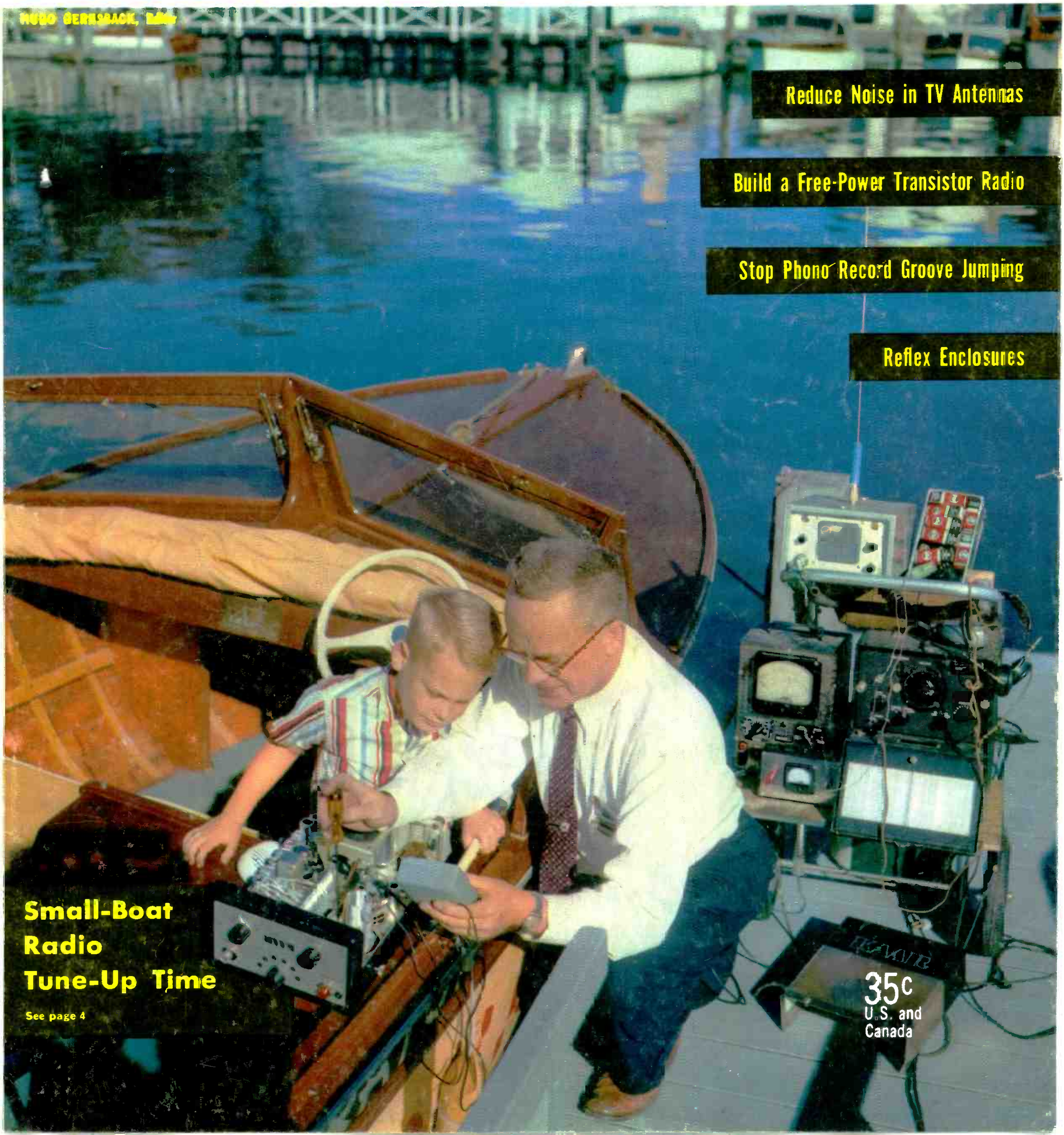
BUILD A SENSITIVE WIDE-BAND VTVM

APRIL 1959
IND

Radio-Electronics

HUGO GERNSBACK, Editor



Reduce Noise in TV Antennas

Build a Free-Power Transistor Radio

Stop Phono Record Groove Jumping

Reflex Enclosures

Small-Boat Radio Tune-Up Time

See page 4

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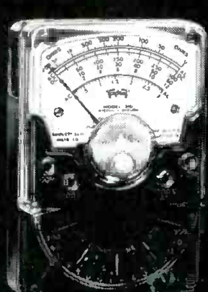

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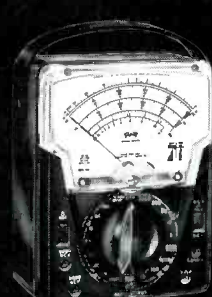

Model 630-PL V-O-M with such advanced features as an unbreakable clear plastic front for wide range, shadowless, instant vision, polarity reversing switch, single king size knob for selecting both range and circuit, continuous resistance readings from 0.1 ohm to 100 megohms.

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WHAT'S NEW

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ON THE COVER

(More on page 59)

Marine radio service specialist Maurice Holland tunes up a small-boat radio preparatory to the 1959 sailing season.

Color original by Jacques Saphier

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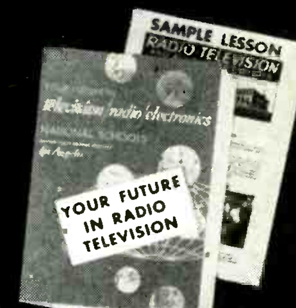

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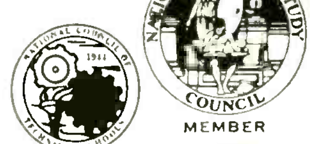

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NEWS BRIEFS

TV PROGRAM LICENSING bill has been introduced in the New York State Legislature by Assemblyman A. Bruce Manley. It is intended to give the State's highest educational authorities censorship power over television of the type that they now have over motion pictures. If passed, many TV programs will have to get a license from the Board of Regents at a cost of $50 or less for each half hour. Public-service, sporting events and news programs would be exempted from the licensing requirement.

Mr. Manley has stated that TV shows had been offering "a disproportionate amount of crime, sex, horror, terror, brutality and violence," harming the morals of young people and promoting juvenile delinquency.

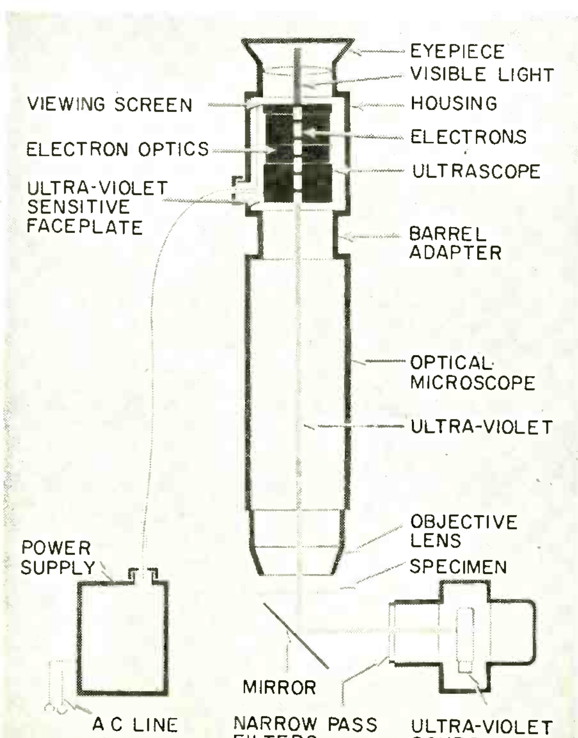
ULTRA - VIOLET MICROSCOPE brings heretofore invisible things to light. Based on the ultrascope, an ultra-violet converter tube, the new device makes it possible for scientists to study living cancer cells. Previously, these were transparent under an ordinary microscope and had to be killed and stained before viewing. Announced by RCA, the ultra-violet microscope is a modified optical microscope. A standard microscope body is used, but, the lenses are made of quartz (ordinary glass absorbs ultra-violet light). The ultrascope tube fits over the top of the microscope and is connected to its 12,500-volt power supply (see diagram). An ultra-violet light source projects light through the specimen and the microscope's objective lens. This beam then hits the ultrascope's face plate, which is ultra-violet-sensitive. The image converter tube changes the invisible ultra-violet light into a visible green-tinted picture on the tube's fluorescent viewing screen.

MAPPING THE WASTELANDS becomes possible at a fraction of the time and cost formerly necessary with the help of a new Doppler radar device. Mapping of desert or waste areas has been especially difficult because of their lack of landmarks. The air surveyor was forced to use navigational systems that required expensive manned ground stations. The new system, called *Radan*, is completely self-contained and operates by direct measurement of the direction and distance traveled. It is produced by General Precision Laboratory Inc., Pleasantville, N. Y.

The system has been used by the Aero Service Co., Philadelphia, Pa., to make an aerial survey of 40,000 miles of the central Sahara Desert in southern Libya. The exploration target was oil. A similar guided survey will cover part of the Spanish Sahara in southwestern Morocco.

Radan uses the same principle as police highway radars. If a radar beam is reflected from a car moving toward the instrument, the length of the reflected waves will be shorter than if the car were stationary, since the car moves a slight distance toward the radar between each wave. The faster the car comes, the greater this *Doppler effect*. In the Radan system, four beams are radiated diagonally downward toward the terrain. They are so patterned that they reach the ground at the extremities of an X-shaped figure, with the airplane directly above the center of the X.

To measure forward speed, the front and rear pair of beams are compared; for side drift, the two diagonal pairs are compared. Results are fed into a computer which indicates the difference between the actual and desired course on a dial, permitting the pilot to fly a true course. For mapping a large area, a number of range lines are plotted and the plane made to fly each of them successively, photographing the terrain beneath with its mapping cameras.



LIVE ACTION and miniature background sets (1/6 scale), still photographs or motion pictures are blended into a single TV scene through a device called *VideoScene*. It enables live television to use a variety of scenes in a limited area, eliminating the need for bulky sets. In the CBS Television Network's VideoScene technique the master camera has two pickup tubes. One photographs the actor against a special reflective pattern background made by Minnesota Mining and Manufacturing Co. The second tube, sensitive to the highly reflective indigo background, silhouettes the actor and blacks out the background scene in the area he occupies. The background camera photographing the miniature set feeds its picture into a keying amplifier, where the background picture is combined with the picture of the actor as a single scene.

The "live" camera and the background camera are linked through a servo system which synchronizes their movements so the background and actor are always perfectly matched. As the master camera pans, tilts or zooms while photographing the actor, the background camera follows.

In its present form, VideoScene is designed for black and white but can be adapted for color television.

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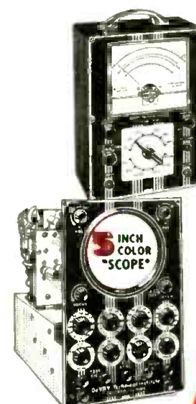

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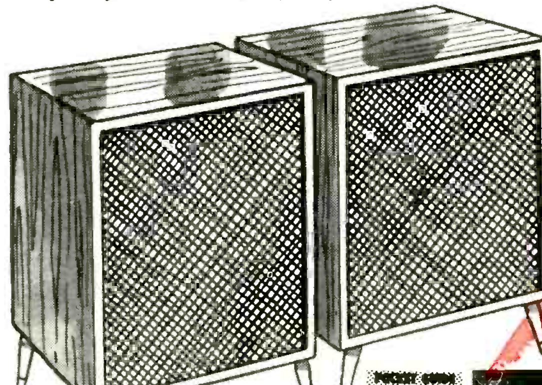

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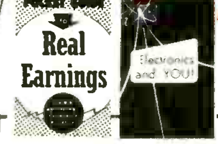

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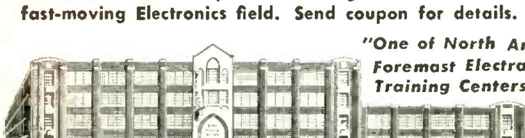

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DR. W. R. G. BAKER, director of the EIA Engineering Department, announced the formation of the National Stereophonic Radio Committee. Set up to study methods of broadcasting stereophonic sound by AM, FM and TV stations, the committee is composed of technical experts in the field. Six panels within the committee will review the technical factors involved. Dr. Baker said all known technical proposals for such systems would be studied and urged those who have such proposals to submit them to the committee, through the EIA Engineering Department's associate director, Virgil M. Graham, 11 W. 42 St., New York 36, N. Y. The committee's formation was suggested last November by Dr. Baker.

Calendar of Events

Symposium on Millimeter Waves, Mar. 31–Apr. 2, Engineering Society Building, New York, N. Y.

Pittsburgh Hi-Fi Music Show, Apr. 3–5, Penn-Sheraton Hotel.

British Radio and Electronic Component Show, Apr. 6–9, Grosvenor House and Park Lane House, London, England.

Buffalo (N. Y.) Hi-Fi Music Show, Apr. 10–12, Hotel Statler.

Conference on Industrial Instrumentation and Control, Apr. 14–15, Illinois Institute of Technology, Chicago, Ill.

Southwestern IRE Conference & Electronics Show, Apr. 16-18, Dallas (Tex.) Memorial Auditorium and Baker Hotel.

Conference on Analog & Digital Recording & Controlling Instrumentation, Apr. 20–21, Bellevue-Stratford Hotel, Philadelphia, Pa.

British Industrial Photographic & TV Exhibition, Apr. 20–24, London, England.

Annual Technical Conference on TV & Transistors, Apr. 21–22, Cincinnati, Ohio.

National Aeronautical Electronics Conference, May 4–6, Biltmore Hotel. Dayton, Ohio.

Society of Motion Picture and Television Engineers Convention, May 4–8, Fontainebleau Hotel, Miami, Fla.

URSI Spring Meeting, May 5–7, Washington, D. C.

1959 Electronic Components Conference, May 6–8, Ben Franklin Hotel, Philadelphia, Pa.

7th Regional IRE Technical Conference and Trade Show, May 6–8, University of New Mexico, Albuquerque, N. M.

Joint Conference on Automatic Techniques, May 11–13, Pick-Congress Hotel, Chicago, Ill.

1959 Electronic Parts Distributors Show, May 18–20, Conrad Hilton Hotel, Chicago, Ill. For manufacturers, representatives and distributors only. RADIO-ELECTRONICS will exhibit in Room 504 and GERNSBACK LIBRARY in Booth 107.

5th National Symposium on Instrumental Methods of Analysis, May 18–20, Shamrock-Hilton, Houston, Tex.

International Convention on Transistors, May 21–27, Earl's Court, London, England.

National Telemetering Conference, May 25–27, Brown Palace and Cosmopolitan Hotel, Denver, Colo.

OPEN LETTER TO THE FCC suggests five changes in rule making to "insure a complete and equitable utilization of

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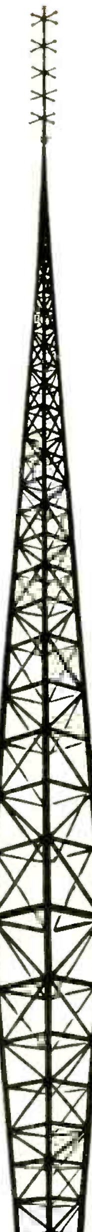

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W. R. Smith, 1335 E. 8th St., Long Beach, Calif.	1st	12
Howard E. Martz, 301 S. Penn. St., Fairmount, Ind.	1st	24
John W. Dempsey, Box 55, Rising Sun, Md.	1st	12
Donald H. Ford, Hyannis RD, Barnstable, Mass.	1st	12
Richard J. Falk, 2303 Holman St., Bremerton, Wash.	1st	22
Denson D. McNully, 1117 N. Houston St., Amarillo, Texas	1st	9
James D. Hough, 400 S. Church St., East Troy, Wisc.	1st	12
Odie B. Perry, Jr., Rt. #3, Zebulon, N. C.	1st	12
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NEWS BRIEFS *(Continued)*

the 88–108-mc band assigned to FM." These changes, detailed in the letter by Charles W. Kline, president of FM Unlimited Inc., are:

1. 105.1–107.9 mc be designated for use by class-A stations only with a maximum power of 3 kw and maximum height of 300 feet, instead of 1 kw at 250 feet.
2. 91.5–104.9 mc be designated for use by class-B stations only.
3. 88.1–91.3 mc be designated for use by class-N (noncommercial) stations — educational, religious, municipal, etc. All 10-watt "campus" stations be assigned to 88.1 mc only.
4. Stations licensed to metropolitan-suburban and community areas be designated as class-A stations and be required to provide maximum service for the areas to which they are assigned.
5. Class-B stations in Zone 1 be permitted the equivalent of 20 kw at 1,000 feet, instead of 20 kw at 500 feet.

Justification for the preceding suggestions is included in the letter along with a list showing what the new channel allocations would look like if the suggested changes are adopted. An interesting point is the following paragraph—one of the reasons behind suggested change 1.

"As FM allocations now stand, class-A channels are situated between or adjacent to metropolitan class-B channels. However, according to present rules, there must be an 800-kc separation between two class-B stations serving the same area. Nevertheless, applications are beginning to be granted for class-A stations serving suburban sections of metropolitan areas—only 400 kc away from existing class-B stations. These suburban class-A stations not only interfere with the primary coverage of the adjoining class B's but are themselves prevented from rendering maximum service to their communities because they are 'hemmed in' by the same class-B stations whose coverage they are interfering with."

TWO ON A CHANNEL is the basic principle behind TASI (*T*ime *A*ssignment *S*peech *I*nterpolation). Bell Telephone Labs say that using this system they can increase the capacity of a 36-channel submarine telephone cable to handle 72 talkers.

In a normal two-way phone conversation, each person, on the average, speaks only half the time and, even while he is speaking, there are gaps and pauses in his speech. So if the two directions of transmission are separated, each path is idle more than half the time. If two conversations were interlaced to take advantage of these gaps, you could get twice as many conversations per channel.

In practice, more than two channels are needed for the system to work—two talkers would frequently speak at the same time. In a submarine telephone cable, say one with 36 channels,

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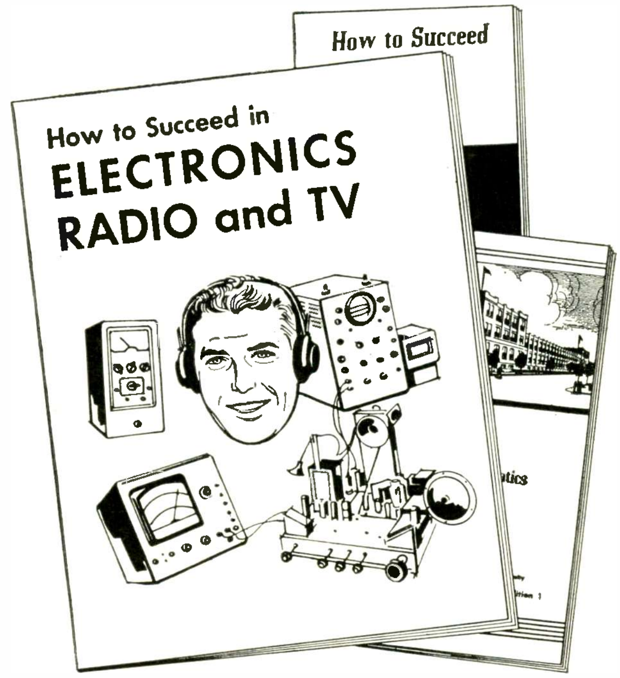

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an averaging effect occurs and at any one instant there is a greater probability of enough free time to accommodate the larger number of conversations.

TASI is essentially a group of high-speed switches and an electronic computer. When there are more talkers than channels, the equipment connects active talkers by disconnecting talkers who are inactive at that moment. In turn, the disconnected talker is assigned another momentarily inactive channel when he starts to speak again. A talker is disconnected only when he is silent.

When a talker starts speaking, his voice triggers a speech detector. The detector is scanned by a control circuit similar to a modern digital computer. The control circuit sends a coded tone burst consisting of four audio tones which precede the voice over the available channel. After the 10-millisecond tone burst, the control circuit connects the talker to the same channel. The coded tones operate switches which connect the talker to the proper line at the receiving end.

THOUSANDS OF MESSAGES handled for personnel at isolated Arctic and South Pacific posts earned Julius M. J. Madey, 18, of Clark, N. J., General Electric's 1958 Edison Radio Amateur Award for public service. One of a family of four licensed radio amateurs, Madey spends an average of 90 hours a week at his station K2KGJ in his home.

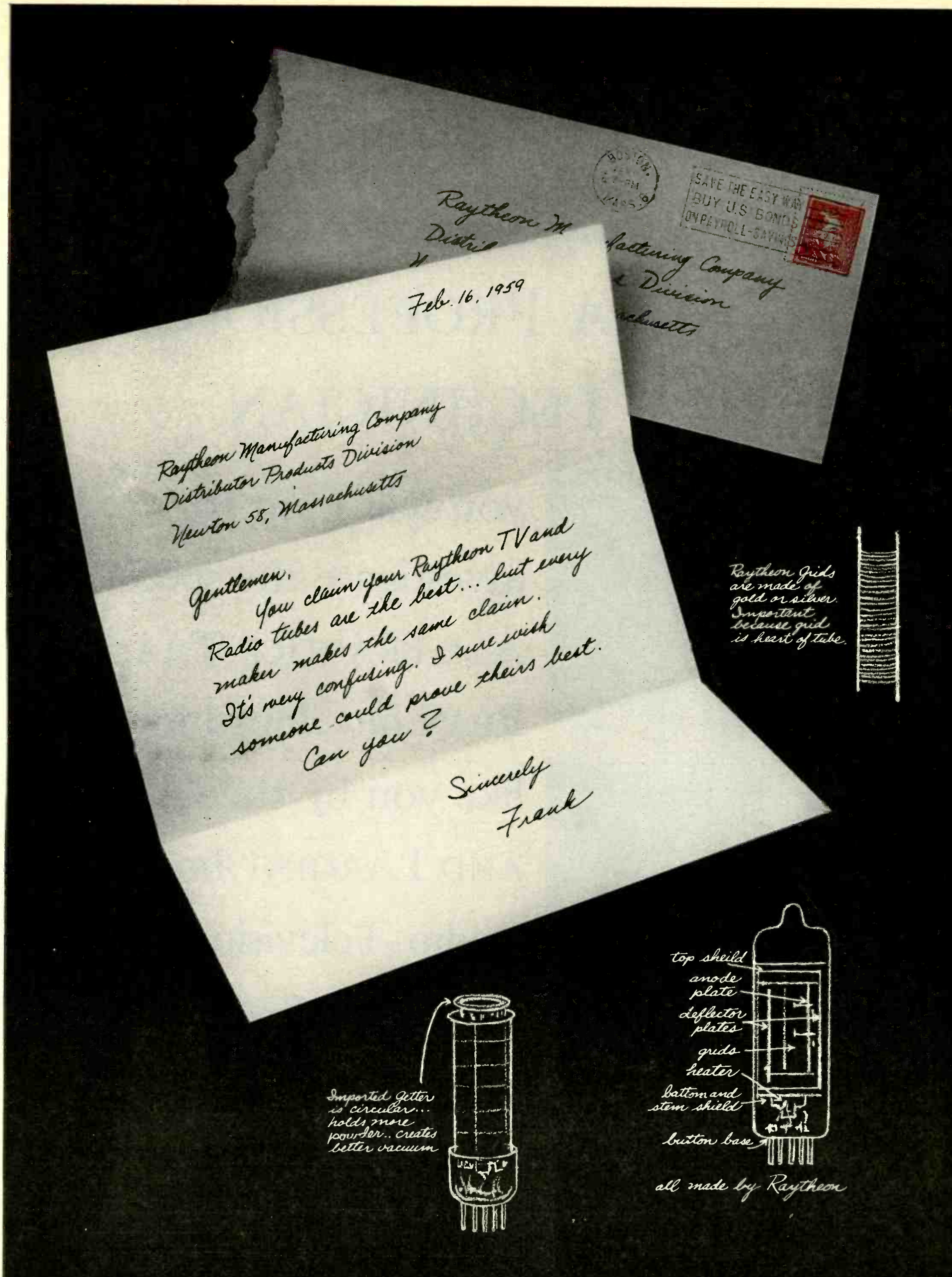
Madey transmitted more than 12,000 messages in the past year, maintaining almost continuous contact with the far-flung outposts from mid-afternoon to

8 am. Several times, he has handled official Navy and Coast Guard messages for those services.

Active in local Civil Defense and other community activities, his work has been featured in several magazines and newspapers. He won student science-fair honors several years ago for inventing an ultrasonic drill. He now plans building a system for creating man-made "whistlers," the eerie high-frequency sounds in space which are attracting scientific attention.

MECHANIZED MAIL PROCESSING from start to finish is the unusual feature

(Continued on Page 18)


SAVE THE EASY WAY BUY U.S. BONDS ON PAYROLL-SAVINGS
Feb. 16, 1959
Raytheon Manufacturing Company
Distributor Products Division
Newton 58, Massachusetts
Gentlemen,
You claim your Raytheon TV and Radio tubes are the best... but every maker makes the same claim. It's very confusing. I sure wish someone could prove theirs best. Can you?
Sincerely
Frank
Raytheon grids are made of gold or silver. Important because grid is heart of tube.
top sheild
anode plate
deflector plates
grids
heater
bottom and stem shield
button base
Imported getter is circular... holds more powder.. creates better vacuum
all made by Raytheon

NEWS BRIEFS *(Continued from page 12)*

of the Post Office's first fully mechanized mail processing plant and post office to be built at Providence, R. I. As in many modern mechanized systems electronic equipment plays an important role. Operations of this plant will be supervised from an elevated control center that will have visual and electronic views of all activities. Cancelled letters will be sorted by operators seated at keyboards which control other machines that will sort thousands of letters hourly. The postal station will be built and equipped by Interlex Systems Inc., a subsidiary of ITT. Scheduled completion date is September, 1960.

TALKBACK TV lets the student watching a remote TV receiver ask and answer questions, and hear questions and answers from students in other classrooms. Currently used in Cortland, N. Y., the system was reviewed in a paper by R. C. Norton and J. B. Davidson of the New York Telephone Co., at the recent general meeting of the AIEE in New York.

Regular telephone circuits provide the talkback over a single pair of wires between each classroom and the studio. Two small loudspeakers are placed in each room and one on the teacher's desk. Using, reversible amplifiers, these speakers serve as both mike and receiver.

ONE NEW TV STATION and the return of an old-timer reinforce the nation's networks.

KOKH-TV, Oklahoma City, Okla.......25
WHCT, Hartford, Conn.......................18

WHCT came back on the air after an absence of a little over a month.

One station closed down:

KXLJ-TV, Helena, Mont......................12

KIDO-TV, Boise, channel 7, became KTVB in January, and WKTV, Utica, N. Y., switched from channel 13 to channel 2.

Leslie F. Garrett, of Derry, N. H., reminded us of our oversight in omitting WHDH-TV, Boston, Mass., channel 5, from our January master list and also called to our attention that WAST, Albany–Schenectady–Troy, channel 13, was shown incorrectly as WTAS. We thank him for his interest.

The US total is now 549, of which 463 are vhf and 86 uhf. KOKH-TV is educational, therefore the non-commercial total is 37.

ELECTRONICS COURSE via radio, sponsored by the First Army, celebrated its first anniversary with the New Year. Outstanding specialists have given lectures over the First Army MARS SSB Technical Net each Wednesday night. Ham members of MARS follow up the lectures with calls, contributing to a "forum by radio."

Although theoretically limited to a 1,000-mile radius of New York, the net has received letters from as far as the Azores, 2,500 miles distant.

The MARS technical sessions are conducted each Wednesday at 9 pm on 4030-kc upper sideband. END

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Gold Label* Vibrators—unequalled performance and life . . . the quietest vibrator ever.
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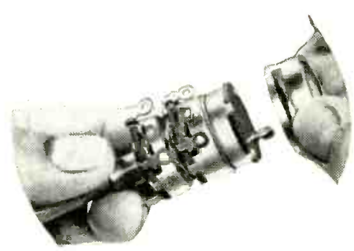

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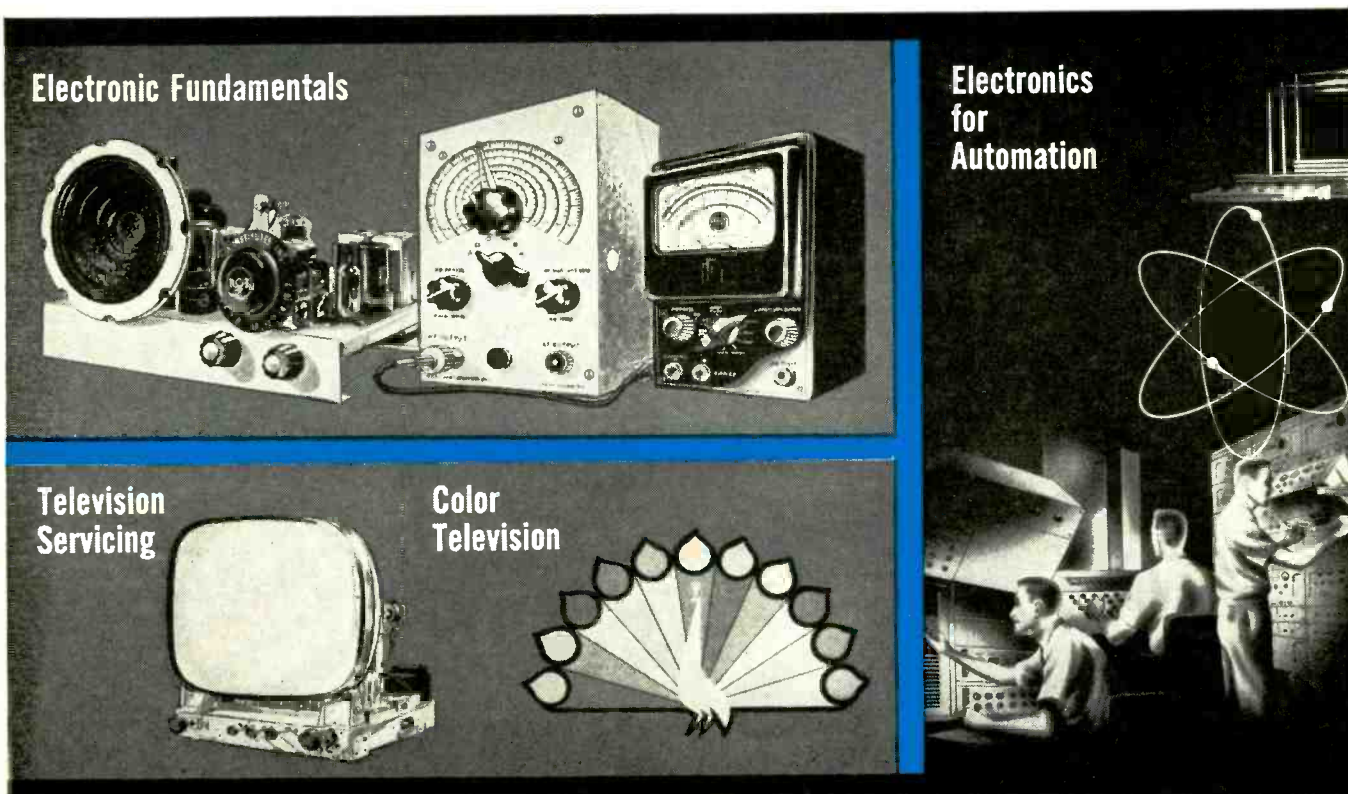

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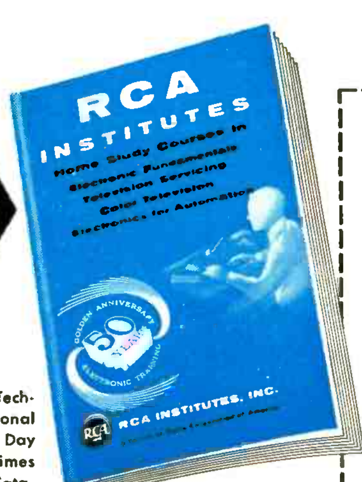

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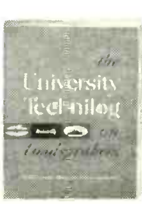

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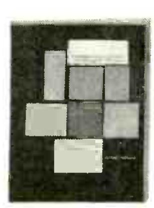

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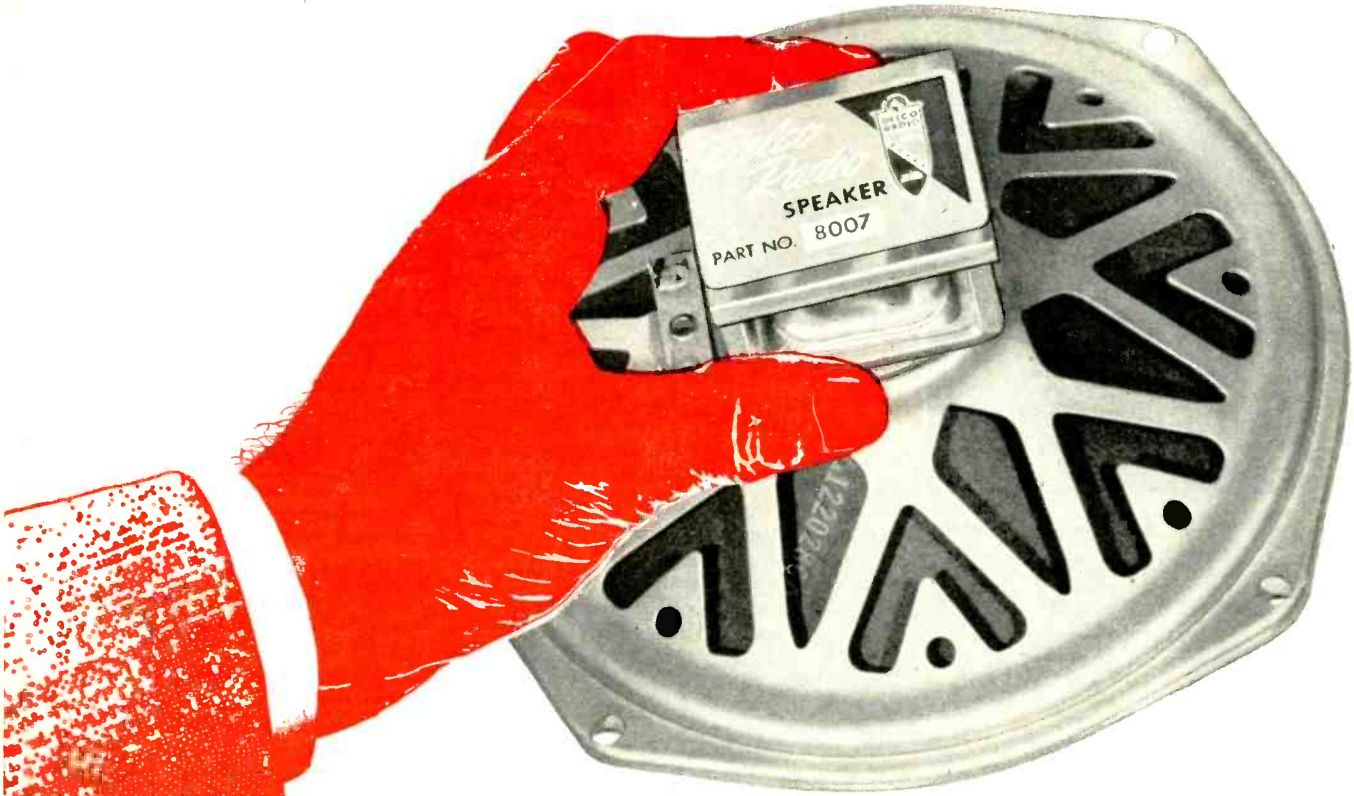

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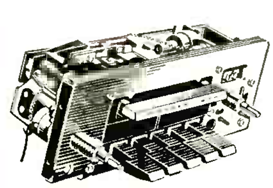
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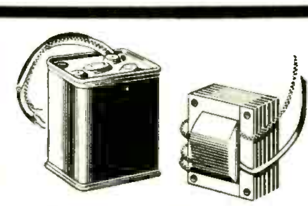
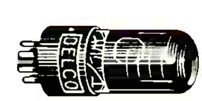
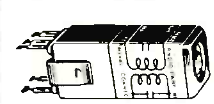

TRANSFORMERS


TUBES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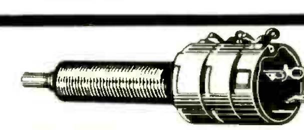
CONTROLS

Correspondence

INTERFERENCE-PRONE SETS

Dear Editor:

The letter "TVI and the Law" in your September 1958, issue omits a rather important consideration. The writer, Mr. Dagion, fails to mention that interference as it finally shows up on the picture tube or in the loudspeaker is *due* to, not caused by, two different things.

First, there is the fact that some machines actually emit spurious radiation. This sort of thing is controlled by rules of the FCC which require proper shielding to eliminate *illegal* emission. Recent rulings have required manufacturers to hold down local oscillator emission by shielding or filtering in radio and TV sets and other devices which may *emit* radiation. Most manufacturers are glad to go along with this sort of treatment because they have to keep peace with their customers.

But the most frequent problem is lack of discrimination in the receiving equipment—both TV and radio. In an effort to get a sharper picture, more brilliant sound—and perhaps most important, to cut production costs—manufacturers use broad-band circuits which will not discriminate between the desired signal and the unwanted one beyond a given point. "Funnel" type front ends which seemingly reach out for unwanted interference have been a considerable problem to those owning industrial, commercial or amateur gear when the fault lies with the design techniques of the manufacturer of the receiving equipment.

This has been recognized by most leading TV manufacturers, who supply, through their distributors, filters to eliminate this trouble, usually at no cost to the service technician or customer. Such filters are not installed at the time of manufacture since the percentage of these interference cases is so low that it would become an unnecessary production expense if incorporated in all sets. It has become standard procedure to supply filters only when required.

The primary misunderstanding is blaming the equipment producing the interference rather than the nonselective receiving equipment. In practically every case, owners of electronic equipment are most anxious to clean their own houses and avoid offending the public but are unable to do the whole job because of design deficiencies in receiving equipment.

After dealing with this difficulty a good many times, I am convinced that the dealer who sells the receiver owes the purchaser an explanation of the problem. Though some may not be aware of this situation, most dealers are and they are doing a distinct disservice to the electronics business and the service profession by not explaining it to the customers who are troubled. There is no excuse for trying to place the blame on an equipment user when it belongs on the set manufacturer.

BOB FORMAN
Forman Co., Monmouth, Ill.

(The problem of TV and radio interference will be treated in detail in a forthcoming issue.—*Editor*)

ANOTHER SA5-M REPLACEMENT

Dear Editor:

The SA5-M used by Ted Ladd in a light meter (page 123, December, 1958) and Rufus P. Turner in a light-powered frequency standard (page 58, February 1959) has been dropped from our standard products line. However, this cell can be replaced by a newer type unit that operates at a higher efficiency. It is the type S-1020B (unmounted) or the SD-1020B (mounted). Two of these cells connected in parallel replace the SA5-M.

HARRY NASH
Chief Application Engineer
International Rectifier Corp.

REFLEX CORRECTION

Dear Editor:

Something unfortunate seems to have happened at a vital spot to my article ("All About the Reflex Enclosure," Part I, February, 1959).

The diagram on page 39 with its three sine curves each a quarter cycle later than the previous one is correct. The error is in the explanation on page 40, column one.

The wording refers to port air velocity and states: "It also increases between E and G." *That is wrong.* The two sentences there should read: "It increases between D and F. The air moving through the port (Fig. I-2-c) moves forward between E and G."

As additional explanation I would say that port air velocity increases (in a forward direction) during the whole time of forward acceleration—from D to F and not E to G. Maximum velocity is therefore reached at F, 90° later than maximum acceleration. The air particle displacement at the port passes through its mid-point at F and reaches maximum forward displacement at G. It is thus at its maximum 180° after maximum rearward motion of the cone (E). By then the cone is fully forward

again and so the port air displacement synchronizes with the motion of the front of the cone. Relative to the inward cone motion which compressed the air cushion in the first place, port motion is reversed in phase.

In connection with Fig. I-3, it should be made clear that the left side illustrates "what one might expect" (and actually happens at very low frequencies), but does *NOT* happen when reflexing. The right side of that figure illustrates conditions when reflexing.

Toronto, Canada P. G. A. H. VOIGT

KNOCKS PRINTED CIRCUITS

Dear Editor:

I think it is about time we got a report out concerning the printed circuits radio and television manufacturers have been using.

We get about two printed-circuit sets to every wired set. The trouble is usually twice as difficult to trace. Parts replacement is also twice as difficult because of the heat-sensitive copper foil and multiple-terminal components. We usually run into twice as many tough dogs and find twice the number of failures per year on printed circuit sets than on wired sets. The failures result from leakage between foil wiring or component breakdown due to the compactness of portables and lack of sufficient ventilation. Usually twice the time is spent in troubleshooting printed circuits. Therefore, printed circuits are a loss to technicians. I still prefer wired sets. I have asked the opinion of many of the technicians in my area—they agree. BRIAN CHIN

New York, N. Y.

RUMBLE'S RUMBLE

Dear Editor:

In the Try This One column in the January, 1959, issue (page 136), Mr. C. E. Cohn recommends disconnecting the plate-load resistor of the first audio stage from B plus and connecting it to the plate of the output tube as a method of applying inverse feedback. However, the item failed to point out that you only get inverse feedback if there are an even number of stages in the amplifier. If there are an odd number of stages, positive feedback occurs and the amplifier oscillates. ROBERT RUMBLE

San Luis Obispo, Calif.

SWEET MUSIC

Dear Editor:

I feel like someone who has been given a map with indications for finding buried treasure. For composers, your "Micromusic" (editorial in the March 1959 issue) is the open sesame to a cave of infinite sound and I, for one, am infinitely grateful.

Your article also calls to mind these warning words of Einstein's: "Our actual situation cannot be compared with anything in the past. We must radically change our ways of thinking, our method of action."

My thanks for "Micromusic."

New York, N. Y. EDGARD VARESE

END

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Reproduces test pattern on picture tube. Injects signals into video detector or video amplifier stage of TV receiver for fast, visual trouble-shooting and correction. Makes it easy to check bandwidth, resolution, shading and contrast.

R.F. OSC.

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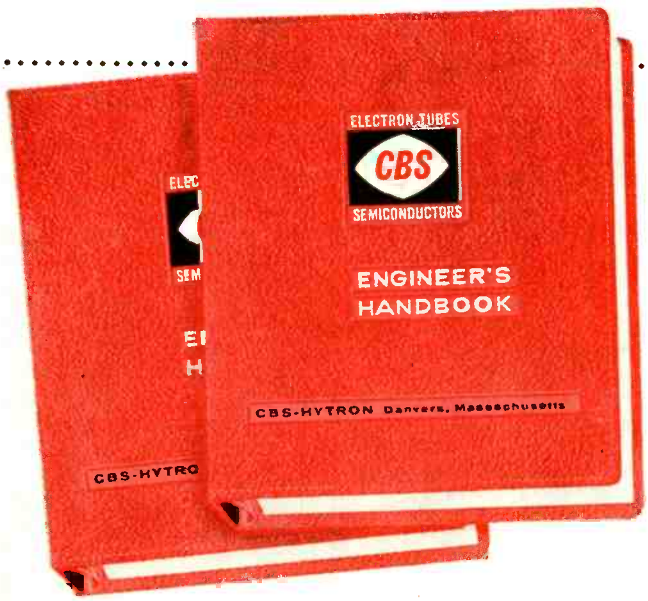

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ELECTRONICS vs WAR

. . . *Why the Billions of Defense Dollars?* . . .

THE following letter by the mother of a young son is one of many similar ones which have reached us periodically throughout the years. It deserves every reader's thoughtful attention, as it correctly mirrors the sentiments of a large cross-section of our population in these most unusual times in our history. The letter is slightly condensed from the original.

> In an old (September, 1955) issue of your magazine that my young son brought home recently, I was interested in some statistics given in the editorial "The Giant Electronics Industry." To quote: "By far the largest customer of the industry is the United States Government. Defense purchases of electronic equipment last year are estimated at $2,300,000,000, . . . and may go up to over $4,000,000,000 a year by 1964."
>
> In my opinion it bodes no good for the future when great nations and blocs of nations concentrate so much of their economy & know-how in technology & science on purely destructive mechanisms of rapidly increasing power. It is obvious that this stupid (in my opinion) waste of human ingenuity is extremely corrupting in several ways. For example, the world's human energy is channeled destructively instead of constructively, natural entropy is needlessly increased by the addition of human entropy, young people sense unknowingly the terrible possibilities of modern technological warfare—hence the rise in juvenile delinquency—& a disproportionate part of national incomes goes into what the nations call defense. It is true that defense mechanisms are needed but not to such an unbalanced degree. Otherwise, if our grave problems should be settled by arbitration or other civilized methods instead of war, I simply cannot see how economies that lean heavily on war mechanisms will be able to adjust to a constructive economy without very considerable hardship.
>
> Whole populations today are living under the black and real shadow of huge scale slaughter; therefore please tell us about the need for far greater applications of technology & science for *constructive* purposes.
>
> *Baldwin Path,* MRS. P. CAMMER
> *Huntington, N.Y.*

The ideas expressed so well by our correspondent are unfortunately not new. They have occurred to every thinking individual since our aborigine days, millenia ago. War, unhappily, has been with us always, and "war" will be with us until the end of the world, *in one form or another.*

The nations recognizing this must build up their defenses, and this admittedly brings considerable waste in its wake. This is true of most large-scale human endeavors.

If the people of a community are threatened by periodically recurring floods, they sooner or later must build a dam or levee to keep the waters from flooding their homes. If they skimp in labor, money—and good engineering—their work may go for naught, as the Johnstown flood demonstrated. Hence, it is better for safety's sake to spend more rather than less. Incidentally, while building many dams, we learn in time how to build them better, and often more economically.

When a nation bolsters its defenses, the human energy expended is not necessarily all channeled destructively. To the contrary, the nation builds up its economy, enriches its engineering in the country's industrial plant, gives vast employment and, through hundreds of byproducts of every imaginable kind, enhances its standard of living.

Even war machines become peace messengers. Our large four-motor civilian airplanes are, in reality, bombers in a new dress. Our new passenger jet planes were born as war planes. *They were brought to their present perfection solely because of our defense efforts.* Is this not in a way a constructive result?

The greatest difficulty most people have today is their inability to distinguish between human-made war and our constant war against non-human enemies.

We are always at war with famine, cold, heat, floods, tempests, epidemics, insect pests and microbe invasions, be they colds, measles or tuberculosis. We fight a continuing war against cancer and heart disease, and countless other minor wars. Our war with accidents of every kind will never be won as long as the world lasts. Nearly 10 million a year, almost 100,000 deaths in the U.S. alone—the best we can hope for is to reduce this frightful toll.

Add up the cost of all these wars, which is far greater in lost lives and treasure in a single decade than any periodic man-made war you can name. The money we pour into the *defense* against these non-man-made wars is fantastic, yet we know we dare not stop lest we revert to the dark ages when man died before he was 40, mostly due to ravages of unconquered diseases.

As to the billions of dollars we pour into the defense against man-made war during peace, it is in the end a cheap insurance against such a war. *The more formidable our defense, the less the chances of war, be it man-made or nature.* Take one instance, smallpox, which accounted for millions of deaths and disfigurement of hundreds of millions before vaccination was introduced.

Now let us turn to the comparatively few billions of dollars expended yearly in electronics. It was World War I which gave us radio and radio communication as we have it today. War or defense *always* speeds up technological inventions, whether we like it or not, and we all hate war. World War II gave us radar and countless other inventions including the atomic bomb, which, when used as atomic power, in the near future, will be a far more important instrument for peace than anything man ever knew.

The electronic defense billions we expend now and later, we repeat, bring in their wake not only war inventions but countless others as byproducts which we would not have otherwise. These discoveries, inventions, devices and methods help us in the fighting of our other wars, too, as, for instance, in the electronic battle against diseases. Since World War II, electronbiology and electronics in medicine, among others, have become big branches in the art of medicine and disease prevention.

Americans should realize that the terminology *war* should no longer apply solely to man-made war. We have never been at peace since man arrived on this planet and we probably never shall be. **As long as humanity endures, there will always be an eternal war for man's survival.** —*H.G.*

Laboratory accuracy in a home-built unit lets you measure ac voltages between .0001 and 10 volts with an error of less than 2% over a bandwidth of 9 cycles to 8.5 mc

SENSITIVE WIDE-BAND AC VTVM

By PHILLIP D. BLAIS

AC VOLTAGE measurements are probably the most important method of evaluating circuit performance. Most vtvm's cannot be used because of insufficient sensitivity and bandwidth. Crystal rectifier probes and preamplifiers are commonly used in attempts to increase the range of ordinary vtvm's. Calibration of such accessories is very difficult, and stability is poor. The ac vtvm described is of laboratory quality, and its accuracy is surpassed by only a few very expensive commercial units.

The requirements for a laboratory voltmeter are many. High input impedance, reliability, etc. are all familiar to the technician. Statistics can best represent these qualities:

Ranges (full scale)	.005, .01, .05, 0.1, 0.5, 1, 5, 10
Bandwidth	9 cycles–8.5 mc±5% 20 cycles–3.5 mc±4% 25 cycles–2.5 mc±2%
Input impedance	10 megohms, 25 μμf
Noise level	Equiv. to 20-μv input
Negative feedback	30 db
Line-voltage error	Less than 2% 90–125 volts

The serious experimenter will immediately see the advantages of this voltmeter and its possibilities in his workshop. Design of preamplifiers, power amplifiers and other test equipment is possible with such an instrument.

Basic circuit design

A block diagram of the ac vtvm is shown in Fig. 1. A cathode follower in the input provides a high input and a low output impedance for the attenuator, which is composed of low-value precision resistors. At all frequencies the attenuator is compensated against errors due to stray capacitance, by small trimmer capacitors. No attenuator compensation is needed on the .005-volt range because there is no additional series resistor between V1's cathode and V2's grid. Thus the current due to V2's input capacitance does not affect the attenuation. At high frequencies, it does shunt the attenuator as a whole and produce an error. This error is very small, because of the low output impedance of the cathode follower, and is negligible up to 10 mc.

The 5- and 10-volt ranges are not compensated because the input reactance to V2 is much larger than the 1.5 ohms presented by the attenuator. On these two ranges the attenuator's output impedance is approximately 1.5 and 0.75 ohm while the input reactance to V2 is approximately 800 ohms at 10 mc. Thus, over 99% of the current in V1's cathode passes through R12 and R13, producing an error of less than 1%.

The attenuator is followed by a high-gain video amplifier to boost small voltages. The output of the video amplifier is rectified by a full-wave diode rectifier and applied to a 0–1-ma milliammeter.

Nonlinear elements, such as vacuum tubes, in a circuit always produce distortion and variations in gain with changes in applied voltage, temperature, etc. Gain variations are intolerable in voltmeters, and some way to control this source of error is needed. The most practical way to stabilize gain is through the use of negative feedback. In this voltmeter 30 db of negative current feedback is applied around four stages, in the video amplifier, and is responsible for many of the desirable characteristics. The meter is included in the feedback circuit for good scale linearity.

The power supply is electronically regulated to reduce further the effects of line-voltage variations. A dc heater supply reduces hum and noise in the first amplifier stages.

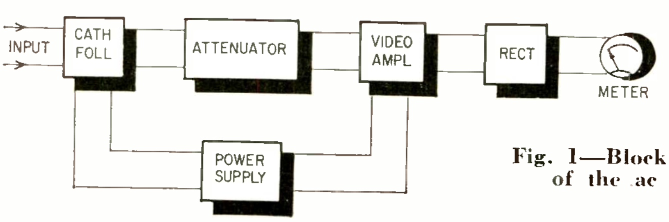


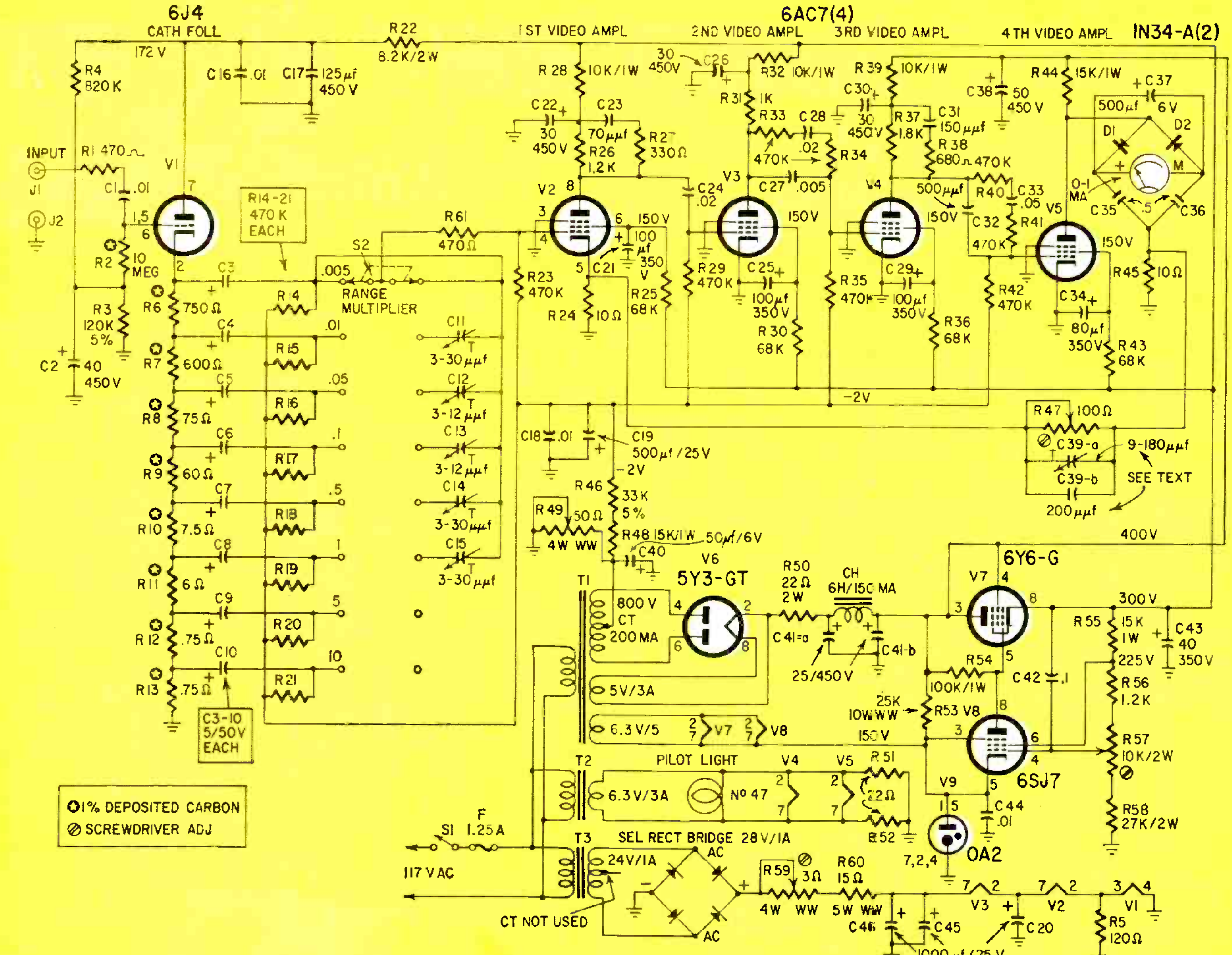
Fig. 1—Block diagram of the ac vtvm.

Cathode follower and attenuator

A voltmeter's accuracy is often limited by attenuator accuracy. The impedance of an attenuator should be as low as possible to minimize the effects of stray capacitance. Large values of resistance show frequency effects which yield an effective ac resistance considerably lower than the dc value. An ordinary ½-watt 1-megohm carbon resistor has an effective resistance of only 570,000 ohms at 10 mc.[1] Precision carbon resistors suffer least from this effect and are used in this voltmeter's attenuator. See Fig. 2.

Resistors R12 and R13 in the attenuator are 0.75 ohm and are not commercially available precision units. Use parallel combinations such as 1 and 3 to obtain 0.75 ohms, or fabricate from resistance wire. If resistance wire is used, keep the inductance at a minimum by keeping the area enclosed by the loop of wire to a minimum. At 5 mc, an inductance of only .02 μh has a reactance of 0.75 ohm and contributes an error of 41%. A short hairpin-shaped loop is satisfactory.

