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RADIO-ELECTRONICS

FEBRUARY 1956

TELEVISION • SERVICING • HIGH FIDELITY

In this issue:

How to Construct a Hartley "Boffle"

•

Easily Built Echo Unit

•

Transistorized Scope Calibrator

•

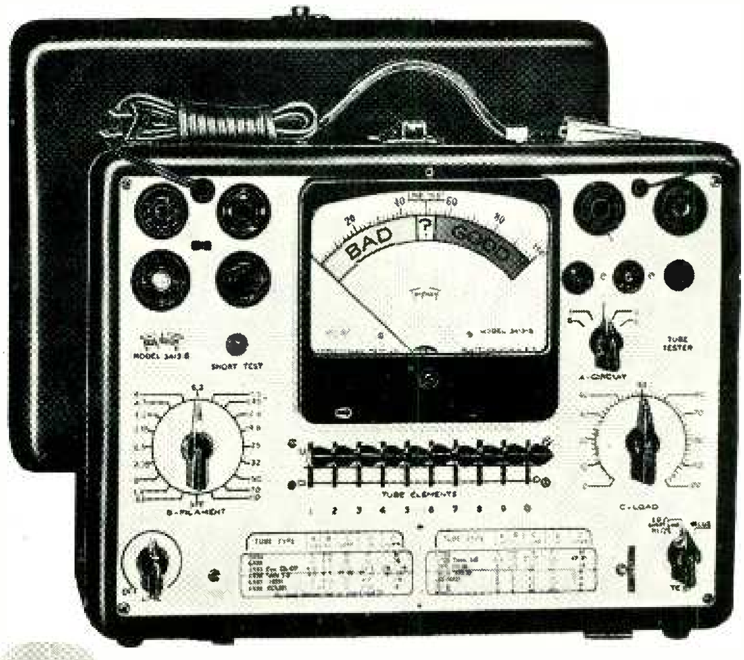
Remote Control for the 630

35¢
U. S. and CANADA

A "Three-Way" Bicycle Radio

(See page 4)

No one piece of equipment can do more for you. As the electronic field expands your tube tester must do more. TRIPLETT TUBE TESTERS meet this demand. More heater voltages including 3.15, 4.2 and 4.7 volts for 600 mill series string heaters. Quickly locating the bad tubes saves time. Tube sales can be a profitable business in itself.



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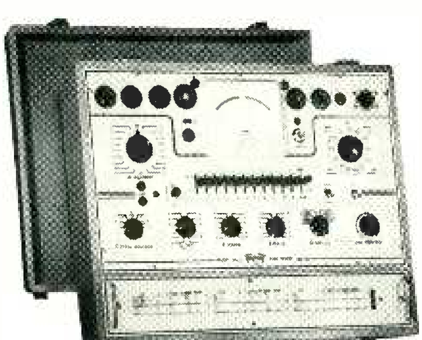

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If you have some Radio or Television experience, or if you know basic Radio-Television principles but lack experience—NRI's new Professional Television Servicing course can train you to *go places* in TV servicing. This advertisement is your personal invitation to get a free copy of our booklet describing this training in detail.

Learn-by-Doing "All the Way"

This is 100% learn-by-doing, practical training. We supply *all* components, *all* tubes, *including* a 17-inch picture tube, and comprehensive manuals covering a thorough program of practice. You learn how experts diagnose TV defects quickly. You see how various defects affect receiver performance—picture and sound; learn causes of defects, accurately, easily, and how to fix them. You do more than just build circuits. You get practice recognizing, isolating, and fixing innumerable troubles.

You get actual experience aligning TV receivers, diagnosing the causes of complaints from scope patterns, eliminating interference, using germanium crystals to rectify the TV picture signal, obtaining maximum brightness and definition by properly adjusting the ion trap and centering magnets, etc. There isn't room on this or even several pages of this magazine to list all the servicing experience you get.

UHF & COLOR TV Making New Boom

Installing front-end channel selector strips in modern UHF-VHF Television receivers and learning UHF servicing problems and their solution is part of the practice you get. To cash in on the coming color TV boom you'll need the kind of foundation in knowledge and experience this training gives.

Get Details of New Course Free

Once again—if you want to go places in TV servicing, we invite you to find out what you get, what you practice, what you learn from NRI's new course in Professional Television Servicing. See pictures of equipment supplied, read what you practice. Judge for yourself whether this training will further your ambition to reach the top in TV servicing. We believe it will. We believe many of tomorrow's top TV servicemen will be graduates of this training. Mailing the coupon involves no obligation.

Train at home easily, quickly, for TV's top servicing jobs. NRI's Professional Television Servicing course includes a 17-inch picture tube and all other tubes and components to build a complete TV Receiver, Oscilloscope, Signal Generator, H.F. Probe. Complete training, including all equipment, available now for a low introductory price—under $200 on easy terms.

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16th and U Sts., N.W., Washington 9, D. C.

Please send my FREE copy of "How to Reach the Top in TV Servicing." I understand no salesman will call.

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Address..

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

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Formerly RADIO CRAFT • Incorporating SHORT WAVE CRAFT • TELEVISION NEWS • RADIO & TELEVISION*

ON THE COVER

(Additional photos on page 43)

The Darb Holiday radio, as used by a typical Southern university coed.

Color original by Ken Schmid

FEBRUARY 1956 **Vol. XXVII, No. 2**

DEPARTMENTS

Average Paid Circulation over 175,000

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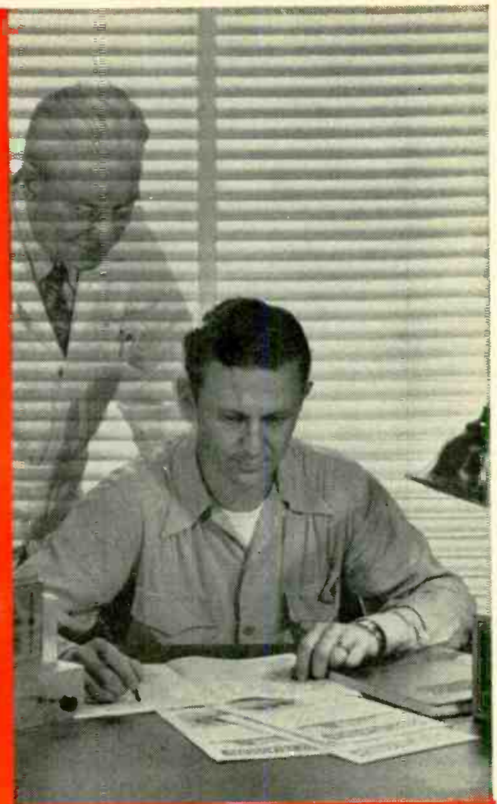

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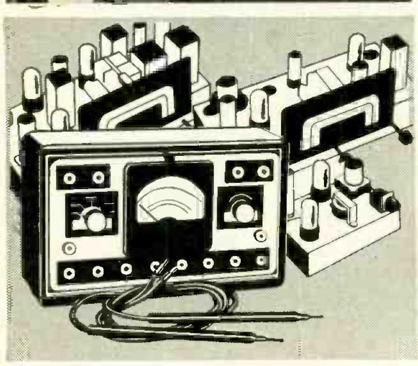

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Please rush FREE TV-Radio Book & Sample Lesson. I understand there is no obligation, no salesman will call.

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the Radio month

RAILROAD AUTOMATION was previewed recently with the New Haven Railroad remotely operating a multiple-unit electric train in the New Rochelle to Rye, N. Y., area. The object of the demonstration was to control the movements of a train from a remote location with no person actually operating the controls on the train. All operation, safety and communication equipment was provided by Union Switch & Signal, Division of Westinghouse Air Brake Co.

The remote control panel (see photo) for the demonstration was located at Larchmont, N. Y. From this point the train was moved east or west, coasted or stopped. The automatic control equipment kept the train from moving unless conditions ahead were safe as determined continuously by the equipment. A visual indicator on the train displayed the control commands transmitted from the wayside station.

The electronic portion of the wayside equipment consists of a power supply, audio oscillator and a carrier modulator. The equipment produces a carrier frequency modulated by certain audio frequencies and amplifies it to the desired level. The output of the carrier modulator is connected to the existing line wires which parallel the track. The train control panel determines the audio frequencies used for modulation: in the "run" position two audio signals are used, "neutral" requires one signal, "stop" needs no modulation.

The control commands from the wayside station are transmitted to the train through inductive coupling between the modulated carrier current flowing in the line wires and a receiving coil mounted on the lead car of the train.

GUIDED TOUR INNOVATION has each guest provided with a miniature transistor radio and lightweight plastic earphone. Conducted by the Hughes Aircraft Co., visitors are kept posted on what they are seeing by tour guides equipped with headset microphones and broadcasting over small portable transmitters.

The receivers used are Regency transistorized units and can be slipped into a jacket pocket, leaving tourists' hands free for taking notes. The system permits larger groups of visitors to accompany each guide, as it is not necessary to crowd near the spokesman when passing noisy areas and the guide may speak from confined areas.

The transmitter is a small three-tube low-power unit with a range of about 40 feet. Operating frequencies are in the broadcast band, but between local commercial broadcasting stations. The transmitter is installed in a box on wheels so that additional receivers can be carried for replacement if necessary. The transmitting antenna consists of a small loop mounted inside the cabinet door.

IMAGE CONVERTER is key to making 200-inch telescope atop Mt. Palomar in California in effect a 2,000-inch unit. This would permit astronomers to look three times farther into space than is now possible. Development of the image converter (see "TV Helps Astronomy," RADIO-ELECTRONICS, June, 1949; "Image Magnifier Amplifies Light," RADIO-CRAFT, August, 1948) is the goal of astronomers and physicists working at several institutions in the United States and Europe.

The image converter gives, on a photoelectric surface, an electronic picture of a stellar view. The electronic picture is then transferred to a photographic plate. Stars too faint to be otherwise caught on a photographic plate can be picked up because the light quanta are used more efficiently. A thin film of aluminum transmits electrons but stops atoms and molecules which would otherwise quickly ruin the photocathode.

WIRELESS THERMOSTAT automatically controls heating system by radio signals. Described as the "control of the future" by Minneapolis Honeywell, the portable device is designed for homes in which electronics would per-

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Build and keep D.T.I.'s NEW 2 Unit TV Set—ideal for custom installation. (D.T.I. also offers home training without the TV set.)
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5 INCH "SCOPE"
ABOVE: Also build and keep this quality Oscilloscope—almost a "must" for Television servicing.
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Insert pictorial diagram on transparent styrene base. (See insert.) Mount parts to follow pattern—using handy "snap in" fasteners. Eliminates wiring errors. Tops for speedy circuit changes . . . for providing maximum circuit experience in minimum time. Build and operate scores of interesting projects — such as the electronic circuit shown below.
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D.T.I.'s training is available in Canada.

form duties ranging from opening and closing garage doors to cooking.

The electronic system includes a conventional heating thermostat into which is built a tiny loop antenna and a crystal-controlled radio transmitter. The thermostat is set at the desired temperature. If the temperature falls below this setting, the thermostat automatically transmits a signal to a small receiver which converts the impulse into energy for operating a valve on radiators or opening and closing dampers or fuel injectors.

UNQUALIFIED PRAISE is pouring in to RADIO-ELECTRONICS as result of magazine's policy regarding mail-order tube advertisements. (See RADIO-ELECTRONICS, January, 1956, page 57.) Groups representing virtually every branch of the electronic industry—General Electric, Philco, Raytheon, Federation of Radio and Television Service Associations of Pennsylvania, Electro-Voice, RETMA, Simpson and Astron, to name but a few—have responded with letters and telegrams congratulating RADIO-ELECTRONICS on its announcement in the January issue that all mail-order tube advertisers must warrent that tubes offered for sale are new and unused, not mechanical or electrical rejects and not washed and/or rebranded. This policy protects not only our readers, but all legitimate advertisers.

TELEPHONE LINE TV transmission was successfullly demonstrated on Dec. 6, 1955, with photographs, printed material and signatures transmitted over 10 miles of ordinary telephone wires. In the first public exhibition of an industrial television system operating without costly microwave or coaxial cables, the Dage Television Division, Thompson Products, in cooperation with the Bell Telephone Co. of Pennsylvania, used a slow-scan transmitter which completed the picture on the screen within 2 to 4 seconds.

Called Data-Vision, the new TV system is to be used experimentally between branch offices of the Philadelphia National Bank. At the demonstration the Data-Vision camera and monitor (see photo) at the sending end stood within a few feet of the receiver but the material transmitted between them traveled 10 miles. The image appears on 6 x 2-inch viewing screens on the monitor and receiver. Data-Vision requires only an 8-kc bandwidth and can be used wherever there is a need to view at a distance any type of visual information such as pictures, printed or written material, meters and gages.

OUTER SPACE transmitters sending radio waves picked up on earth by sensitive receivers (radio telescopes) number at least 1,936, according to Dr. Martin Ryle of the Cavendish Laboratory, Cambridge, England. His report, made at a meeting of the Royal Astronomical Society, was the result of a thorough sky survey. The great majority of the radio sources are not identified with any visible object, though 500 of them have accurately known positions. More than 30 were found to be very large and may be galaxies in collision. Others are the expanding remnants of supernovas.

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

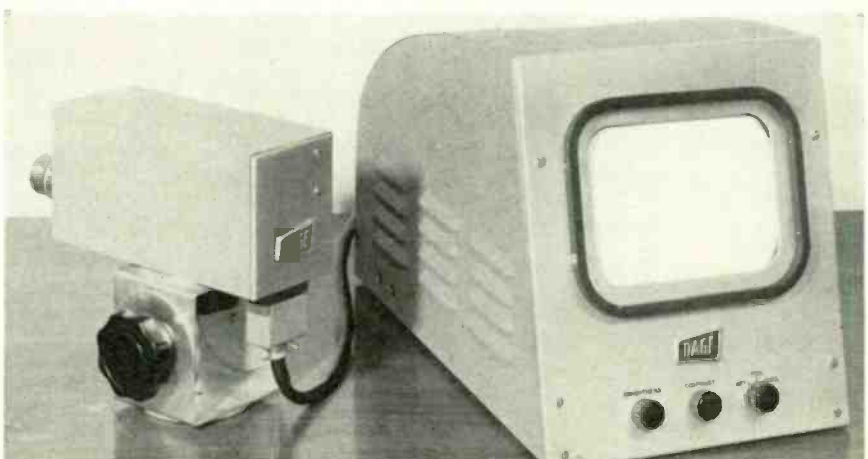
KMUI-TV	Maui, T. H.	12
KLEW-TV	Lewiston, Idaho	3
WREC-TV	Memphis, Tenn.	3
KHAS-TV	Hasting, Nev.	5

Canada's 32d station, CKRS-TV, Jonquiere, Que., channel 12 has also started operation.

WPFA-TV, Pensacola, Fla., channel 15; KTVE, Longview, Tex., channel 32; and WTVQ, Oklahoma City, Okla., channel 25, have gone off the air.

KSLA, Shreveport, La., channel 12, has changed its call letters to KSLA-TV.

RADIATION CONTROL for all receivers operating in the 30–890-mc range, including TV and FM sets, has been promulgated by the FCC. All sets made after May 1 (uhf TV receivers have a Dec. 31 deadline) must be "certified" as adhering to specific radiation limits on the basis of tests made "on a sufficient number of production units . . ." Radiation at frequencies below 25 mc, such as from sweep, color subcarrier and 21-mc if circuits, must meet specified limits in all new TV sets made after June 30, 1956. END



WHY should a set owner call you

instead of Joe's for TV-Radio service?

Honestly, now, what special inducement do you have that will cause customers to select you for service instead of your competitor? Men? Shop? Trucks? Test Equipment? In most cases the answer is simple — *not a single thing!*

The exceptions are service dealers who are among the select group of RAYTHEON BONDED ELECTRONIC TECHNICIANS.

Raytheon Bonded Dealers can offer the public TV-Radio service that is bonded by Raytheon through one of America's largest insurance companies. This creates customer confidence, sways potential customers, helps get more business and make more money. Yet, this tremendous selling advantage costs Bonded Dealers *not one penny.*

Why not ask your Sponsoring Raytheon Tube Distributor if you can qualify as a Raytheon Bonded Electronic Technician? If you can, we'll be happy to pay for *your* bonding.

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RAYTHEON MANUFACTURING COMPANY
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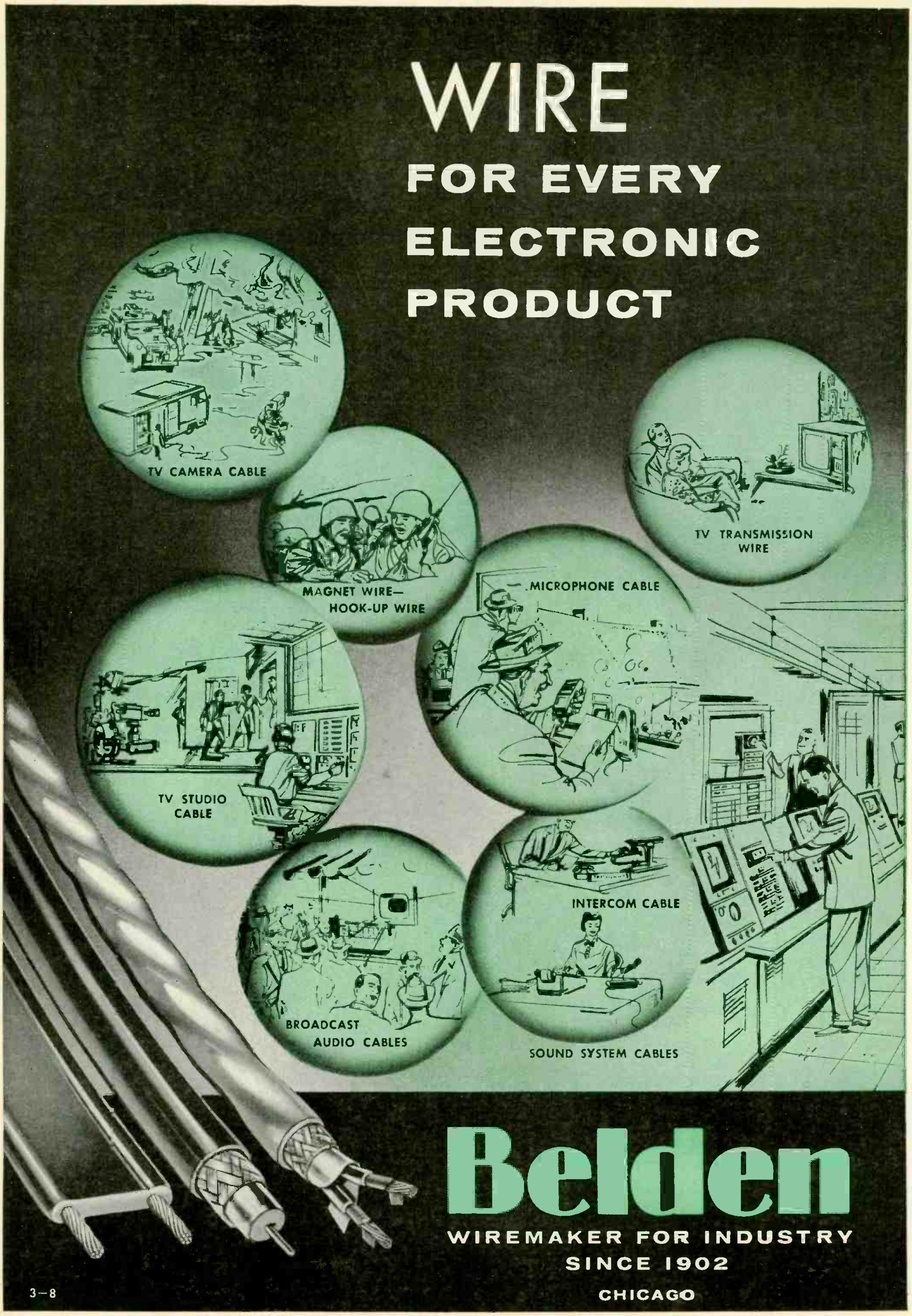
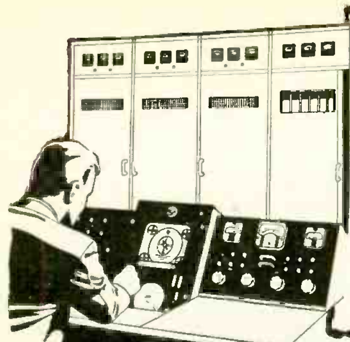
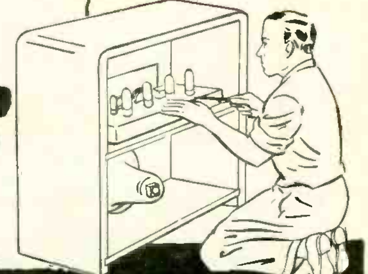
RECEIVING AND PICTURE TUBES • RELIABLE SUBMINIATURE AND MINIATURE TUBES • SEMICONDUCTOR DIODES, POWER RECTIFIERS AND TRANSISTORS • NUCLEONIC TUBES • MICROWAVE TUBES







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If you have had any practical experience —Amateur, Army, Navy, Radio repair, or experimenting.

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TELLS HOW— *Employers make* JOB OFFERS Like These to Our Graduates Every Month

Broadcast Station in Illinois: "We are in need of an engineer with a first class phone license, preferably a student of CIRE; 40 hour weeks plus 8 hours overtime."

West Coast Manufacturer: "We are currently in need of men with electronics training or experience in radar maintenance, and we would appreciate if you will refer interested persons to us."

Letter from nationally-known Manufacturer: "We have a very great need at the present time for radio-electronics technicians and would appreciate any helpful suggestions that you may be able to offer."

These are just a few examples of the job offers that come to our office periodically. Some licensed radioman filled each of these jobs . . . it might have been you!

HERE'S PROOF FCC LICENSES ARE OFTEN SECURED IN A FEW HOURS OF STUDY WITH OUR COACHING AT HOME IN SPARE TIME.

Name and Address	License	Time
A/1C Ronald H. Person, St. Louis 20, Mo.	1st	25 Weeks
Milton L. Geisler, ET3, FPO, San Francisco, Calif.	1st	26 Weeks
Marvin F. Kimball, Lafayette, Ind.	2nd	21 Weeks
L. M. Bonino, Harlington AFB, Tex.	2nd	16 Weeks
John E. Hutchison, Bluefield, W. Va.	1st	27 Weeks

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ELECTRONICS TECHNICIAN

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

Charles D. Sindelar, Cedar Rapids, Iowa

AIRLINES

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

James A. Wright, Beltsville, Md.

INDUSTRIAL ELECTRONICS

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

Glen A. Furlong, Fresno, Calif.

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(Address to Desk No. to avoid delay)

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

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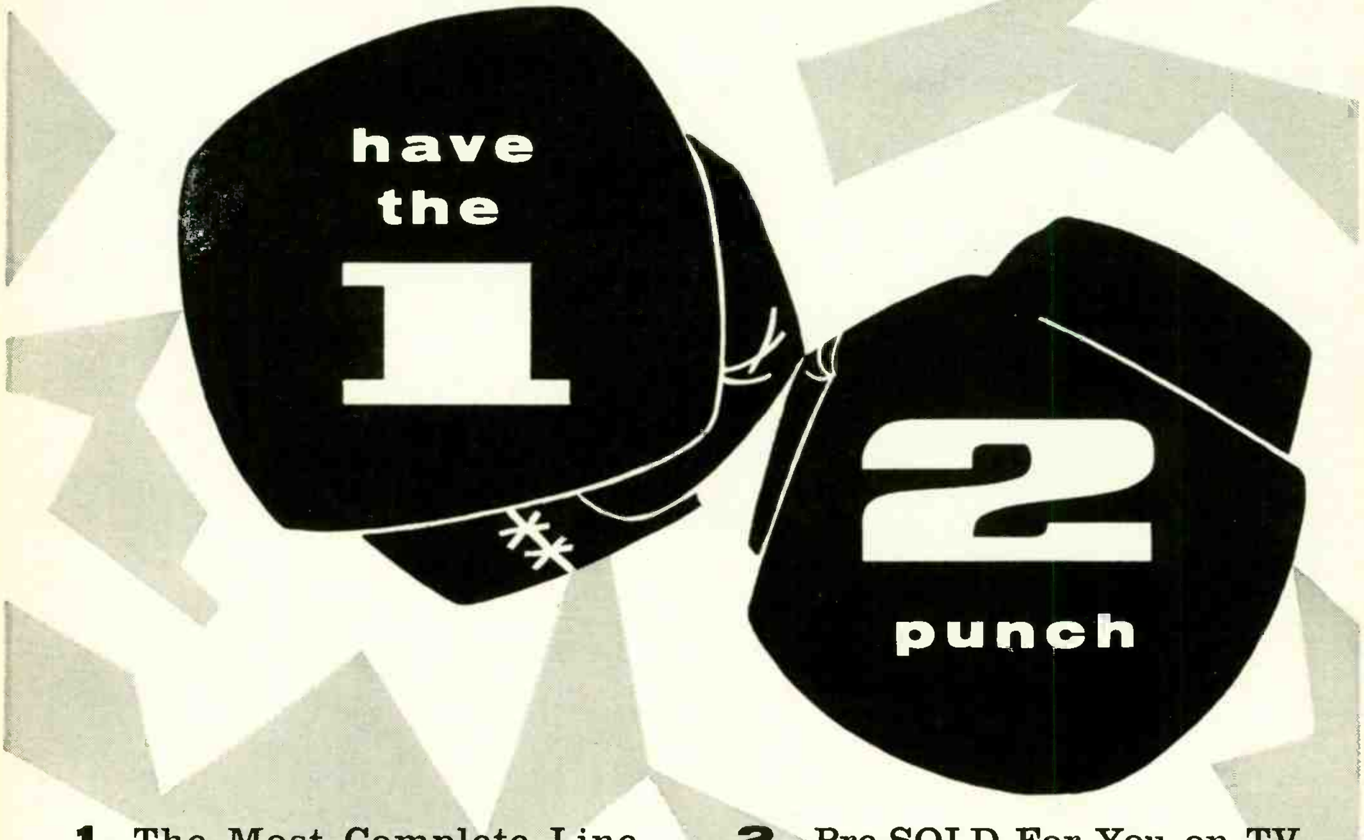

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The CDR Rotor line is COMPLETE to every detail, with a model for every application! A distinct selling advantage because YOU can give your customer EXACTLY what is required! The RIGHT CDR Rotor for the RIGHT job

2. Pre-SOLD For You on TV to millions of viewers

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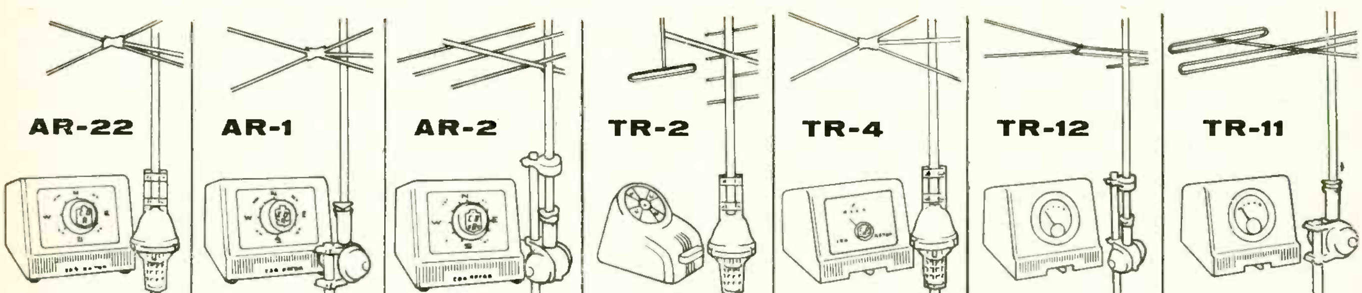
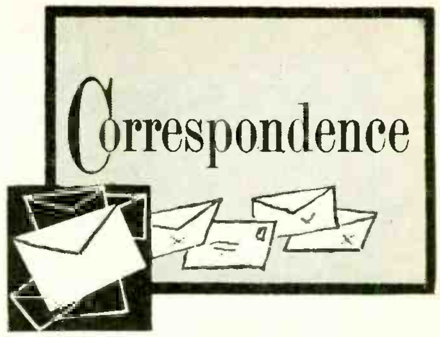


AR-22	AR-1	AR-2	TR-2	TR-4	TR-12	TR-11
Completely AUTOMATIC version of the TR-2 with all the powerful features that made it famous.	Completely AUTOMATIC rotor, powerful and dependable. Modern design cabinet. 4 wire cable.	Completely AUTOMATIC rotor with thrust bearing. Handsome cabinet, 4 wire cable	Heavy-duty rotor with plastic cabinet, "compass control" illuminated perfect pattern dial, 8 wire cable	Heavy-duty rotor, modern cabinet with METER control dial, 4 wire cable.	Combination value complete rotor with thrust bearing. Modern cabinet with meter control dial, uses 4 wire cable.	Ideal budget all-purpose rotor, new modern cabinet featuring meter control dial, 4 wire cable

CORNELL-DUBILIER
SOUTH PLAINFIELD, N. J.

THE RADIART CORP.
CLEVELAND 13, OHIO



Correspondence

MODIFYING CIRCUITRY

Dear Editor:

Mr. Highstone's approach to servicing is shared by many TV repairmen: "If you can't find the trouble, see if there isn't some way to hide it *temporarily*."

Most factory engineers have a pretty good reason for selecting the particular components used in a set. Their experience, training and test facilities are almost always much better than those of the technician. So how can Mr. Highstone justify changing component values in sets which have worked just because he is unable to locate the cause of the trouble?

Don't you think, Mr. Editor, that the real technicians have enough problems without articles by men such as Mr. Highstone?

F. J. JAMES

Jacksonville, Fla.

(Service manual on the editor's own set lists these "Production Changes": R87, 100,000 to 330,000; R79, 47,000 to 33,000; R63, 330,000 to 220,000 ohms; R95 removed. "Factory engineers" modify circuitry sometimes, too!"—*Editor*)

POST-ACCELERATION

Dear Editor:

In the December, 1955, issue of RADIO-ELECTRONICS you describe a so-called "new" post-acceleration tube.

In the interests of accuracy, I feel that you should make it clear to your readers that the General Electric three-gun post-acceleration color tube which you describe as "new" is, in fact, identical to a three-gun Chromatron or Lawrence tube described by me in the *Proceedings of the Institute of Radio Engineers*, Vol. 41, No. 7, July, 1953.

The article on the General Electric post-acceleration tube differentiates it from the Lawrence tube by stating that it "differs distinctly in that the potential on it is fixed and no dynamic voltages are applied. All wires are at the same potential." I would like to direct your attention to my paper in the IRE journal wherein I stated: "In this multigun version (of the Chromatron) no color switching is required, and the color grid remains at a chosen fixed potential."

Fig. 4 in my paper is also directly comparable with Fig. 3 of your article.

ROBERT DRESSLER
Vice President,
Director of Research & Development
Chromatic Television Laboratories
New York, N. Y.

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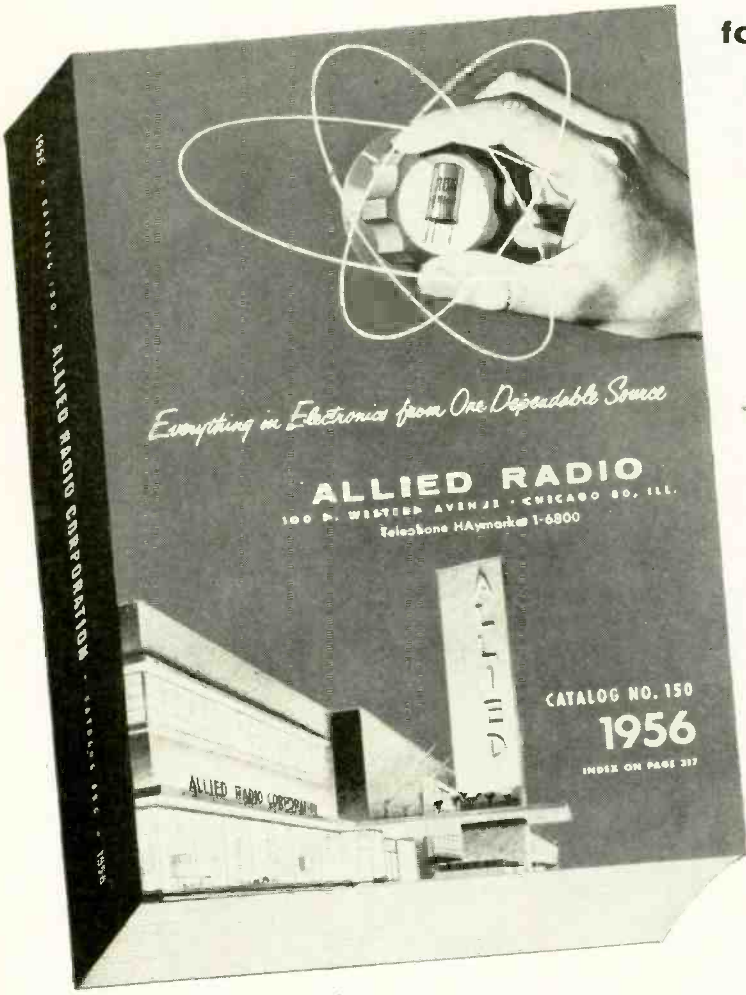

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INDIANAPOLIS UNITY

Dear Editor:

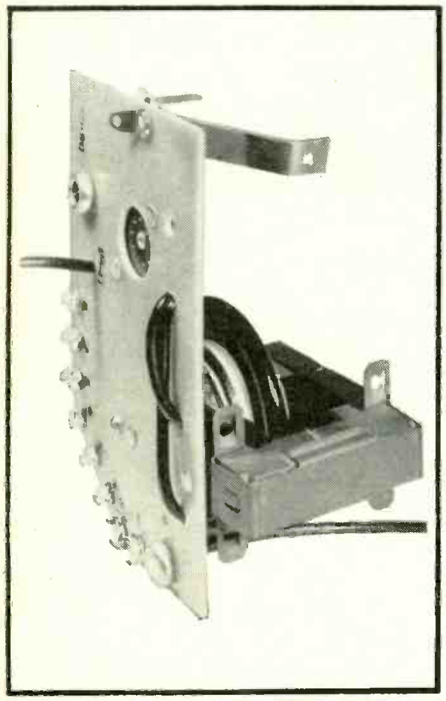
What's wrong with NATESA? This is one of the questions raised at the recent meeting for unity in Indianapolis. Perhaps many like myself were reluctant to comment upon it, not knowing exactly how the constitution of NATESA was written. However, since digesting the comments that were made at the meeting and after reading the NATESA's constitution, one glaring defect appears which perhaps is responsible for so many service groups (and those in the East are not alone, as some would have you believe) being reluctant to accept NATESA in its present form.

The office of president in that organization as it is now constituted carries on the duties of corresponding secretary, as well as those of editor of the house organ, *NATESA Scope*. Such an arrangement tends to prevent expression of divergent opinion and to make the association appear dictatorial, even though such *might* not be the case. With all these duties it is no wonder that NATESA cannot find another man to accept the presidency, as they say they have tried. There are too few persons with the initiative, time and ability to carry out the duties of *one* of these jobs, much less all three. To allow one man to extend himself for all three jobs tends to make him feel that *he* is the organization and to outsiders that the organization is *his*.

