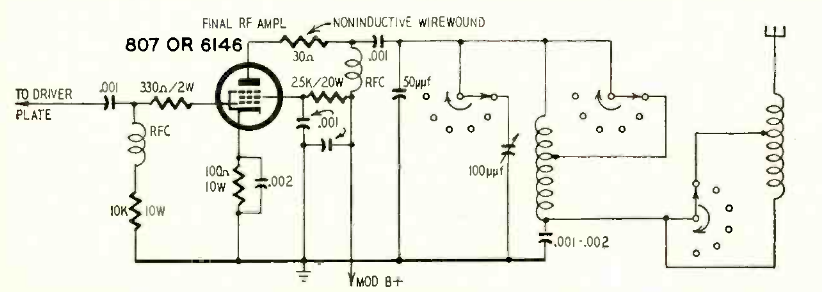


Fig. 2—Schematic of Apelco final amplifier and antenna coupling circuit.

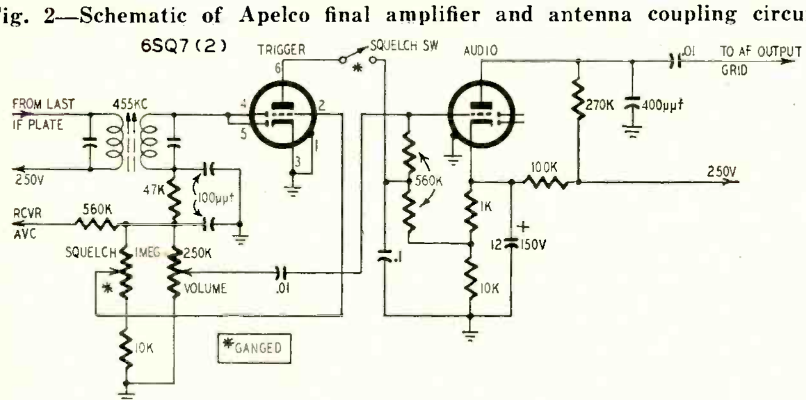
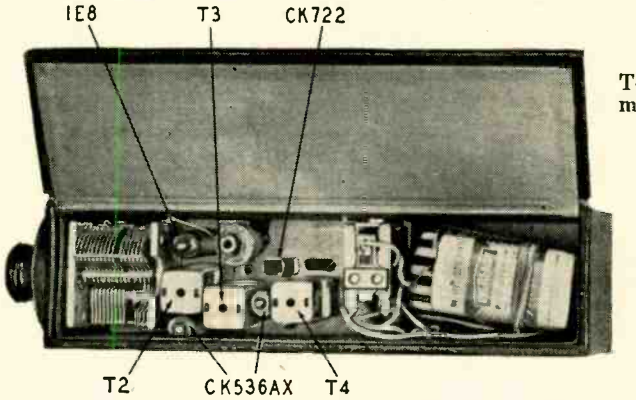


Fig. 3—Schematic of the "signal-gate" squelch circuit in the Apelco H-160.

DX TINY TUNER

By I. QUEEN
EDITORIAL ASSOCIATE



Top view of the miniaturized receiver.

Miniaturized unit is designed for long-distance reception

A HOMEMADE portable radio is not ordinarily very sensitive or selective. If it can receive all the locals without an external antenna, and if it picks up distance under favorable conditions, that is about all we can ask. If you want still more, try this broadcast tuner (see photo). It uses three tubes and one transistor and is designed especially for long-distance reception or use where reception is difficult. Stripped of all nonessentials like a.v.c. and volume control, it is self-contained with its own antenna and power supply.

The tuner is so simple that little description is needed. It is important, however, to point out that it contains subminiaturized parts only recently available to experimenters. Everything has been built into a leather box 2⅛ x 1⅞ x 7¼ inches. Only headphones or an earpiece is needed externally.

This set has undergone many tests alongside two other radios—one, an all-transistor set (using an earpiece); the other, an expensive commercial receiver tuned to the broadcast band and using headphones. Here are some typical results.

The tiny tuner picks up, with satisfactory volume, stations in Bridgeport (600 kc), Philadelphia (610 kc) and Newark (620 kc). These are received *any time of day or night* (in a New York City suburb) and without interference between them. The transistor set picks up the 600-kc station weakly and only with a background of the 620-kc station. It fails to receive the 610-kc signal at all.

The tuner will pick up any station heard on the commercial set that is S2 or better. Any signal whose strength is S5 or better comes in on the tuner very satisfactorily. The big set uses a 30-foot outdoor antenna while the tuner depends only on a ferrite-rod antenna coil! In any normal position, the dx set should pick up 35 or more stations very well and many more should be audible.

Many tiny parts are used. Coil L1 is a Keith *Superloop;* T1 is a J. W. Miller oscillator coil 70-OSC. These are tuned by a dual capacitor made by Radio Condenser Co. It uses cut plates and is designed for 455-kc i.f.'s. Its largest dimension is only 1⅜ inches!

The i.f. transformers are Miller K-Tran types (T2, T3 are type 10-C1; T4 is type 10-C2). These are only 1½ inches high, ½ inch square. Note the direct-coupled transistor audio stage which brings up the volume for satisfactory earpiece level. Plugging in the phones switches on the set's tuner.

Potentiometer R1 is used to reduce the A battery voltage to 1.25 or less for the tubes. If you have a partly used cell whose voltage is low, you don't need this dropping resistor. A cell too old for flashlight service will be suitable here. R2 protects the tube filaments against errors in wiring or shorts. Both batteries should last about 100 hours or more.

Parts list for tiny tuner

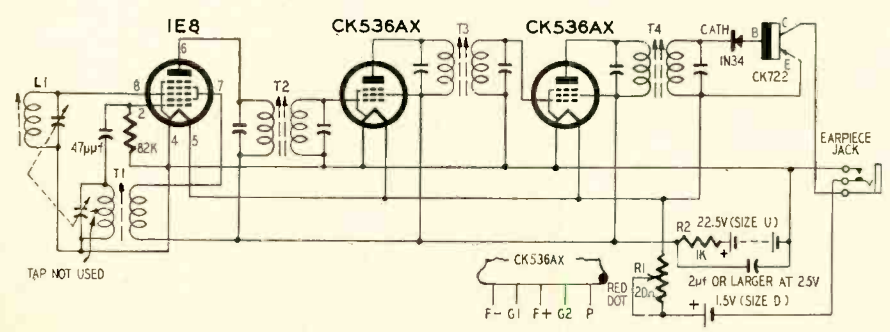
1—1,000-ohm resistor; 1—82,000-ohm resistor; 1—20-ohm potentiometer; 1—47-μμf capacitor; 1—2-μf filter capacitor, 25 volts; 1—1E8 and socket; 2—CK536AX's and sockets; 1—CK722 and socket; 1—1N34 diode; 1—1.5-volt cell (size D); 1—22.5-volt battery, size U); 1—coil L1 (Keith Superloop or equivalent); 1—oscillator coil T1 (J. W. Miller 70-OSC or equivalent); 2—input transformers, T2, T3 455 kc (Miller 10-C1 or equivalent); 1—output transformer T4, 455 kc (Miller 10-C2 or equivalent); 1—dual capacitor, variable, cut plates for 455-kc i.f. (Radio Condenser Co.); 1—jack for earpiece; 1—chassis.

One surprising thing is the use of Raytheon type CK536AX tubes in the i.f. stages. These are audio tubes but were found to perform excellently at the 455-kc i.f. All three tubes will operate with a total of 0.5-ma input at 10 volts on the plates.

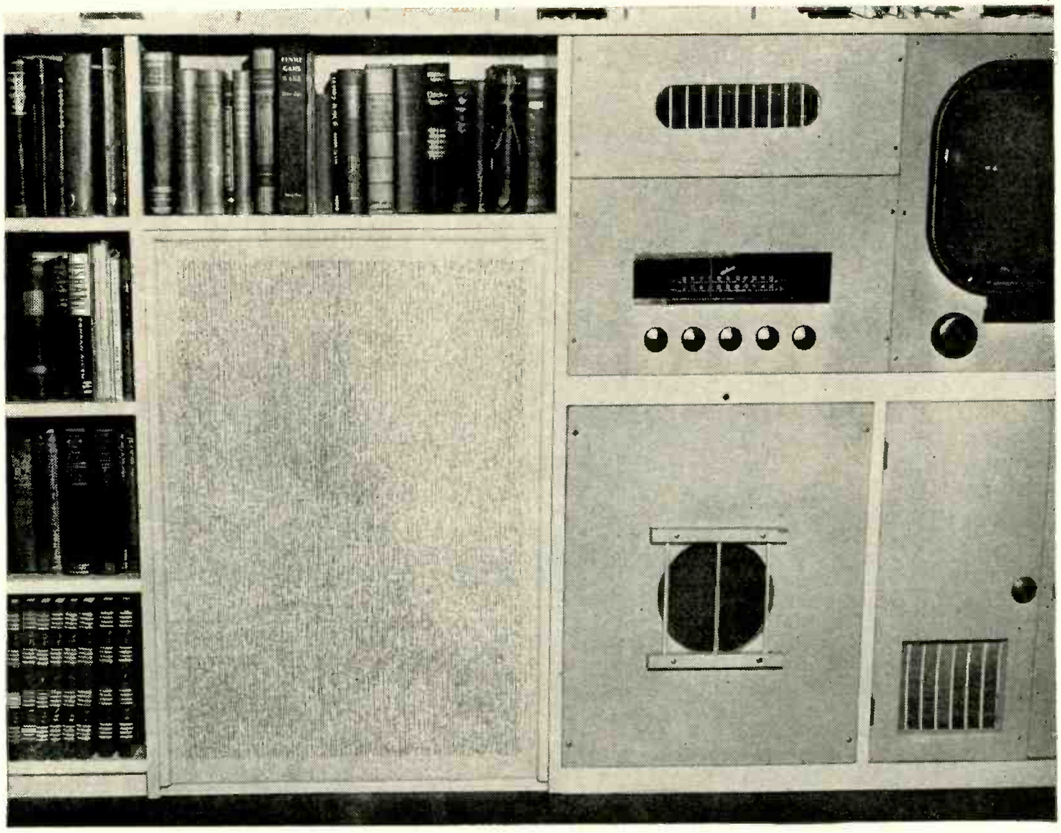
Some portables have to be oriented for sufficient pickup from a broadcaster. This one may have to be oriented to prevent overloading on powerful locals. Another way to prevent overload is to reduce filament power with R1. Filament current can be made as low as 50 ma total for local reception.

A 1-volt d.c. meter may be connected across the headphones for aligning the set. Average stations will show about 0.5 volt. Very strong nearby stations will show 1 volt or even more.

If you are a dx hound you will get lots of fun from this tiny tuner. It can be carried about in a pocket. The entire unit weighs less than 1 pound. END



Schematic of the tiny tuner. Unit contains three tubes and one transistor.



Karlson enclosure installed in wall of room, with grille cloth over ports.

Constructing a KARLSON ENCLOSURE

Dimensions and details on the layout of this popular loudspeaker housing

By DON V. R. DRENNER

IT has always seemed to me that the complexities of most modern speaker housings are intriguing puzzles suitable for an engineer to fathom. To construct one that would sound as the designer intended, or claimed, would require an equally complex array of power tools and an ability to visualize abstract drawings. So, for these and downright contrary reasons, I have been well satisfied with a simple enclosed box—lined with quilting cotton—to house my Western Electric 728-B 12-inch speaker. (I'm still satisfied with that, and no praise of tweeters and crossover networks will sway me.)

But Monitor, writing in the January, 1955, issue of RADIO-ELECTRONICS, offered some praise for an enclosure invented by John E. Karlson and gave a refreshing account of his experiences. "A novel and successful one is the Karlson which . . . claims and (to cut the suspense) *can* in fact deliver a response down to 16 cycles . . . ."

If Monitor was correct, the Karlson seemed to be what I had always wanted —good, smooth bass without 50 watts to make it audible.

I unearthed a copy of a magazine containing Karlson's own exposition of his system, some nice design considerations and drawings. Constructing one didn't appear too difficult, and the overall size wouldn't require rebuilding the house. (This is not funny: I rebuilt my living room once to accommodate a speaker housing. And a 30-foot horn would in most cases require a complete new house.) Sadly lacking, however, in Mr. Karlson's explanation was a complete and definite series of "how to" steps. More important, not all dimensions were given. This is understandable, since the Karlson is a commercial product and completed units and kits[1] are for sale. You can buy one, too, if you prefer, but I like to build my amplifiers and speaker housings — the speaker too, if I could!

To see what the thing would look like on paper, full-scale drawings were made using the dimensions given in Karlson's article. Thus it was possible actually to measure the dimensions for fitting the inside pieces and to measure the angles and placement. A sheet of Kraft wrapping paper was used to make the drawings. These full-size templates make for higher accuracy.

Karlson emphasizes that the sizes of many parts are critical, but my experience indicates that an allowable ⅛-inch leeway in cutting—just so the same error is made on all parts—doesn't affect the performance. Similarly, the placement of the pads (in this case Fiberglas 1 inch thick) was generally followed as Karlson recommends but the pads were thickened to 2 inches by gluing and extended to the side walls

[1]Full-scale plans for complete kits are available from John E. Karlson, 423 Bedell Terrace, West Hempstead, N. Y.

of the enclosure. This, in effect, completely filled the spaces surrounded by the reinforcing 1 x 2 pieces.

Cutting the pieces

The general dimensions can be taken from the drawings shown in Figs. 1, 2, 3 and 4, but I would make a full-scale drawing as outlined above before cutting any of the pieces. This is especially true if other than a full 4 x 8-foot sheet of ¾-inch plywood is used, as many possible combinations of cuts might be worked out to save time and lumber. The layout of cuts from a full sheet of plywood is shown (Fig. 1).

In cutting the various pieces, don't try to sand or plane smooth the saw corrugations: they provide a better gluing surface. And, except for those outside surfaces—such as the side edges—no sanding should be done until the assembling is started.

As shown in Fig. 1 all the pieces except the shelf and the 1 x 2-inch stiffeners can be cut from a 4 x 8-foot ¾-inch plywood panel. First, carefully measure and mark SIDE A. The finished measurements will be 33 inches long and 18 inches wide. Next, cut SIDE B exactly the same size. Finish off the end of the panel by cutting FRONT B. Mark the pieces so you won't get confused.

Now measure, mark and cut the two 21 x 18-inch TOP and BOTTOM pieces. Then cut FRONT A. The two front pieces can be laid aside, as working them into the tapered aperture will come after the cabinet has been completed.

The next cut should be the BACK, exactly 22½ x 33 inches. The piece for the TOP ANGLE can be cut at the same time. Then, cut the SPEAKER BOARD, making the 21-inch cut exact. Don't worry about the 26½-inch length as this will later be mitered to form a 60° angle. The remaining cuts are the two 8¼ x 11⅛-inch port pieces—these should be exact.

The piece for the shelf, 21 x 9¾ inches, will have to come from an extra board. It could have been cut out of the 4 x 8-foot sheet by pruning the front pieces, but this would make for several staggered cuts and be more difficult.

Having made all the cuts, take SIDE A, SIDE B, TOP, BOTTOM and SPEAKER BOARD and clamp them together the 18-inch way—the speaker board the 21-inch way—so you can lightly sand one edge of all the pieces. The sanded edges of the sides, top and bottom will be at the front of the cabinet. The sanded edge of the speaker board will be the first edge to be mounted against one side.

The next two pieces to be worked should be cut on a power saw for accuracy. These are the TOP ANGLE and the SPEAKER BOARD. First, the top angle piece (which is about 9 inches wide by 21 inches long) should be mitered the long way 45°. Then, exactly 6 11/16 inches from the top lip of this cut, miter again 45°. The finished piece will now be 21 inches long and 6 11/16 inches wide on one side. (See Fig. 3.) The speaker board piece should be exactly 21 inches wide and 20¼ inches across one face. The bottom miter (where it

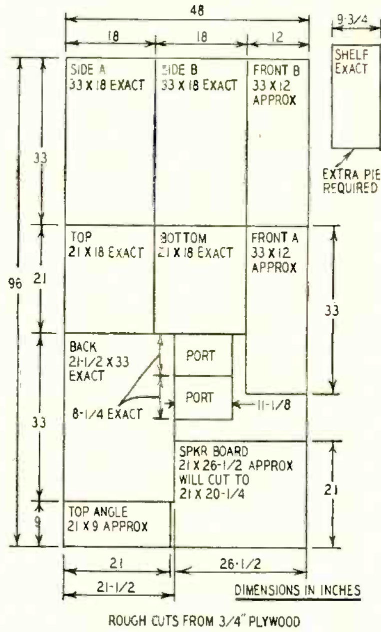
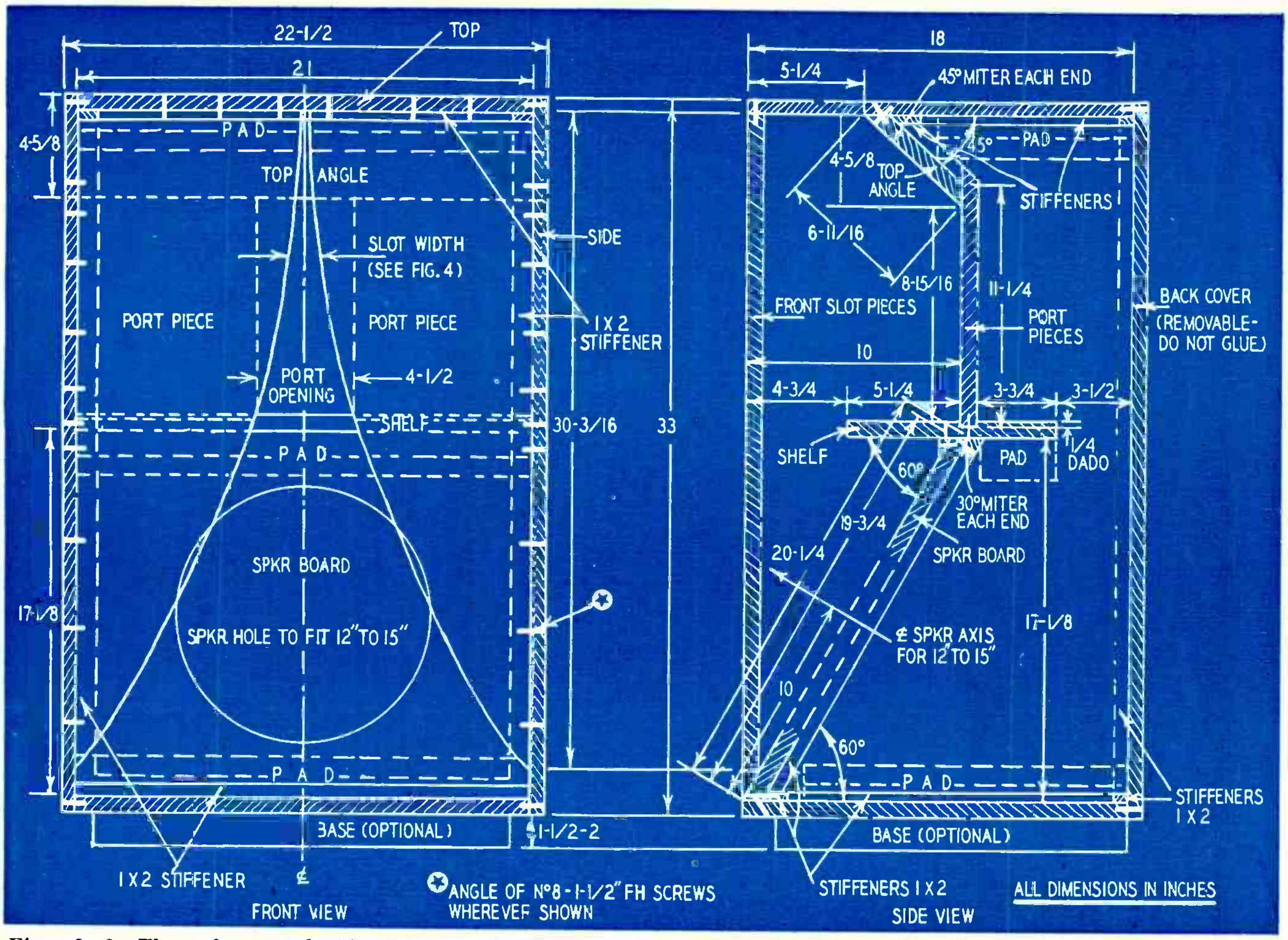
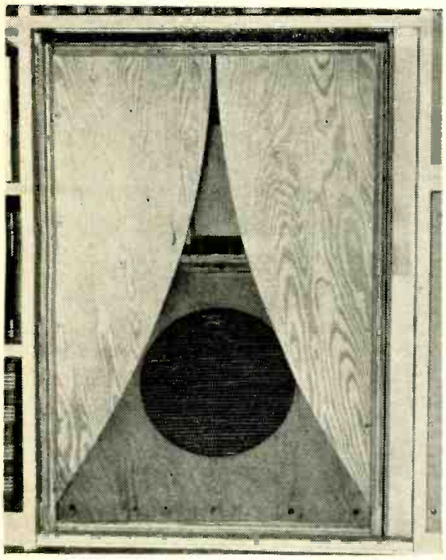


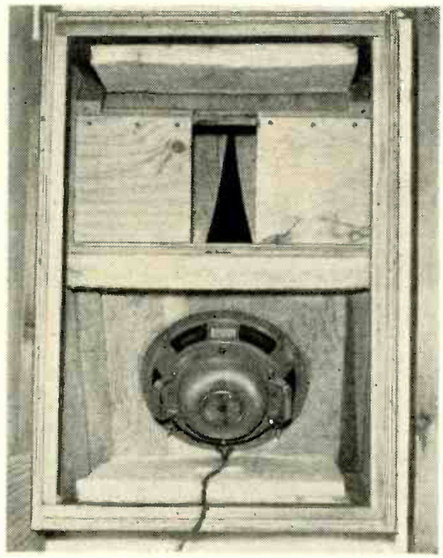
Fig. 1—Plywood panel layout—supplies all pieces except shelf and stiffeners.



Figs. 2, 3—These front and side views of the Karlson enclosure show various dimensions and the miter directions.



Front view of unit with grille cloth removed.



Rear view shows the construction details.

fits against the bottom of the cabinet) is 30°—this will give it an incline of 60°. Make this cut on a power saw. Then measure exactly the 20¼ inches across the face and make another 30° miter. Refer to Fig. 3 for the direction of the miters. If you are in doubt about making these two miter cuts, have them done at a cabinet shop rather than ruin the boards.

The shelf piece, cut exactly 21 x 9¾ inches, has a ¼-inch deep dado to receive the two PORT pieces. You can do this with a handsaw or a wood chisel or have the cabinet shop do it for you. Fig. 3 gives the location of the dado (5¼ inches from the front).

The hole in the speaker board (Fig. 2) for the speaker should now be cut. The diameter will depend upon whether you have a 12- or 15-inch speaker or whether you have a 12-inch and want, later, to install a 15-inch. If you think you'll ever install a 15-inch speaker (or have one now), cut the hole for the larger size and use a conversion board for the smaller (present) size. Otherwise it will be extremely difficult to enlarge the hole once the cabinet is assembled. In my own case, for the Western Electric 728-B speaker which I love and cherish, the hole is 10 15/16 inches in diameter.

Assembling the pieces

Nail lightly *one* side to the TOP and BOTTOM. Tack a piece of 1 x 2 across the open side to steady the pieces. Now fit the speaker board in position against the side and scribe with a pencil on both sides and at the top where it meets the shelf. This will serve as a guide when the gluing process begins.

Assemble the SHELF and the two PORT pieces. The ¼-inch dado is swabbed with glue and the port pieces fitted flush with each end (leaving the port opening in the center) and nailed lightly. Then about six No. 8 flat-head, 1½-inch screws are driven through the bottom of the shelf into the port pieces. This will give you a rigid piece which now may be inserted above the speaker board (see Fig. 3) and, once in exact position, scribed for future fastening to the sides.

The TOP ANGLE should now be inserted and tested for fit. Some slight variations can be expected due to the wood and sawing. If the fit is not perfect against the top and port pieces, some slight sanding or planing may help. But the additional 1 x 2 braces (added later) and the glue and screws will hold it solid even if the miter isn't perfect.

At this stage you should have one side, the top and bottom and the internal structure positioned exactly as in Fig. 3, but no nails or glue applied except to the shelf and port pieces.

Having carefully marked the position of the parts which make up the internal structure, remove all of them and take apart the side, top and bottom.

In the center of the scribed lines where the speaker board, shelf, the edge of one port piece and the top angle fit against one side, drill a series of small holes (about 1/16 inch) through the side. These will serve as guides for drilling from the opposite side (the outside) larger holes to take the No. 8 flat-head screws. Use six screws for the speaker board side, four for the shelf, four for the port side, and three for the top angle. Countersink the larger holes so that the flat-head screws will drive flush with the surface of the plywood.

Now, glue and finish-nail the BOTTOM piece to SIDE A. Drill and insert six to eight screws along the edge to hold the bottom firmly against the side. Repeat the same with the TOP piece. Nail a 1 x 2 as a brace across the open side.

Before gluing the SPEAKER BOARD against SIDE A, attach a 1 x 2-inch strip completely around the inside face of the speaker board, using glue and screws. The bottom piece of 1 x 2 will project beyond the 30° miter: it should be planed flush with the board.

Now, glue the bottom and side of the speaker board, and attach it to the bottom and side pieces. Note that the leading edge of the speaker board is exactly flush with the edge of the bottom piece at the front of the cabinet.

Next glue and screw the shelf and port assembly into place, being sure that the bottom of the shelf—where it meets the speaker board—is coated with glue. After you have attached the shelf firmly to the side, drill a series of holes at an angle through the back of the speaker board into the shelf and draw the speaker board snuggly up to meet it. Notice that a small wedge-shaped brace is inserted under the shelf, against the speaker board at the front. This is one of the pieces cut from the end of the speaker board when it was mitered and is an additional stiffening measure.

Before attaching the TOP ANGLE piece, glue and screw 1 x 2-inch stiffeners along the back edges. The ends of the stiffeners should be cut or planed to conform to the 45° miter and to fit against the surface of the port pieces which project up back of the top angle piece. Once the 1 x 2 pieces are attached and the whole thing fits, glue and attach the TOP ANGLE piece.

You should now have SIDE A, the top, bottom and all the internal structure securely glued and attached with screws. If your miter cuts were accurate and all pieces square, the cabinet should be ready to glue and attach SIDE B. However, in my own case, some slight errors occurred, and to correct them is a matter of sanding and planing the outer edges of the internal structure so everything is flush to receive SIDE B. When this is ready, coat all the edges of the top, bottom, speaker board, etc., with glue and place SIDE B in position. Nail at several points with finishing nails before marking and boring the screw holes. Then drive all screws home.

The inside of the cabinet should be stiffened with 1 x 2-inch strips, glued

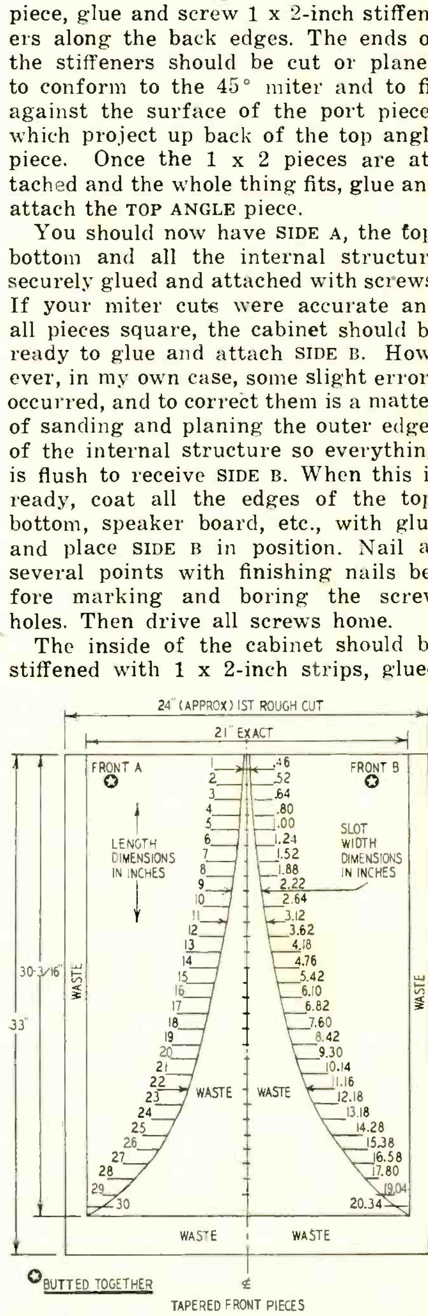


Fig. 4—Dimensions for laying out the curve of the tapered front pieces.

and screwed in the position shown in Fig. 3.

The *back* should be temporarily fitted, marked for screw holes, and the holes drilled and countersunk. Be sure to put screws, not only into the edge of the plywood sides, but also into the 1 x 2 stiffeners. This will give you a "staggered" effect on the back where the screws hold and will increase the rigidity.

Before marking and cutting the two front tapered pieces, measure carefully the *inside* width of the cabinet. It should be exactly 21 inches. If it isn't, don't worry. Whatever the measurement is, use this to lay out the two front pieces. Fig. 4 gives the dimensions for laying out the curve of the pieces. Use a carpenter's square for this as you'll need the tenths scale. When you have the curve drawn—the two pieces will have been butted together—turn them so that the front of each piece is facing out (back to back) and nail together for sawing. This way, one cut will make both pieces exactly the same. I recommend having the curve cut on a bandsaw.

The inside of the front chamber and the *inside faces* of the tapered pieces are given six coats of shellac.

The pads I used are made of 1-inch thick Fiberglas cut to fit in the spaces shown in Fig. 3. I glued them in with linoleum cement and put two layers to make a 2-inch thick pad.

Materials for Karlson enclosure

1—sheet, 4 x 8 feet, 3/4-inch plywood; 1—piece, 21 x 9 3/4 inches, 3/4-inch plywood; 1—12-foot length of 1 x 2-inch white pine; 1—quart can cold-mix resin glue (Weldwood); 1—pint white shellac; 1—lot of sandpaper; 1—1/2 pound 8-penny finishing nails; 6—dozen No. 8 1 1/2-inch flat-head wood screws; 4—dozen No. 8 1 1/4-inch flat-head wood screws; 1—1/2 dozen No. 8 2-inch flat-head wood screws; 1—piece Fiberglas insulation for pads.

After the speaker is mounted, the back can be screwed on and the two front tapered pieces mounted. I did not glue the front tapers, but instead used 2-inch screws along the top and down the sides to hold them. They are rigid with this treatment and no vibration or rattle is heard.

You will now have a heavy, solid cabinet, one that shows traces of dirt, glue, nail heads, screw heads, etc. Not a pretty thing for the living room. I solved this by covering the front with a very porous grille cloth and mounting the cabinet flush in the wall (the rear projects into the attached garage). If you haven't a wall to tear into, I suggest covering the sides, top and back with veneer or, more cheaply, with some suitable cloth or upholstery material to conform to your wife's disposition.

About that: I have a friend who is blind and gifted, not with only acute hearing, but perfect pitch and the ability to "see" color when he hears music. His opinion after a session with the Karlson I constructed (using the Western Electric 728-B speaker) was that he had never heard such absolute fundamental bass response and such "ringing" highs. I agree. END

Variable-Height Fidelity

By VLADIMIR PENN

BY now, the world of music lovers, technicians and their long-suffering friends is well aware of high fidelity.[1] But, to paraphrase the ancient query, exactly how far up is high? To study the problem in a precise and scientific manner, it becomes necessary to establish a system of measurement. It is proposed in this paper to use an arbitrary unit of fidelity which shall be called the *fid*. However, as this unit is too large to be handled in practical calculations, a subdivision called the *decifid*[2] shall be used.

Many articles on how to choose the components of a so-called high-fidelity system are available in the literature.[3] These components can be bought separately and installed in the music lover's home.[4] The problem generally resolves itself into two parts: first, a limit as to the cost of the system must be decided upon. Second, the choice of the components must be made within the limits of this price.[5] Even if the solution to the second part of this problem is left in the capable hands of a helpful salesman,[6] the decision concerning the first part is left in the hands—or at least in the pocketbook—of the eager purchaser.

So far, it has not been established just exactly what the height of the high-fidelity system is to be.[7] For this reason,[8] it is proposed to set up the aforementioned system of fidelity measurement and further to correlate a system's fidelity with its cost.

To facilitate the thinking,[9] we shall consider four broad ranges of fidelity called: "low fidelity," "medium fidelity," "high fidelity" and "very high fidelity indeed."[10] At this point, the quotation marks can be dropped from the discussion since the terms have been defined.[11] This system of fidelity ranges should be of great value to the apparently confused manufacturers of table-model radios and radio-phonographs who advertise high-fidelity equipment.[12]

It becomes necessary at this point to set up a scale for our proposed decifid meter. This presents a bit of a problem, engineering-wise, since it has not yet been shown that decifids bear any simple relation to measurable units such as volts, amperes, etc., but we can try. If we select a panel of judges composed of music lovers, technicians and laymen[13] in equal numbers and let them vote a mark from 0 to 100 for the fidelity of a system, the average would then be the official fidelity of the system. The broad fidelity ranges mentioned above could be assigned numerical values—low fidelity might correspond to a rating of 0 to 25, medium fidelity to a rating of 25 to 50 and so on.

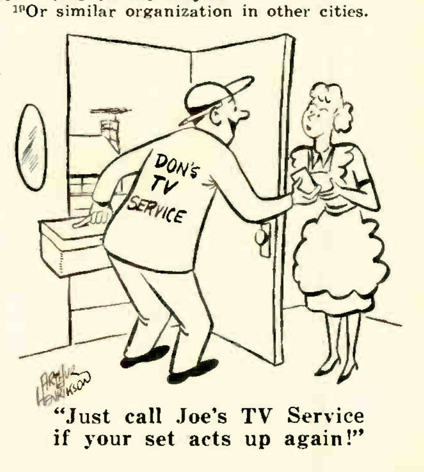
This method could be used until sufficient research and development[14] has led to a transistorized device to replace all the aforementioned good people.

Having now developed a method of accurately determining the fidelity of a sound system, it remains to make an analysis of the variation of fidelity vs. cost. The simplest[15] way to do this would be to buy every piece of sound-reproduction equipment, measure its fidelity in decifids and plot this value against cost. This process could be repeated every year to account for the new products offered for sale. The project could then be directly affiliated with the government, perhaps under a new secretariat called the Office of the Secretary of Fidelity or perhaps the Fidelity Commission.[16]

At this point, when a system can be rated as to its exact fidelity, the prospective buyer of a "fidelity system"[17] should have no trouble in reaching a decision. As an intelligent consumer, he can ascertain the fidelity of the system, consider which brand has the most appealing advertisements, take into consideration the amount of chromium plating on the device, ask his friends' advice and make a choice.[18]

If, however, the primary concern is listening to music, a season ticket to the Boston Symphony[19] is highly recommended. END

[1]The term is interchangeable with hi fi.
[2]This subdivision is equal to 1/10 fid.
[3]The best way to avoid giving references.
[4]Generally over his wife's dead body, unless the works are encased in a cabinet.
[5]In theory only. In practice, the original cost limit has been altered, generally in the up or more expensive direction.
[6]Refer to footnote 5.
[7]Some high-fidelity systems have higher fidelity than others.
[8]See footnote 7.
[9]If this phrase insults your intelligence, disregard it!
[10]Respectively abbreviated: "lo fi", "med fi", "hi fi" and "v.h.f.i."
[11]Not really, but maybe nobody will notice.
[12]Meaning lo fi or possibly med fi.
[13]Laymen being defined as all members of the people class not included in the first two classes.
[14]Preferably government-sponsored.
[15]Although the most expensive.
[16]Not to be confused with the Loyalty Program.
[17]The new generic term for: "Sound Reproduction System", which can be preceded by the proper modifier such as: low, medium, etc.
[18]Better consult the wife, too; she may have a few words on the subject.
[19]Or similar organization in other cities.

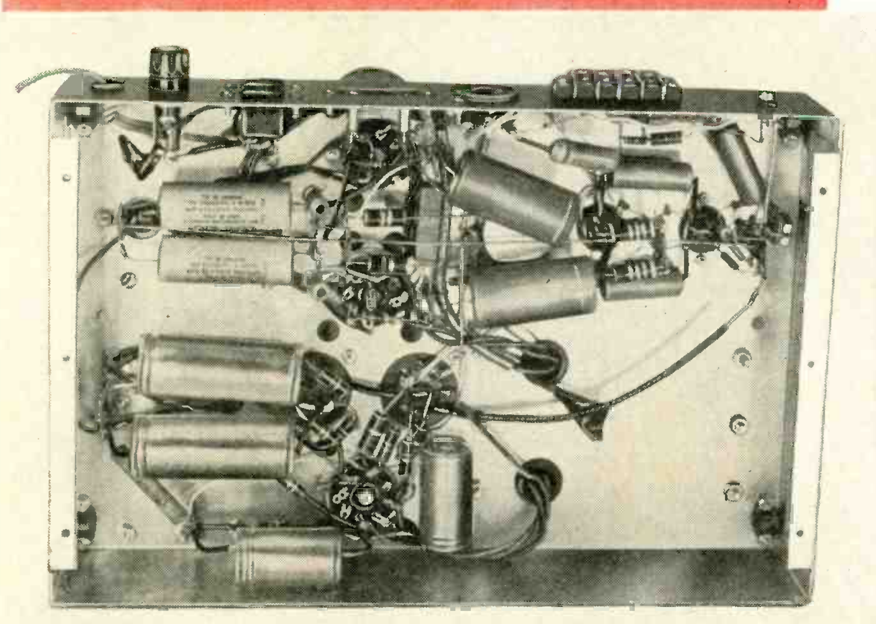


"Just call Joe's TV Service if your set acts up again!"

ACQUIRING A HI-FI AMPLIFIER

By ERIC LESLIE

Solving the problem of the man who needs the basic component of an audio system



Chassis wiring is uncluttered.

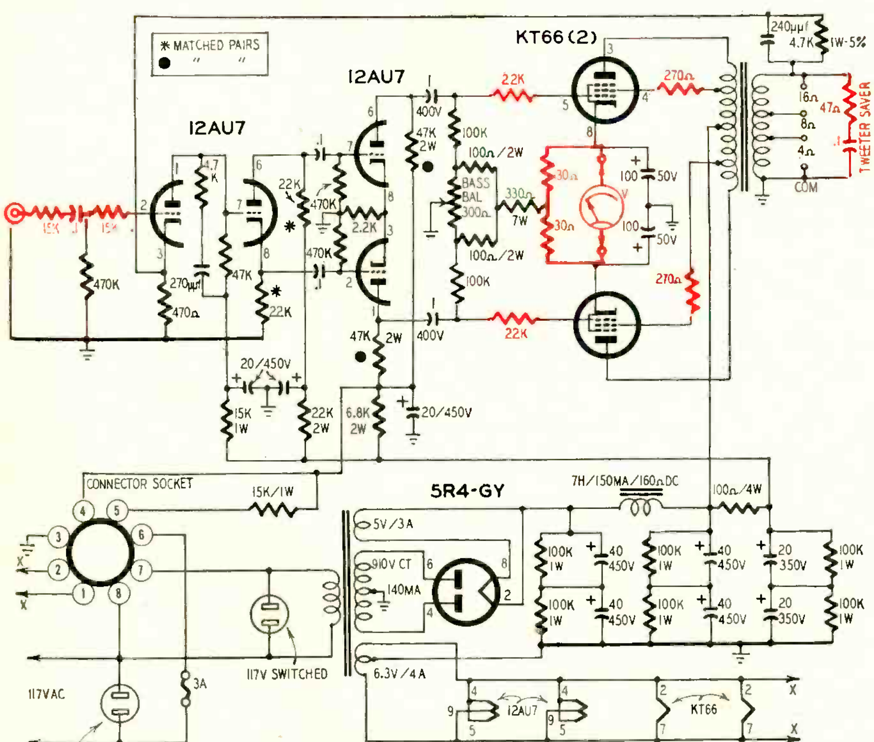


Fig. 1—Schematic of the Heathkit amplifier. Interesting features are in red.

TO buy or to build—that is the question more than one high-fidelity enthusiast is now asking himself. In the past it was considered almost necessary to build one's own audio equipment if one were to have the latest and best circuitry. It has also been considered possible to build a better piece of equipment than could be bought for the same money.

Today the best of audio results can be obtained from amplifiers on the market—some of them at very decent prices. On the other hand, it is possible to approximate the results of the best ready-made equipment with complete kits which are often obtainable for about the same price the parts would cost. The main problem becomes one of time against money. Is it cheaper for a given individual to build his own equipment or to buy it? And just how much time does it take to build?

I needed a new amplifier and decided to find out some of the angles. I was using an excellent job—said to have been built by Collins for his personal use before he started making high-fidelity equipment commercially. With Western Electric 310's in the output, it had "triode quality." But the main amplifier, preamplifier and equalization circuits were all combined in the same unit. And more often than occasionally I wanted to test a single component or part of a system, a job that called for a perfectly linear main amplifier.

The very completeness of the pre-Collins was against it. With its built-in high and low boosts, its voltage and power amplifier (plus the power supply) all in one unit, it was difficult to pin down any particular effect or even to tell if it came from within or without the amplifier proper. What was needed was an amplifier which could be depended on to be absolutely flat, would be used with separate preamplification and equalization and would deliver as much power as might be needed with negligible distortion.

Since you can't figure out the differences between building and buying an amplifier by purchasing one, it was decided to construct one. Parts for an oversize power supply were obtained from various surplus houses, and magazines, friends and the inner mind consulted as to the design of the new amplifier. Should it have a Williamson or Hafler-Keroes type front end? Or is there anything wrong with straight resistance–capacitance coupling? What inversion system? Output tubes? Ultra-linear? Feedback system?

The ultimate amplifier?

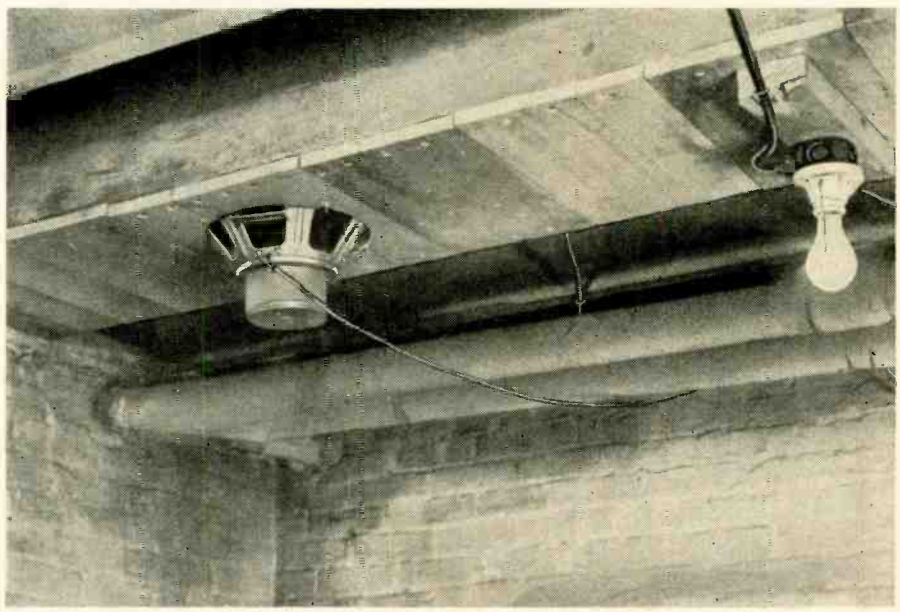
Midway in these deliberations came the 1955 IRE convention and a little work, the *Heathkit Reference Booklet.* It described the latest Heathkit amplifier, the W-5M, just being put on the market. The amplifier was on exhibition at the Heath booth and—according to its designer, who was in attendance —was the ultimate; not only the most, but the nearest (to exact reproduction of the signal). The graphs in the booklet indicated that at 1 watt it was flat from roughly 10 cycles to 100 kc and only slightly less than that at 10 watts output (its rated power output is 25 watts).