Capacitors C3 through C10 in com-



R1, 61—470 ohms
R2—10 megohms, 1%
R3—120,000 ohms, 5%
R4—820,000 ohms
R5—120 ohms
R6—750 ohms, 1%
R7—600 ohms, 1% (300 and 300 in series)
R8—75 ohms, 1%
R9—60 ohms, 1% (50 and 10 in series)
R10—7.5 ohms, 1% (30 and 10 in parallel)
R11—6 ohms, 1% (5 and 1 in series)
R12, 13—0.75 ohm, 1% (3 and 1 in parallel)
R14, 15, 16, 17, 18, 19, 20, 21, 23, 29, 33, 34, 35, 40, 41, 42—470,000 ohms
R22—8,200 ohms, 2 watts
R24, 45—10 ohms
R25, 30, 36, 43—68,000 ohms
R26, 56—1,200 ohms
R27—330 ohms
R28, 32, 39—10,000 ohms, 1 watt
R31—1,000 ohms
R37—1,800 ohms
R38—680 ohms
R44, 48, 55—15,000 ohms, 1 watt
R46—33,000 ohms, 5%
R47—pot, 100 ohms, carbon
R49—pot, 50 ohms, 4 watts, wirewound
R50—22 ohms, 2 watts
R51, 52—22 ohms
R53—25,000 ohms, 10 watts, wirewound
R54—100,000 ohms, 1 watt
R57—pot, 10,000 ohms, 2 watts
R58—27,000 ohms, 2 watts
R59—pot, 3 ohms, 4 watts, wirewound
R60—15 ohms, 5 watts, wirewound
All resistors ½-watt 10% unless noted
C1, 16, 18, 44—.01 μf disc ceramic
C2—40 μf, 450 volts, electrolytic
C3, 4, 5, 6, 7, 8, 9, 10—5 μf, 50 volts, electrolytic
C11, 14, 15—3-30 μμf, miniature disc trimmer
C12, 13—3-12 μμf, miniature disc trimmer
C17—125 μf, 450 volts, electrolytic
C19—500 μf, 25 volts, electrolytic
C20, 45, 46—1,000 μf, 25 volts, electrolytic
C21, 25, 29—100 μf, 350 volts, electrolytic
C22, 26, 30—30 μf, 450 volts, electrolytic
C23—70 μμf, mica
C24, 28—.02 μf, disc ceramic
C27—.005 μf, paper
C31—150 μμf, mica
C32—500 μμf, mica
C33—.05 μf, paper
C34—80 μf, 350 volts, electrolytic
C35, 36—0.5 μf, miniature paper
C37—500 μf, 6 volts, electrolytic
C38—50 μf, 450 volts, electrolytic
C39-a—9-180 μμf, trimmer (see text)
C39-b—200 μμf, mica (see text)
C40—50 μf, 6 volts, electrolytic
C41-a, -b—25 μf, 450 volts, electrolytic
C42—0.1 μf, paper
C43—40 μf, 350 volts, electrolytic
All capacitors 600 volts unless noted
CH—6 henrys, 150 ma
D1, 2—1N34-A
F—1.25 A
J1, 2—terminal-binding-post assembly (National FWH or equivalent)
M—0-1 ma
RECT—full-wave bridge, selenium, 28 volts output, 1 amp or higher
S1—spst toggle
S2—5-gang 5-pole 8-position steatite rotary
T1—power transformer: primary, 117 volts; secondary, 800 volts ct, 200 ma; 5 volts, 3 amps; 6.3 volts, 5 amps; (Thordarson 24R07 or equivalent)
T2—filament transformer: primary 117 volts; secondary, 6.3 volts, 2 amps (Stancor P6466 or equivalent)
T3—filament transformer: primary, 117 volts; secondary, 24 volts ct, 1 ampere (Triad F-40X or equivalent)
V1—6J4
V2, 3, 4, 5—6AC7
V6—5Y3-GT
V7—6Y6-G
V8—6SJ7
V9—0A2
Pilot lamp, No. 47
Chassis
Miscellaneous hardware

Fig. 2—It takes nine tubes and two crystal diodes to give the ac vtvm its accuracy.

bination with resistors R14 through R21 reduce transients in the input circuit when changing ranges, and reduce waiting time. Trimmer capacitors C11 through C15 are adjusted during calibration to compensate for stray capacitance in the attenuator. The attenuator is constructed on a five-gang eight-position steatite switch, and details are shown in the photo. Unused sections are disabled by removing the rotor. A two-pole eight-position rotary could have been used, but it would not allow for easy attenuator construction. All components are mounted on the switch.

A 6J4 triode is the input cathode follower, because of its unusually high transconductance—12,000 μmhos. The special circuit used to obtain the grid bias on the 6J4 reduces the noise figure[2] and illustrates the many special precautions used to obtain the low noise figure. Heater current required by the 6J4 is less than that for a 6AC7, and the 6J4 heater is shunted by R5 to allow series connection of the tubes' heaters. The grid circuit has a small resistor near the tube socket to prevent parasitic oscillations when the input is short-circuited.

Video amplifier

The video amplifier consists of four

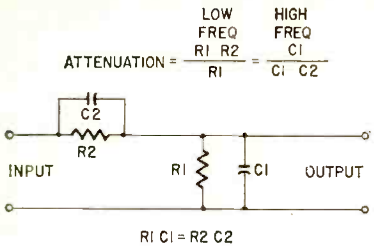


Fig. 3—How to determine component values for a frequency-compensated attenuator.

6AC7 stages. The 6AC7's are used because of their high transconductance and low noise figure. The first two 6AC7's have a dc heater supply. The cathodes of the second, third and fourth video amplifiers are grounded directly to reduce hum and noise. This also removes any complex impedances in the cathode circuits, which tend to produce degeneration at low frequencies.

A collective back-bias arrangement provides the required negative grid voltage.[3] Each grid is returned to a common negative voltage source provided by the center tap of the plate power transformer winding. This voltage is proportional to the total current, and in this way a collective self-bias source is maintained. This design is responsible for the complete absence of hum in the video amplifier.

The screen grids of the 6AC7's are supplied through large screen dropping resistors from the voltage-regulated supply to reduce changes in transconductance due to changes in line voltage. Very large screen bypass capacitors keep degeneration and phase shift small at low frequencies. The cost of electrolytic capacitors is small and "bargain" units may be used here. If their quality is questionable, bypass each one with a .01-µf ceramic unit to eliminate high-frequency inductance effects. These capacitors, not shown in Fig. 2, were used in the finished vtvm. They are visible in the bottom view of the video amplifier. They are coded with the number of the bypassed electrolytic and the suffix "a".

The coupling between stages involves R-C networks called Bode networks[4] to control phase shift and attenuation, for stability with negative feedback. These networks are the result of many trials and calculations, and should not be varied. The balance between frequency response and phase shift is delicate when applying 30 db of negative feedback around four stages with a bandwidth of 10 mc, and the design is vindicated by the final result.

The final 6AC7 stage has a high plate load resistance—15,000 ohms. It is shunted by the relatively low impedance of the meter circuit. The meter-circuit current is thus equal to the ac tube current, which is equal to the transconductance multiplied by the ac grid voltage. The current is rectified by the two germanium rectifiers and applied to the meter circuit as pulsating dc, filtered by C37. The two half-waves of current are then recombined by capacitors C35 and C36, and applied to R45. The negative-feedback voltage is taken from R45. Being familiar with negative feedback, we realize that this tends to keep the voltage across R45 constant. This voltage is merely a measure of the current through the meter circuit, and thus the feedback is actually negative current feedback. The tendency to maintain constant current through the meter circuit by negative current feedback results in a very linear scale regardless of changes in the rectifier's forward characteristics with applied voltage. Feedback is adjusted with R47, and the voltmeter gain is adjusted during calibration by R47. C39 corrects the negative feedback at higher frequencies to improve frequency response.

Capacitor C39 consists of a 9–180-µµf trimmer in parallel with a 200-µµf mica. However, in my unit the trimmer is adjusted for maximum capacitance and the total value of the combination is 380 µµf. Due to differences in construction and tubes, a different value may be required. The outside limits to the value you may need in the meter you build are 40 µµf and .0015 µf. For best results try a 170–780-µµf trimmer as a start. The chances are the value you need will be within its range.

The first 6AC7 stage has a small grid-isolating resistor R61 to prevent parasitic oscillations at high frequencies.

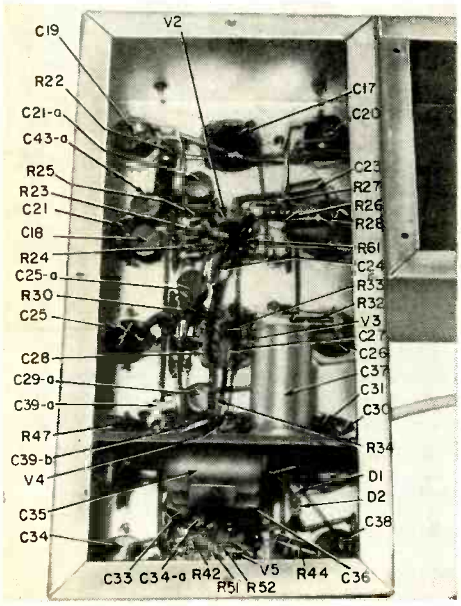
The power supply is straightforward in design and construction and will not be discussed in detail. A separate chassis is used for the power supply to isolate unwanted signals and to facilitate adjustment and repair. I used a power transformer from an old Atwater-Kent and two 6.3-volt heater transformers. However, you can use the arrangement shown in the schematic for greater convenience.

Construction hints

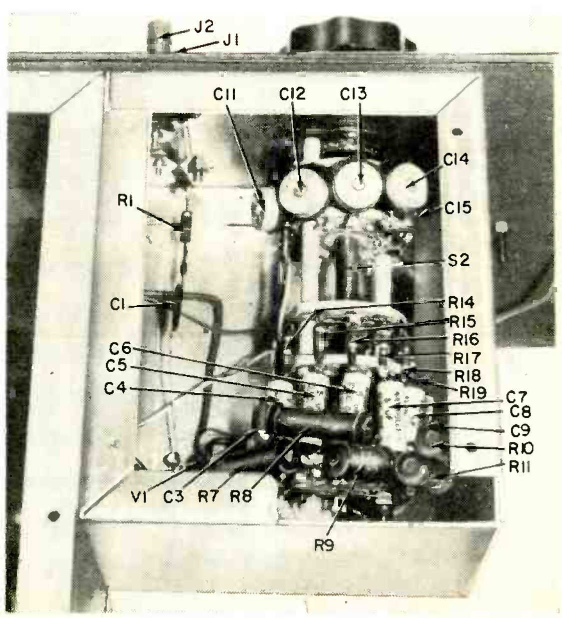
Construction is not critical or tricky and the layout may be modified for special requirements. The layout shown in the photos is recommended for general use. Input capacitance can be reduced slightly by placing V1 closer to the input terminals, and is recommended. A separate, totally enclosed chassis for the attenuator and cathode follower is a necessity to reduce hum pickup in the high input impedance. Placement of circuit components is not critical, although normal precautions should be taken.

The attenuator resistors are the only precision components required; all other components are normal 10% tolerance. Some attenuator resistor values are not stock items, but may be made up as combinations of stock values. Use a heat sink when soldering precision resistors to prevent a permanent change in resistance due to heating. Broad limits are possible on all electrolytic capacitors and nearest available values may be used.

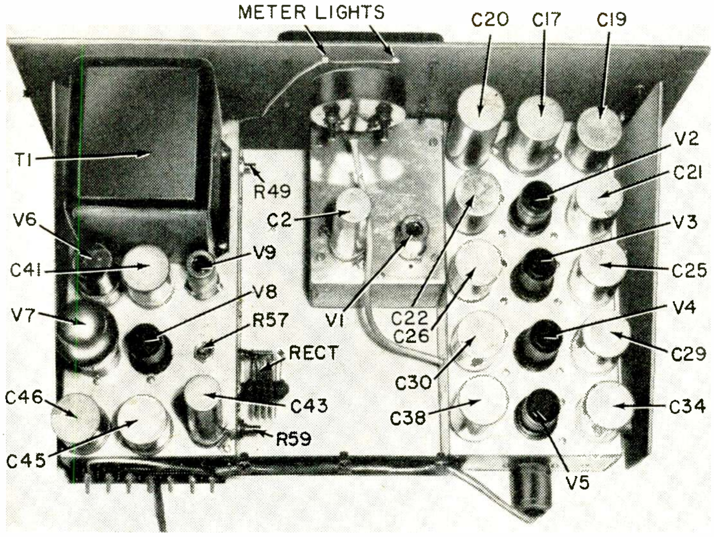
The custom appearance of the indi-



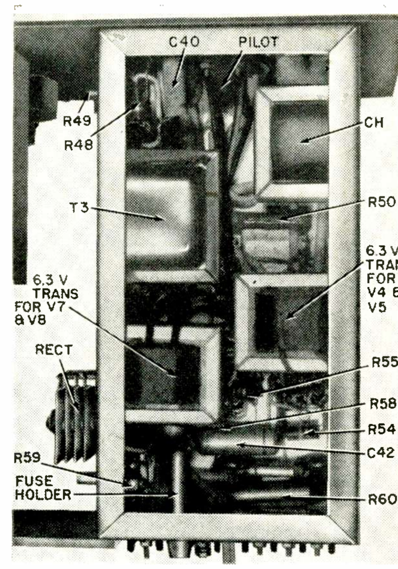
A look under the video amplifier chassis.



The attenuator is in a chassis of its own.



The finished chassis has a professional look.



Under the power-supply chassis.

cating meter is obtained by using a standard 4½-inch Triplett 0–1 milliammeter. The unwanted lettering is removed from the meter scale by gently rubbing with a small cloth dampened with acetone.

Two sets of scale numerals should be applied to match the attenuator ranges. Appearance may be further enhanced by drilling two small holes through the back of the meter and inserting two small pilot lights. These holes must be drilled with a hand drill, being extremely careful not to damage the delicate meter movement. Orient the meter so drill chips fall away from the suspended coil and pivots.

Use decals to label the front of the instrument and give a professional appearance. The clear birch wood cabinet is assembled with screws and glue. Give the sanded surface several coats of clear lacquer, until it is glossy. The finished instrument is very attractive, and professional in appearance and performance.

Adjustments and calibration

Now that the instrument is completed, it must be adjusted to make measurements. After a 30-minute warm-up, adjust:

1. The voltage-regulated supply. Set R57 for 300 volts at the cathode of the 6Y6-G.
2. Heater voltage. Trim R59 to get 18.9 volts dc at C45 and C46.
3. Grid bias in video amplifier. Rotate R49 until −2 volts is obtained across C40.

This completes the adjustments, and all voltage measurements are with respect to chassis ground. It may be necesary to repeat these twice.

Calibration is more difficult, and ingenuity is required if laboratory standards are not available. Get a 60-cycle source that is within the voltmeter's range and the most accurate meter available. With the appropriate meter scale and range setting adjust R47 until the voltmeter reads the same as the calibrating voltmeter used as the "standard."

The attenuator trimmer capacitors require a frequency source above 3 mc with a variable output. The required steps are:

1. Set the voltmeter range switch to .005 volt. Adjust the output of a signal generator, set between 3 and 10 mc and connected to the voltmeter, so the voltmeter reads full scale.
2. Without changing the signal generator's output, set the voltmeter range to .01, and adjust trimmer capacitor C11 until the output meter reads half scale (.005).
3. Adjust the signal generator's output until the voltmeter reads full scale. Now set the voltmeter range switch to .05, and adjust C12 until voltmeter reads .01 volt.
4. Adjust the output of the signal generator until the voltmeter again reads full scale. Set the meter to 0.1, and adjust C13 until voltmeter reads half scale.
5. Increase signal generator output for full-scale reading. Change voltmeter range switch to 0.5, and adjust C14 to read 0.1 on voltmeter.
6. Finally, increase signal generator again to give full-scale deflection, and change the voltmeter range switch to 1 volt. Adjust C15 for half-scale reading.

This completes the attenuator adjustments, and the attenuator should be independent of frequency.

High-frequency calibration is the final adjustment necessary before use. Set the signal generator at 7 mc and the output at 1 volt. The output may be measured at this level and frequency by using a simple diode rectifier probe and an ordinary dc vtvm. The 1-volt output is applied to the input of the voltmeter, and C39 adjusted to give a full-scale reading on the 1-volt range. The voltmeter is then placed in the cabinet, and is ready for use.

Occasionally, due to a 6AC7 with an unusually high transconductance, the video amplifier's gain requires more than 30 db of negative feedback for correct calibration, and any attempts to reduce the gain, by adjusting R47 for correct calibration, may result in violent circuit oscillation. Poorly placed components can also cause oscillation. The stability margin for this voltmeter is only 6 db and is ideal for flat response. Changing circuitry is not advised as a solution, and the best method to correct this trouble is to increase the bias on the 6AC7 tubes by adjusting R49 until oscillation ceases. In this manner, the total gain may be adjusted for 30 db of feedback.

Input attenuators and probes

The reader may wonder why the top range of this ac vtvm is only 10 volts. Why not higher? The reason is simple. It is better to add attenuation by an external attenuator or by a probe, and achieve an even higher input impedance. A 100× attenuator could have been placed in the grid circuit of the input cathode follower to get ranges 100 times those on the present range switch, but the input capacitance would still be approximately 20 μμf. However, with an external probe attenuator, the input capacitance can be made as small as 2 or 3 μμf.

Probes and external attenuators are more versatile, and are necessary at high frequencies to prevent standing waves in the leads. Attenuators and probes may be designed and constructed as in Fig. 3.

For frequency-independent attenuation, R1C1 = R2C2. The designer must include the input capacitance and resistance of the voltmeter as being in parallel with R1 and C1. Also, in the case of probes, the capacitance of the cable must be added to C1. END

References

1 International Resistance Co., *Bulletin B-1.*
2 Langford-Smith, *Radiotron Designers Handbook*, pages 789-90.
3 Langford-Smith, *Radiotron Designers Handbook*, page 597.
4 Bode, H. W., *"Network Analysis and Feedback Amplifier Design,"* D. Van Nostrand.

using SCOPE PROBES

Like a diode tube, a single probe won't handle all jobs. Knowing where and when to use what probe speeds servicing

A typical scope demodulator probe.

By ROBERT G. MIDDLETON
RADIO-ELECTRONICS TELEVISION CONSULTANT

WITHOUT question, the oscilloscope is among the most essential instruments used in TV trouble-shooting. Most technicians have little difficulty in operating their scopes with direct test leads, but *scope probes* often lead to questions.

Field experience proves that some technicians are confused when it comes to which probe to use in a specific application. This article will clarify that question. In general, scope probes extend the applications of a service scope into high-frequency, high-impedance and high-voltage circuits. Without suitable probes, scope applications are seriously limited.

The better grades of probes are adjustable, so their characteristics can be matched to various scopes. Thus, better low-capacitance probes have service adjustments for both probe resistance and capacitance, and the capacitance-divider probe for probe capacitance. Accordingly, these probes can be adjusted for accurate operation with *any* modern scope.

A demodulator probe does not require a service adjustment, since no attenuation factor is involved and the probe responds upon the basis of the peak-to-peak voltage of the applied signal. The total output from a demodulator probe is applied directly to the scope input terminals.

HIGH-VOLTAGE CAPACITANCE-DIVIDER PROBES

(Also termed High-Voltage 100-to-1 Divider Probe)

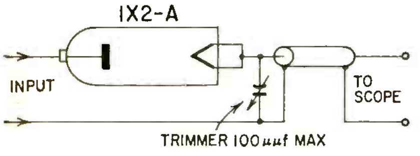
A probe that extends the permissible input voltage rating of a scope to 10,000 peak volts is the high-voltage capacitance-divider type. Without such a probe, a service scope typically withstands only 600 peak volts before waveform distortion starts. Excessively high input voltages will damage a scope's input circuit unless a suitable probe is used.

A high-voltage probe of this type is usually designed for 100-to-1 attenuation. Thus, if a 10,000-volt waveform is applied to the probe, the scope receives 1/100 of this voltage, or 100 volts, which is well within the capability of the vertical amplifier for undistorted reproduction. The probe can be used to advantage at the plate of the horizontal output tube to check the peak-to-peak voltage of the flyback waveform and to compare its shape with the service data specifications for the receiver.

When measuring peak-to-peak voltages, the operator adds two zeros to the scope calibrating factor when the probe is used and no recalibration is required. It is clear that use of decimal attenuation factors in such probes greatly speeds up practical applications. Of course, the probe must be used with an up-to-date scope which has a step attenuator calibrated in intervals of 10 (×1, ×10, ×100, etc.).

A 100-to-1 capacitance divider probe can be used also to check the waveform and peak-to-peak voltage at the cathode of a damper tube, across the horizontal-deflection coils and similar high-voltage points.

There is one limitation in the use of a capacitance-divider probe which must be recognized—the probe is not suitable for checking 60-cycle sweep circuits. At 60 cycles, the resistive component of the scope input circuit becomes appreciable with respect to the reactance of the probe and, since the capacitance-divider probe is uncompensated, its use must be restricted to horizontal-frequency circuits. However, this is not a matter for practical concern, since a 10-to-1 probe will handle the operating voltages of vertical-frequency circuits.



Circuit

This is a high-voltage ac probe, designed to operate at input voltages up to 10,000 peak volts. The 1X2-A tube serves as a small high-voltage capacitor. The trimmer is used to calibrate the probe for 100-to-1 attenuation.

Applications

Probe can be used to check waveforms and peak-to-peak voltages at the plate of the horizontal output tube, cathode of damper tube and across horizontal deflection coils. Should be used in horizontal-frequency circuits only. Distorts 60-cycle (vertical) waveforms.

LOW-CAPACITANCE PROBES

(Also termed High-Impedance or 10-to-1 Attenuating Probe)

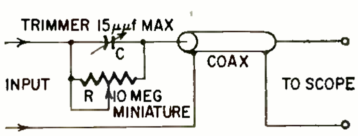
A low-capacitance probe effectively *increases the input impedance* of the scope input circuit. This lets you test high-impedance circuits without undue loading and the resulting waveform distortion incurred when direct test leads are used in this type circuit. For example, many synchronizing circuits, such as the popular Synchroguide phase detector, have high internal impedances and using a low-capacitance probe lets you adjust such circuits more accurately than otherwise possible.

Low-capacitance probes are usually adjusted to provide an impedance step-up of 10 times. Concurrent with this provision for high input impedance is a loss of signal, also of 10 times. In other words, signal strength is traded for stepped-up input impedance. However, the bargain is a good one, as the available signal is usually much greater than required for full-screen deflection, while a higher input impedance is often required for an undistorted waveform display.

The attenuation factor of 10 is chosen so the scope's basic calibration factor is retained, whether or not the low-capacitance probe is used. If the low-capacitance probe is connected to the scope's input, the operator merely adds one zero to his calibration factor and peak-to-peak waveform voltages can be measured without recalibrating the scope's vertical amplifier.

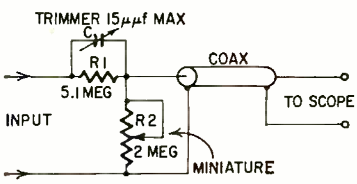
A low-capacitance probe is also valuable for checking signal levels through a video amplifier, as it keeps you from loading the peaking coils excessively. Tests can be made at either the plate or the grid of a video amplifier tube. When testing at the picture tube, the most accurate waveform reproduction is obtained by unplugging the picture-tube socket and inserting the probe tip into the video-signal socket terminal (grid or cathode). The input capacitance of the probe substitutes for the input-capacitance of the CRT, and nearly normal load conditions are realized.

Circuits / **Applications**



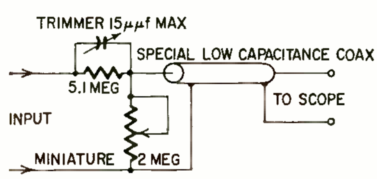
When C is set at 1/9 the input capacitance of the cable and scope, and R is set at 9 times the scope's input resistance, the probe has 10-to-1 characteristics—the input resistance becomes 10 times higher and the input capacitance 10 times lower than when a direct cable is used to the scope's input terminals.

Because the probe has 10 times higher input impedance than a direct cable, it is sometimes called a "high-impedance" probe. The 10-to-1 factor is not always provided, but is preferred to facilitate peak-to-peak voltage measurements with a calibrated scope. The 10-to-1 probe imposes a 90% loss on the signal applied to the scope.



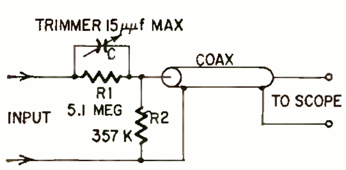
Value of R1 principally determines the probe's input resistance. A 5-megohm metallized-film resistor is suitable for probe construction. Potentiometer R2 is adjusted to provide 10:1 signal attenuation at low frequencies and C to provide 10:1 attenuation at high frequencies. The scope input capacitance is reduced to 1/10 by use of the probe, but input resistance is multiplied by a factor less than 10.

This arrangement is similar to the foregoing, except that a fixed resistor is used in series, and the potentiometer is placed in shunt. Better compensation (better square-wave response is obtained with this arrangement) at the expense of slightly greater complexity.



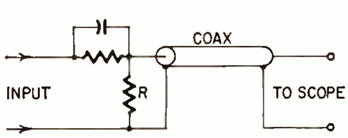
Because the input capacitance of a scope may be about 20 μμf, while the input capacitance of the cable may be about 100 μμf, it is clearly advantageous for the scope user to employ low-capacitance coaxial cable with the probe.

Low-capacitance coaxial cable may be difficult to obtain, but may be constructed by stripping the central conductor out of a length of RG-59/U cable and threading a No. 36 copper wire through instead. This arrangement drops the cable input capacitance to about 1/8 its nominal value. Attenuation factor is still 10:1, but the input capacitance is very much less.



A low-capacitance probe is sometimes simplified by using fixed values for both R1 and R2. This arrangement makes it possible to obtain high-frequency compensation, but low-frequency compensation is correct only with the scope for which the probe was designed.

To illustrate the low-frequency consideration, good low-frequency compensation is obtained when R2 equals 357,000 ohms, provided the scope's input resistance is 1 megohm. However, this is not always the case—a scope may have as little as 500,000 ohms input resistance or as much as 3 megohms.



Maximum simplification of the low-capacitance probe is shown here. Fixed values of resistance and capacitance are used, and proper compensation at low and high frequencies can be obtained only for one particular scope.

Compensation error which results when this type of probe is used with various scopes can be made less serious by using a small value of resistance for R, and a high cable capacitance. This is a "brute-force" arrangement in which compensation is approximated at a sacrifice of input impedance advantage.

NOTE: Low-capacitance probes can be used properly only if the scope has a step attenuator which has the same input resistance and capacitance on each step. Most modern service scopes have satisfactorily constant input impedance on the X1, X10, X100 and X1,000 steps.

VARIOUS DEMODULATOR PROBES

(Also called Detector, Crystal, High-Frequency, RF or Travelling Detector Probe)

The photo shows a typical demodulator probe. This type of probe lets you use a scope in higher-frequency circuits than otherwise possible. Popular uses for the demodulator probe are signal tracing in if amplifiers, display of single-stage if response, display of video amplifier response curves and display of bandpass amplifier response in color television receivers.

There is a practical limitation in the application of a demodulator probe. Remember that waveforms of more than 50 volts peak to peak tend to produce pattern distortion, while outputs in excess of 100 volts peak to peak can impair the sensitivity of the crystal diode or burn it out completely.

A demodulator probe used with a scope must have several special features. Unlike a probe designed for a vtvm, a scope demodulator probe must rectify the rf component of the waveform and it must pass the modulation envelope of the signal to the scope's vertical amplifier. Accordingly, a scope demodulator probe must have optimum filter characteristics to meet the service applications for which it is intended.

The probe shown on page 36 has a voltage-doubler configuration in the crystal-diode network to provide maximum sensitivity. With such a probe, you can trace if signals back to the tuner output, provided a reasonable signal input is applied to the receiver's antenna input terminals. When a strong TV station signal is not available, the output of a sweep generator is useful for signal tracing.

The demodulating capability of such probes is somewhat limited, due to the appreciable input capacitance of service scopes, and this point should be clearly recognized so the receiver is not unjustly blamed for limitations of probe response. The demodulating capability of the probe permits good reproduction of a vertical sync pulse, but only partial reproduction of a horizontal sync pulse. Hence, signal-tracing procedures should always be followed with the scope deflection rate set to 60 cycles (or 30 cycles), and the observations based upon the observed display of vertical sync pulses.

To display a bandpass amplifier response curve, the fundamental requirement is that the probe be capable of displaying a 60-cycle square-wave envelope without distortion. The probe is capable of this response, and hence the test setup shown in Fig. 1 provides an accurate check of bandpass amplifier response in a color TV receiver, with the result shown in Fig. 2.

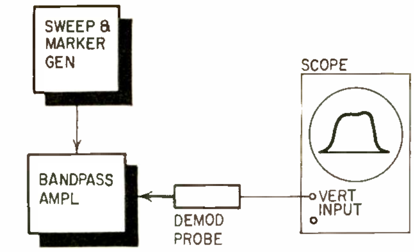


Fig. 1—Test setup for checking bandpass amplifier response in a color TV receiver.

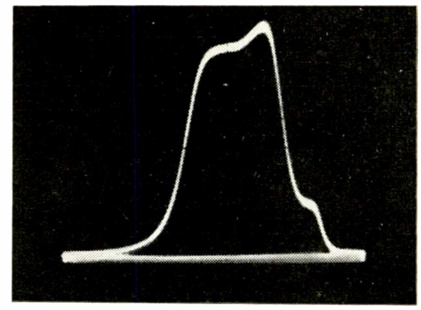
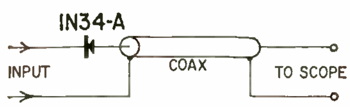
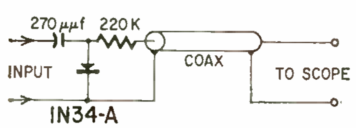
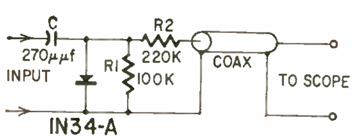
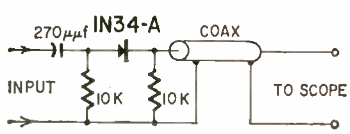
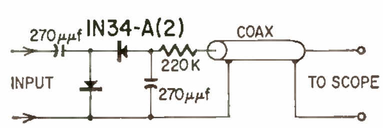
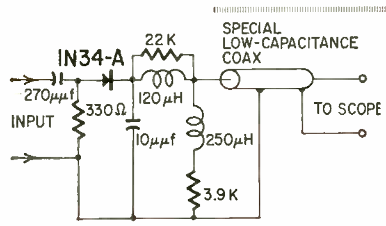


Fig. 2—Typical bandpass amplifier response curve obtained with the test setup in Fig. 1.

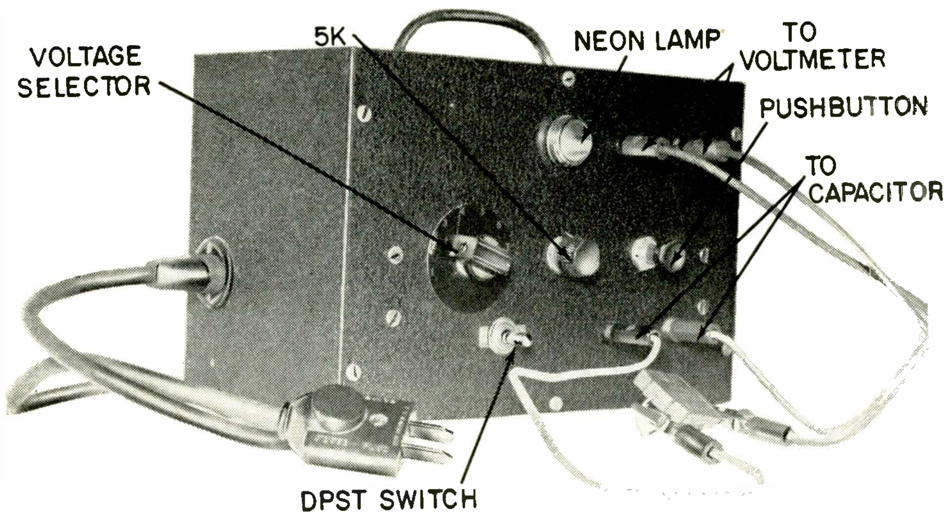
	Circuits	Applications
	Simplest form of demodulator probe, made up of a germanium diode in series with the shielded input cable. The input cable serves as a charging capacitor. A series-detector arrangement, providing half-wave rectification.	Arrangement is simple and economical, but has limited demodulating capability—horizontal sync pulse is greatly attenuated and distorted, although vertical sync pulse is demodulated without severe distortion. Input cable is not isolated from the probe network and operates as a resonant stub at various high frequencies, which makes the probe appear insensitive at certain radio frequencies.
	A general-purpose demodulator probe. The detector is arranged in shunt, with a 270-$\mu\mu f$ charging capacitor. The shielded input cable is isolated from the high-frequency circuit in the probe by a 220,000-ohm resistor. Half-wave rectification is provided.	This type is not resonant at radio frequencies and provides uniform sensitivity. Sensitivity is less than that of doubler types, but its cutoff frequency is considerably higher than that of a doubler probe. The series charging capacitor permits using it in signal circuits where some 60-cycle hum voltage may be present. Vertical sync pulses are demodulated reasonably well, but horizontal sync pulses are greatly attenuated and distorted.
	This arrangement for a demodulator probe is the same as the preceding version, except that the diode is shunted by a 100,000-ohm resistor. When a diode with a high front-to-back ratio is used, the shunt improves the probe's demodulating capability.	Demodulating capability cannot be extended indefinitely by lowering the value of R1, because a limitation is imposed by the time constant of R2 and cable capacitance. It is not practical to reduce the value of R2 appreciably because cable capacitance then imposes an excessive capacitive shunt across the diode and reduces the detector efficiency.
	Demodulator-probe arrangement using a series detector, with a 10,000-ohm shunt on both sides of the diode and no cable isolation. Sensitivity is moderate, and demodulating capability is considerably greater than for the foregoing types of demodulator probes. Demodulates horizontal sync pulse satisfactorily.	Chief disadvantage of this probe arrangement is lack of rf isolation between the cable and the probe network. Therefore, the probe's sensitivity will appear quite good at some radio frequencies, but poor at others. The series input capacitor provides good rejection of 60-cycle hum voltages.
	This arrangement is used in a voltage-doubler demodulator probe, sometimes called a peak-to-peak high-frequency probe. The probe network provides full-wave rectification and correspondingly greater sensitivity, compared with a half-wave probe.	Demodulating capability is not greater than that of conventional half-wave types and horizontal sync pulses are greatly attenuated and distorted. Vertical sync pulses are reasonably well demodulated. The frequency cutoff is only about half as high (about 100 mc) as that of typical half-wave probes.
	Wide-band demodulator probe, with high-frequency compensation for reproducing envelope frequencies up to 4 mc. The input cable to the scope is of special low-capacitance construction having an outer diameter of ½ inch and a No. 40 central conductor.	To obtain the 4-mc bandwidth of output signal from the probe, the scope's input capacitance must be maintained very low (not over 10 $\mu\mu f$). This necessitates bypassing the step attenuator and applying the cable output directly to the grid of the cathode-folllower input stage. The probe's sensitivity is much less than that of the narrow-band probes shown above.

NOTE: The input resistance of all service demodulator probes is relatively low and the input capacitance is appreciable. For this reason, the probe tends to load signal circuits in which it may be applied, and the user must be aware of this limitation to avoid the possibilty of drawing false conclusions in some test situations.

END

SIMPLE CAPACITOR CHECKING METHOD

Simple circuit plus multimeter make accurate test instrument



Front-panel view showing all controls.

By GEORGE P. PEARCE

FOR several years I have been testing capacitors by measuring the current flow through them when connected in a 120-volt 60-cycle line and calculating the capacitance by the standard formula. I never liked the idea although it gave very good results. The trouble was that while testing I was pestered with the disturbing thought of what would happen to the delicate and expensive 50-μa meter in my multitester if the capacitor under test should puncture or short—a flip, a puff of smoke and no meter. I finally decided to build a capacitor checker for testing a wide range of capacitances, one that could not possibly damage my expensive meter even if a capacitor should short while I read the meter.

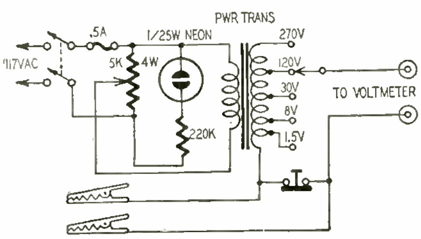
The circuit is shown in the schematic diagram. The potentiometer permits obtaining the exact voltage required for any test on capacitors from .00025–10 μf. My junkbox supplied all the items needed to assemble the checker, except the steel cabinet which I bought. The transformer has a 270-volt secondary with taps at 120, 30, 8 and 1.5 volts. I happened to have a burnt-out power transformer so I pulled it apart, cleaned the steel laminations, wound the coil for the above voltages and reassembled it. The amount of secondary current required is very small so fine wire can be used. I had some No. 33 enameled copper wire on hand and used this for the secondary winding.

(A tube tester transformer has all the voltages but 270. Readers wishing to wind their own transformers would be well advised to pick up one in good condition—from the junkbox, preferably—with a secondary of roughly the required voltage. The filament windings and half the secondary can then be removed and the other taps obtained by winding some of the secondary wire back on again. The center tap will then become the common lead, with 270 volts on one side and the tapped winding from 1.5 to 120 volts on the other. The number of turns needed per volt can be learned by counting the turns on a filament winding and dividing the figure by the voltage of the winding.—*Editor*)

To obtain the testing range I used five voltage scales on my multitester: 250, 100, 25, 5 and 1. I wound the transformer for a higher voltage in each range so that even during the lowest house voltage I would be able to get what was necessary. This is where the potentiometer is so valuable. All that has to be done is to set the selector switch to the nearest higher voltage. Then, with the potentiometer, reduce and adjust the voltage to the meter to the exact amount needed for a given range.

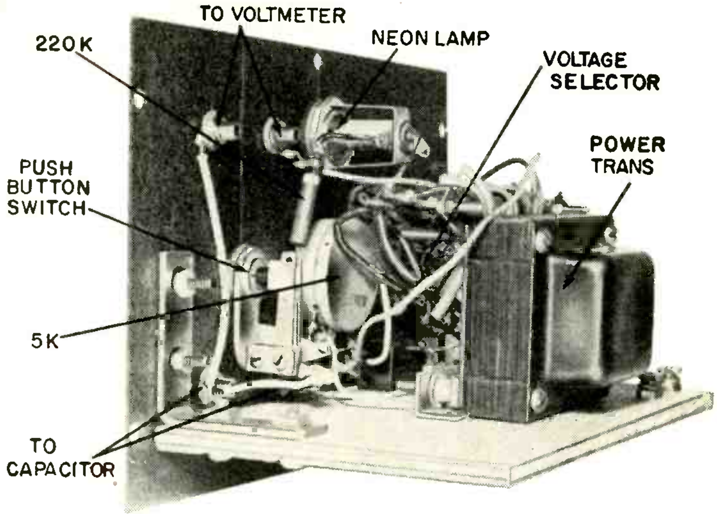
Operating the checker

Suppose the transformer is set to deliver exactly 250 volts to the multitester. If, say, a .001-μf capacitor is placed in series in one of the leads to the meter, the reading will no longer be 250 volts but something less. It is best to read this deflection on the uniform scale which has the most divisions. On my meter there is a scale divided into 50 spaces that I always



1—power transformer with tapped secondary (see text); 1—5-position selector switch; 1—pushbutton switch, normally closed; 1.5-amp fuse and holder; 1—5,000-ohm 1-watt potentiometer; 1—220,000-ohm resistor; 1—1/25-watt neon lamp and holder; 2—alligator clips; 1—cabinet.

Schematic of the capacitor checker.



Layout of capacitor checker parts.

TYPICAL CAPACITOR RATINGS
(50-division scale—numbers indicate divisions from full scale)

Capacitor (μf)	Meter Scale—Volts Ac 250	100	25	5	1
.00025	0.7				
.001	4.0	1.5			
.002	10.0	4.0			
.005	20.0	8.5	1.5		
.01	34.0	18.5	4.0		
.015	41.0	28.0	7.0		
.03	46.0	39.0	14.0	2.0	
.05	48.0	45.5	23.0	4.0	
0.10		48.0	33.0	8.0	
0.20			44.0	16.5	
0.50				36.0	8.5
1.0				44.0	10.5
1.2				45.0	11.0
2.0					22.0
4.0					36.0
6.0					42.0
8.0					46.0
10.0					47.6

use when checking capacitors. On this scale, with 250 volts potential, I get a deflection of 4 divisions when testing a .001-μf capacitor, about 0.7 division for a .00025-μf capacitor and 46 divisions for a .03-μf unit.

By providing a table based on these and other readings the value of any capacitor from about .00025 to .05 μf can be determined immediately in the 250-volt range. If the capacitor to be tested is larger than .03 μf, say .07 μf, then it cannot be tested at 250 volts because the needle deflection would be too small to give an accurate reading.

This difficulty can be easily overcome simply by taking the next lower voltage from the transformer (in my case, the 120-volt tap) and then carefully adjusting the potentiometer to give full-scale deflection. Readings on this scale can be taken on capacitors ranging from about .001 to 0.1 μf, on the 25-volt scale from .005 to 0.2 μf, on the 5-volt scale from .03 to 1.2 μf and on the 1-volt scale from 0.5 to 10 μf. It does not matter what the scale ranges are on your multitester or even a simple high-resistance ac voltmeter, you can make your calibration to suit.

When the capacitor to be tested is placed between the alligator clips (see diagram), it is shorted and the meter reads the transformer voltage. Pushing the test button removes the short and places the capacitor in series with the circuit so you can take the capacitor reading. Release the button and check to see that the voltage has not changed while testing. You now have a simple method of getting an exact voltage across the terminals of the capacitor under test and reading the meter deflection. You know that any other capacitor that gives the same deflection under the same voltage will have to have the same capacitive reactance (and capacitance). Thus you can equate the scale divisions with microfarads. This is your test scale.

It is possible to calculate the exact reading for every capacitor within the range of the multitester, but it is a lot of trouble. It is easier to just pick up a couple of dozen good fixed capacitors from .00025 to about 10 μf and, one by one, get the readings at the various voltages. Then make a table similar to that shown. When testing a capacitor, should the needle just barely dip, you will have to turn to a lower voltage. If the needle swings too near zero, you will have to use a higher voltage. The alligator clips are very handy for they bite onto almost any kind of capacitor connection. If a capacitor should suddenly short, no harm will come to the meter—it will simply swing to full deflection and stay there.

Because the test voltage at times is as high as 250 it is advisable to open the line switch when clipping to a capacitor. When checking a pile of capacitors, one is apt to become confused and either snap the switch twice or not at all so to be absolutely safe I included the little 1/25-watt neon lamp in the primary circuit so it would glow whenever the primary circuit was energized. END

NEXT MONTH

Golden Ears or Bats' Ears?

Is the widely touted frequency response of modern high-fidelity audio equipment necessary—or useful? This and some other fetishes of hi-fi are discussed—and demolished—by George Fletcher Cooper.

Water Is the Trigger

A 1-transistor alarm that senses rain and actuates a relay to shut windows and doors, or warns sleepers of rain. It can also be adjusted to act as a humidity alarm or relay.

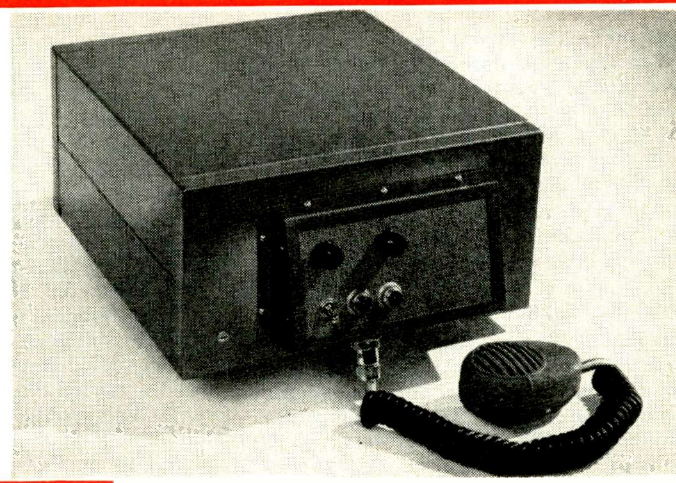
Tube Changers and "tube changers"

Depending on whether the service technician knows what he is doing or not, tube changing can be the quickest and best service technique or it can be worthless. The Old-Timer distinguishes between tube changers and Tube Changers.

ABC's of MOBILE RADIO

Part III—Circuitry and special features of mobile radio equipment

By LEO G. SANDS



New 450–470-mc mobile radio developed by Bennett Laboratories is an AM unit.

ALL makes of mobile equipment are essentially similar: the transmitters must conform to the same FCC technical standards and the receivers must have competitive characteristics. They do differ in circuitry, special features and styling.

Mobile equipment

A mobile unit is a radio station on board a vehicle or one carried by a person. A typical mobile unit consists of a transmitter and receiver with their power supply, an antenna system, hand microphone or handset, speaker, control head and interunit cabling. The transmitter, receiver and power supply are usually housed in a single sheet-metal case, forming a package often called a "communications unit," which is mounted in the trunk or under the dash of a passenger automobile (or in a box or other protective enclosure when installed on a truck).

Some manufacturers have weatherproof cases for radio units that will be exposed to the elements. Sometimes the radio is installed without an external protective enclosure when used indoors. The control head, speaker and microphone are installed near the driver. Mobile communications units installed under the dash of a vehicle are generally provided with a built-in speaker, and the controls are mounted on the front panel.

The transmitter, receiver and power supply may be on individual chassis strips fastened together or combined on a single chassis. Sometimes, there is more than one receiver strip and, in some sets, space for selective-calling decoders or auxiliary audio amplifiers is provided. In some early sets, the transmitter and receiver were packaged as separate units.

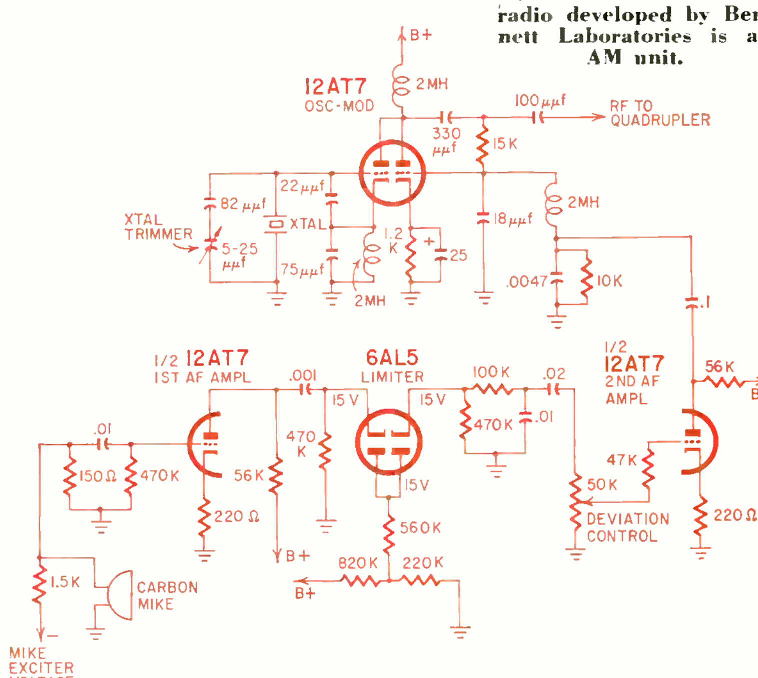


Fig. 1—Unique phase modulator used in the Bendix Dyna-Com 1V14A for the 25–54-mc band.

Mobile units are also available for the 1.6–8.0-mc portion of the radio spectrum. Operation at these relatively low frequencies is restricted to certain industries and governmental agencies which have special need for longer-range communication than is normally available in the vhf and uhf bands.

These medium-frequency mobile units are AM whereas most vhf and uhf equipment are FM. AM vhf sets, compatible with aviation radio systems, are used on land vehicles in airport utility applications and are operated in the 118–134-mc aeronautical band. Some low-power-industrial (LPI) units for the 25–54- and 152–162-mc bands are also AM. Also using AM is a new 450–470-mc mobile unit recently developed by Bennett Laboratories.

Ordinarily, the mobile transmitter and receiver are operated sequentially. The receiver is left *on* so a signal can be intercepted. A squelch circuit silences the speaker except when a strong enough signal to override background noise triggers the squelch circuit and activates the receiver's audio amplifier.

The receiver is disabled and the transmitter turned *on* with the press-to-talk button on the handset or palm microphone. This also switches the antenna from the receiver to the transmitter. When the press-to-talk button is released, the transmitter is turned *off* and the receiver turned on.

Rated power output of mobile transmitters ranges from 0.1 to more than 100 watts. Most mobile units operate interchangeably from either a 6- or 12-volt battery, although there is a trend toward eliminating the requirement for 6-volt operation since modern cars have 12-volt batteries. Mobile units for on trains are generally designed for direct operation from 64 volts dc though some operate from 117 volts ac furnished by a dc-to-ac rotary or vibrator type converter.

25–54-mc equipment

Because of its long-range capabilities, the 25–54-mc band is popular and used by nearly all who are eligible for licensing in this band. Ignition noise and skip interference, however, are more of a problem than at higher frequencies.

Most mobile radio manufacturers build units for this band. Bendix Radio, for one, makes both wide-band and narrow-band mobile sets in 30- and 60-watt models. They can be operated from either 6- or 12-volt batteries without modification and are available with vibrator or transistor power supplies.

The Bendix Dyna-Com 1V14A is a narrow-band model for operation on any frequency in the 25–54-mc range. Output power is 30 watts. Frequency stability of ±.003% is obtained without a crystal oven while ±.0006% stability is realized when a temperature-controlled crystal oven is used. Crystal frequency is multiplied 16 times by a quadrupler and two doubler stages. A single 6146 is used as the final rf amplifier. In the 60-watt model, a pair of 6146's is used.

Bendix uses the unique phase modulator shown in Fig. 1. A 12AT7 dual-triode serves as the crystal oscillator–modulator. The audio modulating signal is fed to the grid of one of the triodes, causing both phase and amplitude modulation. The following class-C stages erase the amplitude modulation, yielding an FM signal at the transmitter's output.

The signal from the microphone is amplified by one section of a dual-triode whose output is fed to the second audio amplifier stage through a dual-diode limiter. The limiter, which uses biased diodes, prevents overdriving the second audio stage, effectively eliminating overmodulation. A 50,000-ohm potentiometer at the input of the second audio stage may be adjusted to set maximum frequency deviation to any point between 0 and ±15 kc.

The receiver employs a unique double-conversion superheterodyne circuit. However, three, not two intermediate frequencies are used. The output of the mixer is at 5.8 mc. The main if amplifier and first and second limiters are tuned to 262.5 kc. The second limiter, however, also acts as a frequency doubler. Its plate circuit, tuned to 525 kc, feeds a third limiter which in turn feeds the discriminator, also tuned to 525 kc. The frequency-doubling action also doubles frequency deviation at the discriminator's input.

To provide ±7.5-kc if bandpass and more than 100-db attenuation of signals ±17 kc off frequency center, two 5.8-mc filter networks are used between the first and second mixers, and four 262.5-kc bandpass filters in the main if amplifier of narrow-band models. Nine triodes and only one pentode are employed as amplifiers in the if section. However, pentodes are used in the three limiter stages. Most of the triode if amplifiers are used in a grounded-grid arrangement and are followed by a cathode follower. Thus, the if transformers are connected between two cathodes rather than between plate and grid as they would be in a conventional pentode if strip.

The Bendix Dyna-Com low-band sets have three separate chassis. One contains the transmitter, another the receiver. The power supply, receiver audio output stage and transmitter speech amplifier–limiter are on the third. All three are in a single metal enclosure.

152–162-mc units

Much of the available so-called 152–162-mc band equipment is also operable in the 144–148-mc Amateur band as well as the 162–174-mc Government band.

This is true of General Electric's Progress Line. This equipment may be packaged in various combinations in different size cases, as is true with 25–54-mc G-E units, to meet individual requirements.

G-E model 4ET21 transmitters are rated at 50 watts output when operated between 144–162 mc, and 40 watts from 162–174 mc. The crystal frequency is multiplied 24 times and frequency deviation can be adjusted from 0 to ±15 kc for wide- or narrow-band operation. Deviation is automatically regulated to prevent overmodulation. Two-channel operation may be obtained by adding a second crystal oscillator. Four frequency-multiplier stages are used, compared to three in G-E equivalent low-band (25–54-mc) equipment. Otherwise the circuitry is similar.

In G-E model 4ER25 receivers, as in low-band G-E units, multiple-tuned circuits are used ahead of the rf amplifier and between various stages. Separate crystals are used for the first and second converters (mixers). The first if amplifier section is tuned to 8.7 mc and the second section to 290 kc. Similar circuitry is used in G-E low-band receivers. The if filters may be replaced when converting from wide-band to narrow-band operation.

Two limiter stages precede a Foster-Seely type discriminator which drives

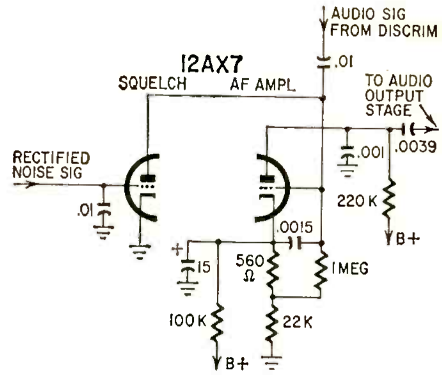


Fig. 2—Simplified diagram of the squelch circuit found in G-E model 4ER25 receivers.

both the audio amplifier and the squelch circuit. In the squelch circuit, shown in simplified form in Fig. 2, the higher-frequency components of the noise voltage at the discriminator's output when no signal is being received are amplified and fed to a noise rectifier. The dc output of the noise rectifier, which is a voltage doubler, is fed to the squelch tube. The grid of the squelch tube is driven to cathode potential, causing plate current to flow and developing a large drop across the plate resistor. This biases the first audio amplifier to cutoff, disabling it and electronically muting the speaker.

When a strong enough signal is received, the high-frequency noise components are eliminated from the discriminator output by the limiter stages. The squelch tube no longer disables the audio amplifier, because of the absence of noise, the received audio signal is amplified and heard through the loudspeaker. Squelch threshold is set by an external variable control.

The choice of 6- and 12-volt power supplies which use vibrators or a combination of a vibrator and a dynamotor depends upon transmitter requirements. There are also transistor power supplies. Smaller than their electromechanical equivalents, they have no moving parts.

For the 450–470-mc band

Several makers are turning out uhf mobile units for the 450–470-mc band. Transmitter power is less significant at ultrahigh and microwave frequencies and range is limited more by obstructions in the signal path than by lack of power. To get a significant extension in range by raising transmitter power would require a drastic increase, beyond the capabilities of existing mobile equipment.

When operating on the same frequency, the man with the higher-powered rig has the advantage that his signal can sometimes *capture* receivers within range, blanking out a signal from a lower-powered transmitter. This *capture effect* occurs in FM systems. The stronger signal saturates the limiter of a receiver, making it insensitive to a weaker signal on the same frequency. The stronger signal

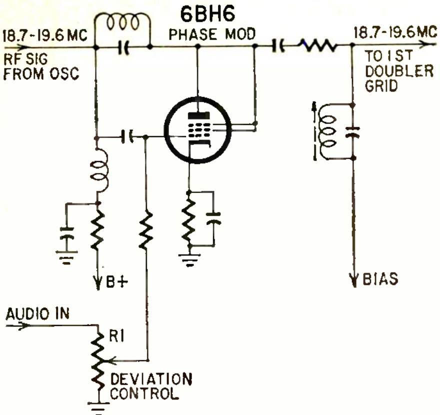


Fig. 3—This phase modulator is in the Kaar Expeditor, 450–470-mc transmitter. It is shown in simplified form.

does not necessarily come from the most powerful transmitter but could come from a lower-powered transmitter a short distance away.

While many uhf mobile transmitters on the market can be loaded to as much as 50 watts input to the final, Kaar Engineering Corp. deliberately designed its TR500 and TR501 Expeditor mobile units for lower power. The transmitters of these 450–470-mc mobile units are loaded to 12 watts input to the final on frequencies where more than 10 watts is permitted and to 10 watts for use in the Citizens band.

Actual field tests revealed that under conditions when a 50-watt-input unit provided 12-mile range, a 10-watt set reached out to 10 miles.

Since a 10-watt set would provide adequate range in urban applications, Kaar designed a compact uhf mobile unit which consumes very little battery power. When transmitting, only 8.5 amperes is required (with 12.6 volts dc input) compared to 20 or more amperes for higher-powered sets.

The transmitter, receiver and transistor power supply are housed in a single case. The model TR500 is intended for mounting under the dash or for use as a base station. It has a built-in speaker, and the operating controls are on the front panel. The TR501, intended for trunk installation, has an external control head, external speaker and remoting cables.

The transmitter section employs nine tubes. A new type, the 6939, is used in the tripler and power amplifier stages. It costs considerably less than tubes used in these stages in earlier equipment. Tests also indicate that it has a greater life expectancy.

While many vhf transmitters employ conventional coils and capacitors in the rf tank circuits, resonant lines or cavities are used in uhf transmitters, lines tunable by trimmer capacitors are used in the plate circuit of the tripler and both the grid and plate circuits of the power amplifier of this equipment.

Frequency stability is ±.0025% in standard models and, when a temperature-controlled crystal oven is used, stability is increased to ±.001%. The crystal frequency is multiplied 24 times.

Fig. 3 is a simplified schematic of the phase modulator. The audio signal from the speech amplifier is fed through a speech clipper to the grid of the 6BH6 phase modulator. This causes the rf signal being fed to the first doubler to lead and lag in step with the modulation. This changes the phase of the rf signal reaching the first doubler, giving the effect of frequency modulation. Potentiometer R1 can be set to produce frequency deviation from 0 to a maximum of ±15 kc.

Overmodulation is prevented by a speech clipper inserted between the speech amplifier and the phase modulator. Fig. 4 shows the speech amplifier and clipper sections of the transmitter. The components have been selected to favor amplification of speech between 300 and 3,000 cycles. The clipper is a two-stage cathode-coupled amplifier which saturates when overdriven, limiting the amplitude of the audio signals reaching the modulator.

The receiver has 18 tubes. It employs triple conversion using 50 mc, 10 mc, and 1,500 kc as intermediate frequencies. Two rf stages, employing coaxial lines, precede the first mixer, which delivers a 50-mc signal to an if amplifier which feeds the second mixer. One if stage at 10 mc feeds the third mixer whose 1,500 kc output is amplified by two more if stages. Two limiter stages precede the phase detector which feeds audio to a two-stage audio amplifier.

A single crystal provides local-oscillator signal for both the first and second mixers. The crystal signal is fed through two tripler stages to the first mixer and directly to the second mixer. A separate crystal and associated oscillator feed local-oscillator signal to the third mixer.