At any rate, it is certainly plain, with the various comments made during the unity meeting of Oct. 9, 1955, and the results that have been attained since, that *something* basic is wrong with NATESA beyond personalities. Perhaps the foregoing is that defect.

To go on to another aspect of the unity meeting, as so ably presented by Forrest Baker of the Texas Electronic Association in reference to the position of the individual shops, the local association and the state association in a national group, the format follows the pattern used successfully by national associations in other fields. The conclusion reached by some, that NATESA already has such a form, does not hold up under closer scrutiny. The Texas plan follows the desires of many of us; the individual shops form the local association from which delegates are elected to the state association *from which* delegates are elected to the national group. As Mr. Baker suggested, to make the national office more efficient and further to cut down travel expense to national meetings, the 48 states could be divided into 4 groups of 12, with a coordinating chairman at the head of each. From these groups could be elected national officers, one from each area, as is done in the National Retail Hardware Association.

As each local association is autonomous, so should each state association be. No directives should be issued by the national association since its prime



functions are to inform, instruct and assist.

Now let us look a little closer at the NATESA arrangement, offered as being the *same:* Individual associations join NATESA directly, they do not have to be members of a state or even regional group; there are regional vice presidents, regional secretaries and, lately, sort of tacked-on governors of states, all of whom report to the president of NATESA who issues directives from time to time to all concerned. All these officers are elected by delegates from the local associations directly.

The answer no doubt to the above will be that NATESA did not have state association divisions until recently and therefore the state groups were not more active in the national group. However, my point is that NATESA format is *not* the same as Texas has proposed and, if the officers of NATESA were really interested in arriving at a *merged* unity, they would have given more consideration to the ideas expressed by the Texas plan—they certainly knew it followed the desires of other groups including the National Electronic Technicians and Service Dealers Associations.

It is perfectly plain, in spite of disclaimers of dictatorship, the members of NATESA have allowed the organization to become a one-man affair; the fact that the incumbent has been president for at least 5 consecutive years emphasizes it. Thus, many of the delegates who attended the Indianapolis meeting cannot sell their local associations on NATESA—they have no enthusiasm for the selling themselves. There was an attitude of resignation in the closing hours of the meeting of Oct. 9, when it became evident that the delegates of NATESA would accept unity only on their own terms. I and many others went to Indianapolis seeking an amalgamation of thought—we were sorely disappointed.

JOHN A. WHEATON

Mineola, N. Y.

TESTING NEW TUBES

Dear Editor:

Here is a gripe—and a problem. The instrument people do their best when they sell a tube tester to keep the tube chart up to date. I have a very reliable unit. However, tube manufacturers come along with three to six new tubes each month and I am unable to check them. Sometimes as much as 6 months pass between additions to the tube chart.

The independent service technician must be prepared to handle a wide variety of tube types and is often criticized when he is unable to test some new tube.

I wonder if there is some way to figure out settings for testing new tubes based on comparing their characteristics with similar older types?

CLIFFORD LESSIG

Radio-TV Service
Milford, N. J.

END

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- Tests receiver screen voltage supply
- Tests receiver video output signal
- Tests effectiveness of brightness receiver control
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One out of every three TV PIX TUBES can be reactivated successfully the B & B way. Just set Selector Switch in "Beam-Curr" position, turn on HV for three minutes and the job is done safely without damage to the cathode.

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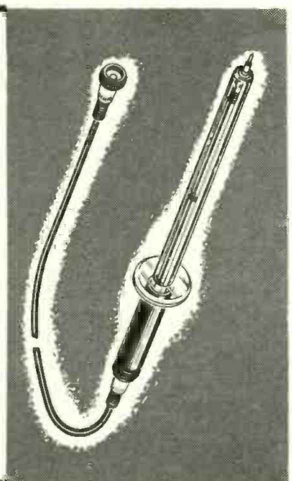

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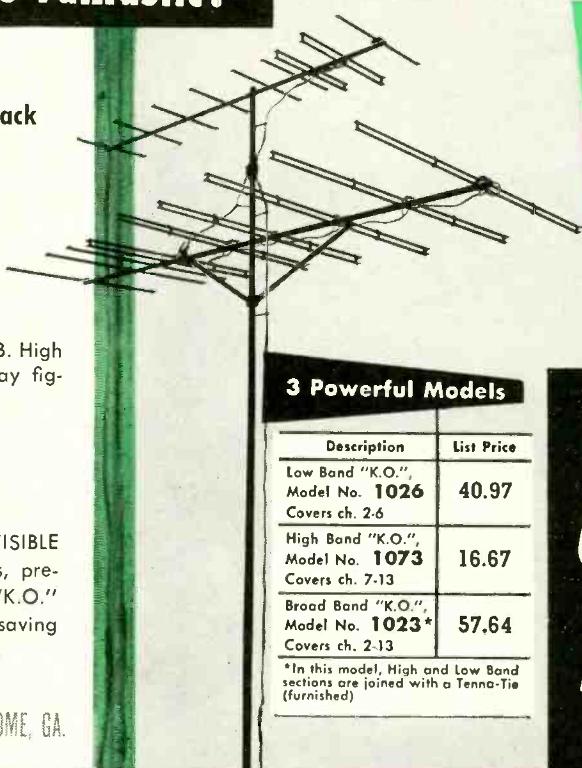

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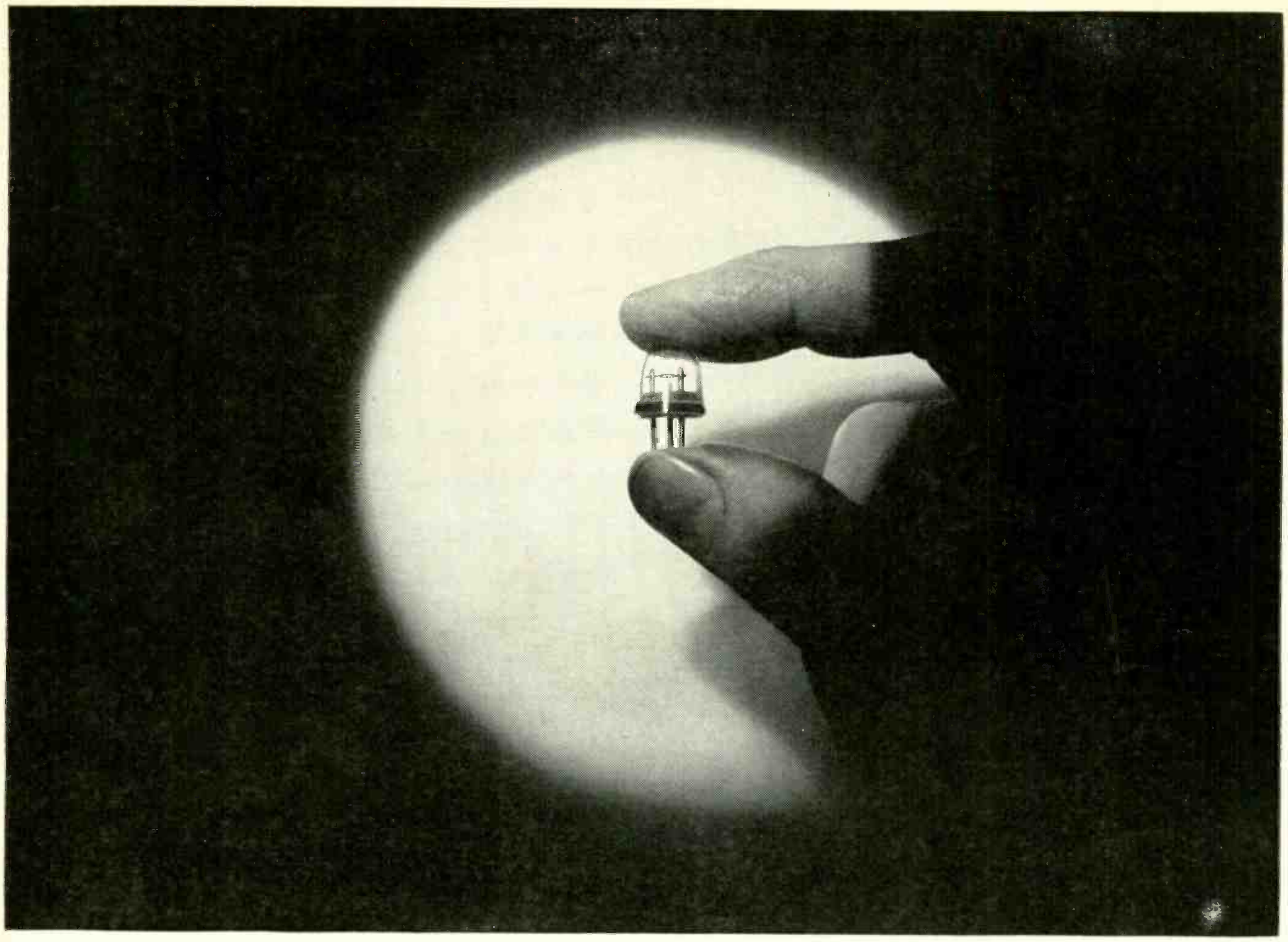

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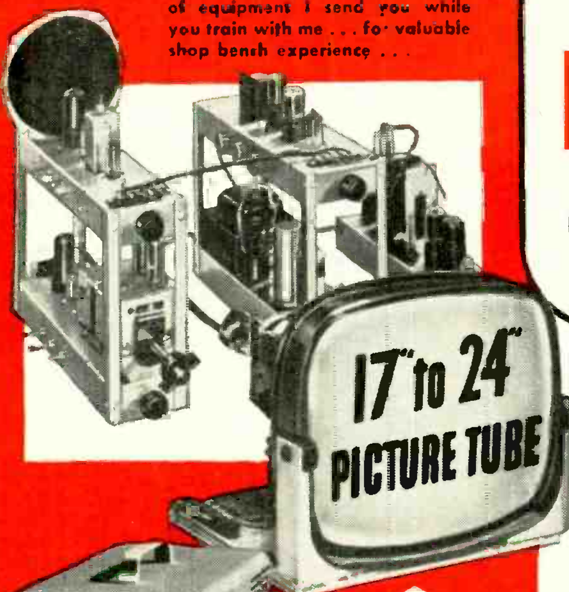

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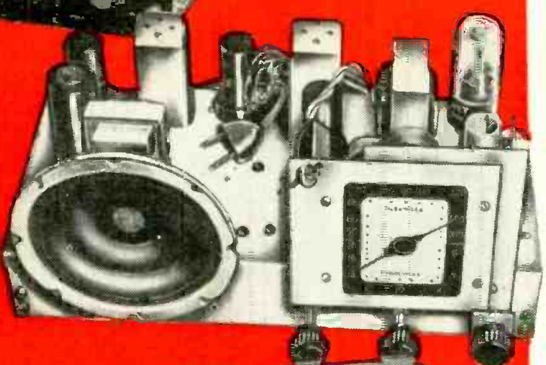

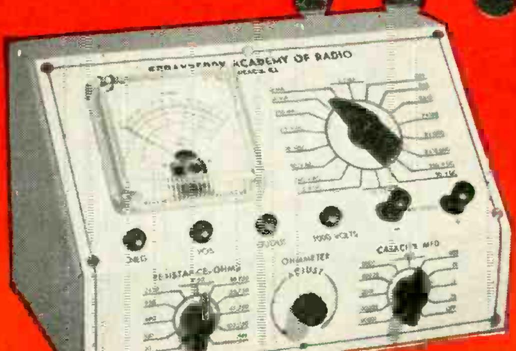

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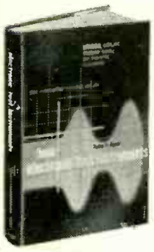

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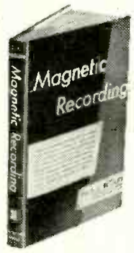

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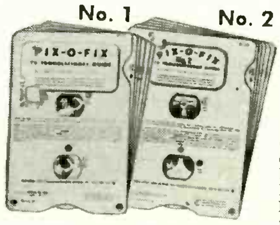

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RADIO-ELECTRONICS
Hugo Gernsback, Editor

SPACE ELECTRONICS

. . . Another new branch of electronics is in the making . . .

IN THE reasonably near future, man will have extended his domain into outer space. Indeed, as this is written, the United States Government is actively engaged in pushing our frontiers in exactly that direction. By 1958 our Government will have launched between 6 and 10 satellites the size of basketballs, which will gravitate between 200 to 700 miles above the Earth. (They will not travel in circular paths around the Earth, but will have elliptical orbits varying from 200 to 700 miles above our planet.)

These tiny satellites will be launched during the International Geophysical Year in 1958. They will be equipped with a variety of electronic telemetering gear, sending to Earth a multitude of data for analysis by our scientists. The distance of 200 to 700 miles above the Earth is still not in a perfect vacuum and there will be some drag on the satellites from the Earth's atmosphere which will eventually slow them down, after which they will crash to Earth.

As we proceed to push out farther into open space, a number of new conditions will be found. Once you get to a distance of several thousand miles away from the Earth, you have to contend with a number of new factors. Chief among these is the cold of interstellar space, where temperatures near absolute zero prevail. While absolute zero is —459.4° Fahrenheit, such a temperature will probably not be reached anywhere in the physical universe. We have, however, already approached close to this point. Thus, for instance, Prof. Kamerlingh Onnes, of the University of Leyden, has reached a temperature of —457.6°F.

In 1946, scientists at Johns Hopkins University of Baltimore announced that radio broadcasts can be picked up and detected without the use of tubes, electric current, antenna or capacitors. They were experimenting with an infra-red bolometer to which was connected a strip of columbium nitride. When placed in a *cryostat,* an instrument which cools down to about 15° above absolute zero, or —444.4°F, a loudspeaker placed in the bolometer circuit gave out broadcast music. The strange phenomenon was due to the strip of columbium metal which, when cooled to near absolute zero, became superconductive.*

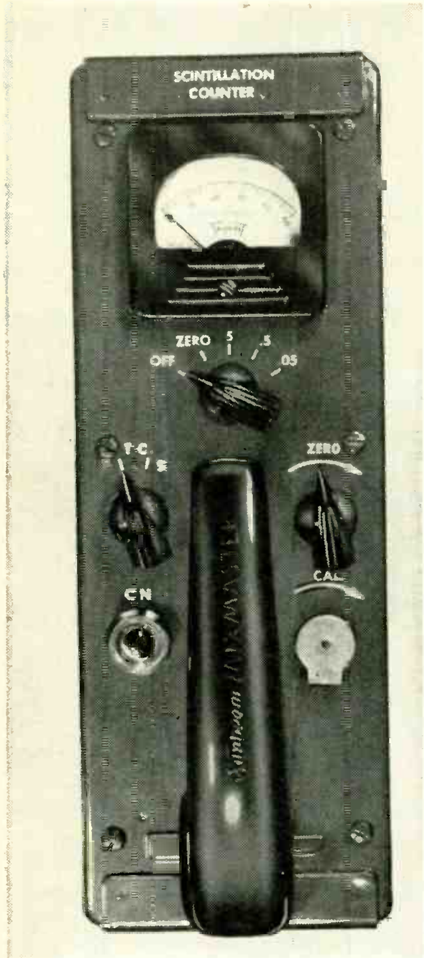
At such low temperatures, Professor Onnes sent tremendous currents through very fine conductors that would ordinarily have become white hot or volatilized. However, when cooled to near absolute zero, ordinary conductors become *supraconductors* because they become superconductive to the electric current. Here they lose all resistance. Once an electric current is started in such a conductor, the current keeps on flowing indefinitely. Here we have to do with a sort of "perpetual-motion current" which, in outer space, is likely to be used for undreamt-of purposes.

The field of superconductivity and supraconductors in outer space opens up an entirely new and fantastic development for the future. One may speculate, for instance, about placing various electric or electronic devices into outer space and starting them going. Once started they would keep functioning forever without the need of any further outside electric current. This may sound shocking to the mundane engineer, who may doubt the possibility of a state where current is constantly furnished without the use of outside energy. However, if we look at the Earth and other larger heavenly bodies that have been moving in their orbits for billions of years without outside power supplying the motion, the idea no longer seems so far-fetched. Coming nearer to Earth, the unlocking of titanic powers from the atom also points the way to almost free energy. *However, possibly the greatest advances in space electronics will come through the use of solid-state semiconductor electronics at near absolute zero available in outer space.*

Thus, for instance, the recent solar electrocells which convert sunlight directly into electricity have been tried out only in our atmosphere, which interposes a very effective shield between pure sunlight and our Earth. Once we can take these electrocells into open space and expose them directly to sunlight without a dense atmospheric blanket intervening, we will really have efficient use of sunlight, and perhaps sufficient energy to power future space ships.

I foresee perhaps the greatest advances in electronics in solid-state electronics in outer space when our present transistors will become *supertransistors* as well as atomic transistors. We can foresee a variety of future supercooled solid semiconductors pressed into electronic service with results quite unimaginable today.—*H. G.*

*See the editorial "Superadio," in our April, 1947, issue.



The portable scintillation counter.

PORTABLE SCINTILLATION COUNTER

Part I—Complete construction details for highly sensitive radioactivity indicator

By JAMES W. BRAY

THE scintillation counter is an extremely useful tool for uranium prospecting, health-hazard surveys and decontamination work. Its sensitivity far surpasses that of the Geiger counter, which make it ideal for surveys of low-grade deposits. It also makes possible prospecting from aircraft and other moving vehicles. This article describes a portable scintillation counter which can be constructed without much difficulty by the average electronic experimenter.

The circuit is a modification of one that appeared originally in Circular No. 535 of the United States Geological Survey "Portable Scintillation Counters for Geologic Use," and with minor changes has been used in at least two commercial scintillation counters.

When gamma rays from radioactive material (such as uranium) strike certain types of crystals, the crystals emit tiny flashes of light or scintillations. The crystal material usually used to detect gamma rays from uranium is sodium iodide in a hermetically sealed unit. One end of the crystal is covered with a thin metal such as aluminum. Gamma rays pass through this metal and strike the crystal. The other end is closed by a piece of special glass, optically coupled to an RCA 6199 multiplier phototube.

The crystal and tube are coupled by applying a thin coating of Dow-Corning

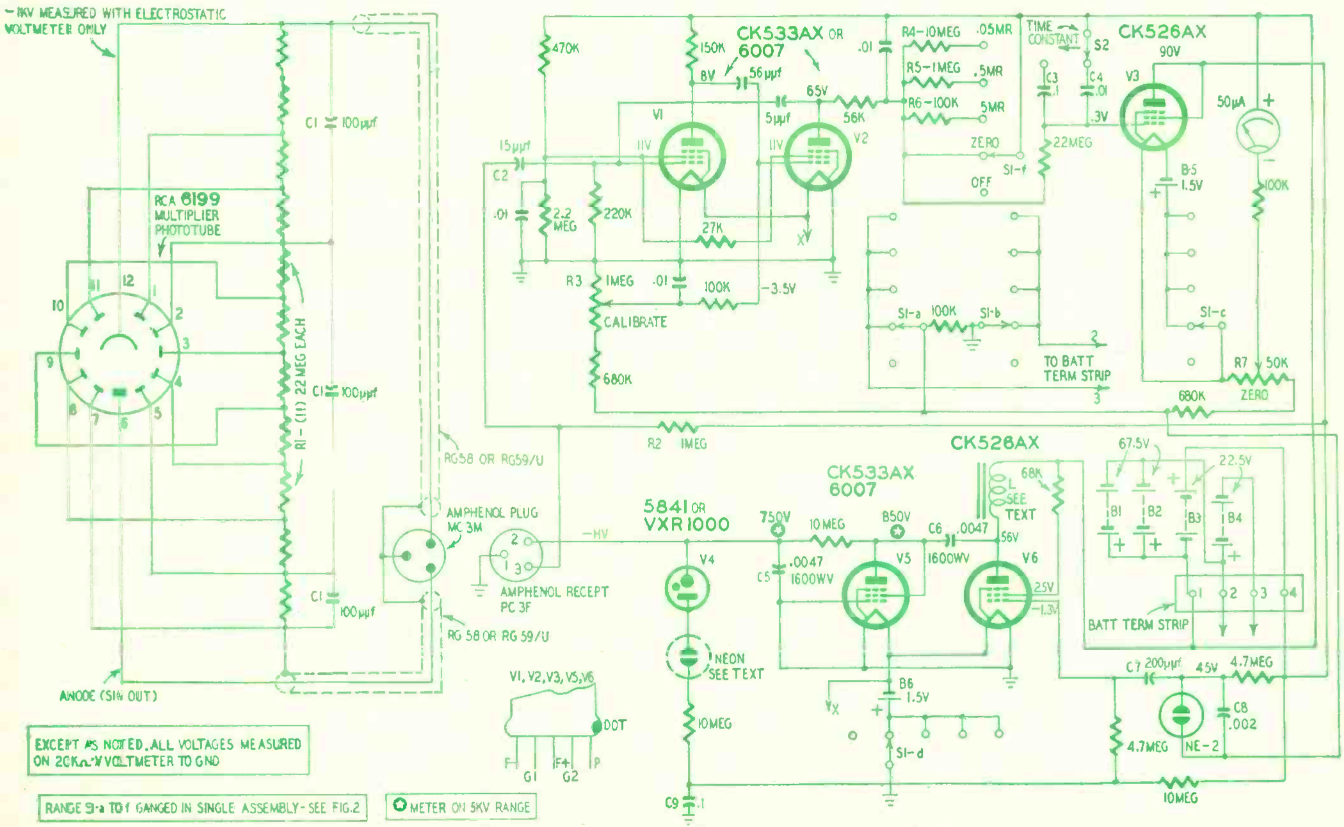
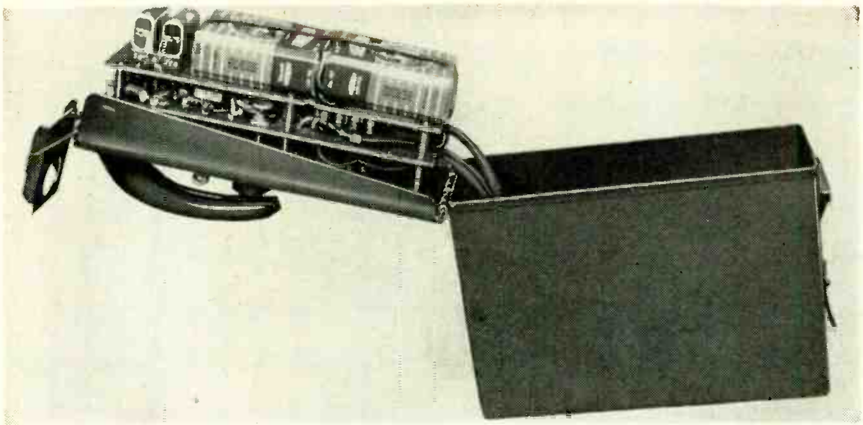


Fig. 1—Schematic diagram of the complete portable scintillation counter.



View of the counter with case open.

DC-200 Silicone Coupling Fluid between the glass surface of the crystal and the end window of the tube. The coupling fluid transfers a maximum of light (scintillations) from crystal to tube.

Scintillations thus received at the photocathode in the end of the tube are passed through 10 dynode stages, each with a difference of potential of 100 volts more than the preceding one. This voltage is supplied by a 900–1,000-volt supply and a voltage divider (Fig. 1).

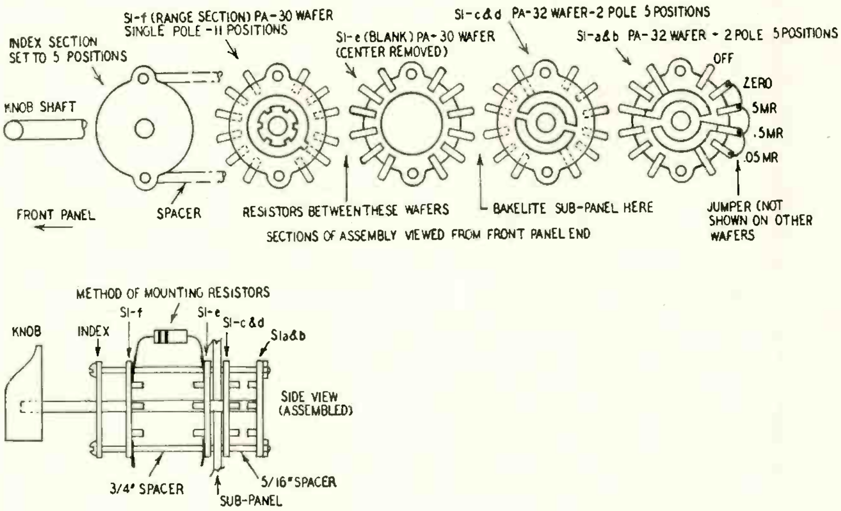
By a process of secondary emission, the current flow caused by the light flashes is amplified up to 1,000,000 times. The amplified pulses appearing at the anode of the tube are coupled to a monostable multivibrator, commonly known as a one-shot or univibrator (V1, V2).

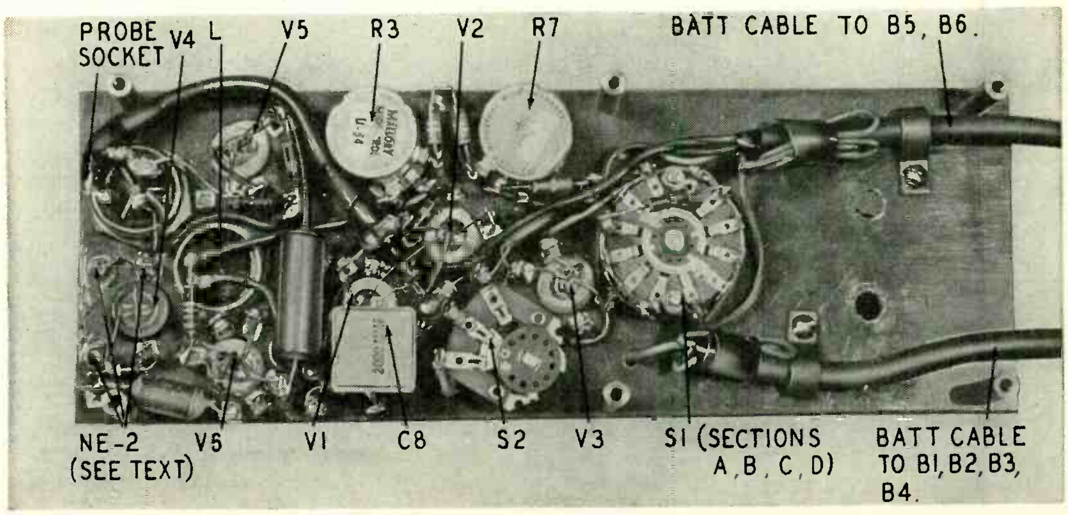
The random pulses at the anode of the phototube trigger the univibrator, producing one uniform output pulse for each input pulse. The CALIBRATE control R3 affects the bias on V2 and to some extent the bias on V1; it varies the input sensitivity of the instrument. Ranges are selected by switching different resistors into the plate circuit of V2. Two time constants can be selected by switching S2, which puts either C3 or C4 in the circuit. These values give time constants of approximately 1 and 10 seconds. The metering circuit uses a vacuum-tube voltmeter, commonly called a ratemeter; R7 zeros the meter.

A potential of 900 to 1,000 volts is needed to supply the 10 dynodes of the phototube. To obtain this a special type of low-current high-voltage supply is used. It operates as follows: The battery fires the neon bulb in a relaxation oscillator circuit. These pulses are applied to the grid of V6. Amplified pulses cause a reactive voltage to be developed across L in the plate circuit of V6. This high voltage is rectified by V5, filtered, and regulated by V4, a corona regulator tube.

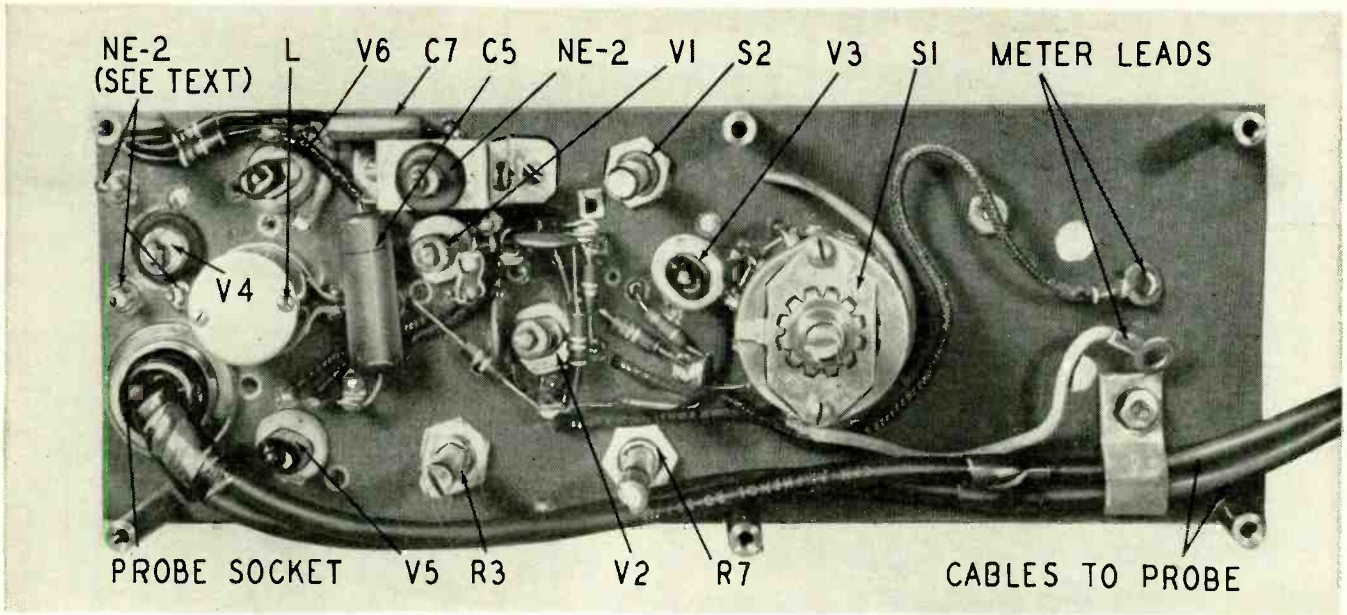
In this unit a voltage in excess of 1,000 gave more signal output from the phototube. To use the 900-volt 5841 tube already on hand, three neon bulbs (NE-2) were added in series to give the correct higher-voltage output. Satisfactory results are obtainable,

Fig. 2—Diagram shows construction details of counter's range switch.





Subpanel bottom—note tube mountings.



Layout of the subpanel topside.

however, using the 5841 or VXR 1000 tubes alone in the circuit shown. Some compensation for drop in battery voltage is provided by feedback between the output voltage and the grid of V6.

The dynode voltage divider (R1) is made up of 22-megohm resistors. Two of these, in series (44 megohms), are used between the cathode and first dynode. An ordinary voltmeter or vacuum-tube voltmeter cannot be used to measure accurately the voltage from this supply; an electrostatic voltmeter is the only type suitable. However, the builder can determine whether or not the supply is working properly by using a conventional voltmeter and comparing readings with the voltages shown. These values serve merely as indications and do not define the actual voltage present. The UTC 0-13 reactor was chosen for L because it was the only miniature available which would work satisfactorily in this circuit. Substitution of another type is not recommended.

Construction

The entire instrument is housed in a .30 caliber ammunition case. These cases are the new aluminum type, available on the surplus market. The case is 6⅝ inches high, 3½ inches wide and 10⅛ inches deep. A metal stiffener under the front panel was first removed to reduce weight and allow for easier assembly. The old handle was removed and welded joints filed smooth.

Electronic circuits were all constructed on ⅛-inch Bakelite panels (see photos) separated by ¼-inch brass spacers. Panels (two required) are of uniform size, 9½ x 3¼ inches. Locate suitable mounting points for the brass spacers and drill both Bakelite panels and the front panel simultaneously. Now place the meter as near the top of the front panel as possible. Drill holes and put the meter in place.

Put the range switch (Fig. 2) together as follows: Next to the knob end, put on a Centralab PA-30 1-pole–11-position wafer section S1-f. Next, a ¾-inch spacer and then a blank wafer, S1-e, is installed. (This is one which has no rotating contact and can be a PA-30 type with the center removed.) This forms the part of S1 which will extend above the subpanel. Drill three holes and mount the switch on the subpanel. It should be mounted as close to the meter as possible, allowing space for decal markings on the front panel. Note that the switch shaft extends through the subpanel to permit operation of the other sections.

Below the subpanel, assemble two PA-32 (dp–5-position) wafer sections with 5/16-inch spacers between them. Resistors for the different ranges are located between the top- and second-wafer sections, S1-e and S1-f. These resistors, R4, R5 and R6 should be selected ½-watt types. The accuracy of the ranges will depend upon their tolerance. Precision types were not used, however, as correct values were found by selection from several standard 10% resistors. For ease of assembly all resistors and jumpers associated with S1 should be soldered in place before final mounting of the switch. The two sections below the subpanel — S1-a and b, and S1-c and d — are for battery switching.

Exact locations of tubes and other components are not given because, the layout can be arranged to suit the constructor. Parts placement is not critical. Keep input leads short and well shielded. Distributed capacitances should be kept at a minimum in the univibrator circuits; short direct leads are the best.

A short length of coax (RG58/U or RG59/U) runs between the input socket from the phototube and the input of the univibrator (C2–R2). Tubes are mounted in rubber grommets. Where 6007 tubes are used, drill the size hole specified for the grommet; holes must be slightly enlarged to allow space for the oval-shaped Raytheon (CK533AX or CK526AX) tubes. A slight undercutting is necessary in the ⅛-inch panel to make the grommets fit. A larger grommet with 5/16-inch hole will fit snugly around the Victoreen 5841 tube.

The neon bulb serves double duty. In addition to its use in the power supply, it is used as a pilot light. To extend it through the front panel, a bracket 1 3/16 inches high is bent from aluminum and mounted on top of the subpanel; a rubber grommet holds the bulb in place. This puts it slightly above the top panel where it is covered with a Johnson neon pilot assembly with a clear bezel. Remove the socket and base of the assembly and saw off the mounting threads close to permit fitting between panel and neon mounting bracket.

The potentiometers R3 and R7, and S2 (the time constant switch) are mounted below the subpanel with the shafts of R7 and S2 long enough to extend through the front panel. After these

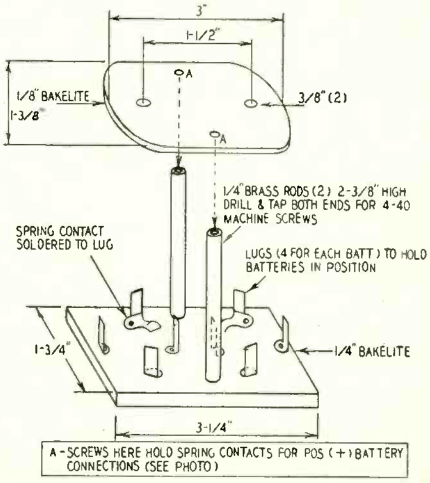


Fig. 3—Setup for mounting B5 and B6.

All components removed from case.

components have been mounted, holes can be located in the front panel. The CALIBRATION shaft does not appear above the front panel. To allow for more hand space this shaft was recessed in a bushing attached to the front panel. A screwdriver slot was sawed to allow tuning. A snap-on phone-jack cover (from surplus equipment) keeps water out.

Drill holes for the S2 and R7 shafts large enough for rubber grommets which fit tightly around the shafts to make water-resistant seals. The meter and pilot bezel are fitted with cork gaskets. Cement the heavy rubber gasket which comes with the case into place inside the top panel.