Distortion figures were not so clear, because expressed in several charts, but harmonic distortion appeared to be practically imperceptible within the range of hearing at powers lower than about 15 watts, and IM distortion below the "extremely high-fidelity" level at the same power.

This seemed to be the "main amplifier" for which I was looking, especially since a preamplifier adapted to working with it was also available. The main amplifier alone, or amplifier and preamplifier together, would be useful standards of comparison for other equipment. The parts I had obtained for my ideal amplifier were carefully placed in the junkbox and the main amplifier and preamp were ordered. Both kits were obtained (with a slight delivery delay since the W-5M was just reaching the market) and wiring the main amplifier commenced.

A carefully kept log indicated that it took me almost exactly 18 hours to wire the amplifier. The wiring was done in short spurts—in no less than 12 sittings—so the time was probably considerably longer than if I had been able to get in two or three 4-hour sessions. The time also included short breaks for such things as answering the phone or doorbell.

Amplifier without its cover. Output transformer is at left—power at rear right.



The Flewelling air coupler from below. From above it looks like a hot-air register.

Intriguing features

When I put my first Heathkit (a v.t.v.m.) together, I reasoned that an old radioman would be further ahead following the schematic rather than the childish step-by-step instructions. I learned my lesson then, and this time followed the instructions literally, without looking at the schematic, so I didn't know what role many of the components played till I checked the hookup. After the wiring was finished one of the results was that the amplifier (unlike the voltmeter) worked immediately it was plugged in. Another was that a number of things that had been accepted without question at the first prepurchasing glance at the schematic now looked puzzling and intriguing.

For one thing, the input looked unique, with a network whose purpose was not readily apparent. Note the two 15,000-ohm resistors (Fig. 1). The output tubes had rather high-value parasitic suppressor resistors on both screen and grid. The "tweeter-saver," though it obviously put a load across the output at high frequencies, still was not too clear. Why isn't it equally necessary to put a load across the output at low frequencies? The little 240-$\mu\mu$f capacitor across the feedback resistor was also a little puzzling.

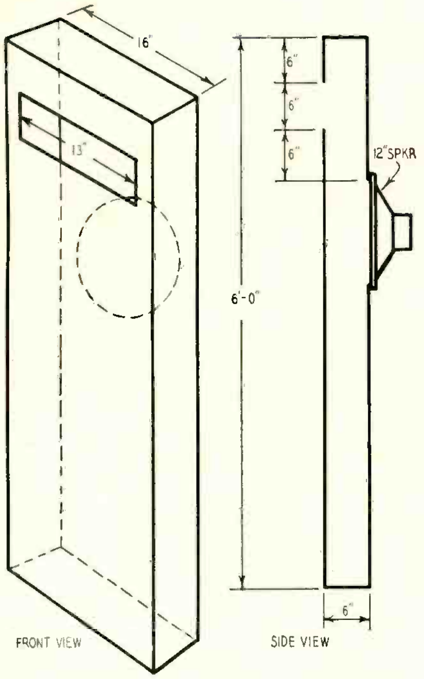


Fig. 2—The air coupler. Dimensions are Flewelling's; my own variation measured 14 x 9½ inches x 7 feet.

Obviously it is intended to feed back more energy at high frequencies than at low, but 240 $\mu\mu$f seems small even in the high end of the audio spectrum. A letter to Heath brought back some answers:

The tweeter-saver—that 47-ohm resistor in series with an 0.1-μf capacitor across the 16-ohm output secondary—imposes a load at high frequencies precisely because that's where it's needed. Most crossover networks or speakers have an impedance characteristic that rises with frequency. In some cases the impedance can become so high—usually at frequencies *above* the audio range—that the amplifier sees no load and "takes off." The tweeter-saver is a very high impedance in the audio range—the 0.1-μf capacitor has a reactance of 1,600 ohms at 1,000 cycles—but at 40,000 cycles its reactance is about the same as that of the resistor, and at the high frequencies where phase relations make the feedback positive the resistor is practically the whole load. Thus oscillation is prevented.

The rather complex input network was developed, I was told, so that the amplifier would not be affected by the source impedance of the unit feeding into it. Two 15,000-ohm resistors are used: one as an impedance raising device, the other as a damping resistor to suppress parasitic oscillation. The total result is that the amplifier looks into a high input impedance at all times, which eliminates feedback instability dangers.

The suppressor values used were recommended by the manufacturer and were chosen about midway of the range specified for the KT's. Explanation of the little capacitor across the feedback resistor was equally simple—it adds extra high-frequency stability and damps out ringing on high-frequency pulse signals.

Another point the boys at Heathkit were so proud of that they mentioned it in their reply (though I had not asked) is the "bass balance" (BASS BAL) circuit. Many amplifiers provide means for balancing the output tubes, as unbalance is highly productive of distortion, especially on the lower frequencies. In the W-5M a meter is connected across the hot ends of two 30-ohm resistors branched from the common cathode resistor. If both tubes draw the same current, a voltmeter connected between the two points shows no reading. The beauty of this circuit is that the meter need not be accurate—all it has to do is register a null. If the tubes are not balanced, the current they draw is adjusted by varying their grid bias with a 300-ohm potentiometer in the common grid-cathode circuit (see Fig. 1). They also pointed out that a lot of inductance and capacitance is used in the power supply to reduce low-frequency intermodulation effects. The filter is truly phenomenal—if the amplifier is turned off with the turntable still running, it plays for a full half-minute on the electricity stored in the filter capacitors before dropping below audibility.

The rest of the system

Once wired and checked, the W-5M was inserted—without benefit of preamp—between available equipment and the speaker system. Fortunately the TV set's output—taken off before the volume control—and that of the little G-E type phone preamplifier were about right. We couldn't turn volume up or down, but in the main the level was well within tolerable limits. Quality had a slight edge on the supposedly superlative pre-Collins, even without any frequency compensation controls. Construction on the preamplifier was hurried—it's nice to be able to adjust the volume and the bass.

The speaker system consists of a 12-inch Jensen, installed in a Flewelling air coupler built under the floor, and a tweeter made from a small cone speaker from a piece of surplus equipment—probably sonar. The Flewelling coupler is a simple way of getting a good enclosure cheaply—if you can cut a hole in the floor and install a hot-air register. Details are shown in Fig. 2. The crossover network was also constructed with the aid of surplus—some small iron-core coils with an inductance of about 1.75 mh each and a number of a.c. electrolytic capacitors in the order of 40 μf each. Purists may frown on iron-cored coils and electrolytics in crossover networks, but results are good. Perhaps the two neutralize each other's bad effects! The circuit—Fig. 3—follows Crowhurst's article on crossover networks in the July, 1952, issue.

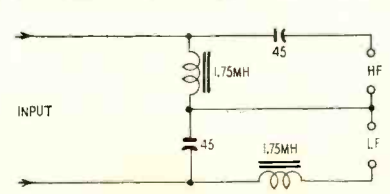


Fig. 3—Output crossover network.

We'd like to see them . . .

After buying, building or using any piece of equipment, there's always something we'd "like to see them do." In this case, the most important thing would be to print a warning in large letters, telling the assembler to look on both sides of his wiring charts. I found the instructions to check out every part against the bill of materials, but had finished checking out and had started wiring before I found that one of the sheets had pictorials which would have helped me identify unfamiliar parts.

A little more explanation on the vertical dimension would also have helped. Should I mount capacitors close over wires "dressed close to chassis" or space them clear? I spaced 'em.

The builder cannot issue instructions to himself but, if I'd had that chance, I'd have told myself to read clear through to the end of each separate instruction before starting to follow it. It's embarrassing to put a wire where it's supposed to go and cut it off, only to find that the last sentence of the instruction tells you to carry it over to another point. Another self-instruction would have been to classify all resistors and capacitors while checking them. Heathkit's suggestion to use the corrugated cardboard edge of one of the cartons to hold resistors is an excellent one. I did that later, when wiring the preamp, keeping the resistors more or less in an ascending order of value, and wrote the values on the cardboard.

Another thing I would tell myself is not to try immediately to improve on the instructions. I decided that the a.c. leads to the connector into which the preamp plug was inserted could well be heavier. So I put in some really good stiff wire—and broke a prong in the connector. A small accident in these days of standardization—a prong from an octal socket was an exact replacement—but it taught me a lesson again.

Only one question is now open—is it better to build or to buy audio equipment? To a person who gets a great deal of joy out of pure construction, there is only one answer. The pleasure of building, the pride of workmanship and the satisfaction of having a well-turned-out job are worth as much as possession of the equipment. But to the man who wants music and whose time is worth money—or who may have things to do with his leisure that he would like much better than handling a soldering iron—it might well be better to purchase one of the many excellent amplifiers now on the market. For the person with a low income and plenty of spare time the answer is easy: building offers him the opportunity of owning equipment he could otherwise never afford. END

ADDING FEEDBACK TO AN OLD AMPLIFIER

Improving frequency response, damping factor and reducing distortion in older audio equipment

By NORMAN H. CROWHURST

NO doubt a modern feedback amplifier provides much better quality than the older non-feedback types. A great many old units are still giving good service and their owners frequently ask how feedback could be added to improve their performance and bring them nearer the standards of a modern feedback amplifier.

George Fletcher Cooper, in one of his articles on feedback, referred to the "cookbook" approach to amplifier design and suggested that some adopt the attitude of adding a little feedback for good measure. It certainly does seem that many still have rather a vague idea as to just what feedback will do when it is added to an amplifier. The main things we shall be looking for are:

1. reduction in distortion
2. improvement of the damping factor
3. improvement of the frequency response.

To achieve any or all of these objectives, care is required. Just slapping a feedback resistor from the output back to the input is unlikely to achieve any of these objectives, for reasons which we will see.

The first thing to remember about putting on feedback is that it will reduce the gain of the amplifier. And if an amplifier had only enough, or just a little to spare, previously, then more gain must be provided to make up for the amount to be sacrificed in feedback. This most probably will involve adding an extra stage because amplifiers are generally designed for maximum gain.

Adding an extra stage at the front end should not be too difficult. The filament supply will probably stand an extra tube heater, and the B plus supply will almost certainly provide sufficient extra current for a front-end stage which will only take a milliampere or so. Of course we need to find a place to put the extra stage—knock a hole in the chassis, mount the tube socket and wire it in. This is a mechanical problem and should not be too difficult.

The next thing is to figure out how we are going to make use of the extra stage to get the full advantage of the extra gain it provides in applying feedback.

Often we are so impressed with the idea that getting some feedback is going to reduce distortion, that we overlook the possibility of its actually *in-*

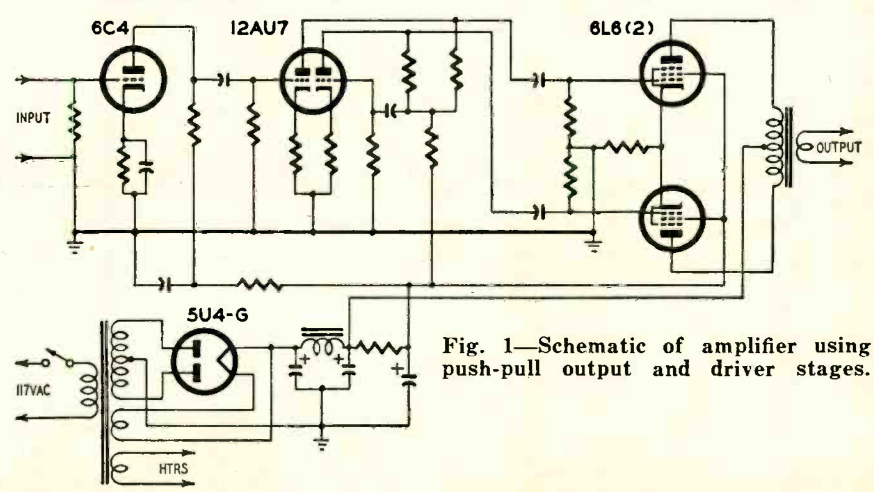


Fig. 1—Schematic of amplifier using push-pull output and driver stages.

creasing distortion. Fig. 1 illustrates this. It represents a typical amplifier using a push-pull output and drive stage. Feedback will be taken from the plates of the output stage back to the cathodes of the drive stage and then some more feedback from the output transformer secondary back to the cathode of the input stage, as shown in Fig. 2.

This is a conventional method of cleaning up a well known kind of amplifier. The point to watch for is this: we clean up the output stage by using feedback, but in doing so we need to push the stage feeding the driver stage to a higher level to obtain the full output. Supposing the amount of feedback from the output plate to drive-stage cathode is 12 db. This means that the stage before the driver has to provide four times more swing at the grid of the drive tubes than it did before. In this case the drive stage is itself a phase inverter of the double-triode type and it should not introduce too much distortion, especially since it is included in the output feedback loop. But the previous stage may not be capable, as it stands, of providing four times the swing it did before. It may run into very serious distortion before full output is reached—so serious in fact that no amount of feedback will be capable of cleaning it up.

So in adding feedback—especially a short-loop arrangement—we must see that every stage is capable of handling the new signal level that the feedback will involve. The best way to do this is to work back from the output, with the aid of tube data, and see just what swing is required and then check whether the preceding stage is capable of delivering that swing at each point through the amplifier.

Sometimes it may be possible to alter the circuit to improve the handling capacity of a stage. If a stage has been designed to give maximum gain, it will probably use a low value of cathode bias resistor so as to operate on the maximum slope of the tube. The handling power can be increased by raising the value of bias resistor. Increasing the plate coupling resistor may possibly yield larger swing.

Sometimes of course the swing required is more than the tube will give at all, using the particular plate voltage it happens to be getting. In such a case it may be possible to use a higher B plus voltage, for example, by going up to the value used for the output stage, together with a higher value of coupling resistor which will give a greater maximum handling power for the tube.

Feedback loops

The next question is how to distribute the feedback. We can use a long loop, a short loop or a combination of both. We have already shown a reason for limiting the amount of short-loop feedback: the fact that it may involve the use of higher signal level than the stages are able to handle. But how much long-loop feedback can we use, and how should we determine the proper amount of each?

Besides seeing that all the stages operate at about their best signal level —that is, high enough to keep background noise low and not too high so as to introduce distortion—there is the question of stability of the overall arrangement. This is not a question only of making sure that the amplifier is stable while you are making tests on it with a resistance dummy load across the output, but also of making sure that the amplifier is stable under practical working conditions.

Some of the early feedback amplifiers were rather dubious from this point of view. For example, the one-time popular Williamson circuit which concentrates on using a large amount of feedback on a long loop is conditionally stable, depending upon the load used. It may be stable with one loudspeaker and unstable with another. And the feedback resistor needs adjusting to get best results for every individual condition.

This kind of amplifier is often critical of the kind of input circuit connected to it. For example, it may be very stable when operating from a radio input but give harsh reproduction when operated from phonograph input, or maybe vice versa, because the source impedance connected to the input of the amplifier is affecting its frequency response if not actually its stability.

This property of feedback amplifiers was pointed out in my article, "Why Feed Back So Far?" (September, 1953). So how are we going to arrive at the feedback arrangement that will give us the best overall result?

To get a picture of what we want to do, the best way to view the problem is to consider that we need the short-loop feedback to reduce the source impedance of the output stage to a value where the long-loop feedback will be reasonably independent of the output loading. Use of a low source impedance will mean the output voltage is not very dependent upon the load impedance connected and, hence, if the long-loop feedback is stable under one condition, changing the load condition is not likely to vary stability or response appreciably. So we want to use enough short-loop feedback to bring the output stage source impedance down to something at least as low as a triode output stage will give—that is, an effective damping factor of from 3 to 5. Short-loop feedback goes over only two stages and, for this reason, cannot become unstable by itself.

Then the long-loop feedback can be used to push the damping factor on out to 10, 20 or 30, as desired, without so much fear of introducing instability. To see how the short-loop feedback by itself is doing in this regard, use an audio oscillator and an output meter. Check the amplifier's frequency response, feeding into the nominal value of resistance load. Particularly watch what happens at the ends of the response. Down at the 20-cycle end, for instance, it is preferable that the amplifier should be rolling off slightly rather than showing a boost. At the high end—20,000 cycles—it should also be doing the same. If a rise shows up at one or both ends, with only short-loop feedback applied, it is a waste of time to try and apply the overall feedback. You are bound to run into instability troubles before you have added very much. The best thing to do is to see how the short-loop feedback can be modified so as to get a better condition before applying long-loop feedback.

This test checks the stability and frequency characteristic of the short-loop feedback. We also want to make sure, at the same time, that it has sufficiently reduced the output source impedance. This can be done by disconnecting the output load and seeing how much the output voltage rises. If E_L is the voltage with the output load connected and E_o the voltage with the output disconnected, the damping factor is E_L divided by $E_o - E_L$. In other words, to represent a damping factor of not less than 3, the rise in voltage when the load is disconnected should not be greater than one-third of the voltage with the load connected.

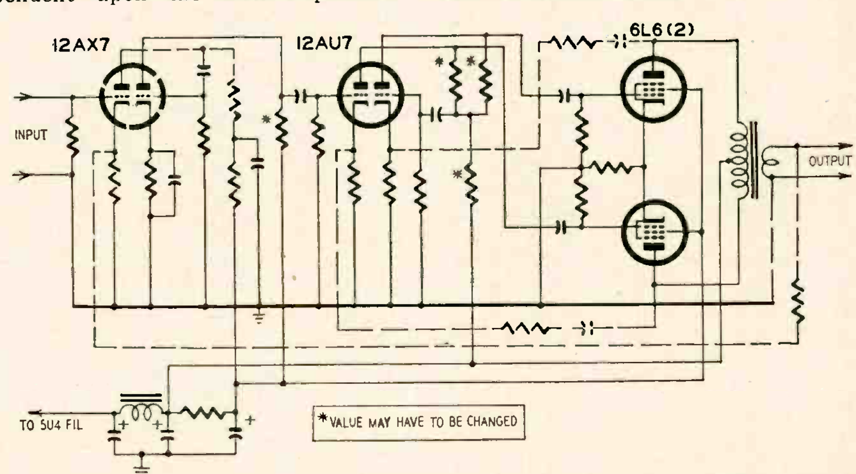


Fig. 2—The dashed lines show additions to Fig 1 circuit when adding feedback.

If either the frequency run test or the load test does not give satisfactory results at this stage, we need to work more on the short-loop feedback before thinking about applying long-loop feedback.

The damping factor can be pushed up by increasing the amount of feedback. If some stage will not handle the increased level which this involves, it will be necessary to redesign that stage to improve its handling capacity, as mentioned earlier. If level handling is not the limitation, but frequency response and stability are, then circuit coupling constants need attention.

If there is a rise in response at the low end, coupling capacitors may be reduced in value until the circuit begins to show a slight rolloff at the low end instead of a rise. If the rise occurs at the high end, the natural stray capacitance of the amplifier should be augmented by some artificial capacitance such as connecting a capacitor across the primary of the output transformer.

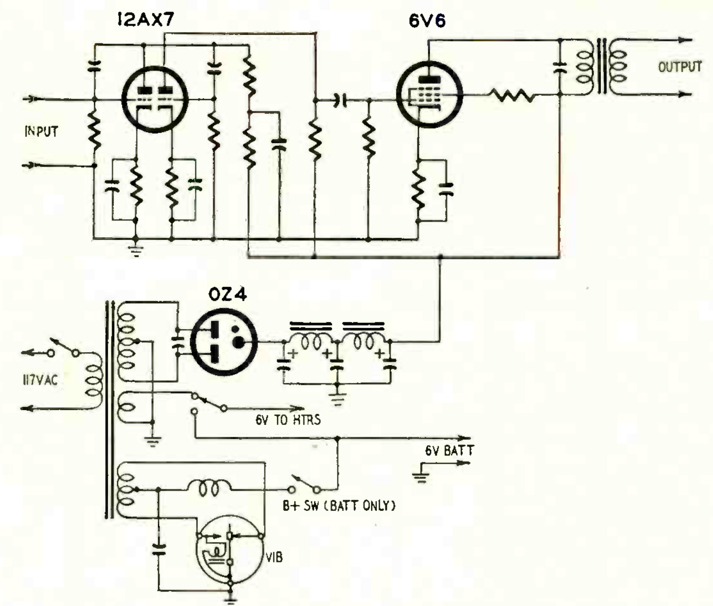


Fig. 3—Amplifier suitable for feedback design—operates on a.c. and battery.

Long-loop feedback

Having under control the short-loop feedback, it is then a relatively simple matter to apply a little more feedback by means of a longer loop to raise the damping factor a little more and improve the frequency response still further.

This method of approach will also take care of the question of achieving a minimum value of distortion. In an amplifier without feedback the stage that will show most distortion is either the drive or output. So a short-loop feedback over these two stages should effectively minimize the distortion they produce. However, having reduced the distortion in these stages to a low level, it is probable that the residual distortion may now be controlled by one of the earlier stages in the amplifier. This is where the long loop or overall feedback can help by providing even further reduction in distortion.

If you have a distortion meter handy it can be used to check just how much reduction in distortion is achieved at each point. Then you will know whether the balance of feedback you have chosen is the best choice for this purpose also.

Besides the practical method just outlined of determining how near the amplifier is to its peaking or its instability condition, it is possible to see just where you are going by doing some simple calculations following the general method outlined by George Fletcher Cooper in his series of articles on feedback design (October, 1950–November, 1951). The important criterion in this is the time constant of the various coupling circuits.

The total series resistance, in conjunction with the coupling capacitor, gives the low-frequency time constant of the coupling circuit. This means that if you take the parallel combination of the plate resistance and the plate coupling resistance, in series with the grid resistance, and multiply this value by the coupling capacitor in farads, you get the time constant of the coupling circuit in seconds. For example, suppose a tube has a plate resistance of 7,700 ohms, a plate coupling resistance of 47,000 ohms, and the following grid uses a resistor of 220,000 ohms. The parallel combination of 7,700 and 47,000 gives 6,600 which, in series with 220,000, adds up to 226,600 ohms. For all practical purposes this is the same as 220,000 ohms. If the coupling capacitor is 0.1 μf, the time constant works out to be .022 second, or 22 msec.

If you feed back from plate to cathode, a coupling capacitor will be necessary to block the B plus voltage from the output plate. The total resistance to ground from the output plate in combination with the blocking capacitor used will give the second time constant.

If it is necessary to improve the stability at the low end, steps must be taken to move the time constants of these two circuits farther apart. Most probably the best way is to reduce the time constant of the plate–grid coupling circuit (less than 0.1 in the example quoted).

At the high end, working out time constants is a little bit of guess work because the exact value of stray capacitances is not usually easy to arrive at. So the simplest method, if there is high-frequency peaking, is to add some additional capacitance, such as across the output transformer primary, as suggested.

Connecting feedback loops

Now we come to another often asked question concerning the advantages of connecting the feedback, whether short or long loop, from the primary or secondary of the output transformer. There seems to be a prevalent opinion that connecting the feedback to the secondary of the output transformer will help eliminate any distortion introduced by the transformer. This obviously arises from a misunderstanding of how transformers introduce distortion.

The only way in which transformers can introduce distortion is through the nonlinearity of their magnetizing current. This nonlinear current flows only in the primary, so feedback from the primary is just as capable of compensating for this distortion as feedback from the secondary. Feedback from primary or secondary of a transformer makes little difference to the distortion, but it can make a considerable difference to the stability of the arrangement due to the fact that the leakage inductance and winding capacitances of the transformer contribute considerably to the frequency response.

If you connect to the primary of the transformer, the modifying effect of the leakage inductance occurs outside of the feedback loop. This is unlikely to have appreciable effect in normal audio circuits for the simple reason that the voice coil inductance of the average loudspeaker is considerably larger than the leakage inductance of an output transformer. As the two are virtually in series, the voice coil inductance will swamp any effect due to the leakage inductance of the transformer.

However, connecting the feedback to the secondary winding of the transformer includes the leakage inductance in the feedback loop, introducing another possible phase shift and making it more difficult to achieve overall stability.

As we are thinking at the moment of applying a large amount of short-loop feedback with a smaller amount of long-loop feedback, it is usually feasible to apply the short-loop feedback from the plate and the long-loop feedback from the transformer secondary. Using this method it may be possible to compensate in some measure for the

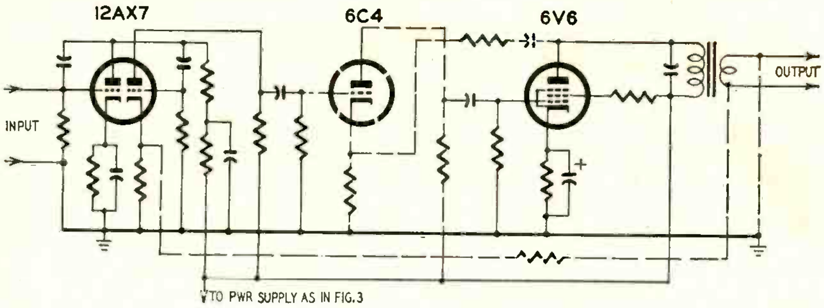


Fig. 4—Dashed lines show two-loop feedback design for Fig. 3 amplifier.

frequency response of the transformer. But do not bank too much on this possibility, because, if the transformer has poor frequency response, adding feedback over the transformer is likely to make the frequency response worse.

This is why transformers for use in feedback amplifiers have been designed to a much higher quality standard than output transformers formerly were. As your old amplifier output transformer was not designed with feedback in mind, it is possible you may run into difficulty here and so you should consider the possibility that you may not be able to use any feedback from the transformer secondary. In this case it may be well to content yourself with only short-loop feedback.

Before concluding this article let's take another example. Suppose we have the circuit of Fig. 3, an amplifier for use either with a regular 117-volt a.c. supply or a 6-volt battery. Here, an extra stage capable of handling a reasonably high level seems to be advisable. A 6C4 should be inserted between the 12AX7 and the 6V6, as shown in Fig. 4. Short-loop feedback can then be applied from the plate of the 6V6 to the cathode of the 6C4 and long-loop feedback from the output transformer secondary to the cathode of half of the 12AX7.

As the first stage is designed to operate at very low level, and hence is not likely to introduce much distortion, the feedback should be taken to the second cathode of the 12AX7 rather than to the first. This will usually permit a larger amount of feedback without instability.

Modern feedback amplifiers

Before leaving this subject a few comments on the trend of modern feedback amplifier design might be helpful in showing what to expect. This may save trading in your old amplifier unnecessarily and enable you to achieve results almost as good by the method just outlined. For the past many months—if not years—the trend in feedback amplifiers has been to push the response way out at both ends, down to a few cycles and up somewhere around a megacycle, even though the amplifier was required only for audio. Also phenomenal amounts of feedback have been applied, some advertising a total feedback of 80 or more db.

Such amplifiers may be wonderful for laboratory purposes because they are extraordinarily flat, working into a resistance load, and have a very low distortion so that extreme fidelity in the laboratory sense is achieved. But this does not always agree with extreme fidelity as listened to over a practical system feeding the amplifier into a loudspeaker. Many have noticed that amplifiers of this type seem to have a higher background noise than ones using less feedback; there seems to be what has been described as grittiness.

Experiments have shown that a cleaner-sounding amplifier is obtained by rolling the response off gradually at the two ends of the audible spectrum, say 20 and 20,000 cycles. This results in a lower apparent noise level because the feedback doesn't retain the amplification of the system way out beyond the range and hence does not continue amplifying spurious components which we can never hear directly but which may interfere through some intermodulation effect around the loop.

Also the very high figures of feedback do not necessarily have as much improvement in quality as may be expected. For example, modern circuit and tube design can produce an amplifier which will give a distortion figure as low as 2% without any feedback. Applying a total of 80 db of feedback to an amplifier which has this initial amount should knock the distortion figure down to .0002%. In practice it is found that the distortion has not been reduced by this much and the reason is that, when such extremely small figures are striven for, the order of distortion multiplies, introducing components of distortion not present in the original amplifier.

To give a simple example of this suppose that our original arrangement produces a distortion of 2% second harmonic and we apply feedback to the extent of 40 db. This will knock the second harmonic from 2% down to .02%. However, in doing this, since the input is now 99% feedback signal from the output, there is practically 2% of second harmonic present in the input which was not there before. And this 2% second harmonic will also generate second harmonic of itself on its way through the amplifier, to the extent of 2% of 2%. So there will be .04% fourth harmonic in the output—that is, assuming that there was no fourth harmonic in the original setup. Thus, in using 40-db feedback, we have reduced second harmonic distortion from 2% to .02% but raised a previously nonexistent fourth harmonic to .04%.

This is the kind of thinking that is going into modern feedback design and will undoubtedly result in an increase in the number of amplifiers designed with a rolloff at the end of the audio spectrum instead of miles beyond; and amplifiers with only enough feedback to achieve optimum performance on audio signals.

And the writer believes that a good many of the better class older pre-feedback amplifiers can, by judicious application of feedback as suggested in this article, achieve results as good from a listening point of view as many of the modern feedback amplifiers. END

Suggested by Bob Loynd, Waltham, Mass.

"He finally found the cold tube, it was in that black cage."

FOR GOLDEN EARS ONLY

The Ampex 620 amplifier—speaker; Gray viscous-damped tone arm; new records review

By MONITOR

SIX months ago, asked when it would be possible to buy a genuine high-fidelity system no bigger than a good sized table-model radio (say 1.5 cubic feet and 25 pounds), I would have replied categorically, "Never." Today, I think it safe to predict that it won't be more than a year and possibly only 6 months. The system won't bring the big bass drums into the room in all their awesomeness (but neither do most of the big hi-fi systems) and it might elicit some slightly carping criticism from the most exquisite Golden Ears. But most people, including many of today's high-fidelity cranks, will be justifiably happy with it.

What principally changed my mind was the Ampex 620 amplifier–speaker system which is exactly 1.3 cubic feet in outside volume, weighs 26 pounds, yet meets the specifications and standards for genuine high fidelity in every respect except possibly one: The distortion across a resistive load is 4.4% at 10 watts (Fig. 1). Though this is as good as or better than most 6V6 amplifiers. It is higher than today's standards call for, particularly limiting because both ends are severely boosted and audible distortion is therefore increased. (Where IM with a resistive load is only 0.4% at 1 watt, it rises to just about 1% when measured across the voice coil.) Otherwise the 620 takes very little backtalk from much bigger and heavier jobs. What's more it sounds even better to the ear than the curves look to the eye.

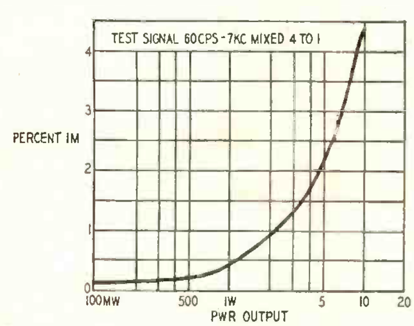


Fig. 1—The 620 IM distortion curve.

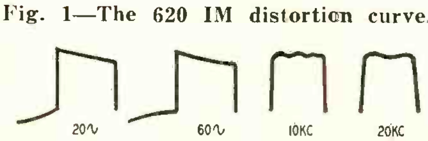


Fig. 2—Response with resistance load.

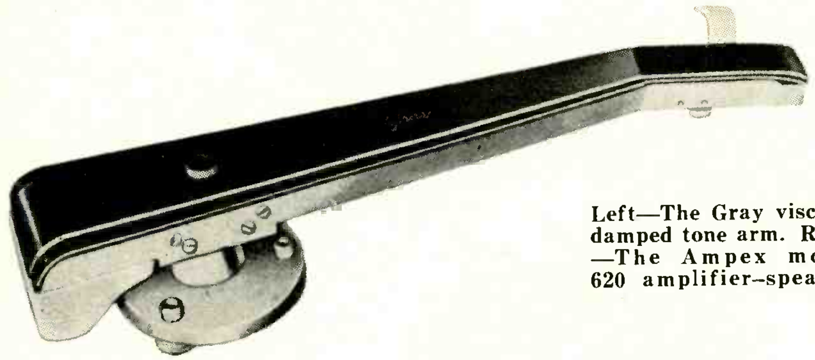
Ampex claims the response of each specific 620 is production-adjusted and tested to be *acoustically* flat from 65 to 10,000 cycles. I am glad to report that in an age of hyperbolous advertising claims, this one is not only conservative but, unless my ears are abnormal, understated. They hear it just about flat from 50 to at least 12,000 cycles. On the high end the response continues with less slope, if anything, than bigger systems to about 16,000 cycles to my own ears and to nearly 20,000 cycles to my daughter's younger and sharper ones. On the low end, the response doesn't seem more than 3 db down at 50 cycles. Below that point doubling sets in, but there is a trace of fundamental response to some point between 30 and 35 cycles. The doubling is not unpleasant and probably deliberately designed into the speaker-enclosure system—the speaker itself in free space is relatively free of doubling. Since the ear has the curious property of imagining it hears the fundamental when it hears only the second or third harmonic of it, the doubling has the effect of making the bass seem a good octave lower than it really is. This is an old trick; the thing which earns respect for Ampex engineers is that the doubling is so thoroughly confined to the final octave that the illusion is produced without any really significant effect on the definition above 50 cycles. In fact, the bass definition of the whole system is superior to that of most amplifier-speaker combinations regardless of size.

The transient response on both ends is also excellent. The only thing lost in Ampex reproduction is the awesome dullness of the very low bass. All the drums and even the organ come through with amazing cleanness and sharpness and a very commendable lack of hangover. Nothing of musical value is lost. Indeed, you almost have to hear it in A–B comparison with a system genuinely capable of reproducing fundamentals down to 25 cycles to be aware that the bottom octave is represented only by the proxy of its harmonics. I suppose one cannot help being somewhat overimpressed by hearing so much good clean sound coming from so small a package; but allowing for that I judge it to be an excellent amplifier. Although designed primarily as a playback system for the 640 tape recorder, it should have much greater usage wherever excellent quality in the smallest package is needed.

The design is notable from beginning to end. The amplifier design is based on the Mullard circuit, which achieves high gain, excellent self-balancing and only one internal time constant (wherefore the excellent low-frequency square waves as shown in Fig. 2). A low-noise pentode is used as a voltage amplifier (Fig. 3), direct-coupled to a long-tailed pair phase inverter—a neat trick in itself. The long-tailed pair is, most authorities agree, superior in every respect to the split-load inverter: it has more gain, better initial balance and is self-balancing because of the large common cathode resistance. The 6V6's are used as pentodes.

Though the constants for the feedback loop used with the internal speaker are not given, it is clear from the loss of gain that an extraordinarily high amount of feedback is applied at mid-frequencies. The amplifier is kept stable, however, because the feedback is tapered at both ends to control the overall response. The overall curve (Fig. 4) shows the response at the voice coil and indicates 12 db less feedback at 20 cycles and 20 db less at 20 kc than at 1,000 cycles. The boost at both ends is intended to make up for the deficiencies of the speaker enclosure, but it also has the incidental benefit of achieving a high degree of stability and of avoiding the transient instability of amplifiers with a lot of uncontrolled feedback at the extremes of the range.

The speaker, manufactured to Ampex specifications, has a husky pot, a heavy



Left—The Gray viscous-damped tone arm. Right—The Ampex model 620 amplifier–speaker.

die-cast frame, a 1.5- or 2-inch voice coil, a dome for high-frequency extension and a shallow straight-sided cone with treated edges. In many ways it looks like a smaller model of the excellent Western Electric 755. The resonant point in free space is about 80 cycles and this rises in the enclosure to around 120 cycles. The combination is then acoustically compensated by the filters in the feedback loop to provide boosts of 12 db at 20 and 20 db at 20,000 cycles. I rather doubt the speaker system itself needs all that treble boost and I suspect that a good part of it is built-in Fletcher-Munson compensation.

Another oddity is the use of a ring cushion of glass fiber between the edge of the cone and the speaker grille so that the suspension works into the resiliency of the cushion. Probably this equalizes, on the front of the cone, the heavy stiffness provided on the rear by the small volume of enclosed air. No doubt it provides heavy mechanical damping at low frequencies and, as in the RCA speakers, minimizes peaks and dips in the mid-range caused by reflection from the edge of the cone. The interior of the speaker enclosure is liberally coated with some sort of smelly, black mastic and half-filled with a pad of glass wool.

The 620 has a level or volume control and a simple tone control which changes the slope of the response curve to provide a good measure of equalization of tapes made on recorders which do not use Ampex–NARTB recording curves, and also a boost at one end or the other to suit the taste or playback conditions. Unfortunately, the input load is only 25,000 ohms and this makes it impossible to obtain good equalization or loud volume from hi-fi ceramic or crystal cartridges. If Ampex would redesign the input for a 500,000-ohm load, the Ronette cartridge would provide very fine record reproduction with enough volume for most living rooms and school rooms. The amplifier would then be ideal for use by music teachers and wherever a portable but very good high-fidelity system is needed.

There is a jack for an external speaker (for those few who really have better speaker systems) and an attached switch disables the speaker equalization to provide the response indicated by the curves and square waves. Square-wave response with the internal speaker is, of course, entirely different. It indicates the severe boost at both ends and a peak at around 50 kc. Nevertheless, despite the peak, the stability remains good, there is no sign of oscillation and very little hangover

Gray viscous-damped tone arm

The two problems in tone arm design are: avoiding resonance of the arm which would produce peaks in the response and high distortion; preventing

(*Continued on page* 79)

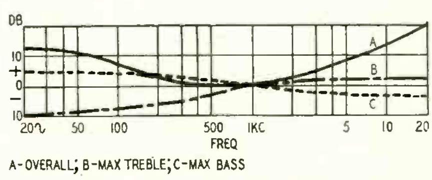


Fig. 4—Response of the 620 amplifier.

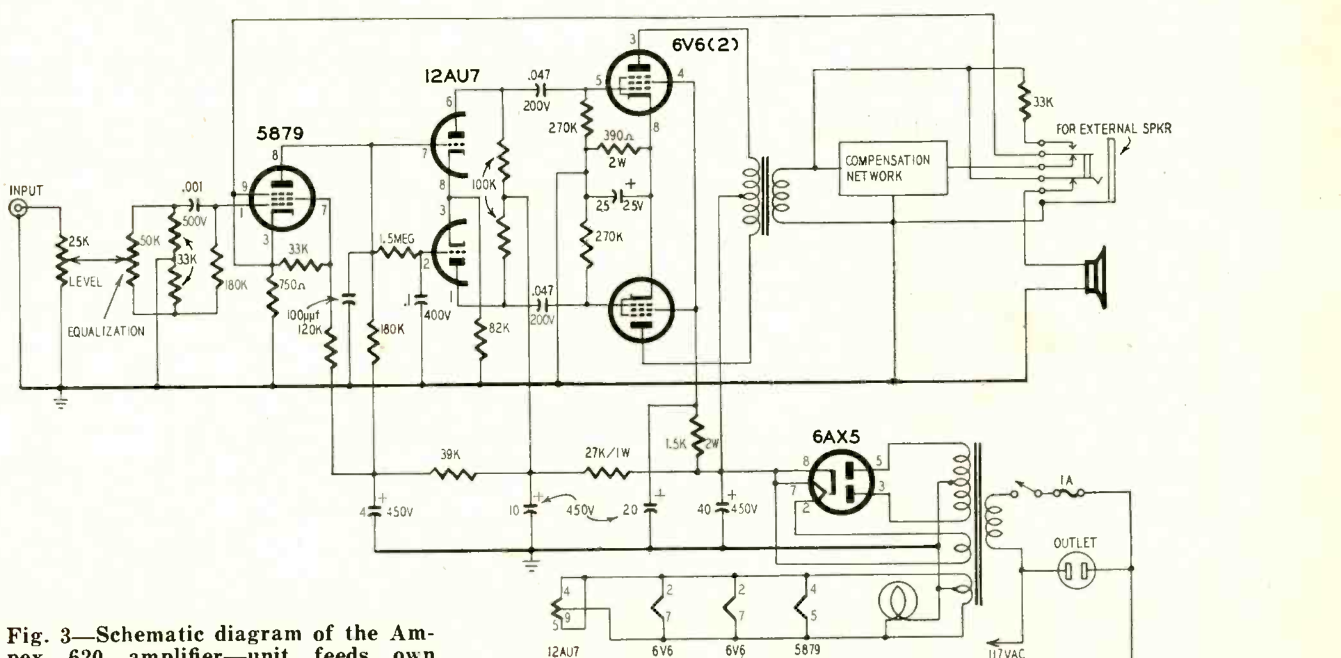
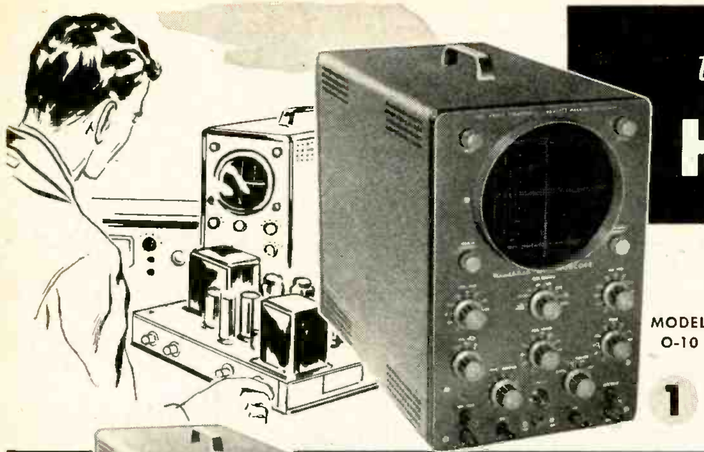


Fig. 3—Schematic diagram of the Ampex 620 amplifier—unit feeds own speaker.