An adjustable L-C filter assembly between the third mixer and the 1,500-kc if amplifier, normally supplied with the equipment, provides adequate selectivity for operating on a 100-kc channel-spacing basis (100 db down at ±100 kc). Another filter may be installed at any time to provide adequate selectivity for 50-kc channel spacing (100 db down at ±50 kc).

The squelch circuit is of the signal-to-noise ratio type, activating the first audio amplifier when background noise is quieted by the presence of a signal. An afc circuit automatically adjusts the first and second mixer local-oscillator frequencies to the incoming signal. The afc correction ratio is 5 to 1 over a frequency range of ±20 kc; a switch is provided for disabling afc if desired.

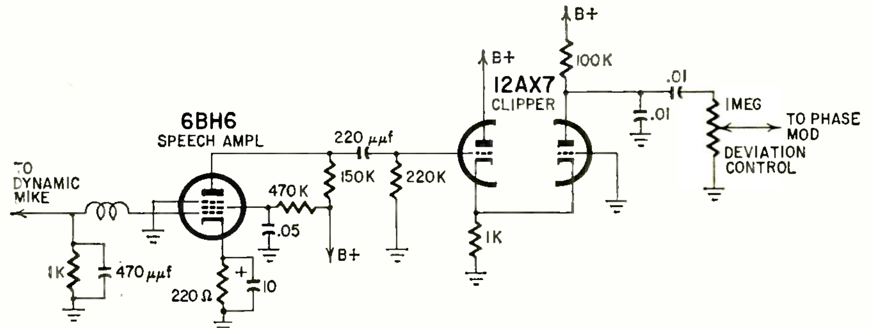


Fig. 4—Speech amplifier and phase modulator circuitry of the Kaar TR500.

The afc control voltage is obtained from the cathode of one of the diodes of the unique phase detector (discriminator) shown in Fig. 5. This detector is sensitive to changes in phase of the incoming if signal yielding the audio component which is fed to the audio amplifier.

The Kaar Expeditor is furnished with either a transistor power supply for 12-volt dc operation only or a universal vibrator type supply for 12-volt dc or 117-volt ac operation. The latter unit permits using the same set as either a mobile unit or as a base station.

So far we have examined several types of mobile equipment. Units for 25–54-, 152–162- and 450–470-mc bands have been described. Next month we continue with details on portable equipment, railroad radio, and AM operation in the 118–134-mc band. A few words on antennas and a forecast of things to come end the series. TO BE CONTINUED

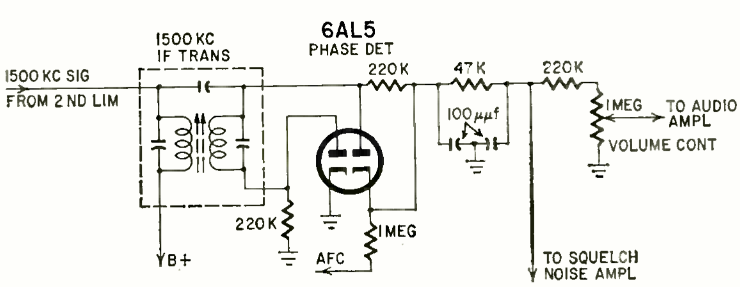
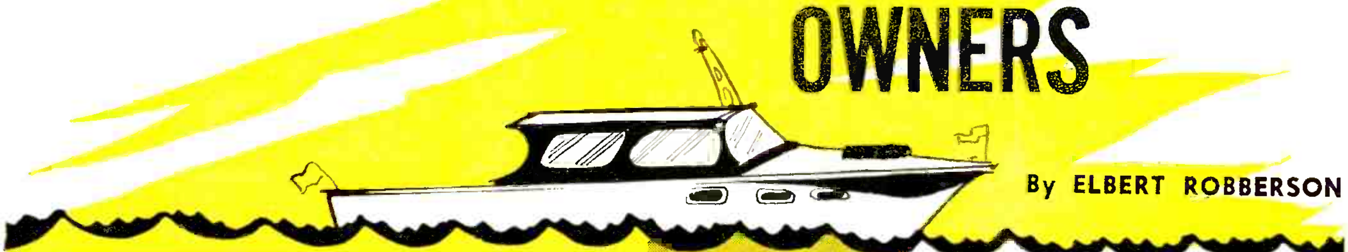


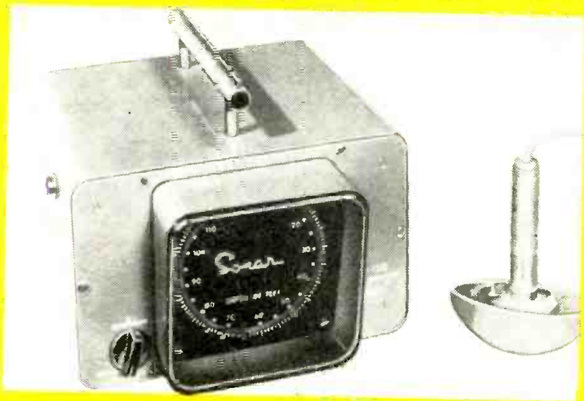
Fig. 5—Phase detector in the receiver section of the Kaar TR500.

You can determine the distance to the ocean floor with an echo sounder. But can you tell someone how it works and can you fix one that comes into your shop?

ECHO SOUNDERS for SMALL BOAT OWNERS



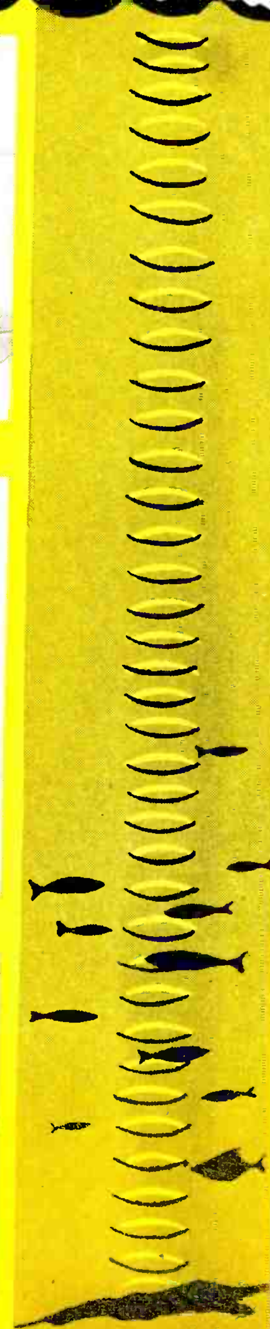
By ELBERT ROBBERSON



Sonar portable echo sounder with single-hole transducer.

Bendix recorder. Right: double type transducer. Left: power cable, "stuffing tube" seals transducer cable passing through hull.

Ross Sportsman echo sounder consists of indicator, power unit and transducer.



WHEN a person gets out in a boat, the land may fade in the distance and seem very remote. Actually, it is never very far away–straight down. Knowing just how far away this closest land lies has always been one of the navigator's prime concerns. And nowadays, the term "navigator" means about 30 million Americans. Use your electronic skill to help these boatmen keep track of the bottom, and you'll be aiding public convenience and safety, and very likely helping yourself financially.

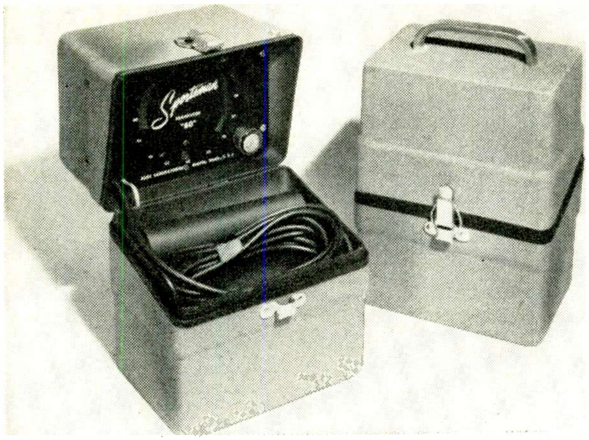
The first commercial echo sounders were several-hundred-pound brutes scattered in pieces throughout a ship, from the bridge deck to the keel. To carry one, a vessel had to be a thousand-tonner, with an owner having money to match. Today, a good sounder can be bought with lunch money and carried away under an arm. No toys, either, are these. They will spot the bottom as effectively as the big babies, and even find fish.

The science of echo sounding began with percussion devices, set in the hull of a ship, that periodically sent out a walloping burst of sound. An operator equipped with a microphone, headset and stop watch measured the interval between the main bang and the echo from the bottom. Sound has an average velocity in salt water of 4,800 fps (feet per second). If the bottom lay 2,400 feet below, the sound would return in 1 second.

In shallow water, it would take a fast man with a stop watch to measure this interval, so various clockwork mechanisms were devised. One had a depth-graduated dial which started revolving when the sound was sent out. The returning echo stopped the dial, and the distance to the bottom could be read off. Primitive though it may seem, this basic scheme is so effective that some variation of it is employed in most echo sounders used today.

The timer indicator

The heart of most modern echo



Ross Labs transistor sounder uses permanently installed or portable transducer.

ELAC (Electroacoustic) echo sounder showing recorded trace of bottom.

sounders is a constant-speed ac motor, which drives a rotating arm carrying a neon bulb at its end. The circle described by the neon lamp on this arm constitutes the time base, and foot or fathom (6-foot) calibrations are superscribed on a transparent cover.

The rotating arm also is fitted with a contactor or magnetic keying arrangement which initiates the sound pulse at time zero. A returning echo causes the neon bulb to flash, and the distance to the bottom is read off the scale. By running the arm at different speeds, the maximum range of the indicator is made to be any desired value from under a hundred feet to many thousands.

Motor speed and accuracy depend upon a carefully regulated power supply, which converts dc power from the boat's batteries to ac. Two kinds of power supply are used: the vibrator type, which chops battery current into square waves that are stepped up to the motor voltage by a transformer, and the more recent transistor oscillator or chopper, which does the same thing electronically.

Instead of indicating depths with a flashing light, some instruments are built to record the contour of the bottom on a specially prepared sheet of graph paper. In place of the revolving arm an electrical stylus on a motor-driven belt writes vertically on the slowly moving sheet of paper. At the return of each echo, the stylus burns a mark, which is interpreted in terms of depth from calibrations printed on the paper. The result is a profile map of the bottom over which the boat has sailed. By comparing this with a standard navigational chart, underwater landmarks may be spotted, or schools of fish.

One instrument, manufactured by Bludworth Marine, has an all-electronic timing and indicating system. A multivibrator flip-flop and integrating circuit allows current flow to build up through a conventional meter 12 times a second. The sound signal is sent out in synchronization. If no echo is returned within the 1/12 second, the meter will reach full scale. However, when an echo is received, the integrating circuit is cut off, allowing only a proportionate amount of the full-scale current to flow. Therefore, the angle of needle deflection indicates the depth, up to 200 feet.

The most elaborate instruments, used on large fishing vessels or ocean-going ships, use electronic timing circuits, with depths indicated as a trace on a cathode-ray tube.

Transducers

The next distinguishing feature of an echo sounder is the transducer system which sends the pulse of sound downward into the water and receives the echo. Some instruments have two transducers—one for each function—while others have one that serves both for sending and receiving.

Magnetostriction transducers use a stack of nickel laminations, excited by current through a coil. An oscillatory discharge of current through the coil causes the nickel to expand and contract, or "ring," and the resulting sound is transmitted from the transducer face to the water. Oscillating frequencies are in or near the ultrasonic range, from 14 to about 50 kc.

Piezoelectric transducers use Rochelle salt crystals or ceramic wafers. An oscillatory pulse of voltage applied to the crystal electrodes causes physical oscillation, which is transmitted through the transducer face to the water. Frequencies used with piezoelectric transducers extend all the way up to 500 kc. Low frequencies have the longest range, while high frequencies detect smaller objects and have better resolution.

For insulation and cooling, and to seal out moisture, transducer housings are filled with a special oil which also acts as an efficient conductor of sound. Most housings are designed to be fitted onto the surface of the keel or the boat's hull, while others are intended to be recessed to present a smooth outer surface to the flow of water. Sometimes transducers are installed inside the hull, in a specially constructed water-filled well. This form of installation eliminates holes in the hull and is a convenient method to use for installations made while the boat is in the water.

Driver–oscillator

To excite the transducer a powerful pulse of current or voltage which oscillates at the transducer's resonant frequency must be generated. The simplest drivers use a gaseous discharge tube or thyratron, fired by the keying circuit in the timer–indicator, to discharge a capacitor into a magnetostrictive transducer. Circuit time constants are chosen to create an oscillatory current discharge at the desired frequency.

Another system uses a coil in parallel with a piezoelectric transducer in the cathode circuit of a thyratron. When the keyer drives the thyratron into conduction, a capacitor discharge is impressed upon this cathode "ringing circuit," creating the oscillatory pulse.

Still another method is to use a conventional oscillator circuit, such as the Colpitts or Hartley. Its output is impressed upon the transducer when the tube is keyed by the timer.

Video amplifier

The type of circuit used to amplify returning echoes depends upon the frequency of oscillation. At frequencies just above the audible range, a conventional R-C-coupled amplifier, using up to five tubes, with coupling components chosen to accentuate the "highs," will turn the trick. Higher-frequency amplifiers very closely resemble radio receiver if amplifiers, and have three or four transformer- or impedance-coupled stages.

Put it all together

You can see how the different parts of an echo sounder work together by tracing through the schematic of the Ross echo sounder (Fig. 1). The vibrator and vacuum-tube rectifier

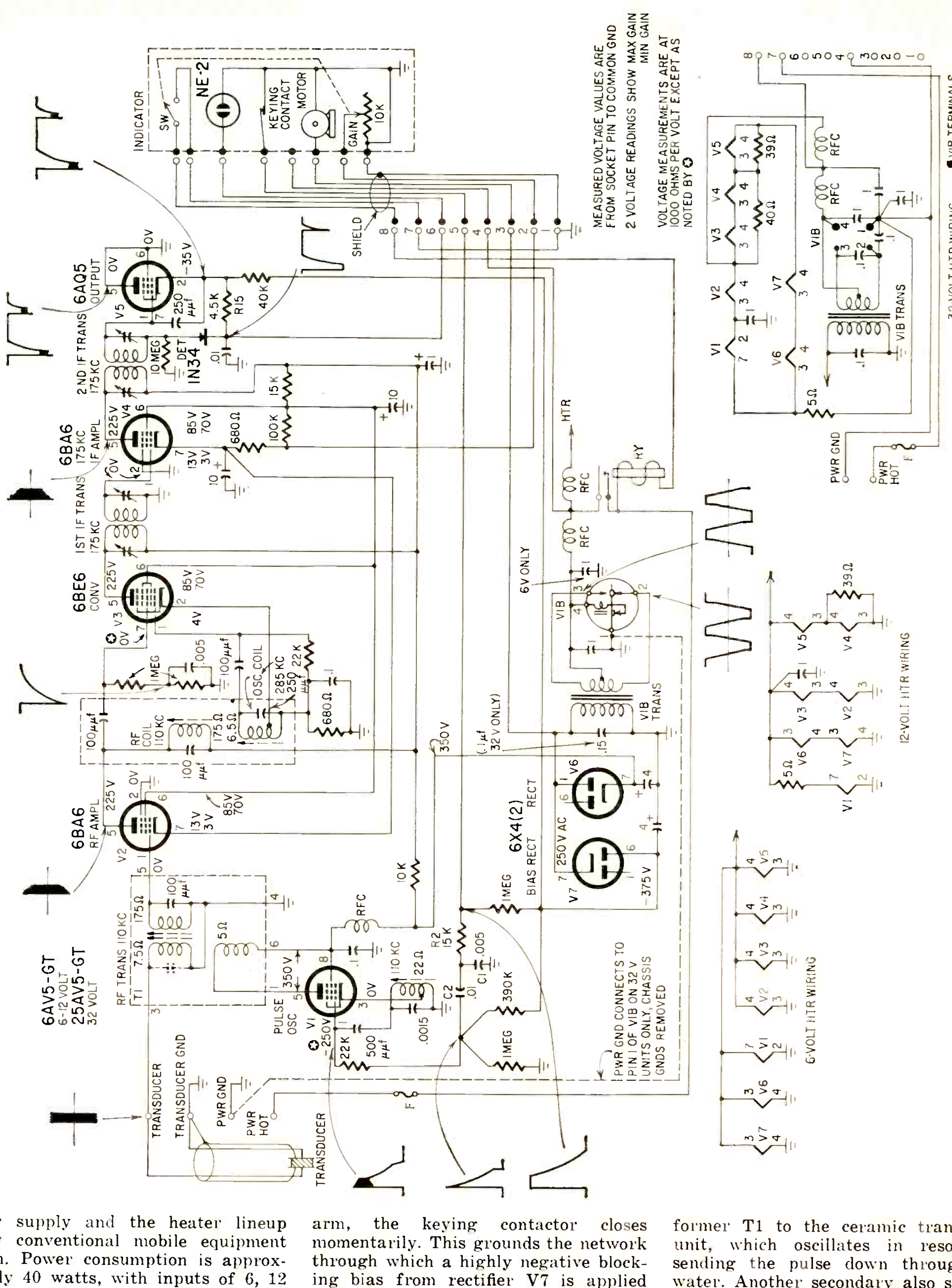


Fig. 1—Complete circuit of Ross Fisherman echo sounder.

power supply and the heater lineup follow conventional mobile equipment design. Power consumption is approximately 40 watts, with inputs of 6, 12 or 32 volts dc.

The synchronous ac timing motor (box labeled INDICATOR) is run from the secondary of the vibrator transformer, the speed being kept within ±5% by the vibrator. Connected to the motor shaft are the keying contractor and the neon-bulb echo indicator.

Once every revolution of the motor arm, the keying contactor closes momentarily. This grounds the network through which a highly negative blocking bias from rectifier V7 is applied to the grid of oscillator V1. When the contact opens, the blocking bias is not reapplied for a total time of 1 millisecond, because of the grid network's time constant (R2, C1, C2). During the time that the bias is removed, V1 oscillates at 110 kc, its power output appearing at the plate.

This burst is applied through transformer T1 to the ceramic transducer unit, which oscillates in resonance, sending the pulse down through the water. Another secondary also sends a small amount of energy to the receiver.

While most receivers consist of a resistance, transformer- or impedance-coupled amplifier, this unit is a superheterodyne, closely resembling a low-frequency radio receiver. With a local-oscillator frequency of 285 kc, the signal is converted to 175 kc in V3, and amplified. The if amplifier ends up

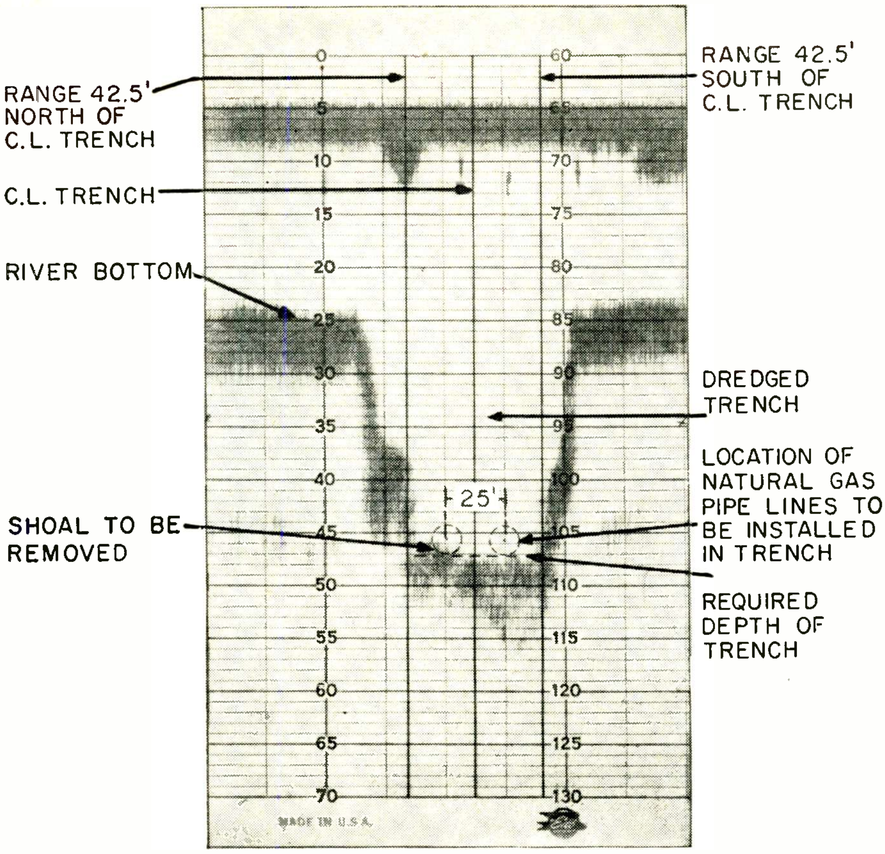


Chart of a pipe-laying operation as traced by a recording echo sounder.

with a diode detector that applies a negative voltage to V5's grid.

The output tube plate is grounded and its cathode connected to the −375-volt line through a 40,000-ohm resistor. The tube is used as a variable resistance. To see how it acts to trigger the neon indicating lamp, see Fig. 2, a simplified diagram of the circuit.

V5 forms part of a voltage divider that applies current to the neon lamp. When V5 conducts, as during normal operation (no pulse), it acts as a low resistance and does not let enough current flow through R15 to fire the neon lamp. When the 1-millisecond transmitted pulse from V1 reaches V5's grid, the tube is cut off and becomes a very high resistance. Now current flows through the tube is at a minimum and enough current flows through R15 to flash the lamp. This is at the zero depth point. When the pulse ends, V5 conducts once again.

The entire circuit has quick recovery so that, immediately after the pulse is transmitted, the system is ready for the reception of echoes. Echoes striking the transducer are coupled into the receiver by T1, and amplified.

After the neon lamp flashes at the zero depth point, it continues around the indicating scale. When the echo is picked up and fed through the receiver, V5 is cut off once again and the neon lamp flashes–this time indicating the distance to the bottom.

Any echo which falls outside the envelope of the transmitted pulse shows

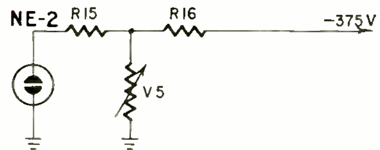


Fig. 2—Partial simplified schematic shows neon triggering circuit.

as a flash of light, so depths from about 1 foot down are registered.

Installation

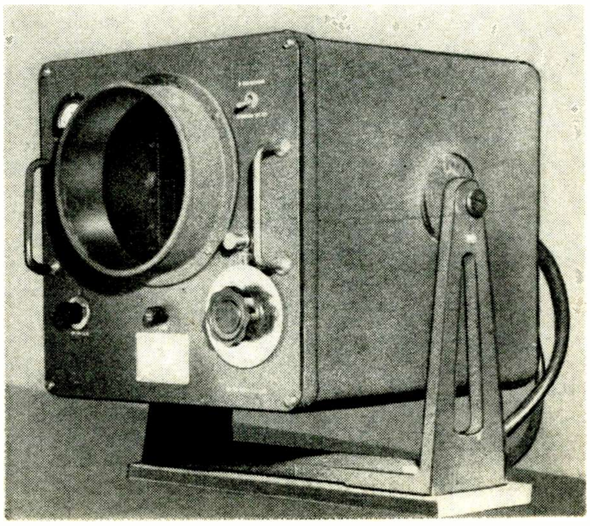
Indicators should be located where they can be easily viewed by the man at the helm. Instruments using flashing lights should be placed in an area where direct sunlight will not fall on the dial, if possible. An external power supply can be mounted in a locker below or in the engine compartment. Keep equipment as far from the compass as conditions permit, and make sure at the time of installation that putting the equipment in place does not swing the compass off.

Transducers are most easily installed when the boat is hauled out or laid up for off-season storage. For this reason, it is a good idea to sell the owner on the idea of an installation in the winter, so the underwater parts can be installed during layup. Some agencies sell the transducer in the winter, the remainder being purchased later. This has the further advantage to the customer of spreading out payments, and it also provides winter work for technicians.

Transducer installation ranges from mounting a clip on the hull, for portable or "flashlight" types, to boring one or more holes in the bottom, and fitting and sealing on fairing blocks for streamlining.

Techniques have even been worked out for installing the transducer on the bottom of the boat while it is in the water. This involves boring a hole in the bottom and sending a "leader" float through the hole and up to the surface of the water outside. Then the transducer cable is attached to the leader, and the unit is pulled down outside the hull. Next, the mounting bolt is pulled up into the hole, and the fastening nuts are installed. A little water comes into the boat in the process, but hardly enough to get your feet wet, and certainly not enough to be dangerous.

The transducer should be mounted so the sending face points exactly straight down. A position amidships is generally best, since the forward part of many fast boats is often out of the water, or at least picking up quantities of air which boil along the bottom for a considerable distance and would block off transmission and reception of signals. In the stern, engine and propeller



Oscilloscope indicator made by Edo.

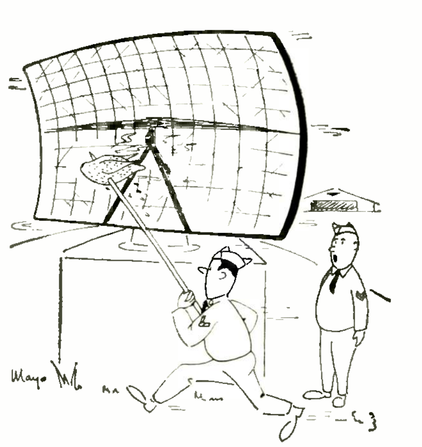
vibration and noise create interference that might obliterate the sounding signals. Another consideration is to make sure that the transducer is not located where it might be damaged by the cradle when the boat is being hauled. The face of the transducer should not be painted.

Wiring should conform to manufacturer's instructions. Also, it is a good idea to get acquainted with the recommendations of the National Fire Protection Association. Standards for small craft are set forth in their publication No. 302, available for 50 cents from their office at 60 Batterymarch St., Boston 10, Mass. Be particularly careful that battery connections are not reversed from the specifications.

Service

As in other mobile electronic equipment, vibrators and tubes should be checked in case of trouble—and remember the neon bulb. Also, the motor should be inspected and lubricated periodically and slip rings, brushes and contactors must be kept scrupulously clean. Intermittent or jumpy indications are usually caused by a dirty contactor or slip rings. An oscilloscope is very handy for servicing by signal tracing, but in its absence trouble can be corrected by the well known procedure of cleaning and tightening connections, checking voltages and resistances, and exercising a little common sense.

One of the peculiarities of marine electronic equipment is that it suffers more from lying idle than from being used. Gear which is operated daily keeps dry. The controls and other vulnerable points are kept clear of corrosion. Capacitors stay formed and the owner becomes familiar with proper operation. Always stress the point that the equipment is aboard to be used, and actually benefits thereby. If the owner operates the equipment every time he is aboard his boat, service will probably amount to nothing more than a routine yearly check up. END



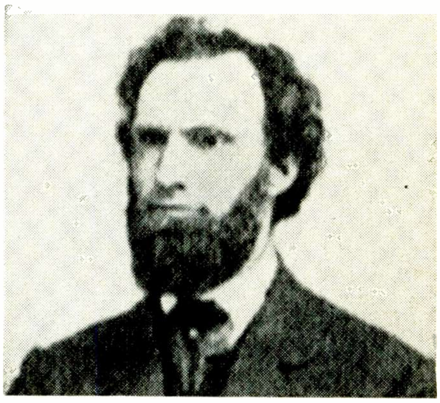
"Ok! Ok! Don't burn it to a crisp this time!"

RADIO TELEGRAPHY in 1866

Like Columbus, Marconi wasn't first

By DARRELL L. GEIGER

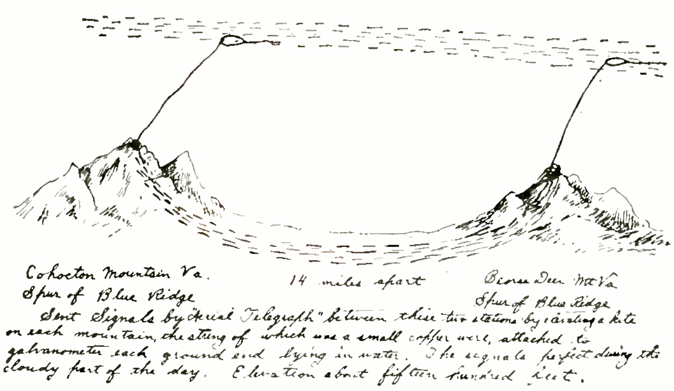
YEARS before Marconi was even born, a now forgotten Washington, D. C., dentist, Mahlon Loomis, was communicating by wireless telegraphy for distances of at least 14 miles. Thus, wireless communication, far from being new, is nearly as old as most other practical uses of electricity. The electric lamp was not invented until 1878, long after Loomis' successful experiments.



Dr. Mahlon Loomis.

Dr. Loomis called his system "aerial telegraphy," and his first public demonstration was made in 1866 between two peaks of the Blue Ridge mountains of Virginia. A kite was sent up from each site, each with a small piece of fine copper-wire gauze attached to its underside. Metallic kite strings, 600 feet long, the ground ends submerged in water, conducted the signals to earth. Galvanometers were used to indicate signal reception.

In his later patent application he states that he dispenses with all "artificial" batteries, using the "natural" or "free" electricity of the atmosphere for power "Upon these mountain tops I erect suitable towers and apparatus to attract the electricity—or in other words to disturb the electrical equilibrum—and thus obtain a current of electricity, or shocks, or pulsations which traverse or disturb the positive electrical body above and between the two given points. . . ."



Sketch of Loomis' transmitting and receiving setup. (Reproduction from Loomis' sketch, 1865. Original drawing now in archives of Library of Congress, Washington, D. C.)

Loomis states that reception was perfect during the cloudy part of the day, "as exact and distinct as any that ever traveled over metallic conductors." The distance was 14 to 18 miles. In 1896, thirty years later, Marconi had succeeded in signaling barely more than 1 mile. Loomis was granted patent No. 129,971, entitled "Improvement in Telegraphing," on his invention in 1872, two years before Marconi was born!

After receiving his patent Loomis, as had Morse before him, appealed to Congress for funds. But Congress did not have the imagination to cope with an idea this revolutionary. Funds were refused and two companies formed to back him were wiped out, first by a Wall Street crash and later by the Chicago Fire.[1] Dr. Loomis died shortly after, without realizing his ambitions.

Loomis was led to his experiments by noting that in wire telegraphy, the earth (charged, it was then supposed, with negative electricity) could be made to serve as one conductor. Why then could not the upper atmosphere, also abundant with electricity, be used as the other conductor, thus doing away with all wires?

By making contact with the atmospheric stratum of electricity through towers built on high mountains, Loomis visualized world-wide communication. The atmospheric electricity, which he considered as positively charged, would with the negative electricity of the ground furnish all needed power.

Should Loomis rather than Marconi be acclaimed the inventor of radio? Probably not. For one thing he did not know that his method of communication was by radio waves. Loomis' patent specifications show that he himself considered his method to be similar to that used with wire telegraphy. But as primitive as his ideas seem to us now, they were advanced for their time. Had Loomis lived, who knows how he would have influenced the early development of radio? END

[1] Mary Texanna Loomis, *Radio Theory and Operating*, Loomis Publishing Co., Washington, D. C., 1925.

EXPERIMENTER'S CARRIER-POWER RECEIVER

Want something for nothing? Try a free-power one-transistor radio receiver that doesn't need a battery

By DR. WILLIAM H. GRACE

IF you live within 10 miles or so of a broadcasting transmitter, this circuit is a way to get something for nothing. The field created by the nearby transmitter can supply the power you need to operate a 1-transistor receiver. Circuits of this type have appeared before (see "Transistor Radio Uses No Power Supply," RADIO-ELECTRONICS, April, 1955, and "Free Power Receiver," RADIO-ELECTRONICS, April, 1957). But the one described here has a few unusual features.

Some models consist of two receivers including separate antennas. In this unit (see Fig. 1) only one antenna is needed and the detector, amplifier and power supply are connected by only one lead to the rf or tuned section. No ground return is used as it is not needed. At first glance the circuit may appear unworkable, but it does work, and very efficiently at that.

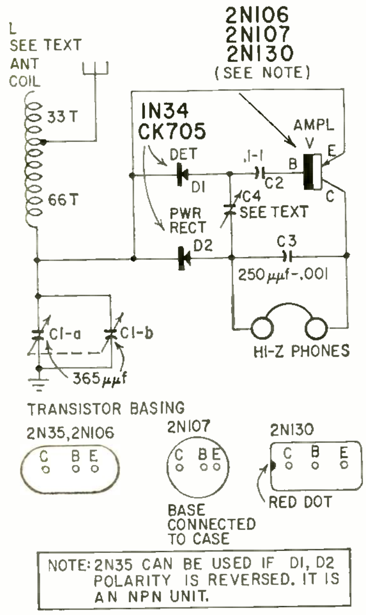
Check for power

Before building any free-power receiver you should determine if your location, plus a suitable antenna system, will deliver enough power to operate the amplifier. There are at least two ways to do this. Dr. H. E. Hollmann, in his April, 1957, article "Free Power Receivers," suggests a formula for the purpose. It is a simple, workable method by which the transmitter's power, the effective length of the receiving antenna and the distance of the receiver from the transmitter are correlated mathematically to give the power available in microwatts.

There is one important factor Dr. Hollmann did not include in his formula that affects the strength of a receiver's signal, and that is the height of the receiving antenna. In practice, antenna height contributes as much as its effective length to signal strength, so place the receiving antenna as high as you can possibly get it.

The second way to determine the amount of available power is empirical—erect the longest and highest single-wire antenna possible in your location and connect it to the simple crystal set shown in Fig. 2. The tuner and the two diodes are connected with clip leads as these components will be used in the receiver. Place a microammeter across the diodes and, if you get a reading of 500 μa or better, you should have enough power for a batteryless transistor radio. If you get a reading between 1 and 2 ma, you have enough dc to operate an efficient speaker. Of course, a good ground such as a water-pipe will contribute to the power received. Sometimes multiple ground connections to separate grounds produce even greater current.

In making your tests, be certain you have tuned in your strongest station because this is the frequency you will use later. In short, if you live within reasonable distance of a strong transmitting station, have an antenna at least 100 or 150 feet long and 35 to 45 feet high, you should have no power shortage. I have seen antenna systems only 75 feet in length at an average height of 35 feet that were capable of delivering better than 1 ma when located in a favorable spot and I have obtained nearly 3 ma, 17 miles north of a New York City station, at night during the winter season.

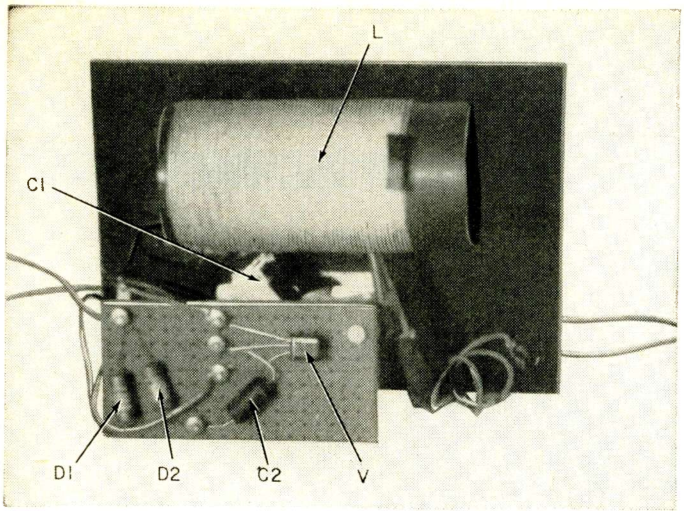


C1—2-gang variable capacitor, 365 μμf each section
C2—0.1 to 1 μf
C3—250 μμf to .001 μf
C4—(see text)
D1, 2—1N34, CK705
L—antenna coil, 99 turns No. 22 or 24 dcc on 2-inch diameter form, tapped at 33 turns
V—2N35, 2N106, 2N107, 2N130
High-impedance headphones
Miscellaneous hardware

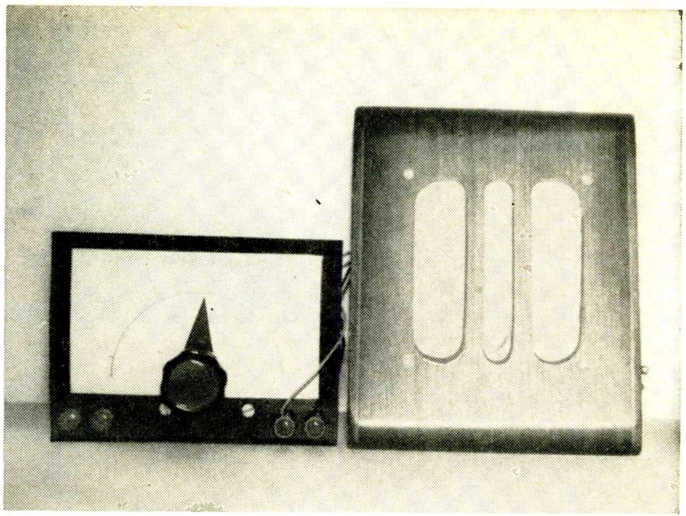
Fig. 1—Circuit of the batteryless receiver.

The receiver circuit

While the few components required are familiar to all radio men and need no description, the unconventional circuit does require some discussion. Its operation is similar to that of the double-diode arrangement in the power-checking circuit of Fig. 2 with detector



One possible parts layout for the carrier-power receiver.



The author got enough output from his set to drive a speaker.

diode D1 working in conjunction with the emitter to the base element of the transistor. Diode D2 is set up so the rectified carrier dc is supplied to the collector in the proper direction. While the circuit appears freakish upon casual inspection, its operation is entirely conventional.

It may interest readers to know that in the power-checking circuit, one of the diodes may be replaced with an rf choke with equal efficiency. This latter type of one-wire feed was used quite often in the circuitry of wavemeters in the days of spark and is employed today in the Miller hi-fi crystal tuner.

Of the several types of diodes tested, the 1N34 and CK705 were found suitable, with perhaps a shade in favor of CK705's. Various types of junction transistors were tried and some performed better than others. Among those which seemed to produce the loudest and clearest signals were the Raytheon 2N106, 2N130, G-E 2N107 and Sylvania 2N35. The last is a n-p-n type and, if used, the polarity of both diodes must be reversed. The circuit works just as well with either type of transistor if proper current direction is insured. The value of the base capacitor is not critical and values from 0.1 to 1 μf were suitable. A base-bias resistor did not add to the circuit's efficiency. Try several diodes and transistors, using the ones that perform best in your final circuit. Many inexpensive types are suitable.

Almost any type of coil may be used in the antenna circuit. A single-layer coil of 99 turns of No. 22 or 24 dcc wire, tapped at the 33d turn allowed for adjusting the total inductance used, so I could adjust for the most favorable ratio of L to C in the series-tuned circuit. For best power response C1 should be the largest value that will let the circuit be resonant at a given frequency in respect to the value of L—more current is passed when the ratio of C to L is large. Naturally, a series-tuned tank is not the most selective type of tuning element, but selectivity is not too important with this receiver. Because both the signal frequency and the power or carrier frequency are the same. A station has to be on frequency for the power circuit to function, hence the amplifier works only when there is sufficient power to activate it. Furthermore, it is unlikely that any builder lives at a location where more than two or three local transmitting stations furnish enough power for signal overlapping. So selectivity is sacrificed for simplicity.

Some operating notes

Receiver operation is exactly the same as that of a simple crystal set—the one dial is moved to the point of greatest volume. With certain transistors, a heterodynelike whistle may be heard just to the higher-frequency side of the station resonant point on the dial. The whistle is caused by feedback, but does not interfere with reception if the dial is turned a slight bit toward the lower-frequency side. By adjusting C4, a small tuning capacitor or medium-sized trimmer, the whistle can be eliminated. The point of clearest reception is easily noted, and once adjusted need not be changed.

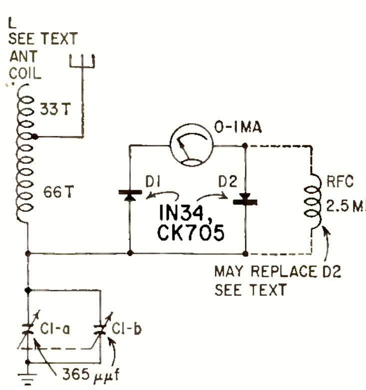
Another interesting point noted was that it does not seem to make much, if any, difference how long a conductor is used to connect the tuning circuit to the rest of the set. One experiment was made with the tuner proper left in one room while the rest of the unit was placed 40 feet away in another part of the house. There was no reduction in volume.

If the receiver is operating correctly, its output is in the order of four to eight times that of a plain crystal set. Exact measurements cannot be given because the volume always depends on the actual power delivered by the antenna. In some places the volume level is surprisingly strong—enough to drive a sensitive PM or an old magnetic type speaker, should one be at hand. Signals from a pair of headphones should be audible 10 or 15 feet away. The whistle effect will be absent and the quality ragged if power is borderline. A longer antenna will usually end this problem.

The percentage of modulation of the transmitter can also affect reception on a receiver of this type if the modulation is less than 100%, the quality of the receiver's output will be far better than otherwise. There must always be more carrier power to the collector than voice signal.

The experimental receiver described above uses the same station to furnish both the signal and power but somewhat more advanced circuitry leads to a batteryless receiver which uses the carrier frequency of a very strong transmitting station to amplify the signals from a low-level or weaker station on another frequency. The receiver described here serves as an interesting introduction to the construction of more complicated receivers using the free-power principle. And we all like to get something for nothing.

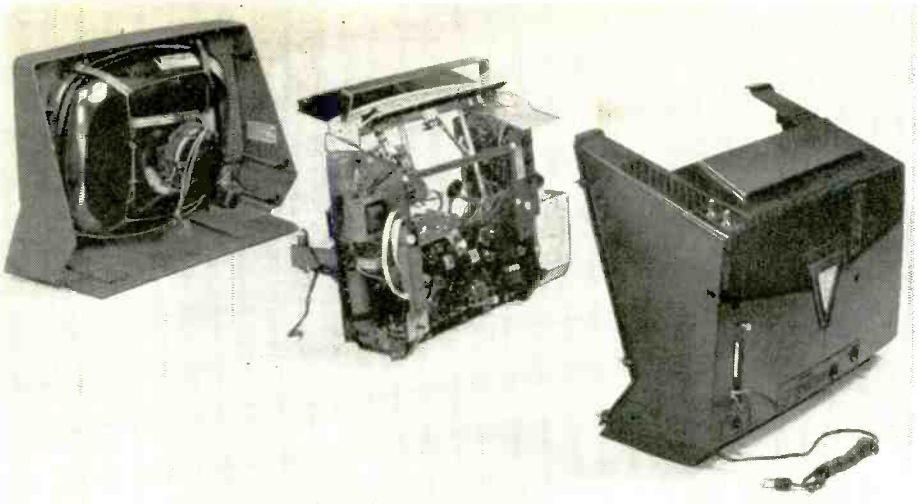
END



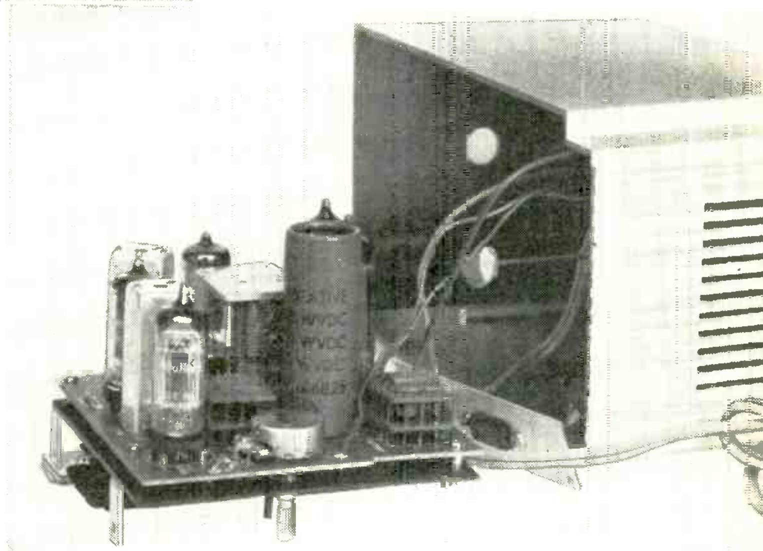
C1—2-gang variable capacitor, 365 $\mu\mu$f each section
D1, 2—1N34, CK705
L—antenna coil, 99 turns No. 22 or 24 dcc on 2-inch diameter form, tapped at 33 turns
M—meter, 1 ma
RFC—2.5 mh (optional, see text)
Miscellaneous hardware

Fig. 2—To check available power use this setup.

what's new?

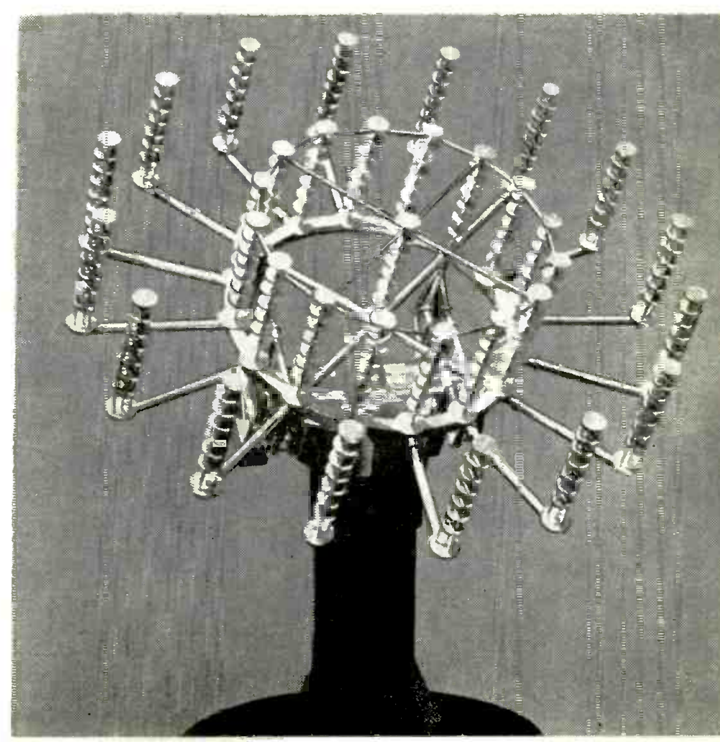


EASE OF SERVICING is emphasized in this new 17-inch TV which doubles as a portable and table model. Housed completely in plastic, the chassis is exposed by removing eight screws (three on each side, two on the top) and sliding the cabinet off. The chassis may be completely removed by unscrewing two more screws, providing access to the filter capacitors. Made by Sylvania, this model is called the Dualette.



MODULES FOR THE KIT BUILDER have now appeared. This Knight chassis (model 83 Y 737 clock radio) uses two of them in its circuitry. The module terminals are pushed into predrilled holes in the printed-circuit board and soldered by the constructor on the under side. All the small fixed resistors and capacitors in the set are in the modules. The schematic supplied to the do-it-yourselfer is standard, with indications showing the module terminals.

MAGNETIC DISC RECORDER combines disc and tape techniques; records and plays back 70 seconds of material on each side of a 7-inch disc at 33⅓ rpm. Recording grooves are premolded into the blank disc which is said to have a life expectancy equal to or greater than tape. Recorded material on the discs may be easily erased. The magnetic head (inset) consists of two C-shaped pole pieces which protrude through the narrow slot (arrow). The recorder in the photo was designed by RCA for broadcasting use; plug-in pickups convert it for playing of standard records or transcriptions. Another version is designed for computer use. No unit for use in the home has as yet been developed.



UNIQUE ANTENNA DESIGN using 33 end-fire arrays in parallel is a scale model of a 40-foot telemetry antenna which will soon be built for operation at about 200 mc by GB Electronics Corp., subsidiary of General Bronze Corp., Garden City, N. Y. The antenna has a gain of 30 db, and is the equivalent of a 60-ft. paraboloid. Other versions of this design, called SVE (for "swept volume efficiency"), replace parabolas in radar and scatter installations. Made of lightweight aluminum, they are far lighter and easier to ship, install and maintain than conventional parabolic units.

HUSH the noise in antennas and lead-ins

Noise can be generated right in the antenna or lead-in—or in the connections. In fringe areas this added noise may make the difference between a usable picture and a snowstorm

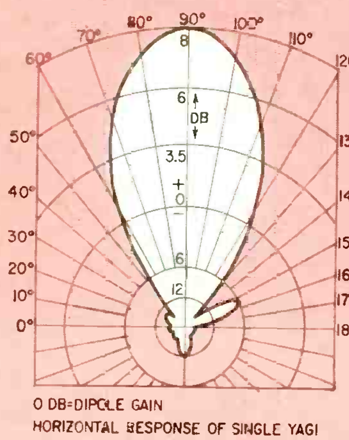


Fig. 1—Polar diagram for a single 10-element Yagi.

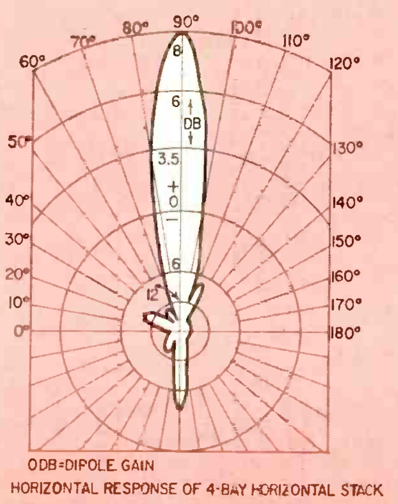
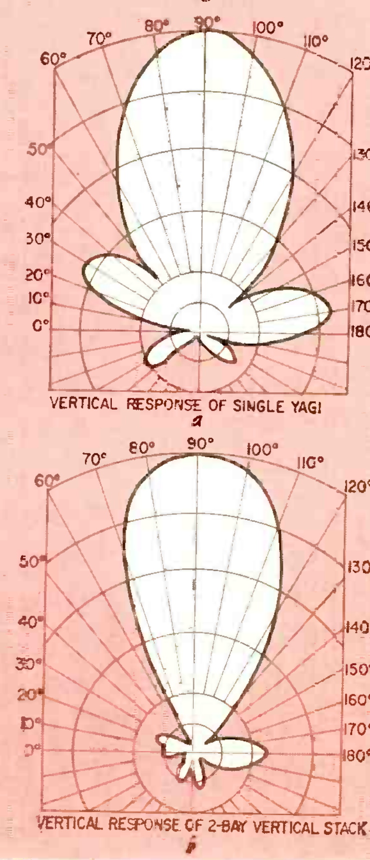


Fig. 2—Horizontal polar diagram for a 4-bay horizontally stacked array.

Fig. 3—These illustrations show how noise from above or below can be rejected by vertical stacking: a—vertical pattern of single 10-element Yagi; b—vertical pattern of two 10-element Yagis.



By The Engineering Staff, Scala Radio Co.

WE measure signal strength in microvolts. If the number of microvolts is above a certain minimum value, we sometimes consider an antenna installation to be satisfactory.

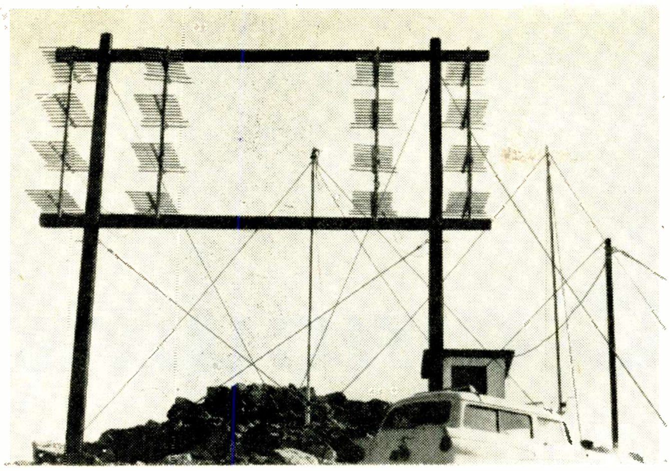
Such a simple measurement can be misleading. What we really need to know is *how much the signal is above the noise level.* For example, 500 μv on a field-strength meter is usually considered good. But such a 500-μv signal can be completely unsatisfactory in a very noisy area. On the other hand, a signal of only 150 μv can be very good if noise is low.

How antennas generate noise

Noise can be, and often is, generated right in the antenna and lead-in system. Metallic antennas corrode when exposed to the weather. Oxidation on metal surfaces adds resistance to the system and decreases antenna efficiency.

Oxidation is chiefly responsible for the noise that develops as the antenna ages. Here is what can happen: The lead-in terminals usually consist of zinc- or cadmium-plated steel bolts. They pass through holes punched or drilled through the aluminum antenna feed element.

Lead-ins and connecting lugs are usually made of copper. These metals fall at opposite ends of the galvanic



Installation at Eagle Mountain, Calif. The left bay is cut to channel 7, right bay to channel 9.

Courtesy Jerrold Electronics Corp.

table. Moisture causes them to form a battery, oxidizing and corroding the metal.

Vibration varies the pressures on the oxidized surfaces. This makes them a changing resistance in series with the transmission line. It changes the terminal impedance and causes the signal at the receiver to vary.

Corrosion progresses more rapidly as time passes. Eventually, a point is reached where there is no effective connection between transmission line and antenna.

The same situation occurs at points where antenna elements are spliced. Hence, we can reduce the inroads of corrosion by protecting connections from the weather. They should be covered with a good high-frequency insulating tape. You can also protect a joint with silicone jelly—Dow Corning No. 5, or some equivalent product.

Corrosion problems are reduced by replacing the cadmium- or zinc-plated screws with stainless-steel or Monel screws of the same size. Noise voltages generated by other joints, such as the connection of the matching section to the driven elements, can also be protected by tapes and plastics. The same precaution applies to joints at center folds, which are provided for easy assembly and shipping.

Polar diagram helps fight noise

We can reduce noise further by proper use of the antenna's radiation pattern (see "Dipoles and Yagis," November, 1958).

For example, Fig. 1 is the polar diagram for a single 10-element Yagi (for a forward gain of 8 db over a dipole). Note that the sensitivity lessens considerably at the sides and rear.

In addition to a gain of 8 db, we have pickup rejection exceeding 12 db from the sides and rear of the array. The smaller lobe at the right would not be present in free space. However, it should be considered in most installations, because of the disturbance of the antenna field by the supporting tower.

This means that much less noise is picked up from the sides and rear. If noise comes from the sides, it can be reduced even further by horizontal stacking. Fig. 2 shows this. Note the increased rejection of pickup from the sides. We can increase this rejection still further, if we wish, by additional horizontal stacking.

If there is a noise source below (or above) the antenna array, we can help solve this problem by vertical stacking, as shown in Fig. 3. Two prominent but minor vertical lobes to the left and right of the single Yagi (Fig. 3-a) (caused by side radiation of the driven element) can be reduced considerably by using *two* vertically stacked antennas (Fig. 3-b). We can stack more than two arrays, to reduce these lobes still further.

Stacking in both horizontal and vertical planes reduces noise from both planes. For example, in the Barstow, Calif., community system, the antennas are located on a tower on a hillside. The city of Barstow is immediately below. A main highway is on the right. After experimenting with various methods of stacking, four Yagis were used for each channel, stacked both horizontally and vertically.

A community system in Guyman, Okla., on the other hand, had little trouble from the sides. Most of the noise was coming from *below* the antenna site. Hence, eight Yagis were stacked vertically for the troublesome channel.

The photo shows the Eagle Mountain installation, located approximately 175 miles from Los Angeles TV transmitters. After careful probing to locate a constant signal level and maximum rejection of man-made noise from the town 2,000 feet below, it was decided to use eight 10-element Yagis for each channel. They were stacked two horizontally and four vertically.

Co-channel interference

Co-channel interference is caused by two TV stations operating on the same channel. This is often a problem in community systems. In fringe areas, signals are received over long distances, because the antenna site is usually on a very high mountain or tower.

We recognize co-channel interference as a venetian-blind or windshield-wiper pattern in the picture. The windshield-wiper pattern results from interfering sync and blanking pulses. Sometimes, sound is distorted by co-channel interference.

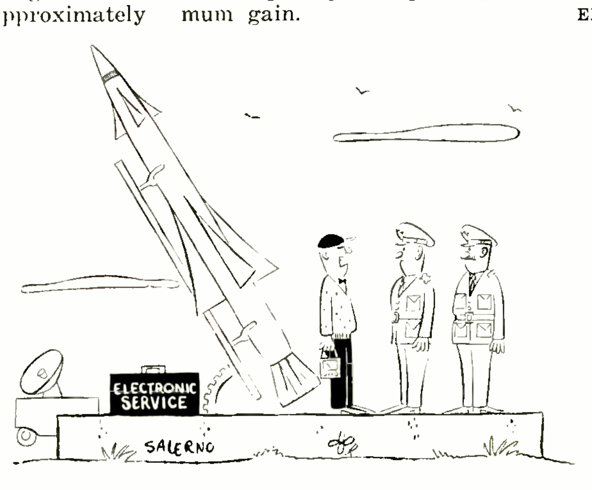
The usual method of locating the source of interference is to study a map of the area. However, because of reflections, conclusions drawn from a map may be incorrect. Direction of the interference can be determined by rotating the antenna carefully, until maximum unwanted signal is noted. Then, measure the angle between the wanted and unwanted signals. This angle, plus the signal strength of the interference, gives the installation man the data needed to determine the required directivity of the array.

A single-channel Yagi has 30° to 60° beam width to the half-power point. Horizontal stacking of the two Yagis reduces this figure to half, approximately. If four Yagis are used, the figure is further reduced.

Thus, the greater the number of antennas stacked in a horizontal plane, the greater is the directivity obtained.