The type of construction used is a modified printed-circuit arrangement in which terminal lugs are riveted to the subpanel wherever needed. Components are then mounted between these lugs and with careful layout leads will be very short. Terminal lugs are obtainable from Cinch or Useco. Lacking these, conventional soldering lugs held against the panel with small screws, or even small screws themselves, can be used as standoffs for the various components. Leads from tubes are soldered directly to lugs mounted around the periphery of the tube. L1 is mounted in a 7/8-inch hole with a mounting strap of the type used for tubular capacitors.

Use flexible leads to the meter long enough for removing the subpanel for inspection without taking the leads off the meter.

Use good-quality mica capacitors for C7 and C8. Ceramic types were tried but found to be inferior to the mica in this circuit. Flat ceramic bypasses can be used for other capacitors except C9 which is a 200-volt tubular and C5 and C6 which are 1,600-volt tubulars.

Battery arrangement

One of the Bakelite panels mentioned is used as a battery mounting board (see photo). All batteries are mounted here except flashlight cells B5 and B6. To allow space for the lid to open and close with batteries intact, 22½-volt batteries B3 and B4 were mounted at the rear of the board (away from the hinge).

Mountings for B3 and B4 (see photo) were made from two 30-amp fuse clips attached to the mounting board (mounting brackets can be purchased). On each end is a contact assembly made from contacts taken from an old relay. They were shaped and bolted to small strips of Bakelite secured to the board with angle brackets. B1 and B2 are fastened to the board by a long spring stretched across the top of the batteries and hooked onto a screw at one end. This mounting keeps batteries in place and permits quick replacement.

The batteries are connected by leads running underneath the panel to a four-terminal strip. A length of four-conductor cable was used to connect from the terminal strip to the circuit. At the circuit end, leads from this cable go directly to points of connection on the switch, etc. The cable should be run to the back of the mounting board and sufficient length allowed to fold back the battery board for access to the components on the subpanel. The cable is held on both panels with cable clamps.

The mounting (Fig. 3) for B5, B6 was constructed from two pieces of Bakelite, brass spacers and some large soldering lugs (or eyelets). Contacts are formed by using two of the relay contacts mentioned and stiffening them on top with an additional piece of spring brass. The bottom contact is a piece of spring metal soldered to one of the base lugs. Recess all mounting screws in the base to prevent shorting. Other lugs simply hold the batteries in position. Connection to B5 and B6 is made with another length of four-conductor cable.

With the scintillation counter completed the constructor will want to test the instrument. The following is a list of sources for obtaining radioactive samples:

Tracerlab, Inc., 130 High St., Boston, Mass. Radium button No. R-20, $3.60.

E. Earle Fletcher, 3209 Madiera Drive, N. E., Albuquerque, N. M. Uranium rock samples, 25 cents each.

New Brunswick Laboratory, U. S. Atomic Energy Commission, P. O. Box 150, New Brunswick, N. J. Calibrated samples, analyzed and marked with uranium percentage. Write for particulars.

TO BE CONTINUED

Parts for scintillation counter

Resistors: 1—27,000, 1—56,000, 1—68,000, 3—100,000, 1—150,000, 1—220,000, 1—470,000, 2—680,000 ohms, 1—1, 1—2.2, 2—4.7, 3—10, 12—22 megohms, ½ watt; 1—100,000 ohms, 1—1, 1—10 megohms, 1%, ½ watt; 1—50,000 ohms, 1—1 megohm, linear taper, potentiometers (Mallory type U or equivalent).

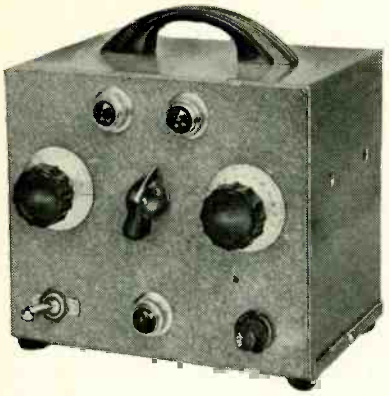
Capacitors: 1—5, 1—15, 1—56 μμf, ceramic or mica; 3—100 μμf, 600 volts; 4—.01 μf, ceramic; 1—200 μμf, 1—.002 μf, 500 volts, mica; 2—.0047 μf, 1,600 volts, tubular; 2—0.1 μf, 200 volts, tubular, metallized.

Switches: 1—Centralab PA-300 shaft and index assembly; 2—Centralab PA30 wafer section (1-pole–11-position); 2—Centralab PA32 wafer section (2-pole–5 position); 1—spdt, shorting.

Tubes: 1—6199 multiplier phototube; 3—Raytheon CK533AX subminiature or Amperex 6007; 2—Raytheon CK526AX subminiature; 1—Victoreen 5841 or VXR 1000 corona voltage regulator.

Crystal: 1—scintillation crystal, sodium iodide (thallium-activated), Harshaw type W4L4 or equivalent; 1 x 1 inch, approximately $62; ½ x 1 inch, approximately $45; Harshaw Chemical Co., 1945 E. 97 St., Cleveland, Ohio.

Miscellaneous: 1—inductor, 50 h, 3 ma, 6,000 ohms (UTC 0-13 Ouncer or equivalent); 1—NE-2 neon bulb; 1—socket for 6199, 12-contact duodecal (Amphenol 59-402 or equivalent); 1—3-contact female chassis receptacle (Amphenol 91-PC3F or equivalent); 1—male cable plug (Amphenol 91-MC3M or equivalent); 1—meter, 0–50 μa (Triplett 227T or equivalent); 1—6-foot length of coaxial cable, RG58/U or RG59/U; 1—3-foot length of 3-conductor rubber-covered cable for battery connections; 2—snap-on type connectors for 67.5-volt batteries; 2—67.5-volt batteries, (Eveready 467 or equivalent); 2—22.5-volt batteries (Eveready 412 or equivalent); 2—1.5 cells (Eveready D-99 or equivalent); 2—mounting brackets for 1.5-volt cells (or make as per Fig. 3); 2—mounting brackets for 22.5-volt batteries (or make as per text); 1—subpanel material, rubber grommets, brass rod for spacers, Bakelite, terminal lugs, etc.; 1—modified pilot light assembly (see text); 1—handle, Sunbeam Mixmaster model 9 (at appliance parts outlets); 1—snap-on jack cover (surplus); 1—.30 caliber ammunition box (surplus); 3—knobs; decals;—4-terminal strip for batteries; 1—2-oz. bottle silicone coupling fluid, Dow-Corning type DC-200, 600,000 centistokes: National Radiac, 10 Crawford St., Newark, N. J. (approximately $3.50).



SIMPLE CYCLIC ELECTROTIMER

By HENRY FRANCIS PARKS*

SINCE the beginning of time man has compared and measured everything with which he came in contact. Primitive man was content to compare objects with stones, trees and mountains whose sizes he remembered. He did not worry much about accuracy. That had to await the machine age when it became a necessity.

As man became more civilized he began to compare sizes with the length of his step or other parts of his body. These varied with the individual, but all primitive man was concerned with was what related to his own personal needs. Time was practically of no importance though he did develop the sun dial to keep some track of it.

About 6,000 B.C. the Egyptians established and recorded the first standards of measurement. The basic unit of length was the cubit, the distance from the point of the elbow, with the forearm bent, to the end of the middle finger of the outstretched hand. In 4,000 B.C., 2,000 years later, the cubit was standardized to 18.24 of our present inches and so remains to this day.

The next important unit was the digit, the diameter of the middle portion of the middle finger—approximately ¾ inch, 1/24 cubit. The span was the length from the tip of the thumb to the tip of the little finger in the Pharaoh's outstretched hand—½ cubit.

The relationship of digit and span to cubit still survives in our system of measuring time—12 hours ante meridian and 12 hours post meridian, a total of 24 hours each day.

These are obviously divisible by 6, a sacred number worshipped by the Chaldeans. So they developed our circular measurement of 360°, the time division of the hour into 60 minutes and the minute into 60 seconds.

Our foot is generally accepted to be the result of a regal decree by an ancient king whose right foot was about the length of our present 12 inches. The word *yard* stems from the Chaucerian-era words *gerde* (*g* pronounced as *y*) and *yerde* both meaning a rod, stick or wand. King Henry I officially decreed that its length was to be from the tip of his nose to the tip of his thumb with his arm outstretched. This was about three times the length of his foot, hence our foot and yard. Retaining the mystical number 6 he established a new standard of length—the fathom, which is 6 feet.

The metric system was the next development. It was imposed on the French people by the first Republican Convention of the French Revolution. The head of this special Weights and Measurements Committee, the famous scientist, Lavoisier, was publicly thanked for his work and then sent to the guillotine to receive a haircut from which he obviously never recovered!

This system not only divided length, area and volume by 10 but also time—the day was to be 10 hours; an hour, 10 minutes; minutes each 10 seconds, and seconds were further subdivided by multiples of 10.

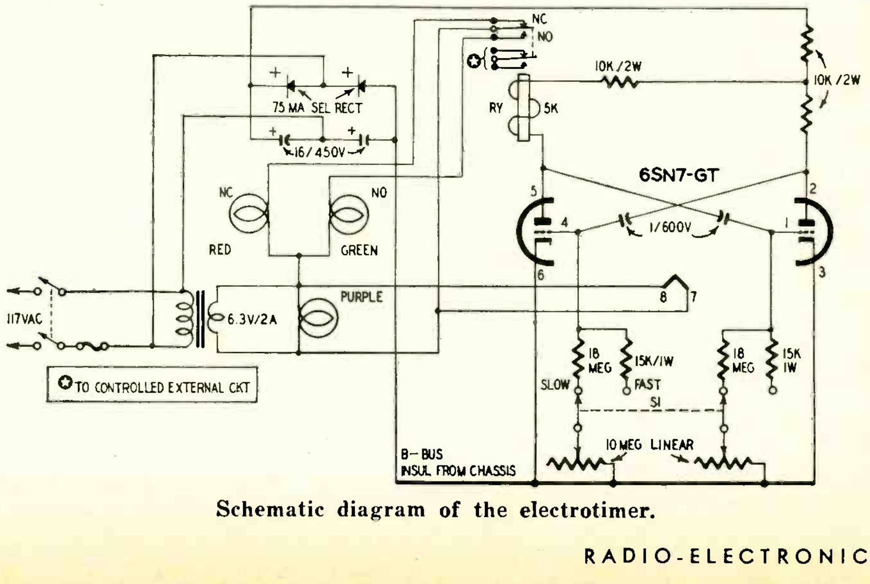
The metric system, particularly its time measurement, has never been too popular in Great Britain and America nor even in France where it originated.

Time has been very important in the past 20 centuries but its full and proper significance in science was revealed by Einstein's famous theory of relativity which postulated time as the extra, or fourth, dimension. Because of this theory nuclear advances became possible and science has been able to present us with such Frankenstein monsters as the atomic and hydrogen bombs! None of these could have evolved without consideration of time in the formula.

Be that as it may, time does concern us all. Electronics is greatly concerned also with circuitry and devices to keep or measure time or to control apparatus within predetermined time limits. One of these applications is the *electrotimer*.

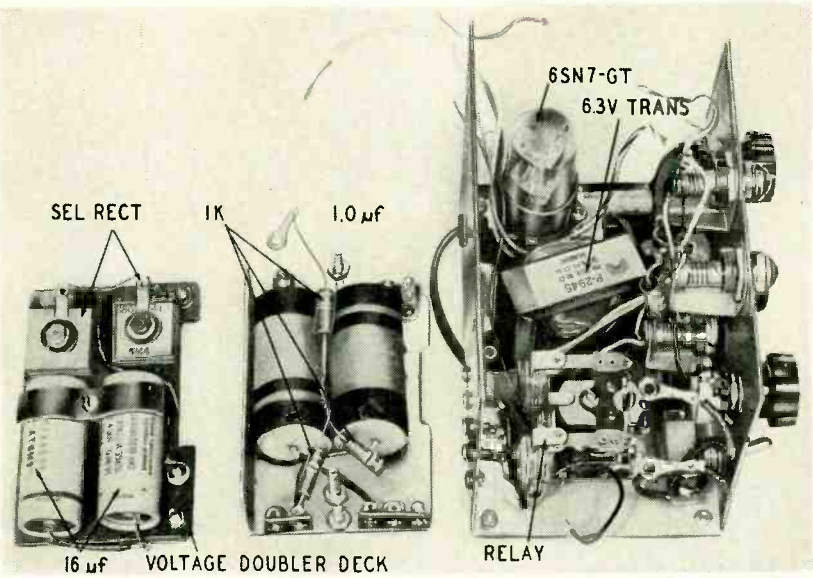
Basically, it works on a multivibrator principle. A multivibrator is essentially two similar resistance-coupled amplifiers, the output of each feeding the input of the other. The rate of oscillations produced is governed by the R-C (resistance–capacitance) parameters used. Since a capacitor charges or discharges nonlinearly, the multivibrator oscillator is a relaxation type oscillator. Its waveform is irregular, so it is rich in harmonics. The output waveform can be altered to make an almost symmetrical square wave. Because of this harmonic richness, this type oscillator can be, and is, used to create an infinite variety of musical tones in electronic organs. And because the waveform is a pulse type, it is widely used in electronics, television and in the electrotimer.

Electrotimers divide into two main groups: fixed-position variable, using decade switches with R-C carefully measured for each switch step, and continuously variable where the timing speed is set with a watch or oscillo-

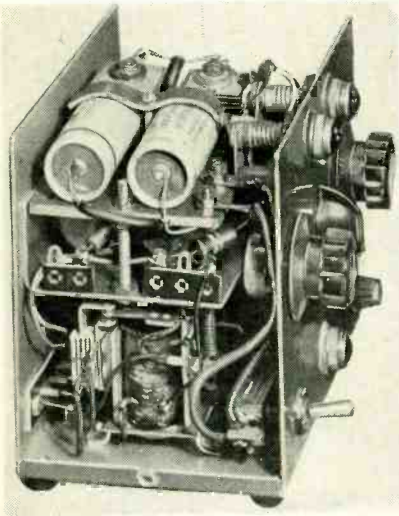


Schematic diagram of the electrotimer.

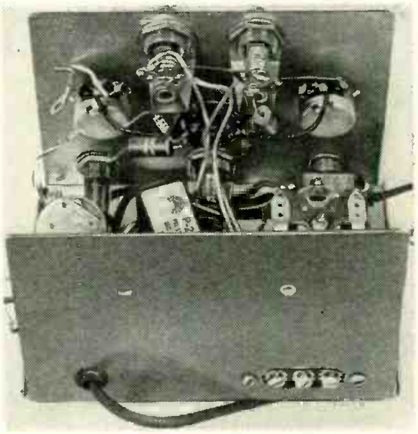
* Henry Francis Parks Laboratories, Portland, Ore.



Main chassis and sub-assembly view.



Internal layout of the electrotimer.



Closeup of front-panel construction in partially assembled instrument.

scope. This electrotimer is the continuously variable type. It is easier to construct and versatile.

Multivibrators are of two main types: synchronized and free running. With the synchronized type, a predetermined controlled frequency is fed to the input and locks in the oscillator frequency to its rate. In the free-running type no synchronizing signal is fed to the oscillator. It oscillates at a rate dependent upon the R-C values in the design.

The circuit divides itself into four main parts: the multivibrator oscillator section consisting of the two halves of the 6SN7-GT and associated components; the R-C timing control consisting of the two 1-µf capacitors, the 15,000-ohm and 18-megohm resistors and the two 10-megohm potentiometers; the B voltage-doubler section which supplies the high voltage for the 6SN7-GT plates; the LM11 5,000-ohm Potter & Brumfield relay and the signal light system.

Construction is straightforward. The ICA box (see photo) comes in several hammertone finishes. The enamel on it tends to flake so use wooden blocks padded with soft cloth during machining operations to avoid deforming the case. The aluminum box is soft. Burrs may be trimmed off with a pocket knife. Each hole should be deburred carefully before proceeding to the next one.

The following assembly procedure may save some time:

Insert four rubber feet on the bottom of box, rubber grommet on the right side and 3-lug Cinch-Jones terminal strip on the back. Mount the filament transformer at slight angle as shown, solder short lengths of hookup wire to the tube socket and mount it. Then install the fuse holder.

Wire input a.c. power—with strain knot—and include toggle power switch, connecting properly to filament transformer.

Check all wiring to this stage of assembly, then mount the LM11 Potter & Brumfield relay so that contacts are to the rear, connecting one end of each of the signal light leads for the time being. Install the two potentiometers and the rotary switch, and complete wiring to the above points.

Mount the two large 1-µf capacitors on the lower shelf (see photo), using a capacitor support. Mount the shelf to the rear of box. Connect additional wiring to these points. The three 10,000-ohm resistors are connected in the shape of a Y—one end of the third resistor being left for connection later to high voltage.

Mount the two electrolytic 16-µf capacitors and Federal selenium rectifiers on the upper shelf. Wire these together. Then mount upper and lower shelves, using collars for spacing the two shelves.

Mount the signal lamp holders on the front panel. Bring wires from LM11 relay (see above) and connect lamps. Complete circuit by connecting all ground and the one high voltage leads. You are now ready for final test.

Set the FAST-SLOW switch to SLOW. Both potentiometers should be set to the extreme left. As soon as the 6SN7 is at a reliable operating temperature—after about 1 minute—the unit will start to time at its lowest speed, which is about once per minute.

Moving the potentiometers to the right will increase speed. For further increase, return the potentiometers to their extreme left positions. Then turn S1 to FAST. Slowly moving the two potentiometers to the right will increase the speed until you reach maximum, about 1/60 second.

The timer operation is plainly seen because the NC (normally closed) and the NO (normally open) signal lights will go on or off according to the speed. You can time with the unit to obtain a maximum *on* or a minimum *off* or vice versa or anything between these extremes by varying the potentiometers.

Check the actual time of operation with a watch on the longer ranges and with an oscilloscope on the shorter ranges. You can use any dial plates and log the timing results for duplication in the future. The unit has found wide use in life-testing relays, solenoids, small motors and other electronic equipment. END

Parts for electrotimer

2—18-megohm resistors, ½ watt; 2—15,000-ohm resistors, 1 watt; 3—10,000-ohm resistors, 2 watts; 2—10-megohm potentiometers, linear; 2—1-µf capacitors, 600 volts, paper (Sprague TC-10 or equivalent); 2—16-µf electrolytic capacitors, 450 volts; 2—selenium rectifiers, 75 ma; 1—6SN7-GT; 1—octal socket; 1—filament transformer, 6.3 volts @ 2 amps; 1—5,000-ohm d.p.d.t. relay (Potter & Brumfield LM11 or equivalent); 1—d.p.s.t. switch; 1—2-circuit 2-position nonshorting rotary switch or d.p.d.t.; 3—pilot lamps and assemblies (colored jewels may be used for rapid identification); 1—5-amp fuse and holder; 2—dials; 1—line cord; 1—cabinet and chassis.

Characteristics of *General-Purpose Transistors*

By RUFUS P. TURNER

THE tables accompanying this article list the important electrical characteristics of currently available domestic transistors. Only conventional general-purpose transistors are included, power types having been discussed separately in an earlier article. (RADIO-ELECTRONICS, August, 1955, page 90.)

Since we compiled our last list, principally for the book *Transistors, Theory and Practice* (Gernsback Library), the transistor picture has enlarged considerably. The present tables include 116 types from 16 manufacturers. Reference to Table I shows that the point-contact type of transistor has almost completely disappeared, only two versions (the 2N32 and 2N33 of Transistor Products Inc.) remaining in our listing. Of the junction types, only 29 are n-p-n. Four are silicon. One transistor (Philco SB100 surface-barrier type) technically is neither a junction nor a point-contact but is of special fabrication somewhat resembling the p-n-p type. Four transistors listed have

TABLE I—MAXIMUM RATINGS, TRIODES

Made by	Type	Kind	Dc Coll Volt	Dc Coll Current (ma)	Coll Cutoff Current (μa)	Coll Pwr Dissip (mw)	Current Amplification (α or β)	Emitter Res (ohms)	Base Res (ohms)	Coll Res (megs)	Coll Cap (μμf)	Operating Freq (mc)	Operating Temp (°C)
Amperex	OC70	p-n-p	−10	−10	−8.0[a]	75[v]	30	39	1,000	1.38		0.3	45
	OC71	p-n-p	−10	−10	−8.0[a]	75[v]	47	6.5	500	0.625		0.3	45
	2-OC72	p-n-p[k]	−18	−100[l]	−10[s]	65[f,y]	50						45
CBS-H	HA-1	p-n-p	−20	−8.0		50	40						50
	HA-2	p-n-p	−20	−8.0		50	30						50
	HA-3	p-n-p	−20	−12		50	35						50
	HC-1	p-n-p	−20	−8.0		50	45						50
	2N36	p-n-p	−20	−8.0		50	45						50
	2N37	p-n-p	−20	−8.0		50	30						50
	2N38	p-n-p	−20	−8.0		50	15						50
G-E	2N43	p-n-p	−45	−50	−10	150	0.98				40	2.5	100
	2N43A	p-n-p	−20	−50	−10	150	0.985				50	1.0	100
	2N44	p-n-p	−45	−50	−15	150	0.97				50	2.5	100
	2N45	p-n-p	−45	−50	−15	150	0.94				50	2.5	100
	2N76	p-n-p	−20	−10	−10	50	0.99				50	2.5	60
	2N78	n-p-n	15	20	1.0	50	0.95				9.0	4.0	100
	2N107	p-n-p	−12	−10	−10	50	0.95				40	1.0	60
	2N135	p-n-p	−15	−50	−5.0	100	20				14	4.5	85[b]
	2N136	p-n-p	−10	−50	−5.0	100	40				14	6.5	85[b]
	2N137	p-n-p	−10	−50	−5.0	100	60				14	10	85[b]
Gen'l Tran	GT-14	p-n-p	−25		−15	70[c]	34	30	1,500	1.5			85
	GT-20	p-n-p	−25		−15	70[c]	45	30	1,500	1.5			85
	GT-34	p-n-p	−25		−15	70[c]	19	30	1,500	1.5			85
	GT-81	p-n-p	−25		−15	70[c]	65	30	1,500	1.5			85
	GT-83	p-n-p	−25		−15	70[c]	45	30	1,500	1.5		0.7	85
	GT-87	p-n-p	−25		−15	70[c]	34	30	1,500	1.5		0.5	85
	GT-88	p-n-p	−25		−15	70[c]	65	30	1,500	1.5		1.0	85
Germ Prod	2N97	n-p-n	30		10[d]	50	0.95	45	500	3.0	25	1.0	75
	2N97A	n-p-n	40		5.0[d]	50	0.93	45	500	10.0	19	1.0	85
	2N98	n-p-n	40		10[d]	50	0.99	45	500	5.0	14	2.5	75
	2N99	n-p-n	40		10[d]	50	0.99	45	500	5.0	10	3.5	75
	2N100	n-p-n	25		10[d]	25	0.999	50	3,000	5.0	20	5.0	50
	2N103	n-p-n	35		50[e]	50	0.85	45	500	2.0	20	0.75	75
Hydro	CQ-1	p-n-p	−40	−10	20	150	0.90	30	200	0.5		0.5	50
	HF-1	p-n-p	−15	−7.0	−5.0	50	0.975					5.0	55
	J-1	p-n-p	−40	−10	−10	150	0.97	50	400	1.0		1.0	50
	J-2	p-n-p	−40	−10	−15	150	0.94	40	300	0.7		0.5	50
Philco	SB-100	p-n-p SB*	−4.5	−5.0	−0.5	10[f]	20				3.5	45[g]	
	2N47	p-n-p	−35	−20	−5.0	50	0.975	25	15	1.0			
	2N49	p-n-p[h]	−35	−20	−5.0	50	0.975	25	15	1.0			
	2N62	p-n-p	−35	−20	−10	50	0.975	25	15	1.0	50		
Radio Recep	RR14	p-n-p	−25	[i]	−50[j]	50	34	25		2.0			75
	RR20	p-n-p	−25	[i]	−50[j]	50	45	25		2.0			75
	RR34	p-n-p	−25	[i]	−50[j]	50	19	25		2.0			75
	RR87	p-n-p	−25	[i]	−50[j]	50	35	30			50	1.0	75
	RR106	p-n-p[k]	−25	−25.7[l]	−6.0[d]	50							75
	RR115	p-n-p	−25	[i]	−15[m]	40	15	25		2.0			50
	2N34	p-n-p	−25	[i]	−50[j]	50	40	25		2.0			75
	2N36	p-n-p	−25	[i]	−50[j]	50	45	25		2.0			75
	2N37	p-n-p	−25	[i]	−50[j]	50	30	25		2.0			75
	2N38	p-n-p	−25	[i]	−50[j]	50	15	25		2.0			75
	2N39	p-n-p	−30	[i]	−50[j]	50	32	25		2.0			75
	2N40	p-n-p	−30	[i]	−50[j]	50	32	25		2.0			75
	2N42	p-n-p	−30	[i]	−50[j]	50	15	25		2.0			75
Raytheon	CK721	p-n-p	−22	−10	−6.0[n]	33	45	25	700	2.0		[illegible]	50
	CK722	p-n-p	−22	−10	−6.0[n]	33	12	25	250	2.0		0.6	50
	CK723	p-n-p	−22	−10	−6.0[n]	33	22	25	350	2.0			50
	CK725	p-n-p	−22	−10	−6.0[n]	33	90	25	1,500	2.0		1.2	50
	CK727	p-n-p[h]	−6.0	−10	−12[o]	30	25			1.0		0.8	50
	2N63	p-n-p	−22	−10	−6.0[n]	33	22	25	350	2.0		0.6	50
	2N64	p-n-p	−22	−10	−6.0[n]	33	45	25	700	2.0		0.8	50
	2N65	p-n-p	−22	−10	−6.0[n]	33	90	25	1,500	2.0		1.2	50
	2N106	p-n-p[h]	−6.0	−10	−6.0[p]	30	25	50	700	1.0		0.8	50
	2N112 (CK760)	p-n-p	−10	−5.0	−1.0[n]	30	40	25	75		14	5.0	50
	2N113 (CK761)	p-n-p	−10	−5.0	−1.0[n]	30	45	25	75		14	10	50
	2N114 (CK762)	p-n-p	−10	−5.0	−1.0[n]	30	65	25	75		14	20	50

Made by	Type	Kind	Dc Coll Volt	Dc Coll Current (ma)	Coll Cutoff Current (μa)	Coll Pwr Dissip (mw)	Current Amplification (α or β)	Emitter Res (ohms)	Base Res (ohms)	Coll Res (megs)	Coll Cap (μμf)	Operating Freq (mc)	Operating Temp (°C)
RCA	2N77	p-n-p[q]	−25	−15	−10[r]	35	55	23	1,430	3.93		0.7	50
	2N104	p-n-p[q]	−30	−50	−10[r]		44	21.7		1.97		0.7	70
	2N105	p-n-p[q]	−25	−15	−5.0[r]	35	55	34		3.45		0.75	50
	2N109	p-n-p[k]	−20	−50[l]	−10[s]	50	70						50
Sylvania	2N34	p-n-p	−25	−10	−10	50	0.975	30	400	1.5	50	0.60	
	2N35	n-p-n	25	10	10	50	0.975	30	600	2.0	40	0.90	
	2N94	n-p-n	20	5.0	3.0	30	40	52	150	2.0	10	3.0	
	2N94A	n-p-n	20	5.0	3.0	30	40	52	150	2.0	10	6.0	
Texas Inst	200	n-p-n	30	10	10[u]	50[t]	19				90	0.83	75[b]
	201	n-p-n	30	10	10[u]	50[t]	49				90	1.75	75[b]
	202	n-p-n	30	10	10[u]	50[t]	82				90	2.0	75[b]
	210	n-p-n	30	5.0	50	50[t]							50
	220	n-p-n	30	5.0	50	50[t]							50
	223	n-p-n	30	5.0	50	50[t]							50
	300	p-n-p	−30	−50	−10	100[t]	19				50	0.7	75[b]
	301	p-n-p	−30	−50	−10	100[t]	49				50	1.0	75[b]
	302	p-n-p	−30	−50	−10	100[t]	55				50	1.3	75[b]
	903	n-p-n Si†	30	10	1.0[u]	150[v]	9–19	150	500	0.5		3.0	150
	904	n-p-n Si†	30	10	1.0[u]	150[v]	19–39	150	1,250	0.5		3.0	150
	904A	n-p-n Si†	30	10	1.0[u]	150[v]	19	150	1,250	0.5		8.0	150
	905	n-p-n Si†	30	10	1.0[u]	150[v]	39	150	2,500	0.5		3.0	150
	2N124	n-p-n[w]	10	8.0	2.0[u]	50	24				10	3.0	75
	2N125	n-p-n[w]	10	8.0	2.0[u]	50	48				10	5.0	75
	2N126	n-p-n[w]	10	8.0	2.0[u]	50	100				10	5.0	75
	2N127	n-p-n[w]	10	8.0	2.0[u]	50	200				10	5.0	75
Trans-prod	2N32	p-c[x,w]	−40	−8.0		50	2.2					2.7	40
	2N33	p-c[w,x]	−8.5	−7.0		30						50	40
Transitron	2N34	p-n-p	−25	−20	−10[r]	125[t]	55				40	0.8	100
	2N36	p-n-p	−25	−20	−10[r]	125[t]	60				40	0.8	100
	2N37	p-n-p	−25	−20	−15[r]	125[t]	38				40	0.6	100
	2N38	p-n-p	−25	−20	−25[r]	125[t]	22				40	0.5	100
	2N43	p-n-p	−45	−50	−15[r]	150[t]	33				40	0.8	100
	2N44	p-n-p	−45	−50	−15[r]	150[t]	16				40	0.5	100
	2N45	p-n-p	−45	−50	−15[r]	150[t]	12				40	0.4	100
	2N63	p-n-p	−25	−20	−10[r]	125[t]	22				40	0.5	100
	2N64	p-n-p	−25	−20	−10[r]	125[t]	22				40	0.5	100
	2N65	p-n-p	−25	−20	−10[r]	125[t]	90				40	1.2	100
	2N76	p-n-p	−20	−20	−10[r]	125[t]	20				40	0.1	85
	2N91	p-n-p[w]	−15	−500[y]	−15	500[y]	40	1.5	50	0.5	50		85
	2N92	p-n-p[w]	−25	−200[y]	−10	500[y]	50	5.0	500	1.0	30		85
Tung-Sol	DR-126	p-n-p	−10		−15	50	0.98						85
	DR-130	p-n-p	−25		−30	50	0.95					0.5	85
	DR-131	p-n-p	−25		−30[j]	30	0.90					0.4	55
	DR-154	p-n-p	−25		−20[j]	50	0.992					1.1	85[b]
	DR-155	p-n-p	−10		−15	50	0.990					1.4	85[b]
Westinghouse	2N54	p-n-p	−45	−10	−6.0	200	0.97					0.5	60
	2N55	p-n-p	−45	−10	−6.0	200	0.95					0.5	60
	2N56	p-n-p	−45	−10	−6.0	200	0.92					0.5	60
	2N73	p-n-p[w]	−20			200							65[z]
	2N74	p-n-p[w]	−50			200							40[z]
	2N75	p-n-p[w]	−20			200							100[z]

* SB = surface barrier
† Si = silicon
[a] Common base
[b] Storage temperature
[c] At 50°C
[d] At v_c = 4.5 v (n-p-n), −4.5 v (p-n-p)
[e] At v_c = 35 v
[f] At 40°C
[g] Maximum oscillation frequency
[h] Low-noise type
[i] Limited only in terms of dissipation
[j] At v_c = −25 v
[k] Intended for push-pull class-B service
[l] Maximum-signal value for push-pull class-B stage
[m] At v_c = −15 v
[n] At v_c = −6 v
[o] At v_c = 1.5 v
[p] At v_c = −2.5 v
[q] Extreme-stability type
[r] At v_c = −12 v
[s] At v_c = −20 v
[t] In free air
[u] At v_c = 5 v
[v] At 25°C
[w] Switching type
[x] Oscillator type
[y] Peak current or total power with heat sink
[z] Reduce power dissipation rating to 50%

TABLE II—MAXIMUM RATINGS, TETRODES

Made by	Type	Kind	Dc Coll Volts	Dc Coll Current (ma)	Coll Cutoff Current (μa)	Coll Power Dissip (mw)	Current Amplification (α or β)	Base-to-Base Current (ma)	Emitter Res (ohms)	Base Res (ohms)	Coll Res (megs)	Operating Freq (mc)
Germ Prod	3N23	n-p-n	30	5.0	10[a]	50		5.0				10–20
	3N23A	n-p-n	30	5.0	10[a]	50		5.0				20–35
	3N23B	n-p-n	30	5.0	10[a]	50		5.0				35–50
	3N23C	n-p-n	30	5.0	10[a]	50		5.0				50–80
Texas Inst	700	n-p-n	30		10[b]	50	0.95		30	1,000	1.0	

[a] At v_c = 4.5 v
[b] At v_c = 5 v

maximum temperature ratings of 150°C, 16 are rated for 100°, 18 for 85° and 26 for 75°. Five tetrodes are available. (See Table II.)

Method of listing

Listing by manufacturers remains the most practical way to tabulate transistor data. It seems unfortunate that we cannot list numerically by type number, but the reason becomes obvious when one notes the differences in ratings of just one type, the 2N34, as manufactured by Radio Receptor, Sylvania and Transitron.

Table I lists absolute maximum ratings on all characteristics of triodes, Table II gives the same data for tetrodes. Table III shows typical operation. In the limited space of these pages it is impossible to present the multitude of typical operating conditions under which the listed transistors are capable of working. We accordingly have selected that mode of operation which seems to give a fair indication of the performance to be expected of a particular type.

Where gaps appear in the tables, the pertinent data have not been released by the manufacturer and we do not take the liberty of calculating the values. When a certain transistor appears in Table I but is omitted from Table III, typical operating data have not been available.

Manufacturers

The transistor manufacturers are indicated in the tables by the following abbreviations:

Amperex—Amperex Electronic Corp., 230 Duffy Ave., Hicksville, N. Y.
CBS-H—CBS-Hytron, Danvers, Mass.
G-E—General Electric Co., Electronics Dept., Syracuse 1, N. Y.
Gen'l Tran—General Transistor Corp., 95-18 Sutphin Blvd., Jamaica 35, N. Y.
Germ Prod—Germanium Products Corp., 26 Cornelison Ave., Jersey City 4, N. J.
Hydro—Hydro-Aire Inc., Burbank, Calif.
Philco—Philco Corp., Government and Industrial Div., Philadelphia 44, Pa.
Radio Recep—Radio Receptor Co. Inc., 251 W. 19 St., New York 11, N. Y.
Raytheon—Raytheon Manufacturing Co., 55 Chapel St., Newton 58, Mass.
RCA—Radio Corporation of America, Tube Div., Harrison, N. J.
Sylvania—Sylvania Electric Products Inc., Electronics Div., Woburn, Mass.
Texas Inst—Texas Instruments Inc., 6000 Lemmon Ave., Dallas 9, Tex.
Transprod—Transistor Products Inc., 241 Crescent St., Waltham 54, Mass.
Transitron—Transitron Electronic Corp., Melrose 76, Mass.
Tung-Sol—Tung-Sol Electric Inc., 200 Bloomfield Ave., Bloomfield 4, N. J.
Westinghouse—Westinghouse Electric Corp., Electronic Tube Div., Elmira, N. Y.