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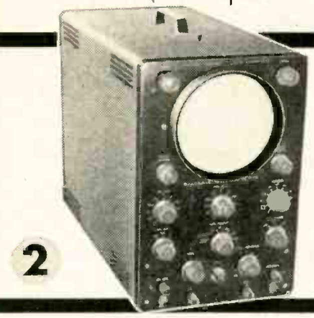

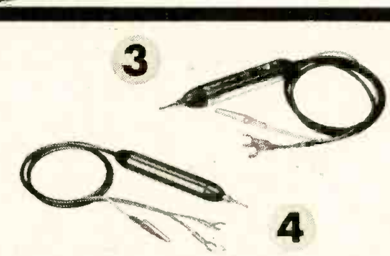

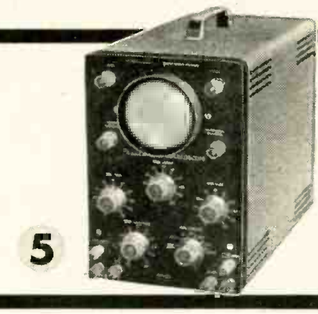

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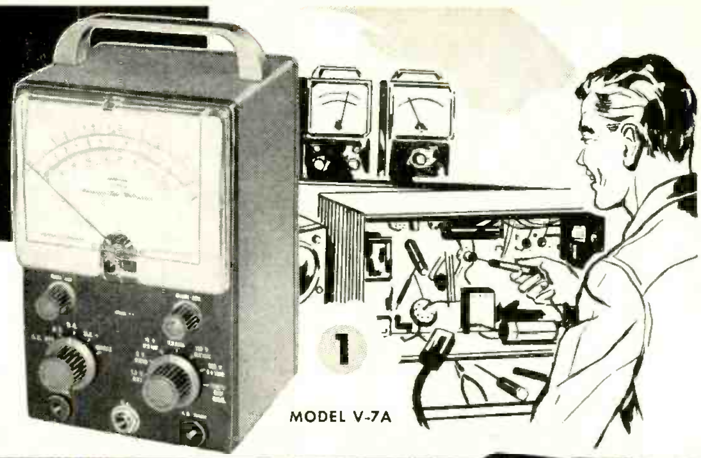

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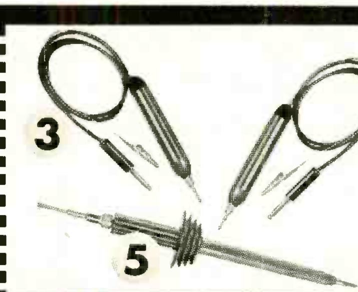

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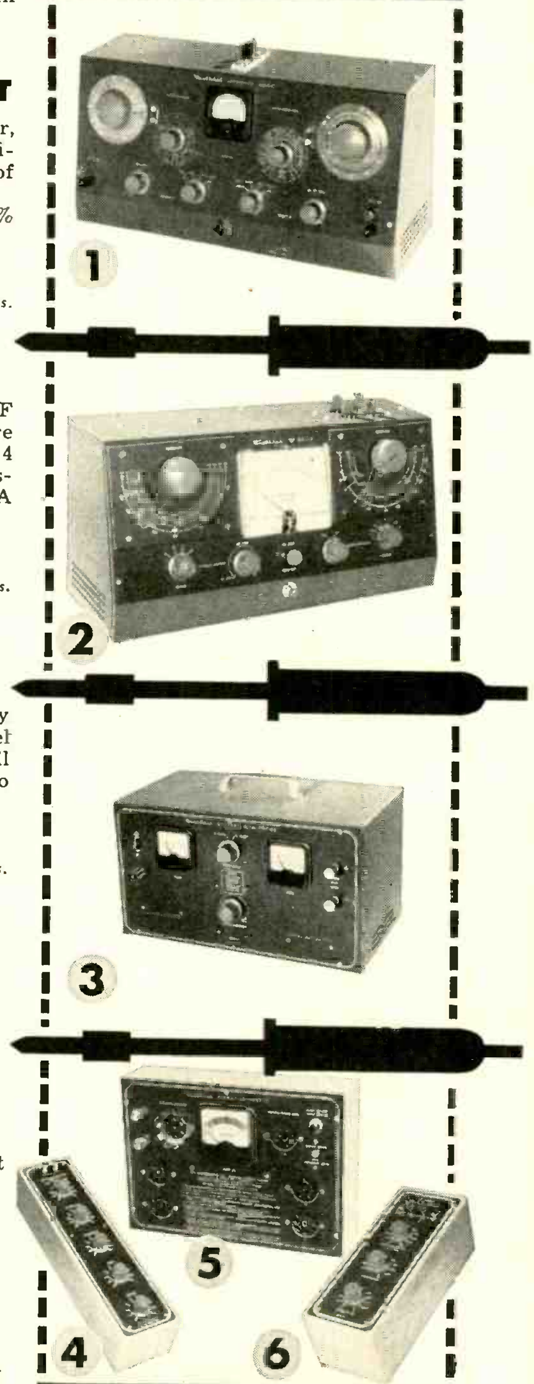
Heathkit SIGNAL GENERATOR KIT

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

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



1 *Heathkit* . . . IMPEDANCE BRIDGE KIT

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

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

MODEL IB-2 59^{50}
Shpg. Wt. 12 Lbs.

2 *Heathkit* "Q" METER KIT

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

MODEL QM-1 44^{50}
Shpg. Wt. 14 Lbs.

3 *Heathkit* 6–12 VOLT BATTERY ELIMINATOR KIT

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

MODEL BE-4 31^{50}
Shpg. Wt. 17 Lbs.

4 *Heathkit* DECADE RESISTANCE KIT

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

MODEL DR-1 19^{50}
Shpg. Wt. 4 Lbs.

5 *Heathkit* VIBRATOR TESTER KIT

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

MODEL VT-1 14^{50}
Shpg. Wt. 6 Lbs.

6 *Heathkit* DECADE CONDENSER KIT

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

MODEL DC-1 16^{50}
Shpg. Wt. 3 Lbs.

HEATH COMPANY
A SUBSIDIARY OF DAYSTROM INC.

BENTON HARBOR 20, MICHIGAN

Heathkit

TUBE CHECKER KIT

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

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

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

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

2 *Heathkit* PORTABLE TUBE CHECKER KIT

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

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

3 *Heathkit* TV PICTURE TUBE TEST ADAPTER

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

MODEL 355
$4.50
Shpg. Wt. 1 lb.

4 *Heathkit* . . . CONDENSER CHECKER KIT

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

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

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

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

5 *Heathkit* VISUAL-AURAL SIGNAL TRACER KIT

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

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

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

HEATH COMPANY
A SUBSIDIARY OF DAYSTROM INC.

BENTON HARBOR 20, MICHIGAN

MODEL HD-1

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

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

Heathkit HARMONIC DISTORTION METER KIT

1 *Heathkit* AUDIO ANALYZER KIT

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

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

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

2 *Heathkit* AUDIO GENERATOR KIT

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

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

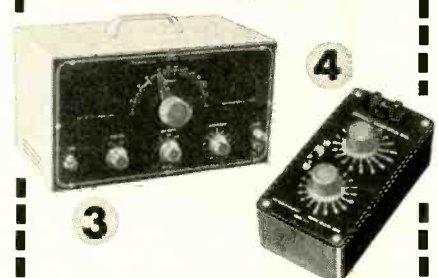
MODEL AG-9 **$34.50** Shpg. Wt. 8 Lbs.

3 *Heathkit* AUDIO OSCILLATOR KIT

(SINE WAVE — SQUARE WAVE)

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

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



4 *Heathkit* RESISTANCE SUBSTITUTION BOX KIT...

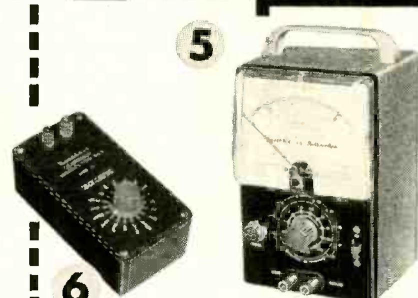
Provides switch selection of 36 RTMA 1 watt standard 1% resistors ranging from 15 ohms to 10 megohms. Numerous applications in radio and TV work, and essential in the developmental laboratory.

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

5 *Heathkit* AC VACUUM TUBE VOLTMETER KIT...

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

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



6 *Heathkit* CONDENSER SUBSTITUTION BOX KIT...

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

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

HEATH COMPANY

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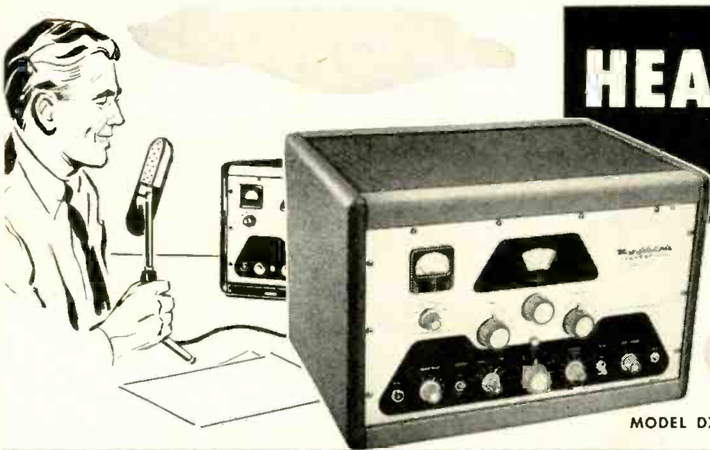
BENTON HARBOR 20, MICHIGAN

HEATHKIT HAM GEAR

for high quality at moderate cost



1

MODEL DX-100

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

2

3

4

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

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

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

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

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

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

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

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

❷ *Heathkit* VFO KIT

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

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

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

❸ *Heathkit* CW AMATEUR TRANSMITTER KIT

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

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

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

❹ *Heathkit* . . . ANTENNA COUPLER KIT

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

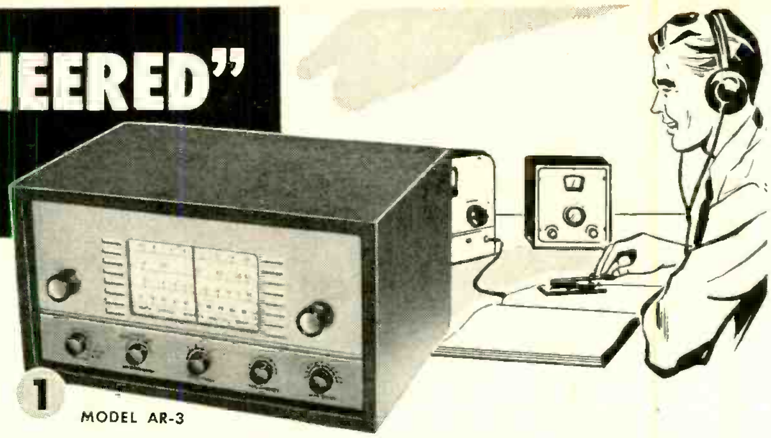
MODEL AC-1
$14.50
Shpg. Wt. 4 Lbs.

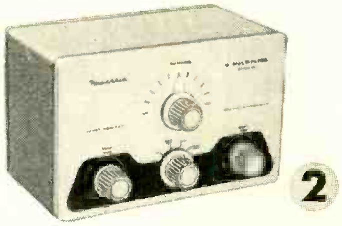
HEATH COMPANY *A Subsidiary of Daystrom, Inc.* **BENTON HARBOR 20, MICHIGAN**

"AMATEUR-ENGINEERED"

Equipment For The Ham

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





❶ *Heathkit* COMMUNICATIONS-TYPE ALL BAND **RECEIVER KIT**

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

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

CABINET: Fabric covered cabinet with aluminum panel as shown. Part No. 91-10, shipping weight 5 lbs. $4.50.

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

❷ *Heathkit* "Q" MULTIPLIER KIT

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

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

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

❸ *Heathkit* VARIABLE VOLTAGE REGULATED POWER SUPPY KIT

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

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

❹ *Heathkit* ANTENNA IMPEDANCE METER KIT

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

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

❺ *Heathkit* GRID DIP METER KIT

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

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

HEATH COMPANY *A Subsidiary of Daystrom, Inc.* **BENTON HARBOR 20, MICHIGAN**

Heathkits
PROVIDE THE "CONSTRUCTIVE" APPROACH TO
HIGH-FIDELITY

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

1

❶ *Heathkit* ADVANCED-DESIGN HIGH FIDELITY AMPLIFIER KIT

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

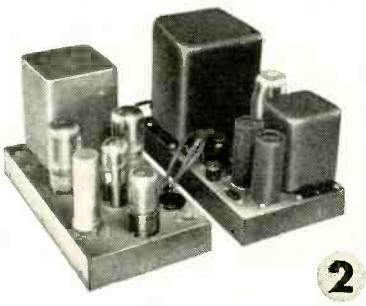
Features a new-design Peerless output transformer, and KT66 output tubes handle power peaks up to 42 watts. The unique "tweeter-saver" suppresses high frequency oscillation. A new type balancing circuit results in closer "dynamic" balance between output tubes. Features improved phase shift characteristics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

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

KIT COMBINATIONS:

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

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



2

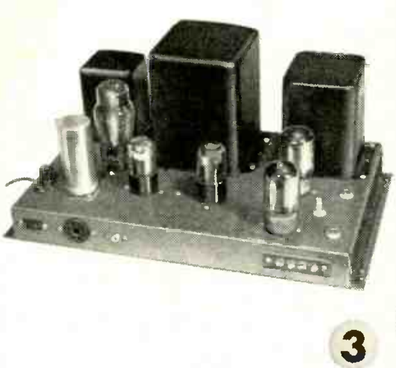
❷ *Heathkit* DUAL-CHASSIS WILLIAMSON TYPE HIGH FIDELITY AMPLIFIER KIT

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

KIT COMBINATIONS:

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

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



3

❸ *Heathkit* SINGLE-CHASSIS WILLIAMSON TYPE HIGH FIDELITY AMPLIFIER KIT

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

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

KIT COMBINATIONS:

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

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

HEATH COMPANY
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BENTON HARBOR 20, MICHIGAN

enjoy...

THE VERY BEST IN AUDIO WITH "BUILD-IT-YOURSELF" HEATHKITS

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

❶ *Heathkit* HIGH FIDELITY PREAMPLIFIER KIT

1

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

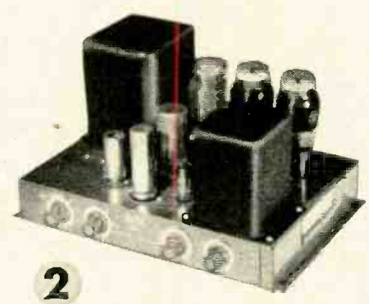
Features five separate switch-selected input channels (2 low level and 3 high level), each with its own input control. Full record equalization with four-position turnover control and four-position rolloff control.

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

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

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

❷ *Heathkit* 20-WATT HIGH FIDELITY AMPLIFIER KIT



2

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

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

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

❸ *Heathkit* 7-WATT AMPLIFIER KIT

3

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

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

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

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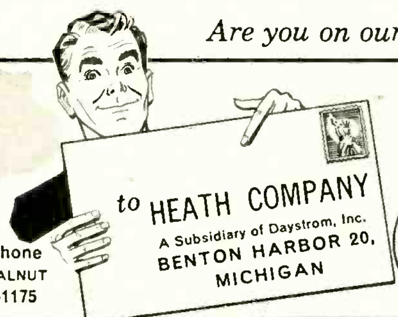

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the mass of the arm from affecting the compliance of the needle. Since modern hi-fi systems in many cases respond over a range of 10 to 100,000 cycles and since practically any material suitable for an arm of any size or form imaginable is capable of resonating somewhere in this range, the problem of resonance is a serious one and has stimulated many solutions.

The most novel solution is offered by the Gray viscous-damped arm which minimizes resonance effects by damping the arm with a film or pool of viscous fluid. The arm proper is supported by a single needlepoint pivot in the center of a ball and socket which are normally separated by a few thousandths of an inch. The needlepoint suspension insures virtually zero mechanical friction. The gap between the socket and ball is then filled with a special silicone fluid about the consistency of Vaseline, carefully chosen for its viscous properties. This layer of fluid serves as a sort of shock absorber to absorb and dissipate any vibrations transmitted by the arm. Varying the separation between the ball and socket, by a knurled adjusting screw, controls the thickness of the layer of fluid and thereby the amount of damping the film supplies. The farther apart the two surfaces, the less the damping; the closer together, the greater the damping.

I don't have any special facilities for measuring arm resonance but it usually shows up on the low-frequency sweeps of the Cook series 10 record, the five tracking bands of the Dubbings 100 or the low-frequency band of the Cook White Noise record. The natural resonance of the Gray arm is specified to be 18 cycles, but apparently it is all but completely damped out because I could find no noticeable trace of it.

But what happens to the compliance of the needle and the pickup? The viscous-damped arm appears to have an extremely high amount of friction when compared with arms using only low-friction bearings. In fact, the superficial friction of the Gray arm is so great that it takes several seconds for the arm to fall 1 inch. One would think that this would offer so much drag to the needle that compliance would be seriously affected. It is—for sudden or violent shocks or movements. But when a record revolves, the lateral movement of the arm is very slow and minute. The viscous fluid easily "falls into the groove" of this movement and offers no resistance to it. On the other hand, the vibrations produced by the modulations in the record groove are too rapid to overcome the friction; therefore, the needle and the needle only is affected by them.

This is the special virtue of the viscous damping—that its compliance is excellent at the slow rate needed to move the arm in the grooves, but poor for rapid fluctuations and shock. So it holds the needle firmly in position to be set in motion by the modulations of the groove, without, as it were, stealing any of the vibrations from the needle as a friction-free arm would do, especially at low frequencies. In this way the arm achieves excellent damping without affecting the compliance of the pickup.

Aside from the minimization of resonance, the unconventional stiffness of the Gray arm has several very practical advantages of great value. For one thing, it is almost impossible to ruin a needle or record or cartridge by accidentally dropping the arm. For another, it is equally difficult for the arm to jump, skip or skate, making it almost immune to shock or vibration from speakers at low frequencies.

The first quality makes the arm especially useful when diamond needles are used in systems operated part of the time by children or unskilled operators. The second makes it equally useful where turntable and speakers have to be mounted in the same cabinet. There is a possible hazard. When a badly warped record is encountered, if the damping is high, it is possible that the stylus could either leave the groove at the high end of its travel, being suspended in air for an appreciable period before coming down, or it could even dig into the record and plow the groove.

However, on present-day equipment such distorted records are virtually unplayable anyhow because the warp produces high-amplitude thumps. Moreover, modern microgroove records seldom acquire so violent a warp. If it is desired to play such a warped record, it is possible to reduce the damping by turning the adjustment screw up. This will remove the friction and the arm will operate as a conventional undamped arm.

The Gray arm is very convenient to mount and to use. There are knurled nuts on the base, above the table, which can be adjusted to change the height above the table as well as to produce exact leveling and cartridge alignment with the record surface. Cartridges are mounted in quick-change slides. Weight or pressure is determined by weights on the slide, so that cartridges can be changed and the pressure maintained at optimum for each cartridge without the need for further adjustment. The arm comes with a wide assortment of slides and weights, sufficient to take care of just about every cartridge in use today. One precaution is likely to be overlooked by those who don't read the instructions carefully: the damping fluid insulates the arm from the base. The arm has three wire leads; one of these is to ground the arm—if it is not grounded, hum pickup will be marked.

New records review

Note: Records below are 12-inch LP and play back with RIAA curve unless otherwise indicated.

STRAUSS (Johann, Jr., and Josef)
Vienna Bonbons
Anton Paulik and Vienna State Opera Orchestra Vanguard VRS-459

Another in the really wonderful series of Vanguard's Strauss recordings. *Egyptian March* (band 1, side 1) is an unsurpassed showoff and demonstration record. If you have one of those $500 speaker systems that goes down at least to 30 cycles, the drum on this will split your shirt with puffed pride and even perhaps convince the missus that the speaker system was worth going without a new mink coat. It may not be true next month but, as of now, this is the lowest, dullest and biggest drum on records. There is also a beautifully sharp snare drum and plenty of all kinds of clean high-highs. The other Strauss waltzes, gallops and polkas will also please one and all both musically and from the standpoint of gorgeous sound.

COPLAND: *El Salon Mexico*
Appalachian Spring
Franz Litschauer and Vienna State Opera Orchestra
Vanguard VRS-439 (NAB curve)

Back in the old shellac days I considered the RCA Victor recording of *El Salon Mexico* the best single test material, and ever since LP's I've been waiting for a microgroove version profiting from modern techniques. This is it. The recording may be used to test the quality of almost any system but it is especially useful for testing for low distortion and cleanness. Copland wrote this in his best cliff-hanging style—teetering on the verge of violent dissonance but never quite going over. The horns especially are chorded exquisitely close to outright anarchy. But if the playback system is virtually undistorted and flat, the result is merely amusing and interesting—never painful or unpleasant. The definition should permit the distinction of the horns in the choirs and the clever polyphony. The bass is nicely dull and free of boom, the drum is prodigious, there are excellent percussive transients and plenty of high-highs. Despite the dissonances there should be nothing harsh or unpleasant about this. If there is, it's 100 to 1 your system is distorting badly somewhere.

Appalachian Spring is a happy coupling from all points of view. A sustained note in the opening is excellent for testing wow—very delicately "dissonant" choirs of strings, winds and brass should always sound clean and pleasant. In addition, there are some sharp transients in section four, plenty of high-high shimmer and again a fine bass. Once you've become acquainted with the sound of this music on a top-notch system, you can test any equipment for just about anything. The music is possibly the easiest of all "modern" music to take. There is a touch of distortion on a couple of peaks; otherwise, it is beautifully clean.

RESPIGHI: *The Birds*
Ancient Airs and Dances
Franz Litschauer and Vienna State Opera Orchestra
Vanguard VRS-533 (LP curve)

The Birds is another old favorite of mine both for the music and for testing and this is a grand recording of it. Of all recent composers Respighi was probably the most fascinated by *sound* as such. It seems to me that melody to him was always a mere vehicle on which to parade a variety of astonishing sound effects. Here he gives some very impressionistic but nevertheless highly faithful imitations of various birds. The melodies are from scores by ancient composers; the orchestration is pure Respighi. Especially notable in the *Dove* is the extremely high bird-talk by a solo fiddle—it must be about as high as a fiddle can go. *Ancient Airs and Dances* is extremely pleasant music. In the *Bells of Paris* the double basses imitate the beat notes of multiple church bells. This needs a response to 40 cycles or lower but is most impressive when you've got it. There is some recorder noise under the music. If you listen just before and just after the music starts, you will hear it—if your own system is free of noise.

ROSSINI: *Seven Great Overtures*
Mario Russo and Vienna State Opera Orchestra Vanguard VRS-456

Tancredi, Siege of Corinth, Turk in Italy, Italian in Algiers, Semiramide, Cinderella, Journey to Rheims cover Rossini's strange composing career thoroughly and this is unquestionably the most spectacular version of these works. There is a little of everything here

AUDIO—HIGH FIDELITY

from that wonderful big drum, excellent string bass to an occasional touch of brassy highs. Above all this is at least as good as any record I know of for testing power output capacity. There are some very terrific but clean peaks (especially on the *Siege of Corinth*). If you set gain controls to give an output about 25 db below maximum on average material, the peaks will just about break into the maximum power output level and you can see what happens.

PROKOFIEFF: *Peter and the Wolf*
BRITTEN: *Young People's Guide to the Orchestra*
Hans Swarowski and Pro Musica Symphony of Vienna — Vox PL-9280

Here is one of the most sensible and happy couplings on records. The two works are outstanding examples of their type. *Peter and the Wolf* is now an old favorite with everyone from 6 to 90. The Britten piece is more recent but coming up fast. Each introduces the listener to the orchestra in a different way. Thus the instruments play solo on the Prokofieff side but in choirs on the Britten side; the Peter is closely miked, the other more remotely. The tonal color of the instruments (presumably they are identical) is very different. This is fine stuff for testing "naturalness" and instructive and enjoyable as music. Again there is a little recorder noise under the music which provides a good test for signal-to-noise ratio. I have only one objection: the voice dubbed in New York, apparently, is out of scale. If you play the record loud enough to hear the music plainly, the voice is like the wrath of God.

PROKOFIEFF: *Chou* (complete)
Lieutenant Kije Suite
Jascha Horenstein and Paris Philharmonia Orchestra — Vox PL-9180

Chou is rather esoteric music which will appeal most to fanciers of Prokofieff, like myself. Lieutenant Kije, however, is very easy to take and one of the best examples of Prokofieff's ironic humor. The sound is brilliant. The solo instruments have great presence and a beautiful tone. The bass outdoes Vox' previous best. They have also, it seems, abandoned the LP treble equalization so that with RIAA equalization the highs are no longer shrill. Those who enjoy the double bass may like to have this because *Lieutenant Kije* there are several examples of melody lead by the double basses.

LISZT: *Les Preludes*
BRAHMS: *Academic Festival Overture*
SIBELIUS: *Finlandia*
WAGNER: *Siegfried Idyll*
Heinrich Hollresiser and Bamberg Symphony — Vox PL-9350

Excellent versions of these old symphonic war horses. A full round sound; clean nice bass, sharp strings, samples of triangles, etc., well defined and with good overall presence. Just a touch of distortion in *Finlandia*.

BIZET: *Roma* (Ballet version)
CHABRIER: *Bourrée Fantastique* (Ballet version)
Leon Barzin and New York City Ballet Orchestra — Vox PL-9320

Another of the new series of Vox records made in the U. S. and very good indeed, with a very live, resonant and opulent sound. The music is pleasant, stressing strings on the Chabrier side and brass on the Bizet.

***Brute Force Steel Bands* — Cook 1042**

In the West Indies since the end of the war an amazing music has grown rapidly around instruments fabricated entirely from oil drums, wonderfully tuned chromatically and made in consorts from counter-bass up and simulating the sound of such normal instruments as plucked double basses, xylophone, celeste, etc. To these consorts of drums are added typical Caribbean rattlers, a few voices, the pervasive chirping of a cricket and in one spot the sound of the surf on the beach. You will enjoy this thoroughly and on the best systems the bass will be astonishing. END

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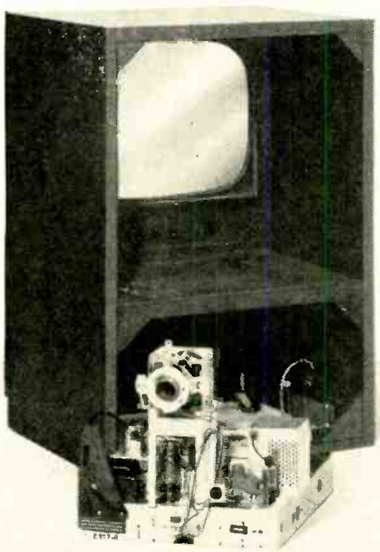

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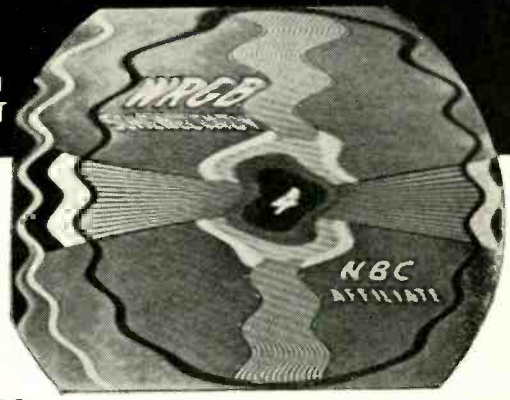

Fig. 1—Cogwheel or piecrust pattern.

By CYRUS GLICKSTEIN

MOST troubles originating in horizontal a.f.c. circuits cause poor horizontal synchronization. This includes horizontal instability (horizontal bend, pulling or picture twist; touchy horizontal hold; tearing; horizontal jitter; intermittent loss of horizontal sync); hunting (Fig. 1); complete loss of horizontal sync; out-of-phase picture (Fig. 2); phasing ghost (Fig. 3). Occurring less often, due to horizontal a.f.c. circuit troubles, are horizontal foldover and, in some types of a.f.c. systems, a blank screen.

Methods for localizing horizontal circuit troubles were discussed in detail in a previous article ("Tracking Down Horizontal Instability," August and September, 1954), and it is assumed the source of trouble has been localized to the a.f.c. circuit.

The purpose of that circuit is to stabilize the horizontal sweep frequency by comparing the incoming horizontal sync pulses with the internally generated horizontal sweep frequency in the receiver. If the frequencies are different, a d.c. correction voltage (either positive or negative) is developed. This voltage is applied to the grid of the horizontal oscillator (or to a reactance tube in the Synchrolock system) to return it to the correct frequency.

The four most popular a.f.c. systems in use are:

1. *Phase detector* (Fig. 4). In this system, a square wave is taken from the horizontal output circuit and integrated (fed through R5–C5 with the output taken across the capacitor). The resultant sawtooth wave is applied to one plate and one cathode of a dual diode (pins 5 and 7 of a 6AL5). Positive horizontal sync pulses are applied to the other diode plate (pin 2) and negative horizontal sync pulses to the other cathode (pin 1) of the 6AL5. When the sync pulses and sawtooth are the same frequency and in phase, no a.f.c. output voltage is developed. When the horizontal sawtooth is at a different frequency or out of phase compared to the sync pulses, one or the other of the diodes conducts. Either a positive or a negative d.c. voltage is then developed at the grid of the horizontal oscillator. This brings the oscillator back to the correct frequency or phase.

2. *Synchroguide (pulse width)* (Fig. 5). This system consists of a horizontal control tube which varies the bias at the grid of the horizontal oscillator, varying its frequency accordingly.

A signal consisting of a horizontal sync pulse and a horizontal sawtooth wave from the horizontal oscillator is applied to the grid of the control stage. The horizontal sync pulse riding on the top portion of the composite waveform is large enough to bring the control tube out of cutoff. When this tube conducts, a positive d.c. voltage is developed at the cathode and the junction of R2–R3. This bucks the negative voltage across R4, part of the grid return of the horizontal oscillator tube. The frequency and phase relationship between the horizontal sync pulse and the horizontal sweep waveform determines the width of the most positive part of the composite waveform. The pulse width, in turn, determines how long the control tube conducts, and therefore how much positive voltage is developed at the cathode and applied to the grid return of the oscillator to cancel out part of the negative voltage at this grid.

A change in the positive voltage at the control tube cathode means a change in the amount of negative voltage at the horizontal oscillator grid, thereby changing the horizontal frequency.

3. *Synchrolock* (Fig 6). The oldest of the a.f.c. systems is still used in 630 type receivers, among others. One input, a sine wave at the horizontal sweep frequency, is generated in the horizontal oscillator and applied to the sync discriminator through the sync discriminator transformer. This is compared with a second input, the incoming horizontal sync pulses from the sync amplifier. If the sine-wave voltage changes frequency or goes out of phase with the horizontal sync pulses, a d.c. correction voltage is generated and applied to the grid of the horizontal oscillator control (reactance) tube. This d.c. voltage varies the reactance of the tube, which is in parallel with the horizontal oscillator tank circuit, and corrects the oscillator frequency. The sine wave at the grid of the horizontal oscillator is squared off at the plate and differentiated by C4 and R3. The resulting pulses trigger the discharge stage (sawtooth generator) at the correct horizontal frequency.

4. *Triode phase detector* (Fig. 7). The general operation of this circuit is similar to the phase detector of Fig. 4. A triode is used instead of a dual diode. The negative horizontal sync pulse input is applied to the cathode of the phase detector. The horizontal sweep waveform is applied to the plate. When the frequency is too low, the sawtooth voltage at the plate is negative when the sync pulse is applied to the cathode. The grid draws current, producing a negative voltage at the phase detector grid. The grid and cathode act very much as a diode rectifier circuit. The pulsating negative voltage is filtered by the R-C circuit connected to the phase detector grid and the resulting negative d.c. voltage is applied to the oscillator grid, increasing the frequency to the original value.

When the frequency is too high, the plate of the phase detector is positive and more cathode current flows. The higher cathode voltage makes the grid more positive since R1 connects grid to cathode. The filtered positive d.c. voltage is applied to the horizontal multivibrator grid, making the frequency decrease to the correct value.

Horizontal instability

This is one of the most usual symptoms resulting from a horizontal a.f.c. circuit defect. The most common cause in all systems is a defective a.f.c. tube (this includes the reactance tube in the Synchrolock system). Another common cause is misalignment of the horizontal sweep circuit resulting from aging of tubes or other circuit components. If tube changes do not cure the condition, realign the horizontal sweep circuit according to manufacturer's specifications. If realignment is not effective, then test for a defective component.

Horizontal bend can be caused by an unbalance of horizontal sync pulses to the phase detector tube (pins 1 and 2, Fig. 4). To check for unbalance note the peak-to-peak amplitude of incoming

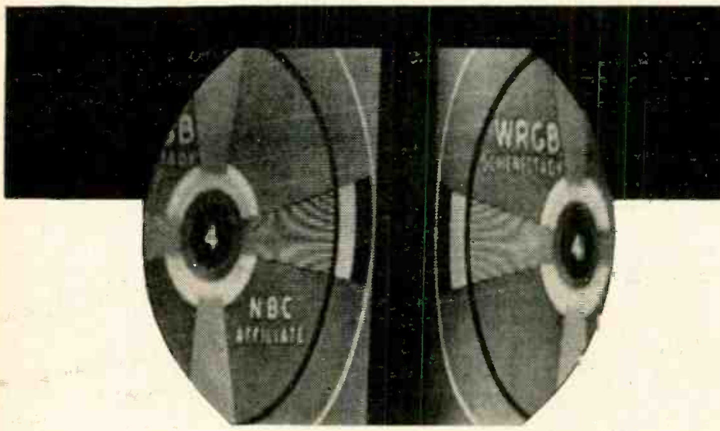

Fig. 2—This picture is out of phase.

Photos courtesy G-E Techni-talk

Fig. 3—A horizontal phasing ghost.

horizontal sync pulses with an oscilloscope and see whether they are within tolerance of the manufacturer's specifications. If not, the component values in the *sync* circuit should be checked.

In some cases, manufacturers have recommended modifications of the a.f.c. circuit to improve stability. For example, two of the many causes of horizontal bend are insufficient filtering of the d.c. correction output voltage from the a.f.c. stage and poor choice of capacitor value at various points in the a.f.c. circuit. If there is a bend or hook in the top of the picture in a receiver with a phase detector, triode phase detector or Synchrolock circuit, it may be helpful to change the output filter capacitor from .05 to 0.1 μf (C4, Fig. 4; C2, Fig. 6; C2, Fig. 7). Increasing the value of this capacitor improves the filtering of the d.c. control voltage of the a.f.c. system.

When bend appears in sets which have been functioning normally for some time, one possible cause is a decrease in the capacitance of the output filter capacitor in the a.f.c. stage.

Replacing the output filter capacitor can cause bend or other kinds of instability. This capacitor is usually a molded-phenolic paper-dielectric type. The outside foil should be connected to ground. If the leads are reversed, stray pulses can be picked up, causing instability. In these capacitors the outside foil is indicated by a solder or plastic bump at the base of one pigtail just outside the plastic case. Leads should be short and the capacitor mounted close to the chassis.

To reduce horizontal pulling at the top of the picture in some triode phase detector circuits, one manufacturer recommends adding a .001-μf capacitor between the cathode of the phase detector and ground (Fig. 7). This provides additional filtering of the a.f.c. correction voltage in this circuit.

Other modifications suggested by various manufacturers to improve a.f.c. action as it affects horizontal stability are:

1. In the Synchrolock circuit (Fig. 6), add another .004-μf capacitor in parallel with C1 if C2 is changed to 0.1 μf.

2. To minimize erratic horizontal sync (flagging at the top of the picture), change C1, C2 (Fig. 4) to 500 $\mu\mu$f.

3. To eliminate all trace of jitter, a 1.3-ohm resistor in series with the phase detector heater is recommended in some circuits to lower the heater voltage and minimize the effect of changing tubes.

Hunting

The horizontal oscillator keeps going above and below the correct frequency—"hunts" for it. The effect may range from a cogwheel or piecrust pattern in severe cases (Fig. 1) to a mild horizontal bend. Hunting is caused by a failure in the anti-hunt circuit or associated components.

In Fig. 4, the anti-hunt circuit C3, R4 operates with R1, R2, R3 and C4 to develop the output correction voltage. This is true in all a.f.c. systems. The anti-hunt circuits in the other systems are: R1, C1 in Fig. 5; R1, C1 in Fig. 6 and R2, C1 in Fig. 7.

In servicing receivers with a cogwheel pattern or horizontal bend, the anti-hunt circuit and associated components should be checked for correct values and for capacitor leakage. While the prime suspect is the anti-hunt circuit, the other components may also be responsible. To eliminate flag waving or bending at the top of the picture, one manufacturer recommends that a 10,000-ohm resistor in series with a 0.22-μf capacitor be placed across C2 (Fig. 6).

Loss of horizontal sync

A complete loss of horizontal sync may be due to an open or shorted a.f.c. output filter capacitor which charges to the d.c. control voltage; an open or shorted coupling capacitor applying

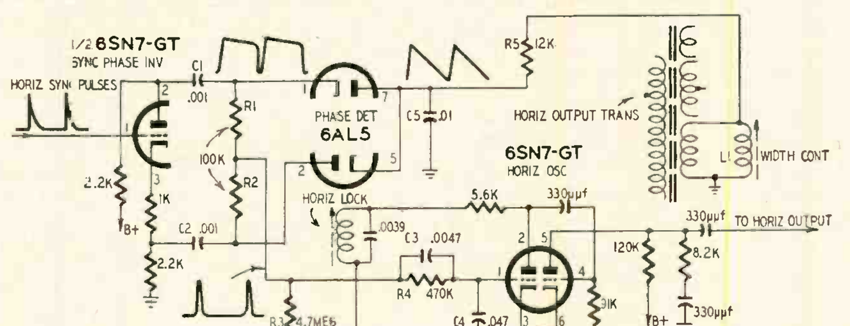

Fig. 4—Diagram of diode phase detector automatic frequency control circuit.

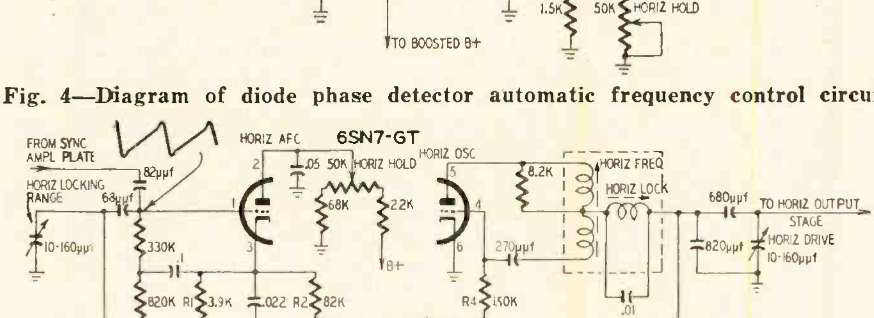

Fig. 5—Diagram of RCA's popular Synchroguide (pulse width) a.f.c. circuit.

sync pulses to the a.f.c. circuit; an open or leaky capacitor feeding the horizontal waveform to the a.f.c. system.

Several troubles which may arise in horizontal a.f.c. circuits are closely related: out-of-phase picture; phasing ghost; horizontal foldover, usually at the left side. In many cases, the fault is accompanied by critical horizontal hold.

An out-of-phase condition (Fig. 2) often produces a split picture. The right half of the picture is on the left side of the screen, with the left half of the picture on the right side. This condition indicates that picture information for a given line starts to come in near the middle of the horizontal line scan and finishes as the next horizontal line is being scanned.

Correct frequency is indicated when: only one picture is seen, even though the blanking bar is in it; the picture falls into sync when changing channels; the picture is stable (does not fall out of horizontal sync). In some cases of incorrect phasing, the blanking bar does not cut the picture in half but appears either along the left or the right side of the screen.

A phasing ghost represents a slightly out-of-phase condition. This fault results when video information starts to come in during the beam retrace period. Normally, video information comes in only after the beam retrace has been completed. A phasing ghost, or horizontal foldover, is sometimes caused by an incorrect setting of the horizontal hold.

Horizontal foldover in some cases is a more exaggerated form of phasing ghost. That is, picture information for the next line starts to come in at the beginning of the retrace. If the horizontal retrace starts before video information for the line is completed, the foldover effect appears along the right side of the picture. Essentially, a phasing ghost is caused by a picture which is just enough out of phase to cause a small foldover at the left.

An out-of-phase picture, especially one with no bend in it, usually originates in the a.f.c. circuit. Occasionally, this effect may arise in the sync or horizontal sweep circuits. A phasing ghost may originate in either the a.f.c. circuit or the horizontal sweep section. When this trouble originates in the horizontal sweep section, the fault is due to a retrace which is too slow.

Among possible reasons for this are unmatched yoke components in the horizontal output circuit and excessive capacitance across the secondary of the horizontal output transformer. In any event, when the fault originates in the horizontal sweep circuit, the retrace portion of the output waveform is too wide and signal tracing with an oscilloscope can be used to find the trouble. There are some models in which a small amount of residual foldover is normal because of the design of the horizontal sweep circuit. In such models, the usual procedure is to adjust the horizontal hold and lock controls for minimum foldover and the width and centering adjustments so the foldover portion of

(*Continued on page* 87)

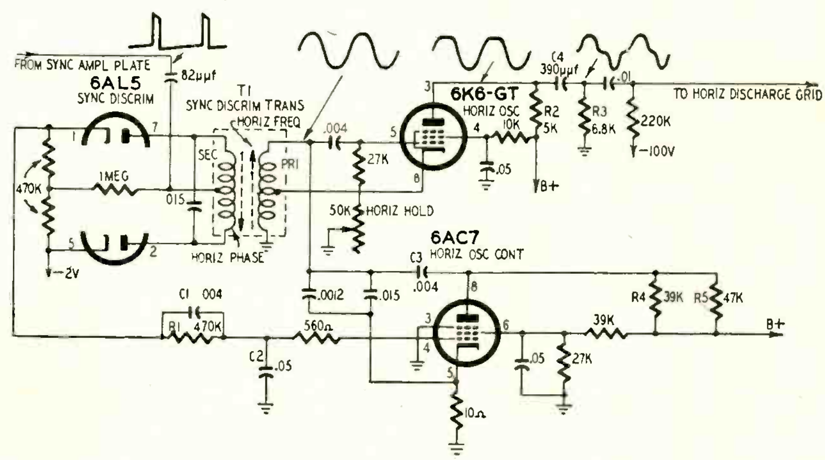

Fig. 6—Synchrolock circuit uses sync discriminator and oscillator control tubes.

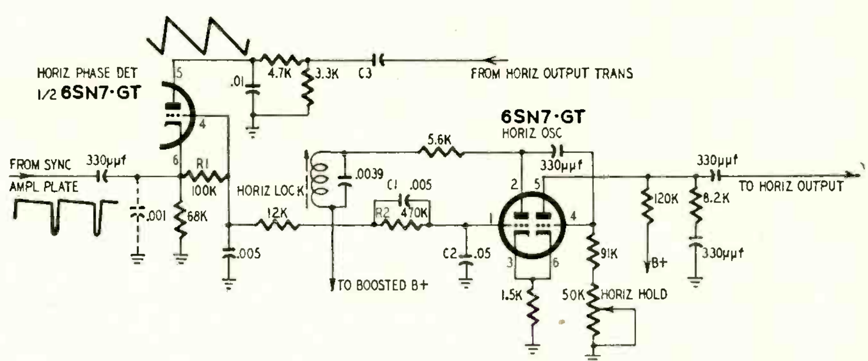

Fig. 7—Triode phase detector. Sync is applied to the cathode; sweep to plate.

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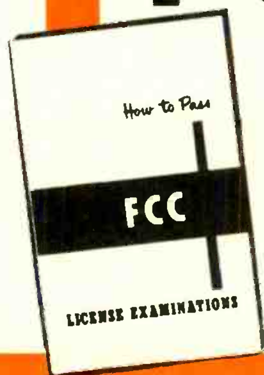

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"I replied to the Job Opportunities you sent me and I am now a radio operator with American Airlines. You have my hearty recommendation for your training and your Job-Finding Service." James A. Wright, Beltsville, Md.