Remember, vertical stacking affects only the vertical lobe. Horizontal stacking effects only the horizontal lobe. Hence, if you need directivity in both planes, stack antennas both vertically and horizontally.

Following our discussion of noise rejection, the next article will cover locating the best antenna sites, shattered wavefronts, impedance matching, antenna spacing and phasing for maximum gain. END



"I'm afraid that I'll have to take it into the shop!"

TV's TRICKY R-C CIRCUITS

Those odd-looking R-C networks in the TV set's horizontal circuits aren't so hard to understand

By CYRUS GLICKSTEIN*

EVERY so often, in servicing some section of a TV receiver, I've come across a complex R-C circuit which made me scratch my head. Complex (series-parallel) R-C circuits don't act like series R-C circuits. They don't even act like each other. *Each basic type of complex R-C circuit acts in a different way.*

The circuit in Fig. 1 is part of the phase-detector system of horizontal afc (automatic frequency control) found in many TV sets. Afc keeps the horizontal oscillator at the correct frequency by changing out-of-phase sync pulses to a dc correction voltage when the oscillator starts to slip out of sync. Afc circuits must prevent noise pulses from developing any control voltage in the system, since that would cause a loss of sync. The systems must also prevent hunting.

Afc hunting

Too much correction voltage developed at the instant the oscillator goes off frequency causes hunting (moving rapidly above and below correct frequency). To prevent hunting, overcorrection of the horizontal oscillator must be avoided by building up the correction voltage gradually.

The general operation of horizontal afc circuits has been described many times. However, almost no information has previously appeared on exactly how anti-hunt action takes place. A large correction voltage is developed instantaneously when circuit conditions change, but the afc circuit is designed to allow only a small part of this to be applied to the horizontal oscillator at the first instant. As the horizontal oscillator starts to come back to frequency, less correction voltage is developed. A point is finally reached where just enough correction voltage is generated to keep the oscillator at the correct frequency under the new circuit conditions. This full correction voltage is applied to the horizontal oscillator's grid.

Hunting is prevented by the small time lag between the instantaneous generation of the input correction voltage (across R3 or R4 in series with R2 in Fig. 1) and the comparatively slow increase of dc correction voltage applied to the grid (across C2). If the full correction voltage were applied immediately to the grid, the horizontal oscillator would shift frequency in the opposite direction, generating a correction voltage of opposite polarity to cause another frequency shift in the original direction, and so on. The oscillator would hunt above and below the correct frequency.

Therefore, the portion of the phase-detector circuit in Fig. 1 consisting of R1, C1, C2, R2 and R3–R4, has three functions:

1. It integrates out-of-phase sync pulses so that only the average correction voltage is applied to the horizontal oscillator to bring it back to the correct frequency.
2. It reduces the effect of noise pulses and minimizes development of a control voltage by these pulses.
3. It prevents hunting.

The R-C circuit has a long time constant and the correction voltage is taken off C2. It can therefore be considered an integrating circuit. The dc correction voltage is applied to one grid of the horizontal oscillator. Positive correction voltages decrease the oscillator's frequency and negative pulses increase the frequency.

A specific example will clarify this action. Assume the plate voltage of the horizontal oscillator drops. When this occurs, the oscillator shifts to a lower frequency. The horizontal sawtooth, fed to the phase-detector diodes (V2), is now out of phase with the incoming sync pulses. Negative pulses are developed across R2 as a result. These pulses are applied to the parallel combination R1, C1 in series with C2 (see Fig. 1). During the initial charge period, series capacitors C1 and C2 act as a voltage divider.

The capacitors charge through R3 or R4. This time, they charge through R3. The time it takes for them to charge depends on the circuit's time constant. At the first instant, the capacitors short out R2. As more sync pulses come in they start to charge. The pulse voltage divides across them in inverse ratio to their capacitance. That is, since C2 is 10 times as large as C1, C2 has approximately 1/10 as much voltage or 1/11 of the applied voltage. The capacitors charge through R3 but discharge slightly through R2 and R1 between pulses.

As C2 charges, the oscillator starts to return toward its original frequency due to the negative correction voltage on its grid. The sync pulses applied to R1, R2, C1 and C2 become smaller since the frequency is a little less off. As smaller sync pulses are applied to C1 and C2, the capacitors try to charge to a smaller voltage. They still continue to charge, since an integrating circuit is unable to charge instantly to the applied voltage because of its long time constant.

As C2 continues to charge, the oscillator's frequency continues to change toward the original frequency. The out-of-phase sync pulses become smaller. C2 continues to charge more slowly as

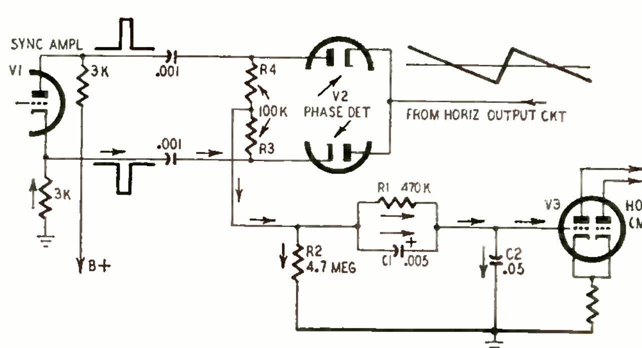


Fig. 1—Phase-detector R-C circuit. Arrows show charge path for C2 when negative incoming pulses are developed.

*Author of *Repairing Television Receivers* (John F. Rider Publisher, Inc.).

it is now closer to the maximum applied voltage. Also as C2 continues to charge, C1 reaches a maximum value and then discharges, allowing C2 to charge fully. (This action is typical in this type of complex R-C circuit and will be discussed in greater detail later.)

Phase and frequency

A point is reached where equilibrium is established with C2 charged to the maximum amplitude of the sync pulses and there is just enough correction voltage at the oscillator's grid to give the correct oscillator frequency. The *phase* of the picture is slightly different but the frequency is correct.

The difference in phase causes a slight sideways displacement of the picture. This displacement is unavoidable and necessary to keep generating a correction voltage as long as the oscillator's plate voltage remains low (Fig. 2). The same kind of corrective action occurs for any change in operating conditions of the horizontal oscillator circuit.

Action of this circuit becomes clear by comparing it with several basic circuits. If two capacitors are connected in series across a battery, both charge instantly (Fig. 3). If a resistor is placed in series with the capacitors (Fig. 4), the action is a combination of a series R-C circuit and the instantaneous action described above. When the switch is closed, the capacitors start to charge. The voltage across each capacitor rises while the voltage across the resistor falls. Through the charge period, the voltage across C1 plus the voltage across C2 plus the voltage across R1 adds up to the battery voltage. When they are fully charged, the smaller capacitor has the larger voltage across it. Voltages across the capacitors equal the source voltage and there is no voltage across the resistor.

In Fig. 5-a, a parallel R-C network is in series with a capacitor. When the switch is closed, the battery voltage divides across the two capacitors. In this first instant R1 has no effect on the action, but immediately thereafter C1 starts to discharge through R1 at a rate determined by the network's time constant. At the same time C2 continues to charge through R1 until it charges to the source voltage while C1 discharges to zero (Fig. 5-b). Curves showing the voltage change across each capacitor appear in Figs. 5-c and 5-d.

The basic R-C circuit corresponding to the one in the phase-detector circuit is shown in Fig. 6. It acts like a combination of the two preceding circuits, but not exactly like either.

When the switch is first closed, C1 and C2 short out R1 and R2, placing the whole battery voltage across R3. As the capacitors charge, the voltage across R2 rises. The voltage across R2 equals the voltage across C1 plus the voltage across C2. In the same way the voltage across R1 rises. Throughout the first part of the charge period, voltages across the capacitors are in inverse proportion to their capacitance. Also, during this period, voltage across R3 decreases across R2 increases.

At the instant the increasing current through R1 equals the decreasing current through C2, C1 stops charging and starts to discharge through R1. This occurs because the total current keeps dropping as C2 continues to charge (C1 is fully charged). Therefore, the voltage across R1 must drop as the current drops. C1 cannot keep its full charge and starts to discharge through R1. C2 charges while C1 discharges. The voltage across R2 keeps increasing, the voltage across R3 keeps decreasing. The voltage across R1 decreases as C1 discharges. As the voltage across R3 started at battery potential and went down while the voltage across R2 started at zero and went up, a point is reached where the voltages across the resistors are proportional to their resistance. At this instant C2 (charged to the voltage across R2) stops charging. C1 is discharged and there is no voltage across R1. A steady current flows through R2 and R3, and they act as a voltage divider.

In the circuit of Fig. 1, positive or negative pulses of decreasing amplitude are the source of voltage, rather than a battery. However, circuit action is essentially the same.

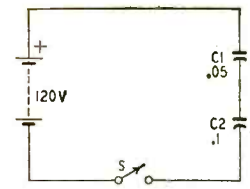


Fig. 3—Two capacitors in series with a battery act as a voltage divider.

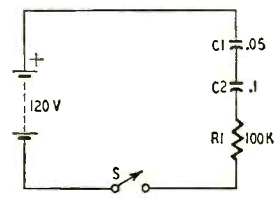


Fig. 4—Series resistor slows down the charge action of the capacitors.

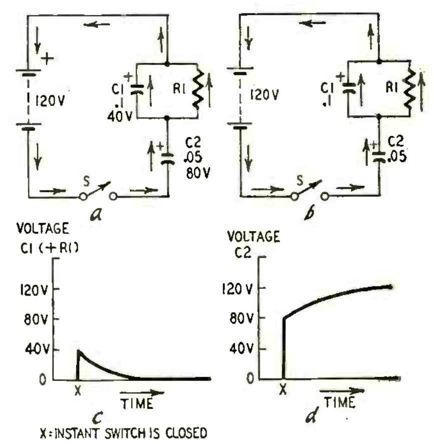


Fig. 5—Action of a parallel R-C network in series with a second capacitor.

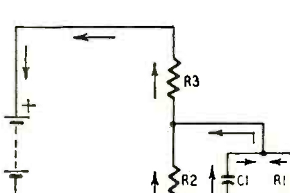


Fig. 6—Basic circuit corresponds to portion of Fig. 1 phase detector. Arrows show current paths during initial charging period.

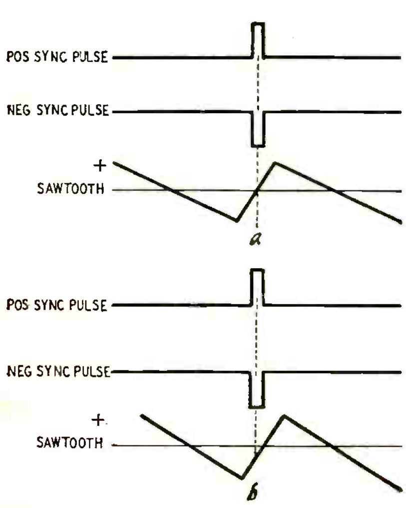


Fig. 2-a — Sawtooth voltage in phase with sync pulses; b—out of phase sawtooth voltage results in negative correction voltage.

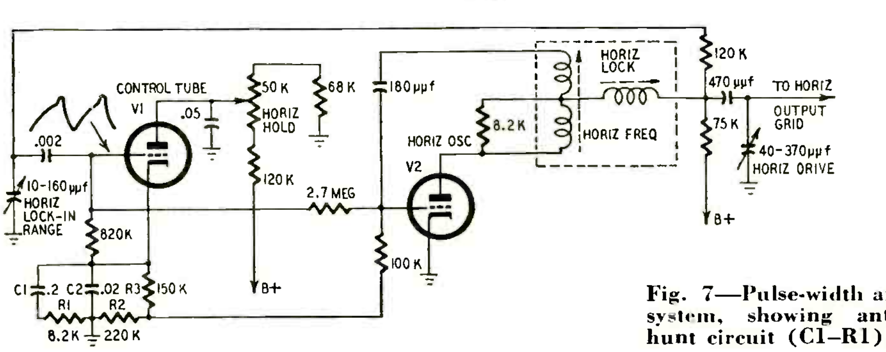


Fig. 7—Pulse-width afc system, showing anti-hunt circuit (C1–R1).

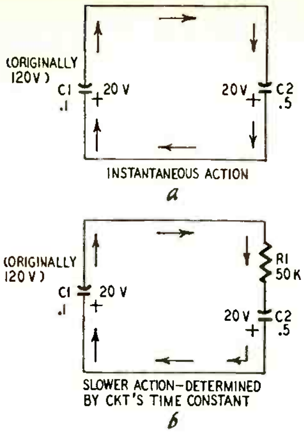


Fig. 8—Circuit action when a charged capacitor is placed across an uncharged one.

The integrating action of this circuit tends to make it less sensitive to noise pulses. Fast, random pulses have little effect in building up a charge on C2. R1 has a double function in the anti-hunt portion of the circuit (R1–C1). First it lets C1 discharge toward the end of the correction period, allowing C2 to build up to the full amplitude of the source pulses. Second, it provides a dc path from the horizontal oscillator's grid to ground through R2.

In this circuit, if C2's capacitance decreases or C1's increases, correction voltages may build up too fast and cause hunting.

Pulse-width circuit

Another common afc circuit is the pulse-width circuit (see Fig. 7). R1–C1 in V1's cathode circuit acts as the anti-hunt network. In this system, a composite signal appears at V1's grid at the end of every line. This signal consists of a trapezoidal (modified sawtooth) signal with a sync pulse riding on top. If the oscillator's frequency changes, the sync pulse is displaced on the composite signal, making the top either narrower or wider. This makes the control tube, normally cut off between pulses, conduct for a longer or shorter interval when the signal comes in. This, in turn, develops a smaller or larger average cathode voltage. Part of the positive cathode voltage is tapped off by R2 and applied to V2's grid. This tapped positive voltage bucks the negative voltage at the oscillator's grid. This bucking voltage determines the point at which the oscillator fires, thereby controlling oscillator frequency.

C1–R1 in V1's cathode circuit prevents hunting by not allowing full correction voltage to be applied to the oscillator's grid at the instant there is a change of frequency. As in the phase-detector system C1–R1 act so that the correction voltage at the grid builds up gradually. The circuit permits an equilibrium point to be reached after several cycles, when a slightly displaced sync pulse provides the required amount of corrective voltage for the oscillator's grid. The correct horizontal frequency is re-established even though the change in operating conditions continues. As before, there is a slight phase displacement of the picture to maintain the correction voltage.

The exact action to the C1–R1 anti-hunt network can be understood by noting the action in the simplified circuits of Fig. 8.

When a charged capacitor is placed across an uncharged one (Fig. 8-a), it discharges into the uncharged one and the voltages across the two become equal. If both capacitors have the same capacitance, the charged one loses half its charge before the voltages become equal. If one capacitor is larger, C2 in Fig. 8-a, it requires more electrons to charge to same voltage as C1. So C1 will discharge more than half its electrons before the voltages across the two capacitors become equal.

Since $Q = CE$, $E = Q/C$. If two capacitors of unequal C are to have the same E, the smaller capacitor must have a smaller Q (quantity of electrons). C1 originally had 120 volts. C1 is 0.1 μf and C2, 0.5 μf. To find the new voltage across both capacitors remember that C2, the uncharged capacitor, is five times as large as C1. Therefore it must have five times as much charge for the capacitors to have the same voltage across them. When C2 is placed across C1, C1 discharges to 1/6 of its original charge or 20 volts. Five parts of the original charge go to C2, one part remains in C1. There are now 20 volts across both capacitors.

Add a resistor to Fig. 8-a as shown in Fig. 8-b. The charged capacitor is again allowed to discharge into uncharged C2. The only effect of the resistor is to slow down the action.

Anti-hunt system

Fig. 9 shows the exact action of the pulse-width anti-hunt circuit. When the switch is closed (Fig. 9-a), C2 instantly charges to the battery voltage. C1 charges more slowly through R1 and can charge to battery voltage only if the switch is kept closed for a period of about 5 RC. (A capacitor charges to 63% of the battery voltage in 1 RC and to 100% in about 5 RC, in a series R-C circuit.) If the switch is kept closed for only a fraction of this time, C2 charges to the full battery voltage but C1 charges to only a small fraction of this voltage. When the switch is opened, C2 discharges into C1 through R1 (Fig. 9-b). C2 also discharges through R2. However, R2 is a high-resistance path compared to C1–R1. Most of the charge in C2 is discharged into C1. Also, since C1 is large compared to C2, C2 loses most of its electrons and its voltage in discharging into C1. C2 gains a small voltage. At the instant the voltages across the capacitors becomes equal, they both discharge through R2 (Fig. 9-c).

The effect of placing C1–R1 across C2, while opening and closing the switch, is to make C2 lose part of its voltage each time the switch is opened. Without C1–R1, C2 would immediately charge to the battery voltage and keep this voltage at practically the same value during the intervals when the switch is open. With C1–R1 in the circuit C2 discharges into C1 at the instant the switch is opened, but, as the switch is repeatedly closed and opened, the average voltage across the capacitors builds up the battery voltage.

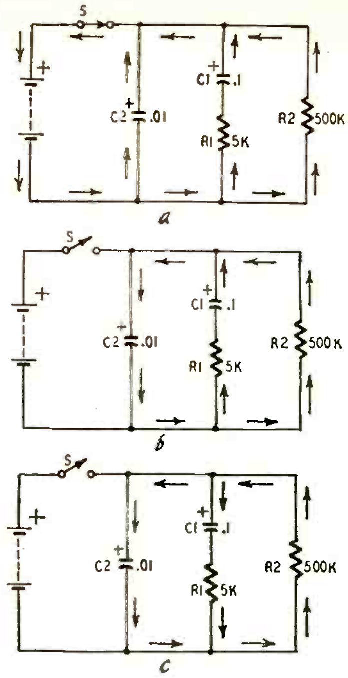


Fig. 9—Equivalent circuit illustrates action of a series anti-hunt network (C1–R1).

Hunting in the afc circuit of Fig. 7 may be caused by anti-hunt capacitor C1 opening or decreasing in value. The anti-hunt circuit would naturally be checked first for defects. However, other possibilities are: cathode capacitor C2 increasing, R2 increasing or R3 decreasing in value.

The basic principles used in analyzing the anti-hunt circuits can be applied to many other complex R-C circuits in TV receivers. END

Transistor Lecture Series

Beginning April 1 and continuing for the next five Wednesday evenings, the Boston Section of the Institute of Radio Engineers will sponsor a series of practical, workshop type transistor conferences. Each will be given by an expert in the field of transistors. The whole venture is supported by six leading transistor manufacturers.

The six-session series will be held at Boston's John Hancock Hall, beginning at 7:30 pm. Cost of the whole course is $7 to IRE members and students, $10 to others. For further information, write to the Boston Section, IRE, 73 Tremont St., Boston 8, Mass.

TV Service Clinic

conducted by

ROBERT G. MIDDLETON
RADIO-ELECTRONICS TELEVISION CONSULTANT

PROBLEMS of *ringing* in the raster or in the picture often are perplexing at the service bench. Hence, we are giving this subject a once-over-lightly this month.

First, we have to distinguish clearly between raster ringing and picture ringing. Raster ringing (Fig. 1) is apparent even when there is no picture. It shows up as a series of vertical gray bars at the left side of the screen.

There are two sources of these bars in a raster:

1. The ringing voltage can be picked up by the video input lead to the cathode-ray tube.
2. The ringing voltage can be generated by transient oscillations in the yoke circuit.

It is easy to distinguish between these types of ringing. If you shunt a 0.1-μf capacitor from the video signal lead to chassis, the first type disappears, but the second type does not.

If you find that the bars disappear when the shunt capacitor is connected in circuit, the remedy is to dress the video signal lead out of any field that

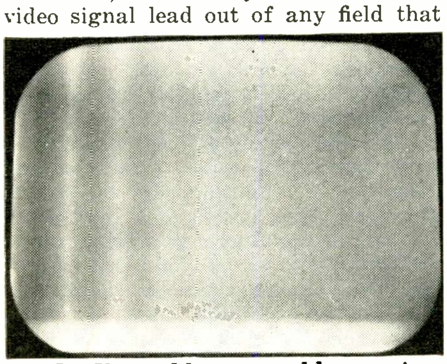


Fig. 1—Vertical bars caused by transient ringing in horizontal yoke circuit. (Foldover was a separate trouble.)

might cause such bars. Ringing fields are strongest near the high-voltage cage.

On the other hand, if you find that the bars remain with the shunt capacitor connected, the yoke circuit needs attention. As shown in Fig. 2, a fixed capacitor or sometimes a resistor and capacitor are needed across the "high" side of the horizontal yoke winding.

Values required vary considerably, but 56 μμf is typical for C. Sometimes the value is rather critical. R is relatively low, and the best value can be found only by experiment.

Note that Fig. 1 also shows a vertical foldover. The receiver had a weak vertical output tube, which was replaced to correct this raster trouble.

If you inspect the ringing bars carefully, you can distinguish between the two types of displays just described. When the ringing voltage is picked up by the video signal lead, the raster lines remain straight but they change in intensity to give the appearance of a bar.

On the other hand, when the bars are caused by transient ringing in the yoke circuit, the raster lines become curved or kinked, as shown in Fig. 3.

Ringing in the picture only is caused by sharp peaks in the response curve—either in the if or video amplifier. The proper procedure is to use a good sweep and marker generator, with a scope, to align the circuits for flat-topped response.

Distorted sound

I have an Admiral 20Z4FFB with distorted sound. It has a background hiss which follows the sound, especially on loud peaks. Sometimes a crackling noise comes through. Any suggestions?—A. A., Chicago, Ill.

The trailing hiss in the audio is characteristic of regeneration. The best approach will be to sweep the 4.5-mc intercarrier circuits from the sound takeoff point to the FM detector circuit. Regeneration will show up as a sharply peaked response curve. By checking the circuit components systematically,

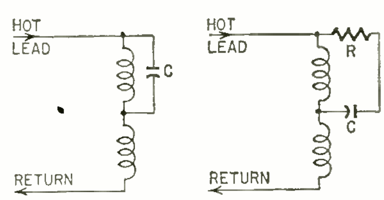


Fig. 2—Transient ringing can be corrected or minimized by shunting the horizontal yoke winding with a capacitor or capacitor and resistor in series.

you will be able to see from the scope pattern which fault has been corrected.

Conversion problem

Can you provide a diagram and list of parts to change from a 16- to a 21-inch picture tube in a Video Products K33130 receiver?—J. I., Fort Lee., N. J.

We have found in the past that this type of conversion is difficult, but it is a job which can be done if cost is not the primary factor. I would suggest that you consider reworking the chassis in accordance with the circuit and parts list for the RCA 21-T-6115, as published in standard service data.

Fuse-blowing 6DQ6

I would like some information about fuse blowing and shorts in the 6DQ6 in an RCA 21D8588. (I replaced it with a 6BQ6.) Also, how can focus be adjusted for a sharp and clear picture? —A. V. P., Troy, N. Y.

It would be advisable to check the voltages at the 6DQ6 socket. Drive or screen voltages may be too high. This receiver uses an electrostatically focused picture tube. The focus electrode requires different voltages for picture tubes with varying manufacturing tolerances. Try adjusting this voltage from zero to full B-plus, to find the best focus.

Drifting vertical hold

The vertical hold drifts in a Motorola TS45 as the set warms up. A heat lamp test shows that the chassis is heat-sensitive. However, I cannot pinpoint this to a definite component. I will appreciate any help.—J. I. L., Niagara Falls, N. Y.

You have made a good start with the heat lamp. The next step is to heat individual components in the general trouble area to see which one is heat-sensitive. Use a soldering gun, and hold it close to each suspected component in turn. You will soon be able to run down the faulty part.

Problem in a color set

I hope you can help solve a problem which has stumped local techs, including the factory service people. A CTC5 color set has off-tolerance vertical linearity. The horizontal linearity also is not too good. Scanning lines are bunched at the top, then spread for about 3 inches, after which the raster appears normal. To avoid a long list of tests and replacements, many parts were replaced in the sweep circuits, the PW board changed, and the chassis tested in another cabinet to check the yoke and picture tube. This is not a breakdown, as it was delivered this

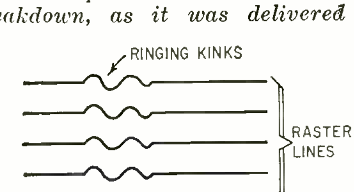


Fig. 3—A ringing yoke circuit shows up as kinks in the scanning lines.

way. Hope you can help.—R. D. P., Marrero, La.

I have seen this type of difficulty in another make of color set, as delivered from the plant. This might be a lead which would apply. The trouble was caused by filtering and decoupling capacitances which were on the low side. As a result, peak current drains were affecting the operation of the vertical section noticeably. With capacitances on the high side in the power-supply circuits, better regulation is obtained, as shown by scope tests.

Too much width

Could you give me a lead on how to reduce the width on a Philco 22C4014, code 131?—F. L. T., Fortville, Ind.

The simplest method is to slide a sleeve of aluminum foil under the yoke. This has very little effect on height, but reduces the width of the picture.

No color sync

We have in our shop a CBS Columbia color receiver, model 205C1, which gives good black-and-white reception. On color reception, however, the colors are in red, green and blue horizontal bars across the screen. Can you give any clues as to where the trouble could be?—H. S., Leesburg, Ind.

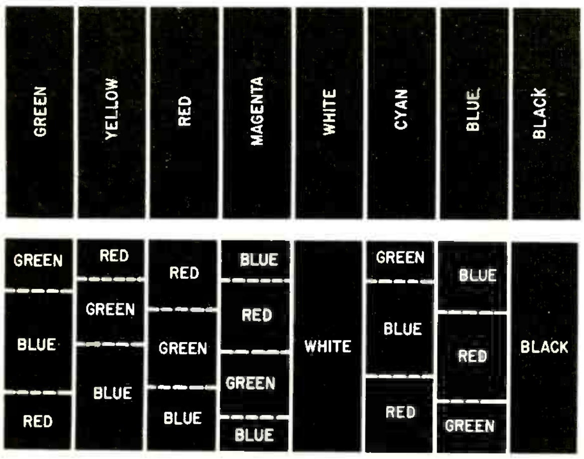


Fig. 4—Loss of color sync causes color picture to split up into horizontal strips of red, green and blue. Color bar generator pattern makes fault obvious.

This is loss of color sync. It would be advisable to try new tubes in the color sync section first. Then try adjusting the color afc balance control for zero volts to ground, with burst present. (See Figs. 4 and 5). If this does not snap the color into sync, the possibility of color sync circuit trouble must be investigated.

Bright, blurred vertical bar

A G-E 21C115 is giving us some difficulty. The raster has a wide vertical bar which is both bright and blurred. The picture can be seen at the left- and right-hand sides, but appears at low brightness. The vertical hold control has been replaced. A suspected electrolytic checked out OK on an ohmmeter test. We would appreciate any assistance.—F. L. A., Los Angeles, Calif.

You are probably on the right track in checking out the electrolytics. I have seen similar cases in which loss of capacitance in decoupling electrolytics caused just this trouble. This is a good job for a scope. The vertical bar is most likely caused by spurious ac voltages entering at one of the picture-tube electrodes. The scope will show whether the dc supplies to the picture-tube electrodes are clean or not. Then, it is a simple matter to follow back through the faulty supply circuit, to find a faulty decoupling capacitor. There is a lesser possibility that the sawtooth current waveform through the horizontal yoke windings is distorted, but your report does not seem to indicate scanning distortion.

Horizontal nonlinearity

We have an Olympic 21KB24 in the shop with considerable nonlinearity. The sweep is compressed on the left and expanded on the right. Since there is no linearity coil in the circuit, we would like to get data on adding one to overcome this difficulty.—J. B., New York, N. Y.

Since the original circuit does not provide for a linearity coil, it is quite possible to get satisfactory linearity if the circuit components are within tolerance. Instead of changing the original design, it would be advisable to locate the faulty component. First check the sweep-circuit capacitors for correct values. If this does not turn up the fault, check the horizontal oscillator plate voltage. This should be close to 240 volts. Low plate voltage will cause a nonlinear sweep.

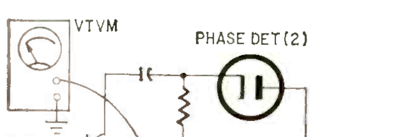


Fig. 5—To adjust color afc balance control, tune in a color signal. Connect a vtvm where indicated. Adjust control for zero volts.

Faulty test instruments?

We recently added a popular sweep and marker generator and a scope to our shop equipment. Failing to get true displays of curves, we returned the generator to the factory for a checkup, but we are having difficulty and are taking alignment jobs to another shop. Do you consider the popular type of alignment equipment adequate? —W. S., Saco, Me.

Our experience has been that inadequate sweep and marker generators disappeared from the market a number of years ago. The equipment you mention should perform satisfactorily. Difficulties in making sweep-alignment tests are to be expected, until the operator has gained considerable experience. Control settings are more numerous than in simpler instruments, and one incorrect setting can throw the pattern completely off. After the operator learns the ropes, such incorrect operation is immediately recognized. Since you have access to a shop which is doing sweep-alignment work, it might be possible to check your instruments against theirs on a chassis, and observe the control settings used by their operator.

Power-line interference

I would like to eliminate interference that seems to be coming from the power lines. Three or four of my customers in different parts of town are having the same trouble. It seems to be a 120-cycle interference, producing two dark bars about 2 inches wide horizontally across the screen. There is a loud buzz. Sometimes the picture rolls and tears. The local channel is unaffected.—J. K., Toledo, Ohio

This report is indicative of diathermy interference. It is quite possibly being radiated from power lines about town. The interference is not noticeable on your local channel because the high signal strength gives a high agc voltage and suppresses the effect of the interference voltage. The only possibility of eliminating the interference at the receiver is to use a directional antenna. A better plan is to run down the source of the interference and eliminate it. If you can establish that the interference is being radiated from power lines, I am sure that your local utility company will offer you all possible assistance in locating the source and eliminating the cause.

Split picture

An Admiral 20A1 has an intermittent split picture. The horizontal lock control does not correct the split picture, but will cause a high-pitched *squeal with a bright vertical line at right screen. The trouble occurs on commercials or from outside interference. If the receiver is turned off, it will start up again OK.—J. O., Copiague, N. Y.*

This is a squegging condition which is almost certainly caused by poor decoupling between circuits which include the horizontal output system. This is a sneaky type of trouble, because usual dc voltage checks do not turn it up. It can be easily found with a scope, which will show abnormally high ac voltages on dc supply buses. Check bypass and decoupling capacitors.

16–21-inch conversion

I would like some advice on converting a Hyde Park 16CD from a 16DP4 picture tube to a 21EP4.—B. P., New York, N. Y.

Some of these receivers used a 60° yoke on the 16DP4 glass tube. If this receiver has a 60° yoke, the 21EP4 can be used with minor electrical changes. Width may be insufficient. If so, it can be increased by any of the usual methods, such as shunting a 20–30-μμf 6,000-volt capacitor from the 6BG6-G plate to chassis. If the receiver does not have a 60° yoke, it will need to be supplied.

Horizontal jitter

I am writing for your opinion on horizontal jitter in a Regal 101. The jitter does not affect the entire picture at one time, but occurs at all points at irregular intervals. Only sections of the picture jitter, and the raster is unaffected. All tubes and the horizontal oscillator coil have been replaced. Capacitors and resistors in the Synchrolock section check out OK. I will appreciate any help you may offer.—J. C. K., Manchester, N. H.

There is not a great deal to go on here, but this report could describe the effect of a small arc somewhere in the flyback or high-voltage circuits. This should be investigated. Frequent intermittent breakdown in an electrolytic capacitor could also be responsible. The report does not indicate that this possibility has been eliminated.

Convert to intercarrier sound

I have the problem of converting a DuMont RA112 to intercarrier sound. Can you help me?—J. S., Bronx, N. Y.

Disconnect the existing sound-takeoff lead. Remove the second sound trap, located at the picture detector input. Take intercarrier (4.5-mc) sound from the plate of the second video amplifier. This can be done by using a 1-μμf capacitor at this point. The sound if system must be converted to 4.5 mc. I would suggest using a circuit similar to the Trav-Ler 517-82. The sound if is driven from the 1-μμf coupling capacitor. END

COVER FEATURE

RADIO IN YOUR BOAT

Now is the time to install new marine radiotelephones or reinstall the old ones on cabin type boats. On open outboards, the new type "outboard radiotelephone," which is designed for easy installation and removal, should be given its "start of the season" tune-up, since every radiotelephone should be tuned to match a specific boat's antenna and ground system. The Kaar TR249 shown on the cover fits onto a permanently installed mounting plate from which it can be quickly slipped off and made more accessible for tune-up before being placed into service for the 1959 boating season. Tune-up includes frequency check, trimming and tube testing. Be sure also to read the interesting article about echo sounders in this issue. The color transparency was taken by Jacques Saphier of Paramus, N. J. at Freeport on Long Island and shows Maurice Holland, veteran marine radio service specialist doing the tune-up with Lee Sands watching.

COLOR-PROJECTION SYSTEMS

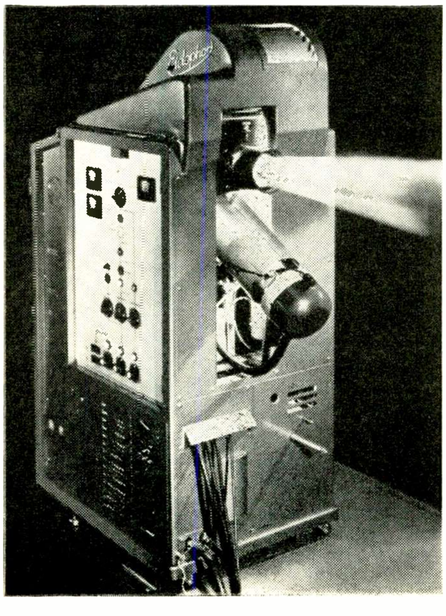
TWO color TV projectors, both developed in Europe, have been demonstrated in the US by two pharmaceutical firms, which will use them for closed-circuit medical demonstrations and seminars. Both color systems set new records for brightness and screen size.

The Swiss-developed Eidophor system, long in preparation (RADIO-ELECTRONICS, October, 1946; October, 1952) was unveiled by Ciba Pharmaceutical Products Inc. Unlike conventional TV projection systems, it does not depend on a cathode-ray tube as the light source and therefore has vastly increased brightness: it can project a bright color picture on a 12 x 16-foot theatre screen.

Eidophor (a Greek word meaning "image bearer") works in this way: An electron beam bombards, and modifies, the surface of a film of oil on a concave mirror. Light from a xenon arc lamp passing through the resulting "wrinkles" in the oil film is projected through a special grating onto the screen. The field-sequential color system is used. The Eidophor projector (left) is 5½ feet high, weighs 800 pounds.

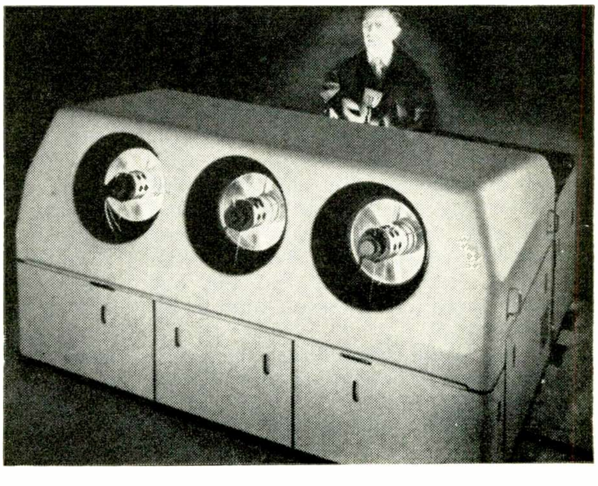
The other new color TV unit is the 1,500-pound Norelco projector built by Philips of Eindhoven, Netherlands, and introduced in this country by Smith, Kline & French Laboratories, Philadelphia.

It uses the more conventional Schmidt optical system, with three separate projector "barrels"—one for each color. It projects a color TV picture of good brightness on a 9 x 12-foot screen. The standard NTSC (broadcast) color system is used. END

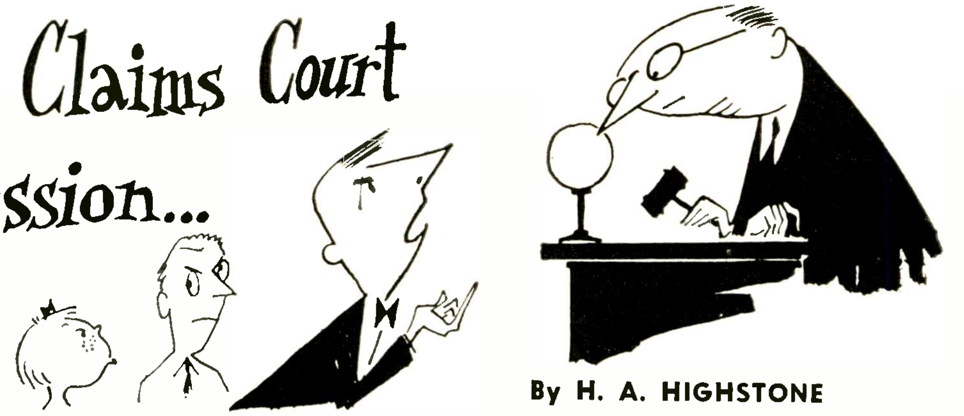


Eidophor system does not use a cathode-ray tube as the light source. ←

Smith, Kline & French use three projector 'barrels' for their color projection system. →



Small Claims Court in Session...



Case 441: Flyback TV Service vs. Slowblow, Praying Judgment in the Sum of $6

By H. A. HIGHSTONE

Q—Please tell the court in your own words, Mr. Slowblow, your reasons for refusing to pay the plaintiff $6 allegedly due for one home-service call.

A.—Well, this man was out to my house about two weeks before and was supposed to have fixed my TV, but he didn't. In fact it played worse than it did before, and I told him so. Right away I said this call should be free.

Q.—How did he respond?

A.—Well, he fumbled around in a book and finally came up claiming his records showed it had been five months since he had been there, and why hadn't I phoned him before if I was dissatisfied?

Q.—Why hadn't you?

A.—I meant to, but just never got around to it.

Q.—Go on.

A.—That seemed to make him mad. Right away he began picking on my kids, asking would I please stop them from jumping on his tube caddy, he called it. Next he snatched some tools away from Junior, who was only looking at them. It he hadn't been so rough, he wouldn't have startled little Clevis and made him break the guy's mirror, like he did.

Q.—You said the plaintiff grew progressively belligerent?

A.—Yes. When I told him I knew there was nothing wrong with my TV except a small tube, he stopped doing anything for about a minute; just sat there glaring into the back of the cabinet, muttering. Sounded like he was kind of swearing under his breath. He didn't even answer when I explained how I'd adjusted all the knobs and controls on the back so he wouldn't have to waste any time fooling with them.

Q.—It was at this juncture that the plaintiff took exception to your dog?

A.—Well, he seemed to be dead scared of Queenie, although I told him she never bites. She just growls and snarls and lunges like that whenever strangers are around. She acts like she was ready to eat you up, but actually there ain't a mean hair in all her 95 pounds.

Q.—You have charged that the plaintiff appeared to be making alibis. How was that?

A.—He was trying to alibi, all right. You see, the trouble with my TV was a short in the condenser or else a short in a small tube. Also it wasn't throwing a very good picture; kind of smeary, which was the main trouble. This short would make the screen go squiggly about every three or four hours, and sometimes it would go four or five days without shorting. That was when this man tried to tell me that intermittents, he said they were, generally had to be taken into the shop for repairs. Right then I said nobody was going to take my TV to no shop. You know how it is; let one of these racketeers get hold of your set and he loads it up with defective parts that break down again right away and bingo, he's got you on the hook again.

Q.—By this time you say the plaintiff became so surly that your children began crying. Tell the Court what happened.

A.—Not all the kids; just little Aspic. All she wanted was to have him wait and leave the set on channel 4 until the Bugs Bunny cartoon was over, but this man kept switching around from channel to channel. Finally he batted little Aspic's hand away from the selector knob so hard she started crying. She's a very sensitive child, you know; her teacher says she's definitely "unusual."

All this got Queenie worked up of course. I kept telling this man she didn't mean a thing by snarling and showing her teeth but he grabbed a big soldering iron out of his kit and acted like he was all set to knock her brains out. The only way I got him to drop the iron was by dragging Queenie out and locking her in the kitchen.

Q.—Everything went from bad to worse quite rapidly thereafter?

A.—It sure did. I have a very good book, "How To Fix Your Own TV," which tells everything. It starts in with aerials, all about the difference between Comicals and Yogis and Elephant Ears, and ends up explaining exactly how to adjust your own iron trap. Very thorough. I could see this man was getting nowhere fixing my TV—I don't think he knows his business—so I tried to help him by showing him page 17, where it says when a set goes squiggly, the thing to do is stick a screwdriver in the horizontal something-or-other.

These TV guys are all alike. The minute they find out you know something about your set, they get mean. Like that other TV gyp downtown where I took my tubes to be tested. Sold me four new ones and the set didn't work a bit better, actually worked worse. Then got very mean and said absolutely no dice when I tried to insist on getting my money back.

Q.—Please confine your remarks to the current case, Mr. Slowblow. Will you proceed?

A.—The way it wound up was by this Flyback TV guy insisting he had to take the set into his shop if he was going to correct this intermittent, and also to find out why the picture was so smeary. When I said uh-uh, nobody was taking my TV into no shop just because the condenser was shorted, he had the nerve to try to collect $6 for a service call. Now he sues me for it!

Q.—You said earlier you subsequently called a second TV repairman who succeeded in correcting the trouble in your home?

A.—Yes. And that goes to show how little this Flyback guy knows about his business. This second man was mean too; didn't like Queenie and got huffy when Aspic broke the lid on his tube tester, but he fixed my set all right, after I all of a sudden remembered and told him how I had tried swapping tubes around in different sockets, hoping that could cure the trouble. It was something about a 6CB6 and a 6AU6 changed around which made the picture smeary and here this Flyback guy . . . Hey, what's he doing, jumping over that rail at me? Ow! Help! Murder! Get him offa me! Police! Judge! . . . END

It's seldom the record that causes the skipping—groove jumping is nearly always the fault of the player. Here's a simple, process-of-elimination treatment for record playing's worst nuisance

the record SKIPS

By CHARLES W. FARRINGTON

SELDOM considered as a subject for service, the skipping and sticking of records is already a hot problem from the industry down to the customer, and it's getting hotter.

Those responsible for and those affected by the problem bat the ball of blame back and forth without producing any remedy. Included are record buyers and dealers, player dealers, distributors and manufacturers.

The ability of the service technician, combined with his unbiased understanding of the situation, can provide the only tangible relief presently available to the frustrated victim of it all—the customer. The remedy can be effectively applied only with clear comprehension of the facts which pose the problem.

Ignored and unrecognized, a common law of standards actually exists for records and playback equipment: *Virtually all 33- and 45-rpm records can be traced without trouble by the majority of players.*

The fact that one allergic record player is unable to trace a particular pressing can never condemn that pressing as "defective" so long as a majority of representative players can trace it. One exception is the vastly superior record, of wide dynamic range, courageously marketed by a few manufacturers; these can be traced only by components of high compliance.

The standard level of record manufacture is necessarily held to a compatibility with the class of parts used in $19.95 super hi fi. To be marketable, any record run must meet these unnatural but exacting playback requirements. As a result, records have a strict uniformity, limiting to be sure, but nevertheless adhering to high tolerances which are sadly missing in playback apparatus. Therefore, players which are unable to trace all ordinary records are subjects for service.

An awareness of such facts permits a straightforward approach to the cure of skipping. One other help is an understanding of the human attitudes involved.

For instance, the record dealer usually placates the customer with an affable exchange. This avoids argument and explanation, but omits the genuine help of locating the real cause of trouble. Player dealers receive fewer complaints, and usually parry those they do with condemnation of records. A little investigation and enlightened servicing could be profitable!

Until some miracle happens to pull into sync the makers of players and the makers of records, here is easy first aid. Service technicians and set owners with superior do-it-yourself ability can be sure of results by following a simple formula.

Although many factors contribute to improper groove tracing, checking all of them is seldom required except to insure optimum preservation and performance of records; skipping usually is cured early in the process.

Testing the equipment

The control in these tests is the current production standard already described—*Any record which can be played by a majority of equipment is normal.*

Test the record first, on equipment in which:

1. The needle is perfect; either new or checked by microscope.

2. Cartridge compliance is considerably superior to that in the one that skipped.

3. The arm is friction-free, nonresonant and nonautomatic (even to trip switch).

4. Stylus pressure is well within the range recommended by the cartridge manufacturer.

Examine under magnification the dull marks left on the record at skip points if tracing is still imperfect (except for the slight clicks to be expected at points where the previous stylus skipped). If jagged or lateral, usually caused by mishandling, accidental needle drop or jarring the turntable, an identical record can be tried on the original player. If there's no skip, check and remedy either handling and care of records or susceptibility of the turntable to any kind of jarring.

Examine the needle with a microscope of at least 100 × power (Fig. 1). Any worn needle should be quickly replaced, but the idea that worn needles are a primary cause of skipping is subject to question. Some cases of skipping which are stopped by replacing the needle may have had other contributing factors. To check on this probability, the tests can be continued with the worn needle. If some other remedy proves effective, its benefit plus needle renewal will provide a double gain toward record preservation.

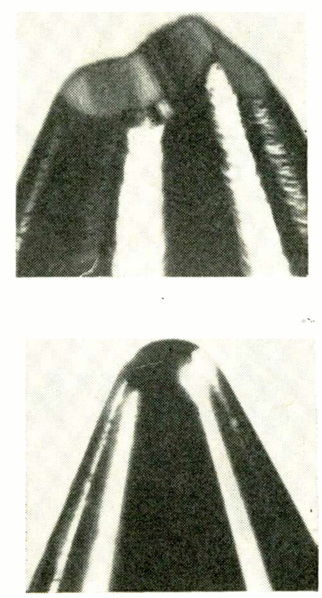


Fig. 1—Microphotograph of a worn needle tip (top) compared with a good one. Worn needles should be replaced immediately.

Reject compromise needles. Quick surgery is the remedy for a hot appendix, and for any compromise needle—cut it out! Replace with a microgroove point. If 78's are used, change the cartridge or give the customer two needles.

After each of the remaining tests, try the record again. If it can be traced without skips, further procedure is optional.

Level the turntable with a circular spirit level.

Measure stylus pressure, accurately,

(*Continued on page 74*)

TRANSISTOR PORTABLE RADIO KIT

Fun for the whole family, this easy-to-build 6-transistor portable radio is ready to go wherever you go. The modern molded plastic case with pull-out carrying handle and fully enclosed back add beauty and convenience to this splendid kit. Six name-brand (Texas Instrument) transistors are used for good sensitivity and selectivity. The 4″ x 6″ PM speaker with heavy magnet provides "big set" tone quality. Use of this large speaker and roomy chassis make it unnecessary to crowd components adding greatly to the ease of construction. Transformers are prealigned making the radio ready for use as soon as kit is assembled. A built-in rod-type antenna assures good reception in all locations. Six standard flashlight batteries are used for power, providing extremely long battery life (between 500 and 1,000 hours) and they can be purchased anywhere. Stylish cabinet is two-tone blue molded plastic with gold inlay and measures 9″ L. x 7″ H. x 3¾″ D. Shpg. Wt. 6 lbs.

MODEL XR-1L: Identical to XR-1P except in handsome leather case instead of plastic case. Leather carrying strap included. Shpg. Wt. 7 lbs.

LEATHER CASE: Can be purchased separately if desired. Fits all XR-1P and earlier XR-1 chassis. No. 93-1. Shpg. Wt. 3 lbs. **$6.95.**

HEATHKIT MODEL XR-1P **$29.95**

MODEL XR-1L **$34.95**

NAVIGATE BY PORTABLE RADIO

HEATHKIT MODEL DF-2 **$69.95**

2-BAND TRANSISTOR PORTABLE RADIO DIRECTION FINDER KIT

Enjoy the safety, convenience and entertainment of this self-contained, self-powered, six-transistor superheterodyne radio direction finder. It receives aeronautical and marine beacons as well as standard band broadcasts with startlingly clear tone reproduction over a long range. Covering the beacon band from 200 to 400 kc and broadcast band from 540 to 1620 kc, the DF-2 is designed to take directional "fixes" on both aircraft and marine beacons as well as standard broadcast stations, while providing the entertainment of a high quality transistor portable radio. You are able to receive aircraft weather reports every thirty minutes and constant Coast Guard beacons on the 200 to 400 kc band. A dial light is provided for night operation. Power is supplied by six standard flashlight batteries which will last you up to one year under normal operation. Shpg. Wt. 9 lbs.

POWER CONVERTER KIT

MODEL PC-1 **$24.95**

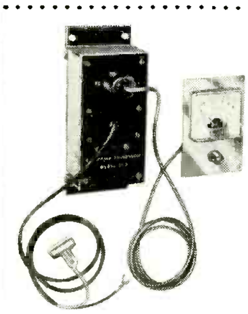
Now you can operate your TV set, radio, razor, and other AC electrical equipment directly from your 12-volt boat or car battery. With the Heathkit Power Converter you can enjoy the convenience of home electricity whether boat cruising or on automobile trips. Two power transistors are employed for years of trouble-free, dependable service. No moving parts to wear out, no tubes to replace. Shpg. Wt. 8 lbs.

ELECTRONIC IGNITION ANALYZER KIT

MODEL IA-1 **$59.95**

Ideal for use on automobiles, boats, aircraft engines, etc., the IA-1 checks ignition systems with the engine in operation (400 to 5,000 RPM). Shows the condition of coil, condenser, points, plugs and ignition wiring. Shows complete engine cycle or just one cylinder at a time. Two test leads are supplied, each 10′ long, which will enable you to reach either the breaker points or the spark plug wires. Shpg. Wt. 20 lbs.

ELECTRONIC TACHOMETER KIT



MODEL TI-1 **$25.95**

Useful on inboard and outboard boats, as well as in automobiles, the TI-1 operates directly from the spark impulse of the engine. Use on any spark ignited 2 or 4 cycle engine of any number of cylinders. Completely transistorized, it works with 6, 8, 12, 24 or 32 volt DC systems. Indicates revolutions-per-minute from 0 to 6,000. Calibration control provided for adjusting to engine type. Easy-to-build and easy-to-install. Shpg. Wt. 4 lbs.

PROFESSIONAL OSCILLOSCOPE KIT

Everything you could possibly want in an oscilloscope is found in the new Heathkit model OP-1. Featured are DC coupled amplifiers and also DC coupled CR tube un-blanking. The triggered sweep circuit will operate on either internal or external signals and may be either AC or DC coupled. The polarity of the triggering signal may also be selected, and any point on the waveform may be selected for the start of the sweep by using the "triggering level" control. An automatic position is also provided, in which the sweep recurs at 50 cycle rate, but can be driven over a wide range of frequencies with no additional adjustment. Prewired terminal boards are used for rapid, easy assembly of all critical circuits. Power supply is transformer operated utilizing silicon diode rectifiers and is fused for protection. Handsome cabinet features silver anodized front panel with red and black lettering and matching knobs. Shpg. Wt. 34 lbs.

HEATHKIT MODEL OP-1 **$179.95**

VARIABLE VOLTAGE REGULATED POWER SUPPLY KIT

Invaluable in experimental and design work, the PS-4 eliminates the need for building up a separate power supply for each new circuit tried. It provides a convenient source of variable regulated B+, variable bias voltage and filament voltage for labs and work shops. The PS-4 supplies regulated B+ output continuously variable from 0 to 400 volts DC at up to 100 ma, bias voltage variable from 0 to —100 volts DC at 1 ma, and filament voltage of 6.3 volts AC at 4 amps. Separate panel meters continuously monitors voltage and current output. Rugged, top-rated components used throughout for long, reliable service. Shpg. Wt. 16 lbs.

HEATHKIT MODEL PS-4 **$54.95**

Your best dollar value... **HEATHKIT**

HEATH COMPANY • Benton Harbor 20, Michigan

a subsidiary of Daystrom, Inc.

TEST OSCILLATOR KIT

HEATHKIT MODEL TO-1 **$16.95**

Provides the test frequencies most often used by servicemen in repairing and aligning modern broadcast receivers. Five fixed-tuned frequencies (262 kc, 455 kc, 465 kc, 600 kc and 1400 kc) are quickly selected for troubleshooting or alignment of the IF frequency and high and low end of the broadcast band for proper tracking. Shpg. Wt. 4 lbs.

HEATHKIT MODEL O-12 **$65.95**

"EXTRA DUTY" 5" OSCILLOSCOPE KIT

Laboratory quality at utility scope price makes this instrument an unusual value. The Heath patented sweep circuit functions from 10 CPS to better than 500 kc in five steps, giving you five times the usual sweep obtained in other scopes. Vertical frequency response extends from 3 CPS to 5 mc +1.5 db —5 db without extra switching. An automatic sync circuit with self-limiting cathode follower provides excellent linearity and lock-in characteristics. Extremely short retrace time and efficient blanking action are characteristic of this scope. Frequency response of the horizontal amplifier is within ±1 db from 1 CPS to 200 kc. Horizontal sensitivity is 0.3 volts RMS-per-inch. Construction is simplified through the use of two etched metal circuit boards and precut, cabled wiring harness. Complete step-by-step instructions and large pictorial diagrams are supplied for easy assembly. An ideal scope for all service applications as well as in standard or color TV servicing. Shpg. Wt. 22 lbs.

MODEL SG-8 **$19.50**

RF SIGNAL GENERATOR KIT

A "must" for any beginning serviceman, this indispensable instrument is used for aligning tuned circuits quickly and tracing signals in faulty RF, IF and audio circuits. Covers 160 kc to 110 mc on fundamentals in five bands and from 110 mc to 220 mc on calibrated harmonics. Coils are prewound and calibrated. Complete with output cable and instructions. Shpg. Wt. 8 lbs.

MODEL AG-9A **$34.50**

AUDIO SIGNAL GENERATOR KIT

This unique generator uses three rotary switches to select two significant figures and a multiplier to determine audio frequency, allowing return to the exact frequency previously measured when making multiple frequency measurements. Covers 10 CPS to 120 kc with less than .1 of 1% distortion between 20 and 20,000 CPS. Shpg. Wt. 10 lbs.

MODEL TS-4A **$49.50**

TV ALIGNMENT GENERATOR KIT

TV service technicians will appreciate the outstanding features found in this sweep generator. Provides essential facilities for aligning FM, monochrome TV or color TV sets. The all-electronic sweep circuit employs a trouble-free controllable inductor which varies frequency by magnetic means. An unusual buy at this low price. Shpg. Wt. 16 lbs.

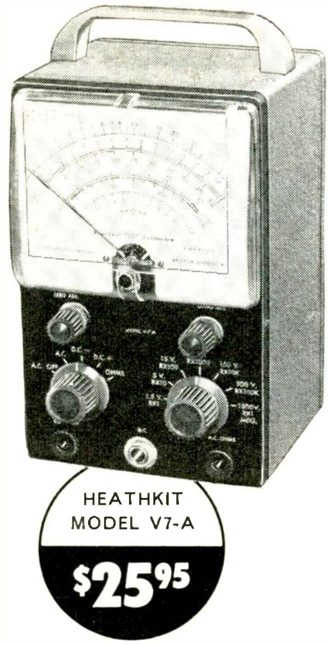
MODEL CD-1 **$59.95**

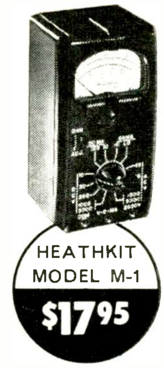
COLOR BAR AND DOT GENERATOR

The CD-1 combines the two basic color servicing instruments, a color bar and white dot generator in one versatile and portable unit, which has crystal controlled accuracy and stability for steady lock-in patterns. (Requires no external sync leads.) Easy-to-build and easy-to-use. No other generator on the market offers so many features at such a great price saving. Shpg. Wt. 13 lbs.

ETCHED CIRCUIT VTVM KIT

Time proven for dependability, accuracy and overall quality, the V7-A is one of the wisest investments you can make for your electronic workshop or lab. Its multitude of uses will make it one of the most often used instruments in your possession. Use it to measure all operating voltages and potentials such as B+ and AC-DC, or straight AC power supplies, filament voltage, bias voltage, AVC voltage, line voltage, etc. Ideal for measurements in all types of AM, FM and TV circuits. Checks discriminator or detector operation, AVC or AGC performance, while the ohmmeter may be used to measure circuit continuity, circuit resistance, to test out individual components with resistance measurement, or to trace circuit wiring through cables or chassis openings. Front panel controls consist of rotary function switch and a rotary range selector switch, zero-adjust and ohms-adjust controls. Precision 1% resistors are used in the voltage divider circuit for high accuracy and an etched circuit board is employed for most of the circuitry. The circuit board not only simplifies assembly but permits levels of circuit stability not possible with ordinary conventional wiring methods. Shpg. Wt. 7 lbs.





HANDITESTER KIT

Ideal for use in portable applications when making tests away from the work bench or as an "extra" meter in the service shop. The combination function range switch simplifies operation. Measures AC or DC voltage from 0 to 10, 30, 300, 1,000 and 5,000 volts. Direct current ranges are 0 to 10 ma and 0 to 100 ma. Ohmmeter ranges are 0 to 3,000 and 0 to 300,000. Top quality, precision components used throughout. Small and compact, take it with you wherever you go. Very popular with home experimenters and electricians. Test leads and 1½ volt size C battery are included with the kit. Shpg. Wt. 3 lbs.

20,000 OHMS/VOLT VOM KIT

Portable and accurate, this kit features a 50 ua 4½" meter and 1% precision multiplier resistors for high accuracy. No external power required. Provides a total of 25 meter ranges on a two-color scale. Sensitivity is 20,000 ohms-per-volt DC and 5,000 ohms-per-volt AC. Measuring ranges are 0-1.5, 5, 50, 150, 500, 1,500 and 5,000 volts AC and DC. Measures direct current in ranges of 0-150 ua, 15 ma, 150 ma, 500 ma and 15 a. Resistance multipliers are X 1, X 100 and X 10,000. Covers —10 db to +65 db. Housed in an attractive bakelite case with plastic carrying handle. Batteries and test leads included. Shpg. Wt. 6 lbs.