Changes have been reported to the author by the following companies: **Hydro-Aire Inc.** advises that their transistor activities have been taken over by **Mar-Vista Electronics** with the same address for the time being. **National Union Electric Corp.** has ceased manufacturing transistors and presently is developing new types. Its older units therefore are not listed in these tables. **Radio Receptor Co. Inc.** announces its temporary discontinuance of transistor manufacturing but advises that it has a sizable stock and "to all intents and purposes is in the germanium business."

Abbreviations

The following abbreviations are used in the tables or footnotes:

α alpha (emitter-to-collector current gain)
β beta (base-to-collector current gain)
CB common-base circuit
CE common-emitter circuit
db decibels
dc direct current
if intermediate frequency
ma milliamperes
mc megacycles
mw milliwatts
n-p-n collector positive
p-n-p collector negative
rf radio frequency
μa microamperes
μμf micromicrofarads
v volts
v_c collector voltage

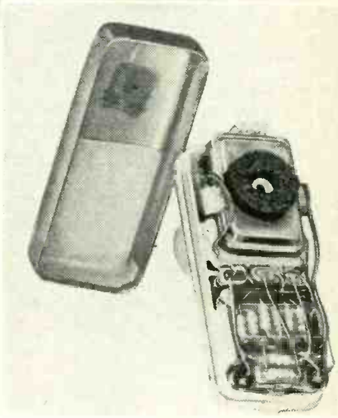
END

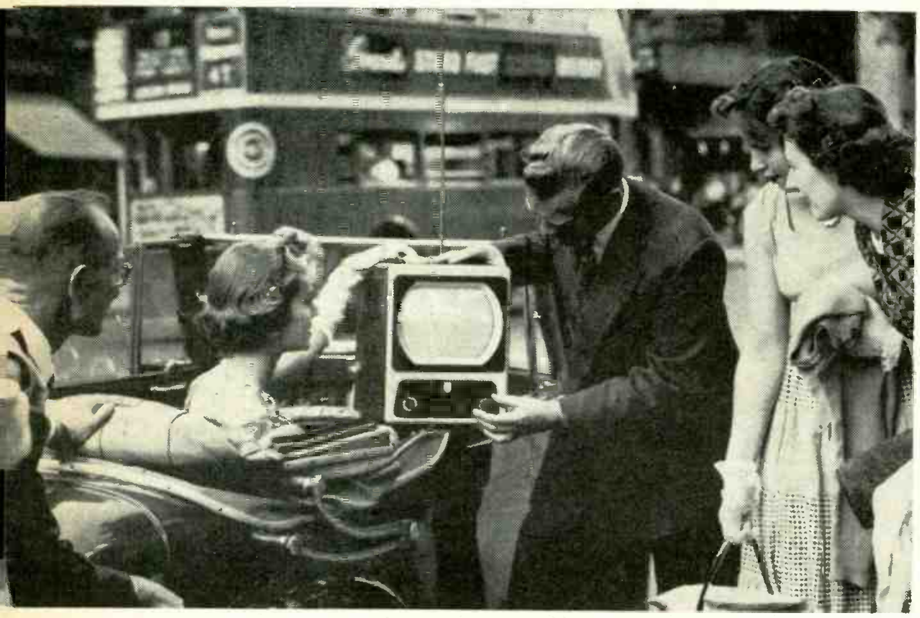
TABLE III—TYPICAL OPERATION

Made by	Type	Ckt	Dc Coll Volts	Dc Coll Current (ma)	Dc Emitter Current (ma)	Input Res (ohms)	Load Res (ohms)	Pwr Gain (db)	Pwr Out (mw)
Amperex	2-OC72[q]	CE	– 6	–50[d]		500[h]	70[g]	25	220
CBS-H	HA-1	CE	– 3.0	– 0.5		1,000	30,000	40	
	HA-2	CE	– 3.0	– 0.5		1,000	30,000	37	
	HA-3	CE	– 3.0	– 2.5		1,000	1,200		
	HC-1	CE	– 6.0		1.0	1,000	30,000	40	
	2N36	CE	– 6.0		1.0	1,000	30,000	40	
	2N37	CE	– 6.0		1.0	1,000	30,000	36	
	2N38	CE	– 6.0		1.0	1,000	30,000	32	
G-E	2N43	CE	–20		5.0	500	4,500	37	40[a]
	2N43A	CE	–20		5.0	500	4,500	25	40[a]
	2N44	CE	–20		5.0	220	4,500	33	40[a]
	2N45	CE	–20		5.0	125	4,500	30	40[a]
	2N76	CE	– 5.0		1.0	700	30,000	38	
	2N78	CE	5.0		–1.0	1,500	10,000	22[b]	
	2N107	CE	– 5.0		1.0	700	50,000	38	
	2N135	CE	– 5.0		1.0			29[b]	
	2N136	CE	– 5.0		1.0			31[b]	
	2N137	CE	– 5.0		1.0			33[b]	
Gen'l Tran	GT-14	CE	– 4.5		1.0			36	
	GT-20	CE	– 4.5		1.0			40	
	GT-34	CE	– 4.5		1.0			34	
	GT-81	CE	– 4.5		1.0			32	
	GT-83	CE	– 4.5		1.0			40	
	GT-87	CE	– 4.5		1.0			36	
	GT-88	CE	– 4.5		1.0			42	
Germ Prod.	2N97	CE	4.5		–1.0	400	100,000	38	
	2N97A	CE	4.5		–1.0	400	100,000	38	
	2N98	CE	4.5		–1.0	850	100,000	47	
	2N99	CE	4.5		–1.0	850	100,000	47	
	2N100	CE	4.5		–1.0	3,500	100,000	53	
	2N103	CE	4.5		–1.0	225	100,000	33	
Hydro	CQ-1	CB	– 6.0		1.0			30[c]	
	J-1	CB	– 6.0		1.0			40[c]	
	J-2	CB	– 6.0		1.0			35[c]	
Philco	SB-100	CB	– 3.0	– 0.5		70	400,000		
	2N47	CB	– 5.0	– 1.0	1.0				
	2N49	CB	– 5.0	– 1.0	1.0				
	2N62	CB	– 5.0	– 1.0	1.0				
Radio Recep	RR14	CE	– 4.5		1.0	1,500	30,000	39	
	RR20	CE	– 4.5		1.0	1,500	30,000	41	
	RR34	CE	– 4.5		1.0	1,500	30,000	36	
	RR106	CE[j]	–12	–25.5[d]			1,200	20.8	200[e]
	RR115	CE	– 4.5		1.0	1,500	30,000	36	
	2N34	CE	– 6.0		1.0	500	30,000	40	
	2N36	CE	– 6.0		1.0	1,000	30,000	40	
	2N37	CE	– 6.0		1.0	1,000	30,000	36	
	2N38	CE	– 6.0		1.0	1,000	30,000	32	
	2N39	CE	– 4.5		1.0	500	30,000	39	
	2N40	CE	– 4.5		1.0	500	30,000	38	
	2N42	CE	– 4.5		1.0	500	30,000	36	
Raytheon	CK721	CE	– 6.0		1.0	1,500	20,000	41	
	CK722	CE	– 6.0		1.0	500	20,000	36	
	CK723	CE	– 6.0		1.0	800	20,000	39	
	CK725	CE	– 6.0		1.0	2,700	20,000	42	
	CK727	CE	– 1.5	– 0.5		1,000	20,000	36[f]	
	2N63	CE	– 6.0		1.0	800	20,000	39	
	2N64	CE	– 6.0		1.0	1,500	20,000	41	
	2N65	CE	– 6.0		1.0	2,700	20,000	42	
RCA	2N77	CE	– 4.0	– 0.7		1,980	100,000	44.1	
	2N104	CE	– 6.0	– 1.0		1,400	20,000	41	
	2N105	CE	– 1.3	– 0.3		4,700	4,700	32.5	
	2N109	CE[j]	– 4.5	–26[d]		375[h]	100[g]	30	75[i]
Sylvania	2N34	CE	– 6.0		1.0	1,000	30,000	40	
	2N35	CE	6.0		–1.0	1,000	30,000	40	
	2N94	CE	6.0	0.5		500	25,000	32[b]	
	2N94A	CE	6.0	0.5		800	25	35[b]	
Texas Inst	200	CB	5.0		–1.0	35	0.63[k]		
	201	CB	5.0		–1.0	35	0.35[k]		
	202	CB	5.0		–1.0	35	0.30[k]		
	210	CE	22.5	2.0		500	10,000	39	12
	220	CE	22.5	0.7		750	70,000	31[b]	
	223	CE[o]	22.5	0.7		300[l]	60,000[m]	20[n]	
	300	CB	– 5.0		1.0	34	0.89[k]		
	301	CB	– 5.0		1.0	33	0.71[k]		
	302	CB	– 5.0		1.0	30	0.47[k]		
	903	CB	5.0		–1.0	90	0.63[k]		
	904	CB	5.0		–1.0	85	0.63[k]		
	904A	CB	5.0		–1.0	85	0.63[k]		
	905	CB	5.0		–1.0	70	0.63[k]		
Transprod	2N32	CB	–25		0.5	400	31,000	21	
	2N33	CB	– 8.0	– 3.3	0.3				1.0[p]
Transitron	2N34	CB	– 6.0	– 1.0		35	1.0[k]		
	2N36	CB	– 6.0	– 1.0		35	1.0[k]		
	2N37	CB	– 6.0	– 1.0		38	1.0[k]		
	2N38	CB	– 6.0	– 1.0		40	1.0[k]		
	2N43	CB	– 6.0	– 1.0		35	1.0[k]		
	2N44	CB	– 6.0	– 1.0		38	1.0[k]		
	2N45	CB	– 6.0	– 1.0		40	1.0[k]		
	2N63	CB	– 6.0	– 1.0		38	0.5[k]		
	2N64	CB	– 6.0	– 1.0		38	0.5[k]		
	2N65	CB	– 6.0	– 1.0		35	0.5[k]		
	2N76	CB	– 6.0	– 1.0		40	1.0[k]		
Tung-Sol	DR-126	CE	– 1.5			1,000	30,000	33	
	DR-130	CE	– 1.5			1,000	30,000	27	
	DR-131	CE	– 1.5			1,000	30,000	24	
	DR-154	CE	– 1.5			1,000	30,000	42	
	DR-155	CE	– 1.5			1,000	30,000	30	
Westinghouse	2N54	CE	– 6.0	– 1.0		741	50,000		
	2N55	CE	– 6.0	– 1.0		563	67,500		
	2N56	CE	– 6.0	– 1.0		439	85,000		

[a] At 5% distortion
[b] Tuned gain as 455-kc if amplifier
[c] For common-emitter circuit
[d] Total maximum-signal current for 2 transistors in class-B push-pull
[e] At 7% distortion
[f] With noise factor = 12 db
[g] Per collector
[h] Per base
[i] Less than 10% distortion
[j] Push-pull class-B amplifier
[k] Output admittance h_{22} in micromhos
[l] Rf input impedance
[m] If output impedance
[n] Conversion gain
[o] Converter stage
[p] As 50-mc oscillator
[q] Matched pair for class-B service

what's new?





12-VOLT TV RECEIVER is a British development. A true portable, it weights 30 pounds and uses a 9-inch picture tube. The set measures 13 x 10½ inches and is housed in an aluminum-covered plastic case. It will run for 12 hours on a 12-volt auto battery. With a telescopic whip antenna it receives TV and FM up to 30 miles from the station. The set is intended to sell for the equivalent of $168 and its manufacturers, the Ekco Co., expect large sales to rural dwellers, car owners and others who may wish to see TV at points where there is no electricity. A switch, however, makes it a standard set operating on house current.

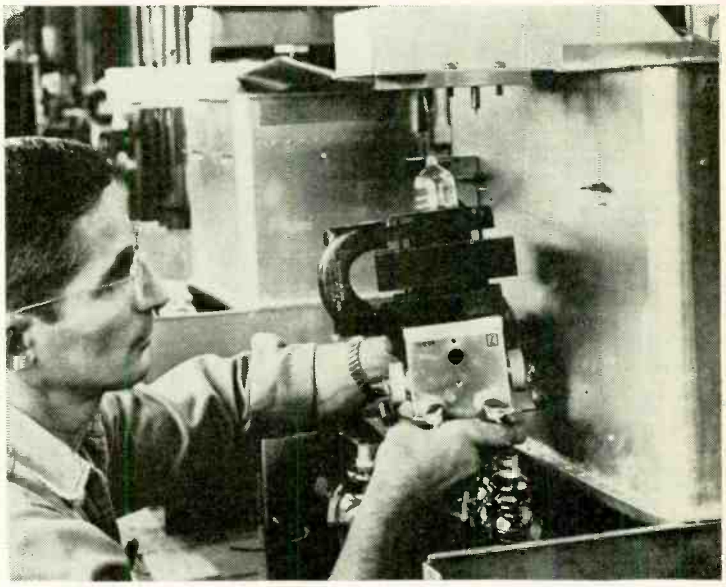
SOLAR-POWERED RADIOS are increasingly popular among experimenters. Admiral is the latest to build an experimental transistor portable powered by the sun. A man-sized job, it uses eight transistors and a seven-cell solar battery. The set also has a standby battery for twilight operation—at night a 100-watt bulb can activate it. Ray de Cola, Admiral's director of engineering, looks forward to further experimental models with automatic gain control to compensate for light changes on cloudy days, improved solar cells and rechargable batteries. Eventually, he says, using troublefree printed circuits, the solar-powered radio could be sealed in a one-piece plastic cabinet and conceivably given a lifetime guarantee.

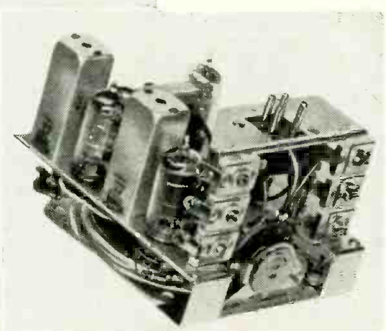
HEARING AID that can be worn in the ear is the latest in ultra-subminiaturization. *Miracle-Ear*, made by the Dahlberg Co., Minnesota, uses three Raytheon transistors no larger than safety match heads. It is powered by a mercury cell only 1/8 inch thick and 7/16 inch in diameter, which lasts up to 50 hours. The battery inserts under hinged lid on top of case. There is no off—on switch or volume control since the 55-db amplification—suitable for persons with moderate hearing loss—is within the range in which the ear adjusts itself to volume changes. Used with a molded earpiece, the aid is worn in the ear. If desired, it may be worn behind the ear, with the plastic tube and earpiece shown in the photo.

WHAT'S OLD? is the query the instrument to our left brings up. The pocket test set is more ancient than we might imagine, to judge from the patent date (1898) printed on this meter which is apparently intended for checking 1.5-volt dry and probably 2-volt storage cells. Not only is it a pocket job, but is built into a watch case with stem and ring for attaching to a chain.

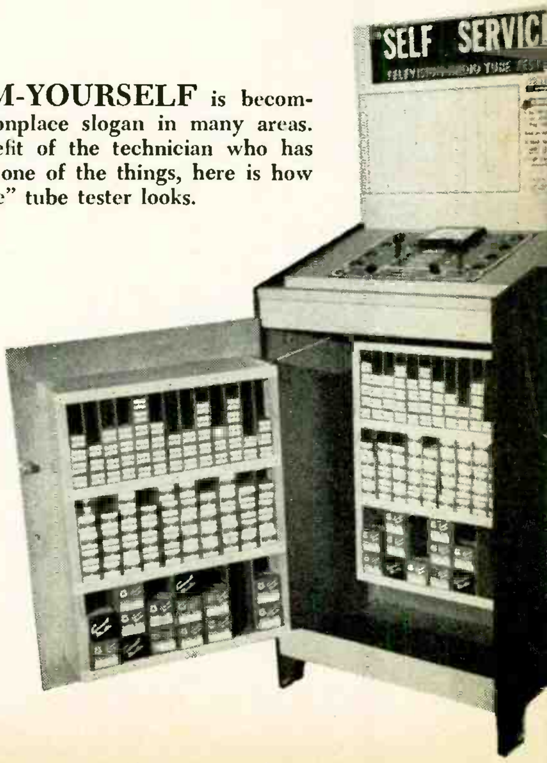
The meter is a vane type with two coils and a gear wheel and balance spring that suggest the whole job was constructed by a watchmaker "from items to be found in the junk box."

ELECTRONIC RANGE that cooks a 5-pound roast in 30 minutes (normal time 3 hours in gas oven) is available. Photo shows technician with the magnetron cooking unit. Using Raytheon's Radarange unit, the stove looks like a compact oven for a standard kitchen unit. Because only the food becomes hot, the range can be put into a wooden cabinet. Besides speed, advantages are cleanliness, convenience (foods can be cooked in serving dishes which remain cool) and safety (no hot pans to burn hands). The range is made by the pioneer Tappan Stove Co. and will cost about $1,000. Frequency is 240 mc and operation from 220-volt line.





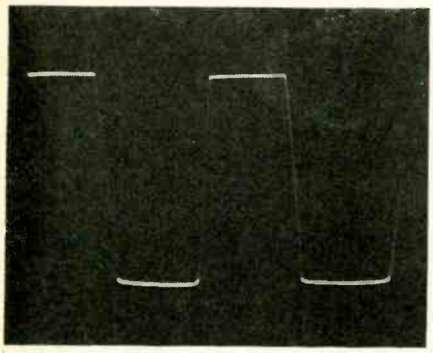
TEST-'EM-YOURSELF is becoming a commonplace slogan in many areas. For the benefit of the technician who has not yet seen one of the things, here is how a "self-service" tube tester looks.



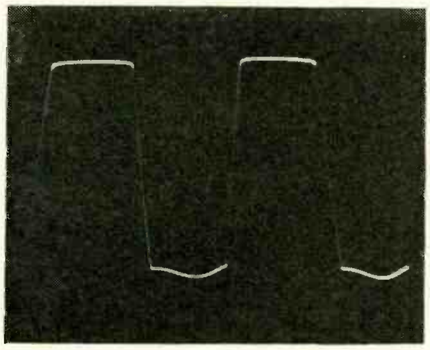
HOLIDAY RADIO

The Darb Holiday all-purpose radio is a 4-tube portable that uses separate power packs for line operation, 6 volts dc or dry batteries. Set plugs into the desired power pack or can be mounted remotely, as in the bicycle installation shown here. Pushbuttons permit tuning in one of three stations. There is no variable tuning.

TRANSISTORIZED **SCOPE CALIBRATOR**



Normal output of scope calibrator.



Abnormal output with poor transistor.

By EDWIN BOHR

Accurate and stable unit uses mercury cells as standard

MODERNIZE your oscilloscope with this simple and accurate circuit. Only four components are needed: a transistor, a three-cell voltage standard and two resistors. For all its simplicity, this calibrator (Fig. 1) is more accurate and stable than vacuum-tube calibrators built into more expensive oscilloscopes.

These advantages, and several yet unmentioned, are possible because of the tremendously high low-voltage efficiency of junction transistors. There is no vacuum-tube counterpart to this circuit. This means the calibrator is not just a transistorized version of some earlier form of vacuum-tube calibrator. It is something new that would have been impossible without the transistor.

Nearly all vacuum-tube calibrators operate by clipping a sine wave when it exceeds a standard reference voltage. This results in a square wave of amplitude equal to the reference voltage, obtained from a gas voltage-regulator tube. The VR tube is notorious for its poor absolute stability. It is easy to find a 3-volt variation from tube to tube, and once the tube is in place there are further variations caused by age, load and environment. Special regulator tubes, such as the 5651, could be used with a considerable increase in stability. But these special purpose or industrial types are more expensive and difficult to obtain. Anyway, I have seen only one calibrator—and a very expensive one at that—which used this improved reference tube.

There are other sources of error with these vacuum-tube circuits. For example, the clipping diodes are not perfect rectifiers and their clipping action slopes within a 1-volt region. Thus, the clipping level must be high. Since two diodes are used, the error even with a level of 100 volts is 2%.

One last undesirable feature of the vacuum-tube circuit is that the output impedance is high, usually 100,000 ohms or more. Thus a serious error is introduced whenever the circuit is loaded, even with 1 megohm. To sum it up, the best accuracy for commercial calibrators under the best conditions is ±5%. The accuracy of this simple transistorized calibrator, under poor conditions, is twice this good.

Voltage standard

The transistorized calibrator has a voltage standard much more accurate and stable than the gas regulator tube. It uses ordinary mercury cells as the standard. These cells are highly stable under wide variations of temperature, age and loading. Fig. 2 is a typical regulation curve for a mercury cell similar to those used in the calibrator.

Believe it or not, in at least one application requiring a precise calibrating voltage, the standard (Weston) cell has been replaced with a mercury cell. They do, however, use a special current-drain type of stabilization circuit. As the reader probably knows, the familiar H-shaped standard cell has up until now had no peer.

Three mercury cells in series furnish a 4-volt reference for the calibrator. This in turn controls with equal precision the amplitude of the output waveform. The e.m.f. of the mercury cell is somewhat less than that (1.6 volts) of the ordinary zinc–carbon dry cell. Also, the center pole of the mercury or RM cell is *negative.*

Vacuum-tube calibrators, we noted, operate by clipping a sine wave. Our transistorized calibrator, in contrast, behaves like a single-pole single-throw switch being thrown off and on at a 60-cycle rate. This transistor, in other words, acts as a switch between the precision 4-volt reference and the output terminals.

In fact, the transistor comes pretty close to being the ideal switch. When it is in the *on* position, there is virtually no voltage drop across its terminals; in the *off* position the leakage current is usually about only 5 microamps. Thus, the transistor adds very little error to the instrument. Poor transistors, however, do sometimes bring about errors and distortions of the output amplitude and waveform. (This trouble and its remedy will be discussed later.) The two resistors in the circuit in no way affect the precision of the output amplitude, hence they can be ordinary 10% carbons.

The transistor circuit, unlike the vacuum-tube circuit, has a low output impedance of 2,200 ohms, reducing loading errors to almost zero.

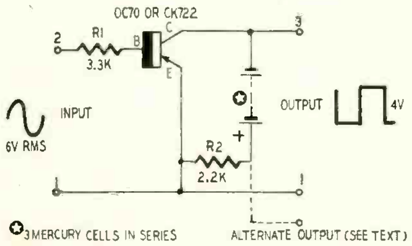
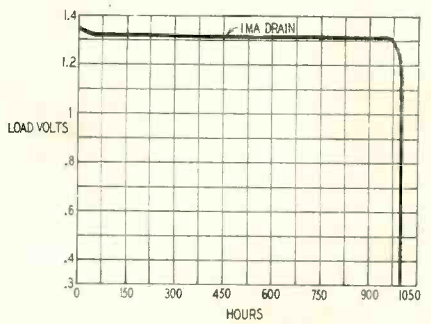


Fig. 1—Schematic of the calibrator.



Courtesy P. R. Mallory & Co.

Fig. 2—Mercury-cell characteristic.

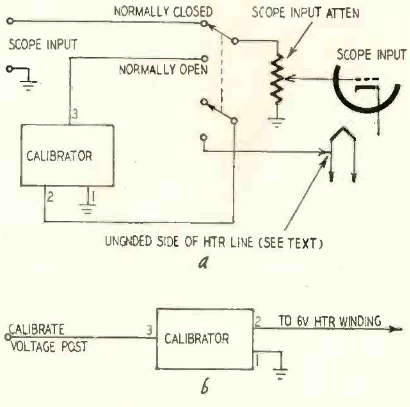


Fig. 3—Diagrams show alternate methods of using the scope calibrator.

Only three external connections to the calibrator (Fig. 1) are necessary: the ground, input and output.

A 60-cycle signal is fed into the calibrator from the scope heater line. When this signal is near zero or in the positive portion of the cycle, the collector does not conduct (is cut off) and the full reference voltage is available across the output terminals. This is because there is no voltage drop across R2. As the base voltage swings negative the base-emitter loop begins to draw full current. The voltage drop from collector to emitter now approaches zero, effectively shorting the output terminals and causing the full reference voltage to appear across resistor R2.

This results in a square wave developed across R2 exactly 180° out of phase with the square wave across the output terminals. If desired, the calibrated output can be taken from this resistor rather than from collector to ground. This alternate connection is shown in dashed lines.

Resistor R1 in series with the input terminals and the transistor base limits the base current to a value several times greater than necessary to cut *on* the collector-emitter "switch" completely.

The calibrator output rise time, sharpness of corners and tilt of the flat top (see photo) are better, in most respects, than the output of a good-quality vacuum-tube calibrator. An Amperex OC-70 transistor was used in the instrument when this photograph was made. The OC-70 is a high-quality hermetically sealed unit designed primarily for hearing-aid circuits.

Fifteen transistors, in large part CK722's, were tried in the calibrator. All gave excellent performance except one that produced a distorted wave-shape (see photo). However, we were able to make even this transistor work by *plugging it in backward:* i.e., inserting it into the socket so the emitter is used as the collector, the collector as the emitter. This will not harm the transistor! The tiny indium dot forming the collector is larger than the emitter indium dot. Otherwise, the emitter and collector of a junction transistor are identical.

Normally, a 6-volt signal from the scope heater feeds the calibrator input. This assumes one side of the heater line is grounded. If the heater winding has a grounded center tap, only 3 volts will be available for the calibrator input. Nevertheless, the calibrator works almost as well on 3 volts as 6. The sides of the square wave are not as steep with 3 volts.

Parts list for transistorized calibrator

1—2,200, 1—3,300 ohms, ½ watt, resistors; 1—transistor (Raytheon CK722 or Amperex OC-70); 3—mercury cells (Mallory RM-625-RT or equivalent); 1—d.p.d.t. pushbutton switch; 1—transistor socket; 3—binding posts; 1—chassis (insulating board).

Calibrator operation

Fig. 3-a shows how the calibrator can be connected to the input of an oscilloscope by a pushbutton transfer switch. When the button is pressed, the calibration voltage is fed to the scope input. The pushbutton should be mounted on the scope front panel as close as possible to the vertical input terminals. All leads should be kept as short as possible.

The calibrator terminals are labeled according to the nomenclature of Fig. 1. Terminal 2 receives the 60-cycle voltage through the switch. If one side of the heater line is grounded the switch must go to the ungrounded side. With a center-tap-grounded transformer, the switch wire may be connected to either side of the tube heater.

Another arrangement, Fig. 3-b, simply brings the calibrator output to a connector post on the oscilloscope front panel. A jumper is then used to bridge this calibration point to either the vertical or horizontal deflection as is necessary. This system is standard on several scopes with built-in calibration.

In this last arrangement, the calibrator operates whenever the scope is turned on, therefore consuming current from the reference cells while the scope is in operation. This may be undesirable if the scope is used extensively. If so, a pushbutton can be used to operate the calibrator only when needed. This switch would be connected in series with terminal 2 of the calibrator and the heater line.

There is no need to switch the mercury cells on and off. With no input signal the drain on these cells is negligible and they should last, theoretically, about 40,000 hours. This is probably longer than their shelf life and may not be a realistic figure. But it does point out the long life than can be expected of the cells.

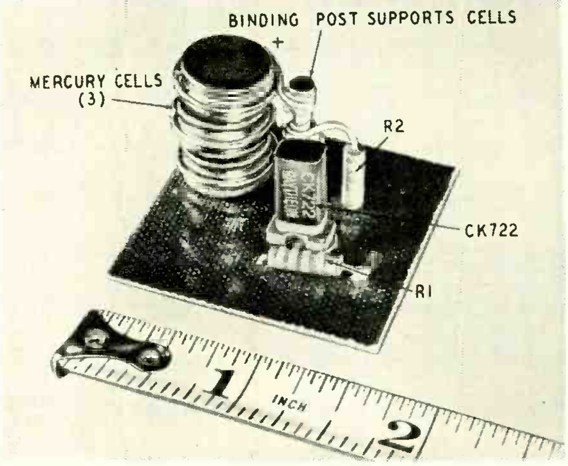
Scope cabinets can become pretty warm inside. Because of the temperature rise, it is advisable, although not absolutely necessary, to mount the calibrator near the bottom of the case.

The mercury cells are available from several mail order jobbers or they can usually be obtained almost anywhere as hearing-aid replacement cells. They are Mallory RM-625-RT. This type has a metal tab, connected to the negative terminal, which can be bent and soldered to the side of the next cell for a series connection. When soldering to these cells, be quick or the cell may overheat and be ruined. After they are soldered it is a good idea to check them with a voltmeter.

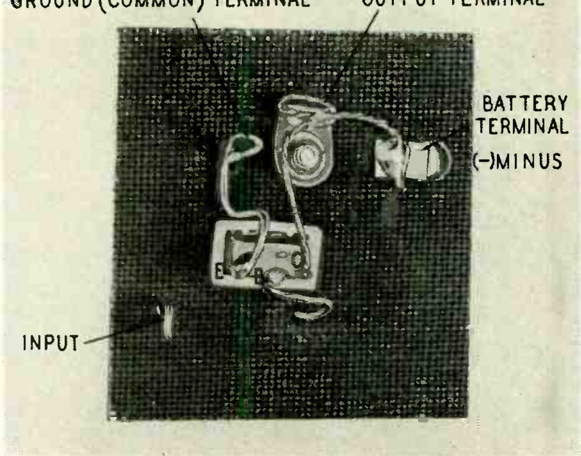
Almost any junction transistor should work in the circuit; n-p-n units can be accommodated by reversing the polarity of the reference cells, i.e., connecting the positive battery terminal to the collector.

The output from the transistorized calibrator was compared with a mechanical chopper operating from the same three mercury cells with no observable difference in the square-wave amplitude. This and other checks lead me to believe the accuracy is around 2%.

If an inexpensive transistor is used, the calibrator should cost no more than \$5 to build. There is no necessary calibration or adjustment; just assemble it and it is ready to operate at full accuracy. END



Topside view of the calibrator.

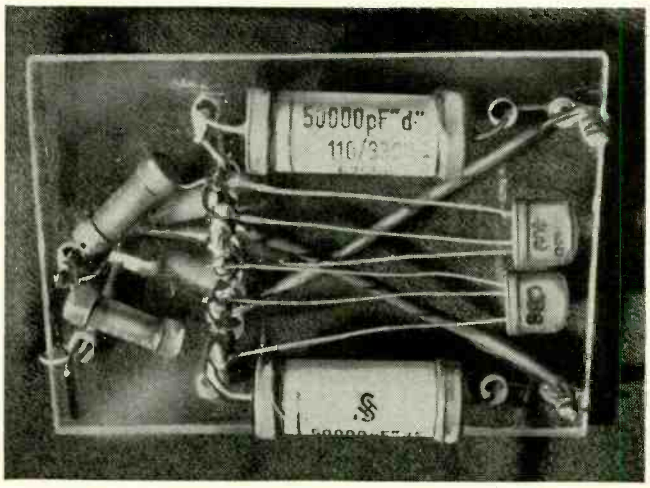


Underchassis of scope calibrator.

TRANSISTOR MULTIVIBRATOR GENERATOR and BALANCE

Conventional vacuum-tube circuitry uses junction transistors

By JOSEPH BRAUNBECK



Polystyrene-mounted multivibrator–sine-wave generator.

THOUGH transistors generally demand their own circuitry, there are some good vacuum-tube circuits that function nicely with transistors. As the phase relations of a grounded-emitter transistor resemble those of a grounded-cathode vacuum tube, it is possible to substitute junction transistors for vacuum tubes in most oscillator circuits.

The multivibrator and two-terminal sine-wave generator perform well with junction transistors, with the transistorized two-terminal L-C having a great advantage over other transistor oscillators. As with vacuum tubes, the circuit oscillates on higher frequencies than single-transistor oscillators with the same components. While transistors must be selected for other oscillators, most transistors, even those not oscillating in single oscillators, work well on r.f. in this circuit.

The multivibrator is in principle a two-stage R-C-coupled amplifier (Fig. 1). The output voltage of the second tube is fed back to the grid of the first

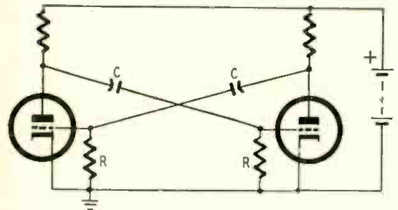


Fig. 1—Basic multivibrator circuit.

tube. Because of this feedback the circuit starts to oscillate at a frequency determined by the time constants of R and C. The circuit will also oscillate if you substitute an element with similar amplifying and phase-shift relations in place of the vacuum tubes. Fig. 2 shows how the grounded-emitter circuit of a junction transistor corresponds to the grounded-cathode circuit of the vacuum tube.

If you make the grid of the vacuum tube more positive, plate current increases and the plate becomes less positive due to the voltage drop across the load resistor. Thus, all "mountains" of a sine wave applied to the grid are transformed into "valleys" of the anode voltage. Now look at the grounded-emitter circuit of a p-n-p junction transistor. If the base is made more negative with respect to the emitter, collector current increases and the volt-

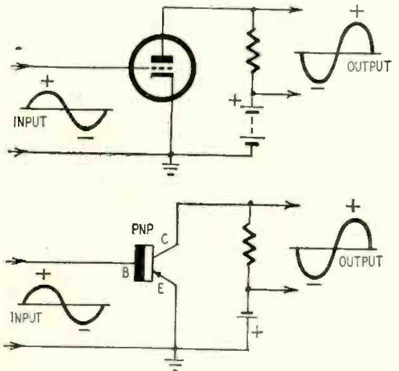


Fig. 2—Tube–transistor comparison.

age drop across the load resistor causes the collector to become more positive. So, a sine wave is "turned over" the same as with a vacuum tube, a grounded-emitter transistor producing the same 180° phase shift as a grounded-cathode vacuum tube.

Fig. 3 shows the circuit of the transistorized multivibrator. It produces an output waveform rich in harmonics, though they are not as rectangular as those produced by tubes. Nevertheless, there are harmonics up to 30 mc when the circuit oscillates at about 100 cycles. An oscilloscope pattern of the output waveform is shown in Fig. 4. The waveform is more complex than with tubes because the transistor requires input power.

There is a sine-wave oscillator circuit which resembles the multivibrator: the two-terminal circuit of Fig. 5. In principle it is a multivibrator with a resonant L-C circuit between the grids. In the old days of radio the two-terminal oscillator (then called a balance generator) was used because of two advantages: there is no need for a tapped coil or feedback winding, any resonant circuit connected between the grids will oscillate; the balance generator worked up to very high frequencies even with the poor tubes of those days.

Some say this was the first circuit which ever produced CW in the 2-meter band. Today we have similar difficulties—only a relatively few individual transistors oscillate in the radio-frequency band. It would seem that the balance generator might help to reach higher frequencies even with components not suitable for oscillating in ordinary circuits. It has been found that it is so. The transistorized balance generator (Fig. 6) oscillates over the entire medium-wave band with individual transistors which are otherwise suitable only for audio purposes. If you omit the resonant circuit, you have a multivibrator again. Therefore, it is possible to combine both circuits with the oscillator being used either as a multivibrator or sine-wave oscillator.

The combined circuit

Fig. 7 is the circuit of the combined oscillator. Two CBS-Hytron 2N36 transistors work with grounded emitters. The bias is obtained by 330,000-ohm resistors between the bases and negative supply. In each collector lead there is a 3,900-ohm load resistor. The two .05-μf coupling capacitors connect the output of each transistor with the base input of the other.