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	License	Time
A/1C Ronald H. Person, St. Louis 20, Mo.	1st	25 weeks
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L. M. Bonino, Harlington AFB, Tex	2nd	16 weeks
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	License	Time
Harry G. Frame, Charleston, W. Va.	2nd Class	13 weeks
Charles Ellis, Charles City, Iowa	1st Class	28 weeks
Omar Bibbs, Kansas City, Mo.	1st Class	34 weeks
Kenneth Rue, Dresser, Wisconsin	2nd Class	20 weeks
B. L. Jordan, Seattle, Washington	1st Class	20 weeks

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Desk RE-81

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(Other types of horizontal foldover originate only as the result of defects in the horizontal sweep circuit. These can be easily identified by indications on the picture or raster—wide vertical stripes or broad vertical foldover sections. When the horizontal sawtooth output is distorted, a definite horizontal nonlinearity is evident in the picture.)

Out-of-phase picture

In the Synchrolock system (Fig. 6), an out-of-phase condition may simply indicate aging of circuit components and may be eliminated by readjusting the phasing control (secondary of T1). If rotating this control does not bring the picture back into phase, the most likely causes of trouble are: defective 6AC7, 6AL5 or 6K6; change of value in R2, R4, R5 or R3; C3 open; defective discriminator transformer.

The other a.f.c. circuits do not have phasing adjustments as such. Therefore, an out-of-phase condition in these circuits indicates a defective component. If tube changes—a.f.c. and horizontal oscillator—do not cure the trouble, the fault is generally at the point where the horizontal sweep voltage is fed to the a.f.c. circuit. In these systems a portion of the horizontal sweep voltage is fed back to the a.f.c. circuit for comparison with the incoming sync pulses. The R-C network which feeds the sweep voltage to the a.f.c. stage affects the phase relationship between the sawtooth voltage and the incoming sync pulses; for example, R5, C5 in Fig. 4.

Any change of component value in this network or a component breakdown can cause incorrect phasing, a phasing ghost or horizontal foldover even though the horizontal hold and lock controls are correctly adjusted. The most likely causes for an out-of-phase condition in the phase detector system (Fig. 4) are: a defective C5, R5, L1 or secondary from which the waveform is tapped off.

In a receiver using the triode phase detector circuit of Fig. 7, an early value of C3 was .0047 μf. The manufacturer subsequently recommended the value be changed to .002 μf (1,000 volts) to cause the picture to start at a point farther to the right and permit easier centering without neck shadows.

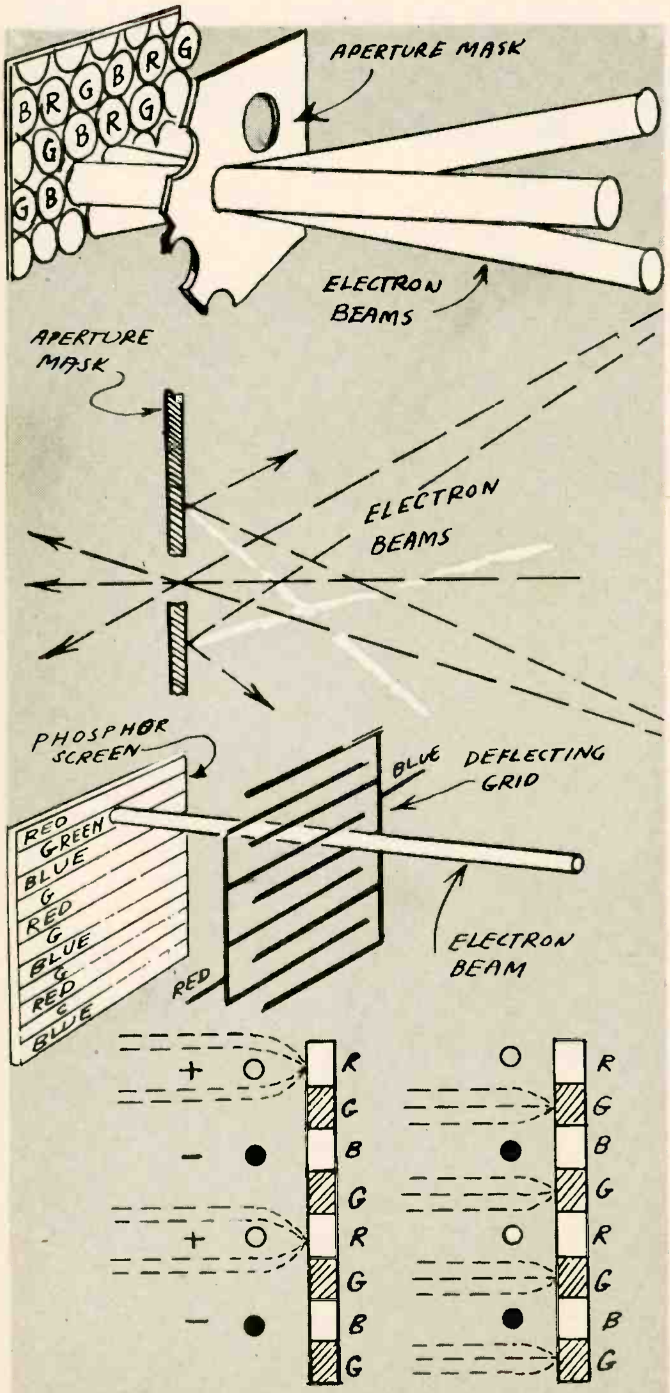
Phasing ghost and horizontal foldover

These may be due to incorrect adjustment of the horizontal hold or lock control or to a defective part. If the horizontal hold is rotated to one extreme and just fails to make the phasing ghost disappear, and a tube change (a.f.c. or horizontal sweep) does not help, realign the horizontal circuit. If realignment fails to eliminate the phasing ghost, the components which can cause an out-of-phase condition should be checked. These components can also be responsible for the type of horizontal foldover which is an exaggerated form of a phasing ghost. END

TELEVISION . . .
it's a cinch

By E. AISBERG

Eighteenth conversation, second half: The color tube; three guns or one; TV is just starting out; a sure future



WILL—Could you go over the receiving picture tube lightly? Just how does it work?

A three-gun battery

KEN—In the three-gun tube, the screen is composed of a pattern of phosphor dots, each of which luminesces in one of the three primary colors. Each of the three guns is triggered by one of the primaries and is so "aimed" that its beam contacts the dots of its own primary color.

WILL—That must be some aiming! The dots would be at least as small as those at my color printer's. And the beam is skipping along from one to the other at several miles a second. Just how is this miracle aiming done?

KEN—It's not so much a matter of good aiming at the desired spots as an ingenious method of keeping the beam from one gun off the other guns' territory. That's done by inserting a "mask" between the guns and the screen—close to the screen. It's a sort of partition pierced with thousands of tiny holes. Each beam, after it goes through one of the holes, *must* fall on a spot of the correct color.

WILL—That *is* a bright idea. Ingenious is right!

KEN—Yes, and it also takes a lot of ingenuity to work out the idea, particularly in mass production!

WILL—Is the one-gun tube simpler or easier to make?

Three in one

KEN—The one-gun tube is the invention of Dr. Lawrence of Cyclotron fame. Its screen is divided into color *stripes* instead of the dots of the color-mask tube. A little ahead of this striped screen is a grid of fine wires. I should say two grids, because half of the wires are connected together and are directly behind the blue stripes in the screen. The other half—also connected in parallel—are behind the red stripes. If—say—the red grid is positive, electrons passing just above one of the red grid wires will be bent down and those passing just below will be bent up, so they'll both strike the red strip . . .

WILL—. . . and the same is true of the blue. But how about the green?

KEN—If the two grids are at the same potential, electrons passing halfway between go straight ahead to the green strip. And—because the screen is at a potential of several thousand volts higher than the grid, electrons passing near the red and blue grids are actually bent away from them and turned toward—or focused on—the green strip.

WILL—Aha! the post-deflection tube?

KEN—Exactly. Now the electrons are kept moving up and down at a frequency of 3.58 mc by a power amplifier coupled to a coil between the two grids. That coil and the grids form a resonant circuit at approximately 3.58 mc, making it easier to drive.

WILL—But wait a minute! According to that, the spot will be moving up and down all the time as it sweeps across the line. Your red and blue grids will simply be acting like a spot wobbler, whether the color is red, green or something else. Surely the beam will sweep along the red line only when there is a red signal . . .

KEN—No, Will, just the opposite. You get a red signal only when the beam is on the red line. The tube is *gated* so that the red signal comes in only when the beam is on the red strip. For example, if you were receiving a pure saturated blue, the beam would be cut off all the time it was on the red and green stripes and would be at maximum strength when it was on the blue.

WILL—But that fine detail you were telling me about?

KEN—Fine detail is black-and-white and is handled the same on both kinds of tubes. White is produced by all color signals working together. In other words, you get the fine detail by feeding it to all color areas—whether dots or stripes—at the same time in proportions which give a black-and-white picture. And if you want a *desaturated* color—a pink for instance—you simply feed some signal into the blue and green channels as well as the red. Part of the red then combines with the green and blue to make white. That dilutes or desaturates the red signal and you get pink.

WILL—Yeah, sounds plausible. I guess we *will* have to get together for another series of conversations on color. But, who knows, maybe something else will turn up before I learn all about color?

KEN—You can be almost certain something will, for TV is still a long way from its final form and studying it is a permanent job. That's one of its main attractions—it's anything but static. Television has now reached about the same degree of perfection as the movies. Like them, it has sound and color. Like the movies, too, it will have little trouble conquering the third dimension for some of the 3D techniques used in moving pictures work just as well on TV. TV is also like the movies in that it has much wider fields of use than mere entertainment. It is being widely used in its closed-circuit form for instruction, conferences, inspection and control, and its capabilities along these and possibly other now unknown lines can't even be guessed at. There's plenty to be done. If you make a career of television, you won't be bothered by limits to your chosen field!

WILL—Do you really think that with what I've learned so far I could go in for a career of, say, television research?

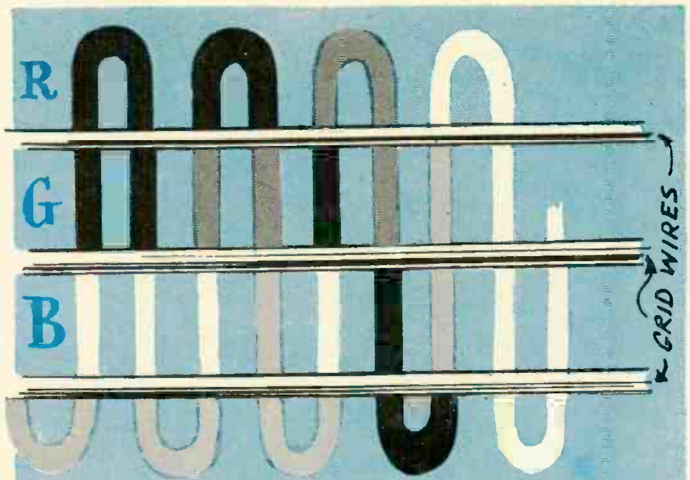
KEN—Modesty was never one of your faults, Will! No, you certainly haven't got enough out of our conversations to make you a laboratory technician. I didn't try to show you all the circuits used in TV transmitters and receivers nor even teach you how to design or repair a receiver. But I think I did give you a fair idea of the various elements of a TV receiver and their functions as well as all those of a transmitter you need to know to understand how a receiver works. Today, no schematic—no matter how complex it may appear at first—can give you any trouble if you study it a little.

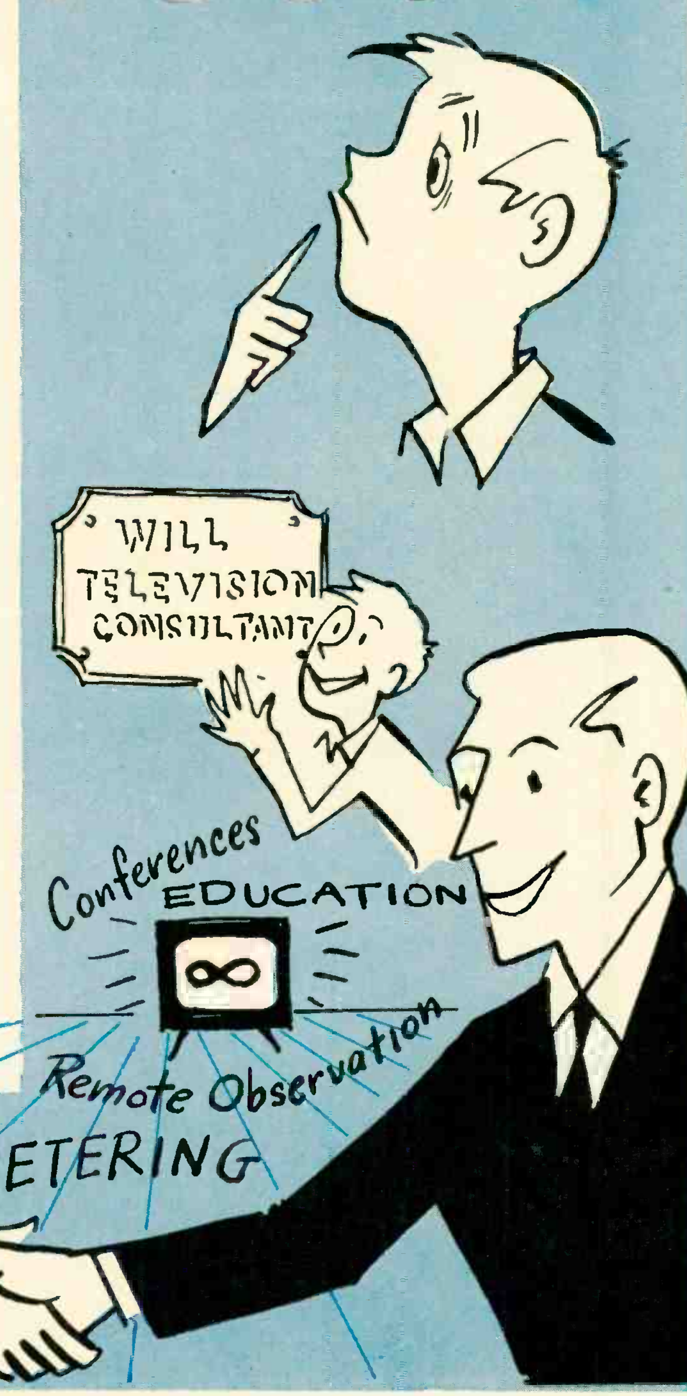
WILL—I think I know what you're trying to get across. You are advising me to decompose the diagram into a certain number of elementary circuits that I can compare with the ones we've talked about. Isn't that what they call the analytic method?

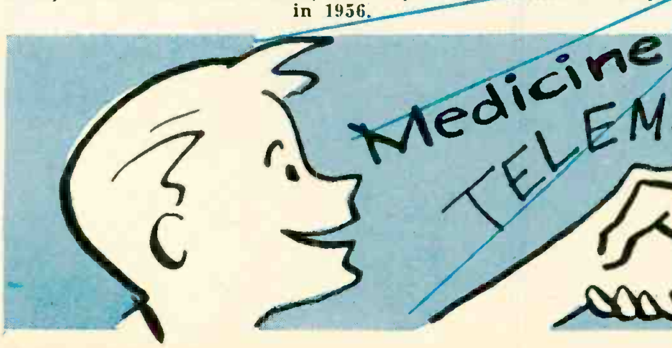
KEN—Exactly. And if you get the habit of analyzing and synthesizing, if you continue to follow the progress of television, if you keep reading the best books and the latest issues of the technical magazines, you'll find that television isn't unsurmountably difficult.

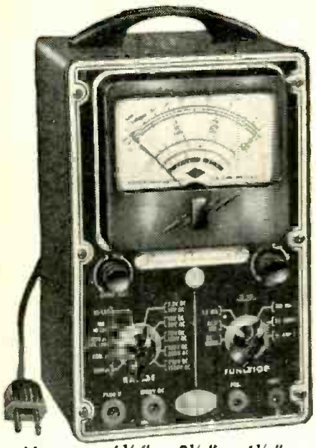
WILL—Difficult? Television? It's a cinch! END

The series "Television . . . it's a Cinch" will soon appear in book form, Gernsback Publications, Inc. expects to release it early in 1956.









Measures 6¼" x 9½" x 4½"

Superior's new Model 670-A

SUPER METER

A COMBINATION VOLT-OHM MILLIAMMETER PLUS CAPACITY REACTANCE INDUCTANCE AND DECIBEL MEASUREMENTS

SPECIFICATIONS:

D.C. VOLTS: 0 to 7.5/15/75/150/750/1,500/7,500 Volts
A.C. VOLTS: 0 to 15/30/150/300/1,500/3,000 Volts
OUTPUT VOLTS: 0 to 15/30/150/300/1,500/3,000 Volts
D.C. CURRENT: 0 to 1.5/15/150 Ma. 0 to 1.5/15 Amperes
RESISTANCE: 0 to 1,000/100,000 Ohms 0 to 10 Megohms
CAPACITY: .001 to 1 Mfd. 1 to 50 Mfd. (Good-Bad scale for checking quality of electrolytic condensers.)
REACTANCE: 50 to 2,500 Ohms 2,500 Ohms to 2.5 Megohms
INDUCTANCE: .15 to 7 Henries 7 to 7,000 Henries
DECIBELS: −6 to +18 +14 to +38 +34 to +58

ADDED FEATURE:
Built-in ISOLATION TRANSFORMER reduces possibility of burning out meter through misuse.

The Model 670-A comes housed, in a rugged crackle-finished steel cabinet complete with test leads and operating instructions.

$28.40 NET

Superior's new Model TV-11

TUBE TESTER

SPECIFICATIONS:

★ Tests all tubes including 4, 5, 6, 7, Octal, Lock-in, Peanut, Bantam, Hearing Aid, Thyratron Miniatures, Sub-miniatures, Novals, Sub-minars, Proximity fuse types, etc.

★ Uses the new self-cleaning Lever Action Switches for individual element testing. Because *all elements are numbered according to pin-number in the RMA base numbering system*, the user can instantly identify which element is under test. Tubes having tapped filaments and tubes with filaments terminating in more than one pin are truly tested with the Model TV-11 as any of the pins may be placed in the neutral position when necessary.

★ The Model TV-11 does not use any combination type sockets. Instead individual sockets are used for each type of tube. Thus *it is impossible to damage a tube by inserting it in the wrong socket.*

★ Free-moving built-in roll chart provides complete data for all tubes.

★ Newly designed Line Voltage Control compensates for variation of any Line Voltage between 105 Volts and 130 Volts.

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

EXTRA SERVICE — The Model TV-11 may be used as an extremely sensitive Condenser Leakage Checker. A relaxation type oscillator incorporated in this model will detect leakages even when the frequency is one per minute.

The model TV-11 operates on 105-130 Volt 60 Cycles A.C. Comes housed in a beautiful hand-rubbed oak cabinet complete with portable cover

$47.50 NET

About Testing Picture-Tubes . . .

Of course you can buy an "adapter" which theoretically will convert your standard Tube Tester into a picture-tube tester. Sounds fine—but—it simply doesn't work out that way!

We do not make nor do we recommend use of C.R.T. adapters because a Cathode Ray Tube is a very complex device and to properly test it, you need an instrument designed exclusively to test C. R. Tubes and nothing else. As compared to a make-shift adapter, which sells for about five dollars, our Model TV-40 C.R.T. Tube Tester sells for $15.85. But, if you believe that Television is here to stay, then you must agree that the difference in price is more than justified by the many years of valuable service you will get out of this indispensible instrument.

Incidentally, the Model TV-40 is the ONLY low-priced C.R.T. Tube Tester, which includes a real meter. Neons are fine for gadgets and electric-line testers, but there is no substitute for a meter with an honest-to-goodness emission reading scale.

Superior's New Model TV-40

C.R.T. TUBE TESTER

Tests ALL magnetically deflected tubes . . . in the set . . . out of the set . . . in the carton ! !

- Tests *all* magnetically deflected picture tubes from 7 inch to 30 inch types.
- Tests for quality by the well established emission method. All readings on "Good-Bad" scale.
- Tests for inter-element shorts and leakages up to 5 megohms.
- Test for open elements.

EASY TO USE: Simply insert line cord into any 110 volt A.C. outlet, then attach tester socket to tube base (Ion trap need not be on tube). Throw switch up for quality test . . . read direct on Good-Bad scale. Throw switch down for all leakage tests.

Model TV-40 C.R.T. Tube Tester comes absolutely complete—nothing else to buy. Housed in round cornered, molded bakelite case. Only

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NO MONEY WITH ORDER—NO C.O.D.

Try any of the above instruments for 10 days before you buy. If completely satisfied *then* send down payment and pay balance as indicated on coupon. **No Interest or Finance Charges Added!** If not completely satisfied return unit to us, no explanation necessary.

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☐ Model TV-11.................Total Price $47.50 $11.50 within 10 days. Balance $6.00 monthly for 6 months.

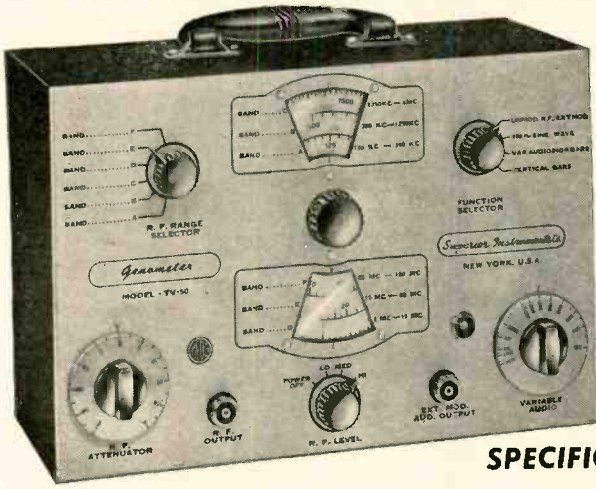
☐ Model TV-40.................Total Price $15.85 $3.85 within 10 days. Balance $4.00 monthly for 3 months.

The Model TV-50

GENOMETER

A versatile all-inclusive GENERATOR which provides ALL the outputs for servicing:

A. M. Radio **F. M. Radio** **Amplifiers** **Black and White TV** **Color TV**



7 Signal Generators in One!

- ✓ R. F. Signal Generator for A.M.
- ✓ R. F. Signal Generator for F.M.
- ✓ Audio Frequency Generator
- ✓ Bar Generator
- ✓ Cross Hatch Generator
- ✓ Color Dot Pattern Generator
- ✓ Marker Generator

SPECIFICATIONS:

R. F. SIGNAL GENERATOR:

The Model TV-50 Genometer provides *complete* coverage for A.M. and F.M. alignment. Generates Radio Frequencies from 100 Kilocycles to 60 Megacycles on fundamentals and from 60 Megacycles to 180 Megacycles on powerful harmonics. Accuracy and stability are assured by use of permeability trimmed Hi-Q coils. R.F. is available *separately*, modulated by the fixed *400 cycle sine-wave* audio or modulated by the *variable* 300 cycle to 20,000 cycle variable audio. Provision has also been made for injection of any external modulating source.

VARIABLE AUDIO FREQUENCY GENERATOR:

In addition to a fixed 400 cycle sine-wave audio, the Model TV-50 Genometer provides a variable 300 cycle to 20,000 cycle peaked wave audio signal. This service is used for checking distortion in amplifiers, measuring amplifier gain, trouble shooting hearing aids, etc.

BAR GENERATOR:

This feature of the Model TV-50 Genometer will permit you to throw an actual Bar Pattern on any TV Receiver Screen. Pattern will consist of 4 to 16 horizontal bars or 7 to 20 vertical bars. A Bar Generator is acknowledged to provide the quickest and most efficient way of adjusting TV linearity controls. The Model TV-50 employs a recently improved Bar Generator circuit which assures stable never-shifting vertical and horizontal bars.

CROSS HATCH GENERATOR:

The Model TV-50 Genometer will project a cross-hatch pattern on any TV picture tube. The pattern will consist of non-shifting, horizontal and vertical lines *interlaced* to provide a stable cross-hatch effect. This service is used primarily for correct ion trap positioning and for adjustment of linearity.

DOT PATTERN GENERATOR *(For Color TV)*:

Although you will be able to use most of your regular standard equipment for servicing Color TV, the one addition which is a "must" is a Dot Pattern Generator. The Dot Pattern projected on any color TV Receiver tube by the Model TV-50 will enable you to adjust for *proper color convergence*. When all controls and circuits are in proper alignment, the resulting pattern will consist of a sharp white dot pattern on a black background. One or more circuit or control deviations will result in a dot pattern out of convergence, with the blue, red and green dots in overlapping dot patterns.

MARKER GENERATOR:

The Model TV-50 includes *all* the most frequently needed marker points. Because of the ever-changing and ever-increasing number of such points required, we decided against using crystal holders. We instead adjust each marker point against precise laboratory standards. The following markers are provided: 189 Kc., 262.5 Kc., 456 Kc., 600 Kc., 1000 Kc., 1400 Kc., 1600 Kc., 2000 Kc., 2500 Kc., 3579 Kc., 4.5 Mc., 5 Mc., 10.7 Mc. (3579 Kc. is the color burst frequency.)

The Model TV-50 comes absolutely complete with shielded leads and operating instructions. Only .... **$47.50 NET**

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Try it for 10 days before you buy. If completely satisfied *then* send $11.50 and pay balance at rate of $6.00 per month for 6 months. **No Interest or Finance Charges Added!** If not completely satisfied return unit to us, no explanation necessary.

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Please rush me one Model TV-50. I agree to pay $11.50 within 10 days and to pay $6.00 per month thereafter. It is understood there will be no finance, interest or any other charges, provided I send my monthly payments when due. It is further understood that should I fail to make payment when due, the full unpaid balance shall become immediately due and payable.

Name ....

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convergence...

not impossible, but difficult

Part II—After much frustration rainbow's end is within reach

By HAROLD DAVIS

THE next day I went through all the back issues of the popular trade journals on hand and laid out everything that had articles pertaining to color convergence. One was very enlightening. It read as if the author had at least seen a color set, which is more than I can say for most of the stuff I've read.

Among other things it stated that the new color tubes have "beam converging pole pieces inside over which the converging coil magnet assembly" must be aligned. Checking the instruction book carefully, I found a diagram showing the position of this assembly. It should be adjusted so that the "blue" coil sits directly over the "blue" pole piece, which would also align the other two coils over their respective pole pieces.

As soon as I saw this, I knew one thing that was wrong with my setup. *The coil was not over the pole piece.* I remembered it was to one side, having presumably slipped over in shipment. With the magnet not over the pole piece, the adjustments would naturally have little or no effect.

It was Sunday before I had time to tackle the set again, and I invited a friend to come along. I was sure I could lick it this time.

4:30—We arrived and I started taking the back off.

"Plenty of screws," Paul remarked.

"Yes," I answered, "and it's a well known fact that sets that need the most servicing have the most screws in the back. Hope it's not true here."

On the way over I had explained to Paul about the position of the magnet assembly, so that was the first thing we looked for. Sure enough, it was over to one side. However, the neck of the tube around the area where the assembly fit was completely black, and we were unable to see the pole pieces.

"That's the trouble with books," Paul cracked. "They never say what to do when you can't do what you're supposed to."

Checking the diagram again, I instructed Paul to set the blue coil straight up and slip it horizontally directly over the black shaded area. Paul pulled on the assembly to make the adjustment, and I heard something fall onto the chassis.

"What was that?" we both asked.

It didn't take long to find out. I stooped over and picked up a knurled knob. It had broken off the "red" cylindrical magnet which is turned to converge the dots. My spirits slumped!

"Well," Paul asked meekly, "how long do you think it would take to get one of those?"

"Just about the same length of time it took the man to perfect the thing in the first place," I answered dejectedly.

"Let's push the end out and turn it with a tuning tool," Paul suggested.

Having no choice, I told him to try.

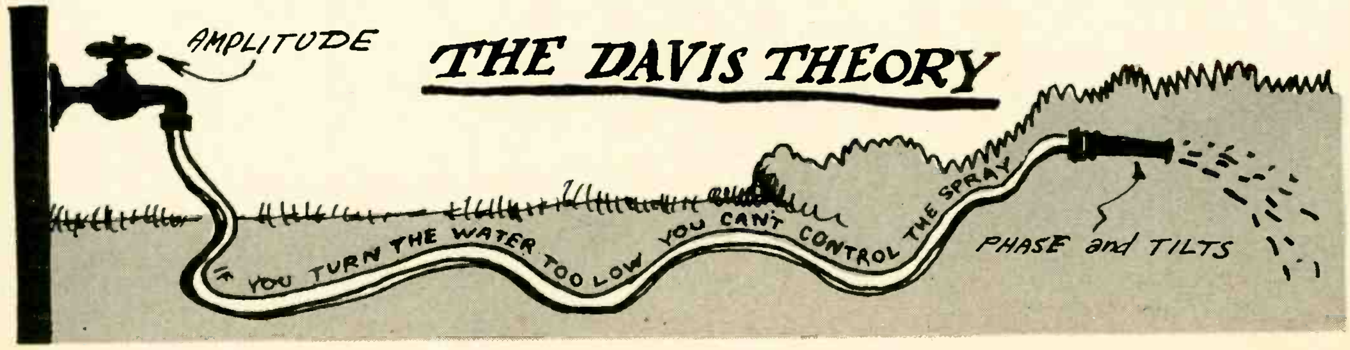
We took a small wrench and pushed the magnet out a bit. We tried all kinds of tools, but ended up with a pair of pliers. Every so often a bit would crumple off making the magnet shorter.

Finally, I suggested that we pull the broken magnet out of the red coil and put it in the blue one and vice versa. The blue was easier to position and in addition had the blue lateral positioning magnet which I had already discovered could be rolled like an ion trap and would have some effect on up-and-down motion.

This looked like it was going to work so we decided to go through the whole convergence procedure.

During the excitement, I had forgotten to try the dynamic convergence. Now I checked it and, sure enough, with the magnet assembly correctly placed, the amplitude controls moved the dots about handily.

We checked purity and screen ad-



justments and proceeded with the convergence. Paul read the procedure step by step and I made the adjustments. When we got through we turned to a station and, while the picture had less fringing, it still was far from being acceptable in my estimation.

6:30—Jack Benny came on on our high-frequency station (channel 25) in color but, as we were 40 miles out and picking up a lot of snow, I was not disappointed that the reception was poor. Snow has more effect on color than it does on black-and-white. It seems to trigger the color sync pulses.

9:30—I instructed the dealer to send the set over to my shop and Paul and I started for home.

On the way I asked Paul, "What do you think is wrong?"

"I kind of think that color is getting in through the color circuits."

"No, you're wrong. The color circuits are actuated only by a signal that comes in at 3.58 mc. And, besides, with the color control off, even that signal is killed. The whole trouble is convergence."

"Maybe so," Paul shrugged. He wasn't committing himself.

The next day I learned that a dealer had received a 19-inch Motorola. I called him and asked about the color fringing on black-and-white pictures.

"We got it," he told me.

I also went to see another dealer who had a 19-inch Capehart. I turned it on and he also had bad color fringing. He stated, however, that when the set first came in it had very good black-and-white pictures. His service technician went to a color school and when he came back decided to try his newly acquired knowledge on the set and since then the pictures had been poor.

I decided then that convergence was something that had to be mastered if we were to have color reception.

I spent several more hours plowing through trade journals and came back to the article where I had discovered the positioning of the magnet assembly over the pole pieces. Reading carefully, I was impressed with several pointers. One was that the yoke had to be positioned correctly or it would be impossible to converge the dots on the edge of the tube. With these I was having trouble. It stated further that, if the yoke was positioned correctly, any one set of dots on the tube could be converged.

Another impressive statement was that *the horizontal hold should be set on a weak station and not moved during the convergence procedure.*

I also studied the diagrams showing the effect of the dynamic convergence controls and from them surmised that the *amplitude controls affected the dots near the center* of the screen, while *phase and tilt* affected those *near the edges*. It also stressed that the dots must be in a straight line *both horizontally and vertically.*

This was further emphasized the next day when the manufacturer's representative in this area came to town.

"You can't trust your eyes," Herb said, "you have to use a reference line."

Paul played with the set during the week and reported no progress. He had worn the controls slick.

Sunday afternoon I went by and decided to give it a fling. Before I could touch it, Paul said, "You needn't try any more. That is as good as it will do. It just wasn't intended to do any better."

I hooked up the dot generator and adjusted everything carefully. The dots in the center and out to within three of the edge looked pretty good. The last three on each end were not converged, showing red and green dots.

"I hate to disagree with you, my good man," I said, "but this is not as good as it will do."

I took an alligator clip and shorted the red gun. I took another and shorted the green. Stepping back about 10 feet, I looked carefully to see if the remaining blue dots were in a straight line. They looked pretty good vertically, but resembled an S on a "Sears" sign horizontally.

I pointed this out to Paul. He wouldn't agree. "They look straight to me," he remarked.

I went to my truck and found a piece of masking tape. Measuring down the same distance on each side, I stuck the tape across the glass.

"Now come see if the dots are straight," I invited. Paul scrutinized the screen carefully and admitted they weren't. However, he also argued that being in a straight line wasn't important as long as the red, blue and green dots were in the same relationship to each other. (This impression was why we were having so much trouble.)

I attempted to line up the blue dots to the masking tape by turning the BLUE PHASE. This phase was as far as it would go in that direction. I turned BLUE AMPLITUDE and moved the center dots down some. Then with the phase control I jacked up the ends. With both controls in extreme position the dots made an S shape.

I discovered another important thing that I hadn't read anywhere. I hope it will become known as the "Davis theory" for it certainly took me long enough to discover! *When the amplitude is turned to minimum, the phase and tilts have little or no effect.*

Examination of the diagram reveals why. The amplitudes are series pots that select the amount of signal fed into the convergence box. The phase and tilts shape the signal into the required form. The horizontal amplitudes and phases receive a signal from the horizontal output section. The vertical amplitudes and tilts receive a signal from the vertical section. After passing through the convergence box, they are fed into the electromagnets located on the convergence assembly—blue into the blue coil, red into the red, etc.

By alternately turning AMPLITUDE and PHASE, I arranged the blue dots along a straight line as indicated by the masking tape.

I uncorked the red dots and with the red converging magnet placed the red dots in the center of the screen in the upper *right-hand* corner of the blue dots. This is highly important.

I then proceeded to arrange all red dots in the center line across the screen in the same relationship. This required lots of turning of the RED AMPLITUDE and RED PHASE, but it worked.

I turned the green gun loose and with the green convergence magnet placed the green dots in the upper *left-hand* corner of the blue dots. (Important!)

Alternately turning GREEN AMPLITUDE and GREEN PHASE, I took the wiggle out of the S.

The dots looked straight and in good relationship when viewed vertically, so I did not readjust these. Had they been out, I would have put a piece of masking tape vertically and proceeded to make a straight line by adjusting vertical amplitudes and vertical tilts. (Some sets use different names for the controls, but their functions are the same.)

Being satisfied that I had perfect triangles in perfectly straight lines, I reached for the red convergence magnet. It was like waiting for an important chemical mixture to jell. The results of two weeks of work and study were about to be revealed. The whole future of color television, so far as I was concerned, was now at stake.

With the red convergence magnet, I kicked the red dots down slightly and to the left. With the green convergence magnet, I slipped the greens down and to the right the same amount. I moved the reds a little more and then the greens. When they were about half-meshed with the blues, I pulled the latter up with the blue convergence magnet. About three times around on all three of the above adjustments did the trick. The dots converged almost perfectly except on the extreme outer edge, which I understood could be expected.

6:00 p.m.—We had a good color program just starting. I hooked up the antenna excitedly and tuned in the station.

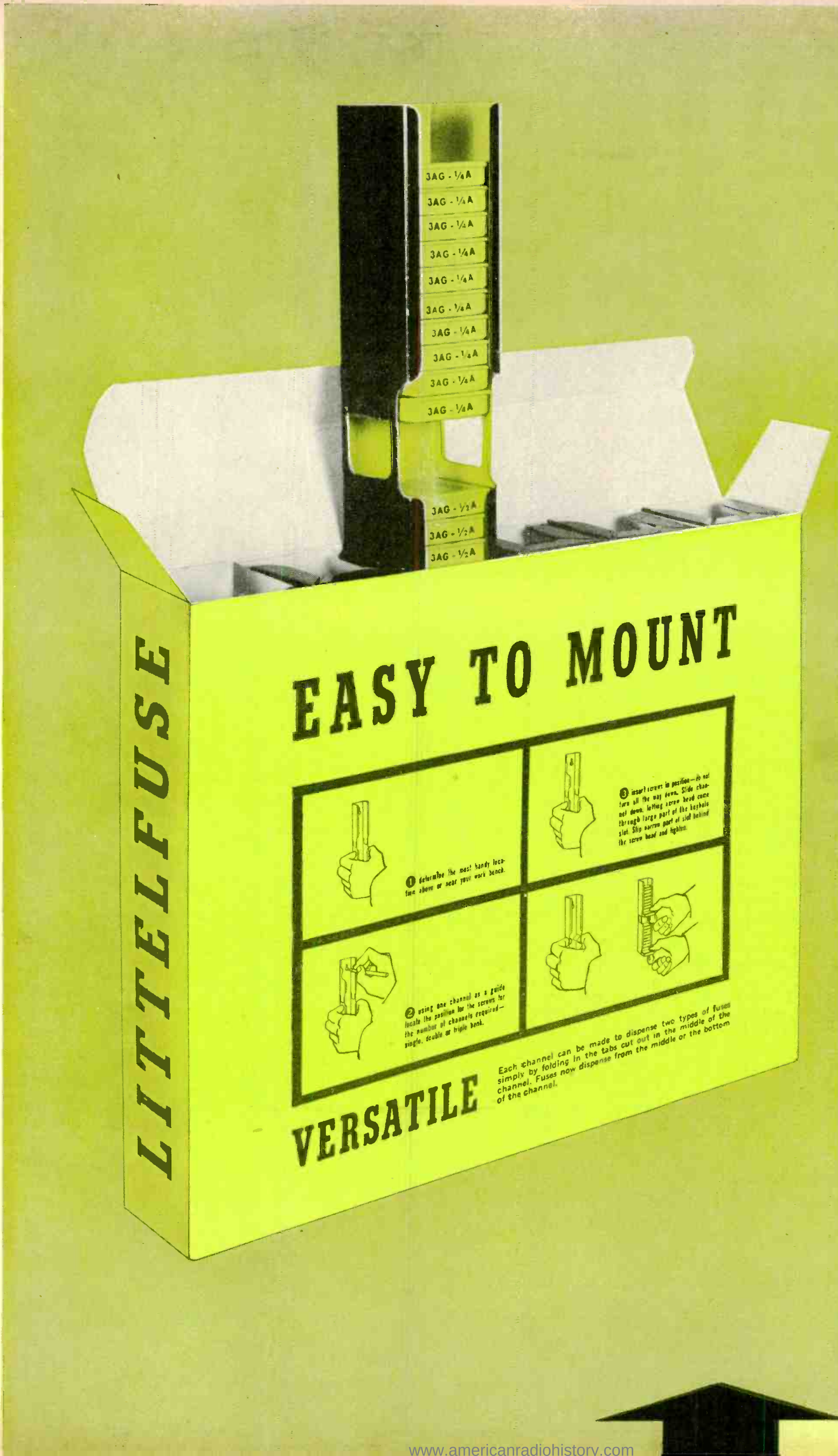
No color.

I was so excited I had forgotten to open the color control. I turned the color knob a bit and the brilliant colors burst forth in a magnificent spectacle.

Adjusting FINE TUNING and HUE carefully, we sat back and enjoyed our first real color show. It was an exciting experience, and when it was over there was only one opinion—color is here to stay.

P. S.—My secretary, when typing this story said, "It ends good, but what I want to know is: did you still have rainbows?"

To which I answered meekly, "Yes." But 'twern't so bad, brother, 'twern't so bad!" END



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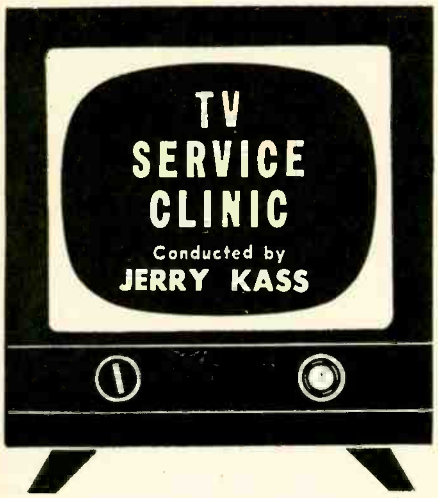
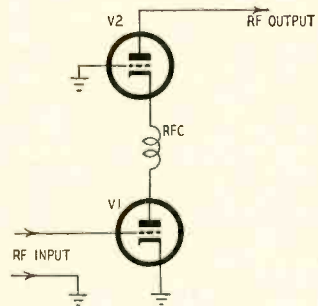




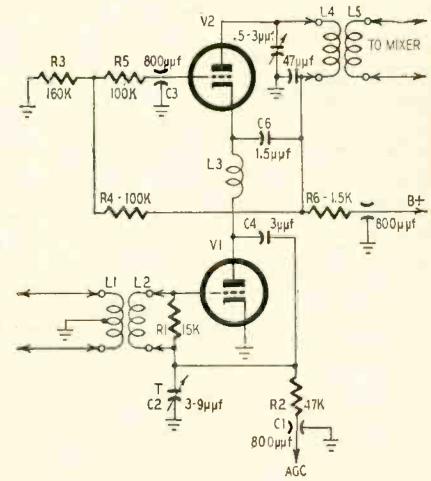


Fig. 1—Above, basic cascode circuit.

Fig. 2—Right, schematic of practical cascode amplifier in Standard tuner.

MANY demands are made of the r.f. amplifier stage in a TV receiver: It should provide uniform frequency response over any particular channel, attenuate local-oscillator radiation, provide proper selectivity and image rejection, properly match the impedance of the transmission line and provide a high signal-to-noise ratio. Of these functions, most important is the task of providing high gain while introducing a minimum of noise (see TV Clinic, June, 1955).

The most effective and practical circuit yet found to satisfy these conditions is the cathode-driven grounded-grid r.f. amplifier, popularly known as the *cascode* circuit. It is shown in its basic form in Fig. 1. Grounded-grid triode amplifier V2 is cathode-driven by triode V1. The amplification in this circuit is provided almost entirely by V2: V1 acts as a driver for V2 and has a gain of about unity. The input impedance of V2 acts as the load impedance for V1. This impedance being fairly small makes the gain of V1 so low as to minimize feedback problems greatly.

The cascode circuit arrangement provides the low noise level of a triode r.f. amplifier, with approximately the same gain and stability as a pentode r.f. amplifier. In addition, energy feed-through from the local oscillator is attenuated by the shielding action of the grounded grid—isolating the input and output circuits—to about the same extent as the screen grid of a pentode amplifier. The cascode circuit lends itself nicely to the use of twin-triode amplifier tubes such as the 6BQ7-A, 6BZ7, 6BK7-A, having a very low plate-to-cathode capacitance. An internal shield separates each triode. The shield is connected to pin 9 and should be grounded.

The two triodes (Fig. 1) being d.c.-coupled, form a d.c. voltage divider consisting of the plate-to-cathode resistance of both tubes across the B plus supply. Therefore, the plate of V2 receives the full B plus voltage (usually about 250) while the plate of V1 is at approximately one-half this potential.

In this arrangement, the cathode of V2 being at a potential of about 125 volts, it is necessary to provide the grid of V2 with a voltage of approximately the same value as its cathode. Otherwise V2 would be deep into cutoff. Placing a potential on the grid of V2 makes it impossible to ground the grid directly. However, this is of no great importance since the grid is effectively at ground potential when bypassed to ground with a capacitor which at v.h.f. would act virtually as a short circuit.