TUBE CHECKER KIT

Brand new in every respect, the TC-3 features outstanding performance and ease of operation. Sockets are provided for 4-pin, 5-pin, 6-pin, 7-pin, large, 7-pin miniature, 7-pin sub-miniature, octal, loctal, and 9-pin miniature tubes. Protection against obsolescence is provided by a blank socket to facilitate odification for checking newly added tube types. A 10-lever switch makes it possible to connect any element to any other element regardless of the pin numbers involved. A neon bulb indicator shows filament circuit continuity and leakage or shorts between elements. A specially designed spring loaded roll chart mechanism permits the roll chart to run freely throughout its entire length without binding. Thumb wheel drive knobs are provided on both sides of the panel to accommodate the left handed operator. Compact and small in size, the TC-3 is ideally suited for portable applications. Both the roll chart and the meter are illuminated to facilitate use in darkened areas. Shpg. Wt. 12 lbs.

MODEL AV-3
$29.95

AUDIO VTVM KIT

This vacuum tube volt meter emphasizes stability, broad frequency response and sensitivity for accurate measurement of critical AC voltages. Features a large 4½" 200 ua meter with increased damping in the meter circuit for stability in low frequency tests. Measures AC from a low value of 1 millivolt to a maximum of 300 volts AC (RMS). Voltage ranges are: 0-.01, .03, .1, .3, 1, 3, 10, 30, 100 and 300 volts. Db ranges cover —52 to +52 db. 1% precision multiplier resistors used for maximum accuracy. Frequency response is essentially flat from 10 CPS to 200 kc. Shpg. Wt. 6 lbs.

MODEL BE-5 $39.95

LOW RIPPLE BATTERY ELIMINATOR KIT

Completely up to date the BE-5 will power all the newest transistor circuits requiring 0 to 12 volts DC, and the new hybrid automobile radios using both transistors and vacuum tubes. An extra low-ripple filter circuit is employed holding AC ripple down to less than .3%. Doubles as a battery charger or marine converter. Shpg. Wt. 21 lbs.

MODEL T-4
$19.95

VISUAL-AURAL SIGNAL TRACER KIT

New in every respect the T-4 features a built-in speaker and electron beam "eye" tube for signal indication, and a unique noise locator circuit. Ideal for use in AM, FM and TV circuit investigation. Transformer operated for safety and high efficiency. Complete with test leads and informative construction manual. Shpg. Wt. 5 lbs.

MODEL C-3 $19.50

CONDENSER CHECKER KIT

Check unknown condenser and resistor values quickly and accurately as well as their operating characteristics with this fine instrument. All values are read directly on a calibrated scale. An electron beam "eye" tube indicates balance and leakage. A valuable addition to any service shop or lab. Shpg. Wt. 7 lbs.

MODEL CT-1 $7.95

IN-CIRCUIT CAPACI-TESTER KIT

This handy kit checks capacitors for "open" or "short" right in the circuit. Detects open capacitors from about 50 mmf, not shunted by an excessive low resistance value. Checks shorted capacitors up to 20 mfd (not shunted by less than 10 ohms). Checks all bypass, blocking and coupling capacitors of the paper, mica or ceramic types. (Does not detect leakage nor check electrolytic condensers.) Electron beam "eye" tube is used for quick indication. A 5-position function switch is featured which controls the power to the instrument and selects the test being made. Easy to build and easy to use. Test leads included Shpg. Wt. 5 lbs.

"APACHE" HAM TRANSMITTER KIT

HEATHKIT MODEL TX-1

$234.95

- Built-in cooling fan
- Rotating Slide Rule Dial
- Compact, Stable, VFO
- Provision for SSB Adapter

$50.00 required on C.O.D. orders. Shipped motor freight unless otherwise specified.

This beautifully styled transmitter has just about everything you could ask for in transmitting facilities. The "Apache" is a high quality transmitter operating with a 150 watt phone input and 180 watt CW input. In addition to CW and phone operation, built-in switch selected circuitry provides for single-sideband transmission through the use of a plug-in external adapter. A completely redesigned, compact and stable VFO provides low drift frequency control necessary for SSB transmission. A slide rule type illuminated rotating VFO dial with full gear drive vernier tuning provides ample bandspread and precise frequency settings. The bandswitch allows quick selection of the amateur bands on 80, 40, 20, 15 and 10 meters (11 m with crystal control). This unit also has adjustable low-level speech clipping and a low distortion modulator stage employing two of the new 6CA7/EL34 tubes in push-pull class AB operation. Time sequence keying is provided for "chirpless" break-in CW operation. The final amplifier is completely shielded for greater TVI protection and transmitter stability. A formed one-piece cabinet with convenient access hatch provides accessibility to tubes and crystal socket. Die-cast aluminum knobs and front panel escutcheons add to the attractive styling of the transmitter. Pi network output coupling matches antenna impedances between 50 and 72 ohms. A "spotting" push button is provided to allow tuning of the transmitter before switching on the final amplifier. This feature also enables the operator to "zero-beat" an incoming frequency without placing the transmitter on the air. Equip your ham shack now for top transmitting enjoyment with this outstanding unit. Shpg. Wt. 110 lbs.

New Styling... New Features

HEATHKIT

HEATH COMPANY
Benton Harbor 20, Michigan

a subsidiary of Daystrom, Inc.

HEATHKIT MODEL SB-10

$89.95

SINGLE SIDEBAND ADAPTER KIT

Designed as a compatible plug-in adapter for the model TX-1 it can also be used with transmitters similar to the DX-100 or DX-100-B by making a few simple circuit modifications and still retain the normal AM and CW functions. Easy to operate and tune, the adapter employs the phasing method for generating a single sideband signal, allowing operation entirely on fundamental frequencies. The critical audio phase shift network is supplied, completely pre-assembled and wired in a sealed plug-in unit. Features include single-knob bandswitching for operation on 80, 40, 20, 15 and 10 meters, an easy-to-read panel meter, built-in electronic voice control with anti-trip circuit. Enjoy the advantages of SSB operation by adding this fine kit to your ham shack now. Shpg. Wt. 14 lbs.

MODEL DX-100-B

$189.50

$50.00 deposit required on C.O.D. orders. Shipped motor freight unless otherwise specified.

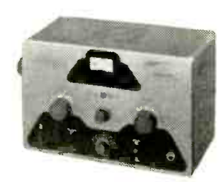
DX-100-B PHONE & CW TRANSMITTER KIT

The same fine performance of the time proven DX-100 is retained in the DX-100-B with improvements in the crystal and loading circuits. The one-piece formed cabinet has convenient access hatch for changing crystals, etc. and the chassis is punched to accept sideband adapter modifications. Features a built-in VFO, modulator and power supply, complete shielding to minimize TVI, and a pi network output coupling to match impedances from 50 to 72 ohms. RF output is in excess of 100 watts on phone and 120 watts on CW. Covers 160 through 10 meters. Single-knob bandswitching and illuminated VFO dial and meter face. RF output stage uses a pair of 6146 tubes in parallel, modulated by a pair of 1625's. Designed for easy assembly. Measures 11⅝" H. x 19½" W. x 16" D. Shpg. Wt. 107 lbs.

MODEL DX-40 **$64.95**

DX-40 PHONE & CW TRANSMITTER KIT

Operates on 80, 40, 20, 15, 11 and 10 meters, using a single 6146 tube in the final for 75 watt plate power input CW, or 60 watts phone. Single-knob bandswitching, pi network output, complete shielding, provision for three crystals and VFO. D'Arsonval movement panel meter. Shpg. Wt. 25 lbs.



MODEL DX-20 **$35.95**

DX-20 CW TRANSMITTER KIT

This fine unit covers 80, 40, 20, 15, 11 and 10 meters with single-knob bandswitching. Features a 6DQ6A tube in the final for 50 watt plate power input, pi network output, complete shielding to minimize TVI. Easy to build with complete instructions supplied. Shpg. Wt. 19 lbs.

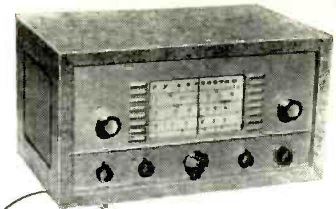
"MOHAWK" HAM RECEIVER KIT

Designed for ham band operation and for maximum stability and accuracy, the Heathkit "Mohawk" receiver will let you enjoy ham activities to the utmost. This 15-tube receiver features double conversion with IF's at 1682 kc and 50 kc and covers all the amateur frequencies from 160 through 10 meters on seven bands. An extra band is calibrated to cover 6 and 2 meters using a converter. The "Mohawk" is specially designed for single-sideband reception with crystal controlled oscillators for upper and lower sideband selection. A completely preassembled, wired and aligned front end coil/bandswitch assembly assures ease of construction and top performance. Many more important features are provided in this outstanding receiver for dependable and effective amateur communications. Ruggedly constructed with well rated components throughout. Shpg. Wt. 66 lbs. Matching accessory speaker kit; optional extra. Model AK-5. $9.95. Shpg. Wt. 8 lbs.

- **Prewired and Aligned Coil/Bandswitch Assembly**
- **Crystal Controlled Oscillators for Drift-Free Reception**

HEATHKIT MODEL RX-1

$274.95



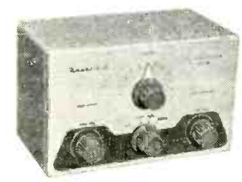
HEATHKIT MODEL AR-3

$29.95

(LESS CABINET)

ALL-BAND RECEIVER KIT

A fine receiver for the beginning ham or short wave listener. Frequency coverage is from 550 kc to 30 mc in four bands. Features include bandswitch, bandspread tuning, phone-standby-CW switch, antenna trimmer, noise limiter, RF and AF gain controls and headphone jack. Easy to build. Shpg. Wt. 12 lbs.



MODEL QF-1

$9.95

"Q" MULTIPLIER KIT

Use with any receiver with IF frequency between 450 and 460 kc to add additional selectivity for separating two signals or to reject one signal and eliminate heterodyne. A great help on crowded phone and CW bands. Not for use with AC-DC type receivers. Simple to connect with cable and plugs supplied. Shpg. Wt. 3 lbs.

"SENECA" VHF TRANSMITTER KIT

Brand new in every respect, the model VHF-1 "Seneca" is the latest addition to our line of ham transmitters. This self-contained 6 and 2 meter transmitter features built-in VFO, modulator, and dual power supply. A pair of 6146 tubes are employed in the push-pull final amplifier stage and features up to 120 watts input on phone and 140 watts input on CW in the 6 meter band. Slightly less in the 2 meter band to prolong amplifier tube life. Panel controls allow VFO or crystal control, phone or CW operation on both amateur bands. Four switch-selected crystal positions. Complete RF shielding to minimize TVI. Spotting push-button provided. The VFO slide rule type dial features edge-lighting and vernier tuning. An ideal transmitter for the ham who wants to extend operation into the VHF region. Shpg. Wt. 56 lbs.

HEATHKIT MODEL VHF-1

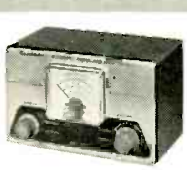
$159.95

MODEL CA-1

$13.95

"AUTOMATIC" CONELRAD ALARM KIT

This easy-to-build device gives instant warning and cuts AC power to your transmitter when a monitored station goes "off-the-air". Use with any radio receiver having an AVC circuit. A sensitivity control adjusts to various AVC levels. Incorporates a heavy duty six-ampere relay and manual "reset" button to reactivate the transmitter. Complete instructions provided for connection to receiver. Shpg. Wt. 4 lbs.



MODEL AM-2 **$15.95**

REFLECTED POWER METER KIT

Check the match of your antenna transmission system by measuring the forward and reflected power or standing wave ratio from 1:1 to 6:1. Handles a peak power of well over 1 kilowatt and may be left in antenna feed line. No external power required. 160 through 6 meters. For 50 or 75 ohm lines. Shpg. Wt. 3 lbs.

MODEL B-1 **$8.95**

BALUN COIL KIT

Unbalanced coax lines can be matched to balance lines of either 75 or 300 ohms by using this balun coil kit. Use without adjustment from 80 through 10 meters at power up to 200 watts. May be located any distance from transmitter or antenna. Protective cover included. Shpg. Wt. 4 lbs.

MODEL VX-1 **$23.95**

ELECTRONIC VOICE CONTROL KIT

This unique device lets you switch from receiver to transmitter merely by talking into your microphone. Provision is made for receiver and speaker connections and also for a 117 volt antenna relay. Adjustable to all conditions by sensitivity and variable time delay controls provided. Shpg. Wt. 5 lbs.

MODEL VF-1 **$19.50**

VARIABLE FREQUENCY OSCILLATOR KIT

Far below the cost of crystals to obtain the same frequency coverage this VFO covers 160, 80, 40, 20, 15, 11 and 10 meters with three basic oscillator frequencies. Better than 10 volts RF output on fundamentals. Requires only 250 volts DC at 15 to 20 ma, and 6.3 VAC at 0.45 a. Illuminated dial reads direct. Shpg. Wt. 7 lbs.

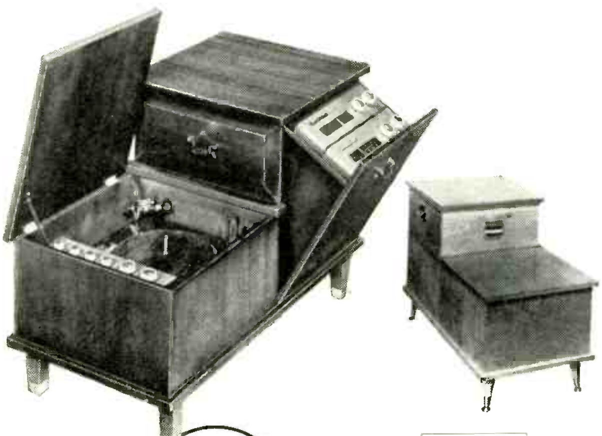
Beautifully Styled With Plenty of Room For The Most Complete Stereo System

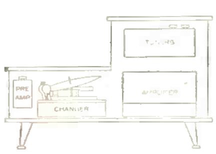
MODEL SE-1 (center unit) **$149^95** Shpg. Wt. 162 lbs.

MODEL SC-1 (speaker enclosure) **$39^95** each Shpg. Wt. 42 lbs.

STEREO EQUIPMENT CABINET KIT

This superbly styled cabinet ensemble is designed to hold your complete home stereo hi-fi system, consisting of a "stereo equipment center" flanked by two individual "stereo wing speaker enclosures". The unit has room for all the components required for stereo sound. Although designed to hold Heathkit stereo components, it is not frozen to this arrangement. The kit is supplied with mounting panels precut to accommodate Heathkits, but interchangeable blank panels are also furnished so you can mount any equipment you may already have. The precut panels accommodate the Heathkit AM-FM tuner (PT-1), stereo preamplifier (SP-1 & 2), and record changer (RP-3). Record changer chassis pulls out easily for convenient loading and unloading. Adequate space is provided for record storage and a pair of matching Heathkit power amplifiers (from 12 to 70 watts). The stereo wing speaker enclosures are open backed, cloth grilled cabinets designed to hold the Heathkit SS-2 or similar speaker systems. The cabinets are available in beautifully grained ¾" solid core Phillipine mahogany or select birch plywood suitable for the finish of your choice. The matched grain sliding tape deck access door on top pops-up flush when closed. Entire top features a shaped edge. Hardware and trim of brushed-brass and gold finish. Rich toned grille cloth is flecked in gold and black. No woodworking experience required. All parts precut and predrilled for easy assembly. Maximum overall dimensions (all 3 pieces): 82¾" W. x 36½" H. x 20" D. Center Cabinet: 47½" W. x 36½" H. x 20" D.





HEATHKIT MODEL CE-1 **$43^95** each

CHAIRSIDE ENCLOSURE KIT

Combine all of your hi-fi equipment into one compact control center and, at the same time add a beautiful piece of furniture to your home. The CE-1 is designed to house AM and FM tuners (BC-1A and FM-3A) and the WA-P2 preamplifier along with the majority of record changers which will fit in the space provided. Changer compartment measures 17¾" L. x 16" W. x 9⅝" D. Adequate space is provided in the rear of the unit to house any of the Heathkit amplifiers designed to operate with the WA-P2. Good ventilation is achieved through properly placed slots in the bottom and back of the enclosure. Overall dimensions are 18" W. x 24"H x 35½" D. All parts are precut and predrilled for easy assembly. The Contemporary cabinet is available in either mahogany or birch, and the Traditional cabinet is available in mahogany suitable for the finish of your choice. Beautiful hardware supplied. Shpg. Wt. 46 lbs.

Plan your own Hi-Fi System...

HEATHKIT®

HEATH COMPANY • Benton Harbor 20, Michigan

a subsidiary of Daystrom, Inc.

HEATHKIT MODEL RP-3 **$64^95**

HIGH FIDELITY RECORD CHANGER KIT

Every outstanding feature you could ask for in a record changer is provided in the Heathkit RP-3, the most advanced changer on the market today. The unique turntable pause during the change cycle saves wear and tear on your records by eliminating the grinding action caused by records dropping on a moving turntable or disk. Record groove and stylus wear are practically eliminated through proper weight distribution and low pivot point friction of the tone arm. Clean mechanical simplicity and precision parts give you turntable performance with the automatic convenience of a record changer. Flutter and wow, a major problem with automatic changers, is held to less than 0.18% RMS. An automatic speed selector position allows intermixing 33⅓ and 45 RPM records regardless of their sequence. Four speeds provided: 16, 33⅓, 45 and 78 RPM. Changer is supplied complete with GE VR II cartridge with diamond LP and sapphire 78 stylus, changer base, stylus pressure gauge and 45 RPM spindle. Shpg. Wt. 19 lbs.

"BASIC RANGE" HI-FI SPEAKER SYSTEM KIT

The popularity of this modestly priced speaker system attests to its high fidelity performance. The SS-2 provides an ideal basic speaker for your home hi-fi system. Flexibility of design allows it to be used as a table top model or as an attractive consolette with optional legs. May also be used as a supplementary speaker in more advanced systems or as replacement speaker for TV sets, etc. The specially designed tweeter horn rotates 90 degrees allowing you to use the speaker in an upright position if desired, as in the Heathkit stereo wing speaker enclosures. Total frequency range is from 50 to 12,000 cycles-per-second. An 8″ mid-range woofer covers from 50 to 1,600 CPS while a compression-type tweeter with flared horn covers 1,600 to 12,000 CPS. Both speakers are by Jensen. A variable balance control allows level adjustment of the high frequency speaker. Power rating is 25 watts. Constructed of ½″ veneer-surfaced plywood suitable for light or dark finish. All wood parts are precut and predrilled for simple, quick assembly. An added feature of the SS-2 is that, although an outstanding performer in its own right, it may be combined with the SS-1B "range extending" speaker system later to extend the frequency range at the high and low ends of the audio range. Build in just one evening for many years of listening enjoyment. Shpg. Wt. 26 lbs.

ATTRACTIVE BRASS TIP ACCESSORY LEGS convert SS-2 into handsome consolette. 14″ legs screw into brackets provided. All hardware included. Shpg. Wt. 3 lbs. No. 91-26. **$4.95.**

Assemble it in

Just One Evening

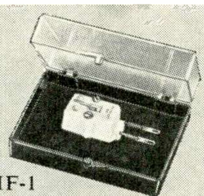
HEATHKIT MODEL SS-2

$39.95

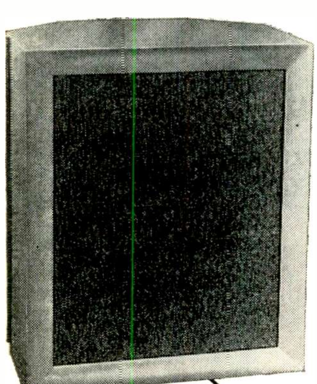
OPTIONAL LEGS NO. 91-26 **$4.95**

DIAMOND STYLUS HI-FI PICKUP CARTRIDGE

MODEL MF-1 **$26.95**



Replace your present pickup with the MF-1 and enjoy the fullest fidelity your library of LP's has to offer. Designed to Heath specifications to offer you one of the finest cartridges available today. Nominally flat response from 20 to 20,000 CPS. Shpg. Wt. 1 lb.



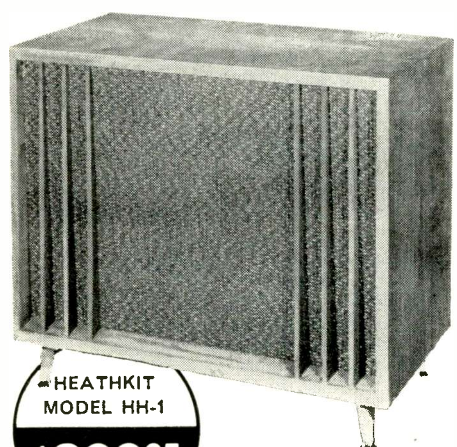
HEATHKIT MODEL SS-1B

$99.95

Extended Frequency Range for Your SS-2

"RANGE EXTENDING" HI-FI SPEAKER SYSTEM KIT

Designed exclusively for use with the SS-2, the SS-1B employs a 15″ woofer and a super tweeter horn to extend the range of the SS-2 to an overall response of ±5 db from 35 to 16,000 CPS. When used together the two units form an integrated four-speaker system and are designed to combine into a single piece of attractive furniture. Impedance of the SS-1B is 16 ohms and power rating 35 watts. A control is provided to limit the output of the super tweeter. Constructed of beautiful ¾″ veneer-surfaced plywood suitable for light or dark finish of your choice. All parts are precut and predrilled for simple assembly. No woodworking experience required. All hardware included. Shpg. Wt. 80 lbs.



HEATHKIT MODEL HH-1

$299.95

"LEGATO" HI-FI SPEAKER SYSTEM KIT

It is difficult to describe in words the performance of this magnificent speaker system. You may never find absolute perfection in reproduced sound, but the Legato comes as close to achieving it as anything yet devised. Perfect balance, precise phasing, and adequate driver design combine to produce the superb quality of reproduction inherent in this instrument. The crisp, clear high frequencies and rich full bass engulf you in a sea of life-like tone. Two 15″ Altec Lansing low frequency drivers cover frequencies from 25 to 500 CPS while a specially designed exponential horn with high frequency driver covers 500 to 20,000 CPS. The unique crossover network is built-in making electronic crossovers unnecessary. The legato emphasizes simplicity of line and form to blend with modern or traditional furnishings. Constructed of ¾″ veneer-surfaced plywood in either African mahogany or white birch suitable for light or dark finishes of your choice. All parts are precut and predrilled for easy assembly. Shpg. Wt. 195 lbs.

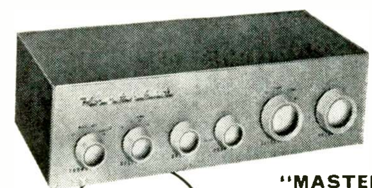
HEATHKIT
MODEL SP-2
(STEREO)
$56^{95}

MODEL SP-1 (MONAURAL)
$37^{95} Shpg. Wt. 13 lbs.

MODEL C-SP-1 (CONVERTS SP-1 TO SP-2)
$21^{95} Shpg. Wt. 5 lbs.

Monaural-Stereo Preamplifier Kit (2-Channel Mixer)

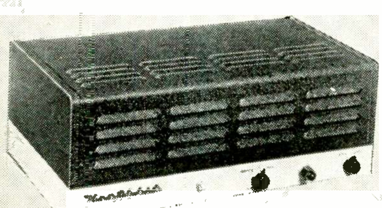
This unique kit allows you to purchase it in the monaural model if desired and then add the second or stereo channel later. The SP-2 features 12 separate inputs, six on each channel, with input level controls. Six dual concentric controls consist of: two 8-position selector switches, two bass, two treble, two volume level and two loudness controls, a scratch filter switch and a 4-position function switch. A separate on-off switch is provided. The function switch provides settings for stereo, 2-channel mix, channel A or B for monaural use. Inputs consist of tape, mike, mag phono and three high-level inputs. NARTB equalization and RIAA, LP, 78 record compensation are provided. A remote balance control is included. Printed circuit boards for easy assembly. Built-in power supply. Shpg. Wt. 15 lbs.



HEATHKIT
MODEL WA-P2
$19^{75}

"MASTER CONTROL" PREAMPLIFIER KIT

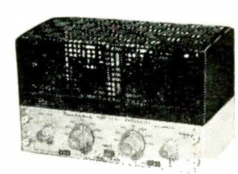
Control your hi-fi system with this compact unit. Features 5 switch-selected inputs to accommodate a record changer, tape recorder, AM tuner, FM tuner, TV receiver, microphone, etc., each with level control. Provision also for a tape recorder output. Equalization for records through separate turnover and rolloff switches for LP, RIAA, AES and early 78's. Shpg. Wt. 7 lbs.



MODEL W-7M
$54^{95}

"EXTRA PERFORMANCE" 55 WATT HI FI AMPLIFIER KIT

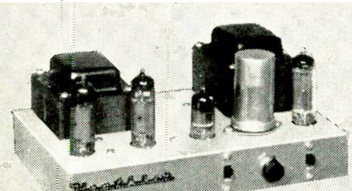
Enjoy this high fidelity power amplifier at less than a dollar per watt. Full audio output and maximum damping is conservatively rated at 55 watts from 20 CPS to 20 kc with less than 2% total harmonic distortion throughout the entire range. Features famous "bas-bal" circuit, EL-34 output tubes and special 70 volt output. Shpg. Wt. 28 lbs.



MODEL XO-1
$18^{95}

ELECTRONIC CROSSOVER KIT

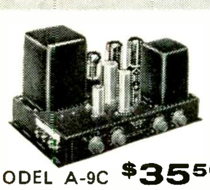
This unique instrument separates high and low frequencies and feeds them through 2 amplifiers into separate speakers. Located ahead of the main amplifier, it virtually eliminates IM distortion and matching problems. Note: Not for use with Heathkit Legato speaker system. Shpg. Wt. 6 lbs.



MODEL UA-1
$21^{95}

"UNIVERSAL" 12 WATT HI FI AMPLIFIER KIT

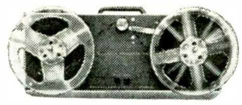
The versatility and economy of this fine kit make it a truly "universal" hi-fi amplifier. An ideal basic amplifier for any hi-fi system or a perfect addition to gear your present hi-fi system to stereo sound. Uses 6BQ5/EL84 push-pull output tubes for less than 2% harmonic distortion throughout the entire audio range. Shpg. Wt. 13 lbs.



MODEL A-9C $35^{50}

GENERAL-PURPOSE 20 WATT AMPLIFIER KIT

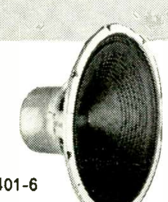
Designed for home installation as well as for PA requirements, the A9-C combines a preamplifier, main amplifier and power supply all on one chassis. Four switch-selected inputs are provided as well as separate bass and treble tone controls offering 15 db boost and cut. Detachable front plate allows for custom installation. Shpg. Wt. 23 lbs.



MODEL SW-1 $24^{95}

SPEEDWINDER KIT

A real timesaver, the SW-1 leaves your tape recorder free for operation while rewinding tape at the rate of 1200 feet in 40 seconds. Prevents unnecessary wear to the tape and recorder. Handles up to 10½" tape reels. Handles 800' reels of 8 and 16 millimeter film as well. Automatic shutoff prevents whipping at end of rewind. Shpg. Wt. 12 lbs.



NO. 401-6
$7^{50}

12" UTILITY SPEAKER KIT

Replace inferior speakers in radio or TV sets to obtain better tone quality or set up an auxiliary speaker for testing purposes with this convenient, high quality speaker. The speaker will handle up to 12 watts with a frequency response of ±5 db from 50 to 9,000 CPS. Speaker impedance is 8 ohms and has a 6.8 oz. magnet. An outstanding dollar value. Shpg. Wt. 7 lbs.

MODEL TK-1 $9^{95}

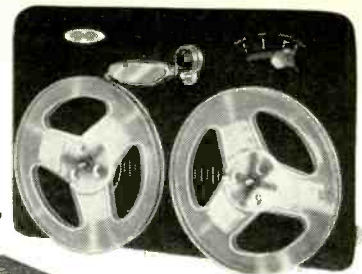
COMPLETE TOOL SET

These basic tools are all you need to build any Heathkit. The pliers, diagonal side cutters, 2 screwdrivers, and soldering iron are all of top quality case hardened steel for hard duty and long life. Pliers and side cutters are equipped with insulated rubber handles for safety. A good example of just how easy Heathkit building really is. Shpg. Wt. 3 lbs.

HIGH FIDELITY TAPE RECORDER KIT

The model TR-1A tape deck and preamplifier combination provides all the facilities you need for top quality monaural recording/playback with fast forward and rewind functions. 7½ and 3¾ IPS tape speeds are selected by changing belt drive. Flutter and wow are held to less than 0.35%. Frequency response at 7½ IPS ±2.0 db 50-10,000 CPS, at 3¾ IPS ±2.0 db 50-6,500 CPS. Both units may be mounted together or separately affording high flexibility in every application. Features include NARTB playback equalization—separate recording and playback gain controls—cathode follower output and provision for mike or line input. Signal-to-noise ratio is better than 45 db below normal recording level with less than 1% total harmonic distortion. A filament balance control allows adjustment for minimum hum level. Complete instructions provided for easy assembly. Overall dimensions of tape deck and preamp is 15½" W. x 13½" H. x 8" D. Shpg. Wt. 24 lbs.

HEATHKIT TR-1A
$99.95



Includes tape deck assembly, preamplifier and roll of tape.

HEATHKIT TE-1
$39.95

Tape preamplifier sold separately if desired. Shpg. Wt. 10 lbs.

Many more Heathkits to choose from

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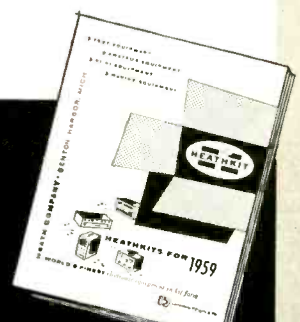


Save with Heathkits ... the quality name in kit form electronics.

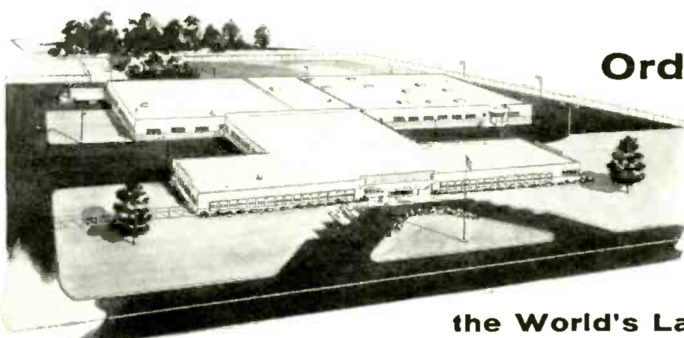
"BOOKSHELF" 12 WATT AMPLIFIER KIT

Here are a few of the reasons why this attractive amplifier is such a tremendous dollar value. You get rich, full range, high fidelity sound reproduction with low distortion and noise . . . plus "modern styling". The many features include full range frequency response 20 to 20,000 CPS ±1 db with less than 2% distortion over this range at full 12 watt output—its own built-in preamplifier with provision for three separate inputs: mag phono, crystal phono, and tuner—RIAA equalization—separate bass and treble tone controls—special hum control—and it's easy-to-build. Complete instructions and pictorial diagrams show where ever part goes. Cabinet shell has smooth leather texture in black with inlaid gold design. Cabinet measures 12½" W. x 8$\frac{9}{16}$" D. x 4⅜" H. Output transformer has taps at 4, 8 and 16 ohms to match the speaker of your choice. An ideal unit to convert your present hi-fi system to stereo sound. Shpg. Wt. 15 lbs.

An Amplifier, Preamplifier all in one!

HEATHKIT EA-2

$28.95



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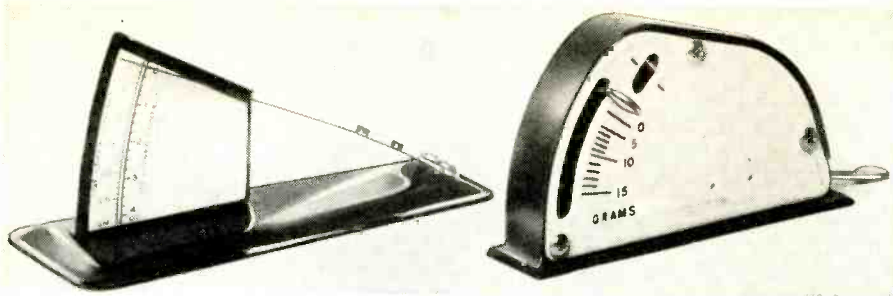


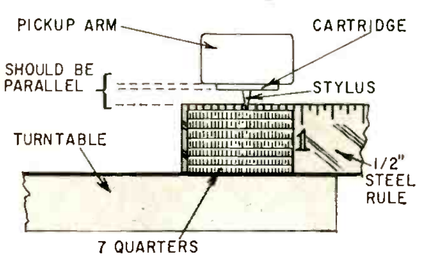
Fig. 2—Two types of stylus pressure gauges. Direct-measurement type (left): pickup arm is rested near fulcrum of spring-steel strip and pressure read directly on scale. Balance type (right): arm is rested on protruding platform, indicator is pushed downward with finger until pointer is centered in oval window.

(*Continued from page* 61)

with a reliable gauge (Fig. 2). Adjust it to within the limits specified by the cartridge manufacturer, neither more nor less. Make sure that no lead wires project below the arm to touch the record.

Check vertical alignment of stylus. Tilted pickup arms, improperly seated cartridges and bent stylus wires are common troublemakers that all too often go unobserved and uncorrected. If the turntable pad can be removed, do so. Make a stack of seven 25-cent pieces on the turntable, raise the arm and push the stack under the front of arm so that the needle may be placed on the back edge of the top quarter (Fig. 3-a). Set the long edge of a machinist's scale (½ x 6 inches) on the turntable, facing front, and check the cartridge and arm for tilt. Correct any deviation from parallel to the top edge of the scale.

Next, determine whether the vertical axis of the needle is at 90° to the turntable (Fig. 3-b). Use a strong front light or a forehead reflector, and magnification (a thread-count glass is best; its folding frame acts as a stand). With the scale held as before, use its end as a square to check alignment of the



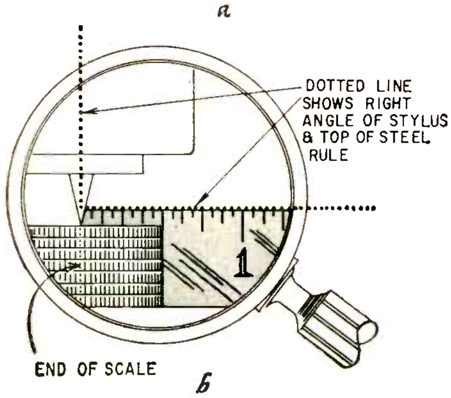


Fig. 3—Checking vertical alignment and tilt of stylus.

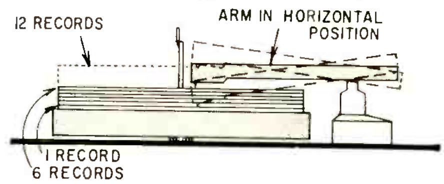


Fig. 4—Proper position for a cartridge is parallel to the record surface, as in professional type arms. Automatic changer arms can be parallel at only one point of the automatic load (in this case six records). Refer to manufacturer's recommended setting for each model.

needle. Correct any deviation, preferably with a new stylus. If bending is attempted, use needle-nose pliers, not tweezers, and grip only the stylus wire, not the needle point.

Check level of arm. Replace the turntable pad and put on a record. Professional type arms usually parallel the record surface. Automatic arms are customarily parallel when half the automatic load is on the table (Fig. 4), but, because of considerable variation with different makes, manufacturers' recommendations should be consulted for correct adjustment.

Check for tracking error. For proper tracking, the lateral or modulation motion of the stylus must be directly across each groove, at a right angle to the groove, Therefore, the stylus and the cartridge should align with the groove at every playing position (where the stylus is offset in the cartridge, only the stylus aligns). With pivot-mounted arms, this ideal can be only approximated.

To determine stylus-angle error, a simple template is useful (Fig. 5). Cut a 13-inch circle from light cardboard and draw a radial line. Measuring from exact center, mark points on the line at 2, 2½, 4¼ and 5¾ inches. These points will be referred to as needle positions. At each needle position, align a protractor with the radial line, the reference point at the needle position. Mark dots at 88°, 90° and 92°. Draw heavy black lines at 90° 2½ inches on either side of the radial line. Draw red lines at 88° and 92°, 2 inches on either side of the radial line. Carefully mark the center-hole radius of .0143 inch and punch it out.

Place the template on the turntable and set the needle on the outer needle position. The stylus should align with

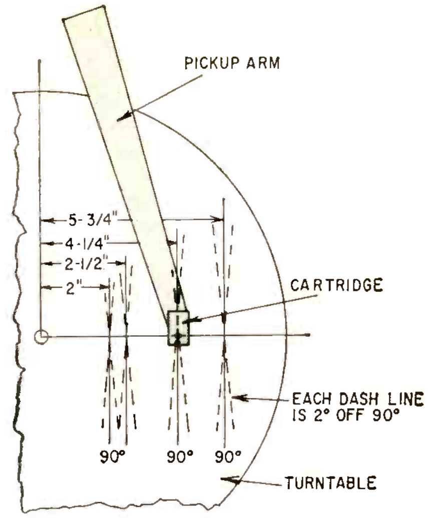


Fig. 5—Use of cardboard template to determine stylus tracking error. At all check points the stylus should align with the 90° tangent line, and in no case exceed the angle of dash lines.

the black tangent line. If its alignment exceeds either of the red angle lines at this or at any of the other three positions, there is undesirable error. The position nearest the center is the inner playing radius for 45-rpm records; the other three positions represent inner, midway and outer playing radii of 12-inch LP's. Points nearest the center require the highest accuracy of alignment. With some types of arms and cartridges it may be more accurate to use the arrangement recommended by Mr. Crowhurst and shown in Fig. 6.

(A more detailed discussion of record tracking was presented in RADIO-ELECTRONICS, October, 1957, pages 40–43.)

A straight arm should be replaced with a good offset arm. If an offset arm has error, try relocating the mounting point or substitute another arm with a more effective offset.

Test for mechanical feedback. Either play the record at minimum volume or turn off the amplifier and listen to needle talk. If there's no skip, probable speaker feedback through the cabinet can be proved by disconnecting set speakers and checking behavior with a remote speaker.

Remaking a "one-room cabinet" is more than a repair job, but how about suspending or cushioning the pickup table? Perhaps it's inadequate, or, if

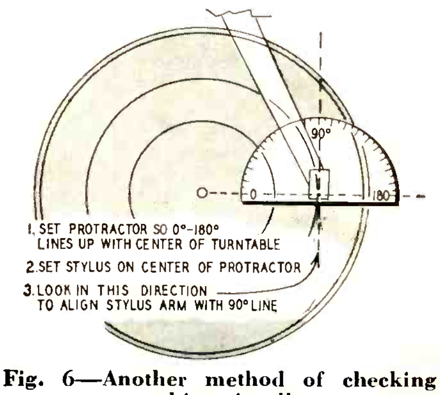


Fig. 6—Another method of checking tracking visually.

the set was bought at "wholesale," maybe still bolted down!

Check pickup arm friction. Tie a loop about 2 inches in diameter at the end of an 18-inch piece of soft cotton string. Slide the loop over the pickup arm near the needle and hold the other end so that the needle clears the turntable.

Move the arm slowly over the playing area, while watching the angle of the string from perpendicular. Compare long and short arms, those of professional quality and those of changers, and you will soon get the feel of a friction-free arm. Those that show unusual resistance should be disassembled and bearing parts checked, cleaned and polished. On changers, additional friction is added when the reject trip levers are reached. When skipping cuts a single deep trench on the inside half of the record, the trip system is usually the cause. Run the changer through a cycle until arm is at the start position. Now *swing* the arm, with the string, over the outer quarter of the record radius. Gradually work the arm toward the center and listen for the slight click when the lever is first engaged.

If the groove was gouged at this point, there's your trouble. If not, kick the lever along a little at a time and notice (by the click) whether a similar swing always moves the lever an equal distance inward. Remember that the lever remains at the point to which it is pushed, until it triggers. If a harder kick is needed at a point where the record is gouged, there may be a burr on the lever or adjacent stampings. Remove the parts and rub over extra fine abrasive paper, laid on a smooth, flat surface. Wipe clean of oil or grease, and powder lightly with graphite.

Cartridge substitution. If all the foregoing factors are normal and skipping persists, the remaining sure cure is a more compliant cartridge. As compliance improves, output voltage usually decreases, so choose cartridges that are within the input requirements of the amplifier. Always check and adjust stylus pressure after changing a cartridge. If a crystal is in use, try a good ceramic. If a ceramic is in use, try a high-output magnetic. If a magnetic is in use, try one of somewhat less output.

END

ELECTRONICS CONFERENCE

The Eleventh Annual Mid-America Electronics Conference (MAECON–1959) will be held this year in the Kansas City Municipal Auditorium and Hotel Muehlebach on Nov. 3, 4 and 5. Technical papers are wanted on engineering management, engineering education, astronautics, electromagnetics, nucleonics, airborne electronics, medical electronics and other electronic subjects.

Abstracts of approximately 100 words should be sent *not later than July 1* to: Dr. Sheldon L. Levy, Midwest Research Institute, 425 Volker Blvd., Kansas City 10, Mo., or Dr. Charles Halijak, Kansas State College, Manhattan, Kan.

ULTRA-STEERED-STEREO PROJECTOR

By MOHAMMED ULYSSES FIPS, IRE*

This totally new technique, "elegant as simplicity," may render most of our stereo thinking—and equipment—obsolete

RECENTLY I visited the New York High Fidelity Show, which was a misnomer because the show was mostly stereo. The more I saw and heard, the more confused I became. The things that were going on completely flabbergasted me, so much so that I came away quite dazed.

The stereo demonstrations which I witnessed were, to my mind, only for the well heeled. Not only that, but most of the gadgets now in use are too cumbersome. Furthermore, why must stereo be so earsplittingly loud? What we need is a completely new approach to sound, *sound* stereo, and the thoughts aired here, I hope, will bring it about soon.

To begin with, why do we need electronic amplification? Have you ever been to an outdoor concert where the musicians sit in an inverted sound bowl and the music is thrown forward to reach the audience several hundred feet away? (See Photo A.) No electronic amplification here! The more I thought about this, the more convinced I became that any other approach was unsound. I then started to go back to

*Itinerant Radio Engineers.

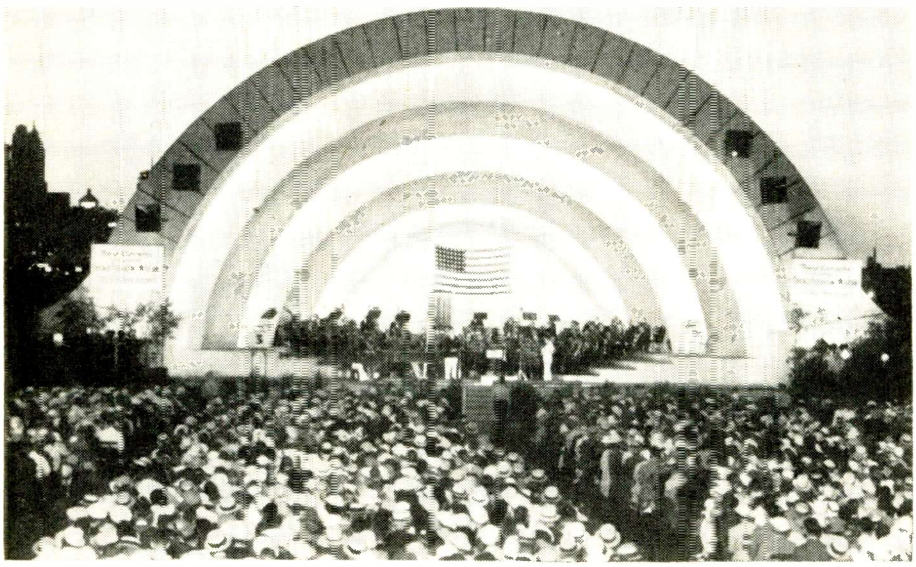


Photo A—Open air orchestra with inverted acoustical bowl which projects sounds over a large audience without electronic amplification.

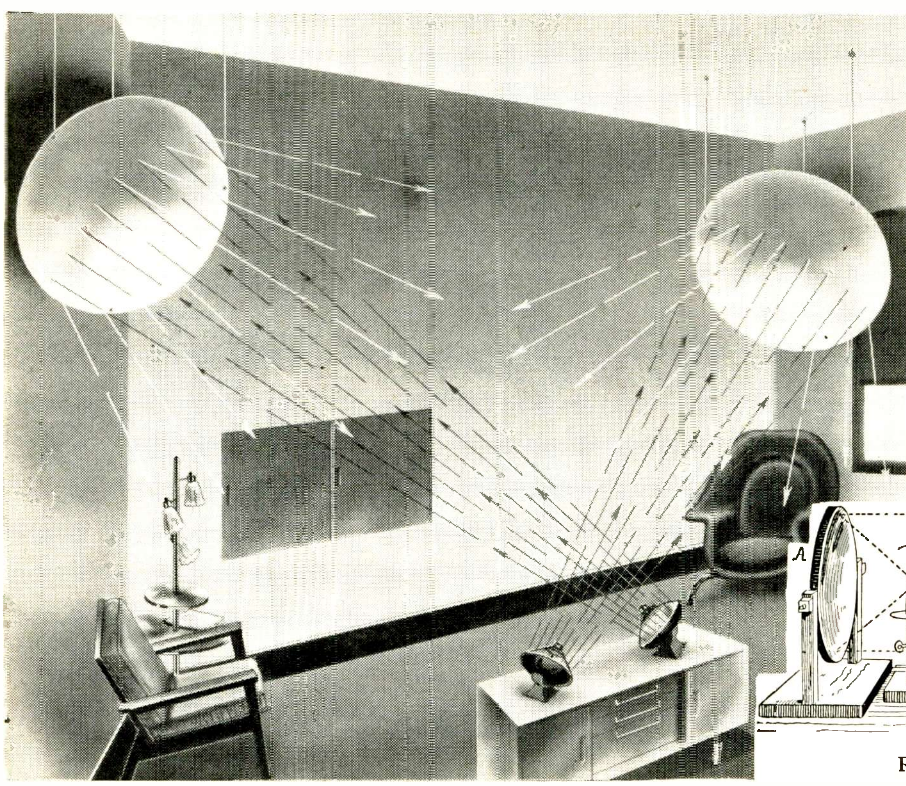
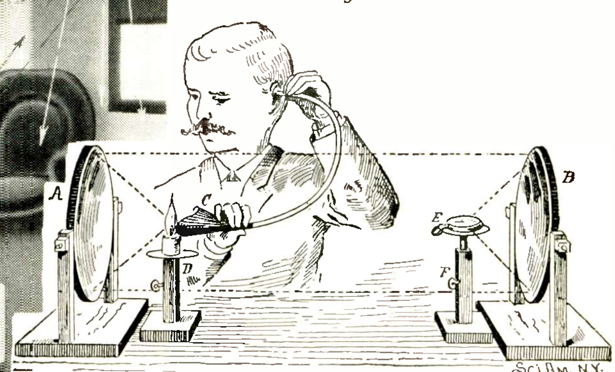


Photo B—Stereo arrangement for homes requires two 12" and two 25" parabolic aluminum reflectors. Loudspeakers throw sounds into large reflectors, then scatter sounds over the room.

FIG 163.



Reflection of Light and Sound.

Fig. 1—Sound of ticking watch in the focus of reflector B at right can be heard in focus of A, 35 feet away, without amplification.

acoustic fundamentals and soon came across what I was looking for.

This was an ancient book entitled "Experimental Science," by George M. Hopkins.† From this book, I reproduce Fig. 163 with the caption: "Reflection of Light and Sound," and a short description (Fig. 1).

"Place two reflectors, A and B, 4 or 5 feet apart, with their concave surfaces facing each other, as shown in Fig. 163. Place a short candle on the stand, D, so as to reflect a parallel beam that will cover the reflector, B, as nearly as possible. Then place a watch, E, in the focus of the reflector, B, upon the stand, F. Now hold the funnel, C, with its mouth facing the reflector, A, and immediately behind the candle, or, better, remove the candle and place the funnel in the position formerly occupied by the candle flame. With the funnel at this point the ticking of the watch will be distinctly heard, *but a slight movement of the funnel in either direction will render the ticking inaudible.* This experiment shows that the laws governing the reflection of light and sound are the same."

A similar illustration on the next page of the book shows the same setup with a large ear trumpet. The article concludes with this significant and almost unbelievable statement: "*With this arrangement the watch may be heard twenty or thirty feet away.*" Mind you, this was all done 70 years ago, without benefit of electronic amplification. The Capitol in Washington, D. C., is well-known for its "whispering" acoustic phenomenon. If you stand on one marked spot and merely whisper, your friend standing on another marked spot 44 feet 6 inches away will hear you clearly. These experiments will give you food for thought, as they gave me. The result is shown in these pages.

I wanted to satisfy myself as to whether it would be possible to accomplish stereo in a revolutionary new manner, and I am pleased to state here that I succeeded. Furthermore, the cost of this new amplificationless stereo is piddling.

Some of the components needed must be made; namely, four reflectors. We require two 25-inch parabolic reflectors for the wall and two 12-inch loudspeaker reflectors for the console. I did not use expensive speakers, either, but secured two secondhand radio speakers. I found it quite unnecessary to match the speakers closely.

The arrangement which is shown in our illustration (Photo B) can be used anywhere. No placement dimensions have been given because they vary depending on the physical makeup of the room.

The secret of this new type of stereo lies in the focusing of the reflectors. It is quite critical! If it's not done correctly, the results will not be good.

Textbooks will tell you that the laws of sound and light are similar for experiments of this type. As the old

†Copyright 1889, 1893, 1895, Munn & Co. (Scientific American), New York.

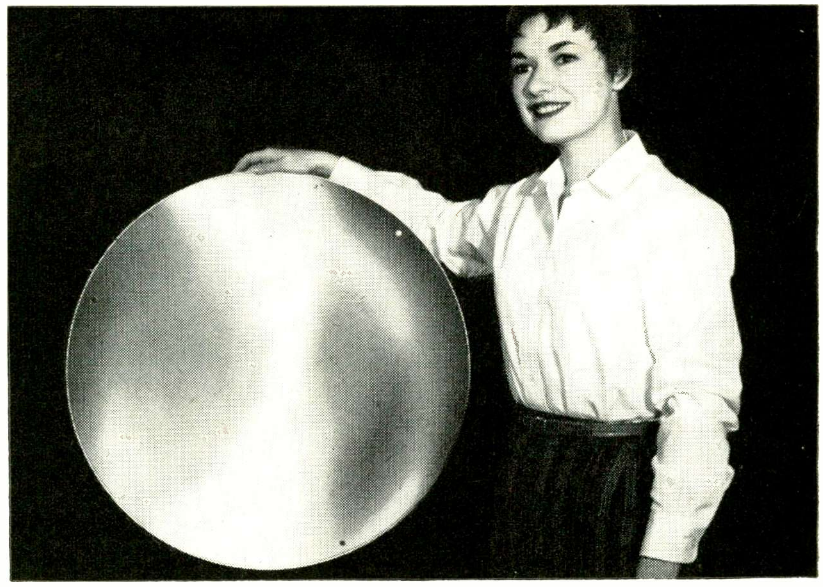


Photo C—An actual photograph of large reflector, showing its size compared to girl, Larayne Limitone.

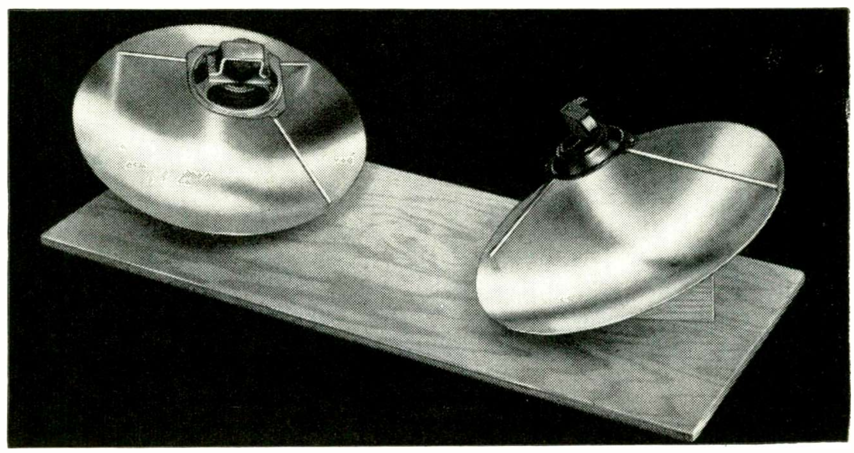


Photo D—This shows the the two loudspeakers as they are trained on the large wall reflectors. The blocks of supporting wood are mounted on metal straps so they can be moved in any direction and permanently fixed.

illustration shows, the candle must be adjusted in such a manner that by moving it closer or further away from the mirror, you hear the watch tick loudly, *even though it is 25 feet away.* With correct adjustments, the rays of the candle will be in the exact focus of mirror, A. The same is true of watch, E, and mirror, B. Here, too, the watch must be in the exact focus for best results.

Therefore, when you assemble the stereo outfit, you may use a watch and candle for correct focusing.

You will see from Photo B that *the two lower audio beams cross each other,* and you might wonder why this is done. The reason, again, is borrowed from the large outdoor orchestra inverted-bowl sound amplifier. If a musician plays at the far right, the sound of his instrument is reflected not only from the right, but also goes to the far left, to be reflected out to the audience. I call this crossed-beam arrangement the "Audio Mixer," and in practice it works out perfectly. From this you will understand that, when you do the focusing, the right speaker is focused with the left-wall reflector while the left loudspeaker is focused with the right-wall reflector.

The wall reflectors must be *sound-insulated* so they do not transmit extra frequencies by vibration to the wall. For that reason I used three heavy wool or nylon cords to suspend each wall reflector. The illustration shows the arrangement. The two small reflectors are mounted on a horizontal board, as shown (Photo D). To guard against extraneous sound transmission to the board, a heavy felt pad is placed between the wooden post and reflector to insulate the latter acoustically. This deadens the sound perfectly.

The arrangement gives excellent stereo reproduction without electronic amplification. Of course, such *natural* amplification does not give an ear-splitting output. It gives beautiful, soft, undistorted music.

Naturally there is nothing to prevent

(*Continued on page* 80)

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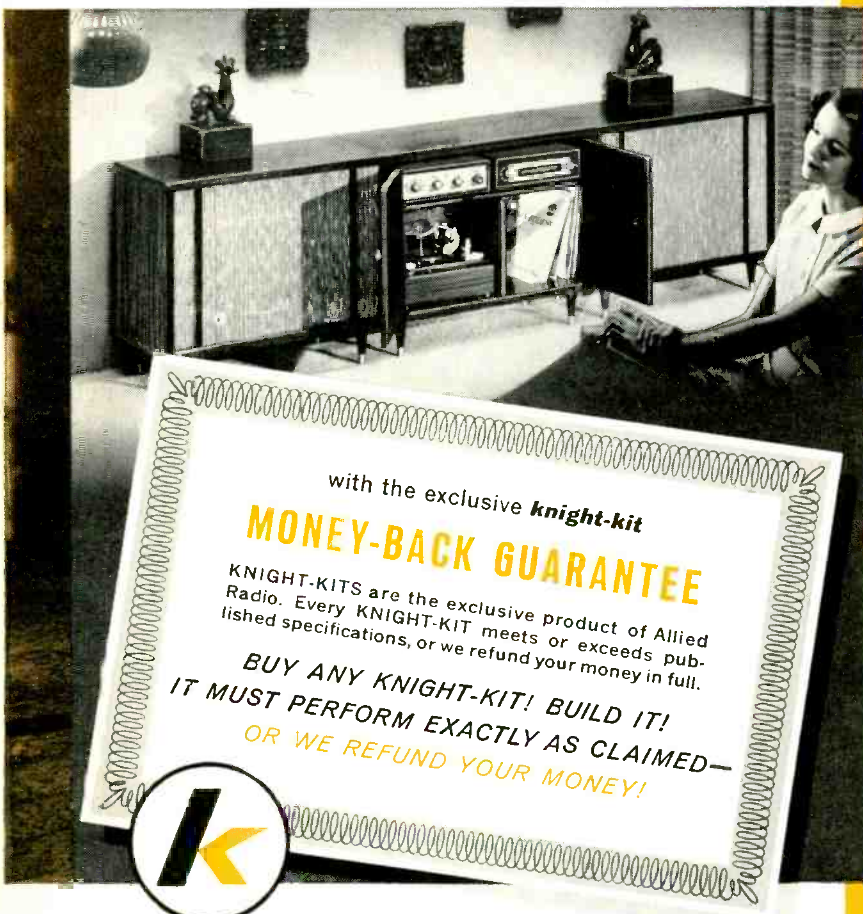

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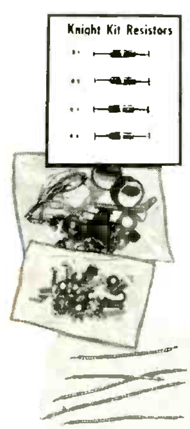

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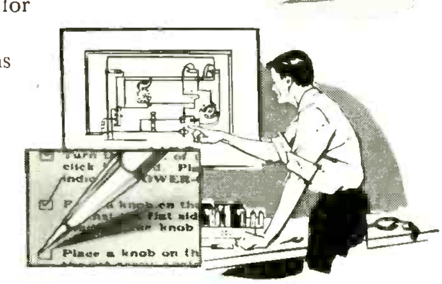

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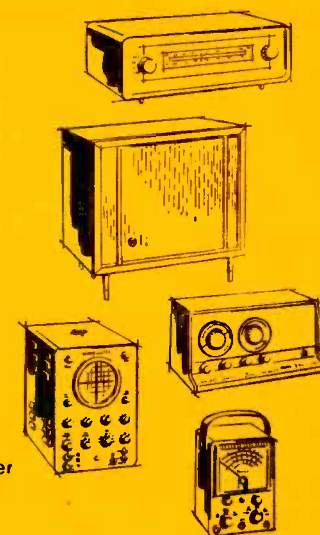

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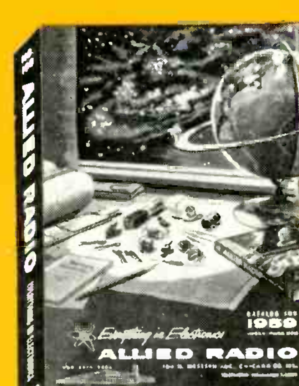

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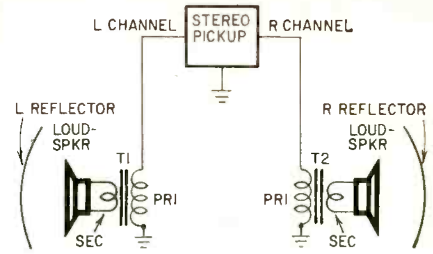

Fig. 2—A high-output pickup and two speakers with ordinary output transformers, hooked up as shown, constitute the whole circuit.