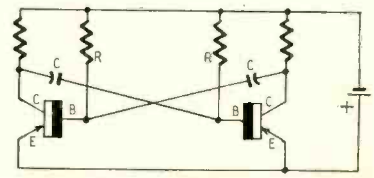


Fig. 3—Transistorized multivibrator.

Without any L-C circuit connected to terminals A and B, the circuit works as a multivibrator and the waveform between A and B is shown in Fig. 8. The circuit oscillates at about 100 cycles. If you connect terminals A and B to the input of a radio receiver, you will hear the 100-cycle signal over all bands

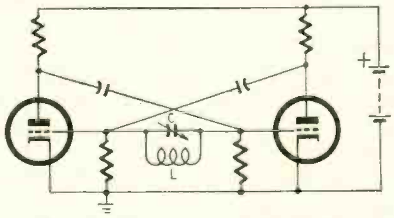


Fig. 5—Diagram of sine-wave generator.

up to 10 meters. Thus the circuit makes an excellent multivibrator for test and alignment purposes. With only a penlight cell used as a voltage source, the unit may be built ultra-compact.

When you connect a resonant circuit to terminals A and B, the oscillator produces sine waves of a frequency determined by the L-C circuit. For low-

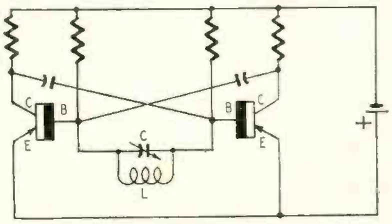


Fig. 6—Transistor sine-wave generator.

frequency purposes any capacitor and choke arrangement may be used. The sine wave produced in that case may be seen on a scope. If you want to hear the audio frequency, use your headphones as the inductor. If the capacitor is omitted, higher frequencies will be generated. If the L-C ratio is too high, the sine waves are distorted as shown in Fig. 9.

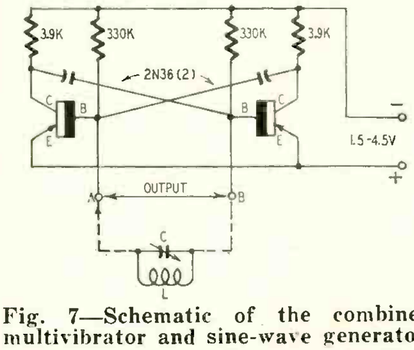


Fig. 7—Schematic of the combined multivibrator and sine-wave generator.

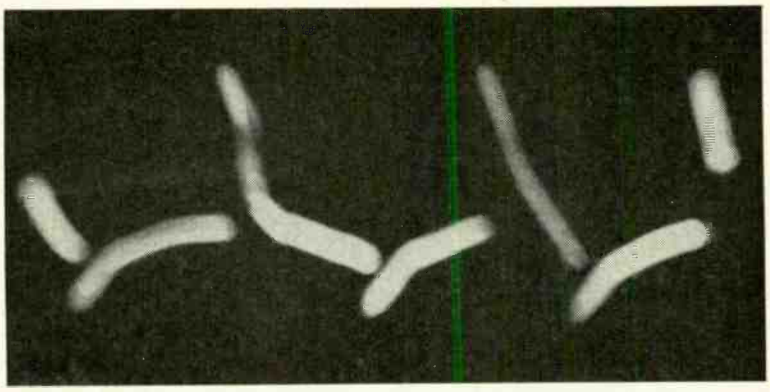


Fig. 4—Multivibrator output pattern.

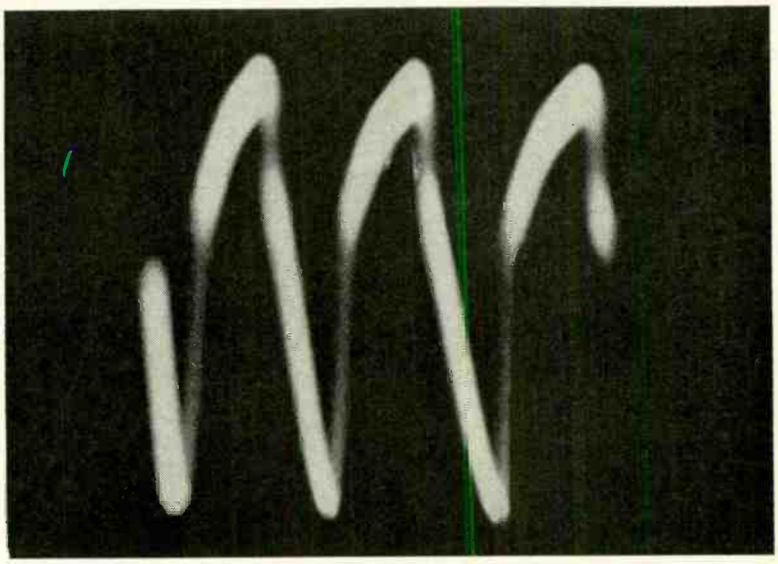


Fig. 8—Waveform between A–B of Fig. 7.

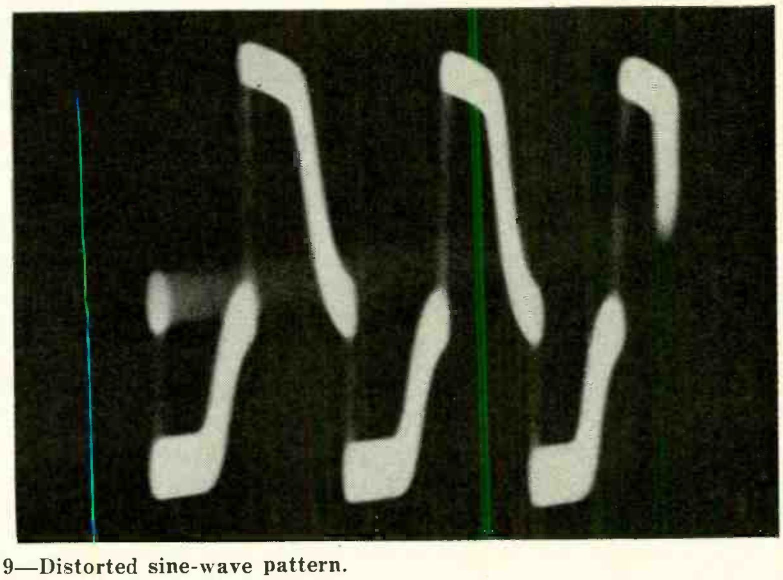


Fig. 9—Distorted sine-wave pattern.

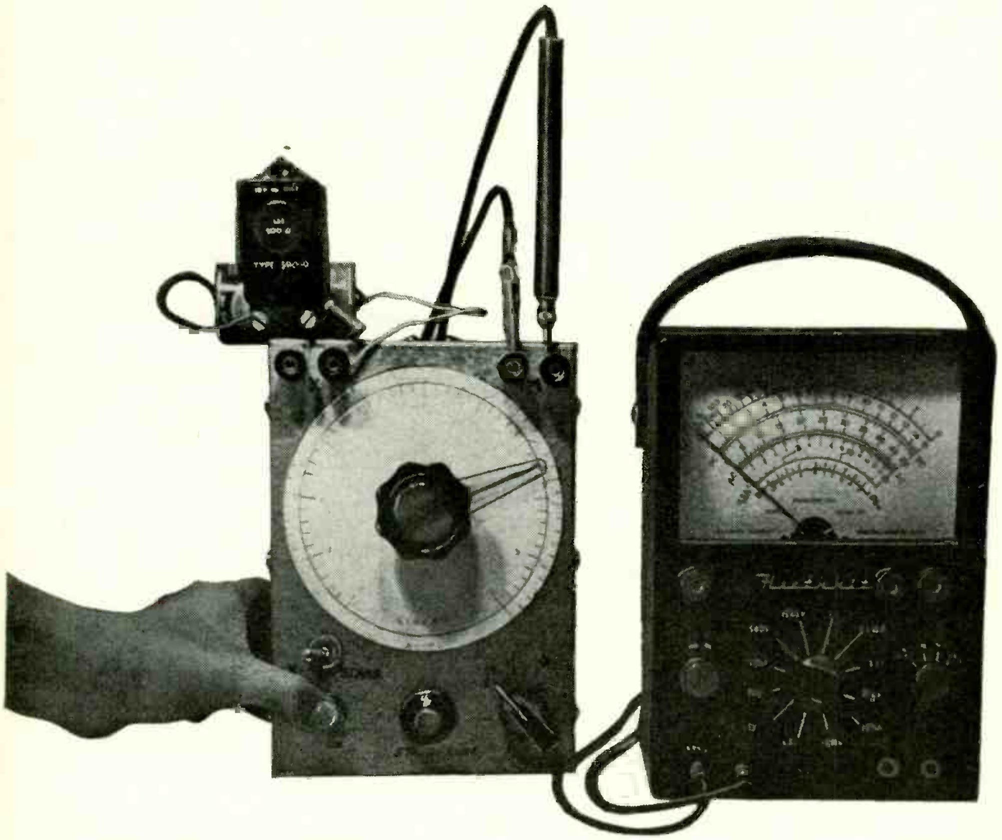
To use this circuit as an i.f. alignment generator, connect a transformer to A and B. For covering the medium-wave band, any wavetrap or crystal set may be used. The battery voltage may be as little as 1.5, though higher voltages of about 4.5 are desirable to obtain higher output on high frequencies. With a battery voltage of about 4.5, a current of 1 ma will be drawn by the circuit when oscillating, which increases to 2 ma when oscillation ceases. The sine-wave output between A and B is about 2 volts r.m.s. at 100 cycles, decreasing to about 0.5 volt at 1.5 megacycles.

Construction

As I planned to build the oscillator into another piece of test equipment, the unit is laid out so that it can be easily soldered into any hookup. The layout may be seen in the photos. A 2 x 3-inch polystyrene sheet serves as a "chassis." Only four soldering connections have to be made if the oscillator is connected into any larger hookup. When assembling the unit be careful not to apply excessive heat to the transistors when soldering.

As it is much easier to get transistors oscillating with this circuit, it should be of interest to everybody interested in experimenting with transistor oscillators at high frequencies. END

A STANDARD POTENTIOMETER



Laboratory type instrument is simple and reliable

Making a precision resistance measurement with the null potentiometer.

FOR PRECISE MEASUREMENTS

By FORREST H. FRANTZ, SR.*

MEASURING dc voltages of less than 0.25 volt is difficult and extremely inaccurate with a conventional multimeter or vtvm. In measuring small voltages with a multimeter, additional inaccuracy is imposed by circuit loading. Since small voltages do not have to be determined frequently, a null type instrument may be tolerated. The null potentiometer is an invaluable instrument for the technician and experimenter.

The potentiometer is a laboratory type instrument which, used with other devices, provides an accurate standard for checking instrument calibration, a precise means for measuring voltage, current and resistance.

The potentiometer's claims for accurate measurement are: It draws no current from the source of emf under measurement at the null and consequently does not load the circuit; its accuracy does not depend on the calibration of a moving-coil type meter; the potentiometer carries its own internal calibration standard; measurement is made by comparison of the unknown emf with a known voltage drop; the potentiometer reads true emf regardless of series or internal resistance.

Potentiometer theory

Null principle: *If the voltage between points A and C (Fig. 1) is exactly equal to that between B and C and if the polarities are the same, the voltage between points A and B is exactly zero, and the galvanometer (or current meter) will not be deflected.* This follows from Ohm's law: since I equals E divided by R, when E is zero, I must be zero. For the null case, if E_{AC} is a battery of unknown voltage and E_{BC} is a standard battery of known voltage, unknown E_{AC} is equal to known E_{BC}. To extend the null principle in the measurement of voltages without requiring an impractical number of standard batteries of odd voltage values, the potentiometer principle must be used.

Potentiometer principle: *If the voltage drop between terminals F and H (Fig. 2) of the linear potentiometer is E volts, the voltage drop between terminals F and G is E times the number of degrees of rotation from F to G divided by the number of degrees of rotation from F to H.* Resistance between FG is proportional to the percentage of total rotation and current through R at any point is the same in this series circuit. Since E equals I times R, it follows that the potentiometer principle as stated must hold.

Fig. 3 shows an elementary null-potentiometer circuit. Battery E_B is the voltage source which causes current to flow through STANDARDIZE rheostat R2 and potentiometer R1. E_S is a standard battery. Assume that the R1 scale is calibrated from 0 to 100 and that E_S is 1 volt. If wiper contact G of R1 is rotated to H (100 on the dial) and switch S is thrown to position 2, R2 may be rotated till the galvanometer reads zero. Then the voltage drop across R1 is exactly 1 volt.

Now, if an unknown potential E_X (of less than 1 volt) is connected to terminals P and Q, switch S set to position 1 and R1 rotated till galvanometer current is zero, the value of E_X may be read directly from the dial of R1 by properly placing the decimal point. Thus, if the dial reads 23, E_X is 0.23 volt. A momentary-contact (normal-off) switch is usually connected in series with the galvanometer and

* Physics Department, Mississippi State College.

sliding arm G of the potentiometer. This switch protects the meter and prevents continuous loading of E_S or E_X before null adjustment is made. As an additional precaution a series resistance is often inserted between the positive terminal of E_S and terminal 2 of the switch. This limits current drawn from E_S before a null is reached and, since no current is drawn at the null, no error is introduced in standardizing the potentiometer.

Potentiometer circuits vary in complexity and cost from the simple hookup of Fig. 3 to very elegant and extremely accurate arrangements costing over $500. It is possible to achieve ±1% accuracy in easily built potentiometers of modest cost without special calibration against an expensive standard. The instruments with extremely accurate potentiometers and standard cells and very sensitive galvanometers, can measure with less than .05% error. Instruments of this accuracy have to be standardized frequently since they tend to drift with changes in room temperature.

My potentiometer was constructed with a parts investment of less than $10. The instrument is extremely accurate for so small an investment. The circuit is shown in Fig. 4 and is very much like that of Fig. 3. Note that a voltage divider is provided off R1 to give ranges of 1, 0.1 and .01 volt. This voltage divider loads R1 and causes a slight deviation in the dial scale (Fig. 5) from absolute linearity.

Another voltage divider is used in conjunction with the standard mercury cell. This divider furnishes a standard emf of 1 volt for the potentiometer. The arrangement draws 0.1 ma from the standard cell when the potentiometer is standardized. This is ordinarily avoided in potentiometer circuits when extreme accuracy is sought and as an economic precaution. Since the other components of the potentiometer limit the accuracy to approximately 1%, the error caused by this small drain on the standard cell is negligible. The divider resistances should be 1%-tolerance deposit type resistors. As an alternative, wirewound potentiometers may be used for the divider resistances. They may be set permanently, using an accurate Wheatstone bridge. Composition carbon resistors should be avoided since they are subject to drift with the passage of time.

The layout of the dial scale is shown in Fig. 5. The original is 5½ inches in diameter but you can make it larger if desired. The scale is calibrated through 280°. The resistance change in the control specified is linear through 280° but the mechanical range of rotation is 300° so the scale must be carefully positioned so 0.5 is reached when the arm of the control is exactly midway (electrically) between the ends of the range. The scale shown in the front-view photo is a special type that is not needed for most applications.

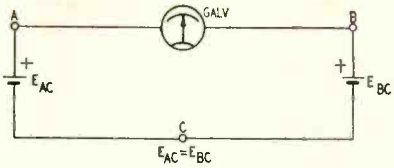


Fig. 1—Demonstrating null principle.

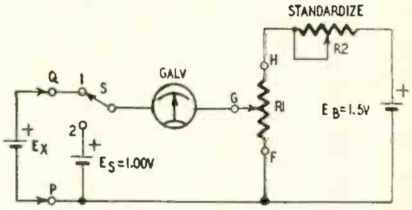


Fig. 3—Simple potentiometer circuit.

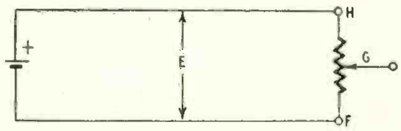


Fig. 2—The potentiometer principle.

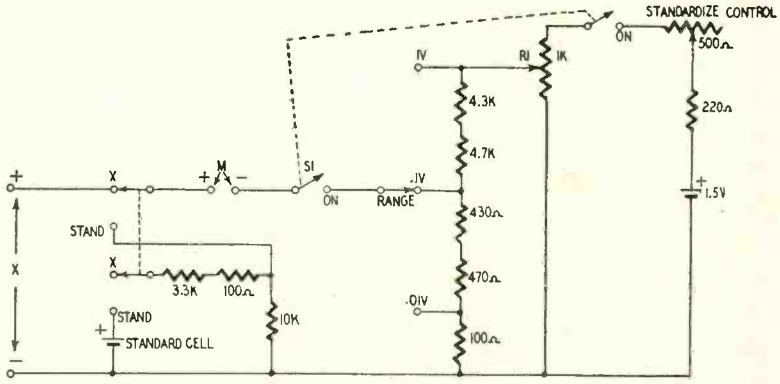
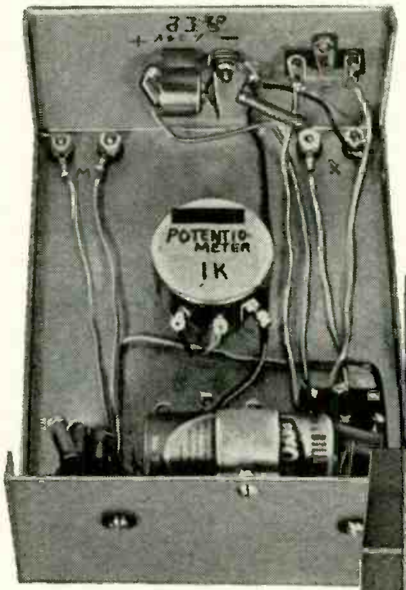
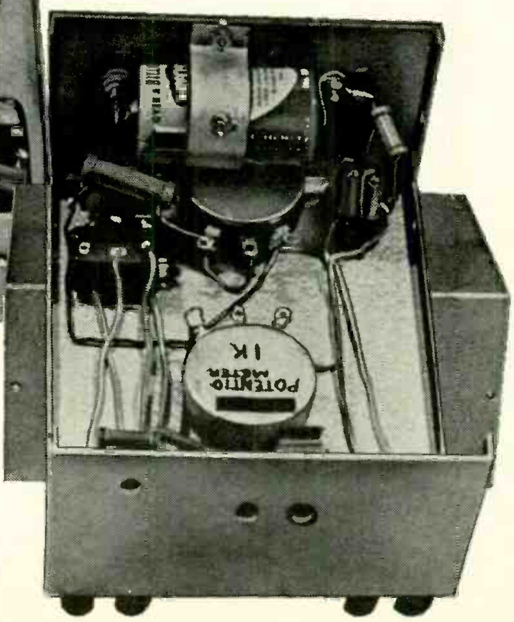


Fig. 4—Schematic diagram of the potentiometer—all values are shown.



Underchassis view of potentiometer.



View shows mounting of standard cell.

Using the potentiometer

Be sure the X-standardize switch is set in the X position when the potentiometer is not in use. To use the potentiometer, connect a galvanometer or current meter to the M terminals. I was able to obtain a satisfactory null for voltages as low as 10 mv with the 150-μa range on my multimeter. To measure less than 10 mv, a more sensitive meter should be used to obtain a more definite null.

To standardize the potentiometer throw the X-standardize switch to STAND, set the range switch to the 1-volt position and rotate the R1 dial to the extreme clockwise position (1.0). Close S1 and adjust the standardize control for null indication on the meter. This completes standardization. Throw the X-standardize switch back to the X position.

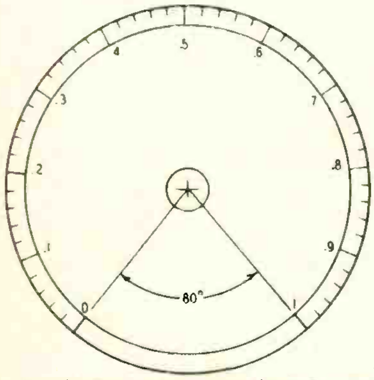


Fig. 5—Instrument potentiometer scale.

To measure a voltage of 1 or less connect the unknown voltage to the X terminals. Close S1 and adjust the range switch and R1 till meter null occurs. Read the voltage directly from the R1 dial and multiply by the value indicated on the range switch. Thus, if R1 reads 0.82 and the range switch is set to the 0.1 range, the voltage is .082. This procedure also applies to the measurement of contact potentials.

To adjust an external potentiometer for precision voltage division connect the potentiometer to be adjusted as shown in Fig. 6. The battery is a 1.5-volt flashlight cell and R1 is approximately equal to R2. For example, assume that the divider is to have a 10 to 1 ratio (if 100 volts is impressed across AC of R2, the voltage from BC is to be 10). On the instrument, set R1 to 1.0, the range switch to 1 volt, close S1 and adjust R1 (Fig. 6) for a null with AC connected to the X terminals. Now move X connection from A to B, switch range switch on the potentiometer to 0.1 volt and adjust R2 for a null. This completes adjustment of R2 for voltage-divider operation. To obtain a larger divider ratio it is advisable to use a large value of fixed resistance in conjunction with a potentiometer; this allows more precise adjustment.

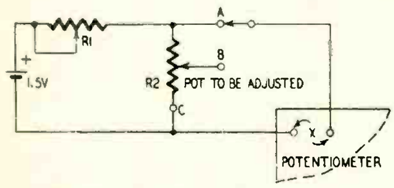


Fig. 6—Circuit for adjusting potentiometer for precision voltage division.

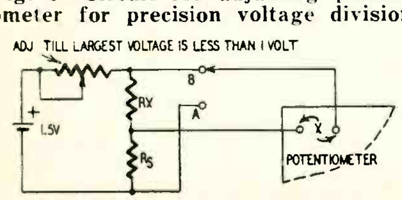


Fig. 7—Arrangement for accurate resistance measurement with potentiometer.

To measure potentials greater than 1 volt (the potentiometer will generally be used in this way only when accuracy is important and to check the accuracy of a voltmeter) adjust a potentiometer for voltage division as outlined above. Terminals B and C of R2 (Fig. 6) are left connected across the X terminals. (The battery and rheostat R1 are disconnected and the unknown voltage is applied across terminals A and C of R2.) The resistance of R2 should be large if the current drawn from the unknown source of emf is to be kept negligible. A 10-to-1 divider will extend the 1-volt instrument range to 10 volts; a 100-to-1 divider will extend it to 100 volts, the 0.1 range to 10 volts and the .01-volt range to 1 volt.

To measure temperature connect a thermocouple to the X terminals. The thermocouple emf depends on the metals of which it is made. Some general physics texts provide tables and charts of thermocouple voltages for wide ranges of temperature. A simple inexpensive thermocouple may be made by twisting a short length (about an inch) of copper wire and a short length of constantin wire together. (Try any resistance wire.) A thermocouple may be used to measure extremely high temperature.

To measure resistance accurately use a standard R_S of known resistance and accuracy in conjunction with the unknown resistance as shown in Fig. 7. If R_S and R_X are exactly equal, the accuracy with which R_X may be determined is equal to the accuracy of the standard. If one of the resistors is less than 10 times the value of the other, the resistance of the unknown may be determined to within 1%. First, measure the voltage across R_S, then measure the voltage across R_X, then,

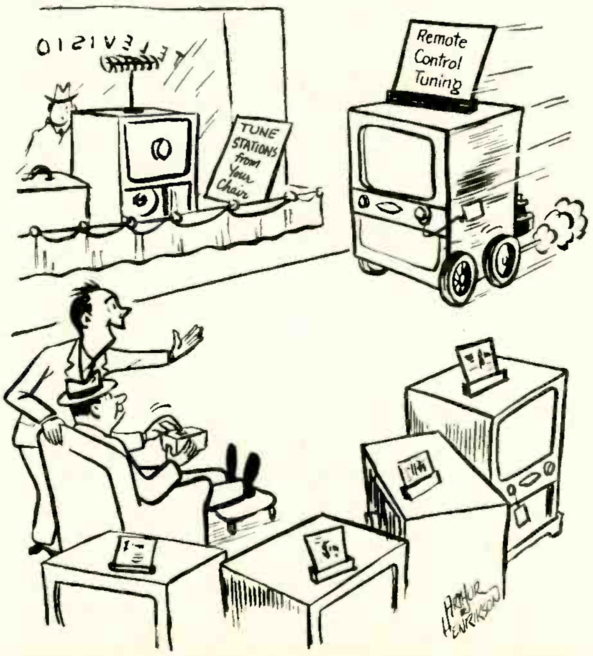
$$R_x = \frac{R_s E_x}{E_s}$$

Many other accurate measurements may be made with the potentiometer. Current may be determined by measuring the voltage drop across a known resistance and applying Ohm's law. Potentiometer resolution may be determined by noting the smallest change in voltage obtainable for a small change in shaft position. The internal resistance of batteries and power supplies may be determined by measuring the emf with and without load and applying Ohm's law. The accuracy of volt-, ohm- and milliammeters may be determined by comparison, using the methods outlined above. The meter resistance and the voltage or current required for full-scale deflection of a basic meter movement may be determined with a potentiometer. By exercising some ingenuity in applying it, the user will find this laboratory type instrument most useful in his work or hobby. END

Parts for null potentiometer

Resistors: 2—100, 1—430, 1—470, 1—3,300, 1—4,300, 1—4,700, 1—10,000 ohms, 1% tolerance, ½ watt; 1—220 ohms, 5%, ½ watt; 1—500-ohm potentiometer; 1—1,000-ohm wirewound potentiometer (Clarostat 58-1000).

Miscellaneous: 1—1-pole 3-position rotary switch; 1—dpdt switch; 1—dpst momentary-contact switch (Switchcraft 1004 or equivalent); 2—binding posts (1 red and 1 black); 1—mercury A battery (Mallory RM1R); 1—flashlight cell, size D; 1—3 x 5 x 7-inch chassis (ICA 29443 or equivalent)

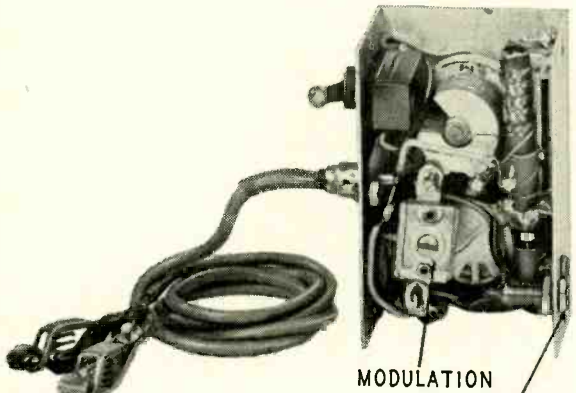


"Press this button—and it moves over to you."

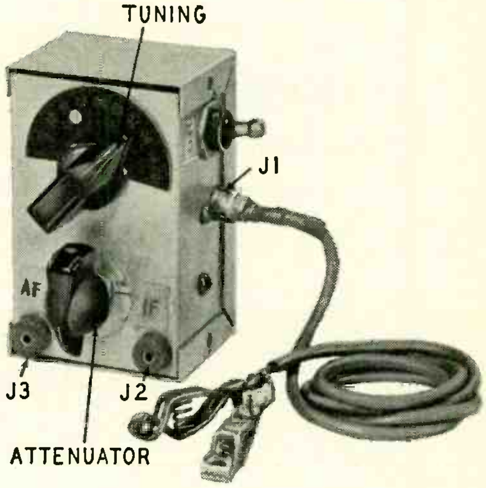
RADIO I.F. TESTER

Transistorized pocket instrument provides i.f. and audio signals, acts as continuity checker

By NATHANIEL RHITA



Underchassis view shows major parts.



Front view of tester shows controls.

MOST radios, home or portable, are superhets. To align, test and adjust such sets an i.f. signal generator, an audio tone and a continuity tester should be available. This instrument can make all these tests. It is a compact transistorized circuit using a single CK722 or equivalent junction transistor powered by a single penlight cell.

Most radio receivers have an i.f. center frequency of 455 kc, but several off-beat values are found—for example, 456, 460, 465 kc. Therefore the generator frequency should be variable to meet any occasion. The range of this tester is approximately 450–500 kc. The variable feature also comes in handy when it becomes necessary to shift an i.f. from its standard value to reduce interference. If output on the broadcast band is needed, the second or third harmonic may be used. For example, the second harmonic of 460 kc is 920 kc on the radio dial and its third harmonic is 1380 kc, also in the broadcast band. Incidentally, this generator is easily calibrated by listening for its harmonics on a nearby radio receiver.

Radio alignment may be done by ear or with an a.c. voltmeter across the voice coil of a speaker. In either case the i.f. must be amplitude-modulated. In this tester, the i.f. is *self-modulated*. The transistor used in this generator oscillates at an i.f. but blocks periodically at an audio rate. A Radio Receptor RR115 and several Raytheon CK722's were tried. When heard on a highly selective (crystal-filtered) radio, separate beats will be heard on both sides of the carrier. On an ordinary broadcast receiver, these sidebands merge to form an audible tone. Trimmer C controls the modulation. If its capacitance is too small, the generator puts out an unmodulated (CW) carrier. Capacitance should be increased until reliable modulation is obtained over the entire dial.

An i.f. generator should have some sort of attenuator. Unless the output voltage can be controlled there is no way of estimating stage gain or overall sensitivity. Controlling the i.f. output also permits testing high-gain i.f. strips with the a.v.c. off, yet without overloading. The potentiometer is the attenuator in this circuit, J1 the variable output terminal. For stubborn sets, those badly misaligned or in a poor state of repair, there is also a high-output terminal, J2.

An a.f. tone is useful for testing a radio detector, audio stage or speaker. It is available at terminal J3 and is generated by the blocking process. Headphones may be connected in series with the tone signal to check for open circuits. Since audio passes through a capacitor, this test also shows whether a capacitor is normal or open. The tone will vary with the value of capacitance in series. The normal tone from my tester is about 400 cycles. With a .005-μf capacitor in series, frequency increases to about 1,000 cycles (and becomes weaker). With 150 $\mu\mu$f in series the tone goes to about 5,000 cycles and becomes very weak. A shorted capacitor gives the same indication as a closed path. An open capacitor will interrupt the path, so nothing is heard in the phones.

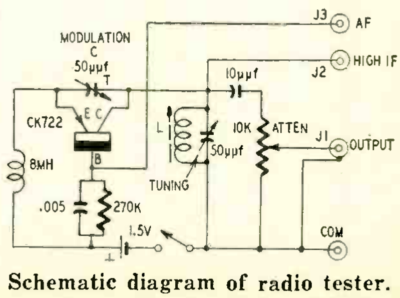
This audio signal is only a fraction of a volt and is safe enough to be used in any circuit including those using transistors; yet there is ample signal for testing amplifiers and for comfortable listening on phones.

The radio tester is very compact and entirely self-contained. The transistor takes very little current so that the cell will last indefinitely. I placed the entire instrument in an aluminum box 3¼ x 2⅛ x 1⅝ inches. The controls include two dials (tuning and output), a toggle on–off switch, two insulated terminals (a.f. and high i.f.), one ground terminal and an RCA type phono jack to take a shielded output lead.

Parts for radio tester

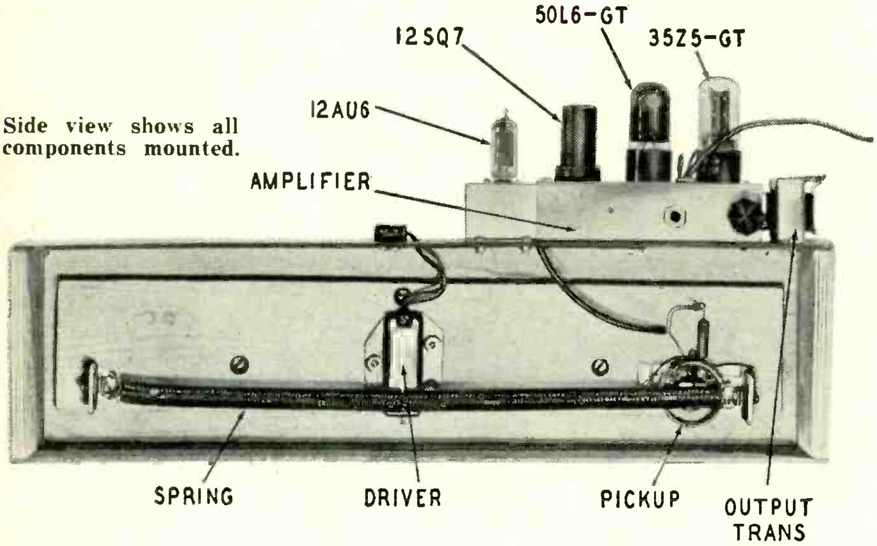
1—270,000-ohm ½-watt resistor; 1—10,000-ohm potentiometer; 1—10 $\mu\mu$f, 1—.005 μf, capacitors; 1—50-$\mu\mu$f mica, 1—50-$\mu\mu$f air, trimmer capacitors; 1—transistor, CK722 (socket optional); 1—8-mh coil; 1—2.5-mh coil, variable (Grayburne Vari-choke, TV width coil, etc.); 1—penlight cell; 1—s.p.s.t. switch; 3—jacks; 1—chassis, approximately 3¼ x 2⅛ x 1⅝ inches; 1—test lead with alligator clips and plug (use shielded lead).

Coil L is any unit that can be tuned to the i.f. band and should be adjustable. This makes it easy to set it to the desired band. The required inductance is approximately 2.5 mh. A Grayburne Vari-choke, TV width control or similar coil is suitable. END



Schematic diagram of radio tester.

Side view shows all components mounted.



A mechanical sound-delay device produces novel echo effect in music and voice

BUILD THIS SIMPLE
ECHO UNIT

By DANIEL M. COSTIGAN

THE listener can generally hear a certain amount of echo effect in most popular commercial recordings made within the past few years. This is the result of a recording technique which, not too long ago, was used only to create novelty effects. The recording industry has discovered that this technique, when skillfully handled, can make a recording sound richer and far more interesting than older methods where reverberation was purposely suppressed.

This echo effect is achieved by several methods, including the use of actual hard-walled chambers, planned placement of microphones and special electrical devices which simulate an echo by delaying the sound mechanically before it reaches the microphone. The sound-delaying mechanism is often a metal spring or network of springs with a driving unit at one end and a microphone at the other. The unit described here is based on this method.

The unit (see photos) consists entirely of such easily acquired items as a screen-door spring, a disc-recording head as the driver, a discarded headphone for the pickup, a modified a.c.–d.c. phono amplifier and a few rubber shock mounts.

Fig. 1 shows the basic layout of the unit. (Only the components shown within the dotted lines are described.) The driver is a low-impedance, magnetic type disc-recording head which can be connected directly across the speaker of the amplifier to which the original sound is being fed. The spring is of the normally compressed type having fairly low tension. A simple test for the required tension is holding one end of the spring in the hand and noticing how far the other end drops. The farther the spring sags under its own weight, the greater will be the echo effect produced. The one used in this unit is approximately ⅝ inch in diameter and 1 foot long when unstretched.