The inductor between the plate of V1 and the cathode of V2 serves a very important function. Its inductance, together with the input capacitance of V2 and the distributed wiring capacitance, forms a series-resonant circuit. The value of inductance is such as to make the circuit resonant at the high end of the v.h.f. band, where additional gain is most needed.

Practical cascode circuit

Easily the most popular tuner now in use is the Standard Coil cascode unit. Its r.f. amplifier circuit is shown in Fig. 2. A short strip of 300-ohm transmission line is connected to the center-tapped input transformer. The grounded center tap provides a balanced input and aids in noise attenuation. The transformer secondary feeds the signal to the grounded cathode stage of the cascode amplifier. Resistor R1 damps the input circuit, lowering the Q and permitting the necessary 6-mc r.f. bandwidth. An a.g.c. voltage is applied to V1 through decoupling network R2-C1. Trimmer C2 is used to align the grid circuit of V1.

With the cathode of V2 at approximately 125 volts, voltage divider R3-R4 supplies the necessary d.c. grid potential for the normal operation of V2. Resistor R5 isolates the grid of V2 from the B plus line. Since the grid of V2 is at r.f. ground through C3, the input signal fed to V2 is developed across the distributed cathode capacitance of V2 to ground. L3 is the plate load for V1 and cathode load for V2.

To increase stability at the higher channels, energy is fed back from the plate circuit of V1 to the grid circuit through C4. This capacitor forms an a.c. voltage divider with C2, placing the voltage developed across the trimmer in series with L2 as part of the signal voltage. Since this feedback voltage cancels the plate signal voltage that is fed to the grid through the plate-to-grid capacitance, C4 is generally called the neutralizing capacitor. The signal developed across L4 is the cascode amplifier output signal and is coupled to the mixer stage. V2 is neutralized by C6.

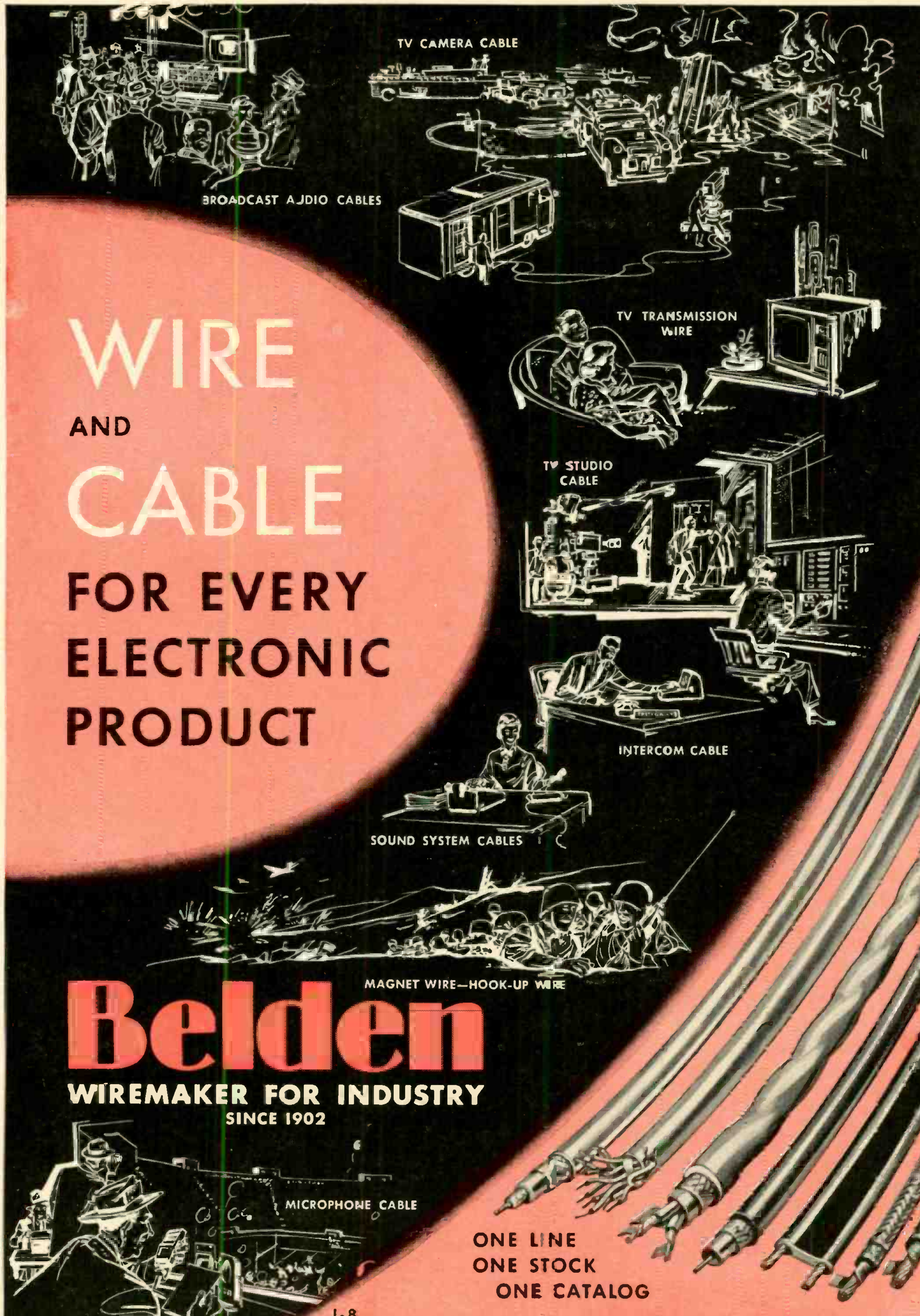
Servicing the cascode amplifier

Cascode circuitry creates certain characteristic troubles. While the cathode of V1 (Fig. 2) is at ground potential, the cathode of V2 is about 125 volts above ground. Thus, while a heater–cathode leakage is of little consequence in V1, it can cause a great deal of trouble in V2. Because of the large potential difference between heater and cathode of V2 these elements frequently short. A somewhat less common occurrence is a short between cathode and the internal shield.

A heater–cathode short in V2 grounds its cathode, thus eliminating the input signal to V2 and placing a positive bias of about 125 volts on the grid (this bias voltage will read much less because of heavy grid current flow). More important, however, is the great increase in plate current which in most cases will burn out R6, the plate resistor. Thus, in cases of snow, replacement of this tube should be in the first order of business.

A burnt-out R6 should never be considered positive proof of a shorted tube. A shorted 47-$\mu\mu$f bypass capacitor will produce the same effect since it would ground the B plus line through R6.

As the result of excessive current flow due to tube or component failure R6 often decreases in value, shortening the life of all subsequent tubes used in this circuit. Thus, measurement of this resistor is a most important check when servicing this circuit. If a ½-watt resistor is being used,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replace it with a 1-watt unit (space permitting).

Except for the d.c. relationship of V1 to V2 and the relatively high potentials on the grid and cathode of V2, the cascode amplifier is aligned and serviced in all other respects the same as other r.f. amplifiers.

Increasing width and high voltage

An Emerson receiver is lacking about 1 inch in width and is not producing sufficient brightness. I have replaced the flyback transformer and the horizontal output tube without success. Up to this point everything checks all right because the grid drive to the output tube is normal and the waveshape looks typical for this circuit. Experiment with the width and linearity controls has not given me the picture I want.

Upon the suggestion of another service technician I increased the voltage on the screen grid of the horizontal output tube—the picture widened and good brightness appeared. Is this a good solution or am I overdriving any circuits?—N. C., St. Paul, Minn.

When the screen grid voltage of the horizontal output tube is increased moderately, it is an effective and safe way to obtain additional width and high voltage. Your present circuit contains a 15,000-ohm 2-watt voltage dropping resistor in the screen circuit. I wouldn't recommend decreasing by more than one-third. Install a 10,000-ohm 2-watt unit. This should increase the picture width and the second-anode voltage.

Distorted sound

A model 416 Sentinel is in my shop for the second time with a complaint of distorted sound. The audio is also weak and occasionally cuts off. The first time I corrected the trouble by adjusting the ratio detector transformer. I made one house call and again corrected the trouble by this adjustment. I would like to fix it once and for all and I have replaced the transformer. In addition, the oscillator circuit has been checked for drift, but it appears to be in good shape and varying it does not correct the sound. Short of changing every component in the sound section, what is my best bet for fixing this defect?—A. R., Erie, Pa.

The most likely component that would be causing the trouble you describe is the 10-μf electrolytic capacitor across the ratio detector output. As this capacitor ages it becomes increasingly leaky and changes the impedance of the ratio detector tuned circuit, shifting it out of alignment. When this capacitor is shorted, it will completely kill the audio.

Replace this capacitor with a new 10-μf 25-volt unit and adjust the ratio detector secondary for best sound—between the two buzz peaks. The trouble is almost certainly related to the ratio detector tuned circuit so, if replacing the capacitor doesn't help, replace all components that could affect this circuit's tuning.

Trailing whites

The picture on a G-E model 806 appears to have a smear that I can best describe as trailing whites. Details are also very poor. The vertical and horizontal sync is perfect so I have not checked these circuits. All tubes in the tuner, i.f. amplifier and video amplifier have been checked. I have a schematic of this receiver and have checked many of the d.c. and signal voltages but still have not been able to come up with the answer.

I have made an attempt at alignment and the bandwidth of the r.f. and i.f. circuits is apparently correct. I tried changing one of the peaking coils in the video amplifier but that made matters worse.—T. W., Odgen, Utah

It appears that you have a lot of checking ahead of you in the video amplifier circuit. The trailing whites generally indicate phase shift and poor low-frequency response in the video amplifier. This is a general trouble and not restricted to this receiver. Replace the 5,100-ohm detector load resistor and the 3,300- and 4,700-ohm video amplifier load resistors. In some cases a change in value of as little as 20% can seriously deteriorate the picture. Often the peaking coils maintain the high-frequency response when this occurs. But since you also have poor detail, you should carefully check or replace these coils as well.

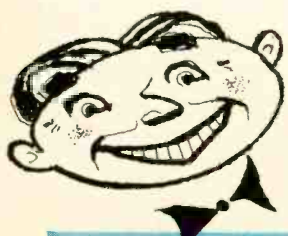
In the first video amplifier there is a 10-μf capacitor decoupling an 18,000-ohm resistor from the plate circuit—replace it. If its capacitance should decrease, its decoupling action falls off and the effective plate load resistance is increased, degrading the picture. In addition, check all coupling and bypass capacitors.

Despite your alignment it is still barely possible that this is the trouble. In checking the i.f. response, carefully locate the video carrier and be sure that it is approximately 50% down on the i.f. response curve.

Delayed a.g.c.

A Sylvania 508 chassis came in with a complaint of a negative picture. A bench check showed the trouble to vary from a negative picture to one with a great deal of snow. Because of the snow we suspected that the tuner was at fault and replaced the tubes and checked for low plate voltage. Further checks included the video i.f. amplifiers, but no luck. Would appreciate suggestions.—E. R. M., New Haven, Conn.

Snow in the picture is generally a tipoff of trouble in the tuner. However you did not mention measurement of an important voltage, the a.g.c. This chassis has a 2-μf capacitor in the a.g.c. line that frequently becomes leaky or open, developing excessive a.g.c. voltage. This attenuates the sig-



nal, causing snow. Try shorting the tuner a.g.c. to ground; if the snow clears up and the picture returns to normal, that capacitor is almost surely the trouble.

If replacing this capacitor fails to clear up the trouble, measure the a.g.c. voltage. If it appears high or if shorting the a.g.c. line to ground clears up the trouble, check every component in the a.g.c. circuit. Should the a.g.c. line be functioning properly, you can best pinpoint the trouble by tracing out the signal path, starting at the r.f. amplifier, by using an oscilloscope and suitable demodulator probe.

60-cycle hum

An Emerson TV receiver, model 651C (chassis 120124), came in recently that seemed like a routine affair. The trouble was hum in the picture with approximately half the screen fairly dark. The field man replaced every tube in the set while in the home, but nothing helped. At the shop all tubes were rechecked on the possibility that he had replaced a tube with heater-cathode leakage with another defective tube. All checked O.K.

Checked with a scope, the video amplifier revealed nothing. I then looked over all wiring for possible stray coupling, with particular attention to the vertical sweep circuits. There was no hum in the audio and the shading appeared on the raster and with a picture. I would appreciate some hints on what could be causing this trouble.—K. S., Tampa, Fla.

You were certainly on the right track in checking all tubes for heater-cathode leakage. However, with the hum appearing on the raster without a signal, it would more or less eliminate all tubes in the tuner and i.f. section. Hum passes through them only by signal modulation.

The video amplifier will pass a 60-cycle signal since it must pass the vertical sync pulses. Thus any heater-cathode leakage originating in any tubes in the video amplifier will be passed on to the picture tube. The video detector should be considered as part of the video amplifier. However, the i.f. amplifiers are designed to pass signals in the i.f. 20- or 40-mc band and will not pass a 60-cycle signal. But when a signal is passing through the i.f. amplifier, the hum modulates it and it is detected in the video amplifier.

You did not mention checking the picture tube itself. Do this first, as it is a very likely source of this type trouble. Also, make sure the hum is 60-cycle and not 120-cycle. Should there be two bars on the screen, the trouble could very well be coming from some defective B supply capacitor or some other component in the plate or screen circuit of one of the tubes.

A most probable source is a defective .002-μf capacitor in the vertical retrace blanking circuit. This circuit feeds the picture-tube cathode. Open this circuit and observe the screen. END

tv dx

October–December

TV dx in the final quarter of the year will be largely of a tropospheric nature in the first part of the period, with the short winter sporadic-E dx season coming along in the last two or three weeks of 1955. October will see some of the best v.h.f. and u.h.f. weather of the year, particularly along both coasts and over the Middle West. This sort of thing is associated with warm days and cool nights, so Southern areas will experience quite a bit through November and even into December.

Sporadic-E skip (signals usually heard or seen over distances of 600 to 1,200 miles) will show up rarely until well into December. The winter period, spaced either side of the shortest day of the year, usually features short openings. These are likely to be scattered geographically and of a single-hop nature. There is little of the country-wide dx that so many of our observers reported during June and July, but the dx-er who keeps a close watch of the low TV channels only during the summer season misses some good bets.

The Over-50 TV DX Club boasts a dozen new members whose complete records, along with those of the original group, will be published in the summary of 1955's dx, to appear in a later issue. If you have logged more than 50 different TV stations, and report dx catches to us regularly, send in your totals with each report. Include the number of stations you have identified positively, listing v.h.f. and u.h.f. separately. Be sure to include date and time.

New members: Gordon Simkin, Fort Lee, Va.; Donald Sanford, Viola, Wis.; Richard Lowry, Temple, Tex. (who has some prize dx including YVKS-2, Caracas, Venezuela; KENI, Anchorage, Alaska, and PRF-3, Sao Paulo, Brazil); Parissa Cox, Visalia, Calif.; Barry Rossum, Mohall, N. D.; Michael O'Rourke, Mesick, Mich.; Frank Greene, Roswell, N. M.; Larry Velhorn, Indianapolis, Ind.; W. C. Stallard, Chambersburg, Pa.; Dennis Smith, Wasco, Calif.; Billy Sevier, Corpus Christi, Tex.; Don Martin, De Ridder, La.; Donald Middleton, Sanford, Fla.

Quite a few letters received by your TV dx Editor ask questions of various kinds. We'd like nothing better than to correspond with each of you individually, but the volume of mail is so great that it is out of the question. Sorry, gang, we simply cannot answer mail, except through the medium of these dx forecasts and summaries. END

TRAVEL AID for the BLIND

By T. A. BENHAM

Left—The Signal Corps Sensory Aid; above—as it looks in actual use.

MANY people have given much thought to the special problems pertaining to helping the blind get along in a society geared for sighted people. One major problem is concerned with making it possible for blind people to travel in safety and with assurance.

In 1943 the Signal Corps began the development of a travel aid to help blinded World War II veterans in their rehabilitation program. The scope of the problem soon included all blind people. Research went through several stages[1] to a point where RCA was contracted by the Signal Corps to manufacture 25 prototypes of their Sensory Aid for testing and evaluation.

The Signal Corps Sensory Aid (see photo) is an electronic device intended to aid blind people in travel by warning the user of discontinuities in the terrain and obstacles in his path. The principle of operation is as follows:[2] A beam of light interrupted 500 times per second is projected in a narrow beam from an optical system, strikes an object or the ground and is partially reflected into a second optical system. This second optical system focuses the reflected image on a perforated coding disk behind which is located a photoelectric cell. The output of the cell is fed through a four-stage amplifier to a vibrator in the handle of the instrument. The amplifier and vibrator are resonant at 500 cycles, the same frequency at which the light beam is "chopped." The coding disk interrupts the reflected light 4, 8, 16 or 32 times per second, depending on the distance to the object.

Thus, the repetition rate of the 500-cycle pulses in the handle informs the user as to the distance to an obstacle or discontinuity in the terrain; the position of the handle indicates the azimuth—that is, whether the obstacle is to the left, right or straight ahead. Fig. 1 is a block diagram of the device; Fig. 2 shows how the instrument is used to locate a curb. When looking for curbs, the light from transmitting lens T (Fig. 2) strikes the ground at the edge of a down curb at point A and is reflected to receiving lens R, giving a distance signal of 6 feet (the instrument is held so that the light from T strikes the ground about 6 feet in front of the user). As the user advances slightly the beam of light from T misses the edge of the curb and hits the ground at B and reflects to R. This causes the distance signal to increase suddenly from 6 feet (T to A) to approximately 7 feet (T to B).

This sudden change in range of 1 foot is detected by a very subtle change in the vibrator signal in the handle of the instrument. Furthermore, obstacles cannot be detected until they are closer than 6 feet although, if stepdowns are neglected and the beam is projected horizontally, obstacles can be de-

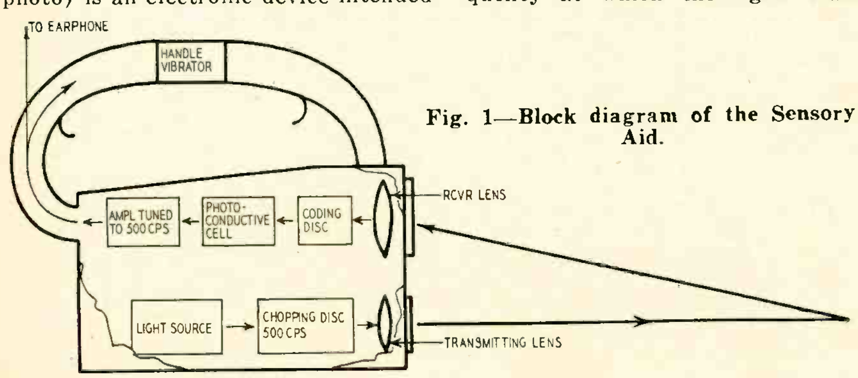


Fig. 1—Block diagram of the Sensory Aid.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tected when they are 10 or 12 feet away. If the instrument is used for locating curbs, the user must be constantly attentive to a continual signal in which very subtle changes occur.

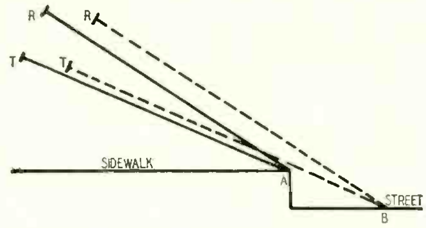


Fig. 2—Diagram illustrates how the Sensory Aid is used to locate curbs.

The testing program

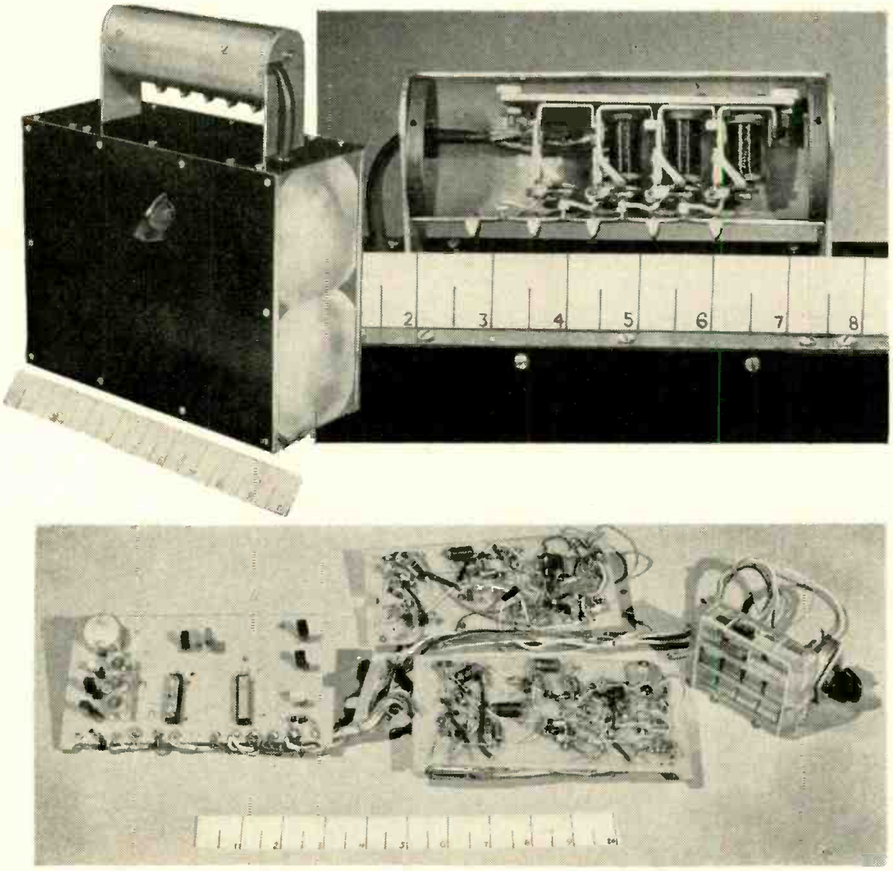
Representing a cross-section of the blind population, 67 subjects were tested: 9 used seeing-eye dogs as guides before trying this electronic travel aid, 16 used a cane, 40 a sighted person and 2 no guide. Of the cane users 8 were willing to change from cane to Sensory Aid; 3 of the 8 who preferred the cane said, "I prefer the feeling of firm contact with the ground which a cane affords."

Subsequent to the testing program, the 67 subjects were classified as follows: 9 excellent, 9 good, 23 fair, 15 poor, 11 dropped. Of the "dropped" category 6 resulted from sickness of the trainer. Each subject was required to travel an unknown course at the end of his training.

It was decided to choose ±20% of the normal time for a sighted person as a maximum permissible deviation; anyone who traveled slower than this was considered too slow for proper evaluation of the instrument. This does not mean that the instrument was not of considerable value or aid to such a subject. Nineteen came within this ±20% tolerance.

Of those tested 37 had difficulty in detecting curbs. This was chiefly due to the fact that the curb signal was an extremely subtle and fleeting change in the distance signal which occurred when the beam of light passed over the edge of either an "up" or "down" curb. An "up" curb appeared as a momentary slight decrease in distance; a "down" curb as a momentary increase in distance. False curb signals were frequently obtained because of the change in distance to the point where the light fell on the ground (a result of instrument jiggling).

It was evident that there is a need for a curb detector not affected by the irregular movements of the hand as the user walks. Eight had no particular trouble, 12 had difficulty detecting obstacles. Six were unable to perform the necessary scanning motion with the wrist to "see" obstacles slightly to the right or left. Four found the change in reflectivity of different surfaces bothersome. The difference in reflectivity appeared as a change in the intensity of the reflected signal.



Top left—The recently developed guidance device; top right—closeup of the interior of handle; below—interior construction of the guidance device.

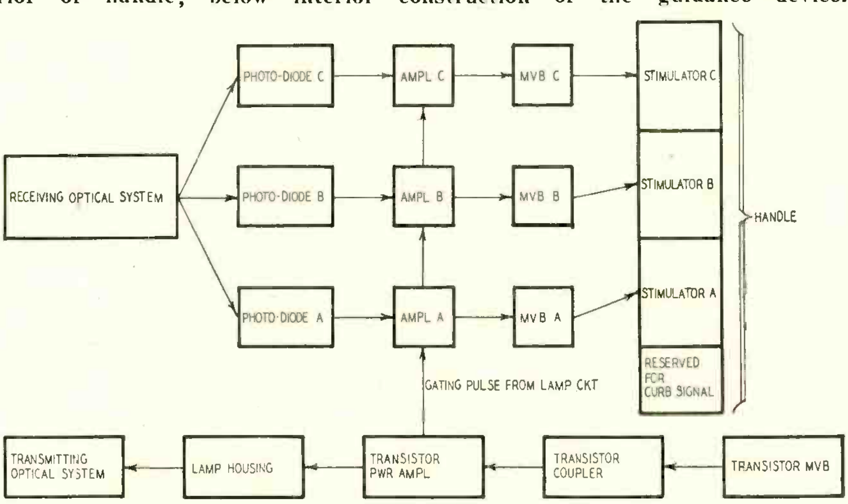


Fig. 3—Block diagram of a recently developed type of obstacle detector.

The change in intensity was sometimes interpreted as a change in distance. Twenty said that the weight of 4.5 pounds was excessive. All subjects found the continual signal presentation tiring.

To discover what would happen if the instrument were used over a prolonged period, 5 subjects used it in their everyday life over a period of 6 months to a year. The novelty did not wear off, the subjects became *more and more dependent* on the Sensory Aid. They were most anxious to have the instrument repaired when a failure occurred and they used it as much, or more, than their previous travel aid.

The results of this program indicate that the two most important improvements required for future development are: separate curb and obstacle detectors, which remain quiescent until there is information to be transmitted; separate curb and obstacle signals (stimulae) sufficiently distinct so that the user has no difficulty recognizing them. The slight changes in the continual signal were not sufficiently emphatic to alert the subject under all conditions, especially after the first 10 or 15 minutes, when fatigue set in.

The testing program has indicated conclusively that in the final production of a satisfactory travel aid, models

ELECTRONICS

of varying complexity should be provided. Some blind people are not capable of assimilating information at as high a rate as others and are confused by having more information presented than they are capable of interpreting.

A three-year development program got under way on Feb. 1, 1953, with the signing of a contract between the Veterans Administration and Haverford College at Haverford, Pa.

It was desired to construct a travel aid that did not have any moving parts and which required much less battery power. To make a simple, probe type obstacle detector would not be too difficult; a satisfactory curb finder much more so.

Recent design

Since the contract got under way, considerable progress has been made. The third experimental obstacle detector (Fig. 3) is nearing completion. Instead of the relatively cumbersome motor, chopper and incandescent lamp which consume about 900 mw, a pulsed gas-discharge lamp is used having a power consumption of about 50 mw. A xenon lamp is operated by a transistorized power supply consisting of a multivibrator, a coupling transistor and a power amplifier. This circuit produces a pulse of 200-μsec duration at a repetition rate of 20 pulses per second with a peak value of about 40 volts. This pulse is superimposed on 80 volts of battery potential to provide a peak of 120 volts, the potential required to "fire" the lamp.

After the lamp "fires," the voltage drops to about 100 where it stays for 200 μsec. When the transistor power supply "turns off" at the end of the pulse, the voltage drops to 80 and the lamp extinguishes. Thus, the transistor power supply has to supply only about one-third of the voltage required to "fire" the lamp.

The light reflected from an obstacle is focused on one of three photosensitive germanium diodes, depending on the distance to the obstacle. If the obstacle is closer than 4 feet, the reflected light falls on diode A; between 4 and 7 feet, on diode B and between 7 and 10 feet on diode C. The signal from each of these diodes passes through separate transistorized transformer-coupled amplifiers. The output of each of these amplifiers triggers a transistor multivibrator, the output of which drives the stimulator in the handle of the instrument.

Thus, if diode A is illuminated, amplifier A triggers multivibrator A which in turn operates stimulator A. Stimulator A in turn communicates with the index finger of the hand. Channel B stimulates the middle finger and channel C the fourth finger. Such a three-channel parallel system (see photo) should be a distinct improvement over a one-channel system because, even if one channel fails for some reason, the other two can still operate. The signal amplifier does not

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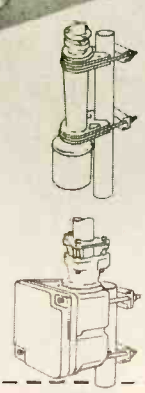

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Available in Canada thru Atlas Radio Corp., Ltd., 50 Wingold Ave., Toronto have to supply power to the stimulator but simply serves as a switch to turn on the multivibrator. Since this amplifier is gated by the lamp pulse, the vibrator is silent except when there is information to be given to the user. This gating action affords an additional advantage because the amplifier is "turned off" so that no transient signals can get through except during the 200-μsec period that the lamp is on.

The total battery drain for the complete system with one stimulator operating is about 165 mw broken down as follows: lamp, 80 ma at 100 volts, consumes 8 watts peak. With a duty cycle of 250 this corresponds to an average power of 32 mw. The lamp drive circuit is approximately 70% efficient so that the total power required to drive the lamp is about 50 mw. Each channel consumes approximately 7 mw and each stimulator plus multivibrator 75 mw. Of course, if all three stimulators are operating simultaneously, which might occur occasionally, the total power drain would be approximately 300 mw. The stimulus for warning curbs and steps would come from a fourth channel activating the little finger.

In the Signal Corps device the lamp was on all the time. This is a waste of power since it is necessary to take a "look" only occasionally and for a brief instant. In the above model a "look" is taken for 200 μsec only 20 times per second.

It may be possible to use even shorter duration using surface-barrier transistors recently developed by Philco, producer of a special photosensitive surface-barrier diode for this project. At the present writing results are promising. The noise level of this transistor is comparable to and perhaps better than previous types and the frequency response characteristic appears satisfactory for pulse durations as short as 50 μsec. A channel using pulse durations as short as this would require surface-barrier transistor amplifiers. A preliminary model of such a channel has been constructed having a gain of 60 db and which appears to have a frequency response flat to about 0.5 mc with a noise level no higher than the Johnson noise.[3]

Thus, the obstacle detector seems pretty well established. However, the curb-locating problem is far from settled. We are planning to project a portion of the otherwise-wasted light through an optical system which would focus it on the ground about 6 feet in front of the user. A second receiving lens mounted at the top of the instrument would be focused on this spot. The image of the spot would fall on a photosensitive surface-barrier transistor, the output of which would be treated in a manner similar to that in channels A, B and C. The output of the curb channel would be applied to a multivibrator, with the output operating the fourth stimulator in the handle. This channel would work in

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reverse to the other three channels in that, as long as a signal was received, the multivibrator would not operate. When a curb came into the region where the spot of light struck the ground, the signal would disappear because no light would be reflected into the curb receiving system. This would allow the multivibrator to operate the stimulator, not an ideal solution for three reasons: It requires that the instrument be held reasonably steady, which may not be easy to do in normal walking; changes in reflectivity of the surface of the ground may cause false signals (one particularly bad change in reflectivity is that produced by a mud puddle); the system will not detect "up" curbs.

The stimulators located in the handle of the instrument (see photo) are somewhat unique. The handle is shaped to fit a wide range of hand sizes. The four fingers fit into small finger grooves in the bottom of the handle. The fingers are separated by a thin partition. Inside the handle are four small solenoid-operated plungers. When the armature moves, it pushes a small round probe through a hole in the bottom of the handle. This probe pokes against the skin of the finger between the first and second joints.

The region between the first and second joints was chosen because the weight of the instrument comes naturally on this area so that it is a relatively fixed position between the finger area and handle. It was found that, if the user became tense and began to squeeze the handle, the operation of the probing stimulator was not seriously affected.

The coil of the stimulator was designed to match the output of the transistor circuit. The multivibrator triggered by the signal and which operates the stimulator is adjusted to have a duty cycle of approximately 0.5; that is, it is on half the time and off half. This is necessary because it would not be practical to use the same duty cycle as for the lamp pulse.

The obstacle problem will not be completely solved by any electronic device under consideration at this time. A blind person would be warned of an impending danger by the obstacle detector, 8 or 10 feet in advance. It would enable him to make measures to "skirt" around" the obstacle, thus avoiding embarrassment and potential injury. One of the problems encountered in testing the Signal Corps Sensory Aid was the tendency for the blind to stop to analyze the obstacle in an effort to determine its nature. He was constantly reminded, "Don't identify it, miss it." END

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[1] Franklin Cooper, "Guidance Devices for the Blind." *Physics Today*, Vol. 3, No. 7, pp. 6–14. July, 1950.

[2] For a technical discussion of the instrument, see *Electronics*, March, 1946, page 116. McGraw-Hill.

[3] F. E. Terman, *Radio Engineering*. McGraw-Hill, 2d edition, page 229.

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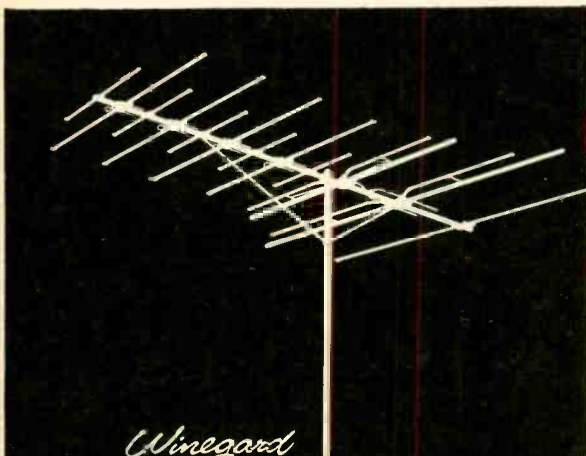

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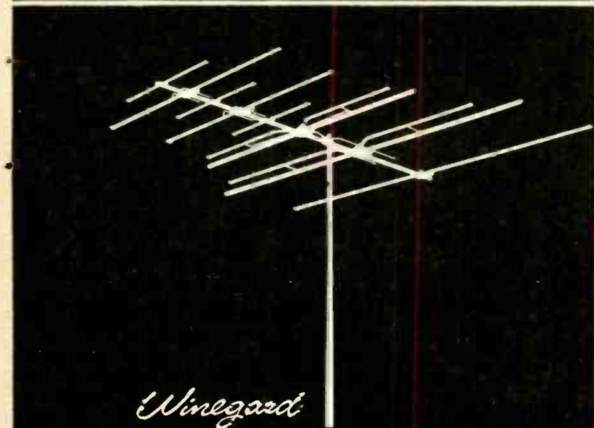

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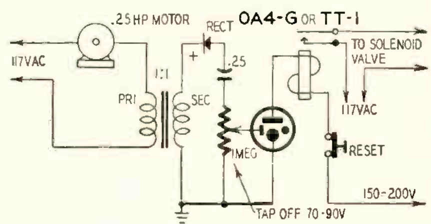
ELECTRONIC INDICATOR AIDS EMULSIFICATION

By HARRY PEACH

EMULSIFIERS have many applications. Resins and similar materials may be made into an emulsion (a mass dispersed in a liquid) and used to waterproof wires or reinforce insulation. Plastics are frequently thus carried by emulsions and used for thin films or coatings.

Water absorbed by an emulsion indicates its efficiency. In this method the amount of water that an emulsion will take on before breaking down is accurately determined.

To test its efficiency, the emulsion is put in a bowl and stirred by a motor. Water is added. When the emulsion breaks, there is a sharp drop in the viscosity (resistance to flow). The motor current indicates the apparent viscosity of the emulsion. The more current the motor draws, the greater the viscosity. When the viscosity breaks down, there is a sharp drop in motor current. The amount of water added before the emulsion breaks down is a measure of its efficiency.



In this setup (see diagram) the emulsion is stirred by the motor, and water is added continuously at a slow rate. A ¼-horsepower a.c. motor is used in series with the primary of a 1:1 turns-ratio transformer. The secondary of the transformer is in series with a rectifier, capacitor and potentiometer. The center arm of the potentiometer feeds the control electrode of a TT-1 or 0A4-G cold-cathode triode. This tube is in a control circuit that regulates the flow of water and shuts it off when the emulsion breaks down.

Before the emulsion breaks down, the bias voltage across the potentiometer prevents the tube from firing. When the emulsion breaks down, the sharp drop in motor current creates a positive voltage on the grid and the tube fires. This activates the control circuit and shuts off the flow of water. Then a reading is made to determine the amount of water needed to break down the emulsion.

Once the tube is triggered, the relay contacts remain closed and the water supply is cut off at the solenoid valve until the plate supply is opened by the reset switch. A conventional single-throw switch may be used but a normally closed pushbutton or a normally closed spring-return slide, toggle or lever switch is recommended. END

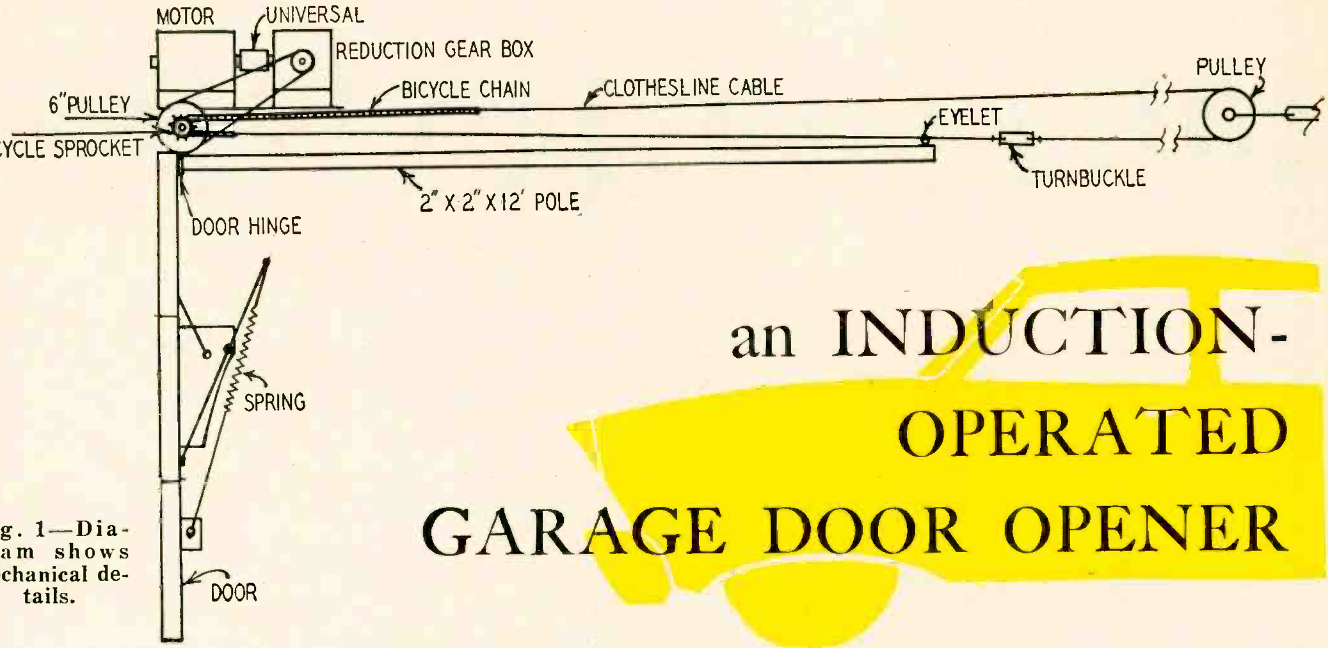


Fig. 1—Diagram shows mechanical details.

an INDUCTION-OPERATED GARAGE DOOR OPENER

By RICHARD FRIEDMAN*

AUTOMATION in the home is one of the fields in which great strides have been made in recent years. We accept automatic heaters, refrigerators, stoves, clock-radios and even television receivers as commonplace, but the grin-and-bear-it task of opening and closing the garage door is, in most homes, a manual operation. After many years of involuntary servitude to the garage door, from which temporary relief was too often found by leaving the car out "just tonight," the inherent laziness that fosters all inventiveness finally took over.

Immediately the problem reduced itself to two phases: the selection of a suitable linkage that would be simple, trouble-free and inexpensive, and, second, a means of remote control from the car which would be simple, foolproof and again inexpensive.

The linkage

The design of a simple linkage to open and close the garage door will vary depending upon the type of door used and whether it folds open, opens sideways or overhead. Of the overhead variety, there are several types. The most popular seem to be those in which the door pivots about two centers as it is raised or lowered. This type is in my home. It is a particularly difficult linkage to mechanize as the motion of the door is not about a single pivot point and is not linear.

This problem was resolved by using a system of driven cables and pulleys (Fig. 1). A 12-foot 2 x 2 was attached to the top center of the door by a door hinge, and the other end connected to a galvanized-iron clothesline cable by a ½-inch eyelet screw and two cable clamps (all from Sears Roebuck).

*Coleman Engineering Co., Los Angeles, Calif.

The prime mover for the system was obtained by purchasing a second-hand agitator type washing machine with a gear-driven wringer for $10. This furnished an excellent ¼-horsepower induction motor, easily reversible and with a good gear reducer.

An induction motor will run continuously in either forward or reverse direction, depending only upon the direction in which it is started. There are two windings in this type of motor—a "run" and a "start" winding. To reverse the motor merely requires that the "start" winding be reversed with respect to the "run" winding. It is, therefore, necessary to modify the motor to the extent of bringing both wires from both windings out of the motor separately. Do not tamper with the centrifugally operated switch. It is used to disconnect the "start" winding when the motor has reached running speed.

The gear reduction is not sufficient in itself and requires an additional 3:1 reduction in a V-belt drive system. A 2-inch pulley is attached to the output shaft of the gear reducer and in turn drives a 6-inch pulley attached to an arbor. The clothesline cable is driven by the arbor which has a 2½-inch diameter bicycle sprocket attached to the other end. A 10-foot portion of the cable is replaced by standard bicycle chain which provides a positive drive for the system.

The induction motor, gear and V-belt speed reducers are placed on a shelf which is solidly mounted to the frame work of the garage just above the center of the door.

Limit switches to control the operator are placed on one of the door hinges (see photo) and should operate before the door reaches the end of its travel, as the door requires a short overtravel to coast to a halt after being shut off. This adjustment is not critical, but should be provided so as not to subject the entire system to excess and unnecessary stress which might cause damage.

Due to the irreversibilty of the worm-gear drive in the washing-machine speed reducer, manual operation of the door will no longer be possible. This has the advantage of self-locking, though an emergency override should be provided.

The control circuit is shown in Fig. 2 with the door fully closed. War surplus

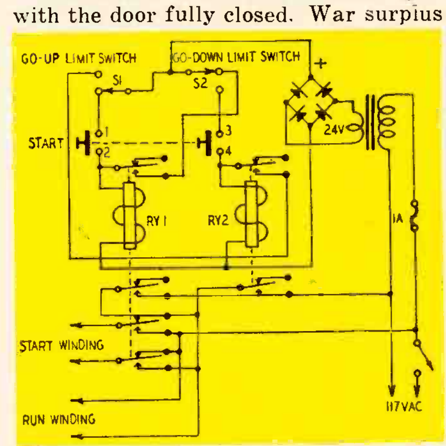


Fig. 2—Garage door control circuit.

28-volt relays may be used throughout with sufficient power being provided by a 24-volt filament transformer with a full-wave bridge rectifier. All the operations can be handled by two relays, RY1 and RY2, in which RY1 could be called the "go-up" relay as it is operated during the going-up operation and RY2 the "go-down" relay by the same reasoning. (The four-pole relay specified for RY1 was not immediately available so I used two double-pole units with coils in parallel.) Motor reversal is

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handled by the contacts of RY1 with power being controlled by either relay. The two relays are wired so that when the door is down and the pushbutton actuated, RY1 operates through the contacts of S1 and will "lock in" through the contacts of the "go-down" limit switch S2 which will release RY1 when the door has reached the "up" position. The pushbutton need be only momentarily depressed as lock in is almost instantaneous.