(*Continued from page 77*)

you from using an amplifier if you *must* have a *fortissimo* audio output. *For my own purposes, I like soft mellow music, without the effects produced by large amounts of feedback.*

The connections

If you wish to try the new improved system without electronic amplification, buy a ceramic type high-output stereo cartridge. Obtain two telephone type induction coils with high-ratio secondary. Hook them up with the secondary toward the cartridge and the primary toward the voice coil. Or you can use inexpensive replacement type output transformers that sell for 60 to 90 cents. Hook them up as in Fig. 2. *Use unshielded types.* With this arrangement, no power or batteries are required.

Practical hints

Small reflectors can be of almost any size in relation to diameter of large reflectors, but the larger the better.

Radius of curvature should be similar to that of large reflector: parabolic is best.

Small reflector does not have to be in exact focal line with large reflector, but should approximate it. Material of which reflectors are made should be thick enough so they do not vibrate at their own resonant frequency. I used aluminum No. 15 B & S gauge.

Beam of sound waves from small reflector will scatter sidewise so it will cover a good part of area of large reflector.

Small reflector should be placed at focal point of large reflector. This figures out to about 8 to 9 feet for 2-foot-diameter large reflector.

For electronic amplification, speakers to be connected in usual way to audio-frequency amplifier outputs.

Speaker units may be placed about 4 to 5 inches from center inner surface of small reflectors. Small reflectors used in setup here shown are 12 inches in diameter with center of curvature about 2 inches from chord of reflector, with similar proportions for large reflector.

Keep shifting all four reflectors until final sound suits you best.

Always remember the focusing of reflectors is very critical.

The reflectors cannot be bought readily, but any good metal spinner can make them. The reflectors shown were made in Brooklyn, *cost only $9*, and are made of fairly stiff aluminum. *On receipt of a reply postal card, we shall be pleased to give you the name of the spinner who makes such reflectors at low cost.*

* * *

After I finished this article, I had some serious misgivings. I wondered how the boss would feel when he sees my latest effort. Fortunately, he's away on vacation, and I have considerable doubts that he would have allowed me to print the article, for these simple reasons:

First, he hasn't seen my demonstration—he always must stick his nose into everything! Then there is the Advertising Department, who haven't seen the article either. What will *they* say when they find out that you *can* get fine stereo results for only a few dollars? Finally, how will the speaker and amplifier manufacturers feel?

I know that, on the whole, people these days are amenable to reason and normally will not stand in the way of progress, even if it hurts their pocketbooks temporarily. I am certain that they will welcome my effort. But for their protection (so I don't get into trouble), I felt it best not to publish as yet my most important later improvement, *by which it is possible to flood the entire room with perfect stereo reproduction, which the system described here can't do. No more putting your head in a small stereo spot!*

For these reasons, I know that my faithful readers will be patient for a little while. My new *Stereo Frequency Dispersor,* when attached to the two wall reflectors, will make four-dimensional stereo possible. It's great! *The most!* I intend to publish it next year, on

APRIL 1

ALL ABOUT THE REFLEX ENCLOSURE

Part II—Reflex enclosures are easy to tune, and tuning is needed for good results

By P. G. A. H. VOIGT

IN Part I* we took a look at the history and some of the basic principles behind the reflex enclosure. We ended by stating that "when we take the Helmholtz resonance into account we find that the motion of the air in the port builds up and helps the cone even more." The reasoning behind this statement is this:

If the drive is maintained at the appropriate frequency, the buildup continues until the losses balance the driving energy. Since a large part of the "loss" above is useful and in the form of sound output at the port, the resonance is one way of increasing the system's efficiency in that frequency region considerably.

The air-flow buildup at the port is accompanied by a corresponding pressure-variation buildup within the cabinet. This increases the load into which the rear of the cone is working and thus diminishes the cone's motion amplitude.

When cone motion becomes excessive, several undesirable things happen. First, the elastic support of the moving parts is rarely linear in its action. This nonlinearity introduces harmonics at large amplitudes. If the coil moves far enough to pass out of the region of maximum flux, there is further distortion of the low frequencies, and, should other frequencies be present just then, IM distortion as well. Lastly, since the cone is usually also the source of simultaneous higher frequencies, these are affected in another way. If they are emitted while the cone moves forward, the pitch rises slightly (Doppler effect) while, as it goes backward, the pitch drops. In this way, a high note is frequency-modulated by the lower one. The deviation depends on and gets worse as cone velocity increases.

The first group of undesirable effects decreases if cone displacement is reduced and the last if cone velocity is reduced. Loading the cone, which decreases both displacement and velocity, is highly desirable.

It is at the natural resonance of the coil–cone system that it is most likely to move excessively and is most sensitive to the effects of extra loading. An accepted theory for optimum conditions in a reflex system is that the enclosure's natural resonant frequency (at which it provides maximum loading) should be made to agree with the speaker's natural resonant frequency.

With both resonances at the same frequency, you might expect serious trouble. Fortunately, things are not as bad as they seem. The load on the back of the cone diminishes cone excursion and velocity considerably, reducing troubles due to excess cone velocity and displacement. The sound output at the cone face is also reduced. This compensates to some extent for the sound output from the port.

There is also an interaction between the speaker and the air cushion. This produces an effect resembling the double-humped or double-peaked effect of an overcoupled bandpass circuit. The marked resonance of the speaker, which represented a prominent package of trouble, is replaced by two smaller ones, one above and one below the basic resonance frequency, each being far less offensive than the original. Finally, if the overall output is excessive at low frequencies, the Q (Quality) of the Helmholtz resonance can be reduced by damping.

In the early stages of the argument we assumed that cushion pressure was caused solely by the motion of the speaker cone. This was a simplification, for both the cone motion and the air flow at the port contribute to the total compression. At the frequency where the two motions synchronize, cone and air flow at the port share the compressibility of the air in the cavity. This makes the air cushion seem stiffer (as though its volume had been reduced) and raises the resonant frequency. This corresponds to the upper "hump" or peak.

Next, if air is rushing in at the port and there is no signal at the speaker, instead of the air pressure in the enclosure backing up as it would in a simple Helmholtz resonator, it acts on the rear of the cone and drives that outward against the cone's control elasticity. To the air moving in at the port, this makes the air in the chamber seem more compressible (as though the volume were greater) and lowers the resonant frequency. Further, since the air in the cabinet is now flowing as a whole (from port to speaker and back as though these were in series), it is now moving in a way quite different from that effective at the upper peak when speaker and port acting in parallel share the air cushion between them.

With the series motion more of the air in the cabinet is moving, and the mass of the cone which the air is driving along with it has to be added in too. The overall increase of mass in motion lowers the frequency still further—down to that corresponding to the lower "hump" or peak.

At the frequency corresponding to this lower peak, cone motion does not synchronize with that of the air in the port. When the appropriate signal is applied to the cone, therefore, the two do not reinforce one another as effectively as at the higher frequency. You might even think that they would cancel one another and that the sound-producing efficiency would drop to zero.

Complete cancellation demands two equal sources 180° out of phase. At this lower frequency, the volume flow at the enclosure port, which is not limited by the elastic control of the cone, is dominant. Further, even if two sources are equal and 180° out of phase at the cabinet, it does not follow that they are 180° out of phase at the listener's ear.

*See also Correspondence page 24 this issue.

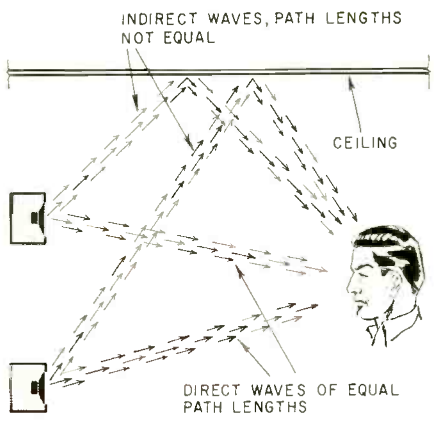

Fig. II–1—If two equal sources are 180° out of phase, but do not coincide in space, they will not cancel each other completely in all directions.

That will depend on the paths of sound. Even if the direct paths are of equal length, some reflected paths, say via the ceiling, might be different in length and thus introduce a time (phase) difference which prevents complete cancellation (see Fig. II–1).

Thus, while a high sound output is not expected at this lower frequency, the output is generally greater than that obtainable with the same speaker in a simple box baffle of equal volume. Therefore, the reflex boosts the response slightly at that lower frequency. Below this lower resonant frequency, the sound output drops off very rapidly indeed. The opening in the cabinet then permits air flow from one side of the cone to another and the disadvantages of the port come into effect. However, with a suitably designed reflex cabinet, this occurs at frequencies so low that the speaker was already very inefficient anyway and the extra loss there is a worth-while exchange for the gain higher up.

We can now summarize the reflex-cabinet designer's objective when trying to match the cabinet to a speaker. He tries to arrange matters so the reflex cabinet quenches the natural resonance of the speaker to some extent, reducing speaker amplitude buildup and possible distortion. Also, he wants to use the phase-reversal characteristic of the air-chamber system to help fill out, as much as possible, the general low-frequency region. Thus he kills two birds with one stone and produce a more acceptable overall result.

Matching speaker and enclosure

Now, our study of the theoretical background of reflex cabinet design is over. From it, the desirability of matching the cabinet to the speaker becomes obvious. What, then, should be said of the practice of many hi-fi salons of fitting a selection of speakers to a number of reflex cabinets, identical except for the diameter of the speaker opening, and then A–B testing from speaker to speaker?

Certainly most of the differences the

(*Continued on page* 88)

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SIGNAL TRACER
which will enable you to trace the signal from antenna to speaker of all receivers and to finally pinpoint the exact cause of trouble whether it be a part or circuit defect.

IT'S A
TV ANTENNA TESTER
The TV Antenna Tester section is used first to determine if a "break" exists in the TV antenna and if a break does exist the specific point (in feet from set) where it is.

Model 76 BRIDGE . . . Total Price $26.95—Terms: $6.95 after 10 day trial, then $5.00 monthly for 4 months if satisfactory. Otherwise return, no explanation necessary!

SPECIFICATIONS:

CAPACITY BRIDGE SECTION
4 Ranges: .00001 Microfarad to 1000 Microfarads. Will also locate shorts, and leakages up to 20 megohms. Measures the power factor of all condensers from .1 to 1000 Microfarads. (Power factor is the ability of a condenser to retain a charge and thereby filter efficiently.)

SIGNAL TRACER SECTION
With the use of the R.F. and A.F. Probes included with the Model 76, you can make stage gain measurements, locate signal loss in R.F. and Audio stages, localize faulty stages, locate distortion and hum, etc. Provision has been made for use of phones and meter if desired.

RESISTANCE BRIDGE SECTION
2 Ranges: 100 ohms to 5 megohms. Resistance can be measured without disconnecting capacitor connected across it. (Except, of course, when the R C combination is part of an R C bank.)

TV ANTENNA TESTER SECTION
Loss of sync., snow and instability are only a few of the faults which may be due to a break in the antenna, so why not check the TV antenna first? 2 Ranges: 2' to 200' for 72 ohm coax and 2' to 250' for 300 ohm ribbon.

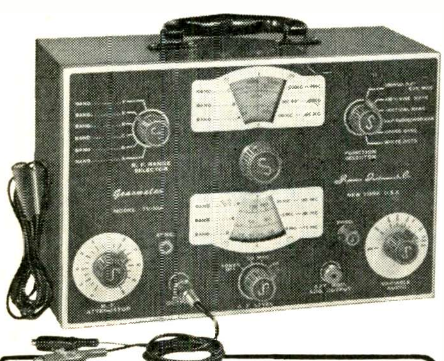
Model 76 comes complete with all accessories including R.F. and A.F. Probes; Test Leads and operating instructions. Nothing else to buy. Only

$26.95 NET

SUPERIOR'S NEW MODEL TV-50A

GENOMETER

7 Signal Generators in One!



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

Model TV-50A GENOMETER . . . Total Price $47.50—Terms: $11.50 after 10 day trial, then $6.00 monthly for 6 months if satisfactory. Otherwise return, no explanation necessary!

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

Specifications

R. F. SIGNAL GENERATOR: The Model TV-50A Genometer provides complete coverage for A.M. and F.M. alignment. Generates Radio Frequencies from 100 Kilocycles to 60 Megacycles on fundamentals and from 60 Megacycles to 180 Megacycles on powerful harmonics.

CROSS HATCH GENERATOR: The Model TV-50A Genometer will project a cross-hatch pattern on any TV picture tube. The pattern will consist of non-shifting, horizontal and vertical lines interlaced to provide a stable cross-hatch effect.

VARIABLE AUDIO FREQUENCY GENERATOR: In addition to a fixed 400 cycle sine-wave audio, the Model TV-50A Genometer provides a variable 300 cycle to 20,000 cycle peaked wave audio signal.

DOT PATTERN GENERATOR (FOR COLOR TV) Although you will be able to use most of your regular standard equipment for servicing Color TV, the one addition which is a "must" is a Dot Pattern Generator. The Dot Pattern projected on any color TV Receiver tube by the Model TV-50A will enable you to adjust for proper color convergence.

BAR GENERATOR: The Model TV-50A projects an actual Bar Pattern on any TV Receiver Screen. Pattern will consist of 4 to 16 horizontal bars or 7 to 20 vertical bars.

MARKER GENERATOR: The Model TV-50A includes all the most frequently needed marker points. The following markers are provided: 189 Kc., 262.5 Kc., 456 Kc., 600 Kc., 1000 Kc., 1400 Kc., 1600 Kc., 2000 Kc., 2500 Kc., 3579 Kc., 4.5 Mc., 5 Mc., 10.7 Mc., (3579 Kc. is the color burst frequency)

THE MODEL TV-50A comes absolutely complete with shielded leads and operating instructions.

$47.50 NET

SHIPPED ON APPROVAL
NO MONEY WITH ORDER—NO C.O.D.

Try for 10 days before you buy! If completely satisfied, send down payment after trial and pay balance at indicated monthly rate — NO INTEREST OR FINANCE CHARGES ADDED. If not completely satisfied, return to us, no explanation necessary.

SEE PAGE 87 FOR COMPLETE DETAILS

MOSS ELECTRONIC, INC. 3849 TENTH AVE., NEW YORK 34, N. Y.

SUPERIOR'S NEW MODEL TW-11

STANDARD PROFESSIONAL TUBE TESTER

★ Tests all tubes, including 4, 5, 6, 7, Octal, Lock-in, 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 TW-11 as any of the pins may be placed in the neutral position when necessary.

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

★ Free-moving built-in roll chart provides complete data for all tubes. All tube listings printed in large easy-to-read type.

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

EXTRAORDINARY FEATURE

SEPARATE SCALE FOR LOW-CURRENT TUBES. Previously, on emission-type tube testers, it has been standard practice to use one scale for all tubes. As a result, the calibration for low-current types has been restricted to a small portion of the scale. The extra scale used here greatly simplifies testing of low-current types.

Model TW-11—TUBE TESTER . . . Total Price $47.50—Terms: $11.50 after 10 day trial, then $6.00 per month for 6 months if satisfactory. Otherwise return, no explanation necessary!

The Model TW-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

SUPERIOR'S NEW MODEL 83

C.R.T. TESTER

Tests and Rejuvenates ALL PICTURE TUBES

ALL BLACK AND WHITE TUBES

From 50 degree to 110 degree types—from 8" to 30" types.

ALL COLOR TUBES

Test ALL picture tubes—in the carton—out of the carton—in the set!

✓ Model 83 is not simply a rehashed black and white C.R.T. Tester with a color adapter added. Model 83 employs a new improved circuit designed specifically to test the older type black and white tubes, the newer type black and white tubes and all color picture tubes.

✓ Model 83 provides *separate* filament operating voltages for the older 6.3 types and the newer 8.4 types.

✓ Model 83 employs a 4" air-damped meter with quality and calibrated scales.

✓ Model 83 properly tests the red, green and blue sections of color tubes individually—for each section of a color tube contains its own filament, plate, grid and cathode.

✓ Model 83 will detect tubes which are apparently good but require rejuvenation. Such tubes will provide a picture seemingly good but lacking in proper definition, contrast and focus. To test for such malfunction, you simply press the rej. switch of Model 83. If the tube is weakening, the meter reading will indicate the condition.

✓ Rejuvenation of picture tubes is not simply a matter of applying a high voltage to the filament. Such voltages improperly applied can strip the cathode of the oxide coating essential for proper emission. The Model 83 applies a *selective* low voltage *uniformly* to assure increased life with no danger of cathode damage.

Model 83—C.R.T. TUBE TESTER . . . Total Price $38.50—Terms: $8.50 after 10 day trial, then $6.00 monthly for 5 months if satisfactory. Otherwise return, no explanation necessary!

Model 83 comes housed in handsome portable Saddle Stitched Texon case—complete with sockets for all black and white tubes and all color tubes. Only **$38.50**

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Try for 10 days before you buy! If completely satisfied, send down payment *after* trial and pay balance at indicated monthly rate — NO INTEREST OR FINANCE CHARGES ADDED. If not completely satisfied, return to us, no explanation necessary.

See following page for complete details

MOSS ELECTRONIC, INC. 3849 TENTH AVE., NEW YORK 34, N. Y.

SUPERIOR'S NEW MODEL 82A

Multi-Socket Type TUBE TESTER

Model 82A — TUBE TESTER . . . Total Price $36.50 — Terms: $6.50 after 10 day trial, then $6.00 monthly for 5 months if satisfactory. Otherwise return, no explanation necessary.

TEST ANY TUBE IN 10 SECONDS FLAT!

1. Turn the filament selector switch to position specified.
2. Insert tube into a numbered socket as designated on our chart (over 600 types included).
3. Press down the quality button —

THAT'S ALL!

Read emission quality direct on "BAD-GOOD" meter scale.

Production of this Model was delayed a full year pending careful study by Superior's engineering staff of this new method of testing tubes. Don't let the low price mislead you! We claim Model 82A will outperform similar looking units which sell for much more — and as proof, we offer to ship it on our examine before you buy policy.

To test any tube, you simply insert it into a numbered socket as designated, turn the filament switch and press down the quality switch — THAT'S ALL! Read quality on meter. Inter-element leakage if any indicates automatically.

Specifications

- Tests over 600 tube types
- Tests 0Z4 and other gas-filled tubes
- Employs new 4" meter with sealed air-damping chamber resulting in accurate vibrationless readings
- Use of 22 sockets permits testing all popular tube types and prevents possible obsolescence
- Dual Scale meter permits testing of low current tubes
- 7 and 9 pin straighteners mounted on panel
- All sections of multi-element tubes tested simultaneously
- Ultra-sensitive leakage test circuit will indicate leakage up to 5 megohms

Model 82A comes housed in handsome, portable Saddle-Stitched Texon case. Only .... **$36.50 NET**

SHIPPED ON APPROVAL
NO MONEY WITH ORDER — NO C.O.D.

MOSS ELECTRONIC, INC.
Dept. D-590   3849 Tenth Ave., New York 34, N.Y.

Please send me the units checked on approval. If completely satisfied I will pay on the terms specified with no interest or finance charges added. Otherwise, I will return after a 10 day trial positively cancelling all further obligation.

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Address ....

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

All prices net, F.O.B., N. Y. C.

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- ☐ Model 83 .... Total Price $38.50 — $8.50 within 10 days. Balance $6.00 monthly for 5 months.
- ☐ Model 82A .... Total Price $36.50 — $6.50 within 10 days. Balance $6.00 monthly for 5 months.

AUDIO—HIGH FIDELITY

(*Continued from page* 83)

listener hears will be due to differences between the particular speakers being compared, but is it fair to any speaker to pair it with a cabinet which might not suit it at all? I, for one, certainly don't think so. The result of such tests may well be the selection of an inferior speaker, which gave better sound on that particular occasion simply because the cabinet matched it. A better speaker might have been rejected because the standard cabinet was so out of match it couldn't do its best.

Either good box baffles, large enough to be neutral in their effect should be used, or, with reflex cabinets, at the very least, each cabinet should be tuned to suit the speaker fitted in it.

Very little electronic equipment is needed. An audio generator, a 1,000-ohm

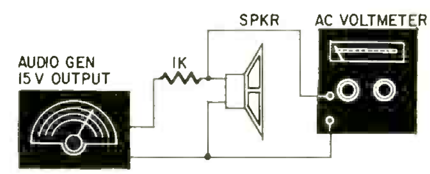


Fig. II–2—Simple circuit for locating main lower-speaker impedance peak.

resistor and a suitable ac voltmeter will do. Laboratory accuracy is not necessary. All that is needed is to show the approximate frequency and height of the main lower speaker impedance peak—first, when measured with the speaker in free air (no baffle at all, lay it on its back or hang it up on a wire) and again while in the cabinet.

The simple circuit for tuning is shown in Fig. II–2. The 1,000-ohm resistor and the speaker are in series across the audio generator. Keep the generator's output constant and slowly tune across the band of approximately 20 to 250 cycles while watching the meter for the sharp peak that shows the speaker's resonant frequency. If the generator delivers 15 volts and the speaker has a nominal impedance of about 16 ohms, the voltage across the speaker should be about 0.25. If the meter circuit has a resistance of 1,000 ohms or more, meter current will not disturb the reading significantly.

The speaker's impedance is partially due to the dc resistance of the coil and partially to the voltage generated when the coil moves in the magnet's gap. When the speaker is in free air (clear of any baffle or cabinet) and fed with constant current at various frequencies, coil motion builds up at the speaker's main lower resonance frequency. This drives the coil velocity up and the back emf generated in the coil peaks also. This shows up clearly on the voltmeter as a peak in the reading.

At the peak, the meter reading may be expected to rise to 1 or 2 volts, sometimes even higher. Thus the exact lower resonant frequency can be discovered. The voltmeter reading gives an idea of the peak's height.

If minor irregularities are ignored, a typical speaker has an impedance

Time-Saver of the MONTH!

by Herb Bowden*

MOST of us are familiar with the age old problem of checking an electrolytic capacitor. We have tried capacitor testers, in-circuit testers and circuit analyzers, only to find that the only real answer to checking any electrolytic accurately is to substitute it with another capacitor. Of course, this presents certain problems; the right value capacitor of the proper operating voltage is usually the one that you installed in the last repair job that you did and you don't have another around the shop for substitution. Then, too, there is always the discharge spark that does little good in creating good-will with your customer, to say nothing of the harm that it can do to the capacitor.

The intermittent electrolytic capacitor is the worst headache, especially where the trouble in the receiver is corrected when another capacitor is connected across it. This we call capacitor healing due to the sudden outrushing current from the capacitor being paralleled. The ES-102 Electro-Sub is especially made to make substitution easy and is ideal for service shop, laboratory or any other place where design, service or experimenting is taking place.

WHY THE ELECTRO-SUB NOW?

The need for an electrolytic substitution unit has increased recently because of the sharp increase in the use of electrolytic capacitors. Hi-Fi amplifiers, for example, use up to 12 electrolytics. This increased again with the advent of stereo sound. One bad electrolytic will make a thousand dollar Hi-Fi sound like a ten dollar AC-DC radio. Portable TV receivers also use more electrolytic capacitors than conventional TV. The filter capacitors are more critical, especially when the portable uses a fuse resistor.

What Electrolytic Capacitors Will The ES-102 Substitute For?

The ES-102 is especially designed to substitute for all capacitors from 2 MFD to 400 MFD. The actual values selected and some of their uses are shown below.

4 MFD... especially handy for transistor radios

10 MFD... very handy for adding capacity to see if it will reduce hum

20 MFD... popular in many low cost AC-DC radios and TV bypass

40 MFD... used in most AC-DC radios and some TV receivers

60 MFD... used in many low cost TV receivers

80 MFD... used in most TV receivers and higher priced radios

100 MFD... used in many TV receivers and low cost Hi-Fi amplifiers

150 MFD... very prevalent in Hi-Fi amplifiers

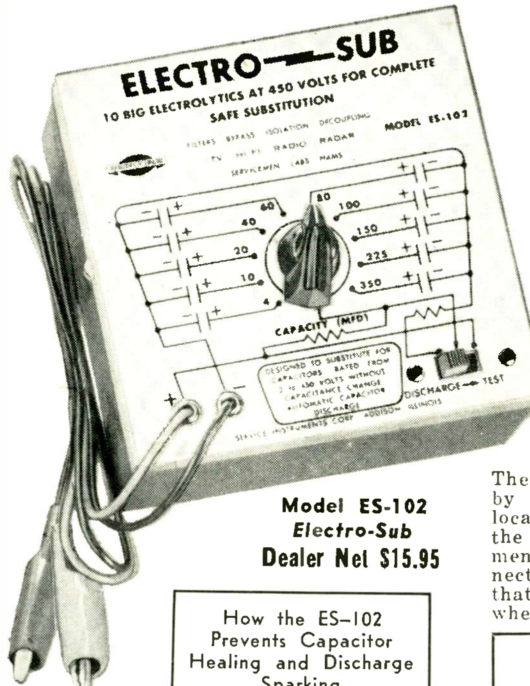
225 MFD... used in some Hi-Fi amplifiers

350 MFD... used only in very high priced Hi-Fi and special applications. Very handy for design work and for trouble shooting hum.

When substituting for in between values, select the nearest value.

WHAT VOLTAGE CAN BE APPLIED TO THE ES-102?

Any voltage from 2 to 450 volts can be applied to the ES-102 capacitors without capacity change. This is because the capacitors used are special dry electrolytics.



Model ES-102
Electro-Sub
Dealer Net $15.95

How the ES-102 Prevents Capacitor Healing and Discharge Sparking

The ES-102 has a special charge and discharge circuit called a surge protector. This magic device is a development of Sencore and is very unique in operation. The surge protector action is shown in figure 1. Following the action of the surge protector, note the three positions of the switch as it slides from left to right. In position 1, the leads are connected to the circuit under test, but the substitute capacitor is not connected. In position number two, the capacitor is connected to the circuit through the 500 ohm resistor. Position number 3 shorts out the resistor and completes the substitution. The action is in reverse as the surge protector switch is released.

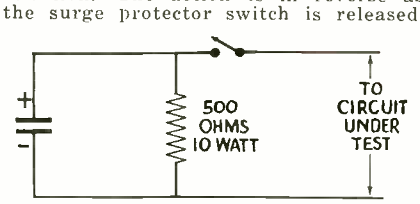


Fig. 1A. Position 1 places resistor across capacitor and only test leads connected to circuit.

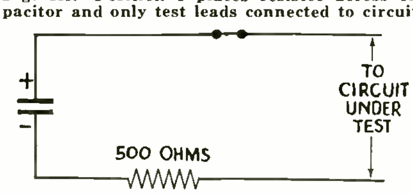


Fig. 1B. Position 2 showing resistor in series with capacitor to "slow down" current in-rush which may heal capacitor being paralleled.

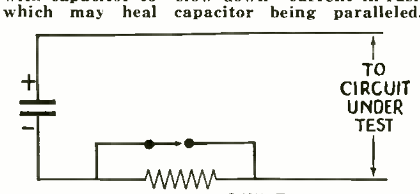


Fig. 1C. Position 3 of surge protector "shorts out" series resistor leaving only electrolytic in circuit.

When it is returned to the extreme left, the 500 ohm resistor discharges the ES-102 capacitor completely within a few seconds. The remaining portion of the ES-102 schematic is screened on the front panel as shown.

Is The Surge Protector Critical In Operation?

It may appear that the surge protector switch must be moved to the right carefully in order to accomplish the connections described. However, this is not the case, as the switch can be compressed as fast as desired and as often as required. The connections and capacitor discharge are automatic.

Can The ES-102 Be Substituted Permanently?

The surge protector switch is returned by an external spring. This spring is located under the front panel. To use the capacitors for engineering or experimental work, you may want to disconnect the spring. Be sure to remember that the surge protector is not operating when the spring is disconnected.

CAN YOU GET A SHOCK FROM THE ES-102?

It is impossible to get a shock from the ES-102 as the test leads are disconnected and the capacitor discharged the instant that the surge protector switch is released. As a matter of fact, you can release the surge protector, disconnect the leads and then touch the leads to your hands without the possibility of shock. This is important, especially where customers or small children may get near your service bench.

DOES THE ROTARY SWITCH ARC WHEN SWITCHING CAPACITORS?

The rotary switch does not arc when switching capacitors because the surge protector switch disconnects the voltage source. This reduces switch wear greatly. One should be careful not to hold the surge protector to the right while changing capacitors.

IS IT NECESSARY TO DISCONNECT THE CAPACITOR BEING CHECKED?

If a capacitor is suspected of being open, you do not need to disconnect it from the circuit. If it is suspected of being shorted, it is necessary to disconnect it while substituting one of the capacitors from the ES-102.

WHERE TO PURCHASE THE ELECTRO-SUB

Over 1000 parts distributors in the United States and Canada carry the complete line of Sencore time savers. These distributors now carry the Electro-Sub in stock. Dealer net is $15.95 (less than your cost of the electrolytic capacitors).

If, for some reason, your distributor does not carry the Sencore line, please drop us a note at the factory, **121 Official Road, Addison, Illinois. In Canada, please write . . . Active Radio and TV Dist., 58 Spadina Avenue, Toronto 2 B.** Look for the colorful Sencore display.

***PRESIDENT SENCORE**

curve like that shown by the solid line in Fig. II–3.

If that speaker is fitted into a reflex enclosure, the vented air chamber affects matters by loading the rear of the cone. In the frequency range where the load is effective, cone and coil motion are diminished. The coil velocity drops, as do the impedance and the voltmeter reading. Therefore, the frequency at which the load is greatest can be ascertained easily, for at that frequency the speaker impedance drops substantially below its free-air level.

If both impedance curves are plotted (with the speaker in air and again in the cabinet) and the two curves are compared, it will seem almost as though the effect of the air resonance was to take a bite out of the impedance curve. The position of the bite indicates the frequency region of maximum cabinet load.

Tune the port

The maximum-load frequency can be made to agree with the speaker's resonance frequency if the cabinet is made so that the air resonance is adjustable. The hi-fi dealer using reflex cabinets needs the simplest method of tuning possible. He cannot alter the volume of his cabinets to adjust the resonance frequency. Instead, he will adjust the air inertia of the port. The simplest way is to alter the port area.

If the port is made as shown in Fig. II–4 and he obtains the inexpensive extra parts shown, he can do this easily.

A simple way of arriving at the correct adjustment is to leave the audio generator set at the speaker resonance frequency, and adjust the port opening while keeping an eye on the voltmeter. By this method it is not even necessary to know what the resonant frequency really is. Just leave the knob set where the free-air reading shows the peak. Now, when the voltmeter reading is at its lowest, the cabinet is adjusted for maximum loading.

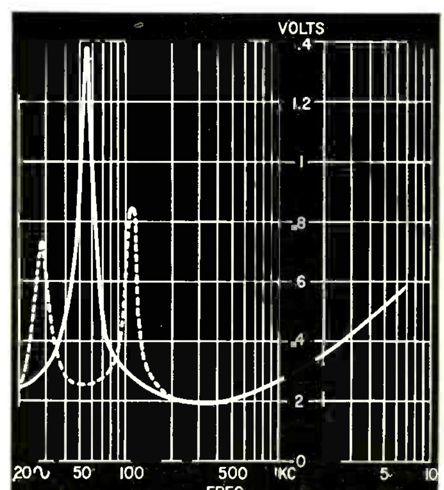


Fig. II-3—Typical speaker impedance curves: solid line for speaker in free air; dashed line for same speaker in small (0.66-cubic-foot) reflex enclosure.

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CREI courses are prepared, and taught with an eye to the needs and demands of industry, so your CREI diploma can open many doors for you. Countless CREI graduates now enjoy important, good-paying positions with America's most important companies. Many famous organizations have arranged CREI group training for their radio-electronics-television personnel. To name a few: All-American Cables and Radio, Inc.; Canadian Broadcasting Corporation; Columbia Broadcasting System; Gates Radio Company; Federal Electric Corporation; The Martin Company; Douglas Aircraft Co.; U.S. Information Agency (Voice of America); Trans-Canada Air Lines; United Air Lines. Their choice for training of their own personnel is a good cue for *your* choice of a school.

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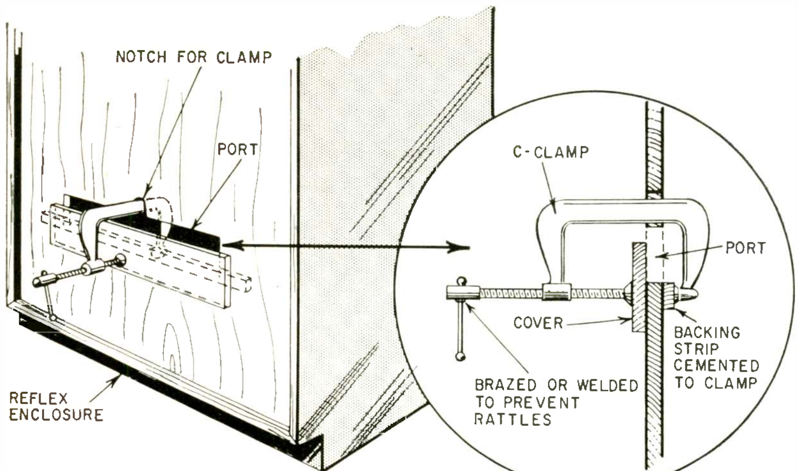


Fig. II-4—Simple method of tuning reflex enclosure calls for an adjustable port. Clamp fits into slot in port and cover is adjusted for best results. At this position, clamp is tightened and cover fixed in place.

If the speaker impedance curve is plotted now, it will look something like the dashed curve in Fig. II–3. In addition to taking a bite out of one frequency region, the neighboring regions above and below resonance are pushed up into minor peaks. These indicate increased cone velocity at their respective frequencies.

The region of lowest voltmeter reading lies in the trough between these peaks and is therefore not very precise. Fortunately the tuning accuracy required is not high and, if in doubt about the tuning, rocking a little to either side of the basic generator setting helps locate the middle of the trough.

It would be convenient if exact tuning was indicated by equal height of the two peaks. In practice this cannot be relied on, because damping (whether natural, accidental or deliberate) affects their individual heights. However, in a reflex system without special damping that is tuned to provide maximum load at speaker resonance, the lesser peak is usually at least half as high as the greater one. The peaks are also about equally spaced on either side of the speaker's free-air resonance frequency when plotted on the usual logarithmic graph paper.

Tune the cabinet

Cabinets can be tuned without fitting the speaker if the resonant frequency of the speaker to be used is known. (Don't go by published specifications. Speakers vary, measure it.)

If a cabinet, after the port has been cut *but before the speaker opening is cut*, is considered as a Helmholtz resonator, it has a resonant frequency. If the cabinet is placed with its port facing upward as in Fig. II-5, a carbon, crystal or other type of pressure-operated microphone[1] can be suspended so as to be within the enclosure. Now, suppose a sound of variable frequency sweeps by. At the frequency of the Helmholtz resonance, there will be a considerable buildup of sound pressure inside the cabinet. (Relative to the pressure at the microphone in the absence of the cabinet, a buildup of between 10 and 30 times is normal.) Thus, by varying the frequency and watching the output from the mike amplifier on a scope or meter it is easy to determine the resonant frequency of the air system very accurately. By modifying the port, the frequency can then be adjusted as desired.

If the speaker opening has already been cut, the same method can be used, provided the speaker opening is sealed off by a reasonably airtight cover. If the speaker has already been fitted, it need not be removed as it will not disturb results appreciably as long as the cover over the speaker opening is effective.

The port and resonance

Experiments show that when a speaker and a reflex cabinet are married, a slight change in the Helmholtz tuning may be desirable for maximum effect. Therefore, the preceding method should be treated as a quick practical way of getting close to the correct port area. The perfectionist, chasing subtleties, will take the impedance curve as well and then make further corrections if necessary.

The graph plots in Fig. II–6 show the kind of variations in the Helmholtz tuning frequency to expect when the port is changed. The graphs were taken for a well-built cabinet with a 3.25-cubic-foot internal volume.[2] Note that the tuning frequency is *not* inversely proportional to the port area or even to the square of the port area. At first, changes in port area for a given frequency change seem to be inconsistent and out of proportion. For instance, the graph of the 8-inch slot of varying width has a slope corresponding to a 15.5-to-1 area change per octave, while the 1-inch slot of varying length shows a 6.5-to-1 area change per octave.

This difference arises because the area of the port alone is not decisive. The shape of the port is involved, and in both graphs the shape was changing. Experiments show that for the same tuning frequency with a square port, a bigger area is used than with a slot-shaped port.

To eliminate variations due to port shape, rectangular ports having side dimensions in the ratio of 4 to 1 were used for each of the points plotted in

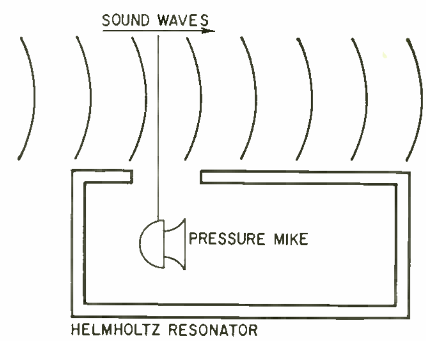


Fig. II–5—If a microphone is placed inside Helmholtz resonator, and sound at resonant frequency sweeps by, there will be considerable buildup of sound pressure inside.

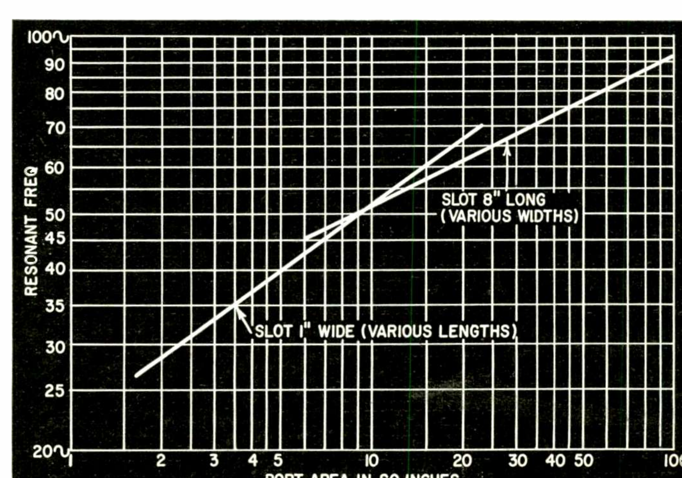


Fig. II–6—Effect of changing port area on the enclosure's resonant frequency. Graph for cabinet with 3.25-cubic-foot internal volume.

[1] If no pressure microphone is available, a headphone earpiece will do.

[2] I am indebted to Mr. O. C. Schwartz, trading as American Radio and T.V. Supply Co. of Toronto, Canada, for the use of lab facilities to obtain the experimental results shown in Figs. II-6 and II-7.

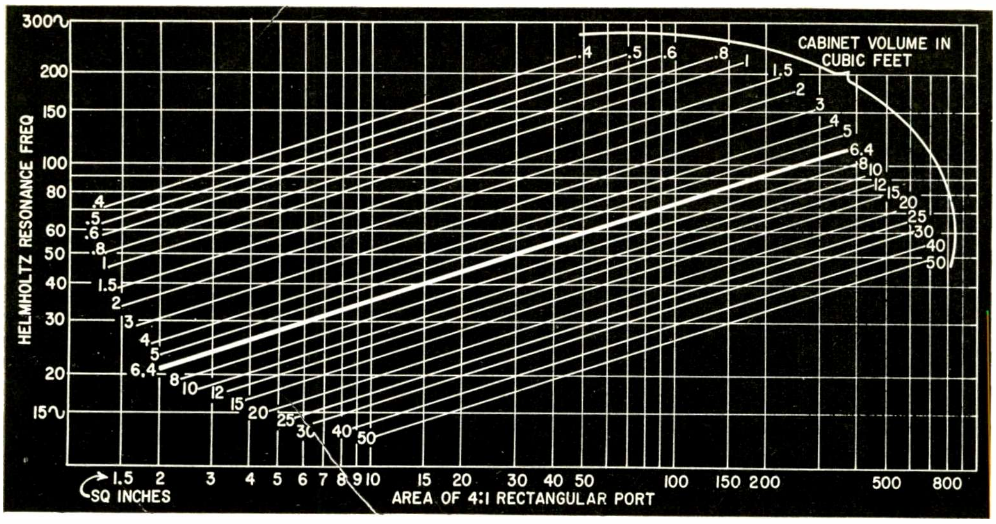


Fig. II–7—Chart showing relationships between Helmholtz resonance of reflex enclosures, port area and cabinet volume.

Fig. II–7 (heavy line). This relates to a well-built cabinet with an internal volume of approximately 6.4 cubic feet. The ports were located well clear of other surfaces as this affects the results. The experiments show that with constant port shape, a change of port area of between 8 and 9 to 1 is required for a 1-octave change in the Helmholtz resonance frequency.

In theory, information from one cabinet can be translated to cabinets of different volumes, if you remember while scaling up or down that volumes vary as the cube, areas as the square, resonant wavelength directly and frequency as the inverse of the linear change.

Another way of translating is to treat cabinet volume as equivalent to electrical capacitance. The tuning frequency then drops by an octave if the internal cabinet volume is quadrupled.

Theoretically, both ways of translating should give the same answers. However, in practice they don't quite and as the latter seems more accurate it was used to obtain the family of derived curves shown in Fig. II–7. From these, the Helmholtz resonance frequencies expected from larger or smaller cabinets with rectangular 4-to-1 ports can be read off. In practice, results are within about 10%, so for an initial design the port area should be made on the large side, and provided with some kind of adjustment.

From Fig. II–7 it will be noted that, if cabinet volume is increased and nothing else is changed, the tuning frequency drops. This will seem natural to those acquainted with electronic circuits, in which the tuning frequency drops when the capacitance (C) is increased. To retain the tuning frequency in the electronic circuit when C is increased, the inductance (L, the magnetic inertia) must be reduced.

Port area and air inertia

With reflex cabinets, the air-inertia factor at the port corresponds to L. Therefore, if a bigger cabinet (more C) is used, a lower air-inertia factor is required to preserve the tuning. It might be expected that the port area would have to be reduced to obtain a lower air-inertia factor and keep the air resonance frequency constant. Yet, examination of Fig. II–7 shows that for the *same* Helmholtz resonance frequency, a larger cabinet requires a *larger* port. Also, from the results plotted in Figs. II–6 and II–7, we find that to raise the frequency (which requires a reduction of the air-inertia factor) port area has to be *increased.* All this seems rather odd!

More air is involved when a bigger port area is used, so one might expect that there will be a greater inertia factor. Sometimes first impressions are misleading and this is one of those times.

The air-inertia factor, though concerned with the inertia of the volume of air around the port, is also affected by other matters. It is really a measure of the energy of motion (kinetic energy) which is tied up when a given volume displacement oscillates in and out at the port.

If, instead of moving in and out through one port, that volume moves through two ports exactly like the first and therefore through double the area, each port handles only half the air flow. With half the air flow per port, the air velocity is halved. Kinetic energy is proportional to velocity squared when other things are equal. So the kinetic energy—that is, the energy tied up in air inertia—is only one-quarter at each of the two ports. The two ports together tie up a total of only half as much energy as a single similar port handling the same total volume. The overall air-inertia factor is halved. Thus, two similar ports in parallel and far enough apart not to affect one another appreciably resemble two similar air-core inductances in parallel and far enough apart for their fields not to interact.

With a single port, made by cutting an opening into the cabinet wall, the kinetic energy of motion is tied up partly in the slice of air occupying the port itself and partly in the surrounding air layers on both sides of the port. If that single port has its area doubled, those surrounding layers are not increased in the same proportion. The air-inertia factor therefore does *not* vary inversely as the port area. But in a general way, the larger the port area the *lower* is the inertia factor. This is confirmed by experiments such as leading to those Figs. II–6 and II–7 and the experience that with a larger cabinet (greater C) a larger port (reduced L) is needed to keep the resonant frequency constant.

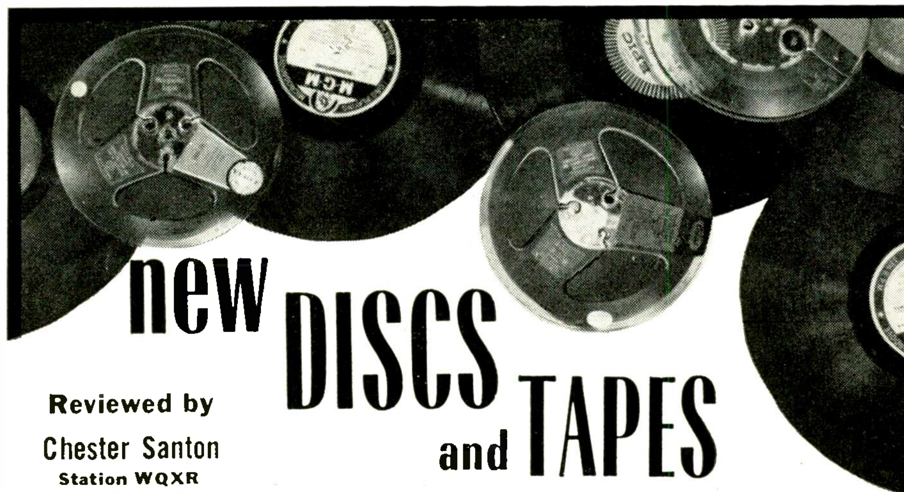
So, when a large cabinet is selected for a certain speaker, a relatively large port with a low inertia factor is needed for correct tuning. If a little cabinet is selected instead, correct tuning demands the higher inertia factor provided by a small port.

It should not be thought that correct adjustment of the port area alone automatically produces the best reflex system for a specific speaker. There are other ways of tuning—using multiple ports, ducted ports, etc. There is damping, and extremely important is the fact that cabinet volume has more effect than just to alter the tuning.

Ideally each speaker manufacturer should issue information regarding each of his speaker types and specify details of the perfect reflex cabinet to go with it. Dealer demonstrations without such a cabinet should then be prohibited.

Unfortunately there is no such thing as the perfect reflex cabinet. Reflex cabinets are necessarily a compromise, and the commercial designer tries to produce an overall system which is a multisided compromise between efficiency, unwanted hangover, response uniformity, size, appearance, weight, cost and perhaps a few other matters besides. What may be the best cabinet from one point of view cannot be the best from all the others. As the enthusiast becomes more discriminating, when he obtains a different speaker or perhaps moves to a new address with larger rooms, the best which he once thought so marvelous ceases to be acceptable, and this may well account for the succession of new designs that keep popping up as the years roll by.

TO BE CONTINUED



new DISCS and TAPES

STEREO and MONO

Reviewed by
Chester Santon
Station WQXR
New York City

Do any spoils belong to the vector? A tentative answer is possible now that additional records have been released by Cook Laboratories in the so-called Vector-Stereo process. Although the idea was suggested by CBS Labs over a year ago, Cook is the first manufacturer to promote the process in his releases. Under the Cook system, the stereo cutter incorporates a reduction of vertical component through feedback. The first half dozen releases in Vector-Stereo exhibit some of the characteristics of Cook monophonic discs. In all instances, output is significantly greater and overall sound no longer has the bottled-up quality found in earlier stereo items. Comparison of the original stereo *King of Organs* record (Bill Floyd at the Paramount Theatre [New York] 1150) and the Vector-Stereo job revealed considerably more presence in the new release, especially in the upper mid-range and the highs. The Vector record includes room noise in passages where the first one did not. Two Vector symphonic albums, Brahms *First* (1060) and the Haydn *Military* and Mozart *40th* (10659), had little or no sign of compression. Unfortunately, review copies of these two releases had defective surfaces. Occasional distortion still exceeds that found on other labels' finest records.

Hugo Winterhalter Goes Latin
Winterhalter Orchestra
RCA Victor Stereo Tape CPS-156
(7-inch; playing time, 25 min. $8.95)

My first impression on hearing this item was that something had gone haywire in my tape machine. The rest of the system sounded normal a few moments earlier when playing stereo discs. I then switched to an older RCA tape. It was normal. The following day, I carried the reel to the station where I tried it on the professional Ampex. Although flattered to some extent by the station's monitor speakers that are also widely used by the record industry, CPS-156 still sounded unlike any other 7.5-ips RCA tape I had ever encountered. The middles are so peaked that it is difficult to recognize individual instruments. Highs can barely be heard beyond the exaggerated mid-range. Output level is almost double that of average tapes. Perhaps someone goofed and applied to a 7.5 reel the 3.75 characteristic of the forthcoming quarter-track tape magazines designed for the consumer unfamiliar with two-track, open-reel stereo tapes.

DeFALLA: *El Amor Brujo*
ALBENIZ: *El Polo*
SURINACH: *Sinfonietta Flamenca*
Carlos Surinach conducting L'Orchestre Radio-Symphonique de Paris
Montilla Stereo Record FMS-2042

The first Montilla classical releases go right to the top in technical features we now expect in stereo records. Distortion is held to a very impressive low. Extra mikes may account for the warmth and presence in the woodwinds, normally a shy and retiring lot. Yet the cohesion of the full orchestra is never lost. The seating arrangement of the players was carefully planned to bring out the inner sorcery of *El Amor Brujo (Love the Magician)*. Surinach's *Sinfonietta Flamenca*, with its allusions to the flamenco music of the gypsies, also fares well under this setup. Highly recommended.

Damiron—Piano and Rhythm
Toreador Stereo Disc TS-534

The Toreador label is a lower priced subsidiary of Montilla Records. At $3.98. it offers dance and folk music from Spain, Cuba, Mexico and other Latin American countries in stereo. Sound quality is surprisingly good, full range, fine output and quiet surfaces. Damiron, a Dominican pianist, plays with authority a collection of merengues, mambos, sones, guarachas and boleros.

***Oklahoma!* (Motion Picture Sound Track)**
Capitol Stereo Record SWAO-595

A highly successful transfer to stereo disc of the movie's multiple-channel recording that features the familiar cast headed by Gordon MacRae and Shirley Jones. Intended for professional stereo playback in theatres, the orignal recording technique is first-rate. The sound of voices and orchestra takes to the air on huge sound stages that are ideal for stereo.

BEETHOVEN: *Symphony No. 3 in E Flat (Eroica)*
Bruno Walter conducting Columbia Symphony Orchestra
Columbia Stereo Record MS-6036

This is the second release in a major project under way on the West Coast. The nine Beethoven symphonies are being recorded in stereo by Bruno Walter. In this symphony and the *Pastoral* already released, smoothly spread stereo reveals his special skills. The interplay of instruments is guided with the sure touch of a conductor who has devoted a lifetime to the study of this music. The width of the sound source makes up for the slight restriction in frequency range that still distinguishes stereo disc from mono.

BACH: *Harpsichord Concerto No. 1 in D Minor*
Harpsichord Concerto No. 4 in A Major
Ruggero Gerlin, Harpsichord
Victor Desarzens conducting Cento Soli Orchestra of Paris
Omega Stereo Disc OSL-13

There is fresh new bite in the sound of these concertos. This is the first time I've heard harpsichord and orchestra in stereo. The solo instrument emerges with far more body and character than it shows in mono. Gerlin is no stranger to recording microphones. In pre-LP days, he recorded a great deal of baroque keyboard music for French labels. If proof ever was needed that Bach spoke an international language, this crisp-sounding record provides it. The soloist is Italian. A Swiss conductor leads a predominantly French orchestra. Smart Americans will enjoy it.

RAVEL: *Bolero*
BIZET: *Carmen Suite*
Alfred Wallenstein conducting Virtuoso Symphony Orchestra of London
Audio Fidelity Stereo Disc FCS-50,005

AF's first classical releases are aimed at the consumer with component equipment. Try the beginning of the Carmen Suite with a compliant pickup of good design. The bass drum on this record goes down to the region covered by only the best present-day woofers. The response reaches far below that of the bass drum on the recent Mercury stereo disc of the *Carmen Suite* (Paray and the Detroit Orchestra). Dynamic range is excellent. Overall response rivals that of a good mono disc. The miking is a bit closer than average but the hall maintains the stereo spread with ease. There is some overload in the climax of the *Bolero*. In several respects, this is the most impressive item of the month.

Stereo Test Record
Audio Fidelity FCS-50,000

This stereo test record is part of Audio Fidelity's release devoted to classical music. One side features symphonic excerpts (mislabeled on my copy) from companion releases. The usual claim found on previous AF stereo discs decorates the jacket of this test record. The musical selections are still said to contain a frequency range extending to 25,000 cycles—using the RIAA curve. Yet the test tones on this record end at 15,000 cycles, and the RIAA curve is not used to reach even that relatively conservative test frequency. It is interesting to find that the only time RIAA is used above 1,000 cycles is in the two bands that test channel separation. These offer 3,000 cycles in the left channel and 800 cycles in the right. The procedure is reversed in the next band. Otherwise, all tones above 1,000 cycles are recorded in phase in both channels at a constant stylus velocity of 5 cm/sec. This calls for playback in a flat position. Frequences below 1,000 cycles, including a sweep from 70 to 15 cycles, are recorded according to the RIAA curve.

Audio Test Record
Institute of High Fidelity IHF 473

The institute has released to subscribers a test record that offers a quick check of mono and stereo systems. One side (blue label) is mono; the other side (red label) is stereo. Essentially the same test material is found on each side. Tones include 15,000, 12,000, 10,000, 100, 70, 50 and 30 cycles. Frequency sweeps cover three areas—50 to 500, 500 to 5,000 and 5,000 to 10,000 cycles. The musical excerpts represent the work of four record firms.

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

WAGNER: *Die Gotterdamerung, Act 3: Brunnhilde's Immolation*
Tristan and Isolde: Prelude and Liebestod
Eileen Farrell, Soprano
Charles Munch conducting Boston Symphony Orchestra
RCA Victor LM-2255

The middle of the recording curve used here is more than Wagnerian in scope. Owners of moving-coil pickups in particular may find that additional rolloff is required in the vicinity of the upper middles to tolerate the highs. Once the response is brought under control, the Farrell voice is a cargo of gold riding the vast sound of the Boston Symphony Orchestra.

TCHAIKOWSKY: *Symphony No. 4 in F Minor*
Leonard Bernstein conducting New York Philharmonic
Columbia ML-5332

Lessons learned in the processing of stereo discs are being put to good use by Columbia in its recent mono records. This one is a beauty. Smoothly extended range with no recourse to artificial emphasis at either end. Bernstein's fresh outlook favors the score's inner voices.

DVORAK: *Concerto for Cello and Orchestra*
Pablo Casals, Cellist
George Szell conducting Czech Philharmonic Orchestra
Angel COLH-30

Another valued reissue of a classic of the past in Angel's *Great Recordings of the Century* series. Recorded in 1937 and processed for maximum range in the recent transfer to LP, the Casals tone conveys an ardor that today's players cannot duplicate. The recent Angel recording by Janos Starker (35417) offers excellent contemporary sound and a splendid performance of this warm-blooded concerto.