The microphone (pickup) is a stand-

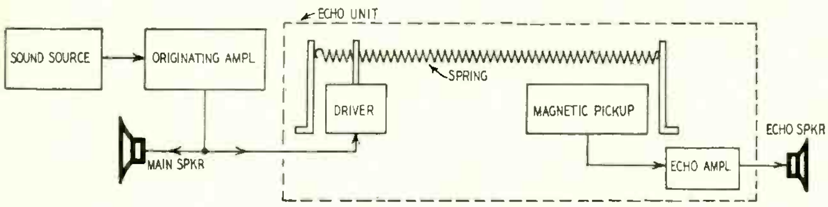
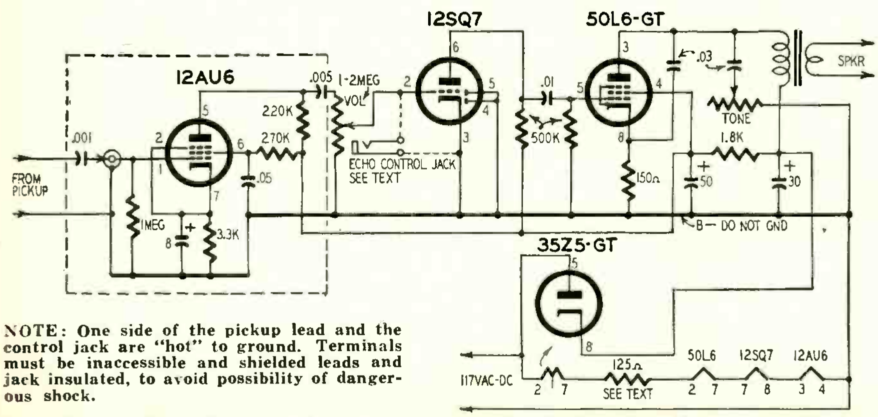


Fig. 1—Block diagram of apparatus for producing musical echo effect.



NOTE: One side of the pickup lead and the control jack are "hot" to ground. Terminals must be inaccessible and shielded leads and jack insulated, to avoid possibility of dangerous shock.

Fig. 2—The echo amplifier—circuitry within dashed lines has been added.

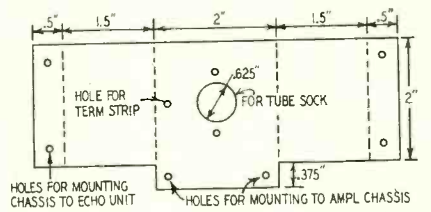


Fig. 3—Pattern for the subchassis.

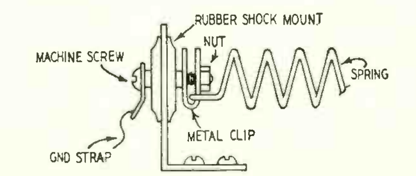
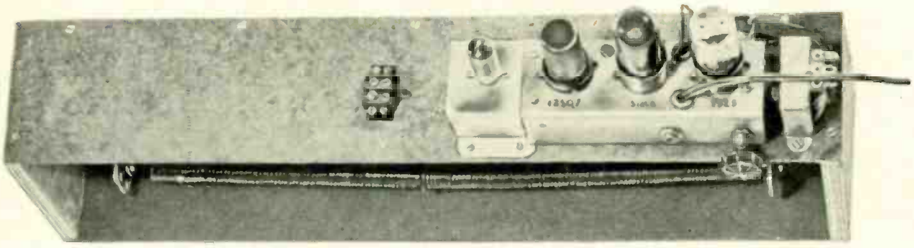
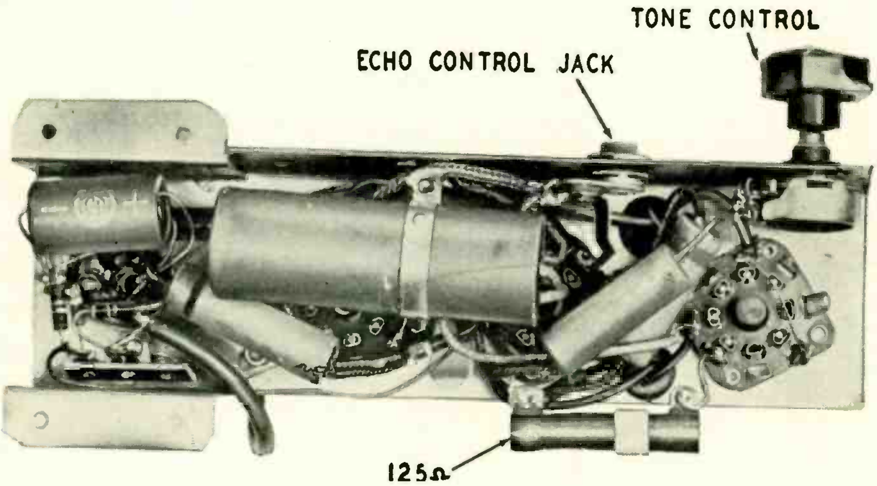


Fig. 4—Diagram shows how spring is attached to its shock mount supports.



Phono amplifier, terminal strip and output transformer mounted on top.

Underside view of the phono amplifier and the attached subchassis.



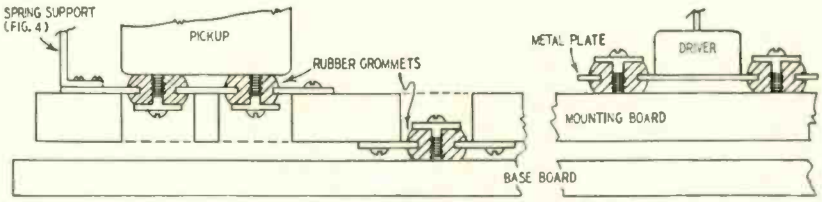


Fig. 5—Cross-sectional view shows method of shock-mounting echo unit.

Parts for echo unit

Resistors: 1—220,000, 1—270,000 ohms, 1—1 megohm, ½ watt; 1—3,300 ohms, 2 watts; 1—125 ohms, 10 watts.

Capacitors: 1—.001, 1—.005, 1—.05 µf, 400 volts; 1—8 µf, 50 volts, electrolytic.

Miscellaneous: 1—a.c.–d.c. phono amplifier; 1—12AU6 and socket; 1—screen-door spring (see text); 1—low-impedance disc-recording head; 1—1,000-ohm magnetic headphone; 1—output transformer to match 50L6; 1—2-terminal barrier strip; 2—rubber shock mounts; 1—subchassis (see text); 5—rubber ⅜-inch grommets; 1—½ x 3 x 20-inch plywood mounting board; 3—½-inch rubber grommets; 1—cabinet for mounting unit.

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ard 1,000-ohm headphone unit with its cover and diaphragm removed, the spring replacing the diaphragm as the vibrating element. It will probably be necessary to do some experimenting to determine the spacing between the spring and the pickup. I found that the most gain could be had by letting the eyehole at the end of the spring rest firmly on the phone casing. This particular type of pickup was chosen because it has no direct mechanical contact with the spring and therefore allows the spring to vibrate more freely and prevents any damage to the pickup in case the spring should vibrate excessively.

The recording head, or driver, is energized by the output of a standard amplifier and the resultant vibrations are transmitted through the spring to the pickup. A stiff piece of wire, extending from the needle chuck of the recording head through one end of the spring, provides the necessary mechanical coupling. The voltage generated in the pickup by the vibrating spring is then amplified and fed to an auxiliary speaker which operates simultaneously with the one to which the recording head is connected. The echo amplifier is a standard a.c.–d.c. phono amplifier modified by the addition of an extra stage of voltage amplification.

Fig. 2 is a schematic of the modified amplifier. The only changes made, other than the added stage (shown within the dashed lines), were replacing a 200-ohm ballast resistor in the heater circuit with one of 125 ohms, and altering the heater wiring to accommodate the 12AU6. Also, since I intend to use the unit with an electronic organ, the gain control on the original amplifier was replaced by a phone jack and the circuit changed to accommodate a shunt type control which will be mounted on the organ console and connected to the echo unit by a shielded cable. This change, of course, is optional.

The added stage was built on a subchassis measuring 2 x 2 x 1½ inches (Fig. 3) and attached to the phono amplifier chassis at the end nearest the first amplifier stage. I had to cut a rectangular opening in the side of the echo unit to clear the large electrolytic capacitor protruding from the bottom of the chassis. The shielded lead connecting the pickup to the amplifier is also run through this opening.

Shock mounting is a necessity because even the most feeble external vibration reaching the spring will be picked up and amplified. In this unit, the spring was stretched between two rubber shock mounts of the type used in military communications equipment and available on the surplus market. Each end of the spring was attached to its mount by a machine screw and a U-shaped metal clip (Fig. 4). The spring, when mounted, was stretched to about 1⅓ times its normal length.

The rest of the shock mounting was done with ordinary rubber grommets. The pickup, for example, was disassembled and the two screws which hold the entire unit together were replaced by longer ones to allow a pair of grommets mounted on a metal plate to be added when the unit was reassembled. Two holes, large enough to clear the grommets, were then drilled through the mounting board and the pickup assembly fastened over them. The mounting board measures approximately 3 x 20 inches. The driver was mounted on a metal plate which, in turn, was isolated from the mounting board by grommets. This whole unit, consisting of driver, spring, pickup and mounting board, was then isolated by grommets (Fig. 5) from the base of the rectangular case which houses it.

The driver was mounted in the middle, instead of at one end of the unit, to give added support to the otherwise flimsy spring. I found that changing the position of the driver had very little effect on the amount of echo produced. Of course, if it is mounted too close to the microphone, there will be an inductive coupling which will decrease the echo effect considerably.

All metal objects within the immediate vicinity of the microphone, including the spring and the pickup casing, should be grounded to provide hum protection. END

Recent innovations in audio circuitry and equipment

Developments in AUDIO CIRCUITS

By ROBERT F. SCOTT

TECHNICAL EDITOR

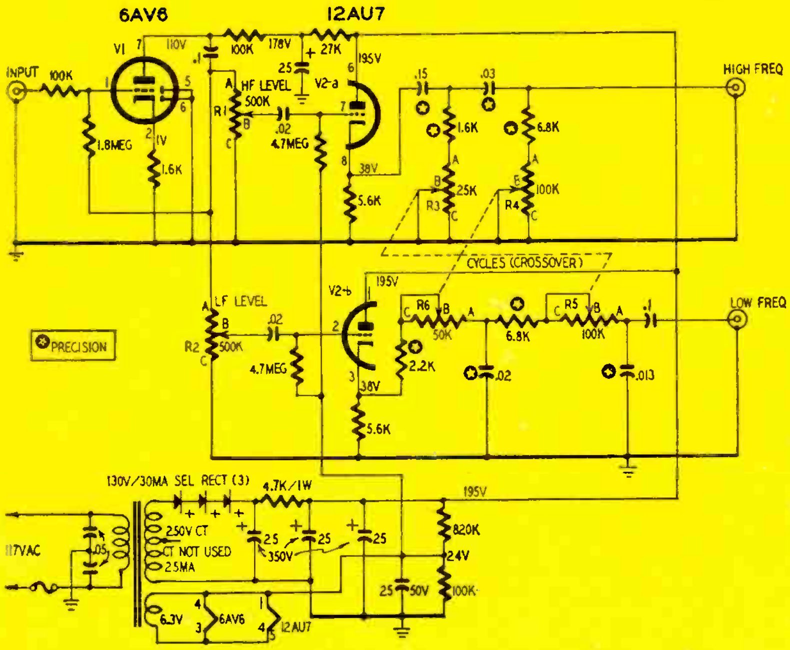


Fig. 1—Schematic of the Van-Amp, a low-level variable crossover network.

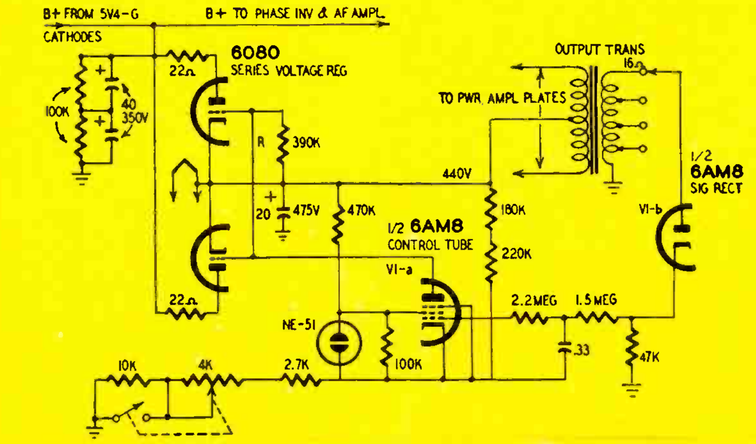


Fig. 2—Schematic of the speaker-saver circuit in the Scott 265-A.

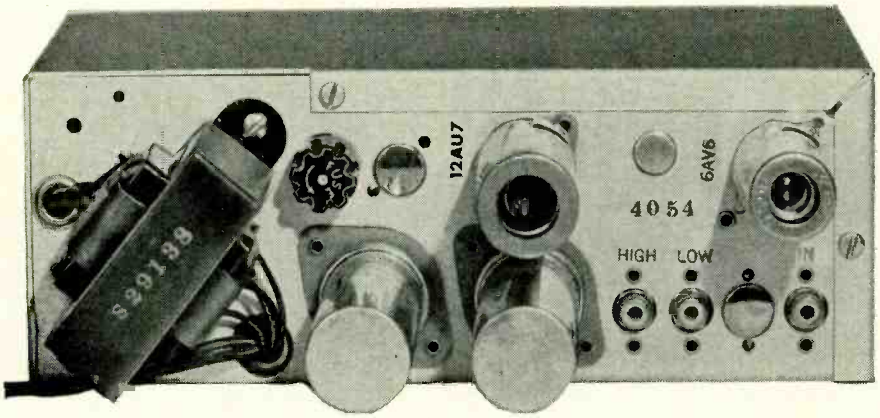
SOON after installing a crossover network in a wide-range speaker system we sometimes begin to question the network's performance. Are the speakers matched to the amplifier? Is the crossover point optimum for this combination of speakers and enclosure? Will this crossover network be satisfactory if I change one of the speakers of the enclosure? Some experimenters avoid these questions by constructing complex multiple-channel amplifiers. This may be O.K. for the avid constructor but what about the fan who has just sunk $200 or so into a commercial amplifier? The General Apparatus Co. has recently developed a solution to this problem in the form of a variable low-level crossover network called the *Van-Amp.*

The unit, shown in the photographs and Fig. 1, is available wired or in kit form. It is inserted between a preamplifier and high- and low-frequency amplifiers, each driving a speaker suited to its range, power output and output impedance. The crossover frequency is continuously variable from 90 to 1,100 cycles. Each channel provides a maximum gain of 8 times and works into amplifiers with input impedances of 500,000 ohms or more.

Individual level controls permit the gains of the two channels to be varied for the desired balance as dictated by room acoustics, speaker enclosure and the listeners' preference. When the Van-Amp is used, IM distortion may be reduced because separate amplifiers are used for high and low frequencies. Low-impedance cathode-follower output circuits permit feeding amplifiers 10 feet or so away without attenuating the high frequencies.

When the Van-Amp and two amplifiers are used with a three-speaker system, the setup is the same except

Opposite page — Front view of the General Apparatus Van-Amp. Below —Rear view of the crossover network.



that a fixed 2,200-cycle crossover network is used between the tweeter and mid-range speaker.

Circuit of the Van-Amp

The variable crossover network is not nearly as complex as some of the simpler phono preamplifiers and equalizers. 6AV6 voltage amplifier V1 is the input stage feeding the high- and low-frequency channels. The output signal appears across high- and low-frequency level controls R1 and R2 in parallel. The arms of these controls feed the grids of cathode followers V2-a and V2-b.

The frequencies are separated by variable high- and low-pass filters between the cathode followers and the output terminals. Each filter is designed for a slope of 12 db per octave. The cutoff frequency for the high-pass filter is controlled by R3 and R4 and the frequency of the low-pass filter by R5 and R6. The controls are ganged and wired so the cutoff points of the filters increase and decrease together.

The power supply is conventional, using a 250-volt 25-ma transformer in a half-wave circuit. Fixed bias (24 volts) for the cathode-follower grids and the tube heaters is obtained from a tap on the bleeder across the output of the supply.

Speaker-saver circuit

The voice coils of expensive low-wattage speakers can be quickly burned out if we are not careful to monitor the output of modern audio amplifiers delivering 20, 30, 60 or even 100 watts. Realizing this danger, E. H. Scott has included in the model 265-A 65-watt amplifier a unique continuously variable "snubber" circuit to reduce the possibility of speaker damage by sustained overloading. The speaker-saver circuit is shown in Fig. 2. It operates by reducing the power amplifier plate and screen voltage, and thus the output, when it exceeds a level which has been set by a preset variable control.

A constant voltage type of electronically regulated supply is used for the plates and screens of the push-pull parallel 1614 output tubes. A 6080 low-mu twin-triode similar to the 6AS7 is used as a series regulator. The effective plate–cathode resistance of the paralleled halves of the 6080 act as a variable resistance in series with the B plus supply to the output stage. The effective resistance is controlled by the bias on the 6080 grids. This, in turn, is controlled by the pentode section of a 6AM8 (V1-a) that operates like the control tube in a conventional voltage-regulated supply.

The 390,000-ohm resistor R is the plate load for V1-a. The voltage drop across this resistor determines the grid voltage and voltage output of the 6080. The 4,000-ohm potentiometer in the cathode return of V1-a sets the bias and the limiting level. When this calibrated control is set for a predetermined maximum power output, the plate current of V1-a flows through R and sets the grid bias on the 6080.

V1-b is connected as a rectifier across the secondary of the output transformer, developing a positive voltage on the control grid of V1-a. When sustained output exceeds the preset level, the positive voltage developed by V1-b decreases the effective bias on V1-a, causing it to draw more current. The increased drain increases the voltage drop across R and raises the bias on the grids of the 6080. The internal resistance increases and the supply voltage to the output stage drops to the level dictated by the desired power output. The time constant of the R-C network in the output of V1-b is long so the circuit does not operate on peaks of the program material and the full dynamic range is unimpaired.

Transistor phono preamp

Transistors are common in small personal type radios, hearing aids and specialized test equipment. Now they have invaded the high-fidelity audio equipment field. RCA uses a 2N104 transistor phono preamp in the new 6-HF-1 and 6-HF-2 radio–phono combinations neatly eliminating a.c. heater hum trouble so common in low-level stages. Circuit is shown in Fig. 3.

The 2N104 is a p-n-p type R-C-coupled to a 6C4 a.f. amplifier. Equalization for the four more common recording curves is provided by switching in suitable R-C networks between the transistor output and the compensated volume control in the grid circuit of the 6C4.

Although it may not be immediately apparent in Fig. 3, the preamplifier circuit is a modification of the basic circuit in Fig. 4-a. When transistor applications and circuits were first developed, this arrangement was called a *grounded-emitter* circuit because the emitter was conveniently returned to the positive side of the battery and

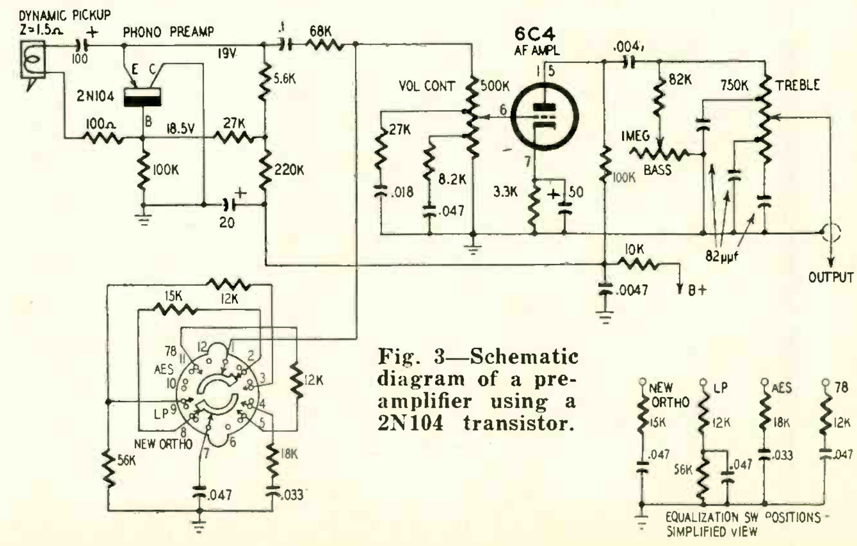


Fig. 3—Schematic diagram of a preamplifier using a 2N104 transistor.

directly to ground. In Fig. 4-a the input is applied between the base and emitter and the output is taken off load resistor R_L connected in series with the battery between the collector and emitter. Except for the reversal in power-supply polarity, this circuit is the equivalent of the vacuum-tube amplifier in Fig. 5-a.

It is not always practical to use a grounded-positive supply so the similarity of Figs. 3 and 4-a may not be immediately obvious. However, since the emitter is common to both the input and output circuits, we conveniently call this arrangement a *common-emitter* circuit. It is now readily identified as such regardless of power supply polarity or where the ground is connected.

Since the circuit in Fig. 4-a normally uses a grounded-positive supply, a modification was made in the preamplifier (Fig. 3) to permit the use of the grounded-negative supply, used for the vacuum tubes, in the rest of the circuit. The basic circuit modified for a grounded negative supply is shown in Fig. 4-b. In this circuit and in Fig. 3, load resistor R_L is transferred to the emitter side of the battery and the collector and negative end of the battery are grounded. This corresponds to the common-cathode amplifier shown in Fig. 5-b.

The transistor (Fig. 3) is biased by the current flow through the 100,000-ohm resistor in an arrangement analogous to cathode bias in a vacuum tube. This increases the base current and lowers the input impedance to provide a better match for the 1.5-ohm dynamic pickup. The low input impedance also enables the transistor to handle large input signal voltages without clipping. The pickup is connected directly between the base and emitter so the circuit is not degenerative.

Wireless intercom

After nearly 20 years, wired-wireless or carrier-current intercoms are staging a comeback. In this system, each station is a radio transceiver with a carrier frequency usually in the range of about 100 to 400 kc. The radio signal travels from one station to the other along the power lines so no additional wiring is required. In addition to normal applications, such systems are ideal for baby-tending in large homes, apartments and other locations where both stations are on the same side of the power-line distribution transformer.

The model RF1 *Com-ette*, made by Webster Electric, is a typical system consisting of two r.f. transceivers, each using the circuit in Fig. 6. The selector switch is normally in the LISTEN position so the circuit is set up for receiving. Throwing the switch to TALK or DICTATE converts the circuit for transmitting. The switch locks in the uppermost (DICTATE) position so the unit can be used conveniently for dictation or for monitoring sound at a remote point.

The r.f. carrier signal is generated by V1, a 50C5, in a modified Clapp oscillator circuit. The frequency is factory set at 175 kc but it can be varied from 175 to 280 kc with an adjustable slug in oscillator coil L1. When the selector is set to TALK or DICTATE, the speaker serves as a microphone working into the grid of the triode-connected 12AU6 a.f. amplifier. The signal is amplified and fed to the grid of V2, used as a Heising modulator to modulate the plate and screen voltages of V1.

When the selector is set to LISTEN, the incoming signal is tapped off the power line and applied to a germanium diode. The signal is detected and the audio and d.c. components directly coupled to the grid circuit of the 12AU6 audio stage.

A positive voltage is tapped off the B supply and fed to the cathode of V3 through a 39,000-ohm series resistor and the 500,000-ohm squelch control. This control permits the positive bias on the cathode to be varied from about 3 to 24 volts to control the gain of the stage. The control is normally set so V3 is biased to cutoff by the voltage on its cathode. The germanium diode detector is connected directly to the grid of V3 and is connected to develop a positive voltage when a signal is being received. The incoming signal provides sufficient positive bias on the grid to overcome the cutoff bias on the cathode and permit the stage to conduct with normal amplification.

The output of the 12AU6 is amplified by V2 to develop an audio voltage across modulation choke L2. This voltage is tapped off and applied to the output primary winding on the transformer. The 0.47-μf capacitor prevents the plate voltage from being shorted to ground through the transformer. The output level for receiving is set by the 11,000-ohm volume control across the output primary. END

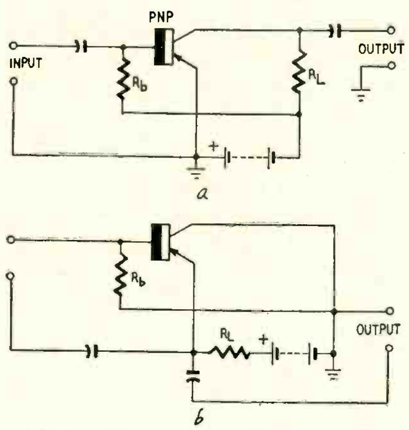


Fig. 4—Basic transistor circuits.

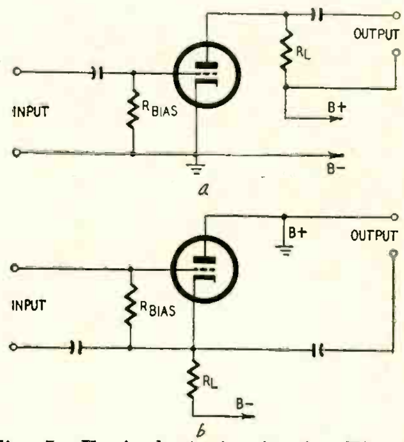


Fig. 5—Equivalent circuits for Fig. 4.

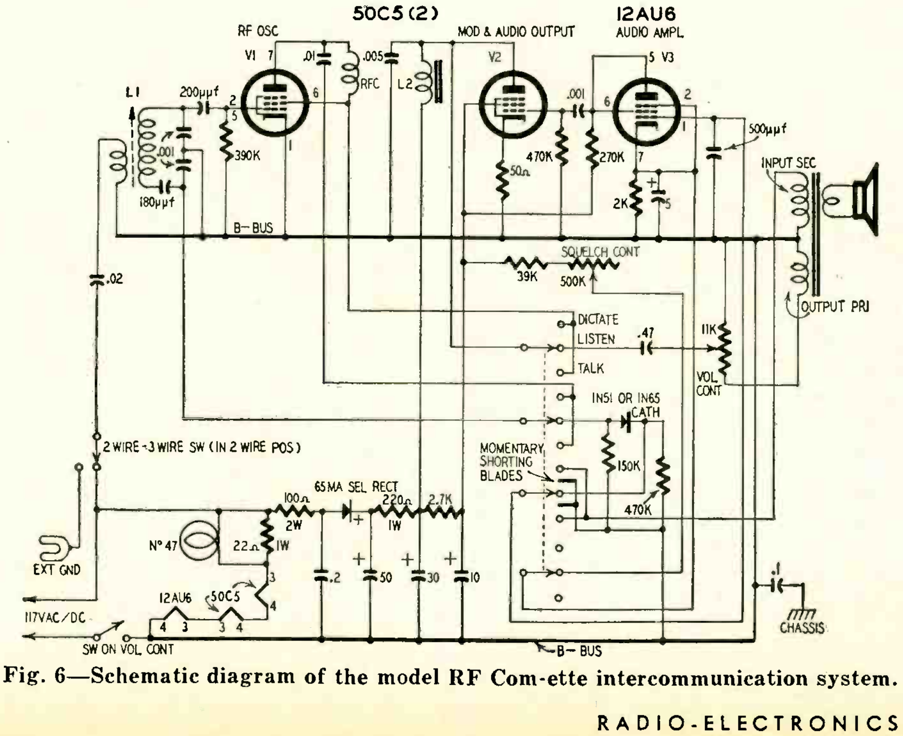
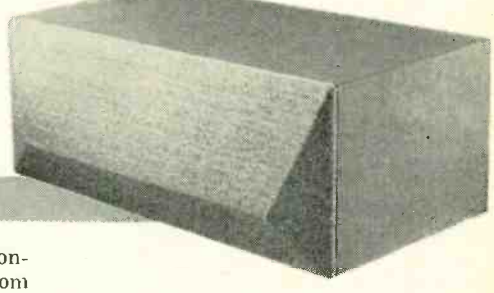


Fig. 6—Schematic diagram of the model RF Com-ette intercommunication system.

FOR GOLDEN EARS ONLY

Ampex stereo system; Pro-Plane Prismatic I speaker system

By MONITOR



Pro-Plane Prismatic I speaker system.

THE Ampex stereo system is the first thoroughly practical complete package compact enough for any home or apartment, simple enough to require no special skill or judgment in installation and capable of providing a dramatically successful demonstration and fulfillment of the realism promised by proponents of stereophonic sound projection.

It consists of two 620 amplifier–loudspeakers and the new 612 tape-playback mechanism. It is complete—nothing but stereo tape is required to provide stereo sound—and available either in three small portable cases (at $694, see photograph below) or in handsome cabinetry (at $699). In either form the system will occupy far less space than any really adequate single-channel hi-fi system.

The 612 tape playback uses the same mechanism employed in the 600 tape recorder but with no provisions for recording. It has a single half-track head for normal tapes and a double half-track head for stereo tapes. A switch provides a choice of either stereo or single-channel operation (even with stereo tapes). In the stereo position each of the two amplifier–loudspeakers is fed independently by one of the half-tracks of the double head. In single-channel operation both amplifier–loudspeakers are operated in parallel with input from the single head for greater output reserve and a wider spreading of the sound source.

The 612 will handle any available 7½-ips single-track, double-track normal tape or *stacked* double-track stereo tapes. It will not handle *staggered* stereo tapes nor 3¾- or 15-ips normal tapes. It plays back NARTB equalized tapes within 2 db from 50 to 12,000 and within 4 db from 30 to 15,000 cycles. The only criticism I have is that the acoustic noise from the motor and drive is rather high with the result that—unless the 612 is placed out of hearing range or covered—the noise ratio at low listening levels in a quiet room is a good bit higher than with good disc playback equipment. The 612 can be purchased separately for use with conventional hi-fi systems or for custom stereo installations.

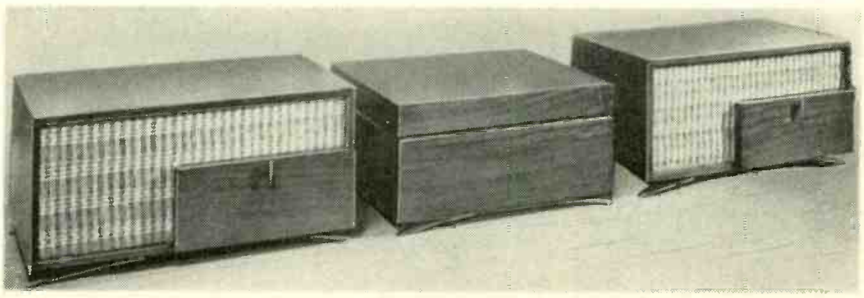
To summarize my evaluation of 620 amplifier–loudspeaker in the October, 1955, issue: Although not in the same class as the best space-is-no-object systems, it provides possibly the highest fidelity per cubic inch of space occupied and an overall quality which satisfies high-fidelity standards and musical needs.

The system delivers a genuine stereophonic effect with the best tapes, in rooms ranging in size from 10 x 12 to 14 x 25 feet. The illusion is very high that the orchestra is in the same room, and with most tapes, that some instruments are on the left, some on the right and others in the middle. Furthermore, adjusted and positioned properly, the stereo effect is fairly independent of the position of the listener. It is not necessary to sit rigidly in one critical spot as has been the case with many previous improvisations; within an angle of about 45° on each side of center the stereo effect is maintained to a degree which depends on the tape itself. The system offers no problems either in installation or adjustment. Anybody who can follow simple instructions should have no trouble achieving good results.

The Ampex demonstration tape provides three modes of sound: 1. single channel with a single sound source; 2. single channel with two spaced sound sources; 3. genuine stereophonic. The demonstration is convincing. Mode 2 is much better than mode 1; but mode 3 is far more spectacular than mode 2. The difference is so marked that the most unsophisticated ear discerns it immediately.

In the specific quality of presence—the capacity for creating the illusion that the orchestra is in the same room with the listener—the Ampex system was greatly superior with most tapes to my own reference system which consists of a 50-watt amplifier feeding $300 worth of speakers in a wall. However, as might be expected, my own system was superior in the awesomeness of the bass, the definition and overall faithfulness of tonal quality. I imagine the same comparison will hold, both ways, for other top-quality combinations of amplifiers and loudspeakers.

Though the Ampex system is meant to be used as a complete system and it is much easier to obtain fine effects when it is installed complete, owners of fine single-channel systems may add a single 620 and 612. I would not recommend mixing the Ampex with other components unless one already has a good system on hand. The use of dissimilar channels requires more care, trouble and skill in adjustment.



Three-section Ampex stereo system.

However, the 620 is small enough so that in almost any room it should be possible to find a position in respect to the present speaker system which yields a good stereo effect.

Connect the left output of the 612 to the big speaker system, the right to the Ampex. In most tapes the left channel carries the heavier bass and will benefit most from a better speaker system. It will be more difficult to balance the system because the differences in tonal balance of dissimilar systems modifies the stereo effect; but once a workable combination of volume and tone controls is found, it will hold for most tapes.

Such a combination will have some idiosyncracies that the Ampex system complete will not have. For one thing, the "tonal polarity" is not the same on all tapes; occasionally some will be found with the bass on the right and, rarely, you'll come upon a tape with several selections in which the polarity will shift from one selection to another. For another, the difference in tonal quality will occasionally produce strange effects. For example, tympani and drums may be doubled—the big speakers will have one pair of tympani in a natural fundamental register, the Ampex will appear to radiate another pair tuned one octave higher. There will be some confusion between cellos and double basses and occasionally the double basses will appear to turn into cellos or play in the cello range. But on the whole the result, in my case, was an even more spectacular stereo effect than with the two 620's and far more spectacular than with the single-channel system alone. In fact, I obtained far better stereo this way than in any combination of two big speaker systems I tried to assemble. I'm pretty confident that those who want to try adding the 612 and a single 620 to their present systems take only a small risk of failure.

Having thus possibly whetted the appetite for stereo I think I have the responsibility of pointing out to those who have not experienced stereo sound that it has faults as well as virtues and not everybody will be happier with it than with a single-channel system. Some people, for example, will find the directional effects highly distracting to an enjoyment of music. A few who have heard my installation have complained of fatigue, possibly because the ear was not accustomed to the work of dealing with the additional stimuli (and quite possibly because the room acoustics were not correct).

Furthermore, to obtain the sense of directionality, the miking is close-up and when played back *in the home* the listening perspective is very likely to be that of the first two or three rows in the auditorium and, in a small room, even in the middle of the orchestra. This perspective will not seem as real and satisfactory to some as to others. Also, stereo recording is still in its infancy and produces some startling and even ridiculous effects (see New Records, page 102). Finally, some people will question whether stereo reproduction is in fact any more three-dimensional than a superb single-channel system. Though stereo does spread the orchestra out from right to left, it seems in most cases to do this at the expense of depth. With most tapes the orchestra seems to be stretched out in a single row. However, though even the best single-channel system does not spread the orchestra out much horizontally, it is capable of a notable distribution in depth — as if one were listening to the orchestra from one end instead of the front.

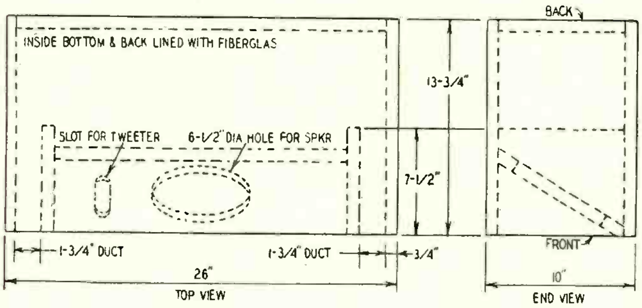


Diagram shows the construction of Pro-Plane Prismatic I enclosure.