The remote controller

The problem of operating the garage door operator by remote control is a real tough one. Photoelectric circuits, radio and ultrasonic transmitters, pressure plates, capacitance relays and sonic-operated devices are nothing new and are fairly easy to design and build. But each of these falls down in some respect in meeting the standards of a good remote control—simple, trouble-free, and, above all, foolproof. None of the aforementioned systems are in themselves fool- or tamperproof. For examples, the photoelectric system is usually actuated by any opaque object interrupting the beam or by light from reflections or headlights on the sensing element. Radio is by nature subject to other transmitters on the same frequency. Ultrasonic devices can be operated by a great many ultrasonic sounds which are commonplace, but, of course, never heard. To achieve a foolproof system almost any of the above can be elaborated upon, but it is doubtful whether the more elaborate system would still be simple.

Of all the systems considered, the old, faithful key-operated switch attached to a pipe set in the driveway entrance seemed the most suitable. However, the seldom-used induction transmitter soon showed itself to be the best means of remote control when considered from all aspects.

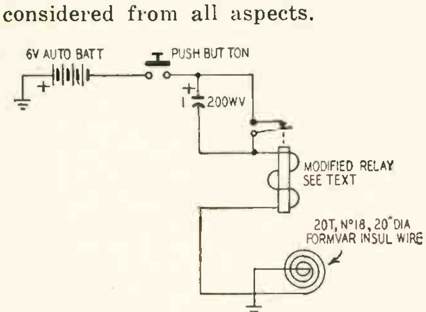
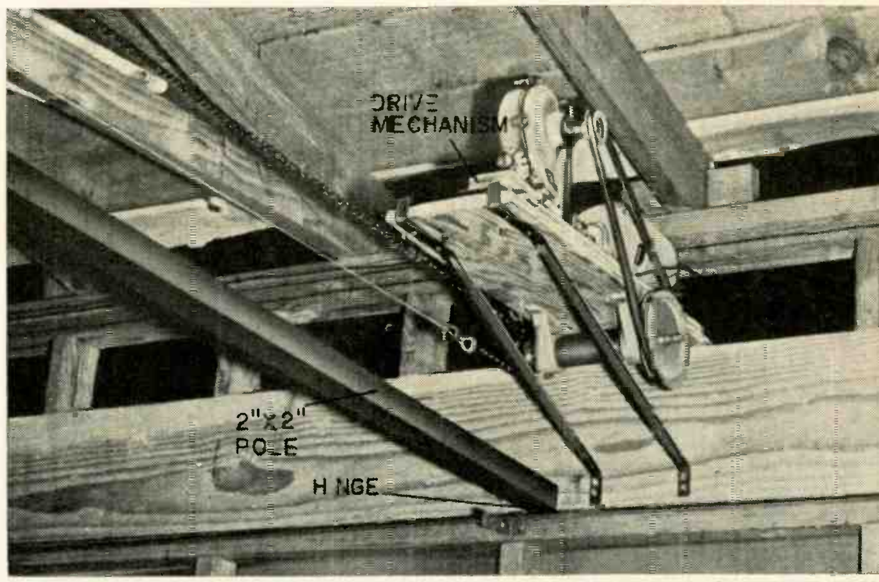
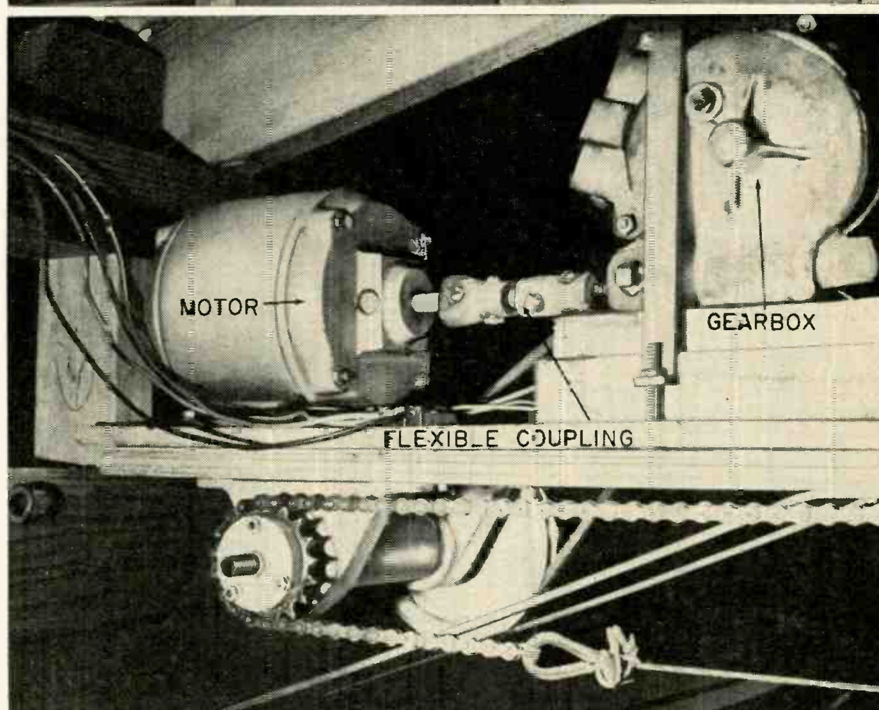


Fig. 3—Induction transmitter diagram.

The induction transmitter (Fig. 3) requires a simple buzzer-excited coil suspended underneath the car. When the pushbutton, mounted just under the dashboard, is depressed, the buzzer excites the coil with pulsating direct current which sets up a field detectable from a considerable distance. Reliable operation was obtained with as much as 6 feet of separation between transmitting and pickup coils.

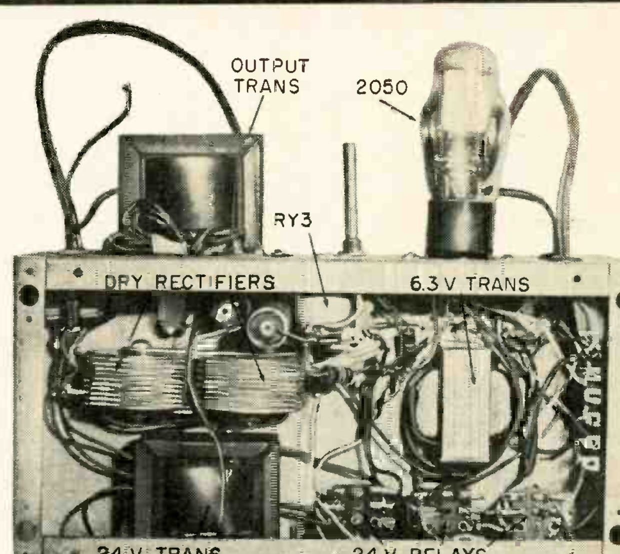
The buzzer is a war-surplus, midget power type relay rewound with No. 20 Formvar insulated wire to provide a





Top—The completed garage door operator.

Center—A closeup of the operator assembly.



Right — Physical layout of receiver chassis.

high-current pulse. The capacitor shown across the relay points protects them against arcing and provides a good clean square wave to excite the transmitter coil. Failure to include this capacitor will materially shorten the life of the contact points and lessen the transmitter's effectiveness.

Because of the comparatively long range of the system, reliable operation was obtained by burying the coil in the grass just alongside the driveway. Thus there was no need to tear up concrete or asphalt.

The receiving station (Fig. 4) uses a small thyratron type tube, a 2050 or 2D21. Do not use the cold-cathode types as they cause insensitive and erratic operation. The saving in heater standby current is not worth the extra trouble and spontaneous operations.

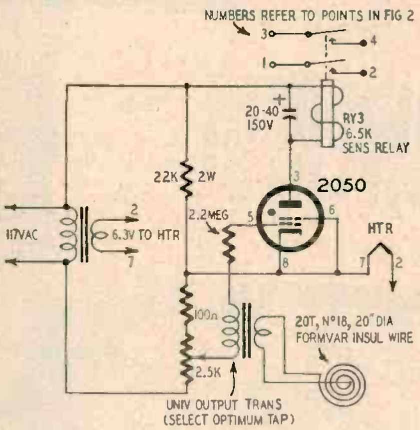


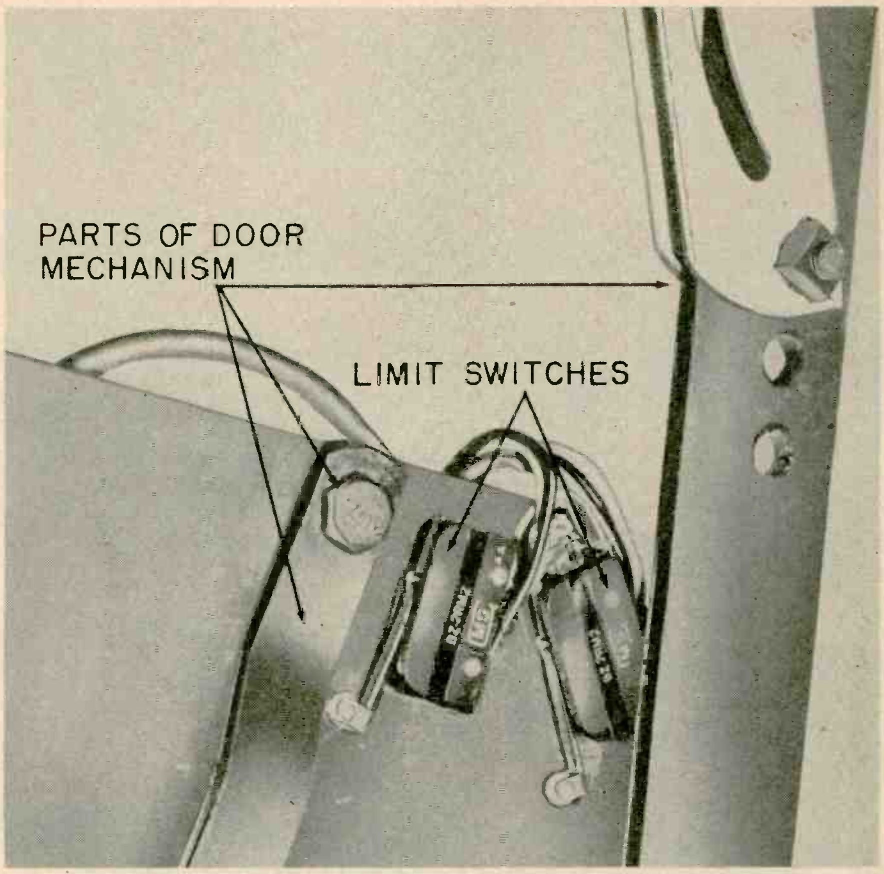
Fig. 4—Diagram of receiver circuitry.

Any sensitive type relay having an impedance between 5 and 15,000 ohms may be used in this circuit. Use a reasonable high-capacitance filter capacitor across the relay to filter the current during the conduction half-cycles.

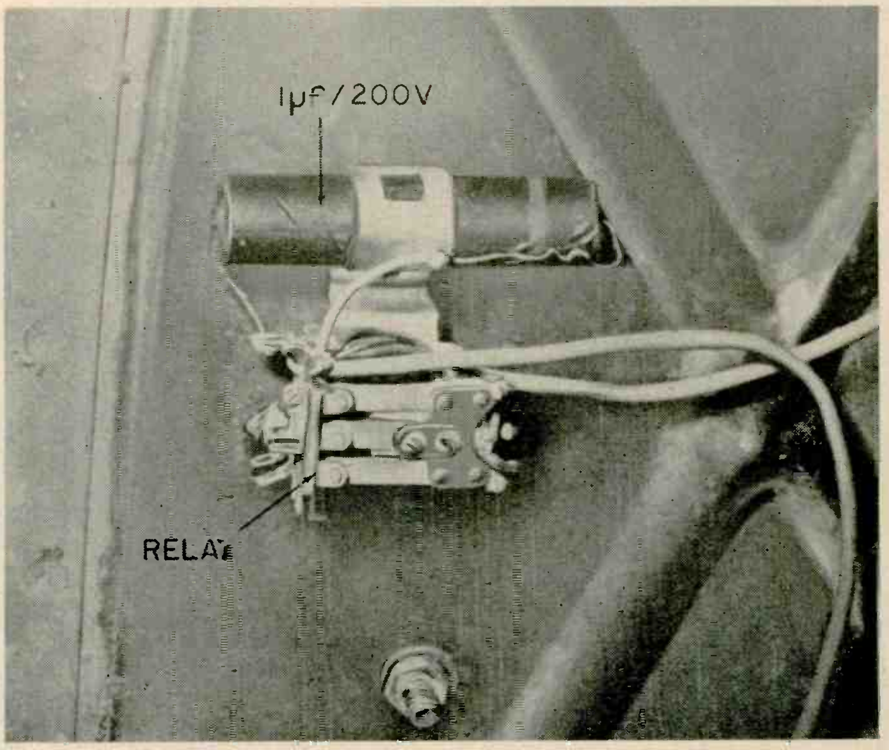
Parts for garage door opener

1—100-ohm resistor, ½ watt; 1—2.2-megohm resistor, ½ watt; 1—22,000-ohm resistor, 2 watts; 1—2,500-ohm potentiometer; 1—1-μf 200-volt capacitor, 1—20-40-μf capacitor, 150 volts, electrolytic; 1—2050 or 2D21 tube and socket; 1—pushbutton switch for transmitter; 1—power type relay, modified (see text), for transmitter; 2—coils, 20 turns No. 18 Formvar insulated wire, 20-inch diameter; 1—filament transformer for tube; 1—universal output transformer; 1—relay, d.p.s.t., RY3, 6,500 ohms, sensitive; 1—24-volt filament transformer; 4—selenium rectifiers for bridge (size to suit relays); 1—pushbutton, d.p.s.t.; 2—snap-action switches; 1—relay, RY2, d.p.s.t., surplus 28-volt unit; 1—relay RY1, 4-pole double-throw, surplus 28-volt unit; 1—¼-hp induction motor; 1—length galvanized-iron clothesline cable, eyelet screw and cable clamps; gear-reduction assembly, V-belt system (see text); bicycle sprocket and chain; 1—12-foot 2 x 2 pole.

Since the remote controller has been installed there have been no failures. One rather amusing incident did arise—a form of relaxation oscillation took place within the thyratron when the standby bias was advanced near the firing threshold. The oscillations do not close the relay so they are not objectionable, although an ominous ticking can be heard on a broadcast receiver when it is slightly detuned—it certainly had everyone wondering about it for a while. END



Snap-action switches on mechanism control motor operation and direction.



The control transmitter on the splash-pan or similar surface below the car.

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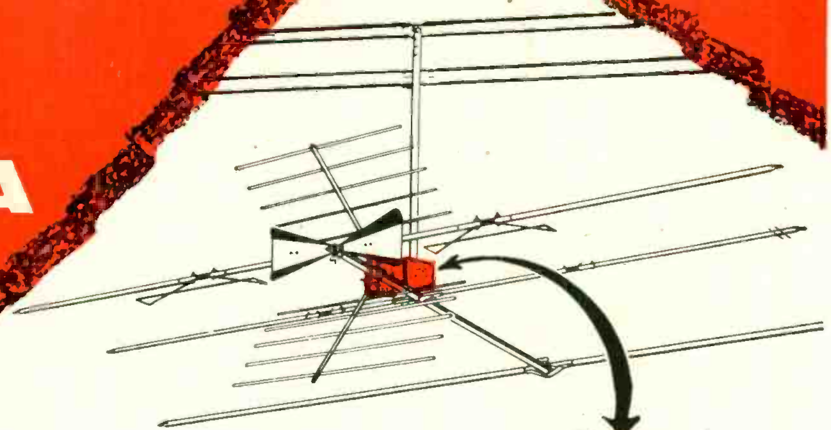
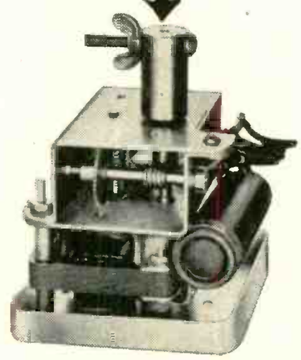


MODEL RO2-83 ILLUSTRATED



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Compact enough to fit in all attics, this **VEE-D-X** Rotenna provides Better Picture Quality than the average outdoor antenna . . . without climbing on Rooftops . . . marring the appearance of the house.

Installed within minutes—never affected by Rain, Sleet, Snow or Windstorms. Compact Rotator unit has long life motor—rotates in either direction.

Beautifully designed control console operates with convenient downward pressure, available in Heather Green or Cordovan Mahogany.

- **Complete Kit—Antenna—Rotator—Console—50 ft. 300 ohm transmission line—50 ft. 4 wire rotator line—isolation network for UHF-VHF—4 dual-line stand off insulators—Aluminum Mast**
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Technotes

NO RASTER, NO SOUND

A Motorola chassis TS-292C-00 uses the audio output tube (a 6W6-GT) as a voltage dropper in a form of stacked B supply distribution system. Low emission of this tube results in no sound and no raster since the B plus bus, fed through this tube, supplies the screen of the horizontal output tube and plates and screens of some of the i.f. amplifiers.—*J. A. McRoberts*

EARLY STROMBERG-CARLSONS

In models prior to the 116, the focus control action can be improved by removing the 47,000-ohm resistor (R286) shunted across the focus potentiometer and series resistor R285. This change will permit proper focus near the mid-range of the focus control.

To reduce the area of the beam spot on the picture-tube screen for improved focus, increase the voltage supplied to the picture-tube screen. This can be done by disconnecting the screen lead from the video amplifier screen supply and connecting it through a 100,000-ohm resistor to the boosted d.c. voltage at the No. 3 terminal of the horizontal output transformer. The screen side of the resistor is bypassed to ground with a .01-μf capacitor. This modification was made in later models. —*E. M. Breckenridge*

RCA KCS 49

A customer complained of no control of brightness and picture tear and general instability. A voltage check on the picture tube socket showed 2[illegible]0 volts on the control grid. The trouble was a defective .015-μf coupling capacitor connected to the grid of the picture tube. A 400-volt unit, it was replaced with a 600-volt capacitor.—*Jacob Dubinsky*

HIGH-VOLTAGE RESISTORS

Some Philco receivers have come up with burned out high-voltage resistors. The resistor is a 2-megohm unit connected from pin 1 of the first 1 x 2 to the plate cap of the second rectifier. Usually, replacing one or both of the rectifier tubes will eliminate the trouble. If this does not help, adjust the horizontal drive control.

This adjustment is very important, and many service technicians simply adjust for maximum picture width. This should never be done. Besides causing the resistor failure, it often

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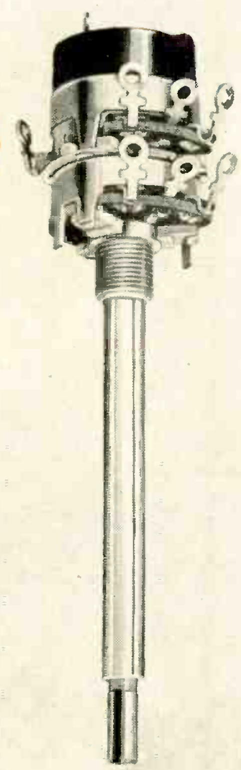

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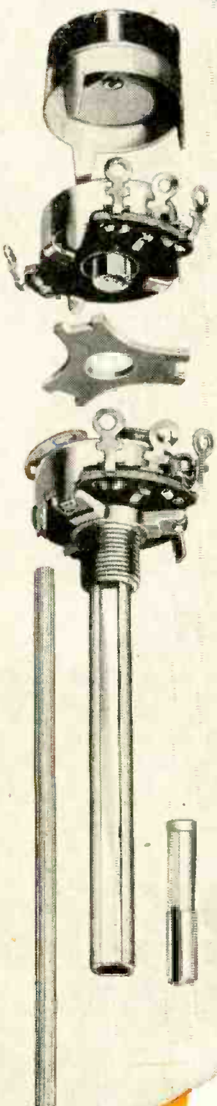

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damages the horizontal output tube. However, if everything checks O.K., just replace the resistor. Do not use standard type resistors. The manufacturer's type are usually longer, high-voltage types, to prevent possible flashover.—*Milo Bannister*

BUZZ IN CROSLEY

Buzz in Crosley's 10, 11 and DU series is often caused by a low-capacitance 10-μf 25-volt capacitor connected between pins 2 and 7 of the 6T8. Replace the unit and touch up the ratio detector adjustments till sound is O.K.—*Vincent Maniccia*

INSUFFICIENT WIDTH

In RCA chassis KCS-92 and KCS-93 there may be a considerable reduction in width due to a change in the inductance of the width coil.

If the width shrinks about 3 inches, it is possible that the inductance of the width coil has changed due to heating of the core. In this case it should be replaced.—*RCA Service Co.*

EMERSON MODEL 673B

This set was very troublesome because it had several defects at once. The complaints were no picture or sound and smoke pouring from the set. The 6J6 and 6AG5 tubes in the tuner were checked. The 6J6 was shorted, the other burned out. Replacing these restored voltage to the heaters, but still no picture or sound.

A check showed no a.c. going to the selenium rectifiers. An open plug-in 3.5-ohm ballast was found on top of the chassis. This was corrected by connecting a 5-ohm 10-watt resistor in place of the ballast. We now had plate voltage but found the 12AU7 video output tube getting red hot. This was caused by a shorted .05-μf capacitor connected between pin 2 of the 12AU7 and pin 6 of the 12AT7.

Replacing the tube and capacitor restored the video and audio, but the picture had a peculiar negative quality. This was traced to the 5,600-ohm resistor in series with the plate of the 12AU7. The positive grid on that tube had caused excessive current flow through the resistor, burning and cracking it—its resistance had dropped to 200 ohms. Replacing this capacitor corrected the trouble.—*Jacob Dubinsky*

RCA AM–FM 6-RF-9

Some early production models have an abnormal amount of hum, especially when the volume control is operated at or near the low-tap position.

This is caused by incorrect lead dress of R17, a 27,000-ohm resistor, from the low tap of the volume control. This resistor, in some receivers, was dressed very close to an a.c. lead from the power transformer.

To correct this trouble dress R17 away from the transformer and other a.c. leads and toward the chassis.—*RCA Service Co.*

TVI ON EMERSON 712F

Interference appeared on the screen of an Emerson chassis 120169B (model 712F) on channel 7. It looked similar to 4.5-mc grain. Other sets have shown the same type of interference with bars on the screen or whistles in the sound. A common horizontal output circuit causing this trouble is the direct-drive type.

The trouble is caused by a parasitic in the plate circuit of the horizontal output tube which resonates at about 160 to 200 megacycles. In this particular case, the frequency was in the passband of channel 7, some 4 megacycles removed from the picture carrier. Other frequencies will cause different patterns or sound TVI on other channels. This trouble may be suspected if removing the antenna lead-in results in a great reduction of the station signal but only a very small reduction in interference.

Insert an r.f. choke (about 2μh, or a few turns of wire) in the plate lead of the horizontal output tube.

If this doesn't help, insert a 1-watt resistor of about 47 to 100 ohms in the plate lead of the output tube. A piece of plastic spaghetti should be slipped over the inserted resistor or coil for insulation.—*James A. McRoberts*

PHILCO AM-FM RECEIVER

This eight-tube unit came into the shop with a complaint of interference. After spending a lot of time searching for the trouble, it was found that when the set was switched in the FM position, the primaries and secondaries of the first AM and FM i.f. transformers were shorted out. Cleaning the switch contacts eliminated the trouble and prevented the i.f. signals from entering the amplifier, causing the interference.
—*John Flint*

STROMBERG-CARLSON NOTES

To improve the range of the focus control in model 16T, the resistance in series with the control should be changed to 68 ohms. The present 220-ohm unit can be paralleled with another for satisfactory results if a 68-ohm resistor is not available.

In the TC-125 model there has been considerable trouble with the locking-in action of the vertical hold control. This can be considerably improved by changing the resistors in the cathode circuit of the 12AU7 sync clipper. The original 560-ohm unit should be changed to 1,200 ohms; the 3,300-ohm resistor should be decreased to 2,500 ohms.

To eliminate a noisy volume control in the TV12 model, add a 0.1-μf capacitor between the range switch and the top of the volume control. This will prevent any d.c. from flowing through the potentiometer.—*George Anglado*

16-INCH MAJESTIC

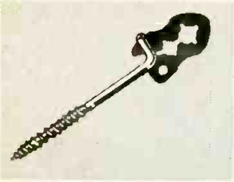
The complaint on this set was no picture. A check showed the high voltage working O.K. and the 1X2 lit. The screen voltage and grid bias were as they should be, but still no raster. I then disconnected the grid lead and the raster appeared.

A check of the circuits around the 12AU7 video output tube showed the .05-μf coupling capacitor from the plate to the grid of the 12AU7 measured only 1,200 ohms. The capacitor was replaced with a 600-volt unit and the set worked perfectly—that is, after also replacing the 12AU7 and the picture tube which were damaged by the component failure.—*Jacob Dubinsky*

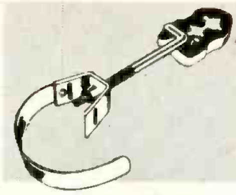
TESTING 1X2's, 1B3's

Many old tube testers do not give accurate tests on rectifiers of the 1X2 and 1B3 type because more than one base pin is connected to the same filament terminal, creating a sort of internal corona ring. This arrangement reduces the filament voltage, giving an inaccurate reading.

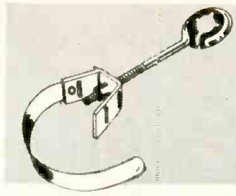
To overcome this, make two adapters —use octal tube bases with an octal socket for the 1B3 and a nine-pin noval socket for the 1X2. In the 1B3 adapter, pins 2 and 7 of the socket are connected to pins 2 and 7 of the base. In the 1X2 adapter, pins 4 and 5 of the socket are connected to pins 2 and 7 of the base. Both tubes can thus be tested regardless of the internal connections of the tubes.—*Hyman Herman* END



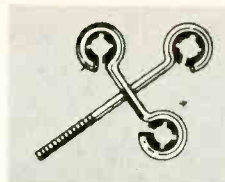
TELCO E-Z "SWING IN" STAND-OFF
Wood screw type, 3½"; UHF-VHF
No. EZ-8027 $4.80/C



TELCO E-Z "KANT-STRIP" STAND-OFF
"Swing In" type; 3½", 9" strap
No. EZ-8253 $0.13



TELCO "KANT-STRIP" STAND-OFF
Round insulator, 3½" 9" strap
No. 8253 NET $0.11



TELCO 3-WAY STAND-OFF
For 3-line use, 7½", wood screw
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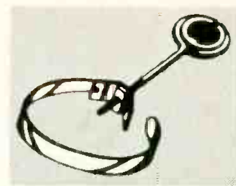
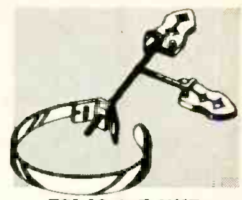
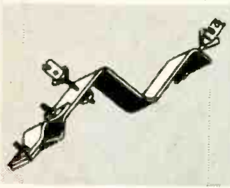


TELCO NUT-TYPE STAND-OFF
Welded 10-23 nut, 3½", 9" strap.
No. 8253-N $0.12



TELCO E-Z NUT-TYPE STAND-OFF
Tougher, inline duplex, 7½", 9" strap.
No. EZ-8258-N $0.24



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Easy to install; complete
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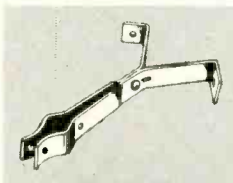

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Fits masts to 1¾" complete.
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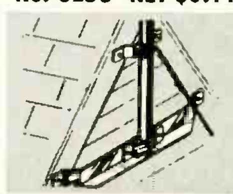

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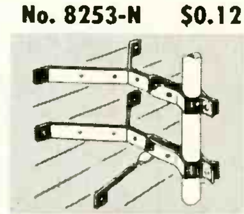

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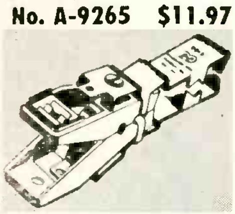

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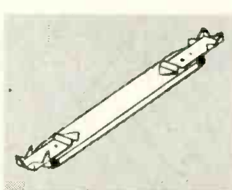

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All one piece, plastic, metal ends
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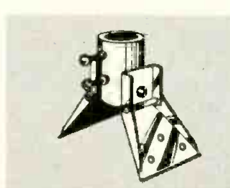

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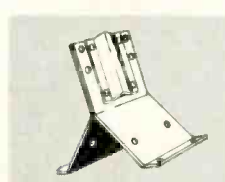

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Fits masts to 1¾" use every where
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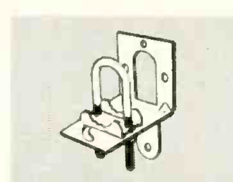

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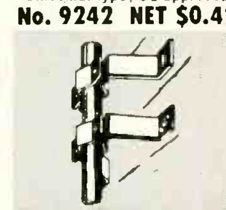

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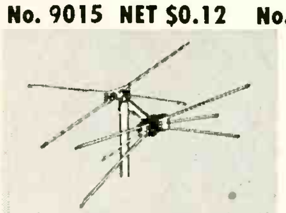

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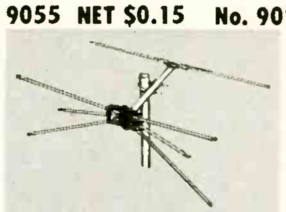

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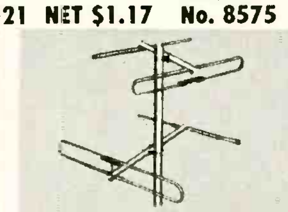
Single bay, 8 element, VHF-UHF.
No. A-110 NET $3.45



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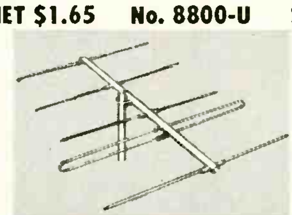

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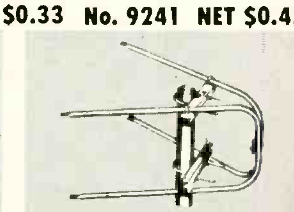

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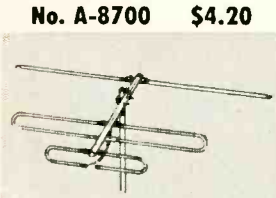

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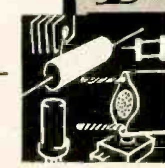

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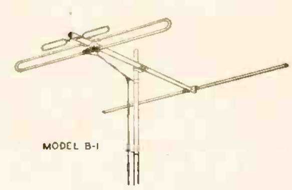
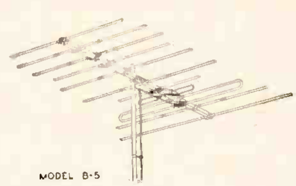


Model B-3 (suburban to fringe areas—75 miles or more): low-band and 3-element collinear high-band reflectors; inductance-tuned combination director for



low and high band. *Model B-4* (deep fringe areas—150 miles or more): low-band and 3-element high-band reflectors; low-band full half-wave and two 3-element collinear high-band directors. *Model B-5* (fringe area —200 miles or more): multiple low-band reflectors and directors, high-band collinear reflectors and directors.—**Finney Co., 4612 St. Clair Ave., Cleveland 3, Ohio**

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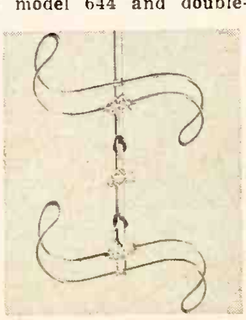
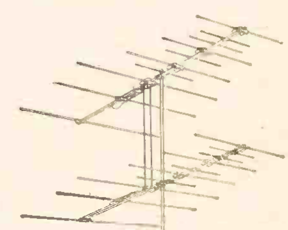


model 645) with *Twin-Driven* feature, for use where greater gain is required.—**Technical Appliance Co., Sherburne, N. Y.**

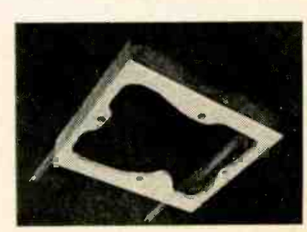
ANTENNA, *Telrex Super Thunder Bird model T-120:* single bay. *Model T-122:* 2-bay array, quarter-wave stacked for gain increases averaging 3 db on all



channels. *Model T-122-S:* half-wave stacked 2-bay array for low-channel emphasis, provides gain increases over single-bay unit to 4.5 db on channels 2 to 6. —**Telrex Inc., Asbury Park, N. J.**

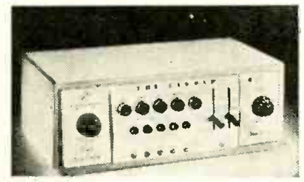
CONICAL V.H.F ANTENNAS, *Welco Zee-Beam,* for efficient high- and low-band v.h.f. reception. Anodized elements of red, green, blue, gold.—**Welco Mfg. Co., Burlington, Iowa**

HI-FI ACCESSORIES, *Cabinart,* includes 20 cabinet kits, 11 unpainted hi-fi cabinets, 15 designs in several woods, Klipsch-designed Rebel speaker enclosures. 10-unit storage wall. *Model*



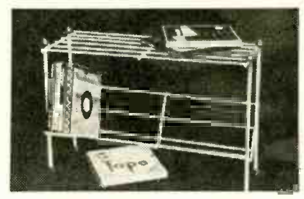
ACC-1 (illustrated) is an assembled record changer or player box, precut, with phono slides premounted for installation.—**Cabinart, 99 N. 11 St., Brooklyn 11, N. Y.**

MASTER AUDIO CONTROL, *Fisher series 80-C,* includes complete mixing and fading facilities for from 2 to 5 channels, tape input to operate directly from tape playback head, 16 combinations of phonograph equalization, calibrated loud-



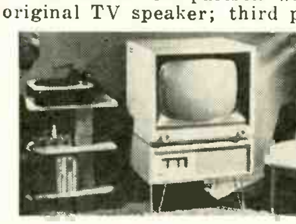
ness balance control, pushbutton channel selectors which select audio input channels and operate a.c. power to auxiliary equipment, individual channel-indicator pilot lights. Frequency response: 10 to 100,000 cycles.—**Fisher Radio Corp.**, 21-21 44 Dr., Long Island City, N.Y.

STACK-A-RACK, *Leslie Creations,* holds either 225 single 45-r.p.m. records, more than 160 extended-play albums, or over 30 recorded-tape or 45-r.p.m. album boxes. 22 x 14 x 9 inches.



Top shelf will hold radio, record player, etc.—**Leslie Creations**, P. O. Box 9516, Dept. 194, Philadelphia 49, Pa.

HI-FI SPEAKER, *Jensen TV Duette,* replaces small speaker of table model TV's. 3-position switch allows comparison with original TV speaker; third po-

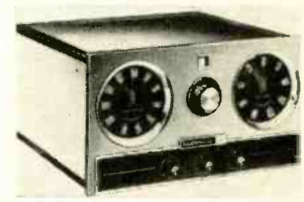


sition transfers Duette to other equipment. *Model DU-500* has compression-driver horn-loaded tweeter, 6 x 9-inch oval woofer. *DU-400* has direct radiator tweeter. Both 24 inches deep with top surface 17¼ inches above floor.—**Jensen Mfg. Co.**, 6601 S. Laramie Ave., Chicago.

DYNAMIC LAVALIER MICROPHONE, *Turner model 58,* for TV, broadcast, recording and PA. Uses versatile Dynaflex diaphragm. Response 60–13,000 cycles; level −57 db at high impedance. For high or low impedance by matching proper conductors at terminal end of cable. *Model 58A* wiring permits selection of 50- or 200-ohm imped-

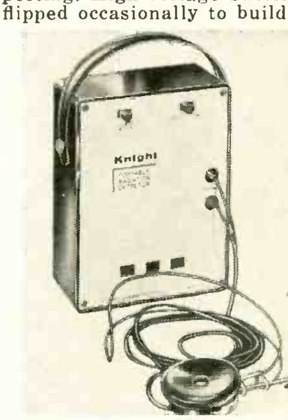
ances only by same method. Supplied with neck cord and support clip, but can be used in hand. —**Turner Co.**, 933 17th St., N. W., Cedar Rapids, Iowa.

BINAURAL TUNER, *Electro-Voice model 3303,* AM-FM tuner and music control center. Covers broadcast and FM bands. Preamplifier; 6-position equalizer for phono records; 5 inputs with 4 chassis level controls, 2 chassis hum adjustments. Output is cathode follower. Total tubes 19; output 1.25 volts. FM sensitivity 1 μv for 20 db quieting; AM section



5 μv for 2 volts a.v.c. Three-position *presence* switch, bass control −20 to −15 db at 50 cycles, treble control −15 to −20 db at 10 kc.—**Electro-Voice, Inc.**, Buchanan, Mich.

KNIGHT GEIGER COUNTER Kit, supplied with precut wire, solder, leather carrying handle, shoulder strap, headphone, batteries, radioactive sample, AEC manual on uranium prospecting. High-voltage switch is flipped occasionally to build up



operating voltage for activating Geiger tube. 1B85 G-M tube provides sensitivity of 0.2 milliroentgen. A 22½-volt hearing-aid and 1½-volt A battery provide 80 hours of continuous operation.—**Allied Radio Corp.**, 100 N. Western Ave., Chicago 80, Ill.

ELECTRONIC PHOTOFLASH KIT, *Illini 300,* uses standard batteries, provides high-quality 100-watt-second output from its 300-volt operation range. For daylight color film. Battery–capacitor unit in leatherette-covered carrying case. Lightweight universal mounting bracket. Instructions and pictorial diagrams are supplied. May be powered by *AC-2-300* power pack (another kit).—

Illinois Condenser Co., 1616 N. Throop St., Chicago, Ill.

DEPARTMENT OF COMMERCE
BUSINESS AND DEFENSE SERVICES ADMINISTRATION
WASHINGTON 25

AUG 1 1 1955

Mr. George Eannarino
Director, Rectifier Division
Sarkes-Tarzian, Incorporated
415 North College Avenue
Bloomington, Indiana

Dear Mr. Eannarino:

The current work stoppages in the copper industry have very seriously affected the production of selenium. A survey made by the Business and Defense Services Administration has found that there is sufficient high-purity selenium available for less than a month's average production of rectifiers.

In view of the seriousness of the situation, I am asking you to help yourself, the rectifier industry as a whole, and those industries to which you supply vital components by making every effort to recover all discarded selenium rectifiers. The program I suggest is as follows:

(a) Immediately contact all your distribution outlets to request their customers to return discarded rectifiers to them.

(b) Immediately request your distribution outlets to collect and return to you all discarded rectifiers of your brand.

(c) You have the selenium in the discarded rectifiers reclaimed for your account.

Such a program should result in an annual reclamation of approximately 20 per cent of the total amount of high-purity selenium used. This will somewhat ease the seriousness of the shortage which we face.

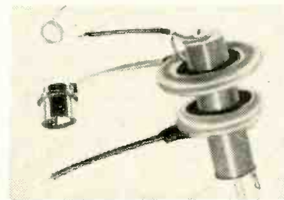
Your wholehearted cooperation in this recovery program is of importance to the national economy.

SARKES TARZIAN INC.
RECTIFIER DIVISION
AUG. 15, 1955

Very truly yours,

H. B. McCoy
Deputy Administrator

REPLACEMENT TRANSFORMERS, *Merit HVO-38* (illustrated) replaces Admiral 79C60-1, 79C60-5, 79C60-7. *HVO-54* replaces Admiral 79C60-2, 79C60-3, 79C60-4. *HVO-40* replaces

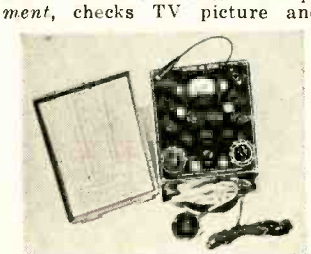


Silvertone T80-320. *HVO-37* replaces Silvertone 55B253, 55D-253; Hallicrafters 55D251, 55B-253, 55D253, 55B266, 55D266; Crosley 157820-5-1, 157820-6, 158481-1, 158481-2, 158481-5, 158481-3-5; Sentinel 20E995.—**Merit Coil & Transformer Corp.,** 4427 N. Clark St., Chicago 40, Ill.

TUBE-TESTER KIT, *General Electronic Equipment 327A*, tests all tubes in use in modern radio. FM and television sets including color TV. For reactivating picture tubes, testing for shorts and leakages; transmitting, hearing-aid, magic-eye,

voltage regulator, miniature tubes, etc. Free-point selector system circuitry. Double fuse protection for meter and transformer. Loose-leaf book with tab-indexed tube chart cards allows for insertion of additional cards. Illustrated detailed instructions for building-it-yourself.—**General Electronic Equipment Co.,** Mantua and Glendale Sts., Easton, Pa.

TV TUBE CHECKER, *U. S. Electronic Research & Development*, checks TV picture and



other tubes in 20 seconds. Steel-cased, weighs 6½ pounds.—**U. S. Electronic Research & Development Corp.,** 1605 W. Lafayette, Detroit, Mich.

LINEARITY PATTERN GENERATOR, *Heathkit model LP-1*, for adjusting monochrome or color TV receivers. Extended operating range covers channels 2–13; unused channel can be used for linearity ad-

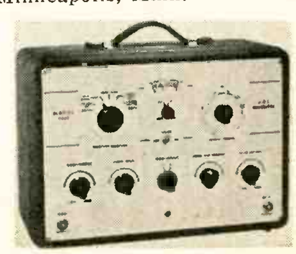
justments. Regulated power supply. Compact and self-contained. Produces 6 to 12 vertical or 4 to 7 horizontal bar, cross-hatch or white dot pattern. Individual horizontal and vertical frequency controls allow synchronization and establish aspect ratio. R.f. carrier modulated with video and sync signals.—**Heath Co.,** Benton Harbor, Mich.

COLOR BAR AND DOT GENERATOR, *Hycon model 616*. Three color sequences identified and selected on front panel. Color band A is the complete

NTSC sequence. Band B has four bars: G – Y at 90°, R – Y, B – Y, black. Band C consists of black, I, Q, black. Quadrature signals held within 1°. Black vertical or horizontal bars or black cross-hatch pattern, with number of bars independently variable. Convergence adjustments made with white dot pattern, number of dots variable.—**Hycon Mfg. Co.,** 365 S. Arroyo Parkway, Pasadena, Calif.

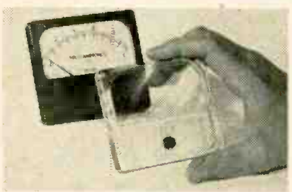
TUBE TESTER, *Seco GCT-5*, detects positive grid in amplifier tubes where circuit has high grid resistance. Checks

grid emission, leakage, gaseous conditions and shorts.—**Seco Mfg. Co.,** 5015 Penn Ave. So., Minneapolis, Minn.