GROFE: *Grand Canyon Suite*
Frederick Stark conducting Symphonie Orchester Graunke
Disneyland Records WDL-4019

This is the mono disc version of the original sound track of the Disney film "Grand Canyon" as recorded in Munich, Germany. The pressing, although a shade beneath today's finest, conveys most of the characteristics of today's wide-range German recording techniques. END

Name and address of any manufacturer of records mentioned in this column may be obtained by writing Records, Radio-Electronics, *154 West 14th St., New York 11, N. Y.*

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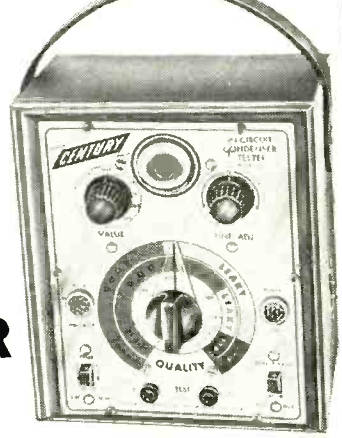

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- Quality of all electrolytic condensers (the abiilty to hold a charge)
- Transformer, socket and wiring leakage capacity

out-of-circuit checks:

- Quality of 100% of all condensers . . .(leakage, shorts, opens and intermittents)
- Value of all condensers from 50 mmfd. to .5 mfd.
- Quality of all electrolytic condensers (the ability to hold a charge)
- High resistance leakage up to 300 megohms
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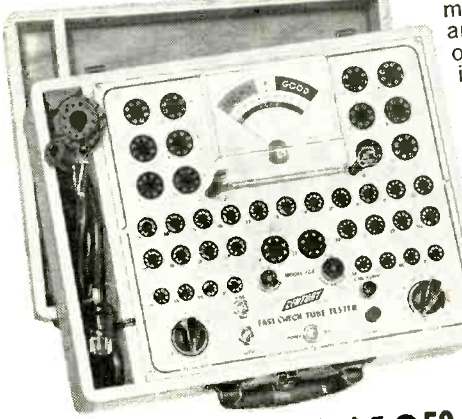

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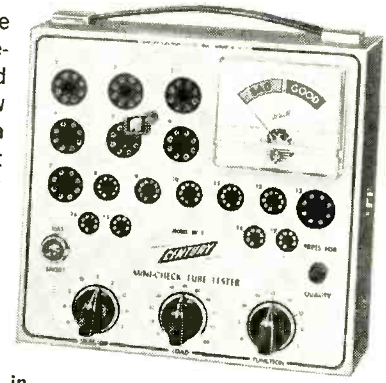

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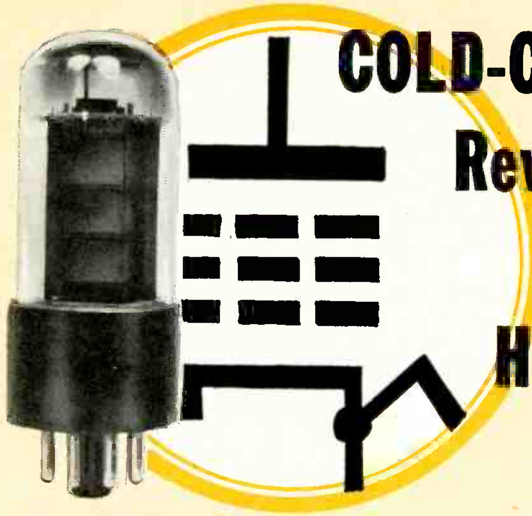


COLD-CATHODE—Revolutionary New Heaterless Tube

By ERIC LESLIE

LAST month this magazine announced that the Signal Corps and Tung-Sol Electric had unveiled, at a special demonstration, a new tube said to be "the first major breakthrough in tube design in more than 30 years."

Outwardly, the tube that was demonstrated is conventional in appearance—for the very good reason that it was constructed in an existing tube envelope. Its internal construction (see Fig. 1) is less conventional, but old-timers will recognize the space-charge circuit that enjoyed a slight popularity for a time in the '30's, using tetrodes such as the type 49.

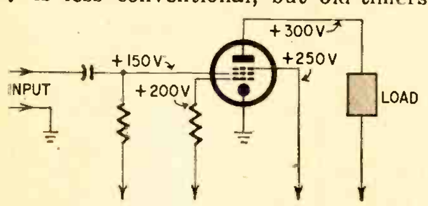


Fig. 1—Internal construction and basic circuit.

It is the cold cathode that makes this tube a "major breakthrough." Almost since the triode was invented, people have wished for a tube that would not waste power heating the cathode. Dr. Dietrich Dobischek of the Signal Corps discovered in 1952 the effect that was to lead to such a cathode. He was bombarding a thin layer of magnesium oxide with an electron beam, to produce secondary emission. The emission was enhanced by maintaining a high positive field near the surface of the layer. Dr. Dobischek was startled to find that the emission continued after the bombarding beam was turned off. The magnesium oxide was emitting electrons on its own, under the influence of the positive field near its surface.

Experiments were immediately begun to see if the newly discovered phenomenon could be adapted to use in electronic tubes. Cathodes were made of various magnesium compounds (some good ones were actually made of drug-store milk of magnesia) and improved methods of preparing and applying the oxide to the nickel sleeve that supports the cathode layer were developed. Tung-Sol scientists concentrated particularly on methods of making cathodes that could be adapted to mass production. The end result was a sprayed-on coating of porous pure magnesium oxide.

When bombarded by electrons to produce secondary emission, the surface of this layer becomes highly positive. It is suspected that this high electric charge draws electrons from the interior of the thin layer and that an avalanche effect similar to that in some semiconductor devices is produced. A characteristic blue glow develops and—with the help of the external field supplied in the new tube by the first grid—the emission continues till the external circuit is broken.

This brings us to the greatest disadvantage of the new tube—the emission is not self-starting. The disadvantage is not too serious—very little is required to start the tube working. In the tube demonstrated, part of the B-supply power was used to light (for less than a second) a tiny filament so placed that light and electrons emitted from it would strike the cathode. Other proposed methods include mixing a little radioactive substance with the cathode material, which would make it self-starting. Or a photoemissive material could be used, which would cause ordinary light to start the action.

Once the tube has been started, it could be maintained by a keep-alive circuit in many types of equipment. The emissive action continues down to less than .01 μa per sq cm. A resistor in the order of megohms around the on–off switch would keep the tube at standby.

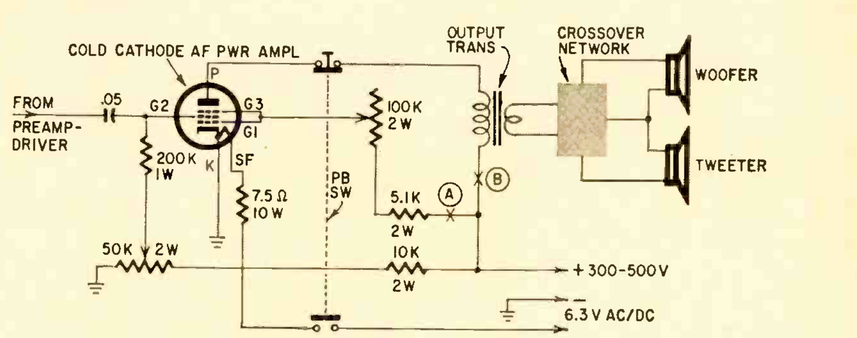
Another disadvantage cited against the tube is the high voltage—300 to 500—required to operate it. This voltage has already been reduced in some tubes, and it is believed that tubes will be built to use no more than 180 volts.

The great advantage is, of course, the power economy. In many receiver and industrial electronic applications, the heater consumes practically all the power used by the tube. Its almost instant starting is an important feature in many applications. And the cathode has an indefinite life, some cathodes having already run 14,000 hours with no signs of deterioration. The service technician will also note the impossibility of a cathode–heater short.

The only type so far constructed is a power amplifier tube. An amplifier (Fig. 2) using one of these sounded exactly like what would be expected from similar equipment using hot-cathode tubes. The tube was also used to operate relays at the Signal Corps–Tung-Sol demonstration. It flashed lights or closed relays in milliseconds, from a cold start.

Tung-Sol plans to put the new type on the market as soon as a complete line of tubes is worked out. Work is also under way on a cold-cathode electron gun for cathode-ray tubes (something which should bring true portable televisers even closer).

But the future of the new cathode material does not stop there. According to Dr. A. M. Skellet, Tung-Sol director of research, the material may make possible a flat picture-on-the-wall display device for TV or radar. It may also lead to great advances in amplifier tubes employing secondary emission multiplication. It may have applications even in the field of lighting, producing a lamp similar in appearance to present fluorescent types, but with greater brightness and longer life. It would work as well at 50° below zero as in the 100°-plus of the tropics. END



(A) Meter may be inserted to measure emission sustaining current.
(B) Meter may be inserted to measure plate current.
G1 Emission sustaining grid.
G2 Control grid.
G3 Screen grid.
SF Starter filament.
K Cathode.
P Plate.

Fig. 2—Typical circuit for cold-cathode audio power amplifier. Double-pole momentary switch is pressed to start cathode emission.

A team headed by electronics' most famous scientists and inventors has developed a system for complete guidance and control of automobiles on the highway, now ready for a full-scale road test

Electronics Guides Your Car

By VLADIMIR K. ZWORYKIN*
and LESLIE E. FLORY†

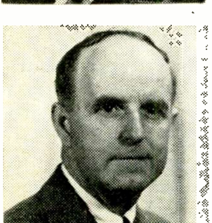
DURING the past 5 years we have been giving increased attention to the problem of improving highway safety through the use of electronic controls. Our interest in this field has been stimulated by the obvious need to reduce traffic accidents, and the availability of electronic tools and techniques which may meet this need.

The need has become increasingly apparent as a direct consequence of improvements in road and vehicle engineering. Because they permit higher road speeds and eliminate mechanical causes of accidents, the importance of the human driver has been emphasized. The minimal effort demanded in guiding a modern car along turnpikes and limited-access roads makes it easier for the driver's attention to stray, and inadequate reaction speed, inattention and drowsiness have become major causes of accidents.

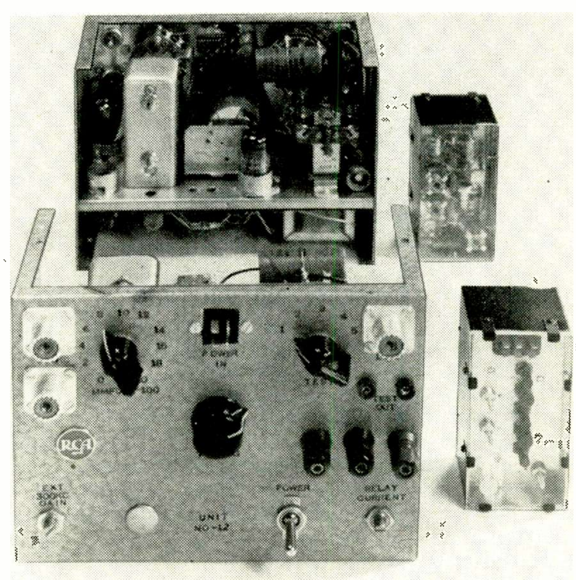
At the same time, the simplicity of the driving process suggests that it can be handled by a mechanical device, much more reliable and faster-acting within its range than the human brain. This suggestion becomes even more reasonable since miniaturization and the transistor have put at our disposal components for control devices which excel in permanence, compactness and low power consumption.

* Honorary vice president, Radio Corporation of America.
† Research engineer, RCA Laboratories.

VLADIMIR K. ZWORYKIN



LESLIE E. FLORY



The two-tube roadside detector unit used in the Nebraska test (left) has already been replaced by more compact and reliable transistor equipment (right).

In approaching the problem of vehicle control on the highways, we recognized two basic requirements.

The first is the visualization of an ultimate system of vehicle control, to which all intermediate steps must contribute. The development of gadgets to meet specific needs without a common goal is wasteful and can retard progress toward the final objective.

The second requirement is that the system can be introduced gradually and compatibly. It is obvious that neither our entire road system nor 100% of our motor vehicles can be converted to automatic operation in a single step. We must expect the coexistence of equipped and unequipped roads as well as equipped and unequipped vehicles for many years after a program of automatic vehicle control has been initiated. Therefore, it is essential that every new road installation contribute to the safety and convenience of all vehicles, equipped or unequipped. Similarly, equipping vehicles with automatic control devices must not work to the disadvantage of unequipped vehicles.

Does three jobs

The functions of the ultimate vehicle control system are threefold: detection, guidance and collision prevention.

Detecting vehicles on the highway gives the traffic-control authority complete information on traffic conditions.

Guidance serves to keep vehicles centered in their traffic lanes, changing lanes or routes when required by external conditions or a preset program in the vehicle.

Collision prevention involves speed

control and lane selection to prevent hitting other vehicles in following a preset route.

In practice, these functions are interlocked. The detection system does more than provide the authorities with a survey of the traffic situation. Its primary purpose is to provide the intelligence to actuate the collision prevention system. Again, while it is the function of the guidance system to keep the car in its proper course, choices between alternate courses, such as staying in lane or switching to another lane to pass a slower vehicle, are determined by signals which form an integral part of the collision-prevention system.

In the system which we shall describe[1], as much of the control system as possible is part of the road. Since high-speed road systems—limited-access roads and turnpikes—are under continuous skilled supervision, this seems preferable to concentrating the equipment in the vehicle. We can visualize three stages in the development of the system.

In the first, only the roadway is modified—the vehicles are completely unequipped. Detectors in the roadway actuate warning lights on the side of the road which warn the driver of a car ahead of him in his own lane or of vehicles approaching in the opposite direction (Fig. 1). Such arrangements are especially valuable where visibility is obscured by a curve, a hill or some other obstacle and should be equally useful in areas subject to fog, smog, etc.

With the next stage, in which visual or auditory indicators are installed in the vehicle, the scope of the system is greatly extended. The detector system in the roadway now excites a "flying tail" of electromagnetic warning signals behind every vehicle on the road, which is picked up by radio receivers in vehicles following in line. The receiver translates the flying tail into a warning indication within the car, which replaces or supplements warning lights installed along the roadside. The signal within the car has the obvious advantage of being uninfluenced by external weather conditions and poor visibility.

Also, the signal which warns the driver he is getting too close to another vehicle or obstacle may be supplemented by a second indication showing his position with respect to the center of the lane. Thus, an auditory signal indicating departure from the center of the lane reduces the hazards of driving under conditions of poor visibility.

In the final, fully automatic stage, the collision-prevention signals act directly on the accelerating and braking systems in the vehicle and the guidance signals control the steering. Thus, as long as the vehicle is on the electronically controlled road system, the driver is relieved of his responsibilities and the vehicle proceeds along a preset course. When the vehicle leaves the controlled road system, it shifts from automatic to manual control. The situation is essentially similar to the piloting of long-range aircraft, where the autopilot may take over except near takeoff and landing.

Of course, for many years these stages will overlap, with cars in all stages of automation using the highway simultaneously.

[1] Developed by a research group including the authors and Winthrop S. Pike and George W. Gray of RCA Laboratories.

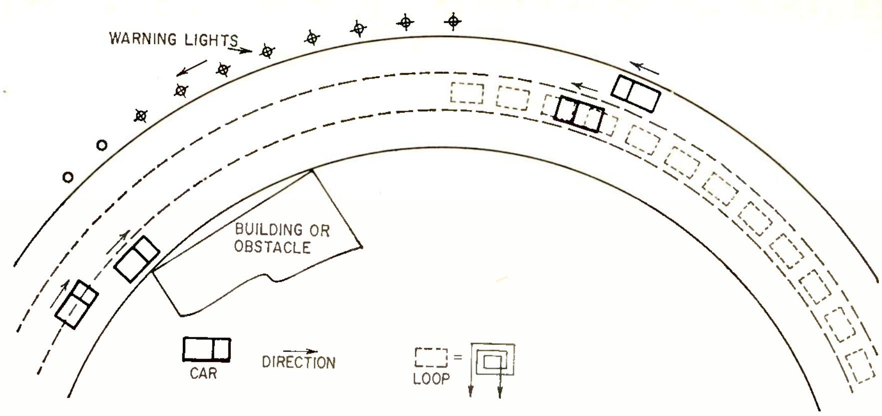


Fig. 1—An application of the electronic highway-control system for which no special equipment is required in automobiles. The diagram represents an overhead view of a curve in a three-lane highway. The approach of a vehicle in the center lane causes a sequential series of warning lights to flash on around the curve ahead of the car, warning approaching vehicles that the center lane is occupied. Dotted rectangles in center strip represent electronic detector units buried in the highway.

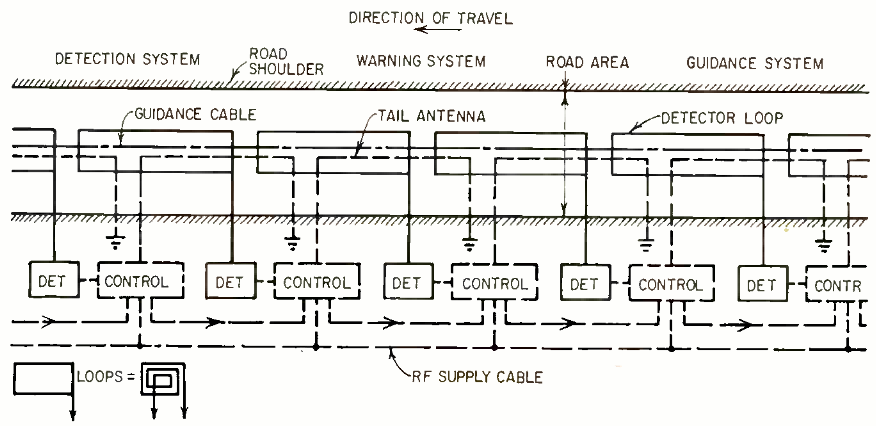


Fig. 2—Basic elements of the electronic control system.

How it works

After this very brief description of the vehicle control system, let us examine its practical realization. Take a look at the road installation. A simplified diagram of a short, straight section of a single lane is shown in Fig. 2. Here we see the detection, warning (or collision-prevention) and guidance systems.

The most conspicuous element of the detection system is a sequence of rectangular loops, about the length of a car, which are inserted in the hardtop and form part of detection circuits whose active components are buried in capsules by the side of the road. The loops can be installed quite simply during road construction and have been installed experimentally in existing roads by using a diamond-saw technique. Detector units used up to now have two vacuum tubes. Replacing tubes with transistors in new units now being designed will reduce power consumption and increase reliability greatly.

When a vehicle passes over a loop, it changes the loop's inductance. This change, acting through the detector, gates the roadside control unit so that warning signals are fed to a sequence of antennas buried in the roadway and extending some distance behind the vehicle in question. These signals, whose amplitude decreases as their distance behind the vehicle increases, constitute the "flying tail" for warning following cars. The same signals may also actuate warning lights by the side of the road, either behind the car or ahead of it. Fig. 3 illustrates the flying tail concept.

Power for the detection units and the flying-tail signals is supplied by a cable carrying high-frequency currents, buried alongside the road. However, these currents themselves, tranmitted with an amplitude determined by the opening or closing of the detector gates, must not serve as the warning signal. Otherwise a failure in the road installation which would suppress the flying tail altogether might be wrongly interpreted as a clear road ahead.

The difficulty is avoided by feeding the high-frequency currents continuously to the flying-tail antennas and impressing a suitable modulation on them through the detector gate. The receiver on a following vehicle will infer the distance from the source of the modulation from the modulation factor of the high-frequency carrier and correctly interpret the absence of the carrier as a system failure.

What about the danger of rear-end collision if a vehicle stalls on the electronic highway? The flying tail which extends behind the vehicle keeps operating, even when the vehicle stops, providing an automatic warning to the following cars. In the completely automatic system, this warning would be picked up by a receiver that would activate the brakes or steering mechanism of the following car, causing it either to stop or steer around the stalled vehicle by changing lanes.

Provision may also be made for an off switch that would let the driver of the following car cut off the automatic system and take control of the car himself to steer around the obstruction. As an additional safety factor, the complete system would include a supplemental warning in case another car were approaching in the passing lane.

The guidance system forms the last part of the road installation. Along a straightway it can take the form of a cable laid in the center of the lane, using the same construction techniques as for the detector loops. This cable may carry a high-frequency current of a frequency different from that of the flying-tail carrier although in a modification of the system the two functions may conceivably be combined.

Equipment in the vehicle

Let us now turn to the equipment of the vehicle. It must be stressed that essential equipment in the vehicle is passive. It consists of sensing devices which are linked, either through the driver or directly, to the vehicle's mechanical controls. No signals are transmitted by it. The car influences following vehicles only through its presence, which, through the detectors in the roadway, modifies the electromagnetic fields radiated by the buried antennas for some distance to the rear—forms the flying tail. It follows that the flying tail of warning signals will be formed behind *any* car or similar obstacle, regardless of its equipment or what the driver does.

In early stages, the vehicle's equipment could be detachable and be installed in the car at the entrance gates to the controlled road system. Of course, more advanced equipment would necessarily form part of the vehicle construction.

The warning signal detector consists of an antenna attached to the undercarriage of the vehicle and a radio receiver whose rectified output may control a buzzer, warning light or other dashboard indicator or, in a fully automatic system, the car's power brakes. Automatic gain control makes the output signal independent of the precise relative location of the detecting antenna and flying-tail antennas in the roadway, and makes it proportional to the depth of modulation impressed by the presence of the obstacle on the high-frequency field. The warning and braking signal amplitude may, in addition, be amplified in a manner dependent on the speed of the vehicle and upon its speed relative to the obstacle. The latter may be derived from the rate of change of the flying-tail signal. Thus, car spacing is controlled by the actual as well as the relative speed of the vehicles. In addition, the overall modulation may be adjusted from the highway, permitting external control of spacing to conform to traffic or highway surface conditions.

In past experimental installations, the guidance signal has been obtained from two tuned antennas mounted on the left and right sides of the front bumper. As the car deviates to the right or left of the lane's center, the current induced by the field of the guidance cable in the left antenna exceeds that induced in the right antenna and vice versa. The difference in the rectified signal from the two antennas controls either an indicator in the car or, in an automatic system, the hydraulic control valves of the steering mechanism.

Thus, with properly stabilized servo controls, the car proceeds down the center of the lane without wavering, unless the driver takes deliberate action which supersedes the automatic guidance mechanism.

Aural instructions to driver

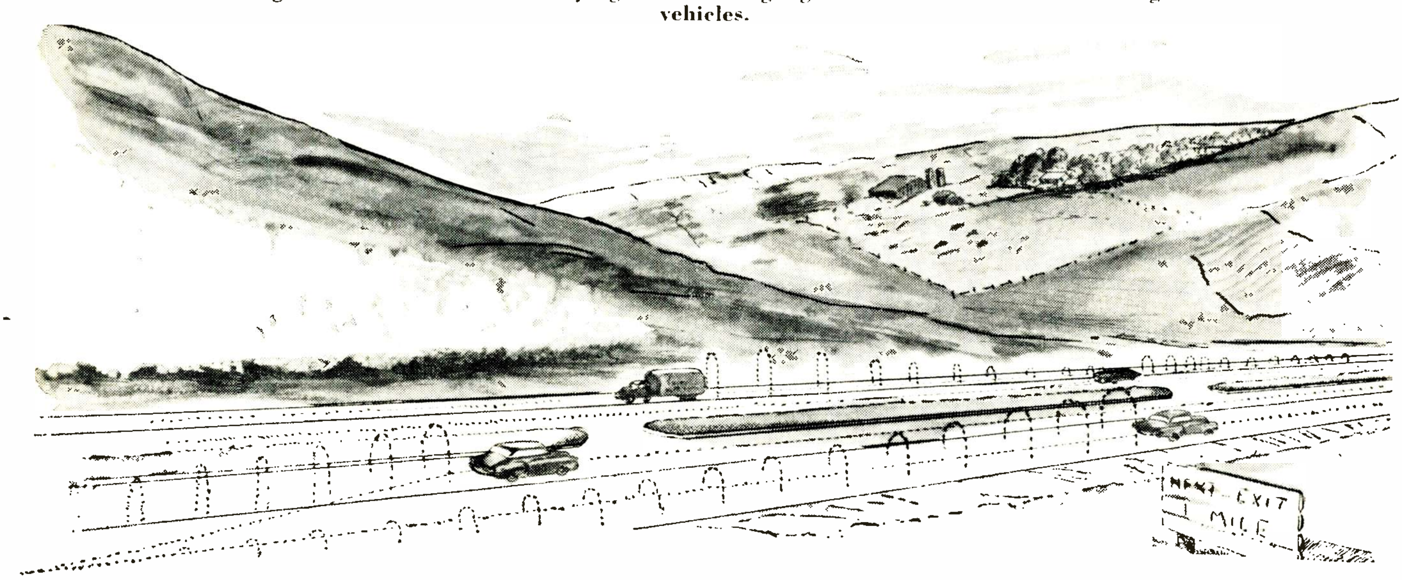
The high-frequency carrier current in the guidance cable permits voice communication from highway control stations to the driver without any additional road installation. Thus the driver can be informed of route numbers, destinations and other pertinent data as he approaches an intersection. Warnings of weather changes, unfavorable road conditions and hazards along the route may contribute to traffic safety. Voice modulation of the guidance signal may also be used to transmit important news flashes and emergency orders and eventually, information regarding commercial facilities in the area, such as motels, restaurants or service stations.

Similarly, the detectors may do double duty as traffic counters and speed controllers. For instance, circuits measuring the time interval between the triggering of successive detector units can control illuminated signs informing the driver (and others) that he is exceeding the speed limit. In a more sophisticated system, the warning may equally well appear inside the offending car and, if desirable, might be used as a control signal to set the maximum speed.

Still another function is the timing of traffic signals at intersections so

(*Continued on page* 104)

Fig. 3—Illustration of the "flying-tail" warning signals that extend behind moving vehicles.



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Electron Tube Division Harrison, N. J.

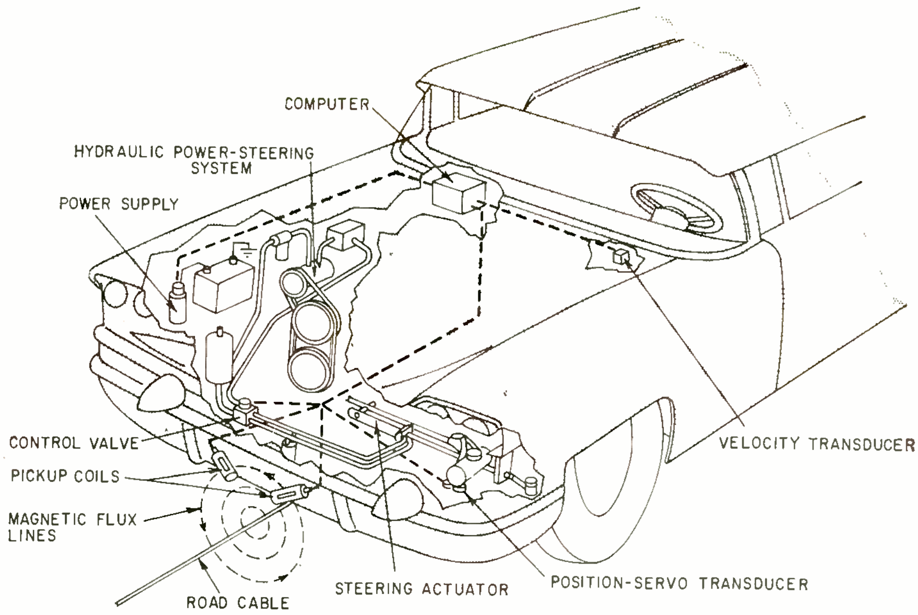


Fig. 4—Automatic steering equipment used by General Motors in test of the RCA guidance system. Glove compartment control-center computer is fed data on car location (from difference of voltages induced in pickup coils), wheel angle (from position servo transducer) and speed (from velocity transducer). When pickup-coil voltages are unequal, it develops a "command voltage" which activates the control valve, adjusting the angle of the wheels through the conventional hydraulic power steering system.

(*Continued from page* 101)

green-light periods for the two roads are always proportional to the flow of traffic along each. Their use for pushing a row of lights ahead of a vehicle approaching a hill or curve to warn vehicles proceeding in the opposite direction against passing has already been mentioned. Other applications, of value particularly in the early stages of the system's development, will be apparent to anyone faced with practical problems of traffic control.

The basic features of the vehicle control system which we have described have recently been tested and demonstrated in cooperation with Mr. L. N. Ress, State Engineer of Nebraska's Department of Roads. The road installation was made on a 300-foot section at a newly constructed intersection in Lincoln, Neb.

The demonstration covered the operation of the vehicle detectors with buried loops, the tail warning system employing both lights and radio signals, and the guidance system. Dashboard indicators permitted a manually controlled car to be driven safely along the lane's center, adjusting its speed to that of preceding vehicles, even when the windshield was completely covered to simulate automatic-control conditions.

A similar system with automatic steering control of a standard 1958 Chevrolet has recently been demonstrated along a 1-mile check track at the General Motors Technical Center in Warren, Mich. The guidance cable had been inserted in the road surface by the diamond-saw technique already mentioned. The electrical signals derived from two bumper-mounted pickup coils controlled the steering by means of a hydraulic power piston (Fig. 4).

The results of these and earlier tests have confirmed our belief that a large measure of automatic control is technically possible. Furthermore, we are convinced that it is essential if the accident toll is to be materially reduced. The electronic techniques developed so far indicate a way to realize the desired objective. However, an optimized, workable system demands the cooperation of many groups, including as a minimum, highway engineers, automobile manufacturers and the electronics industry.

The results of their efforts must be tested on an enlarged test facility permitting the operation of controlled experimental vehicles at normal speeds. In this manner we can determine the optimum length and shape of the flying tail, the preferred dimensioning of the detector loops, the best ways of generating and applying the control signals within the car and many other factors which must be known before vehicle control systems are installed on public roads. Clearly, much remains to be done. The urgent need to reduce the accident toll on our highways demands that the work get under way. END

This is the second article of a series on highway safety and electronics, the first of which appeared in January. The next will appear in an early issue.

ADVANCE ANNOUNCEMENT

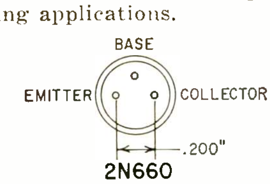
The 14th Annual Old-Timer's Nite Round-Up and Banquet will be held Saturday, April 18, 1959, in the Grand Ballroom of the Hotel Stacy-Trent in downtown Trenton. The party will be stag and a turkey dinner will be served. Contact Ed G. Raser, 19 Blackwood Drive, Trenton 8, N. J., for details. The sponsor is by the Delaware Valley Radio Association.

NEW TUBES and SEMI-CONDUCTORS

THE past month has provided us with an array of new units. Keeping step with transistor development are three vhf Mesa transistors. A high-frequency junction transistor, switching transistors and a 21-inch 110° picture tube are listed.

2N660

A high-frequency p-n-p fusion alloy junction transistor for computer and switching applications.



Maximum ratings of the Raytheon 2N660 are:

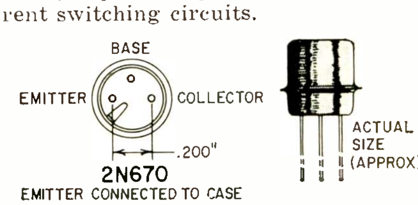
V_{CB}	25
V_{EB}	12
V_{CE}	11
V_{CE} (V_{BE} = 0.1)	16
I_C (amp)	1

Average characteristics at 250°C are:

h_{FE}	65	(I_B = 10 ma, V_{CE} = 0.35)
$f_{\alpha b}$ (mc)	15	

2N670

A p-n-p germanium alloy junction transistor intended for use in high-voltage pulse-amplifier and high-current switching circuits.



Maximum tentative ratings of the Philco 2N670 are:

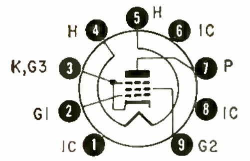
V_{CB}	40
V_{CE} (V_{BE} = 1.5)	40
V_{EB}	40
I_C (amps)	2
P_{total} (mw) (25°C)	300

Typical electrical characteristics at 250°C are:

h_{fe}	100	(V_{CE} = 1.5, I_C = 1 amp)
$f_{\alpha b}$ (kc)	650	(V_{CB} = 2, I_C = 100 ma)

6BQ5, 8BQ5

Power pentodes in a 9-pin miniature envelope intended for use in the audio output stage of radio and television



6BQ5,8BQ5
IC=INTERNAL CONN (DO NOT USE)

receivers and in phonographs. The 6BQ5 has a 6.3-volt 760-ma heater. The 8BQ5 has an 8-volt 600-ma heater with controlled warmup for use in series-string heater circuits. All other specs hold for both tubes. The 6BQ5 is an exact replacement for the EL84.

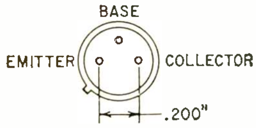
The 6BQ5 and 8BQ5 are made by RCA. Maximum ratings in class-A1 amplifier service are:

V_P	300
V_{G2}	300
V_{G1} (pos bias value)	0
I_K (ma)	65
P_P (watts)	12
$G2_{input}$ (watts)*	2

*must not exceed 4 watts under maximum-signal conditions.

2N1141, -142, -143

Three p-n-p germanium high-frequency Mesa transistors featuring alpha cutoff frequencies up to 750 mc and power dissipations of 750 mw. All are designed for reliable rf operation in the vhf range.



2N1141
2N1142
2N1143

Maximum ratings of these Texas Instruments transistors are:

	2N1141	-42	-43
V_{CE}	35	30	25
V_{EB}	1	0.7	0.5
I_C (ma)	100	100	100
I_E (ma)	100	100	100
P_{total} (mw)	750	750	750

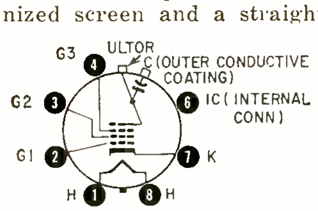
Typical characteristics at 25°C are:

	2N1141	-42	-43
$f_{\alpha b}$ (mc)	750	600	480
h_{fe} (db)	12	10	8

(V_{CB} = 10, I_C = 10 ma, f = 100 mc)

21EQP4

Another addition to the line of 110° picture tubes, the 21EQP4 is a 21-inch rectangular glass tube made by Sylvania. It has a spherical faceplate, aluminized screen and a straight gun



21EQP4

design which needs no ion trap. Its 6.3-volt 600-ma heater has an 11-second controlled warmup for use in series-string heater circuits.

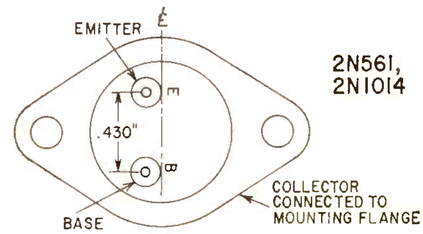
Maximum ratings of the 21EQP4 are:

V_{ultor}	20,000

V_{g3}	700
V_{g2}	700
V_{g1} (neg bias value)	154
(neg peak value)	220
(pos bias value)	0
(pos peak value)	2
$R_{g1\ circuit}$ (megohms)	1.5

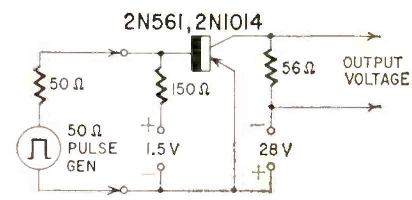
2N561, 2N1014

Germanium, p-n-p, alloy-junction power transistors for applications in power-switching, voltage-regulator, multivibrator, dc-to-dc converter and power-supply circuits. They may also



be used in audio oscillator service and in large-signal class-A or class-B push-pull audio amplifiers.

Typical ratings of these RCA transistors in an on–off power-switching circuit (see diagram) are:



$V_{dc\ supply}$	28
$V_{dc\ base\ bias}$	1.5
R_{gen} (ohms)	50
$R_{base\ bias}$ (ohms)	150
R_L (ohms)	56
I_B (turn-on) (ma)	6
(turn-off) (ma)	0
Switching time:	
T_{on} (μsec)	140
T_{off} (μsec)	110
On condition:	
I_C (amp)	0.49
V_{BE}	0.36
V_{CE}	0.25
$P_{driving}$ (mw)	2.34
P_{total} (mw)	123
Power gain (db)	33.7
Efficiency (%)	99.3
P_{out} (watts)	13.1

The 2N1014 differs from the 2N561 in that it has a higher maximum peak collector-to-base and collector-to-emitter voltage rating.

	2N1014	2N561
V_{CB} (peak)	100	80
V_{CE} (peak)	65	50

END

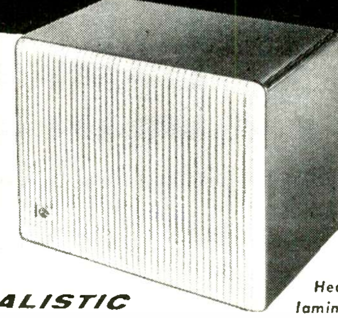
CORRECTION

Through a printer's error, there are discrepancies between the diagram, parts list and text of the article "Duo-Rectifier Power Supply" on page 49 of the February issue. The values of R10 and R11 are correct on the diagram and incorrect in text and parts list.

We thank Mr. Sidney Wolin, Fort Wayne, Ind., and others for calling this to our attention.

'REALISTIC-ALLY' SPEAKING

Here's Why RADIO SHACK'S 1959 SOLO Speaker Is Worth Twice Our Price!

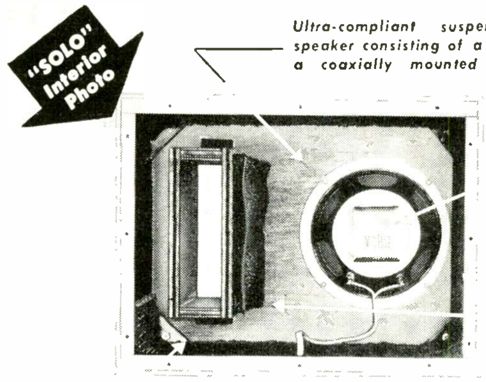


Heavy laminated mahogany cabinet

REALISTIC
"SOLO"
$15.95
2 for Stereo $29.50

If made in this country, Radio Shack's exclusive "SOLO" speaker system would cost **more than twice** its low price. Here at last is a VERY SMALL SPACE HI-FI speaker with **real lows** and **clean highs.** It's designed by the same Radio Shack engineering staff that created the world famous ELECTROSTAT-3 tweeter. And its magnificent performance is matched in appearance by its handsome **furniture-finished** dark mahogany enclosure with blending grill.

Size 14½" x 11" x 10½" deep; 8 ohms to match any hi-fi amplifier, console or TV set; sealed back with terminal strip; cabinet finished on **four sides** for horizontal, vertical or suspended use; 2 runners of matching mahogany included; response is 50-14,000 cps. **Quality-wise, space-wise and budget-wise** . . . there's no other speaker to compare with our "SOLO"!

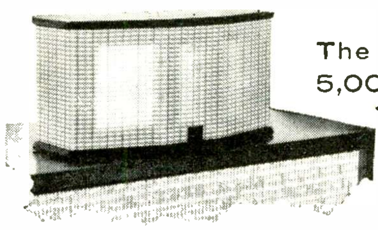


Ultra-compliant suspension cone speaker consisting of a woofer with a coaxially mounted "whizzer"

Extra heavy Alnico magnet

Acoustic lining throughout for clean sound

Tuned, vented, duct-type enclosure . . . Helmholtz resonator . . . especially designed to extend the range of the SOLO with REAL lows



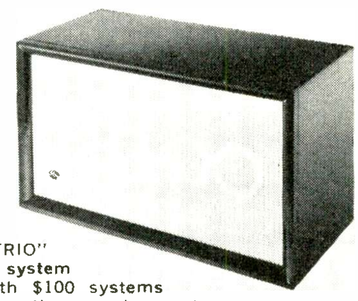
The World Famous 5,000-25,000 cps TWEETER

REALISTIC
"ELECTROSTAT-3"
$27.50

Radio Shack's REALISTIC ELECTROSTAT-3 adds a new acoustic brilliance to any speaker system . . . smooth, silky response from 5,000 cps to **beyond the range of human hearing.** It's the tweeter that's been getting the rave notices . the tweeter the whole world wants most, **regardless of price.** Mahogany, blond or walnut finish. Size 11⅞" wide x 5⅞" high x 4½" deep.

REALISTIC ELECTROSTAT-3 CROSSOVER NETWORK KITS include coils, condensers and L pad, complete with simple assembly instructions. Either 8 or 16 ohm kit .... **each $4.95**

REALISTIC
"TRIO"
$44.50
2 for Stereo
$79.50



Radio Shack's REALISTIC "TRIO" is a **magnificent 3-speaker system** that compares brilliantly with $100 systems . . . and includes features no other speaker system has . . . such as the patented center-mounted acoustic cut-off filter in the 8" woofer. This provides **clean lows without h-f interference.** The superbly engineered dual tweeters have a smooth wide range and are mounted at offset angles for dispersing the sound **uniformly in all directions.** In addition to being solidly encased, they are so mounted that they may be rotated 90° for maximum effectiveness in either upright or lowboy positions. Dual hi-pass filter; response **35-17,500 cps;** 8 ohms; laminated dark mahogany furniture-finished on 4 sides; size 22½" x 13" x 11½" deep; complete with 2 separate, matching runners.

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- 730 Commonwealth Ave., Boston 17, Mass.
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730 Commonwealth Ave., Boston 17, Mass.
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Quan.	REALISTIC	Sh. Wt.	Order No.	Sale
	SOLO Speaker	12 lbs.	90LX250	$15.95
	TRIO Speaker	25 lbs.	90LX210	44.50
	ELECTROSTAT-3	7 lbs.	36CX017Y	27.50
	8-Ohm X-Over	2 lbs.	91L500	4.95

☐ Radio Shack 1959 Hi-Fi Buying Guide

☐ Check ☐ Money Order ☐ C.O.D.

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Address________________

City________ Zone____ State________

TECHNICIANS' NEWS

TWO ESFETA MEETINGS

The Empire State Federation of Electronic Technicians Associations was held February 8 at Syracuse, N. Y. A meeting of ESFETA delegates and representatives of TV set manufacturers to discuss printed circuitry in TV receivers was held the previous evening. The manufacturers' case was stated by Dan Creato of RCA, Steve Mihalic of G-E and Mac Romey of Westinghouse. At the end of the discussion, it was the unanimous opinion of ESFETA that printed circuitry is here to stay, even though at present it is the cause of considerable consternation to the service industry. It was felt that certain problems will be solved through cooperation between manufacturing and service, and that future development of printed circuits may advance both the servicing and manufacturing industry. ESFETA has established liaison with the manufacturers' service departments, through which it is hoped to be possible to supply proper service data to the membership.

Chief subject discussed at the regular business meeting was the proposed bill for certifying TV repair technicians, which was to be introduced to the New York State Legislature immediately. The meeting favored some changes and revisions in the bill proposed by the Attorney General. Most important of these were those referring to qualification of technicians and to the composition of the board that would administer the Act. The proposed bill would qualify technicians on the basis of a practical examination. The association feels that this might pass school graduates who would not be efficient service technicians and proposes a minimum of 1,000 hours of study in a recognized course plus the equivalent of 2,000 hours of experience under a qualified technician. (See "Guild Talks Certification," below.) However, the requirement of 1,000 hours of school might be dispensed with if the applicant had more than 4,000 hours' experience. ESFETA also feels that the administering board should include five men with at least eight years of servicing experience (proposed bill calls for two, with four years of experience each, on a three-man board).

GUILD TALKS CERTIFICATION

Differing views about TV service technician certification were the major topic for discussion at a recent meeting of the Radio & Television Guild of Long Island. The legislation, as proposed by the State Attorney General's office, would set up a certification board to pass on the qualifications of service technicians. Those who met the board's requirements would be certified. However, a noncertified technician could still operate a shop, as the certification would be on a voluntary basis.

Among those opposed to the proposal is Max Leibowitz, a member of the Associated Radio-Television Servicemen of New York. He appears to feel that such a bill cannot prevent technicians —certified or not—from claiming that they are authorized dealers and fully qualified to service TV receivers.

On the other side is Murray Barlowe. A former Guild president, he says that, should the bill be passed, it will give TV technicians the same status enjoyed by certified public accountants.

Requirements of the proposed bill, which were worked out with the help of Robert Larsen, Guild president, are:

1. Service techs must have completed television studies totaling at least 1,000 hours.

2. Service techs must have worked under proper supervision for at least 2,000 hours.

3. They must pay a yearly fee of $30.

The certification board of examiners would include two representatives of servicing with four years of experience, a representative of television education, a manufacturer's service manager, a dealer with five years' experience selling receivers, a licensed engineer and a representative for the public.

PROTEST CAPTIVE SERVICE

The Radio-TV Association of Santa Clara Valley (Calif.) moved against an invasion by Packard-Bell captive service, the *RTA Magazine* reported in a recent issue. A formal letter of protest was sent to P-B's regional manager, Kenneth R. Johnson, and George Gillespie, local P-B distributor.

The protest was sent after members learned in general meeting that P-B was getting ready to open a service company shop in San Jose.

The letter said, in part:

"Surveys have established quite clearly that the many fully equipped, well staffed service shops are well able to meet TV and radio service needs in this area.

"It is our firm conviction that Packard-Bell and its representatives do not wish to be responsible for introducing the problems attendant with captive service in Santa Clara Valley and environs. . . ."

SELF-REGULATION IS AIM OF CONNECTICUT GROUP

The Norwalk Association of Television Servicemen has adopted a plan for testing and certificating TV repair technicians, apprentices and installers. The plan was drawn up as an alternate to a proposal that the city adopt ordinances covering TV servicing. NATS believes that TV service regulation should come from within the industry

(Continued on page 114)

How far can you go in electronics without a degree?

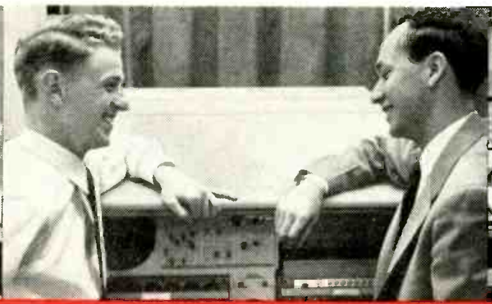
A few years ago, Lincoln E. Kitchin had no formal degree and knew nothing about electronic computers.

He still doesn't have a degree, yet today, he is a Field Engineer on one of America's biggest electronics projects. He helps maintain one of the largest computers in the world. He's doing work ordinarily done by engineers—an opportunity usually denied to men without a degree. This is a story of unusual significance to every technician who feels himself handicapped by lack of a formal degree.

"It all started back at the Base," Link recalls, "about two years ago. We were having lunch. One of my fellow Aircrewmen described an interview he had just had—with IBM.

"It sounded good to me—particularly the field engineering aspects. I wasn't anxious to start my civilian electronics career stuck in a corner of some plant. Here was a chance to work in the field—with all the advantages of a permanent location. I made a note to add IBM to the companies I was considering for civilian work."

Taking notes in IBM Field Engineering class



Discussing a SAGE display console

Front view of computer frame

Interviewed by IBM

A month later, Link sat across the desk from an IBM interviewer. "Frankly," confesses Link, "I was scared at the thought of this interview. I didn't know the difference between an analog and a digital computer. I didn't expect to get the job."

The interviewer put Link quickly at his ease. A check of his background revealed Link's Service training—28 weeks of Class "A" aviation electronics plus Class "C" schooling in LORAN, RADAR and SONAR. He took a test, which indicated excellent aptitude for computer work.

Then Link learned how IBM would train him in electronics—for five months at full salary—to become a Field Engineer on the SAGE Program. He learned about SAGE, part of our nation's radar defense net, which is built around giant IBM computers—each containing 50,000 vacuum tubes plus 170,000 diodes. He heard about IBM's excellent company benefits, especially interesting to Link who had a wife and child. By the time the interview was over, Link had decided that IBM and the SAGE Program were what he was looking for. He decided then and there that he wanted to come with IBM.

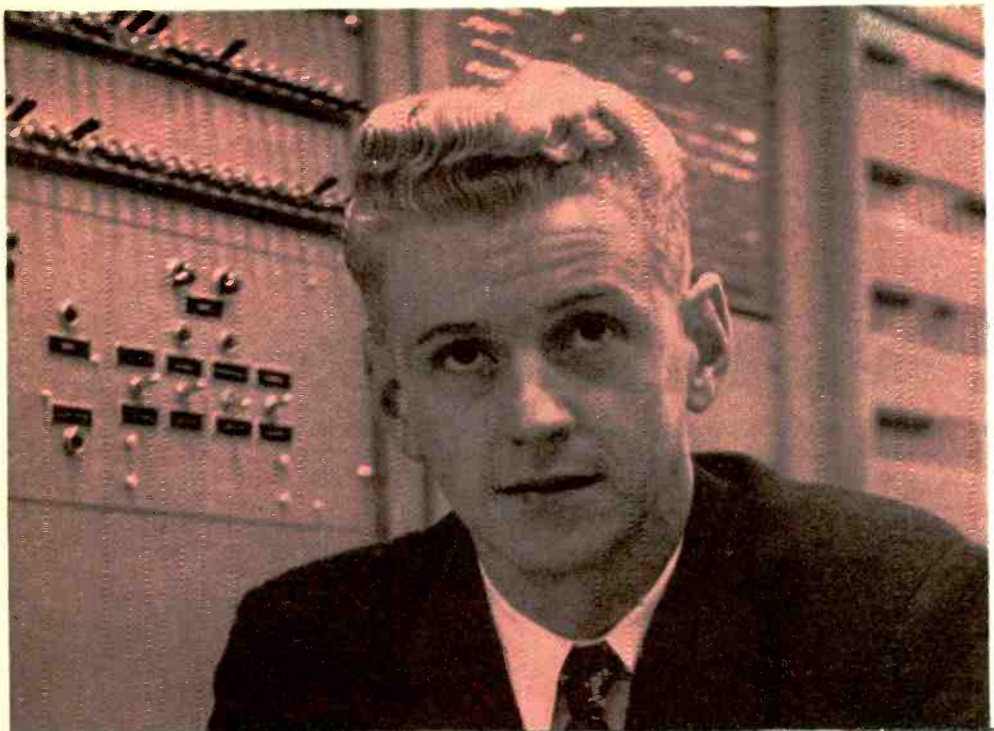
Receives 20 weeks' training

Link reported to Kingston, N. Y., for training. In the IBM "school," he studied basic computer circuits, computer logic and programming, card punch machines—all part of the twenty-week course a Computer Units Field Engineer takes. "The instruction was excellent," he recalls. "Our teachers, experienced field men, often made points not in the textbooks." Formal classroom lectures accounted for half his time, the other half being spent in the laboratories, where he worked on actual computer equipment for SAGE. During his training period, Link received a living allowance in addition to his salary.

Assigned to site in home state

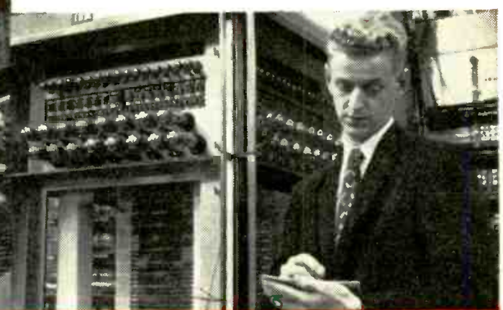
His twenty weeks' training completed, Link was assigned to the SAGE site at Topsham, Maine. "IBM makes every effort to assign you to a location of your choice wherever possible," Link, who is a native State-o'-Mainer, points out.

At Topsham, Link has completed the installation phase of the computer. Now, his work consists of preventive maintenance and "keeping the customer happy"—the customer, in this case, being the Air Force personnel who man and operate the computer. "Installing this giant computer was a significant engineering feat," Link recalls. "First we ran 2,509 cables from 4 to 300 feet long. Then we bolted the computer sections together and hooked up the cables. Next came the testing phase in anticipation of Air Force acceptance tests.



A problem in pluggable units

Working on manual input board of SAGE computer



Recording data on main core memory unit

"I'm in the Display Group," Link continues, "which has responsibility for over one hundred display consoles. Each of these has a 19-inch and a 5-inch cathode ray tube (similar to a TV tube) plus associated circuits. The knowledge of complex circuitry which we learned in the IBM school is essential for this work. We also maintain our own test equipment—oscilloscopes, meters, signal generators and specially designed pluggable unit test equipment."

What does the future hold?

Link looks forward to a rewarding career as a Computer Units Field Engineer. Promotion-wise, he could become, with further training, a Computer Systems Field Engineer, a Group Supervisor or Group Manager. Most important, however, he believes, is the excellent electronics background he's acquiring for the years ahead. "I've had a new engineering dimension added to my career—thanks to IBM's willingness to spend time and money training technicians to assume engineering responsibilities."

A career for you with IBM?

Since Link Kitchin joined IBM and the SAGE Program, opportunities are more promising than ever. This long-range program is destined for increasing national importance and IBM will invest thousands of dollars in the right men to insure its success.

If you have a minimum of 3 years' technical schooling—or equivalent experience—you may be eligible for advanced training for 5 months as a Computer Units Field Engineer. While training, you receive full pay plus living allowance before assignment to a permanent location. You are paid a salary, not hourly wages, plus overtime.

From then on, you can go as far as your abilities and ambition will take you. IBM is the leader in a field that offers you unlimited horizons. And, as you may already know, at IBM you receive company-paid benefits that set standards for industry today.

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instead of from without, says Ralph Boyle, president of the group. To this end, NATS has also named a grievance committee and a code of ethics committee.

1-HOUR SERVICE PULLS FOR FORT WORTH SHOP

"TV service while you wait" is offered by Advance TV Service of Fort Worth, Tex., according to the newspaper *Home Furnishings Daily*. The owners, John Turner and Dave Simon, say that many owners who hesitate to have sets removed from their homes bring them in willingly if they feel that the work can be done immediately and they can take their TV's home again.

Rates are $6.50 per hour for bench work, plus cost of parts. When service calls are made, Advance TV charges $4.50 per call.

OLD-TIMER HEADS PA. FEDERATION

Dave Krantz of Philadelphia was elected president of the Federation of Radio & Television Service Associations of Pennsylvania (FRTSAP) at their recent annual meeting. Krantz was one of the founders of the federation 12 years ago, and served as its president for the first 6 years of its life. Earlier, he had been active in the Philadelphia Radio ServiceMen's Association (PRSMA). Leon Helk of Carbondale, another veteran association worker, was elected corresponding secretary.

RAYTHEON AD NOTED BY COLUMBUS TECHS

The January issue of *Radio-Television Service Dealers' News* (Columbus, Ohio) calls attention to the Raytheon ad pictured here, which ran in *Time*, *Newsweek* and other magazines.

It pictures a housewife and states: "Before you call a TV-Radio Service Dealer *ask yourself these four questions* 1. Does he have an established business facility? 2. Does he guarantee his work and parts? 3. Does he charge a fair price for a home service call? 4. Does he provide an itemized bill?" "Get a copy of one of these magazines," says ARTSD News "and see what Raytheon is doing for you."

I.D.E.A. DISCUSSES TV SERVICE POLICIES

Communications from TV manufacturers on their plans or lack of plans to supply repair service directly to the user of home TV receivers constituted the most important business of the Chicago meeting of the Independent Dealers Electronic Activities Committee, held in January.

Robert Sickels of Indiana acted as chairman in place of Karl Heinzman, who was ill. Service association members representing 84 associations in 13 states were present.

Ten of 12 television manufacturers contacted replied to the request of I.D.E.A. for a statement. Though in some cases these statements were vaguely worded (resulting in occasional cries of "double-talk" from the delegates), the concensus was favorable to independent service. Replies ranged from Sylvania's "We have never been in captive service and do not plan any change" to "Our customers . . . depend upon the independent service dealer for the vast majority of service," but that "we cannot abdicate our service responsibility," which paraphrases the replies of two or three of the larger companies.

Committee officers for 1959, elected at the meeting, were Karl Heinzman, Detroit, president; Al Niehaus, San Antonio, vice president; John Perez, Columbus, secretary. A July meeting was decided upon; exact date and city to be set later.

PUBLISHER OFFERS OLD-TIME DIAGRAMS

Supreme Publications announces the availability of schematics and service data on equipment dating back as far as 1926 and continuing to the present. Individual radio schematics will be available for 40c, TV data 75c per model. A manual covering the most-used sets of the 1926–38 period is also available at $2.50.

Some of these sets are of purely historical interest, but a recent request for old photos by this magazine unearthed a surprising number of sets 25 and 30 years old that are described by their owners as "still operating perfectly."

SAN ANTONIO TRAINS HANDICAPPED WORKERS

Texas Electronics Association of San Antonio has completed a draft program for training handicapped individuals. Under the plan, according to the local technicians' paper *SARTA News*, each interested shop would take one or two of these state-supported people and train them in basic radio and television work. The state contributes $40 monthly to the shop owner and, for the first 9 months, the shop pays no salary.

"These men," says *SARTA News*, "will be screened by our own committee as to their aptitude and willingness to learn the trade, and then sent to the shop desiring to cooperate. After the 9-month training period, the shop may hire the man as a regular employee, but is not required to do so."

NEED THREE PARTS SHOWS, SAYS MOCH OF NATESA

The service industry would welcome and support three or more regional electronic parts shows a year, as proposed by the executive committee of the electronic reps association, in the opinion of Frank J. Moch, executive director of the National Alliance of Television and Electronic Service Associations (NATESA).

"Particularly attractive to service groups would be the feature of the proposed shows which would give service organizations an opportunity to participate in the event as customers of the distributors," Moch said.

"We have long felt that a single distributor show in Chicago to which the distributor's customers, the service business operator, is not admitted, is not, in any sense of the word, an all-industry show," he said. "We believe the pattern set at a recent independent regional parts show, to which service people were admitted, is the type of industry exposition vitally needed at this time. The idea of holding shows in three or more markets is, in our opinion, a good beginning. At least it would bring a manufacturer's products to his customer, the distributor, instead of attempting to introduce such a show in one area to which manufacturer's customers must come, and to which the distributor's customer cannot come.

"As for the educational feature of these shows which now is being emphasized, it would provide the manufacturer and distributor with an ideal opportunity to conduct a service seminar where it would do the most good."

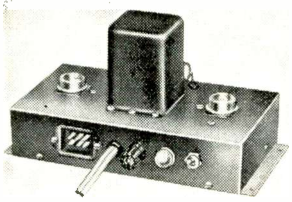
SOVIETS HAVE TROUBLES WITH TV REPAIRS

Some newspaper "exposés" would lead one to believe that sharp practices in TV repair were limited to this country. But the Soviet trade-union newspaper *Trud* came out with a blast at poor service and dishonest dealings.