Pro-Plane Prismatic I speaker system

The box enclosing the Prismatic I (see photo on page 57) is 26 inches long, 10½ high and 14 deep (a little more than 2.5 cubic feet in outside volume); the net price is $79.50. Though this places it in the category of small, compact and inexpensive systems, its performance will stand comparison with very much larger and costlier ones. For example, the deep pedals in Cook's *Organ in Symphony Hall*, which even on some very big systems tend to sound rather like a pair of pants flapping on a clothesline in a stiff wind, come through nicely and with enough floor vibration to provide an excellent verisimilitude to live sound. Again, the very big, low but soft drum in the Vanguard recordings of the Strauss music, which disappears entirely on many systems, is audible, albeit it sounds as if the diaphragm had been tightened. It does a job on all the percussion records in my collection — which should make both the designer and the owner proud. Even *Thunderstorm* and *Earthquake* are impressive. In other words, the system not only does not produce any significant loss of musical values, but the loss in awesomeness over very large systems is so small that most people will need an A–B comparison to be aware it exists at all.

Efficient bass enclosures often seem to put a hole in the mid-range because of the relatively higher output in the bass end but here the tonal balance is very good to my ears. Although a single speaker is used, the high-end response is excellent to 15,000 cycles; I did not note any particular coloration of the highs, which seemed very pleasant.

The speaker is mounted at an angle so that the highs are directed upward from the floor. Possibly the most distinguishing quality is the unusual dispersion of sound or widening of sound source which results in far less "hole-in-the-wall-effect" than most speaker systems yield. This widening is somewhat comparable to the widening of a light source by a prism; hence the name Prismatic.

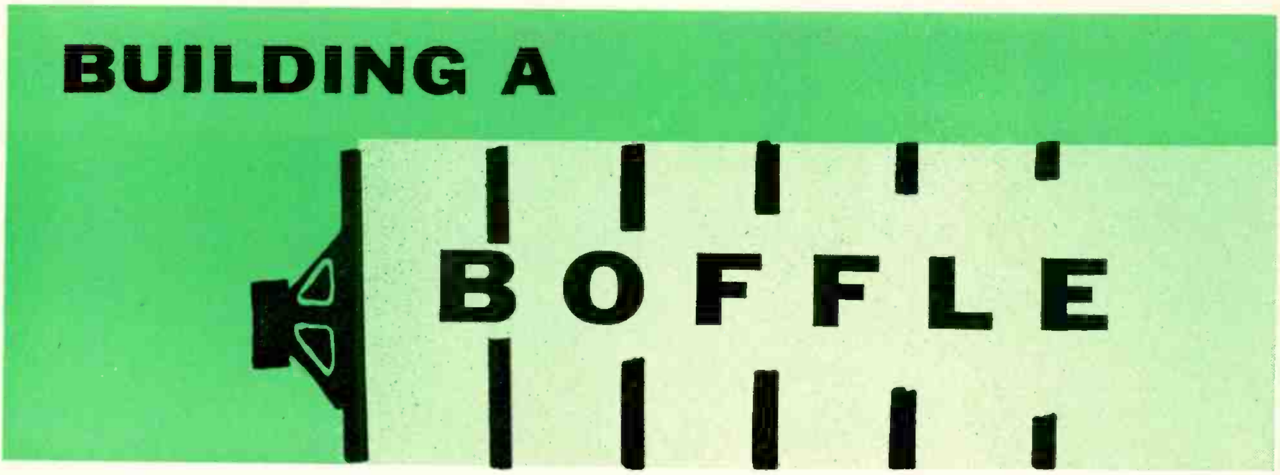
The efficiency is very good. Electrical inputs of from 10 to 50 mw average and 150 to 500 mw in peaks will yield a plenty loud sound in even a big living room. The system does not entirely eliminate a trace of the ringing characteristic of bass-reflex systems (though I think that only an experienced and critical ear will notice it) and it produces no significant degradation of quality or transient response which is excellent.

There are some commendable novelties which deserve copying. For one, all production models are "polarized" and polarized the same way so that, if the connection from a voice coil is made to the same terminals on two or more Prismatics, they will all be in phase. Also, the cone will move forward if the positive side of the line is applied to the right terminal facing the back of the cabinet. Third, every individual system is tuned to take up tolerances in individual speakers and enclosures and to produce specified performance not only by instrument but a good sound to the ear. (Anthony Doschek, the designer, is a well known violinist who has played with the Chicago and Pittsburgh symphonies, as well as a competent engineer; he maintains that mere engineering or normal quality control is no more capable of producing a really fine speaker than it has proved capable of duplicating a Stradivarius.)

The housewife will undoubtedly like the fact that the entire grille can be removed without tools in a few seconds and the grille cloth, which is fine drapery fabric, can be sent to the cleaners for refurbishing. The enclosure, though small, is heavy because it is made of ¾-inch marine plywood and rigidly put together to avoid mechanical vibration. The finish is Formica in a choice of five "wood" finishes.

Pro-Plane also has a Prismatic II which is twice as large, uses two Axiettes, delivers about 3 db more bass with about ½ octave more of range and takes high inputs with less strain. It sells for $119.50. END

BUILDING A BOFFLE



By H. A. HARTLEY*

THE speaker housing to be described here is not a stunt, not an attempt to have something different for difference's sake. I produced its prototype many years ago and since then it has been developed and improved. It was an attempt to solve the problem of how to house a high-fidelity speaker so that the sound coming from the speaker was still hi-fi; it did not owe allegiance to any preconceived idea of what constituted a high-fidelity housing but was developed out of a reasonably good knowledge of how acoustical materials behave. Many types of housing have been produced since then but I still like it best, not because I thought of it, but because I find it adds no coloration to the reproduction.

The odd name means simply "box-baffle" shortened to one word. It is a box baffle. And if the picture suggests that it is rather too boxy-looking for the average living room, remember that it can be of almost any shape and dressed up how you like it; what matters is the arrangement of components inside the box. As the mathematical analysis is extremely difficult, I shall try to give the argument without recourse to what the scientist would call a rigorous proof.

For adequate bass response, the sound waves from the back of a speaker diaphragm must be separated from those coming from the front because they are in exact opposite phase and if merged would cancel. In the higher frequencies this cancellation does not occur as the wavelengths of the higher frequencies are not appreciable compared with the size of the speaker diaphragm. At low frequencies, however, the wavelength can be several feet, so some device must be used to separate the front radiation from the back; such a device is called a baffle.

*H. A. Hartley Co., Inc.

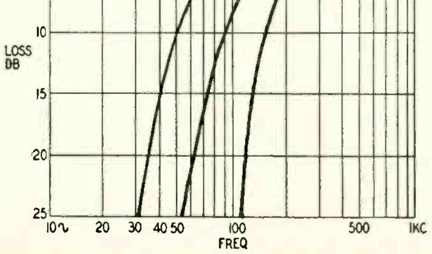


Fig. 1—Bass loss with finite baffles.

The bass response is a function of the baffle size and Fig. 1 shows the bass cutoff in db for different sizes of baffle. Since the important dimension is the shortest distance from the front to the back of the speaker diaphragm, the most economical baffle, in terms of consumption of material, is a circle. However baffles are usually cut from lumber; cutting circles means wasted material and circles are difficult things to handle. Thus, the most convenient shape for a baffle is square, and Fig. 1 gives the sizes of the sides of squares for the results desired. That part of the baffle outside a circle of equal diameter contributes nothing to the performance and may even detract from it.

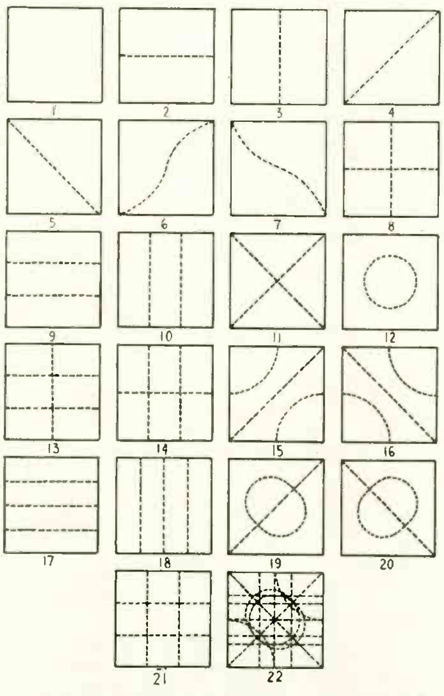


Fig. 2—Nodal lines in a baffle. 1 indicates fundamental with no node; 2–7, second-harmonic nodes; 8, third; 9–12 fourth; 13–16, fifth; 17–20, sixth; 21, seventh; 22, second to seventh harmonics.

When a speaker is mounted in the exact center of a square baffle, interference sets up irregularities in the response so there has grown up a tradition that speakers should be mounted off-center. This removes some of the irregularities, but the moment the speaker is removed from the center of the square the effective baffle size is reduced since the shortest path is still the effective baffle size. Moreover, a flat-fronted speaker baffle can cause distortion of the forward radiation of the speaker because the frontal sound waves are hemispherical and impinge on the front of the baffle as well as on the air in front of the speaker. These wavelets (a convenient term for part of a hemispherical wavefront) are reflected from the baffle in a forward direction, out of phase with the direct radiation thus causing distortion.

It is desirable, therefore, to break up the flat front of the baffle by bending it into a three-dimensional form such as a box, preferably with the front edges and corners heavily chamfered. The ideal form to avoid out-of-phase re-radiation is the sphere. But apart from the difficulty of making a sphere there is the problem of getting the speaker into it. However, the sphere introduces the notion of a completely enclosed speaker housing (and a housing *is* a baffle).

Before considering boxes, open or closed, another property of the flat baffle must be considered. An infinitely rigid baffle would have no resonance of its own, but practical baffles can and do vibrate. Their natural resonant frequency is determined by their size, whether they are free-edge or solidly framed. Their resonant frequency is also a function of their stiffness, as can be seen in the analogy of the tympani of an orchestra, which can be *tuned* by tightening or slackening the membranes. An untunable drum, such as the big drum of a brass band, emits a fundamental frequency determined by the size of the skin and its predetermined degree of tightness; plus a range of harmonics controlled by the type of drumstick, the depth of the drum and whether it is single- or double-ended. A drum with two skins is analogous to a closed speaker housing.

The magnitude of the harmonics depends on the force with which the membrane has been hit. By the same argument the flexing of a speaker baffle is a function of the power applied to it by the power fed into the speaker. Harmonics of the natural fundamental resonant frequency of the baffle develop along nodal lines in the baffle (Fig. 2). If the fundamental is 60 cycles the second harmonic is 120, the third 180 and so on. The baffle would node something like the last sketch in the figure with all harmonics present up to the seventh — a nasty sight. If the flat baffle is formed into a cubical box, the front and all the side will node in a somewhat similar manner for each of the elements of the box is itself a membrane. The front, however, is fixed on four edges, the four sides on three edges. If the box is a closed box, all six membranes are fixed on four edges. The nodal patterns will be identical in all six sides with a closed box, but with an open box the four sides will equal each other but differ from the nodes of the front. How much effect this can have on smoothing the overall response is almost impossible to estimate; a rectangular box will give different nodal patterns for front, top and bottom and sides.

Assuming, now, the desirability of having a box rather than a flat baffle, both for acoustic and convenience reasons, what sort of box is best? Bafflewise, the equivalent size of a box is again the shortest possible path from the front of the speaker to the back, if the back is open. If the back is closed, the box will form, in theory at any rate, an infinite baffle. But there is a very big difference between this sort of infinite baffle and a real infinite baffle such as the wall of a room with a hole in it. The box must be a complete insulator against sound of any frequency and magnitude and it must impose no restraint on the speaker mounted in it. Moreover, the interior of the box must not reflect a sound wave of any frequency, otherwise curious effects on speaker performance will be noticed. It does not require much thought to suggest that a box having such desirable properties would be extremely difficult to make within reasonable dimensions. There is a further serious snag.

The air contained within the box is compressible but it is also elastic. If the diaphragm of the speaker moves backward, the air within the box will be compressed and will tend to resume its natural volume by pushing the cone forward. If the cone moves forward, the air will be rarefied and will try to resume its normal volume by sucking the cone back. It might be thought that the cone movement is so small that this could be ignored, but practical tests prove that it cannot. The effect of mounting a speaker in a closed box is to raise its natural resonant frequency because the springiness of the air is added to that of the cone suspension, and the bigger the cone the greater the effective raising of the resonant frequency of the speaker.

Further drawbacks are that, first, the air contained within the box has its own natural resonant frequency, usually called "air-column resonance," which will be added to the acoustic output of the speaker as one-note coloration; second, the sound waves reflected from the internal sides of the box will create a complex pattern of speaker loading that still further causes deterioration of the speaker output. Lining the box with sound-absorbing material cannot possibly damp low-frequency reflected waves because, in a practical layout, the material is too thin for the long wavelength of low-frequency sound waves; such lining will only damp out high frequencies. And no lining can kill air-column resonance, for so long as there is unimpeded air inside the box it will resonate at its own frequency.

A more popular type box housing is the phase-inverter or bass-reflex cabinet. In this the resonant frequency of the air column should be exactly the same as the bass resonant frequency of the speaker. The effect will be to neutralize the excessive output of the speaker at its resonant frequency by imposing a load on the speaker movement. If the speaker one wishes to use has a well-marked bass resonance, a carefully designed bass-reflex housing will make it sound much better and increase the power-handling capacity of the speaker at low frequencies. But no internal padding will prevent internal low-frequency reflected waves, nor, in either a completely closed box or a bass-reflex housing, will noding of the cabinet sides be prevented without extremely rigid panels and construction. Good speaker housings of conventional designs are heavy, some even being sand-filled for rigidity; reinforced concrete is even better.

Construction of the Boffle

Electrical filters are made up from resistance, inductance and capacitance. Mechanical filters (acoustics is a form of mechanics) consist of masses, springs and friction. The acoustic filter is encountered whenever sound-absorbing treatment is applied to any surface, for sound is absorbed by a combination of springiness of the material used (a hard surface reflects sound almost completely) and the friction in penetrating the material. There is no particular difficulty in absorbing high frequencies, owing to the short wavelengths involved, but, as already has been pointed out, low frequencies have long wavelengths.

It occurred to me that the inside of a box containing a speaker could be made nonresonant by hanging screens of soft material across the box, acting as springs to check the passage of the sound waves. However, if the screens were not perforated the first screen would be subject to severe stresses since the whole wavefront would impinge on the screen and stretch it beyond its limit of elasticity, making it useless after the first impact. Accordingly, I cut a large hole in the first screen, sufficient to clear the speaker chassis, and then added a second screen with a smaller hole, a third with a still smaller hole and so on. This produced a graded filter. And as the absorption of the long waves through the filter was also increased by steps, the successively smaller holes lined up and the air pressure lessened with each step.

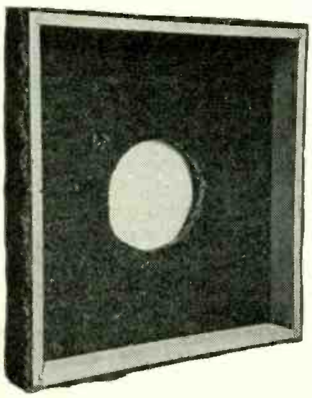


Fig. 3—A single screen on its frame.

Fig. 4—Frames and screens stacked.

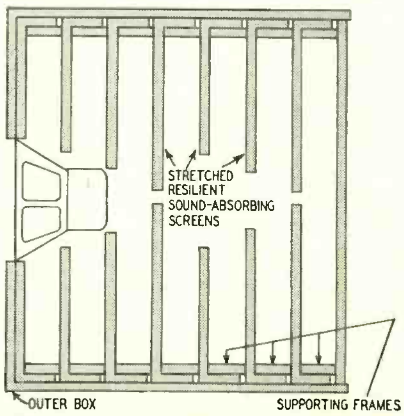


Fig. 5—Cross-section of the Boffle.

That these screens do what is intended was proved by my earlier models which had screens made from upholsterer's wadding (industrial cotton wool) stretched across wooden frames. After some use the layers of cotton in each screen gradually separated so that the whole interior of the box became full of "exploded" cotton; the energy of the sound waves was truly absorbed by the cotton screens. However, this interfered with the notion of graded filters with intervening air spaces, and a change was made to the kind of felt used underneath carpets. This material is convenient to use and, being felted on a burlap core, does not lose its shape. Compressed felt is not suitable, having insufficient springiness, and fortunately the uncompressed variety is also the cheapest. A nominal thickness of ⅜ inch is about right.

Fig. 3 shows a single screen made up ready to slide into the box. The lumber frame is made from 2 x ½-inch *unplaned* stuff. The frame is shown notched to prevent slipping (the joints need not be glued), but the joints could be nailed. The felt is cut 2 inches larger all round the frame and tacked into place as shown, a square 2 x 2-inch piece being taken out of each corner to avoid overlapping. The sizes of the holes depend on the size of the speaker chassis, for the first frame must just clear the largest diameter so that it presses hard against the inside of the front of the box. The taper of the successive holes is not critical and Fig. 4, which shows a stack of five frames, gives a good idea of the sort of gradation wanted. The frames in this photograph were 17 inches overall.

Fig. 5 shows a cross-section of a complete Boffle with all frames in place. There are two complete tapered filters and the rearmost screen, which has no hole, is tacked to the back of the last frame, the felt being cut the same size as the frame. The depth from front to back should never be less than 15 inches and can, with advantage, be as much as 24 inches — the deeper the Boffle the better the bass response because of greater absorption. The back is not closed solidly since complete absorption of the lowest frequencies is not aimed at. What comes out of the back is so attenuated that it does not interfere with the performance of the speaker. But if that little were trapped inside the box by a solid back, there would be deterioration of response.

The outer box is best made from laminated board not less than ½ inch thick. It should be strong at the joints since the felt on the frames is jammed tight at the corners and exerts a pressure all over the sides of the box so as to damp out nodes. Fig. 6 shows the first frame in place hard against the back of the front of the box and the speaker leads left trailing. These should be passed through the hole of frame 2 but then taken down to the bottom of the box and trapped between the frames and box. This is shown in Fig. 7 which also shows six frames in place, the five of Fig. 4 and the first of the second filter. Figs. 6 and 7 show a box which is an 18-inch cube, so there are eight frames and nine screens (the last being tacked to frame 8 and without a hole); the box of Fig. 5 was only 15 inches deep so there is room for only seven frames and eight screens.

It is becoming widely appreciated that it is better to us two or more small speakers than one large one. Large speaker cones are heavy and do not respond well to transients; they are much more liable to node and lose output at low frequencies and they seem to have an inborn tendency to "hoot" at a fixed frequency, possibly due to air-column resonance within the cone angle. A single Boffle can contain two or more speakers with a tapered series of holes for each speaker; separate frames are unnecessary.

A popular size of speaker housing is about 18 x 30 inches and this is about right for two identical speakers arranged in a vertical pair. The frames for such a cabinet would be about 17 x 29 inches and unless made of strong lumber might sag in the longer sides. But this can be avoided by inserting an intermediate strut in each frame, thus virtually giving each speaker its own "sub-Boffle." Fig. 8 shows a finished Boffle with four identical speaker units connected in series-parallel. There was enough room to provide for strong frames and each screen is a sheet of felt pierced with four holes, each centered on a speaker. Intermediate supports were not needed.

The Boffle system can be applied to any rectangular container, whatever the size and proportions. Its basic advantages are complete elimination of air resonance within the enclosure, substantial reduction of resonances and nodes within the material of the cabinet itself, noninterference with the performance of the speaker, substantial increase in effective baffle size as compared with an empty box. It is *inert;* it adds nothing, takes nothing away. And by virtue of that it does nothing to reduce the bass resonance of the speaker.

I confess that it was originally produced to house my own speakers, which do not have a bass resonance, so on the face of it the Boffle may not seem a very good proposition for a more conventional speaker as compared with a bass-reflex housing. I say "on the face of it," but I think that speakers are frequently not given a square deal in the way they are housed. I believe it is fundamentally wrong to view the speaker in its housing as a cute combination of resonating systems for the speaker should be an impersonal undistorting entity, having no defects of any sort.

It is not an easy matter to design a speaker without a bass resonance. The way to overcome that disability is to introduce a trap filter in the amplifier to attenuate, sharply, the frequency at which the speaker resonates so that the ultimate acoustic output from the speaker is level for a level input to the amplifier. A trap circuit can be designed with absolute precision whereas a bass-reflex cabinet is at best an approximation only, since one is dealing with parameters that cannot be measured with precision. I have used such circuits in conjunction with conventional speakers housed in Boffles and achieved far better reproduction than was possible from the same speakers in a resonating housing such as a reflex cabinet. It seems to me that first we must have a level response from the speaker, then place it in an aperiodic housing. The Boffle is such a housing and its use will clean up the performance of any decently designed speaker at low cost and with very little trouble.

Note: Proprietary rights in the Boffle are vested in the author who has indicated that he raises no objection to readers constructing Boffles for their own personal use. Commercial exploitation rights are strictly reserved. END

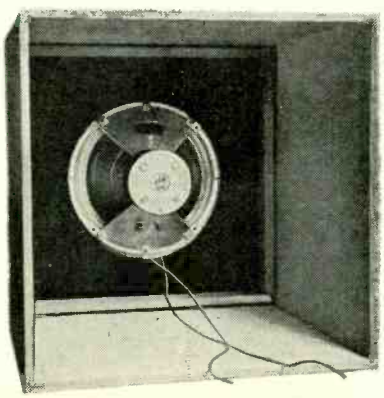


Fig. 6—The first frame and screen.

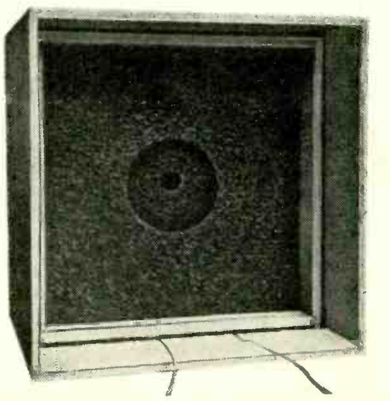


Fig. 7—Frames and screens in place.

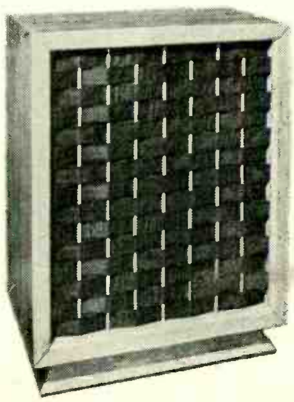


Fig. 8—"Grand" Boffle for two, three or four Hartley nonresonant speakers.

RAILROAD RADIO'S FIRST DECADE

The past 10 years have seen an amazing expansion in the use of radio communications by the nation's railroads

By LEO G. SANDS

Courtesy Northern Pacific Ry.

Courtesy RCA

Above—engineer awaits go-ahead signal via radio—antenna is above locomotive. Right—a portable two-way radio used by car inspectors and flagmen.

SAVINGS in operating costs of more than $100,000,000 annually are being realized by the American railroads through improved communications. This statement—recently made by Richard G. May, vice president of the Association of American Railroads—was the first public announcement by the railroads placing a dollar value on communications. It had been generally acknowledged that radio, sound systems and expanded wire line communications were helping railroads operate more efficiently but no estimate as to the number of dollars saved had been made.

The latest available figures indicate that 145 railroads have been authorized to install and operate 16,792 radio and inductive-carrier transmitters serving over 46,000 miles of road bed.

The total railway mileage in the United States exceeds 220,000. American railroads operate over 35,000 locomotives and approximately 25,000 cabooses. Approximately 70,000 radio units will be required to equip all trains and right of way completely with radio communications facilities.

More radio stations have been authorized than have been installed; it is estimated that about 10,000 are in actual service. The authorizations include stations not only on locomotives and cabooses, at wayside points and yard offices, but also on maintenance equipment, trucks and automobiles. The railroads operate thousands of highway and materials-handling vehicles so the overall potential is far in excess of 70,000 radio units.

Therefore, less than 10% of the nation's railroad radio requirements have been fulfilled almost 10 years after the introduction of v.h.f. radio for such applications. Notwithstanding, the recent activity in railroad radio is gratifying to those in the industry. The number of authorizations has doubled during the past 2 years.

The saturation point is far off. In fact, it will never be reached because the replacement market will continue. Some of equipment installed shortly after the end of the war is already being replaced. Obsolescence and rising maintenance cost of old equipment will create a demand for newer facilities.

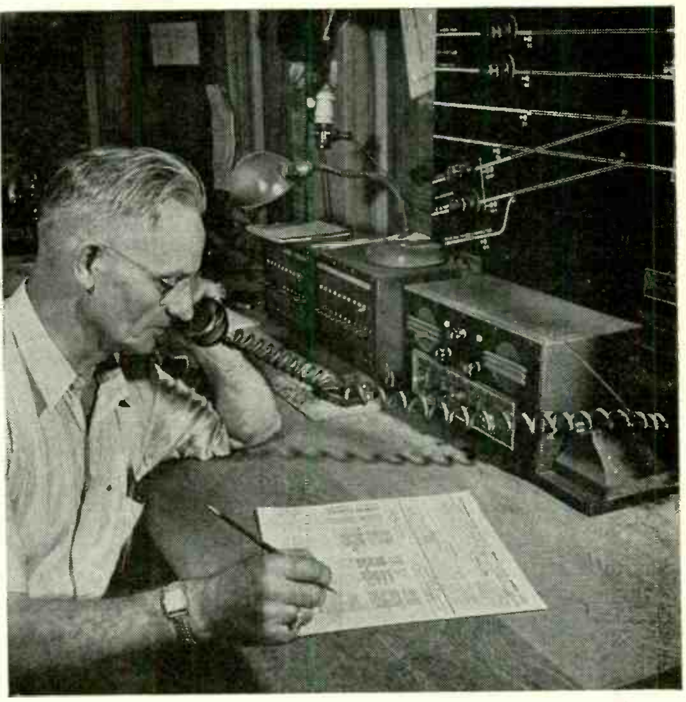
The first permanent railroad radio systems were installed in classification yards where their economic advantages were most apparent. Today, the emphasis is on main lines where the movement of freight can be handled much more efficiently with rapid communications. Approximately 75% of new installations are for road use.

Equipping trains with radio is not a new idea. Way back in 1914 the Delaware, Lackawanna & Western Railroad experimented with spark transmitters to determine the practicability of communicating between wayside points and moving trains. In 1936 RCA worked with the Pennsylvania Railroad on caboose-to-engine communication.

Ten years ago, v.h.f. radio in the 152–162-mc band was tried out in railroad applications and was found to be very satisfactory. The low power requirements, short antenna length, freedom from noise, limited and controllable range and multiple reflection characteristics combine to make v.h.f. ideal.

The military SCR-522 v.h.f. transmitter–receiver unit designed for airborne applications was modified and pressed into service in experimental installations. When it had been determined by field tests that v.h.f. was the answer, several manufacturers designed and started building two-way equipment for railroad applications. One of the earliest units used AM and provided excellent performance but was abandoned in favor of an FM unit because of the popular demand at that time for frequency-modulated systems.

The first permanent railroad radio authorizations were granted by the FCC



Above—Communications system in caboose.

Right — Railroad way-station operator talks via inductive carrier communications system with the crew of a train.

to the Denver & Rio Grande Western Railroad and the Baltimore & Ohio Railroad. These were followed shortly by grants to others, including the Santa Fe System; Burlington Lines; Milwaukee Road; Elgin; Joliet & Eastern; Gulf Mobile & Ohio; Central of Georgia; Northern Pacific; Seaboard Air Line and the Delaware, Lackawanna & Western Railroad.

In 1945 the Baltimore & Ohio Railroad conducted tests between Baltimore and Washington to determine the practicability of using radio communications between wayside stations and fast trains in areas of high traffic. The following year the Seaboard Air Line Railroad tried v.h.f. radio for point-to-train communication between Atlanta and Birmingham. It was found that a portable walkie-talkie with less than 1/10 watt r.f. power output operated inside of a steel railroad coach provided excellent communication with a fixed station 8 miles away. However, this does not mean that the low-power unit will provide such excellent range under other than freak or ideal conditions.

Several manufacturers spent considerable time and money during the early years of railroad radio in developing suitable special equipment and demonstrating that radio was a reliable means of train communication and that its economic advantages were worthy of consideration.

Its wide-scale application did not occur immediately and for very justifiable reasons. The railroads first had to be convinced that radio could be justified economically in the face of long-established operating and labor policies. Secondly, they had to be assured that the equipment would perform adequately with reasonable maintenance and that the manufacturer would remain in the railroad radio business on a permanent basis to stand by his equipment. The railroads listened and watched several companies enter and leave the field.

By 1949, railroad radio was expanding on a serious basis. The Chicago, South Shore & South Bend Railroad installed radio along its entire main line, permitting headquarters personnel to contact all freight train crews and maintenance personnel instantly. The Erie Railroad has since equipped its entire main line from Chicago to Jersey City with radio facilities. The Pennsylvania Railroad has installed a widespread inductive radio system and the Great Northern is in the process of extending radio along hundreds of miles of main line in the prairie and mountain areas it serves. The list of systems now in service is impressive.

Railroad equipment

To meet operating requirements the equipment in a locomotive may have to operate on two or three channels which are selected by a switch on the control box. One channel may be for communicating with yard offices, a second for contacting the dispatcher or wayside operators and a third for caboose-to-engine and train-to-train communications. In cabooses, two channels usually suffice, one for caboose-to-engine and one for point-to-train and train-to-train contacts.

Yard systems generally use a single base radio station operated from a remote control point and one or more dispatch points all interconnected by wire lines. Where range requirements are short, and they generally are in yard service, individual portable stations like the RCA CTR-1A may be installed permanently or temporarily as required on the desks of yard masters, clerks and other supervisors. Each portable unit is independently operated. Wire lines are not required and individual base stations may communicate with each other as well as with engine crews.

On the main line and on branches, radio stations are being installed by many railroads for providing contact with the crews of moving trains and for emergency point-to-point communication between base stations.

These base stations may be operated independently by personnel at these points. In some instances, they are linked together by wire lines to permit remote control from the dispatcher's office at hours when the base stations are unattended. Special devices permit the dispatcher to select individual wayside base stations. The already heavily loaded dispatcher's telephone line is often used for interconnecting base stations, using step type selective devices for cutting in as desired.

New equipment and techniques are being developed to permit remote control of wayside base radio stations without additional loading on the dispatcher's selective ringing system. Wire line carrier current equipment may be used for deriving a radio control channel independent of the busy dispatcher's line. In the future, microwave relay systems will be used for controlling wayside stations.

Wayside stations may operate on one channel so all concerned may listen to all train conversations within range. However, where traffic is fairly heavy, a two-channel system is often specified, one channel for point-to-train talking.

Should wire lines fail, wayside base radio stations may be pressed into service for point-to-point communications. Facilities can be provided for remote control of the base stations nearest each end of the line break.

All railroad radio systems in the United States, with the exception of the inductive setups, operate in the 152–162-mc band where 39 channels have been assigned to such service. Several additional channels are available in the 450–460-mc band and it is anticipated that the railroads will soon start

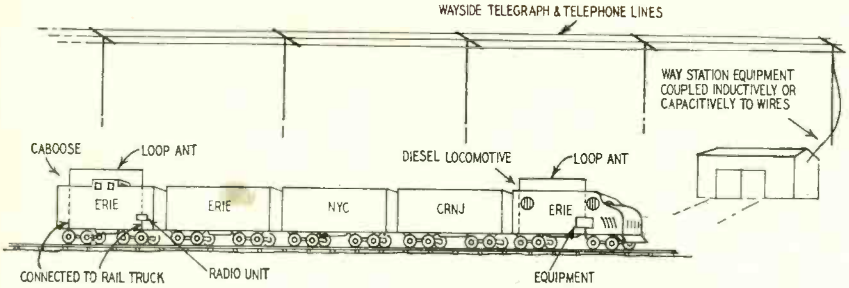


Fig. 1—The layout of an inductive-carrier train communications system.

making use of these before some other services attempt to pressure the Government into taking them away from the railroads because of nonuse.

Railroad mobile radio units are available in two distinct types: single-package sets and three-package combinations. In the single-package type, the transmitter, receiver and power supply chassis are bolted together and enclosed in a single metal cabinet. The three-package combinations consist of a separate transmitter, receiver and power supply in individual drawer type enclosures.

FM is universally used. Transmitters and receivers are fixed-tuned and crystal-controlled. Transmitter power output ratings run from 10 to 30 watts although 60-watt units are available. Receiver sensitivity is in the order of 1 microvolt for 20 db of quieting.

Inductive-carrier train communications systems (Fig. 1) which operate on frequencies between 75 and 200 kc depend upon wayside telephone wire lines to act as conveyors of the signal. Wayside stations are directly coupled to the wire lines whereas mobile units are coupled inductively (the transmitter feeds current into the rails, inductively energizing nearby wire lines). A large loop antenna is generally used on cabooses and locomotives.

The main advantage of inductive-carrier systems is their extended range far in excess of that obtainable with v.h.f. systems. However, inductive-carrier mobile units require more power than v.h.f. radio and are more costly.

More than 90% of train and yard engine communications stations use v.h.f. radio; inductive carrier accounts for less than 10%. Both systems provide excellent communications.

Most diesel-electric locomotives have 64-volt storage batteries kept charged by an auxiliary generator. Some, however, use 32- or 110-volt batteries. Radio equipment in a diesel locomotive is powered by the battery and installed in a shock-mounted rack in the nose of the locomotive, under a seat or in the engine compartment, depending upon the type of locomotive or the preference of the railroad. The available d.c. is converted to a.c. by a vibrator type inverter, rotary converter or motor generator set. Most radio equipment (Fig. 2) used in locomotives is designed to operate from an a.c. source although one manufacturer has introduced a unit with a vibrator type power supply for operation directly from a 64-volt battery source.

Two types of axle-driven generators are widely used: d.c. generators and a.c. generators with rectifiers. The d.c. generator is a standard device widely used in passenger-car service. The alternator–rectifier system is newer and popular in caboose applications. It consists of an alternator with a rotating field which supplies three-phase a.c. to

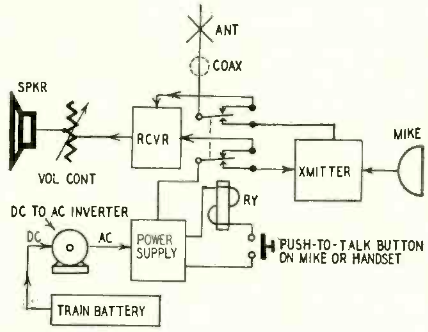


Fig. 2—Basic requirements for locomotive or caboose communications.

a selenium rectifier which in turn furnishes d.c. to the battery and the load. The use of air-driven generators for battery charging and powering radio equipment has been tried by the Rock Island Lines. Air is obtained from the brake system with safety devices preventing brake trouble.

The caboose presents a problem because it is seldom provided with an electrical system. Thus, when installing radio, it is necessary to provide electric power. Internal combustion engine driven generators were tried but most have been discarded in favor of axle-driven generator and battery systems.

Cabooses are being equipped with 12- or 32-volt electrical systems. A few have been fitted with 6-volt battery systems but the slightly increased cost and operating advantages of 12-volt setups have caused most railroads to specify the higher voltage. A caboose electrical system is similar to that of a conventional passenger coach. A generator is driven by the car axle through a belt drive system.

A 12-volt system is generally used when only the radio equipment and a minimum, if any, of lights are to be operated. When the load requirements are greater, 32-volt systems are more desirable in caboose applications.

With a 12-volt electrical system, the radio equipment used usually operates directly from a 12-volt d.c. source. When 32-volts d.c. is available, an inverter is generally used with a.c.-operated radio equipment.