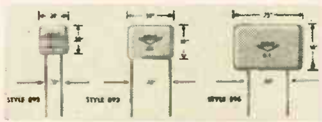
DOT GENERATOR, *Triplett model 3438*, checks video r.f., i.f., sync and color circuits with modulated r.f. (channels 2 to 6) and i.f. (20 to 55 mc) outputs available. Horizontal (15,750 cycles) and vertical (60 cycles) sync pulses for checking sync circuits. Horizontal bars (480 to 600 cycles) and vertical bars (crystal controlled at 189 kc) for checking linearity on black-and-white and color. Cross-hatch used to check overall linearity with 11 vertical and 8 horizontal bars. Square block produced for cross-hatch pattern. White dots to check convergence of color TV. Will produce red, blue and green spectrum and colors corresponding to phases of R – Y, B – Y, I and Q axes.—**Triplett Electrical Instrument Co.**, Bluffton, Ohio.

METERS, *Weston model 1331*. Self-shielded movement eliminates intereffect of closely mounted instruments, permits mounting on magnetic or non-



magnetic panels. One piece snap-on front with zero corrector. Front surface, except for window area, in any color. In d.c., rectifier type a.c.—**Weston Electrical Instrument Corp.**, 614 Frelinghuysen Ave., Newark 5, N. J.

HIGH-CAPACITANCE CERAMICONS, *Erie Resistor*. Phenolic-dipped coating, wax-impregnated No. 22 hot-tinned copper leads. Rectangular; 3 sizes: *style 892*, 0.34 x 0.34 inch; *style*

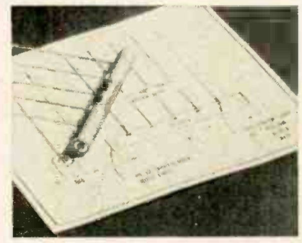


893, 0.58 x 0.43; *style 896*, 0.75 x 0.56. For transistor and other miniaturized circuitry. Value range from .0022 to 0.1 μf; 200-volt rating. — **Erie Resistor Corp.**, Erie, Pa.

REMOTE CONTROL DEVICE, *Hallicrafters Tun-o-magic*, cylindrical control, with 20-foot

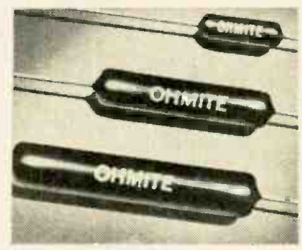
cord to TV set. Pushing control button switches channels. Switch on side turns set on or off. Can be used on most TV sets.—**Hallicrafters Co.**, 4401 W. 5th Ave., Chicago, Ill.

SELENIUM CARTRIDGE RECTIFIER, *International Rectifier 60-6979*, for strobe flash units and similar instruments requiring high transient peak currents for capacitor charging. Single-phase full-wave bridge selenium unit. Delivers 9.6 ma average current, 190 ma peak pulse current at 495 volts with



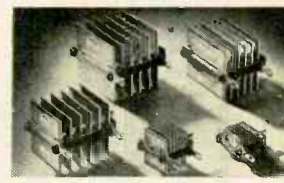
d.c. capacitive load. 3⅛ inches long, ⅜ inch O.D. with 3½-inch radial pigtail leads. 6-32 threaded brass inserts at both ends for easy mounting.—**International Rectifier Corp.**, 1521 E. Grand Ave., El Segundo, Calif.

WIRE-WOUND RESISTORS with axial leads, steatite cores, vitreous enamel coating in extensive range of sizes and watt-



age ratings. Smallest only ¼ inch diameter by 19/32 inch length overall, rated at 3 watts. Two sizes, rated at 5 and 10 watts, in wide range of resistance values.—**Ohmite Mfg. Co.**, 3678 Howard St., Skokie, Ill.

SELENIUM RECTIFIERS, 5 *RCA* universal types for general replacement use in TV receivers, radios, phonographs, etc. Cover all current-handling requirements from 50 to 500 ma. Corrugated metal separators (between each pair of plates and anchored firmly to U-clamp surrounding the stack of plates), conduct current from



one rectifying surface to next while their open-work construction permits better heat radiation. — **Tube Division, Radio Corp. of America**, Harrison, N. J.

POCKET ROLL KIT, *Xcelite 99 Junior*, combination handle and 11 tool bits: 7 smaller-size nut driver shafts (3/16 through ⅜ inch), 3/16- and ¼-inch slotted screwdriver bits and Nos. 1 and

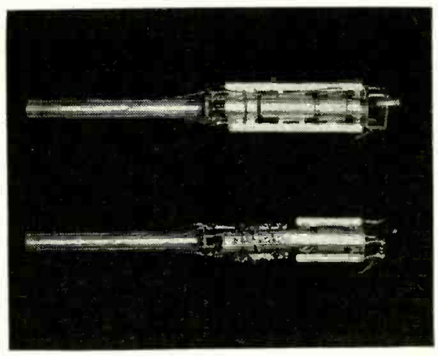
2 Phillips. Two extra pockets for extra tools.—**Xcelite, Inc.**, Orchard Park, N. Y. END

All specifications given on these pages are from manufacturers' data.

new Tubes & Transistors

LARGE-SIZE television picture tubes requiring no external ion-trap magnets have been announced by G-E. They include four 21-inch types—the 21BAP4, 21BCP4, 21BDP4 and 21BNP4—and one 24-inch unit, the 24ZP4.

TV picture-tube operation without the use of external magnets is made



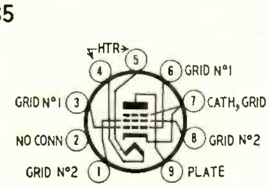
possible by a new straight gun (see photo) and an improved processing technique controlling the thickness of the aluminum coating inside the tube face. The aluminum coating is thin enough to permit the electrons to penetrate and activate the phosphor, but thick enough to stop the larger ions that cause phosphor burns.

6AU4-GTA

A half-wave vacuum rectifier tube of the glass octal type, the 6AU4-GTA, has been announced by RCA. It is particularly suited for use as a damper diode in monochrome and color television receivers.

The 6AU4-GTA is rated to withstand a maximum peak inverse plate voltage of 4,500. It can supply maximum peak plate current of 1,150 ma (1,050 ma for the 6AU4-GT) and maximum d.c. plate current of 190 ma (175 ma for the 6AU4-GT). Negative peak pulses between heater and cathode of as much as 4,500 volts, with a d.c. component of as much as 900 volts, may be used when the heater is operated negative with respect to cathode.

12AB5



12AB5

A beam power tube of the nine-pin miniature type, the 12AB5, has been announced by RCA. It is designed for use in the output stage of an automobile radio receiver operating from a 12-volt storage battery. The base connections of the 12AB5 are shown in the diagram. Its electrical ratings are identical with those of the octal-based 12V6-GT.

5604

A general-purpose, forced-air-cooled triode for communication and industrial service, the 5604, has been announced by RCA. It has a maximum plate dissipation rating of 10 kw and can be operated with full ratings at frequencies as high as 25 mc.

In unmodulated class-C service, the tube has a maximum plate voltage rating of 12.5 kv and a maximum plate input rating of 32.5 kw. When operated class C at a plate voltage of 12 kv, a single 5604 has a power output of approximately 22.5 kw. END

HARD-HITTING TRANSMITTER

To demonstrate the ruggedness of their surface barrier transistors, Philco has built a miniature transmitter using these semiconductors into the head of a hammer (see photo). The hammer is banged on a hard surface and the transmitter continues to operate, indicating the ability of this type of transistor to take hard shocks without disturbing its operation. Philco is using these transistors in computer development.

Radio Thirty-Five Years Ago
In Gernsback Publications

HUGO GERNSBACK
Founder

Modern Electrics	1908
Wireless Association of America	1908
Electrical Experimenter	1913
Radio News	1919
Science & Invention	1920
Television	1927
Radio-Craft	1929
Short-Wave Craft	1930
Television News	1931

Some of the larger libraries still have copies of ELECTRICAL EXPERIMENTER on file for interested readers.

In October 1921 *Science and Invention* (formerly *Electrical Experimenter*)

Testing Insulators and Controlling Power Systems by Radio

Home-Made Electric Phonograph, by Carl Mayer, Jr.

A Practical Radio Telephone Set, by Arthur H. Lynch

Technicians News

UNITY CONFERENCE SET

At a meeting of delegates from electronics service organizations held in Pittsburgh on Aug. 7, it was decided to hold a conference in Indianapolis on Oct. 9 to discuss and implement unity of all electronic service groups.

The Pittsburgh meeting was attended by representatives from service associations in Indiana, Minnesota, Missouri, New York, Ohio and Pennsylvania. Chairman was Bert Bregenzer of Pittsburgh, one of the chief organizers of the gathering. Prominent among those who took part in the discussions were Max Liebowitz, president of the National Electronic Technicians and Service Dealers Association (NETSDA); Vincent Lutz, vice president of the National Alliance of Television and Electronic Service Associations (NATESA) who read a letter from Frank Moch, and John Hemak, recently very active in the formation of the Minnesota state organization, Minnesota Television Service Engineers, Inc. (MINTSE).

An encouraging letter was read from the National Appliance and Radio Dealers Association (NARDA) which had been invited to send representatives but had been unable to do so. Letters were also read from secretaries of service associations in Alabama and Connecticut.

The group organized to forward the work of unity and especially to make arrangements for the coming Indianapolis conference, under the temporary name Television Service Council, with unity of the whole radio–television service industry as its objective. Bert Bregenzer was named chairman, with the provision that the chairmanship be rotated. Gordon Vrooman of Syracuse was elected secretary pro tem.

PIX TUBES ON CREDIT

A plan by which the service dealer can sell his customer a picture tube on credit and be reimbursed immediately by the distributor has been announced by J. T. Thompson, General Electric manager of distributor sales. The plan, says Mr. Thompson, will cover not only the cost of a G-E picture tube, but also any G-E receiving tubes and parts required to complete the service job, including the labor charges, even if the job is a complete TV overhaul. The customer may pay as little as $5 down, with 6 months to pay the balance.

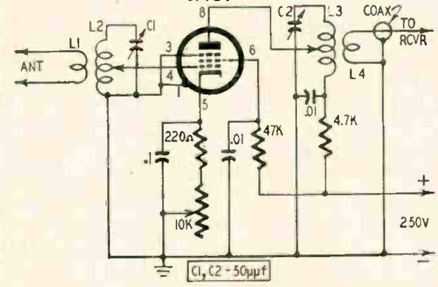
An important benefit from the service viewpoint, Mr. Thompson stated, is that it will create new service business. Set owners who have been postponing grid and ground leads in through a hole in the back cover and connect to the antenna through Fahnestock clips so the back cover can be removed without unsoldering wires. The 2.2-megohm resistor and .01-μf capacitor (see Fig. 2) can be mounted in the box. Slip the coil over the rod terminals inward; leave enough slack in the connections to allow the coil to be slid along the rod for alignment. A good starting position for alignment is with the end of the rod flush with the end of the winding. Its final position will not deviate more than ¼ inch from this.

The second major change made in the set is the modification of the gain control system. The a.v.c. was not completely satisfactory. The 1G6 has a rather early cutoff so, when used as a grid-leak detector, it distorts on signals larger than a volt or so. The a.v.c. system did not limit signals to that low a level and distortion was sometimes noticed on strong local stations. The a.v.c. system was removed and the volume control transferred from the audio stage to the screen circuit of the i.f. amplifier as in Fig. 2. Now the detector and audio stages operate at full gain and the input to the detector is limited by the volume control setting so distortion caused by detector overload can be eliminated. The detector grid resistor is reduced to 2.2 megohms and returned to the positive filament line to improve linearity. R-C networks were added to the converter input and i.f. amplifier grid returns to provide grid-leak bias. This change greatly increases the i.f. gain and selectivity and a 0.1-μf capacitor was added across the B supply to prevent oscillation. The on-off switch was changed to a double-pole type to open the B supply line and prevent the B batteries from discharging through the volume control.

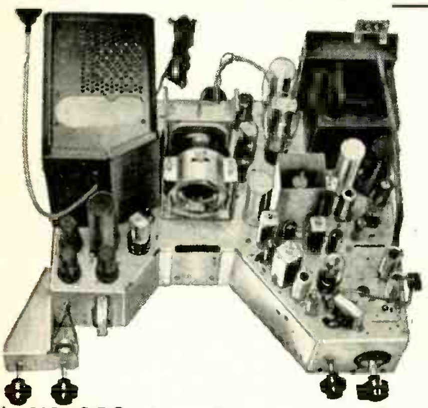
Align the set in the original article. Make the low-frequency r.f. adjustment by sliding the antenna coil over the ferrite rod. This adjustment is critical and should be made carefully, keeping the fingers away from the terminals or the winding.—*Charles Erwin Cohn*

HIGH-GAIN PRESELECTOR

If your present shortwave superhet has less than two stages of r.f. amplification, its performance can be greatly improved by the addition of a high-gain preselector. The improve-



THE #630 TV RECEIVER remains unmatched for quality and performance • • • RCA designed and developed this set quality-wise *not* price-wise • • • The original 10" set retailed at $375.00 • • • Subsequent TV sets serve to prove the sacrifice of quality for price • • • what better proof can there be of its superiority than the fact that it is the choice of TV engineers and TV technicians! Herewith we offer you—YOUR BEST BUYS IN TV!—All you pay is the price shown • • • Excise taxes have already been paid by us.



Build your own #630

Super De Luxe TV CHASSIS

With a

#630 SUPER DE LUXE 31-TUBE TV KIT

OPERATES 16" to 21" PICTURE TUBES ● Engineered in strict adherence to the genuine RCA #630 plus added features ● FULL 4MC BANDWIDTH ● CASCODE TUNER ● COSINE DEFLECTION YOKE ● LARGER POWER TRANSFORMER ● KEYED AGC ● 12" SPEAKER ● CONDENSERS and RESISTORS at rated capacities and tolerances. You receive a COMPLETE SET of PARTS and TUBES, everything needed is included (less CRT & wire). All I.F. Coils and Transformers are factory pre-aligned and tuned. You will enjoy building it with "LIFE-SIZE easy to follow step-by-step ASSEMBLING INSTRUCTIONS" included with each KIT.

slashed to **$99.99** **Same KIT for 27" and ALL 90° CRT's** **$110.39**

#630 SUPER DE LUXE TV CHASSIS

LICENSED UNDER RCA PATENTS

COMPLETE READY TO PLUG IN AND PLAY

Similar in features to the 16" to 21" TV KIT above.

Slashed to **$142.27** (less CRT)

DUMONT OR THOMAS PICTURE TUBES

BRAND NEW in Factory Sealed Cartons — With a Full Year Guarantee

17" #17BP4A $22.66 | 21" #21EP4B Aluminized $32.21 | 24" 90° #24CP4A Aluminized $48.99 | 27" 90° #27EP4A Aluminized $74.31

CUSTOM-BUILT CABINETS for #630 and all Other TV SETS—from FACTORY to YOU

5 NEW 1956 STYLES in genuine mahogany or walnut (blond 10% extra) • Ready drilled for any #630 TV chassis and cutout for any 16", 17", 19", 20" or 21" picture tube at no extras in price • Also supplied with undrilled knob panel for any other TV set • EVERYTHING NECESSARY for an easy perfect assembly is included • Each cabinet is delivered complete as pictured with mask, safety glass, mounting brackets, backboard, backcup, hardware and assembling instructions • Each cabinet is shipped in an air cushioned carton **from FACTORY to YOU!**

The GEM

Popular Table Model

H-25", W-26", D-22"

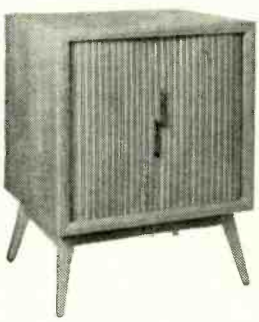
$35.91

GEM also available for 24" or 27" picture tube. H-31", W-27", D-23"

$59.54

The FUTURAMIC

Latest sensation in styling with tambour roll-in door.



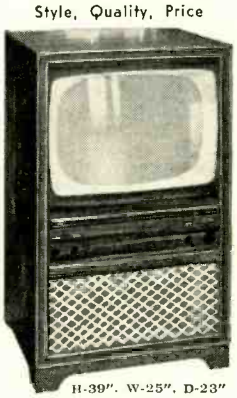
H-37", W-28", D-24¼"

Underneath mounting for 12" speaker

Slashed to **$79.34**

The MANHATTAN

Style, Quality, Price



H-39", W-25", D-23"

$53.43

MANHATTAN ....for 24" or 27" $79.22 H-46", W-30", D-24"

The WESTCHESTER

Choice of Interior Decorators, truly superb in every detail.

H-41", W-26", D-25"

$88.70

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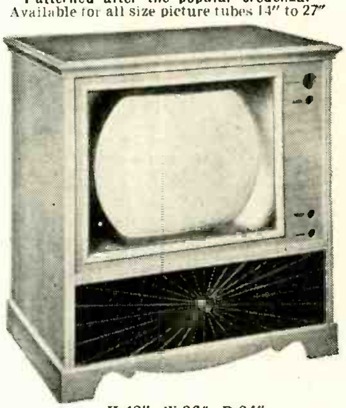

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ment in image ratio and signal-to-noise ratio will be most noticeable on the higher-frequency bands, and will be especially noticeable if your receiver has no r.f. stage at all.

The unit shown in the schematic uses a high-gain 6AC7 pentode with a low noise level and high transconductance. The tuned plate circuit is link-coupled to the input terminals of the receiver with coaxial cable. This efficient coupling system makes the unit greatly superior in performance to the simple more common type of 1-stage preselector in which the plate of the preselector tube is capacitance-

COIL TABLE

Band (Meters)	Coil	Turns	Tap from ground	Length (Inches)
160	L1	12	—	—
	L2	80	4	cw
	L3	80	4	cw
	L4	3	—	—
80	L1	8	—	—
	L2	44	7.5	cw
	L3	44	7.5	cw
	L4	3	—	—
40	L1	5	—	—
	L2	24	10	1.5
	L3	24	12	1.5
	L4	3	—	—
20	L1	3	—	—
	L2	15	15	1
	L3	15	15	1
	L4	2	—	—
15, 11, 10	L1	2	—	—
	L2	8	20	1
	L3	8	20	1
	L4	2	—	—

NOTE: Use 1½-inch diameter coil forms for 10, 80 and 40 meters and 1⅛-inch forms for 20, 15, 11 and 10 meters. Use No. 26 enameled wire for 160 meters, No. 22 for 80 and 40 and No. 20 for the others. Coils are closewound (cw) on 160 and 80 meters and spaced as indicated on the remaining coils. Antenna and output windings (L1 and L4) are wound about ⅛ inch below the ground and B plus ends of L2 and L3 respectively.

coupled to the receiver's antenna post.

The unit is moderately regenerative, and tends to oscillate unless the input circuit is tightly coupled to the antenna. The 6AC7 has a rather low input resistance around 30 mc, so the grid is tapped down on the input coil approximately to the center. This reduces the grid loading without appreciably reducing the input voltage. Tapping the grid and plate leads down on the coils also reduces the shunt capacitances allowing a greater tuning range with a given tuning capacitor.

With the 50-$\mu\mu$f tuning capacitors each set of coils covers a tuning range of approximately 2 to 1. The coils—listed in the table by the amateur bands that they cover—give continuous coverage from about 1.7 to 33 mc.

Should oscillation occur even when tight coupling is used, move the plate tap down a little farther towards the ground end.

The voltages for operating the unit may be taken from the receiver, as most present day sets will stand a slight additional drain on the plate and filament supplies without overheating. However, if the receiver power supply already runs hot, a separate power supply should be used.—*George R. Anglado.* END

Question Box

BURGLAR ALARM

I want to construct a simple battery-operated burglar alarm to protect a gun collection that is displayed horizontally in a large cabinet. I would like a system that will trigger the alarm whenever one of six guns is lifted off a sensitive switch concealed beneath it or whenever one of three cabinet doors is opened. Once activated, even momentarily, the system must lock on and continue to sound the alarm until it is silenced manually. A remote OFF–TEST–ALERT *switch should bypass the lock-in operation and permit momentary testing of the individual switches.—C. D. H., Tokyo, Japan.*

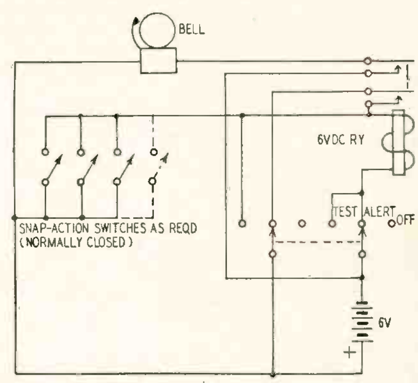


Fig. 1

Two circuits are shown. Fig. 1 is the simplest. Normally closed snap-action switches are held open by the cabinet doors and the weight of the guns. Closing any switch operates the relay that immediately locks in through one set of its contacts. The other contacts close the circuit to the alarm bell. Throwing the switch to TEST checks condition of battery, bell and relay.

The circuit in Fig. 2 uses normally

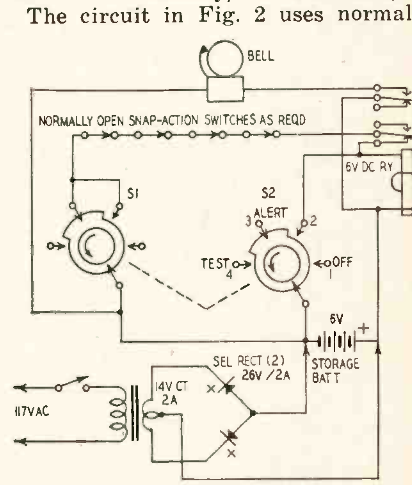


Fig. 2

open switches, held closed by the weight of the guns. Opening a switch or cutting switch leads releases the relay and sounds the alarm. A small 6-volt storage battery is recommended for this circuit because a constant current flows through the relay coil while the protective circuit is in operation. A trickle charger keeps the battery fully charged and permits the alarm to remain in operation during reasonably short power interruptions. The charger may be used periodically or may be connected permanently across the battery.

Sections S1 and S2 of the function switch should be a shorting (make-before-break) type. As the blade of S2 touches contact 2 the relay coil is momentarily connected directly across the battery so the armature pulls in and locks in through S1 and the detector switches. Throwing the switch to TEST interrupts the holding circuit and sounds the alarm. The circuit is reset by rotating the switch through OFF to ALERT.

RE: WIDE-RANGE OSCILLATOR

I'm having trouble with the wide-range audio oscillator described by Mr. Graham in the July, 1954 issue and would appreciate help. I have followed his parts layout and have shielded the heater leads as recommended.

I can't adjust R11—in the oscillator tube cathode circuit—and eliminate distortion plainly visible on a 3-inch scope. I start with an unsymmetrical wave with a pip on top and the leading edge considerably steeper than the trailing edge. Varying R11 improves the waveshape. But, just as the pattern begins to approach a sine wave, it suddenly disappears. After about 10 seconds it reappears for about a second and then disappears again. This occurs on the lowest range. Operation is normal on the others.

In calibrating the first three ranges I find that they do not correspond to those given in the article. I get 24 – 200, 210 – 2,000 and 2,000 – 19,000 cycles on bands A, B and C, respectively, with the specified variable capacitor.

Hum is a problem in the range of about 30 – 80 cycles. In this region I cannot get a stable circular trace when calibrating the oscillator with another. I get tearing and several distorted superimposed circles.—H. K., Santa Barbara, Calif.

Mr. Graham believes that the peculiar waveshape is probably caused by a defect in the feedback circuit. Check the lamp and make sure that it is the type specified. Since the trouble occurs only on the lowest range, it is possible that there is a defect in its frequency-determining circuit. Perhaps the resistors for this range are reversed.

The upper end of each range is determined by the minimum capacitance of the tuning capacitor. Your tuning ranges will not correspond to the original if the trimmer capacitors are set too tight. Try loosening them up a bit and then recalibrating.

Your hum problem is serious because it is a matter of layout and wiring. A simple check will show if the hum originates in the heater circuits. Turn on the oscillator and then open one side of the heater circuit at the power transformer while observing the pattern on the scope before the heaters cool. If hum is still present, it is coming from the power transformer and can be eliminated by re-orienting and remounting it. If the hum disappears when the circuit is opened, look for heater-to-cathode leakage in the tubes and around the tube sockets. Dress all a.c. leads away from the variable capacitor, range switch and all components associated with them.

CIVIC PATROL CONVERSION

I use a Hallicrafters S-81 Civic Patrol receiver for reception on 154.37 mc. The set drifts badly after it warms up so I want to convert to crystal control for single-frequency operation. —W. K., Brooklyn, N. Y.

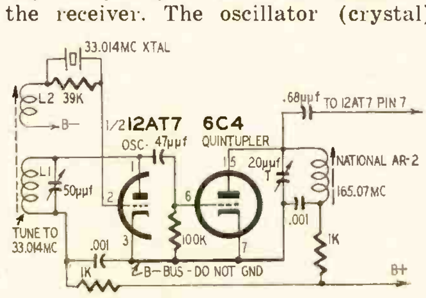
The diagram shows how the oscillator circuit can be converted for crystal control. The variable oscillator section of the 12AT7 is removed and replaced by a regenerative type crystal oscillator circuit operating at about 33 mc. A 6C4 tripler must be installed close to the 12AT7 and wired as shown.

L1 is a Cambridge Thermionic type LS-3 30-mc coil. L2 consists of 3–5 turns of No. 18 wire around the B plus end of L1. Adjust the coupling and number of turns in L2 for reliable starting as the receiver is turned on and off. Make the coupling sufficiently tight so the circuit does not oscillate with the crystal removed from its socket.

The 6C4 quintupler supplies the oscillator injection voltage to the converter half of the 12AT7. Its plate coil is a National type AR-2 with its slug and the tuning capacitor set for resonance at 165.07 mc. A small capacitor may be needed for coupling to the mixer grid. You can use two 1.5-$\mu\mu f$ ceramics in series or a gimmick adjusted to give optimum converter performance.

Short out or remove the heater dropping resistor and connect the 6C4 heater (pins 3 and 4) between pin 5 of the 12AT7 and ground.

This circuit can be used for single-channel crystal-controlled operation on any frequency within the range of the receiver. The oscillator (crystal)



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frequency is equal to (F1 + F2)/5, where F1 is the desired signal frequency, F2 the receiver's i.f. (10.7 mc) and the 6C4 operates as a quintupler. Coil and capacitor values hold for frequencies in the 152–173-mc band.

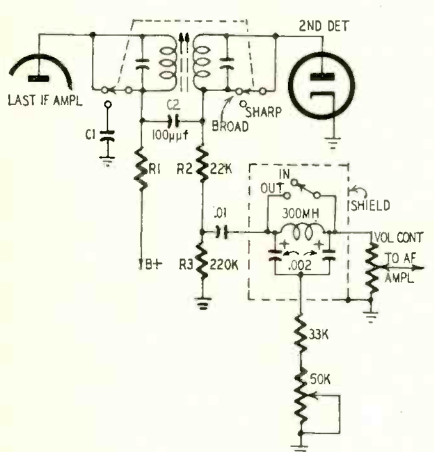
IMPROVING AM TUNER

I want to modify an inexpensive AM tuner to provide variable selectivity and a whistle filter. Do you have any simple circuits that I can use?—J. P. B., New York, N. Y.

The circuit shows modifications that can be made in most AM tuners and receivers. C1 and R1 form the decoupling circuit for the last i.f. amplifier. If your set has these components, you need not change their values. If the set does not include them, use a 0.1-μf capacitor for C1 and 15,000 ohms for R1. C2 is the r.f. bypass capacitor for the detector load consisting of R2 and R3. Lift one end of C2 from ground and connect it to the B plus side of the transformer primary as shown.

Connect the d.p.d.t. switch so it shorts the transformer windings in the BROAD position. In this position R1 is the plate load resistor and C2 the coupling capacitor in a resistance-coupled amplifier circuit. In the SHARP position C2 returns to ground through C1. The volume will be lower in the BROAD position but you can compensate for it by increasing the value of R1.

The whistle filter is a parallel-tuned L-C circuit inserted between the detector load and the volume control. If



you use a 300-mh r.f. choke, each of the .002-μf capacitors may be made up of a .0015-μf mica capacitor shunted by a 360–1,000-μμf mica padder. The 300-mh r.f. choke may be hard to find so you can use a 150-mh unit with .003-μf fixed capacitors paralleled by 360–1,000-μμf padders.

Tune the filter for maximum interference rejection and then adjust the variable resistor for minimum interference with least deterioration of the desired signal.

The components shown within dashed lines must be well shielded to prevent hum pickup and feedback. END

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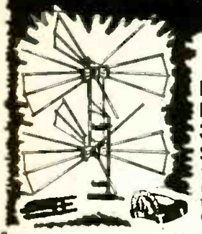

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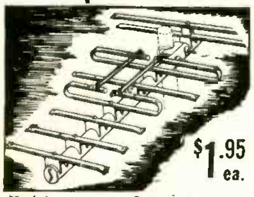

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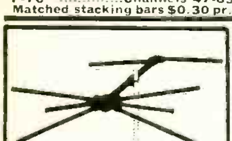

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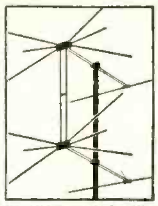

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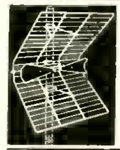

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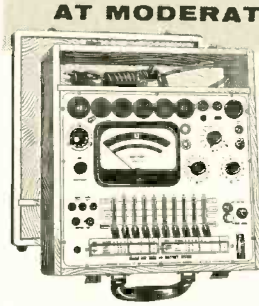

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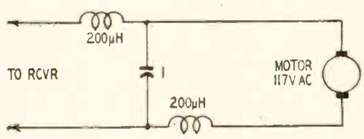
Patents

R.F. NOISE ELIMINATOR
Patent No. 2,705,759

Robert W. Taggart, Indianapolis, Ind. (may be manufactured or used by the U. S. Government without payment of royalties)

This simple network to reduce noise caused by motors, vibrators, etc. is especially effective where a radio or TV receiver is on the same power line as the noise source. The network, containing one capacitor and two coils, has been found much more effective than the usual pi filter.



The table below shows noise output (in µv) at various frequencies.

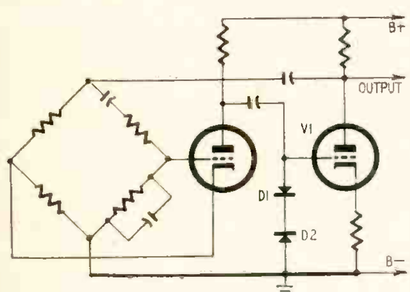
Frequency (mc)	Without Filter	With Pi Filter	With New Network
1	300	12	1.2
2	450	45	.0
6	100	2.5	.0
20	6	3.5	.0

WIEN-BRIDGE STABILIZER
Patent No. 2,704,330

Thomas F. Marker, Sandia Base, Albuquerque, N. M. (Assigned to U. S. Atomic Energy Commission)

This circuit may be used to stabilize the output of an R-C oscillator. It replaces the usual incandescent lamp regulator — which uses considerable power — with a pair of crystal diodes.

If power input to V1 increases, more current flows through the diodes. This increases their temperature, lowering their impedance. The product of higher current and lower impedance



tends to maintain a steady voltage input to the tube.

The back-to-back connection of D1, D2 means that the same impedance is offered to both halves of the wave so there can be no distortion. At frequencies above 100 cycles, the temperature variation during any one cycle may be neglected.

GATED TIMING OSCILLATOR
Patent No. 2,705,287

Arthur Wu-Nien Lo, Elizabeth, N. J. (Assigned to RCA)

This circuit triggers an n-type point-contact transistor into and out of oscillation. When negative signal A is applied to the base of the transistor, oscillations begin. It is blocked when positive signal B is applied. By counting the number of cycles, it is possible to measure the time interval between A and B. The circuit is shown in Fig. 1. Fig. 2 shows how the pulses

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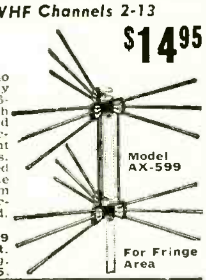

No roof orientation, no ghosts—it's electronically beamed by Directonic 6-position Selector Switch on or near TV set. Around the compass. 360° electronic rotation gives bright sharp pix on all channels. Complete, double stacked array with 18 hi-tensile double alloy aluminum elements. Includes Selector Switch. 75 ft. 3 cond. cable. Guaranteed.

TX-599 same as AX 599 but includes 3 3½ ft. masts, guy ring & mtg. base. Terrific buy, $16.95.

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WHOLESALE RADIO PARTS CO., Inc.
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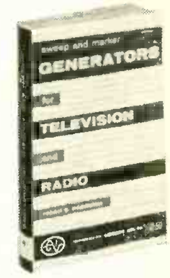
new—middleton on sweep and marker GENERATORS

Bob Middleton, well-known author-engineer, takes you behind the dials and shows you how and why sweep and marker generators operate. In the same free and easy style in which he speaks to thousands of technicians all over the country, he clarifies all the fundamental concepts which are frequently misunderstood.



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No. 55. By Robert G. Middleton. 224 Pages. Over 200 illustrations. Paper cover. $2.50

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Sweep and marker generators are standard servicing tools today, and unless you understand fully how they work, you're not getting all you can out of them. This book will give you confidence in your instruments and show you how to put them to uses you never before thought possible. No service technician can afford to be without this book—especially with color TV on the way!

10 BIG CHAPTERS

- The sweep generator signal.
- Generating a sweep signal.
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- Shielding the output.
- Aspects of sweep output.
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control oscillation of this gated timing oscillator.

The transistor tends to oscillate at a frequency determined by tank L-C in its base circuit (Fig. 1). When A drives the base negative (through D1), the transistor conducts and oscillates. To block it, B is fed through D2. During half a cycle, C will discharge through L and from base to emitter. During the other half-cycle, current would block the transistor and interfere with oscillations. To prevent this, D3

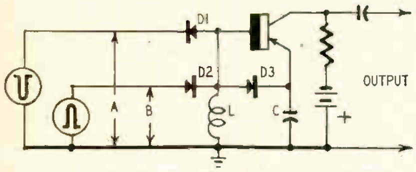


Fig. 1

conducts this current during the second half of each cycle.

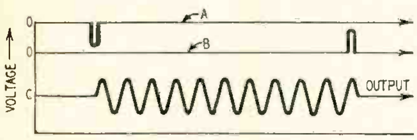


Fig. 2

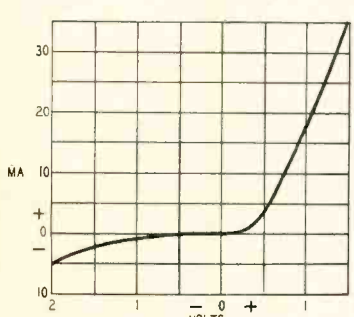
SEMICONDUCTING ALLOY

Patent No. 2,710,253

Robert K. Willardson, Harvey L. Goering and Arthur E. Middleton, Columbus, Ohio (Assigned to Battelle Development Corp., Columbus, Ohio)

Early transistors were made of germanium. Within the past year or two, silicon types were put on the market. More recently, alloyed types have begun to appear. This patent discloses several efficient alloys suitable for transistors.

The important characteristics of a semiconductor are energy band separation, melting point and charge mobility. Germanium has low band separation so it is not suitable for operation at high temperature. Silicon is better in this respect, but its high melting point makes it difficult to



process and form.

These inventors find that alloys combining gallium, aluminum and antimony, are excellent semiconducting materials.

The diagram shows a typical rectification curve using one of these alloys. END

PHASE SHIFTER

Patent No. 2,702,365

Abraham Hyman, New York, N. Y.)

(May be manufactured or used by U. S. Government without royalty payment)

This phase shifter provides a range of 180° and maintains constant output impedance. It is a bridge containing two current paths. One path (L–R1), passes a *lagging* current I_1. The other current, I_2, is *leading* and flows through C–R2. R1, R2 are ganged, so their sum remains constant.

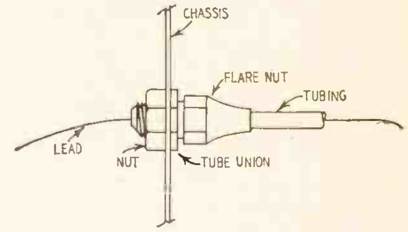
When R1 is near zero, R2 is near maximum. I_1 is large and I_2 negligible. The output of the bridge is a current that *lags* the bridge voltage by nearly 90°. With R1 maximum, the bridge current *leads* by nearly 90°, so a shift of 180° is available.

Reversing either winding of either transformer, shifts phase through the remaining 180°.

try This one

COPPER TUBE SHIELD

Often it is desirable to run shielded leads between chassis in a permanent installation or between shield boxes or subchassis on a single large chassis. When the standard shielding braid does not provide sufficient protection against accidental damage to the lead, try using soft copper tubing and flare type fittings as shown in the drawing.



It is easier to bend than rigid conduit, is neater than BX and comes in smaller sizes.

A union (connector) with a suitable nut anchors the tubing to the chassis. A flared nut joins the tubing and union. Soft copper tubing is sold in coils and may be bent by hand. Do not use rigid tubing that comes in straight lengths. It cannot be shaped without special bending tools.

The tubing size depends on the number of conductors to be shielded.—*Charles Erwin Cohn*

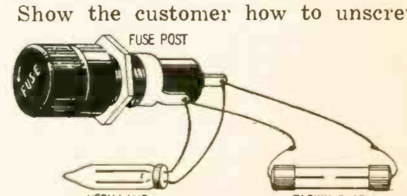
FUSE INDICATOR

Every technician knows that there is some reason for a blown fuse. Finding that cause is not always simple and can often require several trips to the customer's home. That can become expensive.

I recently devised the gadget shown in the diagram. It consists of a *blown* pigtail fuse, a short piece of well insulated wire, a fuse extractor post and a small neon lamp.

Connect the pigtails of the blown fuse to the contact points on the fuse holder and solder the neon lamp across the latter. Ream a hole in the TV back to accept the holder. Stick the neon lamp in one of the small ventilating holes on the back cover. Insert the *blown* pigtail fuse into the fuse holder in the set.

Show the customer how to unscrew

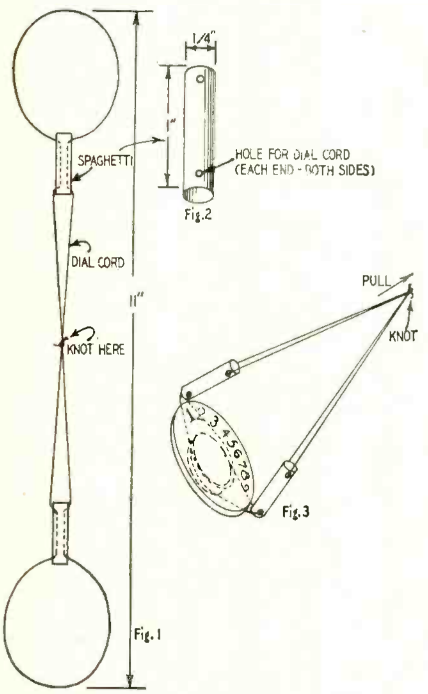


the cap and replace the fuse when the lamp lights and indicates that the fuse has blown. Instruct him to call for service only after the fuse has blown repeatedly.—*Harold Davis*

RADIO KNOB PULLER

Sometimes the hardest part of taking a TV or radio chassis out of the cabinet is getting tight knobs off without breaking them or scratching the cabinet. A simple but very useful knob puller that won't harm the knob, cabinet or fingernails is shown in Fig. 1.

Take a length of heavy dial cord about 22 inches long and thread on



two pieces of 1-inch long, ¼-inch diameter flexible spaghetti. Small holes are punched in the walls of the spaghetti as in Fig. 2. Then tie the ends of the cord together at the center of the assembly between the two pieces of spaghetti. Next tie the entire assembly in a knot also at the center. This knot keeps the knotted ends of the cord from snagging in the spaghetti.

To use, insert the loop, at one end, behind the knob to be pulled and slide the spaghetti up to the knob as far as it will go. Insert the other loop in the same manner but from the opposite side of the knob. With both pieces of spaghetti slipped up tight, put the fingers of one hand around the center of the cord and pull straight out. See Fig. 3.

It's a good practice to keep the other hand on the front of the set above the knob with the thumb in front of the knob to keep the set from pulling forward and the knob from scattering when it pulls off.—*Charles Garrett*

USEFUL HAND TRUCKS

The purchase of a few discarded grocery carts from a self-service market has simplified the problem of loading and unloading chassis and appliances from our pickup trucks. We removed the top basket and welded four pieces of 2 x 3/16 x 28-inch flat steel on the top rack to form a platform.

We haul large assemblies on the top platform. The bottom basket is for parts and smaller appliances. The top platform being high enough for easy loading and unloading of items from our trucks, it is now much easier to wheel heavy parts, materials and appliances to the shop than to carry them. —*Stanley Clark*

HANDY MAGNIFIER

Many shops have obsolete 7- or 10-inch bubbles lying around idle. The photo shows how we put one to work. In addition to its usefulness in chassis

work, it is invaluable in "blowing up" to a readable size the ridiculously small schematics issued by some companies. The upright supports are adjustable for height by nails through holes drilled every ½ inch.

This type of TV screen magnifier is also useful during demonstrations and servicing lectures where oscilloscope patterns are shown to a large audience such as a class or meeting of service technicians. Rig the magnifier so it does not obstruct the scope's controls and make rapid adjustments difficult. —*R. W. Reid*

MAKING MARKING DECALS

To make your own professional-appearing decals for marking controls and instrument panels, apply two coats of clear or colored nail polish to the gummed side of ordinary paper tape and then draw in the dial scale or print the desired legend. When the treated paper is thoroughly dry, soak it in warm water and then transfer the collodion base to the desired surface just as you would a commercial decal. I use a pen and waterproof marking ink on the lacquer base but it might be worth while to try a typewriter.—*A. W. Moyes*

(Model airplane dope or automobile touchup lacquer will probably work as well as nail polish.—*Editor*) END

People

L. Kline

Larry H. Kline, joined Thompson Products, Cleveland, in the newly created position of manager of commercial products sales for the Electronics Division. He was formerly general sales and merchandising manager for Ward Products Corp. In his new position, he will direct sales of the company's new Superotor antenna rotor.

Dr. B. H. Alexander

Dr. Benjamin H. Alexander was appointed manager, semiconductor operations, for CBS-Hytron, Danvers, Mass. He will make his headquarters at the Lowell, Mass., Plant. He was formerly with Sylvania.

S. W. Archer

Samuel W. Archer, service manager of the Delco Radio Division of United Motors Service, was promoted to assistant general merchandising manager of United Motors Service Division of General Motors Corp., Detroit, Mich.

Ralston H. Coffin was elected vice president in charge of advertising and sales promotion for RCA. He was formerly director of advertising and sales promotion.

Carl E. Smith, president of Cleveland Institute of Radio Electronics, Cleveland, was awarded a Fellowship in the IRE. Mr. Smith is at the left in the photograph below.

Obituary

Richard W. Cotton, assistant to the president of National Co., Malden, Mass., died of a heart ailment while visiting his summer home in Jefferson, Mo.

Personnel Notes

. . . **Roy G. True,** treasurer of I.D.E.A., Inc., Indianapolis, was given additional responsibilities as executive vice president and chairman of the management committee. **Richard C. Koch,** senior project engineer and acting assistant chief engineer of the company, was promoted to chief engineer of I.D.E.A.

. . . **Morris S. Lewis** was named manager of market planning and analysis of the RCA Tube Division, Harrison, N. J. He was formerly manager, sales administration. **Donald R. Weisenstein,** heretofore administrator of sales budgets and analysis, succeeds Lewis in his former position.