The regimented employee of the state-owned repair shops was the target of *Trud's* denunciations. The newspaper stated that some TV and refrigerator repairmen just don't come through with service unless the customer slips them an illegal bonus. One man, says the newspaper, lugged his set from shop to shop, finally leaving it at one for 2 months, but was unable to get it fixed at the state-set price. He tipped the repairman—the job was done. END

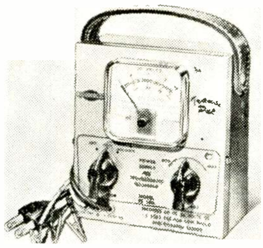
On the Market

MOBILE POWER-SUPPLY KIT, *model MP-1.* Heavy-duty transistor supply furnishes 120 watts of dc power, up to 150 watts intermittently. Designed



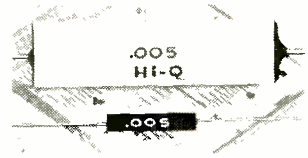
to power manufacturer's MT-1 transmitter and MR-1 receiver. Includes connecting-cables. Operates from 12-volt battery. Contains push-to-talk power-switching relay. 9 1/16 x 4¾ x 2 inches.—**Heath Co.,** Benton Harbor, Mich.

TRANSISTOR POWER SUPPLY, *Sencore Transi-Pac PS-103.* Isolated power supply re-



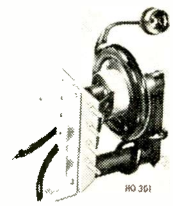
places batteries while repairing transistor radios. Provides 0–24 volts output with a 1.5-volt tap for radios with a tapped supply. Delivers up to 200 ma on peaks, 100 ma continuously. Meter gives continuous output indication.—**Service Instruments Corp.,** 121 Official Rd., Addison, Ill.

CERAMIC CAPACITORS, *Cerafil line.* Ultra-miniature units; compared with standard capacitor in photo. Values from 10 $\mu\mu$f to 1.0 μf in working



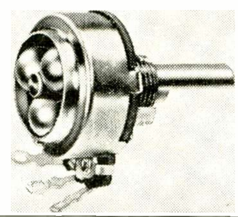
voltages of 30 and 100.—**Aerovox Corp.,** New Bedford, Mass.

REPLACEMENT FLYBACKS *Stancor HO-301* (shown) replaces Admiral parts 79D65-2 and 79D65-4. *HO-300* for Wells



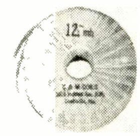
Gardner 53X355. *HO-307* for Setchell-Carlson T-123, T-124, WF-14 and FW-70. *HO-308* for Setchell-Carlson T-201, T-132, T-133, WF-71 and WF-80.—**Chicago Standard Transformer Corp.,** 3501 W. Addison St., Chicago 18, Ill.

VERNIER VARIABLE RE-



SISTOR. Contact arm rotates 1° for each 13.5° shaft rotation. *Type VA-45* is 15/16-inch-diameter unit only 5/32 inch deeper than standard nonvernier type 45. Resistance range, 250 ohms through 5 megohms. Available in variety of resistance tapers. —**Chicago Telephone Supply Corp.,** Elkhart, Ind.

AIR-CORE INDUCTORS for crossover networks. 80 values in No. 17 wire range from .05 to 12.0 mh. 52 values in No. 16 wire range from 5.0 to 20 mh. Inductors are oven-baked, calibrated and have spaghetti applied to a 7-inch tinned lead. Then they



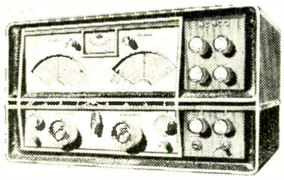
are cotton wrapped, dipped in varnish and baked.—**C & M Coils,** 3016 Holmes Ave. NW., Huntsville, Ala.

MOBILE HAM TRANSMITTER KIT, *Cheyenne MT-1.* 90 watts input on phone. Covers

80, 40, 20, 15 and 10 meters. Built-in vfo, modulator, 4 rf stages, 6146 final and pi-network output coupling. Requires

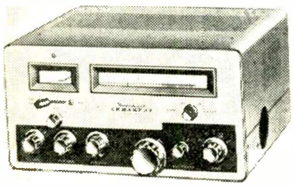
500–600 volts dc at 150 ma and 300 volts dc at 100 ma.—**Heath Co.**, Benton Harbor, Mich.

COMMUNICATIONS RECEIVER, *NC-400*. AM, CW and SSB. 18-tube receiver has range



of 540 kc to 31 mc in 7 bands. Selectivity range of 16 kc to 150 cycles with if and crystal filters supplied. With accessory filters, selectivity range is 16 kc to 500 cycles. Sensitivity is approximate 1 µv for a 10-db signal-to-noise ratio.—**National Co., Inc.**, Malden, Mass.

MOBILE HAM RECEIVER KIT, *Comanche MR-1*. 8-tube superhet for AM, CW and SSB

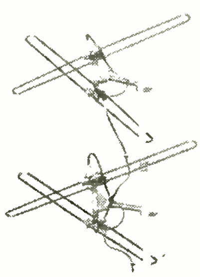


reception on the 80-, 40-, 20-, 15- and 10-meter Amateur bands. 3-mc lattice type if filter permits single conversion without image interference. Included are rf stage, converter, 2 if amplifiers, 2 detectors, noise limiter, 2 audio stages and a voltage regulator. Sensitivity better than 1 µv on all bands. Signal-to-noise 10 db down at 1 µv input. 2-watts undistorted audio output—**Heath Co.**, Benton Harbor, Mich.

AMATEUR BEAM ROTATOR, *HM 120 Powerotor*. Low-cost precision-built unit with continuous-reading accurate direction indicator. Heavy-duty thrust bearing supports anten-

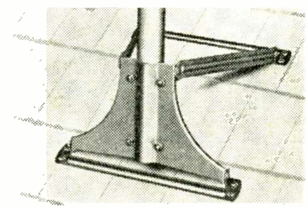
nas weighing up to 50 pounds.—**Moran Products Co.**, 2925 E. 55 St., Cleveland 27, Ohio.

FM RADIO ANTENNA, *model FM3T*. Mounts on TV antenna



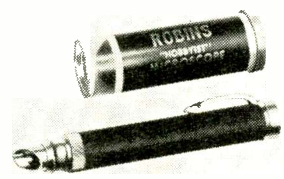
mast. 4 bays can be stacked with 300-ohm line. Anodized gold finish.—**Winegard Co.**, 3000 Scotten Blvd., Burlington, Iowa.

TV ANTENNA MOUNT,



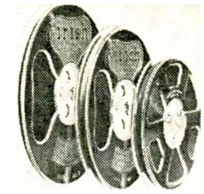
Fastmount TV Antenna Holder. Mount can be placed in any location on a roof, regardless of pitch. Eases one-man installations.—**Vokar Co.**, 201 E. Catherine St., Ann Arbor, Mich.

STYLUS MICROSCOPES, *MX1* (bottom) and *MX-40*. Used



to check stylus wear.—**Robins Industries**, 36-27 Prince St., Flushing 54, N. Y.

MAGNETIC RECORDING TAPE, *Continental Series*. 5¾-inch tape reel holds 850 feet Brown-Band, 850 feet Green-Band, 850 feet Shamrock, 1,150 feet long-play (Mylar), 1,150 feet long-play (Acetate) or 1,650 feet double-play tape. In-

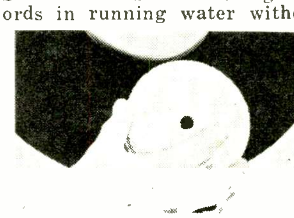


tended for use with European tape recorders.—**ORRadio Industries Inc.**, Shamrock Circle, Opelika, Ala.

REPLACEMENT STYLI, for Columbia CD stereo phono cartridges. *CD-1SMD* is diamond

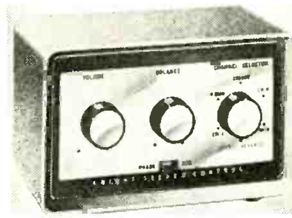
version. *CD-1SMS* sapphire.—**Available through CBS-Hytron, Danvers, Mass. and Columbia Record distributors and dealers.**

RECORD CLEANING KIT, *Stardust*. Aid for washing records in running water without

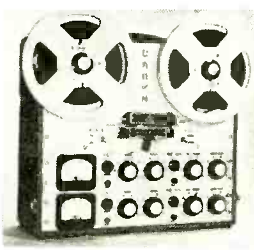


damaging label or record. Also serves as airtight holder for sponge, kept wet for wiping and dampening records just before playing.—**C & D Products Co.**, Old Marlboro Rd., East Hampton, Conn.

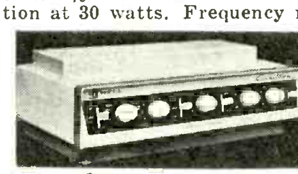
STEREO CONTROL KIT, *model 83 Y 778*. For centralized control of stereo hi-fi systems. Has volume and balance controls. Function switch selects stereo, reverse stereo, monophonic operation. Phase reversal also provided.—**Allied Radio Corp.**, 100 N. Western Ave., Chicago 80, Ill.



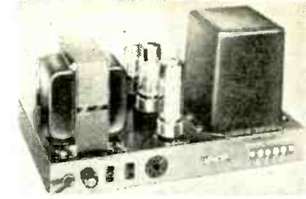
STEREO TAPE RECORDER, *Crown Stereo X*. 2- or 4-track heads. 3 speeds, 3 motors. 4 mike inputs. At 15 ips, response is within 2 db from 30 to 30,000 cycles. Flutter and wow measure .06%; noise ratio 57 db down. At 7.5 ips, 20–20,000 cycles within 2 db; flutter and wow, .08%; noise ratio 54 db. At 3/75 ips, 20–11,000 cycles within 3 db; 0.18% flutter and wow; noise ratio 51 db.—**International Radio & Electronics Corp.**, Elkhart, Ind.



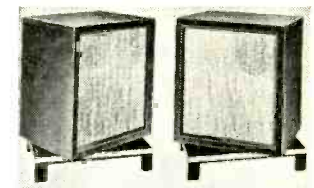
STEREO AMPLIFIER, *Carillon model 6060*. 60-watt output—30 watts per channel. Less than 1% third-harmonic distortion at 30 watts. Frequency response flat within 1 db from 15–30,000 cycles. Hum level 71 db below rated output. 7 dual inputs—mike, NARTB tape head, magnetic phono, ceramic phono, tuner, tape preamp, auxiliary. Selector switch; right- and left-channel bass and treble controls; balance and volume controls; low-filter, high-filter, function, speaker-selector lever switches. Dual 4-, 8-, 16-ohm and high-impedance outputs.—**Bell Sound Div.**, Thompson Ramo Wooldrige Inc., 555 Marion Rd., Columbus 7, Ohio.



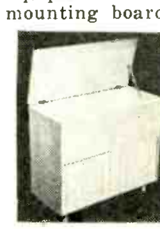
ULTRA-LINEAR POWER AMPLIFIER, *EICO kit model HF35*. 35-watt output. 1.5% IM distortion at 35 watts. Harmonic distortion less than 1% at any frequency between 20 and 20,000 cycles within 1 db of 35 watts. Response within 0.1 db from 20–30,000 cycles at 35 watts. 0.43-volt input gives full output. Hum 90 db down. 4-, 8-, and 16-ohm outputs.—**Electronic Instrument Co. Inc.**, 33-00 Northern Blvd., Long Island City 1, N. Y.



DIRECTED-SOUND ENCLOSURES, *Swivel-Master*. Enclosures pivot on base, can be angled in any desired direction. Mahogany, cherry, blond, walnut and ebony finishes.—**Universal Woodcrafters Inc.**, La Porte, Ind.



KITS, CABINETS, ENCLOSURES, finished and unfinished. Line includes speaker enclosures, equipment cabinets and phono mounting boards. *Model EC* equipment cabinet illustrated.—**Stereo Craft,** Div. of 20th Century Woodworking Co., 79 Clifton Pl., Brooklyn, N. Y.



FURNITURE CABINETS for 75 and 85 series tape decks and related components. *W3SX* is used for 75 or 85 deck and single recording amplifier or two playback preamps. *W4SX* for tape deck and two recording amplifiers for stereo systems.—**Viking of Minneapolis,** 9600 Aldrich Ave., Minneapolis, Minn.

COMPONENTS CABINET. *Model KN-1400K* is kit version, *KN-1400* is assembled unit. Houses record changer on base, tuner, amplifier and records. Finished in mahogany, limed oak or walnut. 27 inches high, 33½ inches wide, 16 inches deep.—**Allied Radio Corp.**, 100 N. Western Ave., Chicago 80, Ill.

SPEAKER ENCLOSURES. The *Hague* (shown) is a back-loaded folded-horn enclosure designed for 12-inch speakers. Other smaller units are distributed-port bass-reflex types for 8-inch speakers.—**North American Philips Co.**,

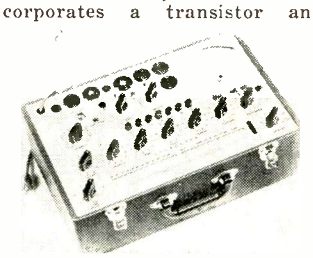
Inc., High Fidelity Products Div., 230 Duffy Ave., Hicksville, N. Y.

STEREO TAPE HEAD, *model TLD-L.* Laminated in-line record–playback unit. Pole pieces are laminated. For 4-track stereo tape systems. Records and reproduces frequencies between 30 and 15,000 cycles at tape speed of 3¾ ips. Performance nearly identical to single laminar heads at 7½-ips tape speed. Gap thickness less than 100-millionths of inch.—**Nortronics Co. Inc.,** 1015 S. 6th St., Minneapolis 4, Minn.

SLEEP TEACHER, *Electronic Educator,* is a self-contained tape recorder that uses endless tape cartridges. Can also be used as standard tape recorder

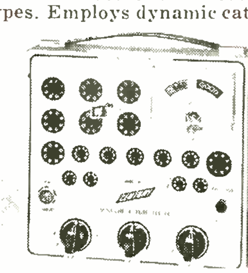
as it has record, playback and erase functions.—**Sleep-Learning Research Association,** P.O. Box 24, Olympia, Wash.

MUTUAL-CONDUCTANCE TUBE TESTER, *model 800.* Incorporates a transistor and



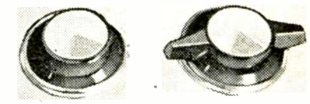
diode check. 5-inch meter. Tests tubes under simulated operating conditions.—**Hickok Electrical Instrument Co.,** 10531 Dupont Ave., Cleveland 8, Ohio.

TUBE TESTER, *Mini-Check model MC-1.* Multiple-socket unit tests more than 600 tube types. Employs dynamic cathode-



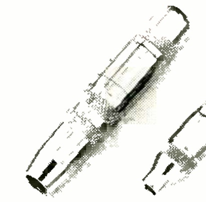
emission test, checking emission, interelement shorts and leakage. 3 settings, and tester is ready to check tube. 3½-inch meter, detachable line cord. —**Century Electronics Co. Inc.,** 111 Roosevelt Ave., Mineola, N. Y.

REPLACEMENT TV KNOBS. Exact replacements for 1953



and 1954 RCA TV receivers are now part of this firm's line of replacement knobs.—**Colman Electronic Products Inc.,** P.O. Box 7026, Amarillo, Tex.

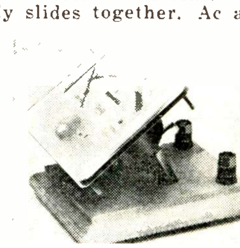
SHIELDED EXTENSION JAX attaches to end of shielded cable. 3 models. Terminates cable in 2-conductor jack for ¼-inch phone plugs; in 2-conductor jack for Tini-Plugs; in 3-conductor jacks for ¼-inch



121
131 125

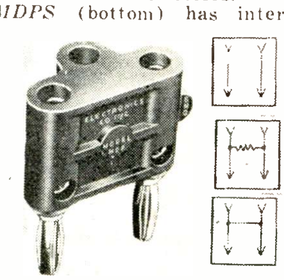
3-conductor phone plugs.—**Switchcraft Inc.,** 5555 N. Elston Ave., Chicago 30, Ill.

4-INCH UNIMETERS. Obtain variety of panel meters by combining dial component with basic meter movement. Assembly slides together. Ac and dc



linear scales, dustproof construction.—**Triplett Electrical Instrument Co.,** Bluffton, Ohio.

DOUBLE PLUGS. *Model MDP,* (top schematic) attaches to cable of user's choice. Plugs rated at 15 amps and 5 kv. Available in 10 colors. *Model MDPS* (bottom) has internal



shorting bar. *Model MDPR* (center) has precision 1% resistor molded in.—**Pomona Electronics Co.,** Pomona, Calif.

OFFICIAL TUBE SURGE-GUARD reduces initial surge current when radio or TV receiver is turned on. Plugs into line outlet.—**Alfred Barone Co.,** 488 E. Delvan Ave., Buffalo 11, N. Y.

END

All specifications on these pages are from manufacturers' data.

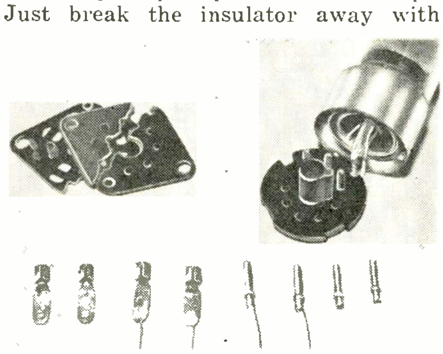
FILE CLEANING KINK

When files are used on soft materials such as plastic, aluminum, solder, copper and brass, the flutes have the tendency of becoming clogged with filings. This makes it almost impossible to clean fine smoothing files with an ordinary file card or wire brush, as the large bristles cannot reach deep enough into the gullets where the filings are imbedded. A small gob of modeling clay pressed firmly against the file will, however, remove the filings and restore the file's bite.

Kit builders, experimenters, service technicians and others who work with files will find this kink especially useful.
—*John A. Comstock*

EXPERIMENTAL CONNECTORS

Old tube sockets can be taken apart and their contacts used as connectors for temporary experimental hookups. Just break the insulator away with



pliers and the contacts will fall free. Solder wires to the contacts and use them for making fast temporary connections to tube base pins or standard phone tips. Also use tube base pins removed from old tube bases as male connecting plugs.—*J. C. Alexander*

ERASER FIXES RECORD CHANGER

Ever run into a V-M changer with a missing rubber tip on the size index finger? This is a simple thing to repair. Cut the eraser off an ordinary pencil, punch a slot in it with a small screwdriver and mount it with a dab of cement.—*E. Slitsko*

SWITCHING WITH VIDAIRE MS-6

In the April, 1958, issue of RADIO-ELECTRONICS (page 36, Fig. 9), you show the wiring layout and equivalent circuit arrangement for six speakers connected in series-parallel. Switching

TRY THIS ONE *(Continued)*

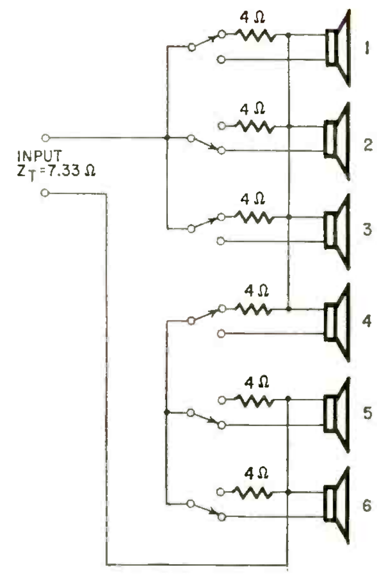


Fig. 1

facilities for substituting resistors let you cut out speakers and still maintain proper impedance matching to the amplifier's output.

As stated in your description of Fig. 9 "A different wiring arrangement is

EQUIVALENT CIRCUIT

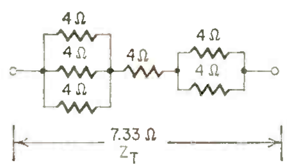


Fig. 2

needed" (see Fig. 1). Fig. 2 is the equivalent circuit. Here is just such a setup using the Vidaire model MS-6 switching panel.

The resistor and voice coil for speaker No. 4 should have a wattage rating high enough to handle the total current in the circuit.—*John J. Haskell*

RECORD CHANGER HUM

Rubber washers are generally used between the motor mounting bolts and the changer base. If the rubber hardens or if the bolts are tightened excessively, motor vibration may be transfered to the changer's frame and thence through the turntable to the record and needle, causing hum. If the hum stops when you short the pickup terminals with a screwdriver while the needle is resting on a stationary record (speed selector in neutral), motor vibrations are the probable cause. Examine the motor mounting and replace the rubber washers if necessary.—*Warren J. Smith*

AIMING ANTENNAS

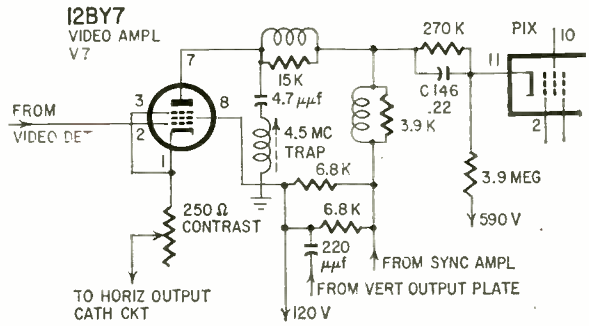
We find a trouble light in the form of a long extension cord a simple aid to aiming a TV antenna during installation. Poke the light out a window where it can be seen by the man on the roof.

The person watching the screen image flashes the light fast if the antenna is way off and slows the flashing to a stop as the correct orientation is reached.—*H. J. Miller* END

Technotes

SYLVANIA CHASSIS 1-518-1

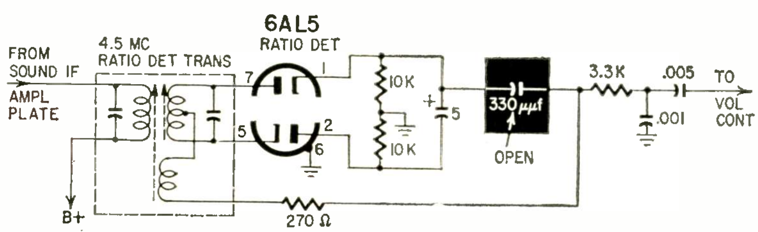
Picture smear was evident on this set, on all stations and at all settings of the contrast control. Therefore, the



trouble was obviously due to poor response of the video amplifier and not in preceding sections of the set. Operating voltages of the video amplifier were tested and found normal. Tubes were checked by substitution. Next came a check of components.

Shunting capacitor C146, a 0.22-μf unit, removed the smear. Replacement was the final cure. C146 couples the plate of the video amplifier to the picture tube cathode. The lowered capacitance of this capacitor increased its reactance to low-frequency signals and resulted in smear. A capacitor checker showed its value had gone down to .0035 μf.—*Eugene Rollins*

CROSLEY MODEL F-24COLH



This set suddenly developed sync buzz. A check of the 5-μf electrolytic in the ratio-detector circuit showed normal capacitance. Bridging the 330-μμf capacitor with a 250-μμf unit reduced the buzz. A check showed that the capacitor in the set was practically open. Replacing the open unit put a rapid end to the sync buzz.—*James A. McRoberts*

GREEN-GUN GUNK?

This was a large-screen RCA receiver. The setting of the green screen control was unstable, as if the control were faulty. However, the trouble was tracked to the picture tube.

When the neck of the tube was tapped, the green field fluctuated erratically. On a hunch, we tilted the cabinet forward and tapped the neck of the picture tube sharply. This treatment corrected the trouble.

The green screen control response was normal, and the receiver has been operating several days with no sign of the trouble. Probably some gunk lodged in the green gun, which caused a leakage path. The treatment was effective.—*Robert G. Middleton*

TAPE RECORDER ROLLER REPAIR

When the rubber-covered pressure roller of a tape recorder has become glazed, dented and worn from use (Fig. 1) and there's no replacement available, here's a method that often works to renew its nonslip surface and shape. Start up the machine without tape on the spindles and set the controls for either playback or record. This will cause the roller to engage the capstan and start rotating. Now, while the roller is turning, hold a fine-cut file lightly to the roller to relevel the roller's uneven sur-

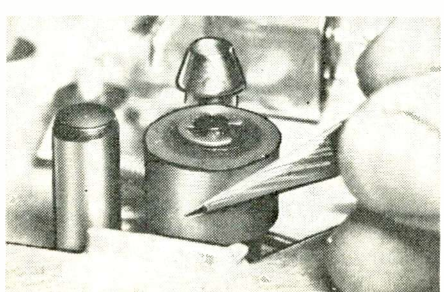


Fig. 1

Fig. 2

face (Fig. 2). (Don't remove any more rubber than absolutely necessary and hold the file flat against the roller's surface.) The renewed roller will at least be satisfactory until an exact duplicate roller can be obtained for the machine.—*John A. Comstock*

WESTINGHOUSE MODEL H-600T16

The set had a thin vertical line on the screen. Tubes were OK. Voltage checks revealed no B plus at the horizontal output tubes. Circuit tracing led to an open width control. A quick replacement and the job was finished. —*Carl Hennig*

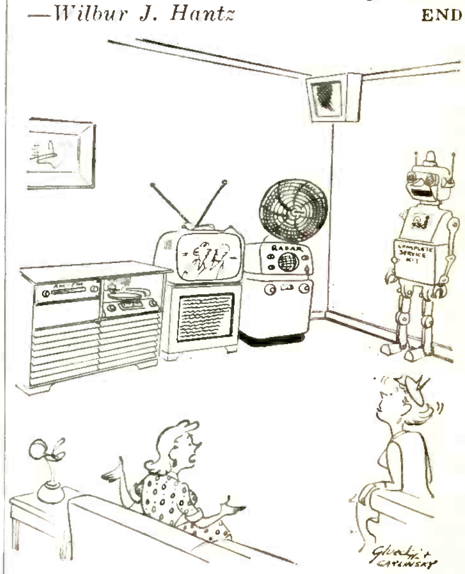
EMERSON 120087 D CHASSIS

Complaint: Vertical foldover at bottom of picture, poor vertical linearity, inadequate height after warmup.

The vertical oscillator's plate load resistor (R97), normally 470,000 ohms, had increased in value. Replace it with a 1-watt unit. Also, the 100,000-ohm resistor (R93) connected to the vertical oscillator transformer's secondary had gone up. Replace it with a 1-watt unit too.—*Harry C. Keller*

BENDIX MODEL 235M1

This receiver had a severe case of vertical jitter. After checking the vertical integrator and sync amplifier circuits half of a (6SN7) I noticed that the 6SN7 plate and decoupling resistors were charred. Replacing these resistors and the tube restored normal operation. —*Wilbur J. Hantz* END



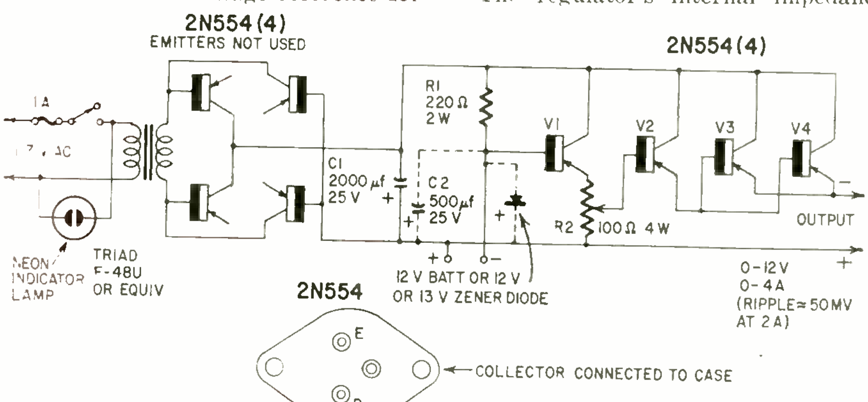
"This one came complete!"

NOTEWORTHY CIRCUITS

REGULATED POWER SUPPLY

This supply delivers a continuously variable output voltage at currents up to 4 amps. Maximum available output voltage is dependent on the battery, which acts as the voltage reference for the circuit used is commonly called an emitter-follower regulator in which V3 and V4 act as a variable resistor in series with the load.

The regulator's internal impedance



the supply. For better results, replace the battery with a 12 or 13-volt Zener diode.

Ac ripple at the output varies from 10–80 mv, depending upon the load. However, ripple is reduced by a factor of 3 by adding C2 (the 500-μf capacitor shown in dashed lines). The regulator is about 0.5 ohm. V3 and V4 should be mounted on a suitable heat sink as they dissipate up to 60 watts at low output voltages and high output currents. V1 and V2 should also have small heat sinks as they dissipate approximately 1 watt apiece.—*Motorola Semiconductors*

DIFFERENT VOLTAGE DIVIDER

Re: "Stiffer Voltage Divider," by Leonard E. Geisler, Noteworthy Circuits, RADIO-ELECTRONICS, December, 1958, pages 121–22.

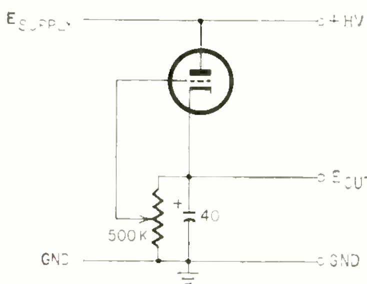
I'd like to submit a circuit that is very simple, yet rarely used by anyone except radio amateurs. It has been in use in my home station for several years. In one application it drops the high voltage down to supply the multiplier and driver stages of my transmitter. In another it acts as a screen control resistor and is used to vary the output power of my transmitter's final amplifier.

By far, the best application I've found for it is as a grid-controlled rectifier supplying various voltages for the many pieces of equipment I have around the shop.

The circuit requires only a resistor (a pot) and a capacitor and a tube. Although I use a 6AS7, just about any other tube will also work—excluding diode types.

The plate of the tube (a triode, or triode-connected tetrode or pentrode) is connected to the supply voltage. The cathode is connected to the load. A 500,000-ohm pot is connected between the cathode and ground, with the grid connected to the arm. This pot controls the output voltage. By varying the pot you vary the grid-cathode bias, which in turn varies the tube's conductance.

The *minimum* output voltage should not be less than the maximum allowable plate voltage of the tube. That is, if the maximum plate voltage is 400 and



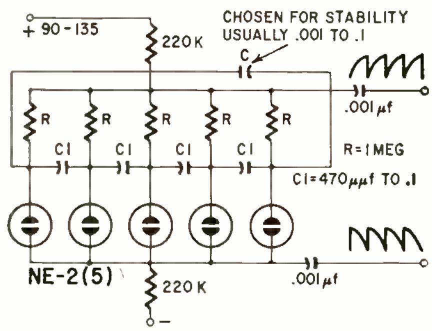
a 900-volt supply is used, the lowest permissible output voltage should not be less than 500 ($E_{out} = E_{supply} - E_{plate}$) or the tube will be damaged by excessive voltage.

The maximum current that can be drawn is limited only by the tube's maximum current rating. The 40-μf capacitor across the output smooths any minor voltage variations and presents a low-impedance source to the load. Several tubes may be paralleled for higher output currents, or placed in series for larger voltage drops or different output voltages. Any tube combination can be used for any output power desired. The tube type is dependent upon power and space considerations.

One novel feature of this circuit is that the grid can never go positive with respect to the cathode. This undoubtedly prevents damage to the tube and provides for longer life. The output voltage regulation is dependent upon, but no different than, the supply voltage regulation.—*Leonard J. D'Airo*

NOVEL NEON BLINKER

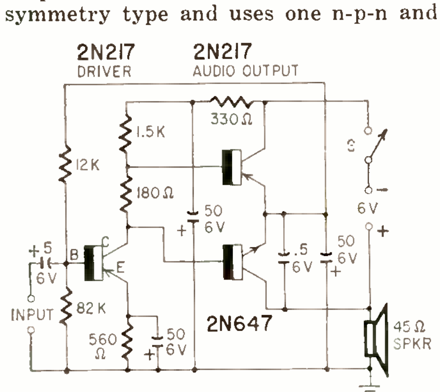
The output frequency of this circuit is obtained by multiplying a single lamp's repetition rate times the number of lamps used. Unfortunately, instability increases rapidly once you go



beyond five or six. I have tried using various capacitances between the lamps as shown, and the results are interesting. Where a single lamp will not oscillate past a certain frequency, five or seven of them will. Nothing special, just something to do when no one is looking.—*Robert D. Holm*

TRANSISTOR AMPLIFIER

With a 20-mv input this simple three-transistor circuit delivers a 100-mw output. It is of the complementary-symmetry type and uses one n-p-n and



one p-n-p transistor in its push-pull output stage. The circuit provides a very low output impedance for the output stage, making it possible to drive a 45-ohm speaker directly—no output transformer is necessary.—*RCA Transistor Spec Sheet*

END

PATENTS

MULTIPLEXED STEREO

Patent No. 2,851,532

Murray G. Crosby, Riverhead, N. Y.

Stereo can be transmitted over a single FM channel with the help of a subcarrier (about 45 kc). See Fig. 1. The audio components are used. The difference between microphone signals (A — B) modulates the subcarrier. Their sum (A + B) modulates the main carrier.

At the receiver (Fig. 2) the A — B component is recovered from the subcarrier after filtering. A + B is detected from the carrier as usual. Transformer T combines them, the sum 2A feeding the upper speaker, the difference 2B feeding the lower.

Due to small deviation, the subcarrier signal-to-noise ratio is high. The noise in A — B may be 10 times worse than in A + B. Now when a small voltage is added or subtracted from a much larger one, the resultant remains nearly equal to the latter. Thus the speakers have nearly equal noise output for true stereo. Furthermore, the poorer of the channels (A — B) is associated with a double-strength (2B) audio signal so there is a definite gain in signal-to-noise for it.

The system is compatible. The 2A component in the upper speaker would be used for monaural listening, so the A — B channel of Fig. 2 would not be needed.

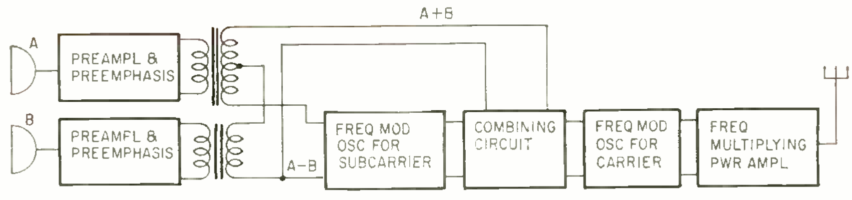
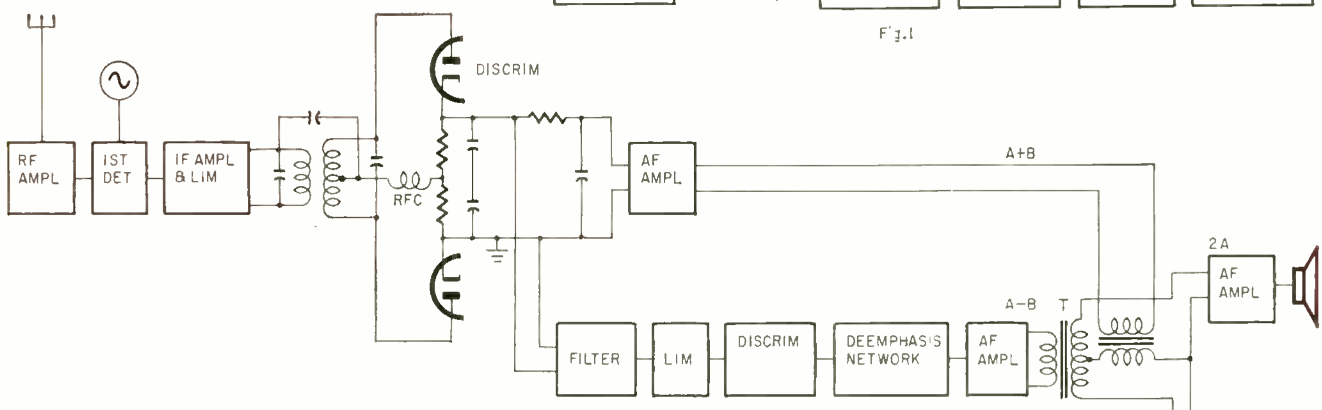


Fig. 1



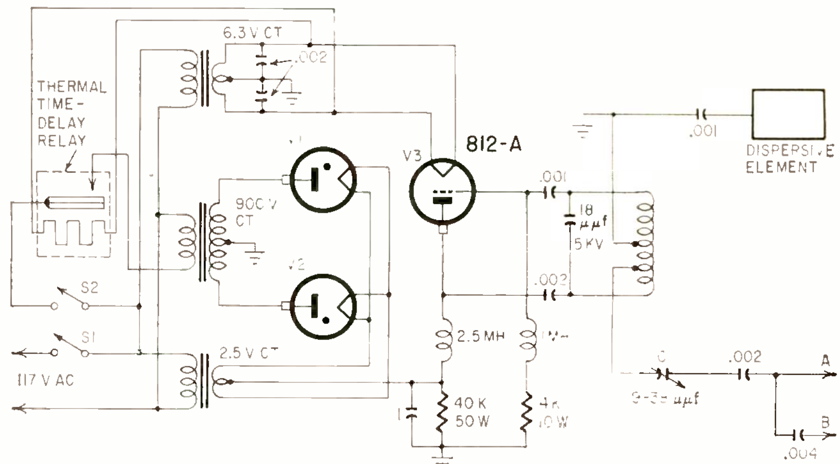
RADIO KNIFE

Patent No. 2,835,254

William A. Coles, Upper Darby, Pa.

This patent discloses a method for making surgical incisions with a minimum of damage to live tissue. Shock hazard is minimized also.

Output leads include blocking capacitators. The dispersive element is a conductive plate which grounds the patient. The other lead is



The cutting edge, which may be a needle, knife or wire loop, is fed with high-frequency current.

The diagram shows a full-wave rectifier pair, V1 and V2, which converts line power to dc. The dc is fed to triode V3's plate. V3 oscillates at about 3 mc. A Hartley circuit is used.

either A or B. The first delivers greater current if needed. Capacitor C is an output control.

Note that S1 turns on the filament circuits, but no rf is delivered until S2 is also thrown. All blocking capacitors are rated at 2.5 kv, but capacitor C has a breakdown rating of 5 kv.

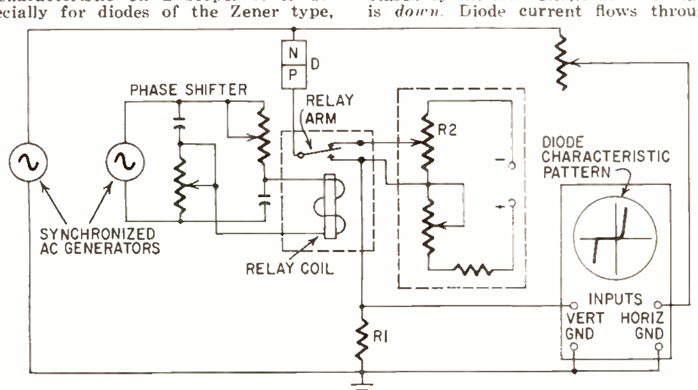
ZENER DIODE TEST

Patent No. 2,847,646

Frank C. Marino, Montclair, N. J. (Assigned to Bell Telephone Labs, Inc.)

Here is a quick, convenient test that displays the diode characteristic on a scope. It is designed especially for diodes of the Zener type,

relay, and assures that diode D is *forward*-biased by the low-voltage ac when the relay arm is *down*. Diode current flows through R1, the



which require small forward voltage but relatively high bias in the reverse direction to reach breakdown.

The circuit switches automatically from low forward to high reverse voltage. A few volts of ac are applied to the scope's horizontal input terminals. Another voltage source, synchronized with the first, drives the relay coil through an R-C phase shifter. This synchronizes sweep and

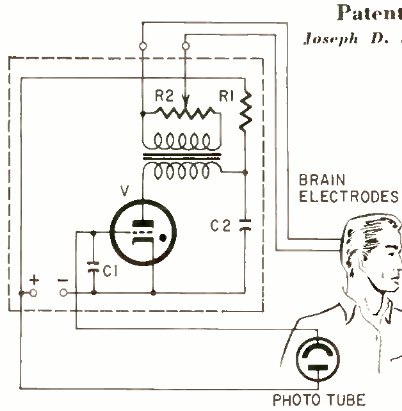
voltage drop being applied to the scope's vertical terminals.

During the next alternation the relay arm moves up. This adds a large dc voltage in series with the ac to assure a high enough reverse bias on D. Now the *reverse* portion of the diode characteristic is scanned on the scope. Note that this portion corresponds to the *negative* half of the ac sweep.

SIGHT FOR THE BLIND

Patent No. 2,721,316

Joseph D. Shaw, Cincinnati, Ohio.



The December 1958 issue of this magazine described on page 53, actual experiments which make it possible for the blind to see. This patent describes somewhat similar instrumentalities.

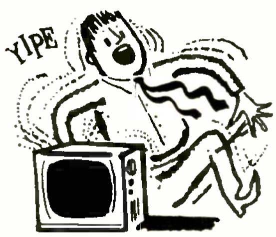
A photocell or phototube is held by the blind person and is biased with dc from a battery. Light falling on the cell charges C1. Upon reaching a predetermined voltage, thyratron V breaks down and permits C2 (previously charged through R1) to discharge through the transformer. The intensity of this pulse is controlled by R2.

The pulse is fed to a plastic socket attached by surgical means to the skull of the blind person. Conductors through tiny holes in the skull terminate at the vision area of the brain. Each pulse produces the sensation of sight.

The equipment shown in the diagram produces a single light spot at any time. If a light and shadow pattern is desired, multiple sets must be used, each terminating in a different part of the vision area of the brain.

BUSINESS and PEOPLE

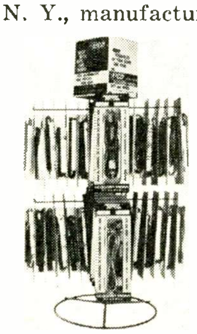
Sprague Products, North Adams, Mass., is offering service technicians a



HE DIDN'T KNOW THE SET WAS LOADED!

series of newspaper advertising mats to discourage do-it-yourself TV repairs.

Electronic Instrument Co., Long Island City, N. Y., manufacturer of Eico



kits and other electronic products, is promoting its vtvm and scope probes with a new package and display stand.

Curtis R. Hammond (left), assistant vice president of Raytheon Mfg. Co., Waltham, Mass., is now corporate director of regional commercial administration as part of a move to strengthen commercial sales by the establishment of six regional sales offices across the nation. Regional executives in Boston,

New York, Baltimore, Cleveland, Chicago and Los Angeles will report to him. **Dr. W. Crawford Dunlap** (right), former supervisor of solid-state research at Bendix Aviation, joined Raytheon Research Div. as director of semiconductor research. **John L. Herre** joined the Semiconductor Div., Needham Heights, Mass., as government and special accounts sales manager. He formerly supervised government sales activities for Philco.

EIA Annual Unit Production and Sales

	1958	1957
TV set production	4,920,428	6,399,345
Total radio production	12,577,243	15,427,738
FM radio production (July–Dec.)	376,114	not available†
TV retail sales	5,140,082	6,560,220
Radio retail sales	8,631,344*	9,721,285*
Receiving-tube factory sales	397,366,000	456,424,000
TV picture-tube factory sales	8,252,480	9,721,008
Transistor factory sales	47,050,814	28,738,000

*Excluding auto sets
†Last available figure—1955—252,880 FM sets

J. Frank Leach (right) has been promoted to vice president and general manager of the Amphenol Connector Div. of the newly merged Amphenol-Borg Electronics Corp., Chicago. He had been vice president, manufacturing, of Amphenol Electronics Corp. **Robert E. Svoboda**, distributor sales manager of Amphenol, is now general manager of the Amphenol Distributor Div.

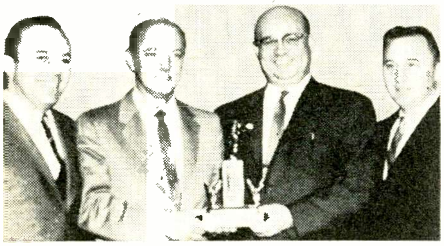
Frank P. Vendely (right) is now Eastern regional sales manager of the P. R. Mallory & Co., Inc., Distributor Div., Indianapolis, Ind. He started with the company as a distributor salesman and later served as merchandise manager. **Leon Robbin**, a Mallory vice president for the past 18 years, was elected to the board of directors and named president of the newly formed subsidiary, P. R. Mallory International, Inc.

Neal W. Turner (left), merchandising manager of Heath Co., Benton Harbor, Mich., was promoted to director of production planning. **Robert K. Swan-**

der advanced from purchasing agent to director of purchasing. **Ellis Grear**, assistant purchasing agent, succeeds him. **William E. Johnson** (right), former assistant advertising manager of Whirlpool Corp., joined Heath as dealer sales manager. **John T. Caviezel**, ex-Bell & Howell, joined Heath as dealer sales representative.

Charles Molitor is now with Electro-Voice, Inc., Buchanan, Mich., as chief industrial engineer. He comes to Electro-Voice from Allen Electric Equipment Co., where he was factory manager.

Edward I. Flaxman (left), vice president in charge of sales for Service Instruments Corp., Addison, Ill., is shown presenting the Sencor "Rep of the



Year" award to **John Havercamp** and **Jack Collins**, as Sencore president **Herb Bowden** (right) looks on.

Thomas H. Moss has been appointed vice president of the Turner Co., Cedar Rapids, Iowa. He joined the company in 1952 and was appointed general sales manager in 1956, which position he still holds.

Hans D. Sylten, electronics research engineer, joined Winegard Co., Burlington, Iowa, as head of the expanding research dept.

Thomas L. Eckersley, radio pioneer with English Marconi from 1919 until recent years, died in February at the age of 72. His work in wave propagation gave us much knowledge of the ionosphere and of the earth's resistivity. He was a Fellow of the Royal Society and of the IRE, and received the Faraday Medal in 1951. END

50 Years Ago

In Gernsback Publications

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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 larger libraries still have copies of Modern Electrics on file for interested readers.

In April, 1909, *Modern Electrics*

Majorana Aerophone Work, by A. C. Marlowe.
Loud Talking Telephones, by the Berlin Correspondent.
New Experiments Producing Electric Sleep, by Frank C. Perkins.
250-Watt Closed Core Transformer, by Carleton Haigis.
How to Make a Wireless Control Relay, by H. W. Secor.
Wireless Banquet.
French Wireless Telegraph and Aerophone Devices.
How to Make a Revolving Condenser, by A. Ward.
The Aerophone Automatic Signaling Device, by René Homer.
Condenser Phenomena, by C. C. Whittaker.
Wireless Registry.

LITERATURE

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.

WIRE–CABLE–TUBING of all types are described and illustrated in colorful catalog *T-258*. Everything from aerial and antenna wire through magnet wire to weatherproof cable.—**Birnbach Radio Co. Inc.**, 145 Hudson St., New York 13.

ELECTRONIC COMPONENTS are offered in 2-color 4-page illustrated folder. Record changers, resistors, soldering guns, switches, wire, etc.—**Brooks Radio & Television Corp.**, 82 Vesey St., New York 7, N. Y.

STEREO PHONO CARTRIDGES and how to use them is the topic of a 16-page booklet *Application Considerations in the Use of Stereo Cartridges*—publication *EP-681*. The illustrated text discusses factors influencing stereo performance, cartridge tracking force and loading, problem diagnosis, and cartridge connections and input wiring practices.—**General Electric Co.**, Specialty Electronic Components Dept., West Genesee St., Auburn, N. Y.

HI-FI CABINETS, kits and assembled units including speaker enclosures, and equipment and record storage cabinets are shown in a colorful 4-page folder.—**Stereo Craft**, Div. of 20th Century Woodworking Co. Inc., 79 Clifton Pl., Brooklyn 38, N. Y.

STEREO SIMPLIFIED is a pocket-sized booklet that explains high-fidelity stereophonic reproduction of music in the home. Covers the entire process of stereo recording and reproduction.—**Sonotone Corp.**, Elmsford, N. Y.

SOLDERING IRON TIPS are presented in an enlarged catalog sheet *No. 601*. Plug-in and screw-in types are illustrated. 124 shapes and sizes are covered.—**Hexacon Electric Co.**, 186 W. Clay Ave., Roselle Park, N. J.

CORRECT STEREO GEOMETRY and optimum tonal range are described in an illustrated folder titled *Pocket Facts*. Circuitry for driving a third channel from the two stereo tracks is illustrated.—**Klipsch & Associates Inc.**, 116 N. Louisiana St., Hope, Ark.

STEREO EDITION of *Understanding*

High Fidelity details the components required for a hi-fi system, and explains the difference between stereo and mono systems in terms of results to be expected. The 64-page booklet is well illustrated. Glossary of technical terms is included.—**Bogen-Presto**, Div. Siegler Corp., Box 500, Paramus, N. J., 25c.

FRACTIONAL-HORSEPOWER MOTORS, of all types are presented in *Motor Catalog M 159*. Complete specifications including a dimensional drawing for each type motor are included.—**Carter Motor Co.**, 2711 W. George St., Chicago.

CORRECTION

Mr. Snader reports that he had listed the TONE EQUALIZATION control (R16R and R16L) as 250,000 ohms in the diagram and parts list of his "Tape Amplifier for Stereo" in the March issue. The correct value for each section of the dual control is 5,000 ohms. The control should be set to about 2,500 ohms for NAB equalization.

USING THE ECONOMY TUBE CHECKER

Mr. Jaski has received a number of requests for clarification of the operating instructions for his Experimenter's Economy Tube Checker, described in the December, 1958, issue and has supplied this additional information:

Testing rectifiers. Test each half of a full-wave rectifier separately. One section may be bad while the other is good. The load resistor in Figs. 2-b and 2-c provides a normal full load for the rectifier. Its value is determined by Ohm's law. The maximum continuous current delivered by the tube is listed in tube manuals. There is no standard test voltage. It depends on your meter. With a 1-ma meter, approximately 30 volts ac is often used. The voltage is a matter of choice.

Amplification tests are made with dc plate and screen voltages listed in the tube manual under "typical operating conditions." The load resistor must be determined from tube characteristics listed in the manual.

Noise tests are made with normal operating voltages on *all* elements. If the plate and screen are normally operated at 100 and 75 volts, respectively, match or approximate these voltages for the test.

Mr. Jaski also calls our attention to wiring errors in the connections to the plate- and screen-voltage selector switches in the diagram of his tube checker on page 33 of the December, 1958, issue. The 3- and 7.5-volt positions on S5 should connect to corresponding taps on transformer T2. The 10-volt position on S3 should go to the 7.5-volt tap on T2.

He also points out that he labeled the instrument's screen-voltage switch S5 with the ac voltage level applied to the rectifier and plate switch S3 with the dc output from the plate-supply filter, and that this notation was carried on to the schematic, causing some leads to have two voltage readings.

BOOKS

WORKING WITH THE OSCILLOSCOPE, by Albert C. W. Saunders. Electronic Technical Publishing Co., Inc., P.O. Box 306, Boston, Mass. 8½ x 11 in., 93 pp. $4.

This dean of electronic instructors has designed a book especially for the student, including all the facts necessary for the absolutely green beginner without being boring to the advanced student who is looking for a refresher. The book is divided into five parts. Part One discusses the electroscope, beginning with some simple principles of electron optics, then describing the interior construction clearly, with the help of diagrams and photographs. Part Two is devoted to oscillographic patterns, showing the function of the tube elements in producing them. There are two sections on the time base and associated horizontal circuits, and one on the vertical deflection amplifier. The last part is a laboratory manual, describing 26 projects, ranging from voltage calibration to squaring the sine wave and measuring transistor characteristics. These 26 projects cover practically all the uses of the scope the student and technician are likely to need.

The value of the book is enhanced by the excellent readability, due to the large, heavy modern type on good paper, and the number and quality of the drawings, schematics and photographs.—*FS*

INTERNATIONAL RADIO TUBE ENCYCLOPEDIA. Bernards, Ltd., The Grampians, Western Gate, London, W.6, England. 7½ x 9¾ in. 768 pp. 63 shillings.

This is a small world, but it has many thousands of tube types. This encyclopedia lists no less than 27,500, and in such a way that full specifications and ratings are available at once. The tubes are listed in groups. The first contains types released before 1949. The more recent types (including 1958) appear in several supplements, with a master index making it easy to locate any desired type. The same page contains all data and basing, so there is no need to turn over.

Among other information are: equivalent types, wartime tubes, manufacturers' names and addresses. Use of the book is explained in 15 languages. —*IQ*

IHFM STANDARD METHODS OF MEASUREMENT FOR TUNERS, prepared and published by Institute of High Fidelity Manufacturers, Inc., 125 E. 23 St., New York 10, N.Y. 7 x 10 in., 22 pp. $1.

Ratings of AM and FM tuners have been so ambiguous that it has often been impossible to compare one with another from their specifications. To establish a uniform and unambiguous method of specifying such equipment, the institute has published this standard. Terms—both for AM and FM—are defined; operating conditions and requirements for testing apparatus are set forth, and test procedures are given separately for AM, FM and AM–FM tuners.—*FS*

TV AND OUR SCHOOL CRISIS, by Charles A. Siepmann. Dodd, Mead & Co., 432 Fourth Ave., New York, N. Y. 5¼ x 8 in., 198 pp. $3.50.

Education by remote control has been tried and found desirable. Courses in foreign languages, science, history and other subjects are given successfully by TV. One physics course called "Continental Class," originating from the University of California, is broadcast weekday mornings to an estimated 270,000 students over TV.

In this book the chairman of the Department of Education at New York University reviews results of closed-circuit and open-circuit TV, and finds them highly satisfactory. He believes that the new medium will become even more important in the future.—*IQ*

MAGNETIC RECORDING TECHNIQUES, by W. Earl Stewart. McGraw-Hill Book Co., 330 W. 42 St., New York 36, N. Y. 6 x 9 in., 272 pp. $8.50.

Distortionless magnetic recording is a recent development, but already has become important in science, entertainment and industry. Soon it will probably supplant films for recording movies and TV. This engineering book is well organized and complete in covering theory and practice. It describes processes, materials and mechanisms. It shows how to obtain optimum performance in recording.

Among paragraph headings are magnetic media, recording and reproducing processes and ferromagnetism. Typical test and amplifier circuits (tube and transistor) are illustrated and discussed. The book closes with a chapter on "standards" which give dimensions of tapes and films, terms and definitions, measurements, etc. Engineering equations appear in the appendices.—*IQ*

ELECTRONIC MEASURING INSTRUMENTS (Second Edition), by E. H. W. Banner. MacMillan Co., 60 Fifth Ave., New York 11, N.Y. 5½ x 8¼ in., 496 pp. $7.95.

Modern industry, science and medicine rely heavily on specialized types of measuring apparatus. This book discusses many kinds: voltmeters, electrometers, transducers, radiation detectors, counters, electrocardiographs, pyrometers, photometers, among others. Its information is useful for engineers, students and users of the equipment.

The first two parts discuss indicating meters, tubes, transistors, photocells and radiation meters. The last two describe instruments using these devices. Treatment is brief, but clear and complete. The author includes specifications, block diagrams, schematics and photos where helpful.—*IQ* END

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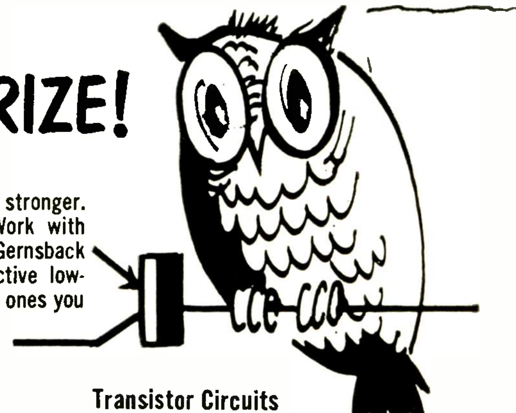

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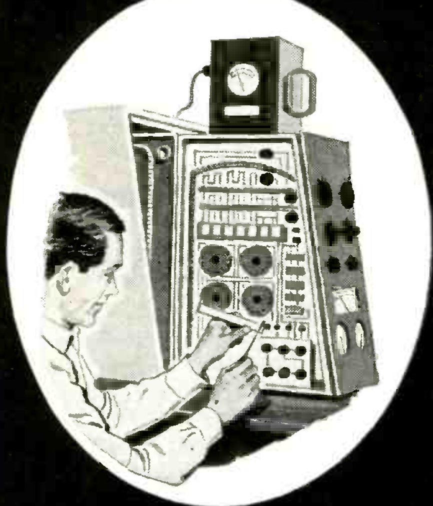
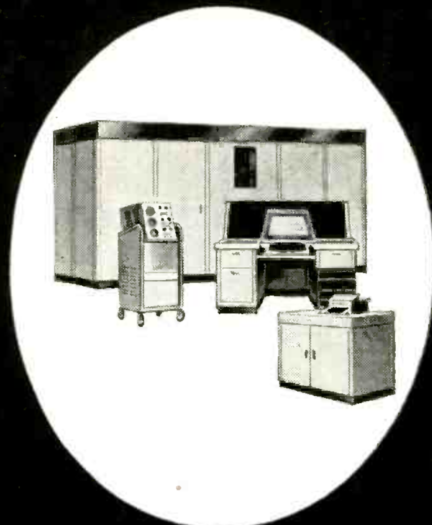
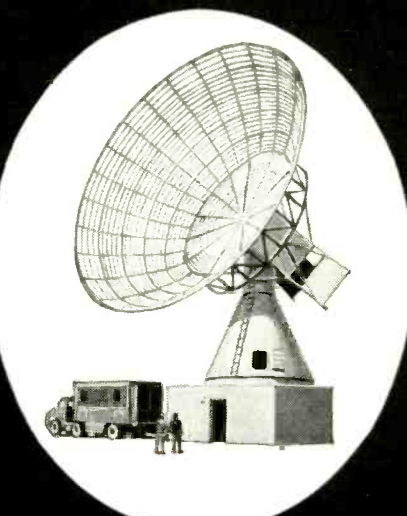

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