. . . **Kenneth B. Bryden** was promoted to manager, government coordination and services, for the RCA Tube Division, Harrison, N. J. He was formerly manager of research and financial controls.

. . . **Curtis B. Hoffman** was appointed vice president-sales of Brush Electronics Co., Cleveland, a division of Clevite Corp. He comes to the company from Foote Bros. Gear and Machine Corp.

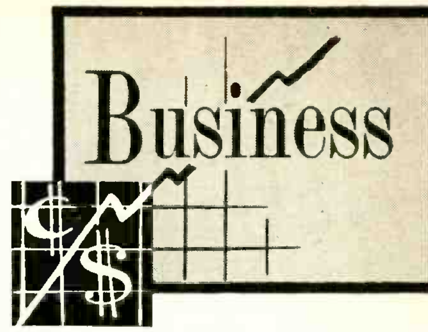
. . . **C. A. Swanson,** former director of West Coast Sales for Standard Coil Products Co., Inc., Chicago, was promoted to general sales manager. **J. R. Johnson,** general manager of the Los Angeles plant, was advanced to the post of technical assistant to the president. **Oden Jester,** former distributor sales manager of the company, is now assistant general sales manager.

. . . **Wilfred L. Larson,** Switchcraft, Inc., was elected chairman of the Association of Electronic Parts and Equipment Manufacturers, Chicago. **J. Wayne Cargile** of Permo, Inc., was elected vice chairman. **Helen Staniland Quam,** Quam-Nichols, was re-elected for her 18th annual term as treasurer.

. . . **P. Newton Cook** was named general sales manager of Chicago Standard Transformer Corp., Chicago. He was formerly sales manager of both the Chicago and Stancor Catalog divisions. **R. J. Reigel** was promoted to Cook's former position.

. . . **E. W. Carlson,** vice president of Phaostron Co., South Pasadena, Calif., heads the company's new relay engineering team for the design and manufacture of subminiature relays. **Phillip Chamberlain,** chief engineer, and **Chester R. Rhodes,** chief research engineer, were also appointed to the new group.

. . . **Sid Weiss** was named regional sales manager of Berlant-Concertone, Audio Division of American Electronics, Inc., Los Angeles. He joined the company in 1954 as Los Angeles service manager. END



Merchandising and Promotion

Oxford Electric Corp., Chicago, designed two new point of sale displays for distributors handling its line of re-

placement speakers. One is a window streamer and the other, which may be read from either side, may be hung over a wire or line in the store.

RCA Tube Division, Harrison, N. J., prepared an "Across America" 1956 calendar as consumer advertising for its dealers, showing scenes from all sections of the country.

Electronic Instrument Co., Inc., Brooklyn, N. Y., is offering distributors of its

Eico kits a satin banner as a point-of-sale display.

Vaco Products Co., Chicago, manufacturer of a line of screwdrivers, nut drivers and other tools, is offering a miniature six-piece toy tool kit to its

dealers for distribution to customers. The firm name of the donor may be imprinted on the real screwdriver and on the plastic carrying case.

EDLIE for TOP VALUES

Larrel's E-Z TV REPAIR GUIDE

The Only FIX-IT-YOURSELF Guide Made expressly for YOUR TV Set!

Now you can save costly TV repairs with this new, simplified method which includes all necessary data for just YOUR set. No confusing, unimportant information applicable to hundreds of other makes. Simplifies detection of faulty tubes in your TV receiver quickly, accurately.

It's a terrific idea—It's a terrific guide! Order today and have your set back in perfect condition at once. Be sure to send us make and model of your TV when ordering. .... only **50¢**

For Most TV Sets—Old & New

SAVINGS ON KITS

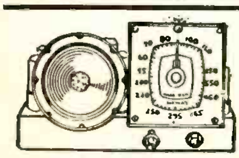
5 TUBE AC/DC Superhet Kit

Kit #1: 5 tube superhet kit. AC/DC includes all quality components required to construct this latest design, highly sensitive superhet broadcast receiver, complete with black, glistening bakelite cabinet (excludes wire & solder). Kit of 5 tubes. 12AT6, 2/12BA6, 12BE6, 35W4, 50B5.

Price, Less Tubes........ **$7.95**

Extra for Tubes........ **$3.25**

6-TUBE RADIO KIT



Kit #2: Low priced 6-tube kit designed for extra high sensitivity, excellent selectivity and good, rich tone quality. Uses 25L6, 25Z6, 6SQ7, 6SA7, 2/6SK7 in an easily constructed circuit. Includes all parts: punched chassis, resistors, condensers, coils, sockets, PM speaker, hardware, etc.

Special closeout price. (Less tubes & cabinet)........ **6.95**

Matched set of 6 tubes for kit........ **$3.25**

3-Way Portable RADIO KIT AC/DC Batteries

NEW, compact, lightweight portable radio kit with the very latest supersensitive superhet. circuit. Wonderful reception from either batteries, or 115 V., 50-60 cycle AC or DC. Includes all complete parts (except wire & solder) necessary to build a great sounding radio.

Also includes circuit diagrams and simplified, complete step-by-step instruction folder which makes assembling easy. Housed in a beautifully high-glossed Catalin cabinet in two delightful and distinctive colors: maroon or alabaster (ivory). Size: 9½" x 5⅞" x 4¾". Includes tubes! **$13.95** (maroon or ivory)

BATTERY KIT: add........ **$2.59**

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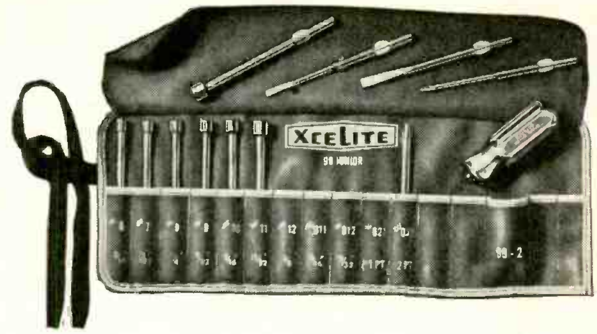

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SPEAKER RECONING: Guaranteed workmanship. C&M Recone Co., 255 Tioga St., Trenton 9, N.J.

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RCA, Motorola, Link, GE and Kaar new and used two-way radio equipment bought and sold. Communications Associates, 138-17 Springfield Blvd., Springfield Gardens, N. Y. Phone LA 7-2727.

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TELEVISION Tuner Repairs. DAN'S Television Laboratory, 2 West 183 St., N.Y. 53, N.Y.

DIAGRAMS FOR REPAIRING RADIOS $1.00. Television $2.00. Give Make. Model. Diagram Service, Box 672-RE, Hartford 1, Conn.

FIDELITY UNLIMITED: AUTHORIZED DISTRIBUTORS of HIGH-FIDELITY COMPONENTS. SHIPMENTS PREPAID and INSURED. SPECIALS: NEW COLLARO RC-54 with Mounting Board, 45 spindle, dual Blank Heads, $38.75. Accessories: RPX-050, dual sapphires, $6.50. Diamond and sapphire Stylus, $10.75. WRITE US YOUR HI-FI REQUIREMENTS. FREE AUDIO GUIDE, COMPLETE STOCK. FIDELITY UNLIMITED, 63-03 39th Ave., WOODSIDE 77, N.Y. Dept. RE.

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TUBES—TV, RADIO, TRANSMITTING, AND SPECIAL PURPOSE TYPES BOUGHT, SOLD AND EXCHANGED. Send details to B. N. Gensler W2LNI, 512 Broadway, N.Y. 12, N.Y.

ALL MAKES OF ELECTRICAL INSTRUMENTS AND TESTING equipment repaired. Write for free catalogue on new and used instruments at a savings. Hazelton Instrument Co., 128 Liberty Street, New York, N. Y.

CRYSTAL-RADIO EXPERIMENTERS Write Leslie Hulet, 305 Hope, Lakewood, N. J.

TELEVISION sets $14 up. Jones, 1115 Rambler, Pottstown, Pa.

USED COURSES and books bought, sold, rented and exchanged. Catalog free. Lee Mountain, Henagar, Ala.

WANTED: AN/APR-4, other "APR.", "TS-", "IE-", ARC-1, ARC-3, ART-13, BC-348, etc. Microwave Equipment. Everything Surplus. Special tubes. Tec Manuals. Lab Quality Equipment. Meters. Fast Action. Fair Treatment. Top Dollar! Littell, Fairhills Box 26, Dayton 9, Ohio.

EARN ESTIMATED $2,000.00—GIANT RADIO PACKAGE $2.00. MASTER KIT COMPANY, BOX 206, BELLEVILLE, ONTARIO.

BUY WHOLESALE. 25,000 Items. Catalog 25c. Matthews, 1472-P1, Broadway, N.Y.C. 36.

SURPLUS METERS, WALKIE-TALKIES, PARTS. BARGAIN LIST 5 cents. MESHNA, 580 LYN, MALDEN 48, MASS.

Your choice $1.35 postpaid: T49C radiosonde transmitter less tube, 25 assorted mica capacitors, 100 insulated carbon resistors, 10 assorted switches or 20 wirewound resistors. All five for $4.95; bargain list on request. PALMER, 1440 Las Salinas Way, Sacramento 21, Calif.

SPEAKER RECONING, low prices. Michigan Speaker Reconing Service, 930 Metropolis, Marine City, Michigan.

DIAGRAMS: Professional Model Timers, Counters, Intercoms, Organs, etc. $1.00 each. List free. Parks, 101 S.E. 57th, Portland 15, Oregon.

POWER TRANSFORMERS REBUILT—all makes. TV-Radio or Special. Red Arrow Radio, 924 Metropolis, Marine City, Michigan.

RADIOS, New, $13.46 net and up. Details 10c. SONORET, Box A, 36 Woodbury St., Wilkes-Barre, Pa.

25-50% DISCOUNT, guaranteed. Factory Fresh LP records; 69c and up; pre-recorded tapes. Send 20c for catalogue. SOUTHWEST RECORDS, 1108 Winburn, Houston, Texas.

FREE BOOKLET "Forming Sheet Metal." Also catalog unusual bench tools. TELVAC, 1412-B Great Northern Bldg., Chicago 4, Ill.

TELEVISION RECEIVERS $28.80 UP. W4API 1420 South Randolph, Arlington 4, Va.

TV FM ANTENNAS. ALL TYPES INCLUDING UHF. Mounts, accessories. Lowest prices. Wholesale Supply Co., Lunenburg 2, Mass.

Wendell Plastic Fabrics Corp., New York, has prepared two new *Mellotone* grille-fabric merchandising displays

for its distributors. One is a display stand for square-yard packages and the other a roll display for larger quantities.

Tekni-Labels Co., Burbank, Calif. introduced a kit containing 10 packages of its *Universal* decals for titling electronic equipment. It is merchandising the new kit in a self-service counter display.

Production and Sales

RETMA reported the production of 3,828,793 TV sets and 7,058,889 radios for the first 6 months of 1955. TV set production was better than 34% higher than for the 1954 period and radio production increased by more than 44%.

RETMA reported a record sale of 3,202,995 TV sets for the first six months of 1955. This compares with 2,805,760 for the same period last year. Exclusive of automobile sets, 2,429,018 radios were sold for the same period compared with 2,410,893 for the first half of 1954.

Calendar of Events

High-Fidelity Show, Sept. 30–Oct. 2, Palmer House, Chicago. (RADIO-ELECTRONICS will exhibit in Room 746.)

3d Annual Northern California High-Fidelity Audio Show, Sept. 30–Oct. 2, Sheraton-Palace Hotel, San Francisco, Calif.

National Electronics Conference, Oct. 3–5, Hotel Sherman, Chicago.

Audio Fair, Oct. 13–16, Hotel New Yorker, New York City. (RADIO-ELECTRONICS will exhibit in Room 716.)

1955 Radio Fall Meeting, Oct. 17–19, Hotel Syracuse, Syracuse, N. Y.

1st Annual Technical Meeting of the IRE Professional Group on Electron Devices, Oct. 24–25, Shoreham Hotel, Washington, D. C.

High-Fidelity Show, Nov. 4–6, Benjamin Franklin Hotel, Philadelphia, Pa.

New Plants and Expansions

Astron Corp., East Newark, N. J., opened new West Coast distribution facilities in Los Angeles under the direction of its Southern California representative, Harry A. Lasure Co.

Phaostron Corp., South Pasadena, Calif., moved its Engineering, Drafting and Meter Departments into its new 13,000-square-foot building adjacent to its present plant.

BUSINESS *(Continued)*

RETMA Engineering Department moved into larger quarters in Suite 650, 11 West 42nd St., New York City. David Kaufman, formerly with Sylvania, joined the department to work on tube registration and standardization.

Corning Glass Works, Corning, N. Y., established a new department in its Electrical Products Division to accommodate the demands of the growing electronics industry. The new Components Department will be headed by Forrest E. Behm, former manager of the Pressware Plant.

General Electric Tube Department is planning to build a new receiving tube plant in Owensboro, Ky.

Raytheon Manufacturing Co., Waltham, Mass., is expanding its Chicago equipment operations engineering facilities. It has already tripled the space available to engineering personnel and an intensive recruitment program is under way to enlarge the engineering and research staff.

G & H Wood Products (Cabinart) moved to expanded quarters at 99 No. 11th St., Brooklyn, N. Y.

CBS-Columbia, Long Island City, N. Y., has converted about one-quarter of its manufacturing facilities to government and industrial operations within a 3-month period.

Business Briefs

. . . RCA president Frank M. Folsom praised the TV service industry for the quality of its work, on the occasion of the presentation of the President's Cup to the four top branches of the RCA Service Co.

. . . The U. S. Department of Commerce Business and Defense Services Administration issued a report which indicated that production of electronic products in 1955 would reach $6.2 billions. Black-and-white TV set production attained a near record-level of 3,750,000 units for the first half of the year.

. . . **Shure Bros., Inc.,** Chicago, announced that 10 of its new Concert-Line 333 studio microphones were used in the first outdoor hi-fi system installed at the Music Theater of the Villa Park Moderne Restaurant in Highland Park, Ill.

. . . **1956 Electronic Parts Distributors** Show management sent out a questionnaire to exhibitors and distributors asking their preference for show dates, duration, location, registration, and opinion on a new educational program.

. . . **Erie Resistor Corp.,** Erie, Pa., is producing a line of special assemblies engineered and produced on a custom basis at its new Electromechanical Division.

. . . **Blonder-Tongue Laboratories,** Westfield, N. J., was granted two patents covering its wide-band r.f. amplifying circuits.

. . . **Bell & Howell,** Chicago motion-picture equipment manufacturer, entered the high-fidelity field with a series of radio–phono–tape recorder instruments.

BUSINESS *(Continued)*

. . . **Technical Appliance Corp.**, Sherburne, N. Y., awarded four engineering scholarships valued at $2,500 each to four central New York high school graduates.

. . . **General Electronic Equipment Co.**, a division of Radio City Products, Easton, Pa., introduced a line of electronic instrument and geiger counter kits which will be sold through distributors.

. . . **Telrex, Inc.**, Asbury Park, N. J., signed licensing agreements with S & A Electronics, Toledo, Ohio, and Skysweeper, McHenry, Ill., for the manufacture of conical antennas under the Telrex patent.

. . . **ORRadio Industries**, Opelika, Ala., was granted a U. S. Government contract exceeding $200,000 for the manufacture of magnetic tape.

. . . **Hamner Electronics, Inc.**, Princeton, N. J., was formed by a group of Princeton physicists, chemists, engineers and physicians to develop, manufacture and market advanced design instruments for research, testing, medical and industrial applications.

. . . **Ampex Corp.**, Redwood City, Calif., and **John F. Rider Publisher, Inc.**, New York City, joined the Institute of High-Fidelity Manufacturers, New York City, bringing total membership to 34.

. . . The NBC Department of Research and Planning reported that there were 36,477,000 TV installations in the U.S. as of July, 1955, an increase of 2,661,000 since January 1. The **Bureau of Census** of the U. S. Department of Commerce reported that about 32,000,000, or 67% of the homes in the U. S. had one or more TV sets as of June, 1955.

. . . **Audak Co.**, New York City, and **Presto Recording Corp.**, Paramus, N. J., joined the Institute of High-Fidelity Manufacturers, New York City. END

CORRECTION

There are errors in the parts list of the C-R tube tester and rejuvenator on page 74 of the August issue. All resistors are 10-watt units in the following values: 1—10, 1—100,000 ohms, potentiometer; 1—500, 2—10,000 ohms. Capacitors are: 1—50 and 1—150 μf, 150 volts.

Our thanks to the readers who reported the error.

In the circuit of the Simpson model 383 capacitor checker, on page 46 of the September issue, the 10-megohm resistor shown across the 1-μf charging capacitor should have been shown connected between pins 3 and 6 of the thyratron. When connected as originally shown, this resistor passes the d.c. pulse component through the meter and causes erroneous pointer drift in low-impedance circuit tests. When the 10-megohm resistor is connected between pins 3 and 6, only the a.c. component of the test pulse is admitted to the meter circuit and no erroneous pointer drift occurs even when the instrument is operated on a dead short circuit. We thank the author of the article for this correction.

technical Literature

PULSE TRANSFORMERS

Data sheet *PD 4-220* describes high-power pulse transformers and supplies technical information on distortion minimization, high-temperature capability, windings and construction as well as a specification list and outline drawings of typical transformers.

Bernard Levin, Technical Information Representative, Equipment Marketing Div., Raytheon Mfg. Co., Waltham, Mass.

TELEVISION

Tung-Sol's 16-page color cartoon book *The Finest TV Picture Ever Seen in the American Home* presents the TV service dealer, his skill, his fair charging and his importance as a member of the community. The integrity of service dealers and the reasonableness of their charges are stressed. The story of making and aluminizing the Magic Mirror picture tube is also told.

Sales Promotion Dept., Tung-Sol Electric Inc., Newark 4, N. J.

Any or all of these catalogs, bulletins, or periodicals are available to you on request direct to the manufacturers, whose addresses are listed at the end of each item. Use your letterhead—do not use postcards. To facilitate identification, mention the issue and page of RADIO-ELECTRONICS on which the item appears. UNLESS OTHERWISE STATED, ALL ITEMS ARE GRATIS. ALL LITERATURE OFFERS ARE VOID AFTER SIX MONTHS.

KLYSTRON FACTS

Eitel-McCullough's booklet *Klystron Facts—Case #2*, discusses klystron power amplifier applications as well as new Eimac developments in the klystron field. The pamphlet is a continuation of *Klystron Facts* published in 1954.

Both available from Eitel-McCullough, Inc., Technical Services Dept., San Bruno, Calif.

CAPACITORS

Mallory's book *Birds, Bees and Capacitors* describes in detail, along with illustrations what a capacitor is, what it does, its history, what causes it to fail, and other interesting facts about capacitors.

P. R. Mallory & Co., Inc., Indianapolis 6, Ind.

MOLDED PRINTED CIRCUITS

Type MCR molded printed electronic circuits are described in *Bulletin M-1*. It contains comprehensive data on types, construction, applications, dimensions, design service, leads and terminals, and charts.

International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa.

PRINTED CIRCUITRY

Mechanize Your Wiring With Copper-Clad Phenolite (2nd edition) in 12 pages covers the advantages of printed circuitry for electrical and electronic systems. Photographs, schematics and tables illustrate the advantages of printed circuitry over conventional hand-wiring methods. It also includes a discussion of their economies and a description of the ways in which printed circuits are produced.

National Vulcanized Fibre Co., 1055 Beech St., Wilmington 99, Del.; also available from National Fibre Co. of Canada Ltd., 107 Atlantic Ave., Toronto, Canada.

SERIES PTW POLAR RELAY

Bulletin RH gives data on Automatic Electric's series PTW polar relay with new mounting. Electrical characteristics, travel time and other details are given.

Automatic Electric Sales Corp., 1033 W. Van Buren St., Chicago 7, Ill.

GEIGER COUNTERS

Nuclear Measurements' 8-page bulletin on *Geiger and Scintillation Counters* describes and illustrates portable units for uranium prospecting, covering specifications and construction features. A cartoon booklet *Cyril Buys a Geiger Counter* describes the adventures of a clerk who bought and used a prospecting instrument.

Nuclear Measurements Corp., 2460 N. Arlington Ave., Indianapolis 18, Ind.

TRANSFORMERS

Linear variable-differential transformers are described in *Bulletin LVDT-100-A*. Complete data includes dimensional drawings, test circuit diagram, actual-size photo, a graph showing displacement of core from null point *vs.* output voltage, applications, temperature range, sensitivity, voltage and frequency range, d.c. resistance, impedance and weight.

Gudeman Co., 340 W. Huron St., Chicago 10, Ill.

MOUNTING BASES

Detailed descriptions of standard and special mounting bases and a wide selection of vibration and shock controls—which meet JAN and MIL specifications—are contained in *Catalog No. AB-35.*

T. R. Finn & Co., Electronics Div., 200 Central Ave., Hawthorne, N. J.

CONNECTORS

Bulletin PN-1 describes the fields of application for Deutsch AN connectors and provides general information on performance requirements, size and handling capacity, basic parts and the numbering system used.

A detailed description is presented on the shell construction for wall- and box-mounting, cable-connecting receptacles—straight, solid shell and 90° angle, split-shell plugs.

Deutsch Co., 7000 Avalon Blvd., Los Angeles, Calif. END

ELEMENTS OF ELECTRICAL ENGINEERING, Sixth Edition, by Arthur L. Cook and Clifford C. Carr. John Wiley & Sons, Inc., New York, N. Y. 6 x 9 inches, 682 pages. $6.75.

This is the latest revised edition of a standard engineering work. Emphasis is on electrical machinery, starters, transformers and batteries, but there is good coverage of circuit theory. Photos and diagrams are given to familiarize the reader with motors, generators, circuit breakers and other common electrical devices.

The first half of the book deals with direct, the remainder with alternating current. Problems appear at the end of each chapter. This book seems suitable for self-study, since it is written from a practical viewpoint.

A few short chapters at the end describe measuring instruments and electronic controls.—*IQ*

YOUR TAPE RECORDER—How to Select One and Get the Most Out of It, by Robert and Mary Marshall. Greenberg, Publisher, 201 E. 57th St., New York 22, N. Y. 278 pages. $4.95.

Prepared for tape recordists and potential owners and users of tape recorders, this book—based on more than 2,500 experiments on almost every type of machine—enables the reader to select the right machine for his purposes and to get the most out of it without resorting to painstaking and often costly experiments. The reader learns in Part I what he can and cannot do with a recorder through discussions of the various features and characteristics of types of equipment and detailed descriptions of the hundreds of ways in which the machines are being used. Part II is devoted to applications of tape recording in business, the professions, education and special fields.

THERMIONIC VALVES—Their Theory and Design, by A. H. W. Beck. Cambridge University Press, 32 E. 57th St., New York 22, N. Y. 570 pages. $12.

Geared to the graduate level in physics and electrical engineering, this book is prepared for practicing tube engineers and post-graduate students in electronics. The first part deals with the physics of thermionic emission, the second covers the theory of fields and electron motion due to charged conductors and the third applies the foregoing material to the study of various classes of tubes.

ELECTRONIC MEASURING INSTRUMENTS, by E. H. W. Banner, Chapman & Hall, 37 Essex St., London W.C. 2, England. 395 pages. 45 shillings.

The author surveys and almost completely covers the field of electronic measuring devices used in research and industry. Part I discusses the characteristics of indicating instruments, Part II describes their electronic circuits and Part III covers applications. The field of electronic and related counters is covered, and there is also a chapter on electromechanical transducers.

The research worker and engineer will find this book helpful in selecting and applying electronic measuring equipment to his particular problem.

NETWORKS, LINES and FIELDS, by John D. Ryder. Second Edition. Prentice-Hall, Inc., 70 5th Ave., New York, N. Y. 5½ x 8½ inches, 593 pages. $7.65.

This new edition discusses the transmission of energy through networks, lines, guides and space. Algebra is used throughout but rigor is avoided. Determinants and vector analysis are introduced to the reader when needed.

The first chapters describe the basic network, T and pi. More complicated networks are studied here (and in subsequent chapters) in terms of these two. The very important Foster's theorem is explained in connection with resonant networks.

Several chapters are devoted to transmission lines. Radiomen will be particularly interested in the material on stubs, impedance matching, power and impedance measurements. The Smith transmission-line chart and stub design charts are fully explained and examples given. The chapters on guides and antennas, necessarily short, form an excellent basis for further study. —*IQ*

FUNDAMENTALS OF ELECTROMAGNETIC WAVES, by Paul C. Shedd. Prentice-Hall, Inc., New York, N. Y. 5½ x 8½ inches, 191 pages. $5.65.

In this very unusual book the author restricts himself to only four simple postulates and the fact that charged particles exert force on each other. From these bits of information, the basic equations and fundamentals of electromagnetism are derived by mathematics and logic. Yet the reader is assumed to know only as far as elementary calculus. All other math is developed by the author as needed.

The book is divided into very short chapters, averaging about five pages each. This permits important principles and theorems to be developed by themselves and aids the reader. Each chapter has its own summary. Practical applications of field theory—waveguides and antennas—are described in the last chapters.—*IQ*

END

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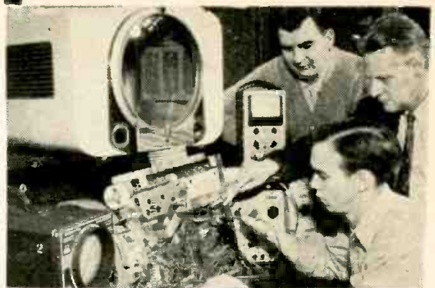

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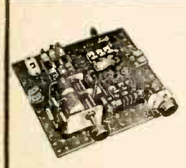
ADVERTISING INDEX

Radio-Electronics does not assume responsibility for any errors appearing in the index below.

LAFAYETTE Leads the Field in TRANSISTORS Circuits Kits & Componets

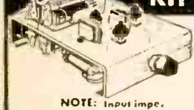
TWO TRANSISTOR RADIO RECEIVER KIT



This regenerative two Transistor Radio has given more than ample earphone volume on broadcast stations located several hundred miles away. When used with 60 ft. outside antenna well beyond 1000 miles have been repeatedly heard. Kit comes complete with two transistors, Argonne transistor audio transformers, condensers, resistors, masonite board, etc.; schematic diagram plus 115 page book, showing more than 50 practical transistor circuits and "How-to-do-it-instructions".

KT-70 Complete Kit with Batteries
Net 10.95

3 TRANSISTOR PUSH-PULL AUDIO AMPLIFIER KIT FOR SPEAKER OPERATION

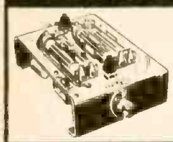


NOTE: Input impedance 1000 ohms. For high impedance inputs matching transformer is needed (AR-100); for magnetic input use pre-amp (KT-71)

With the New Lafayette KT-69-Kit you can now build a self-powered, push-pull Class "B" transistor, audio amplifier for speaker operation, having a frequency response of 100-8000 cps. The Argonne Transistor transformers were especially designed for transistor circuits. Kit comes complete with 3 transistors, push-pull input and output transformers chassis 3"x4"x1", condensers, resistors, battery holders, etc., schematic diagram.

KT-69 Complete with batteries....Net 17.95

TWO TRANSISTOR PREAMP KIT



With the Lafayette KT-71 you can now build a simple Transistor preamp in a matter of hours. The overall result will be a noiseless, humless and virtually distortionless amplifier. The complete unit is mounted on an aluminum chassis size 3"x4"x1". The Kit comes complete with two transistors, condensers, resistors, battery holders, batteries, etc., and schematic diagram.

KT-71 Complete Kit ....Net — 8.95

2 TRANSISTOR POCKET RADIO KIT

Packed into a 2½"x3½"x1¼" plastic case. This Two Transistor plus crystal diode radio kit offers many surprises, utilizing a regenerative detector circuit with transformer coupled audio stage, gives you high gain and excellent selectivity. Pulls in distant stations with ease with more than ample earphone volume. Kit comes complete with two transistors, crystal diode, loopstick, Argonne transistor audio transformer, resistors, condensers, plastic case, etc. Including schematic and instructions.

KT-68 Complete kit with Miniature Dynamic
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Less Earphones ....Net 11.80

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Lafayette Geiger Counter Kit with High Sensitivity Victoreen 1B85 tube, makes this one of the most outstanding kit buys in the country. This tube is used only in the most expensive equipment. Easy to build, at only a fraction of the price, of commercial instruments of this type. Just turn it on, flip the high voltage switch and listen to the clicks. Kit includes all parts, tube, carrying case, 22½ and 1½ volt Batteries. Complete instructions for quick assembly. Shpg. wt., 1½ lbs.

KT-75 ....Net 14.95

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F-184	—	7x.35	C.F. Wide Angle	NET 29.50
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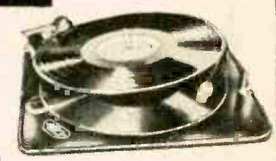

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Garrard Model RC-80 3 speed Record changer less cartridge ....Net 48.51
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High quality Dynamic microphone exceptionally fine for Public address recording, etc. Flat response 60-10,000 cps. Impedance 40,000 ±15% at 1,000 cps. output level —55 db. Die cast metal case equipped with 6 ft. of shielded cable. Shpg. wt., 3 lbs.

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A new lightweight plastic ear phone especially imported by Lafayette to bring you the high quality of a dynamic ear phone with the ease and comfort of an almost weightless unit—at a price less than half that of any comparable unit. Fits right into ear. Excellent sensitivity of 65 db. Ideal for use with miniature sets, hearing aids, transcribing, etc. DC resistance 2000 ohms, impedance 5000 ohms at 1000 cycles. Complete with 3 ft. plastic covered cord.

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Will replace speaker on any radio set or T.V. for silent listening, by direct connection to secondary of output transformer. Impedance 8 ohms.

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- For Late Listening

The hard-of-hearing can listen to radio or TV without turning the volume so high that others can't stand the noise. They can listen with loud speaker cut off, or if others want to listen with normal speaker volume. Excellent for noisy programs. Let the Kids listen and view with speaker cut off. Comes complete with miniature phone, fits snugly in ear, 20 feet of cable and instructions.

MS-125 .... 6.50

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5" Tweeter AND Crossover Network

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A specially designed 5" Tweeter and Crossover Network that will assure high frequency response when used with any speaker you now possess. You can now make your present speaker into a 2-way speaker system increasing the high frequency range up to 15,000 cycles. Diagram included. Shpg. Wt. 5 lbs.

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FOR RECORDING TELEPHONE CONVERSATIONS

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MS-16.......... 2.95

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"TAB" 60 $21.95 Lots of 3
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A complete precision test instrument. 20,000 Ohms per Volt DC-10,000 Ohms p/v AC. 38 micro ampere movement. 8 easy to read scales: DC 0-6, 30, 120, 600, 1200, 6000 Volts. AC 0-6, 30, 120, 600, 1200 Volts. Current 0-60 ua, 6, 60, 600 ma. Resistance 0-8K, 80K, 800K, 8 megohms. Decibels Cal 600 ohm —20 to +6, 20, 34, 46, 60 DBS. Capacity 250 uufd to 10 mfd. Inductance 10 to 1000 millhys. Hi accuracy, versatile 1% Precision Resistors. Scale 3". Plastic engraved panel. Rugged metal case. Lgth. 4¼" x 6¼" x 2¾". Complete w/batteries & leads. RF Diode Probe included for signal measurement. Shpg. wt. 4 lbs.
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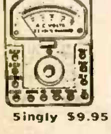

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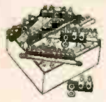

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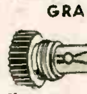

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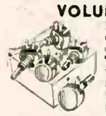

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OB2	.74	3B4	2.70	6BG6	1.24	6U5	.99	12K8	.48
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OC3	.88	3Q5	.68	6BJ6	.68	6V6GT	.56	12SF7	.78
OD3	.78	3S4	.46	6BK7A	1.11	6W4	.38	12SH7	.62
OZ4	.50	3V4	.79	6BL7	.97	6X4	.42	12SJ7	.54
1A5GT	.64	4BZ7	1.55	6BN6	1.19	6X5	.46	12SK7	.48
1A7GT	.96	5AX4	1.22	6BQ6	.96	7A4	.78	12SL7	.56
1AD4	3.95	5AZ4	.54	6C4	.38	7A5	.74	12SN7	.56
1AE4	3.75	5R4GYW	1.56	6C5	.68	7A7	.79	12SQ7	.54
1AH4	1.07	5T4	1.48	6C6	.56	7A8	.68	12SR7	.46
1AX2	1.25	5U4	.46	6CB6	.52	7AD7	1.41	12Z3	.89
1B3	.66	5V4	1.28	6CD6	1.08	7B4	.81	14A7	.89
1E5	.69	5X4G	.78	6D6	.84	7B6	.72	14AF7	.95
1G4GT	.69	5Y3	.36	6D8	.81	7B8	.82	19BG6	1.38
1G5	.69	5Y4	.62	6F6	.76	7C4	.26	19T8	1.49
1G6GT	.69	6A5	2.98	6F8	.86	7E6	.54	19V8	1.96
1H4G	.49	6A7	1.09	6G6	.92	7E7	.72	24A	.92
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1J6G	.79	6AB7	.78	6J5	.42	7H7	.72	25L6	.42
1L4	.48	6AC5	1.19	6J6	.48	7N7	.68	25Y5	.84
1LA4	1.01	6AC7	.68	6J7	.72	7S7	1.29	25Z6	.60
1LB4	1.09	6AF6	1.18	6K6	.49	7V7	1.06	28D7	1.29
1LC6	.89	6AG5	.50	6K7	.46	7X6	.89	35/51	.60
1LD5	.98	6AG7	1.14	6L5	1.09	12A6	.48	35A5	.71
1LE3	.99	6AH6	.88	6L6	.98	12A8	.79	35B5	.54
1LH4	1.01	6AK5	.62	6L7	.80	12AH7	.92	35C5	.71
1LN5	.78	6AK6	.74	6N7	.80	12AL5	.54	35Y4	.68
1Q5	1.19	6AL5	.42	6S4	.48	12AT6	.42	35Z3	.69
1R4	.96	6AL7	1.22	6SA7	.54	12AT7	.68	35Z4	.64
1R5	.52	6AQ5	.46	6SC7	.74	12AU6	.44	35Z5	.46
1S4	.88	6AQ6	.54	6SF7	.74	12AU7	.54	39/44	.56
1S5	.42	6AR6	2.74	6SG7	.62	12AV6	.38	45Z3	.66
1T4	.52	6AS6	1.75	6SH7	.42	12AW6	.84	50A5	.54
1T5	.98	6AS7	3.48	6SJ7	.69	12AX7	.58	50C5	.52
1U4	.46	6AT6	.42	6SK7	.52	12AY7	.68	50L6	.60
1U5	.48	6AU6	.46	6SL7	.62	12BA6	.52	71A	.74
1V2	.62	6AV5	.84	6SN7	.56	12BA7	.94	75	.82
1X2A	.62	6AV6	.48	6SQ7	.56	12BD6	.65	76	.68
2A4	2.37	6AX4	.81	6SR7	.60	12BE6	.62	77	.68
2A5	.78	6BA6	.48	6SS7	.89	12BH7	.69	83V	1.22
2V3	2.90	6BC5	.60	6SU7	4.20	12C8	.62	117Z3	.68

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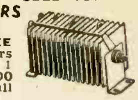

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2AMP	2.10	2.95	5.35	10.00
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10AMP	6.50	12.50	19.50	41.35
12AMP	8.00	15.75	22.10	44.25
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RECTIFIER & XFMR COMBO, Up to 28VDC at 24 Amps Cont. Duty . . . $60

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For 220-240 V/50-60 cy In. To 110-120 v or step-up.† w/ Cord, Plug & Receptacle.
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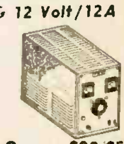

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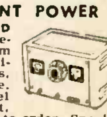

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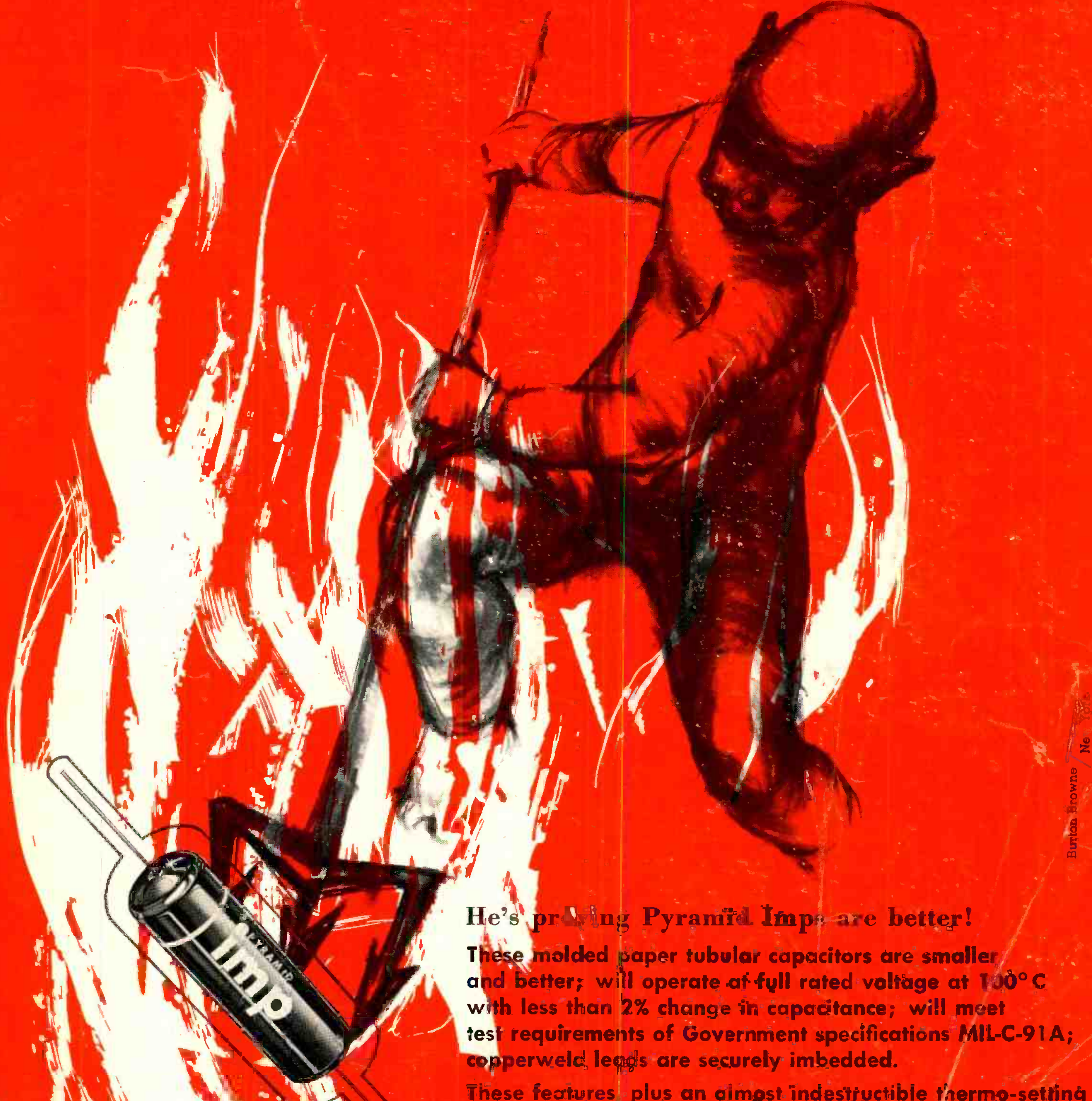
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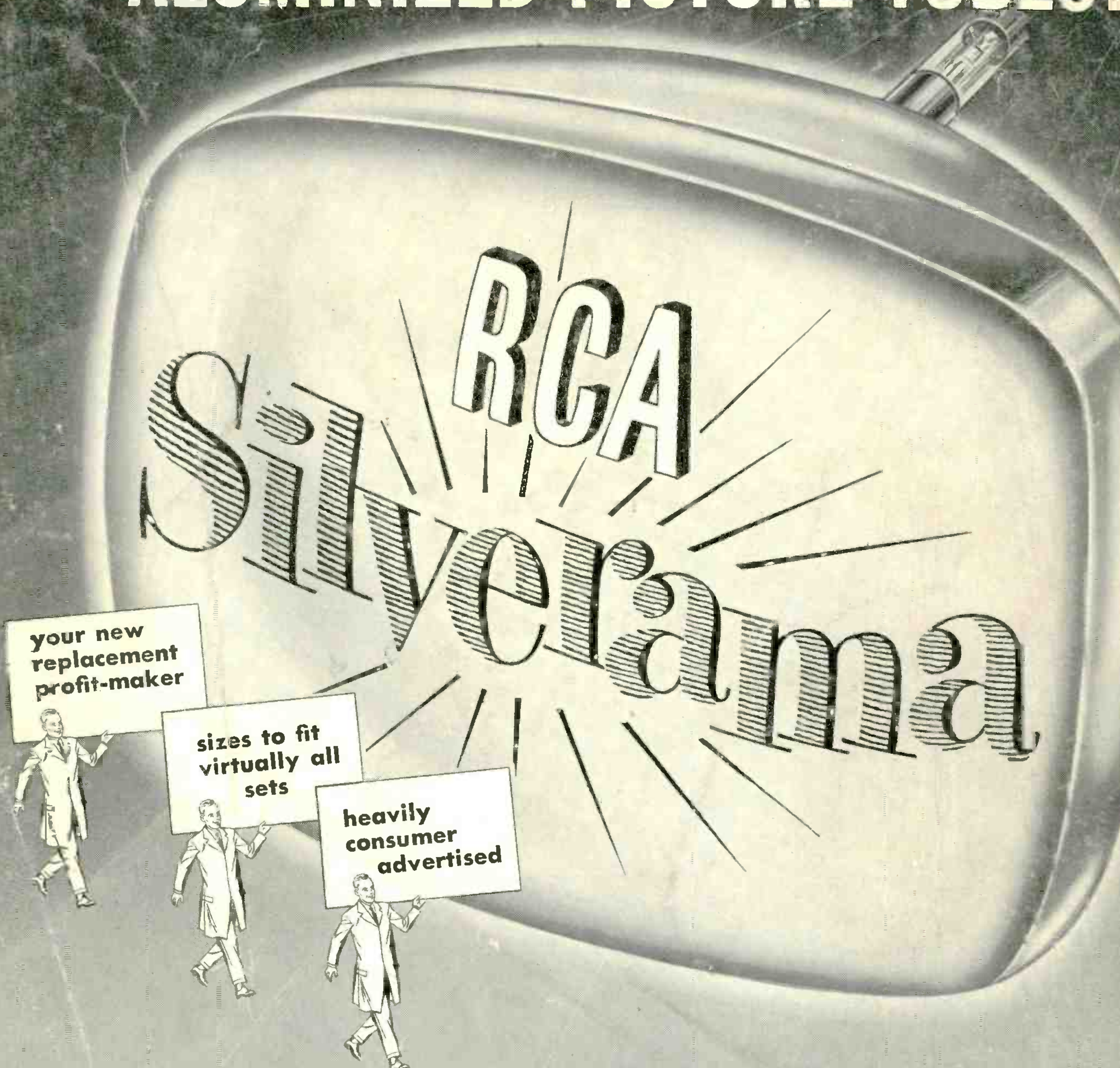

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