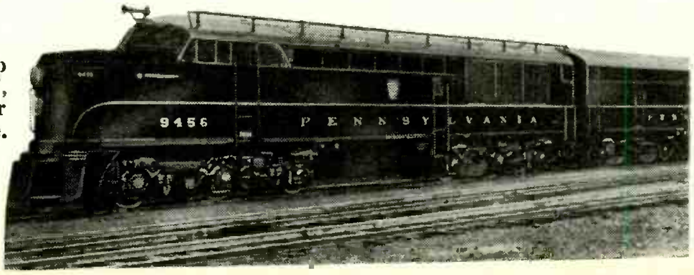
Portable pack sets are being used in cabooses in lieu of regular heavy-duty railroad radio equipment to avoid the installation of electrical power systems. The conductor may call the engineer with his pack set but, because of short battery life, he does not monitor transmissions from the locomotive. Furthermore, pack sets in cabooses will not permit wayside stations to call the conductor directly. Instead, the engineer is usually alerted by radio and by whistle or other signals the conductor is notified to turn on his radio. When trains are more than a mile long, whistle signals are sometimes inadequate.

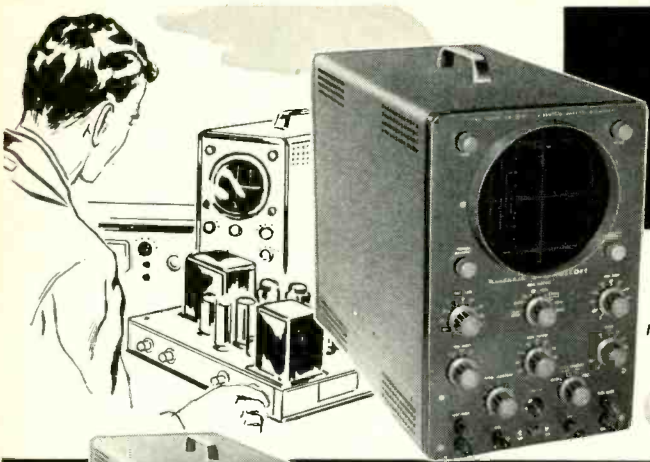
The antenna used on a locomotive or caboose may be a simple quarter-wave whip about 18 inches long or a sturdy, electrically shortened one designed specifically for limited clearances.

A loudspeaker, handset and control unit are installed in the locomotive cab convenient to the engineer, fireman or both. In the case of multiple-unit locomotives with a cab at each end, it is customary to equip both cabs with complete, independent systems. However, some roads install control equipment in each cab with a common radio unit for both. This requires cabling and interconnecting devices between locomotives. Failure to disconnect the connectors when uncoupling locomotive units has resulted in damage and when the units are separated and used in other combinations, one or both cabs may be left without radio.

The railroads have gained considerable experience in the use of radio and even faster expansion can be expected. Labor no longer looks upon radio as a job snatcher. Instead, it finds that jobs are more comfortable and secure because radio saves steps and places the employer in a better competitive position which means more jobs. END

Transmitting loop on locomotive roof, receiving inductor on opposite side.





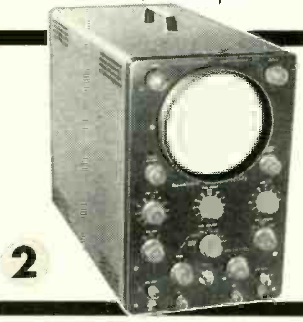
MODEL O-10

1

there is no substitute for

HEATHKIT QUALITY

YOU GET MORE: *All first-run, top quality parts—the latest in electronic design—complete and comprehensive step-by-step assembly instructions with large pictorial diagrams and assembly drawings. Proven performance through the production of thousands of kits.*



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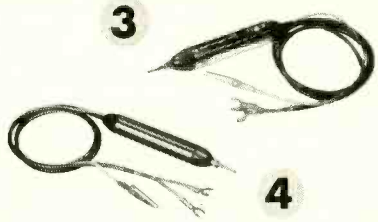

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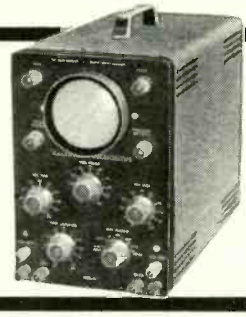


❶ *Heathkit* ETCHED CIRCUIT COLOR-TV 5" OSCILLOSCOPE KIT

This deluxe quality oscilloscope has proven itself through thousands of operating hours in service shops and laboratories. Features the best in components—and the best in circuit design.

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

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

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

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

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

❷ *Heathkit* ETCHED CIRCUIT 5" OSCILLOSCOPE KIT

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

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

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

MODEL OM-1
$49.50
Shpg. Wt. 21 Lbs.

❸ *Heathkit* LOW CAPACITY PROBE KIT

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

NO. 342
$3.50
Shpg. Wt. 1 Lb.

❹ *Heathkit* ETCHED CIRCUIT SCOPE DEMODULATOR PROBE KIT

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

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

❺ *Heathkit* ETCHED CIRCUIT 3" OSCILLOSCOPE KIT

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

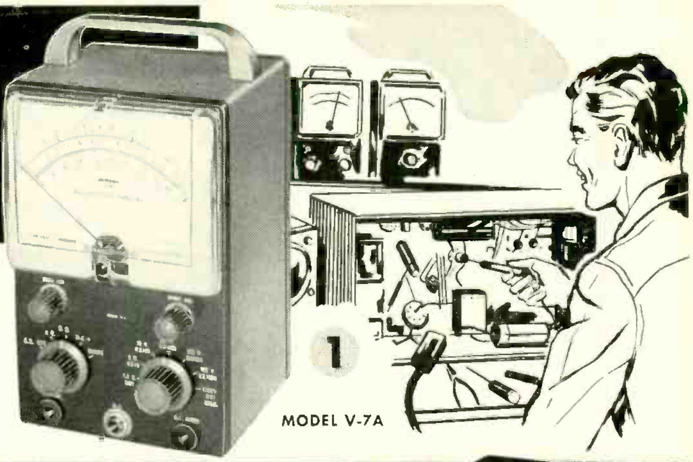
Employing etched circuit boards, the Model OL-1 features vertical response within ± 3 db from 2 cps to 200 Kc. Vertical sensitivity is 0.25 V. RMS/inch peak-to-peak, and sweep generator operates from 20 cps to 100,000 cps. Provision for r.f. connection to deflection plates for modulation monitoring,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

MODEL OL-1
$29.50
Shpg. Wt. 14 Lbs.

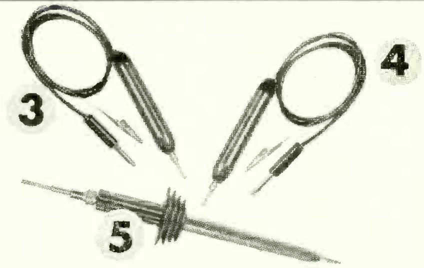
HEATH COMPANY *A Subsidiary of Daystrom, Inc.* **BENTON HARBOR 20, MICHIGAN**

fill your test requirements

WITH HEATHKITS



DESIGNED FOR YOU: *Heath Company test equipment is designed for the maximum in convenience. Besides being functional, Heathkits represent the very latest in modern physical appearance, and incorporate all the latest circuit design features for comprehensive test coverage.*



❶ *Heathkit* ETCHED CIRCUIT VACUUM TUBE VOLTMETER KIT

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

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

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

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

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

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

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

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

❸ *Heathkit* ETCHED CIRCUIT RF PROBE KIT

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

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

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

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

NO. 338-C
$5.50
Shpg. Wt. 2 Lbs.

❺ *Heathkit* 30,000 VOLT D.C. HIGH VOLTAGE PROBE KIT

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

NO. 336
$4.50
Shpg. Wt. 2 Lbs.

❻ *Heathkit* HANDITESTER KIT

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

MODEL M-1
$14.50
Shpg. Wt. 3 Lbs.

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

Heathkit TV ALIGNMENT

GENERATOR KIT

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

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

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

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

1

❶ *Heathkit* LINEARITY PATTERN GENERATOR KIT

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

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

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

2

❷ *Heathkit* LABORATORY GENERATOR KIT

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

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

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

3

❸ *Heathkit* CATHODE RAY TUBE CHECKER KIT

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

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

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

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

4

❹ *Heathkit* DIRECT READING CAPACITY METER KIT

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

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

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

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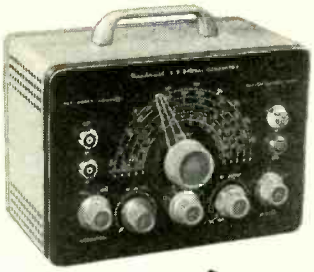

MODEL SG-8 **$19.50**
Shpg. Wt. 8 Lbs.

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

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

Heathkit SIGNAL GENERATOR KIT

1 *Heathkit* . . . IMPEDANCE BRIDGE KIT

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

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

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

1

2 *Heathkit* "Q" METER KIT

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

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

2

3 *Heathkit* 6–12 VOLT BATTERY ELIMINATOR KIT

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

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

3

4 *Heathkit* DECADE RESISTANCE KIT

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

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

5 *Heathkit* VIBRATOR TESTER KIT

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

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

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4 6

6 *Heathkit* DECADE CONDENSER KIT

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

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

HEATH COMPANY
A SUBSIDIARY OF DAYSTROM INC.

BENTON HARBOR 20, MICHIGAN

Heathkit
TUBE CHECKER KIT

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HEATH COMPANY

A SUBSIDIARY OF DAYSTROM INC.

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

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

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

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

2 *Heathkit* PORTABLE TUBE CHECKER KIT

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

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

3 *Heathkit* TV PICTURE TUBE TEST ADAPTER

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

MODEL 355
$4.50
Shpg. Wt. 1 Lb.

4 *Heathkit* . . . CONDENSER CHECKER KIT

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

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

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

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

5 *Heathkit* VISUAL-AURAL SIGNAL TRACER KIT

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

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

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

BENTON HARBOR 20, MICHIGAN

MODEL HD-1

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

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

Heathkit HARMONIC DISTORTION METER KIT

1 *Heathkit* AUDIO ANALYZER KIT

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

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

MODEL AA-1

$59.50

Shpg. Wt. 13 Lbs.

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2 *Heathkit* AUDIO GENERATOR KIT

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

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

MODEL AG-9

$34.50

Shpg. Wt. 8 Lbs.

2

3 *Heathkit* AUDIO OSCILLATOR KIT

(SINE WAVE — SQUARE WAVE)

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

MODEL AO-1

$24.50

Shpg. Wt. 10 Lbs.

4 *Heathkit* RESISTANCE SUBSTITUTION BOX KIT...

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

MODEL RS-1

$5.50

Shpg. Wt. 2 Lbs.

3 4

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

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

MODEL AV-2

$29.50

Shpg. Wt. 5 Lbs.

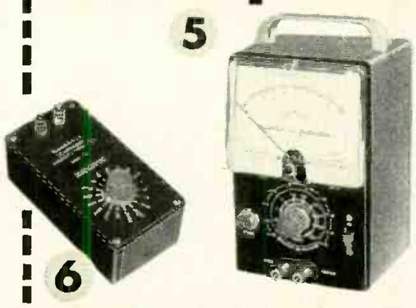
6 *Heathkit* CONDENSER SUBSTITUTION BOX KIT...

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

MODEL CS-1

$5.50

Shpg. Wt. 2 Lbs.



5 6

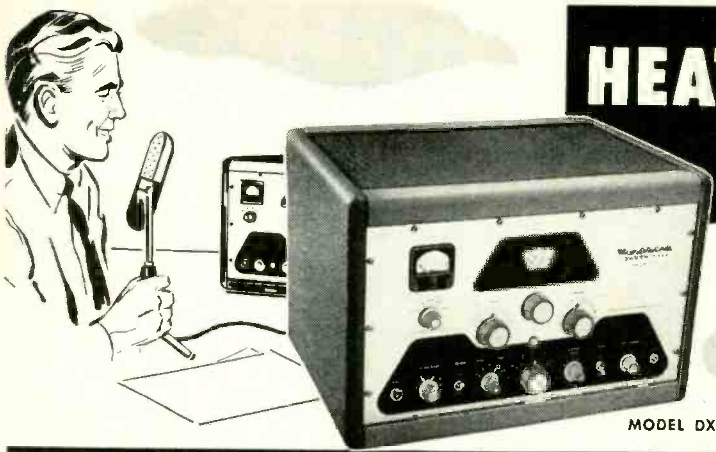
BENTON HARBOR 20, MICHIGAN

HEATH COMPANY

A SUBSIDIARY OF DAYSTROM INC.

HEATHKIT HAM GEAR

for high quality at moderate cost



1

MODEL DX-100

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

2

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

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

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

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

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

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

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

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$50.00 Deposit Required on C.O.D. Orders

❷ *Heathkit* VFO KIT

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

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

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

❸ *Heathkit* CW AMATEUR TRANSMITTER KIT

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

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

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

❹ *Heathkit* . . . ANTENNA COUPLER KIT

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

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

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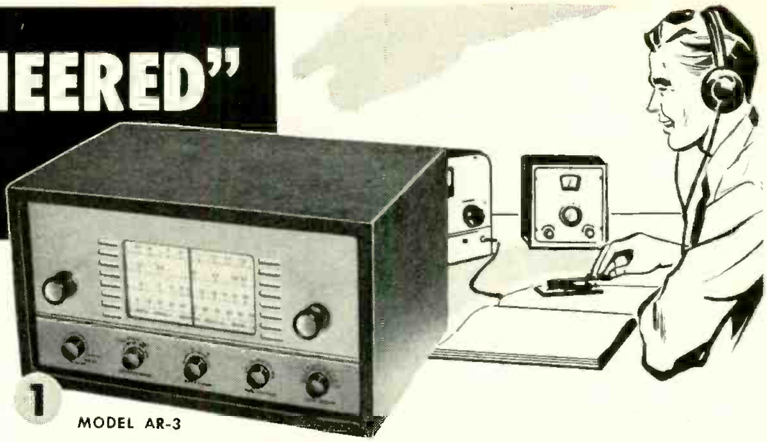

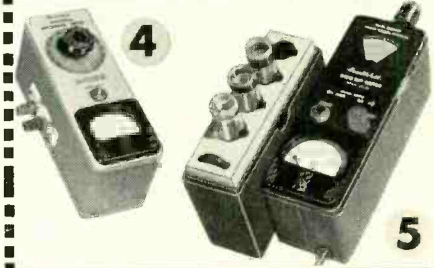

❶ *Heathkit* COMMUNICATIONS-TYPE ALL BAND **RECEIVER KIT**

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

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

CABINET: Fabric covered cabinet with aluminum panel as shown. Part No. 91-15, shipping weight 5 lbs. $4.50.

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

❷ *Heathkit* "Q" MULTIPLIER KIT

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

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

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

❸ *Heathkit* VARIABLE VOLTAGE REGULATED POWER SUPPY KIT

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

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

❹ *Heathkit* ANTENNA IMPEDANCE METER KIT

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

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

❺ *Heathkit* GRID DIP METER KIT

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

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

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1

❶ *Heathkit* ADVANCED-DESIGN HIGH FIDELITY AMPLIFIER KIT

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

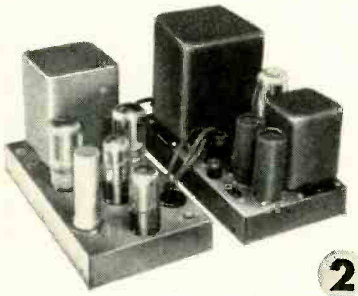
Features a new-design Peerless output transformer, and KT66 output tubes handle power peaks up to 42 watts. The unique "tweeter-saver" suppresses high frequency oscillation. A new type balancing circuit results in closer "dynamic" balance between output tubes. Features improved phase shift characteristics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

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

KIT COMBINATIONS:

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

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



2

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

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

KIT COMBINATIONS:

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

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

3

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

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

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

KIT COMBINATIONS:

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

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

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

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❶ *Heathkit* HIGH FIDELITY PREAMPLIFIER KIT

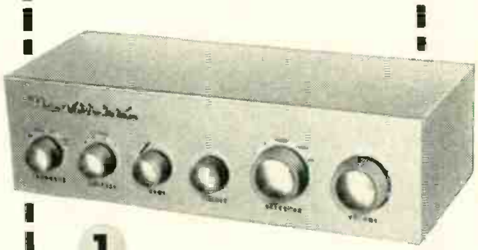
This outstanding preamplifier is designed specifically for use with the Heathkit Williamson type amplifiers. It completely fulfills the requirements for remote control, compensation and preamplification, and exceeds even the most rigorous specifications for high fidelity performance.

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

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

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

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



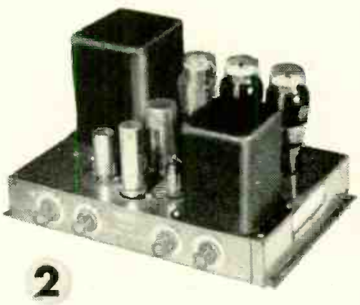
1

❷ *Heathkit* 20-WATT HIGH FIDELITY AMPLIFIER KIT

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

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

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



2

❸ *Heathkit* 7-WATT AMPLIFIER KIT

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

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

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

3

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

BENTON HARBOR 20, MICHIGAN

HEATH COMPANY
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Brand New HEATHKIT HIGH-FIDELITY FM TUNER KIT

MODEL FM-3

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

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

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

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

Features

- *Brand New, Modern FM Circuit Using Latest Type Miniature Tubes.*
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- *Extremely Good Sensitivity and Band-Pass for Outstanding Performance.*
- *Strikingly Attractive Satin-Gold Finish to Match Heathkit Model WA-P2 Preamplifier.*
- *Compact Physical Dimensions for Most Pleasing Appearance and Increased Circuit Efficiency.*

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

MODEL BR-2

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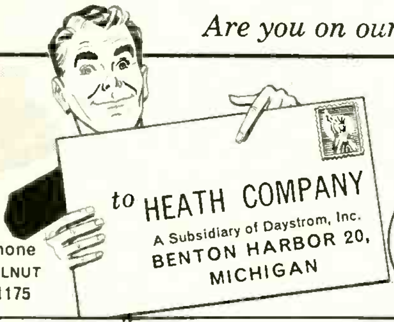

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Not all inductors are COILED

How the size and shape of wiring affects inductance

By H. P. MANLY

Fig. 1—The grid dip meter checks inductance by measuring frequency.

WHEN the radio fan of 1922 built his three-tube blooper with a regenerative detector and two audio stages, he didn't worry about the inductance of long leads. To make circuit connections he bought bus bar by the bundle and used it by the yard. Luckily, all the good stations operated with carriers of 1 mc and below, which was the reason why lead inductance didn't matter (much).

Today a typical TV tuner has the equivalent of four tubes, considering the twin types. You could put 75 such tuners into the 1922 radio cabinet. The rf oscillator in the tuner works at frequencies up around 260 mc, and not a single inch of unnecessary signal wiring can be tolerated because it would add lead inductance.

An inch of No. 20 hookup wire has a self-inductance of about .02 μh. At 1 mc the inductive reactance would be about 0.12 ohm, of no importance whatsoever. At 260 mc the same inch of wire has reactance of nearly 33 ohms. At the top of the μhf band the reactance would be 112 ohms. Such reactances can cause feedback and degeneration as well as regeneration. They can reduce the strength of oscillations and produce other undesirable effects. Keep in mind, we are talking about 1 *inch* of wire.

What about tuning? To tune to 1 mc with an inductance of .02 μh, in the old radio, would have taken the total capacitance of more than 1,200 of the biggest tuning capacitors on the market.

To tune to 260 mc with an inductance of .02 μh, in the TV tuner, takes only about 16 $\mu\mu$f of capacitance. When you recall that input or output capacitance of a tube plus capacitances in socket and essential circuit elements seldom total much less than 15 $\mu\mu$f, it is apparent that the inductance of an extra inch of wire might mean the difference between good performance and none at all.

Supposing you were designing a high-frequency circuit and found it necessary to reduce lead inductance to the very minimum. Naturally, your first step would be to place parts in such positions as to be able to connect them with very short leads or none at all. Were inductances still too great, what could you do next? Well, you might use bigger wire for connections. If that didn't do the trick, you could use two or more paralleled wires for each connection.

It is easy to prove that two or more paralleled leads have less inductance than one and that leads of large diameter have less inductance than small ones. All you need is a grid dip meter or any other resonance indicator, some pieces of wire and a fixed capacitor.

When the meter is used as in Fig. 1, it will dip when tuned to the resonant frequency of the circuit containing the wires. Frequency variations will show whether changes in the number and diameter of wires raise or lower the inductance because more inductance will drop the resonant frequency and less inductance will raise it.

To see things happen, select a capacitor with long pigtails and solder it between two pieces of heavy wire (Fig. 2). Between these heavy wires solder three smaller ones. Solid bare hookup wire is just right. If the cross wires are about 4 inches long and the capacitor is 200 $\mu\mu$f, the arrangement will resonate around 30 to 40 mc.

When the coil of the grid dipper is brought near any part of the wire circuit, there will be a dip when you tune to the resonant frequency. Make note of this frquency. Then remove one cross-wire and check the frequency—it will be slightly *lower* than before. Remove another wire and check frequency again—it will be much lower than with only one wire removed.

Changes in frequency mean that removing wires has altered inductance, capacitance or both. Because our fixed capacitance is so large, 200 $\mu\mu$f, any change in circuit capacitance due to removing wires must be such a small percentage of the total that it cannot account for appreciable changes in frequency. Therefore, the principal effect of removing cross-wires must be to change the inductance. Since frequency drops, inductance must have in-

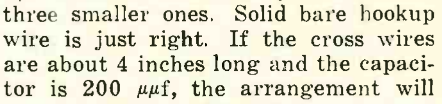

Fig. 2—A circuit for observing effects of inductance in straight wires.

creased. Thus we prove that fewer wires have more inductance and more wires have less inductance.

For the next experiment take off the remaining cross-wire and substitute two wires of the largest diameter on hand. Fig. 3 shows two pieces of No. 8 copper ground wire. Check the resonant frequency with the grid dip meter. Then remove one of the large wires and measure frequency once more.

Compare all the measured frequencies. The highest frequency and least inductance occur with two wires of large diameter; lowest frequency and most inductance with one wire of small diameter. In one series of tests the frequencies checked like this:

	Wire Gauge	
Wires added	No. 20	No. 8
3	36.0 mc	
2	35.1 mc	38.2 mc
1	32.5 mc	37.2 mc

Unfortunately, we cannot compute the true inductance of a single wire from the known capacitance and measured frequencies. This is because changing the number of wires changes

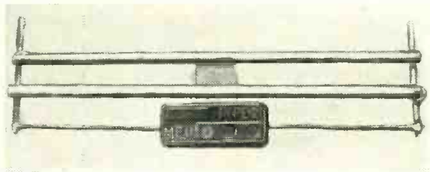

Fig. 3—Large-diameter wires have less inductance than smaller ones.

the enclosed area, because wires so close together have mutual inductances and because of many stray capacitive and inductive factors in the setup.

However, the experiments do prove three things: First, short straight wires have considerable inductance; second, one conductor has more inductance than any greater number of the same kind paralleled; third, small-diameter conductors have more inductance than those of larger diameter.

Other small inductances

All conductors of any kind whatever have enough inductance to be important at high frequencies. This means that fixed capacitors have inductance because they have metal plates and pigtails. It means that all composition resistors have inductance, in the element as well as in the pigtails.

Conductors made of iron or iron alloys have much more inductance than copper at low frequencies, but the difference drops to only about 15% at 500 kc and to practically nothing above 10 mc. It is true also that frequency has almost no effect on the inductance of copper wire, the change between zero and infinite frequency being only 3–4%.

When insulated live conductors are run close to chassis metal which acts as the circuit return, the effective inductance of the conductors increases with length. The increase is greater for short lengths than for longer ones. For instance, increasing the length from 1

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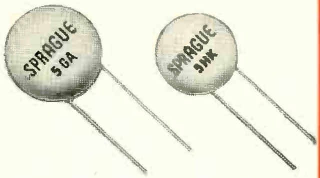

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to 2 inches may increase inductance nearly 6 times, an increase from 2 to 4 inches may increase the inductance about only 2⅓ times.

The inductance of a wire increases as it is brought closer to chassis metal that forms the return circuit. A wire

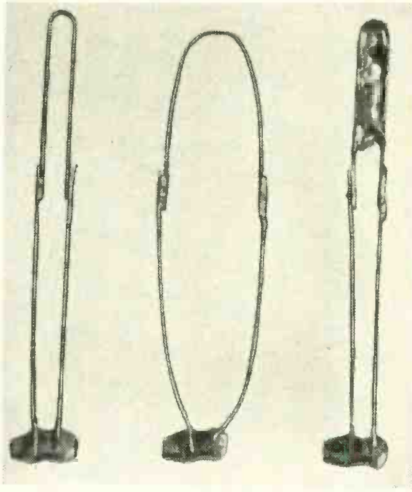

Fig. 4—Various hairpin inductors.

1 inch long originally spaced away from metal by 1 inch may increase its effective inductance by about 80% when brought so close that there is just room for insulation.

In some television tuners the inductors are wire loops or hairpins of small size. They provide inductance that combines with fixed, stray and tube capacitances to form resonant circuits.

You may simulate hairpin inductors as in Fig. 4. The capacitance is furnished by 25-$\mu\mu f$ ceramic units of 10% tolerance. Inductance is supplied by the capacitor pigtails joined with loops of wire. At the left the distance from the capacitor to the end of the loop is about 2.5 inches. Spacing between the sides of the loop averages about 0.18 inch. This particular arrangement was resonant in the neighborhood of 122 mc.

If you make this set of experiments proceed next to spread the loop, as at the center. Maximum separation here is 0.60 inch. The grid dipper showed resonance at slightly above 105 mc. This lower frequency means more inductance. It is true in a general way that greater area enclosed within a loop increases the inductance. The technician can spread a loop or hairpin for more inductance and lower frequency, squeeze the sides together to get less inductance and higher frequency.

A final experiment is illustrated at the right in Fig. 4. Here a considerable area of the loop has been filled with a film of solder. This brought the resonant frequency up to 160 mc, proving that there is less inductance than with either of the other arrangements, also that less loop area raises the resonant frequency. The solder film method may be used by technicians when no regular adjustment is provided.

If we assume that the total capacitance in the hairpin circuits is 25 μμf, the inductances may be computed from measured frequencies. On this basis we have, from left to right, .068 μh, .092 μh and .040 μh.

Capacitances

The story of what happens with short wires should include something about their capacitances. Two of the 4-inch crosswires from Fig. 2, spaced as there shown but not connected, would have a capacitance around 0.9 μμf. Two of the bigger wires from Fig. 3 would have a capacitance of nearly 1.7 μμf.

Were you to move two 4-inch lengths of No. 20 or No. 8 wire closer and closer together their capacitance would increase as shown by the curves in Fig. 5.

The curves end where the wires are as close together as possible, allowing for a little insulation. Plainly, to avoid excessive capacitance, thin wires should be at least ⅜ inch apart and fat ones twice as far apart. And, as always, keep the wires as short as possible. Capacitance increases in almost exact proportion to length.

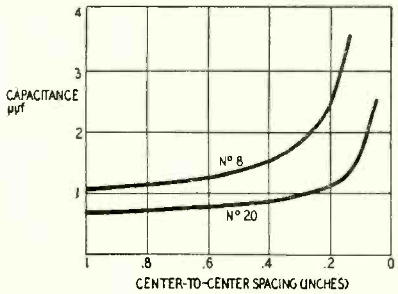

Fig. 5—Spacing vs. capacitance graph.

Capacitance exists between any two conductors separated by any kind of insulation. This is true when the separation is resistance. Between the ends of a composition resistor there is an effective capacitance approaching 1 μμf at low radio frequencies. At high frequencies the capacitance appears distributed along the resistance element. Then a resistor, acting like a capacitor, may short circuit or bypass high-frequency signal currents which it is supposed to oppose. END

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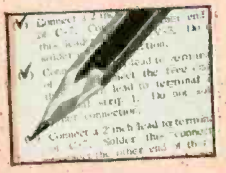

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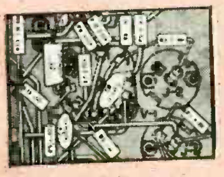

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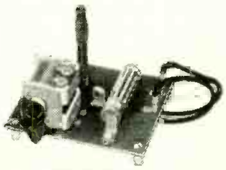

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630 REMOTE CONTROL

By RAYMOND L. CLIFT

New tuner and remote controls give new life to old 630 sets

IF there are several TV channels in your area, remote control of your receiver may be a desirable feature. With the prevailing large-screen TV chassis, the ideal viewing position is the far side of the average living room. This remote control unit will make it unnecessary for you to leave your favorite chair to change channels; adjust the fine-tuning, contrast, brightness or volume controls or to turn the set on or off. Developed for 630 type chassis, it can be adapted to other types of sets.

The original 630 type receiver often drifts considerably during the warmup period. This affects the sound (in split-carrier sets) and the fine-tuning control must be readjusted several times before the set stabilizes. Retuning is no longer bothersome with this remote control at your fingertips.

Later 630 type sets such as the Airex, Mattison, Philmore, Regal, Tech-Master and Video Products have several circuit modifications that make them superior to the earlier types. Some of these have intercarrier sound to minimize the effects of drift on the sound. Standard Coil tuners are widely used on the later types. If your set is an early type, make the following modifications before converting it to remote control:

1. Replace the original RCA tuner with a Standard Coil cascode type and move the sound take-off point to the plate circuit of the first video i.f. amplifier as shown in Fig. 1. The sound take-off coil is a Standard Coil type XM-752 or equivalent.

2. Disconnect the picture control circuit and the bias line to the first, second and third video i.f. amplifier grids and install a 6AU6 keyed a.g.c. circuit as in Fig. 2.

3. Move the picture (contrast) control to the cathode circuit of the 6K6-GT video output stage (Fig. 3).

4. Modify the d.c. restorer circuit and move the sync take-off to the plate circuit of the 6AU6 first video amplifier. (See Fig. 3.)

5. Move the brightness control from the grid to cathode of the picture tube and change the polarity of the bias supply voltage as in Fig. 3.

6. Connect a 1N34 diode as a d.c. clamp for the a.f.c. circuit (Fig. 4).

The cascode tuner provides greater gain with less noise than does the original tuner. Taking the sync pulses from the first video amplifier makes their amplitude independent of brightness and contrast settings. The keyed a.g.c. circuit holds the video output and sync-pulse level fairly constant and produces pictures of uniform quality as the set is switched from one channel to another without resetting the brightness and contrast controls. The brightness bias circuit is changed from negative to positive so it can be easily supplied and controlled from the remote-control chassis. With these modifications, the 630 is now an ideal receiver for remote-control operation.

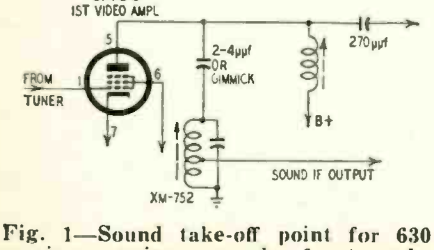

Fig. 1—Sound take-off point for 630 receivers using cascode front ends.

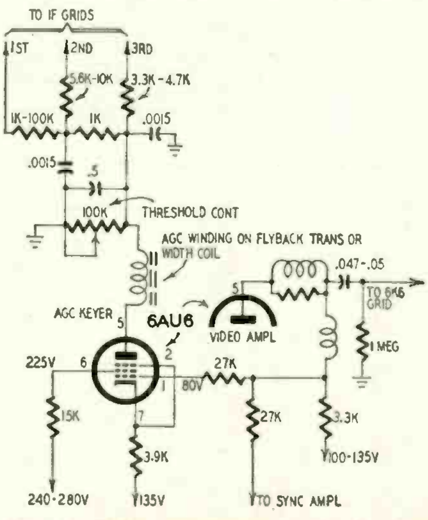

Fig. 2—This keyed a.g.c. circuit improves performance of old 630 receivers.

Converting to remote control

The diagram of the remote-control chassis and its connections to the main chassis are shown in Fig. 5 and the layout of major components in Figs. 6 and 7. The remote unit is mounted on a 10 x 17 x 4-inch aluminum chassis. The tuner, audio preamp and brightness controls are supplied from a source delivering around 250 volts at 50 ma or so.

After building the supply and associated circuits on the remote chassis, remove the cascode tuner from the main chassis and install it on the remote unit. The output of the tuner is coupled to

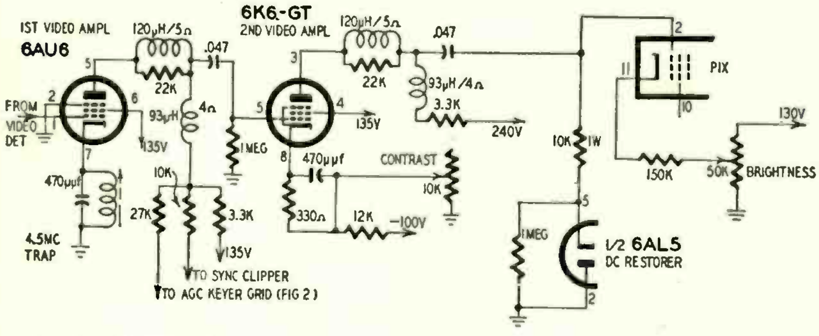

Fig. 3—Modifications to brightness, contrast and d.c. restorer circuits.

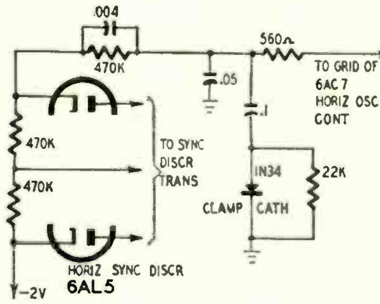

Fig. 4—A.f.c. stabilization circuit.

the grid of the 6AB4 cathode follower that feeds the 6AG5 first video i.f. amplifier through a length of coaxial cable. Contrast is controlled on the remote chassis by varying the bias on the tuner r.f. amplifier. This permits the tuner to be adjusted manually for maximum gain in fringe areas.

After wiring the remote-control unit, cut and mount an adapter plate to cover the hole left by the tuner on the main chassis. (See Fig. 8.) Install the 100-μμf coupling capacitor between the coax connector and the grid of the 6AG5 first i.f. amplifier. You can check your work thus far by connecting the tuner and main chassis through the coax, plugging both units into the power line and tying a good antenna to the tuner. You should now be able to receive normal pictures.

Set the contrast control to the extreme counterclockwise position. Turn the channel selector to the strongest station and adjust the area control so the picture has slightly less than normal contrast. With this preset adjustment, the contrast control will have a uniform range capable of handling signals of the levels usually encountered. Adjust the slug in the 19–26-mc tuner i.f. output coil for the best picture. Check the tuner voltages under load for approximately 130 volts to the mixer and 250 to the r.f. amplifier.

The brightness control is removed from the receiver chassis and installed on the remote unit as shown.

Three possible modifications may be made on the audio circuit. Some later models have a pretty good sound system with a push-pull output circuit. This can be used by mounting a 12AU7 on the adapter plate and using the circuit in Fig. 9 to provide a low-impedance volume control line. In this case, the 12AU7 preamp and tone-control stage on the remote chassis may be omitted.

If you have a separate high-fidelity amplifier, disconnect the discriminator output from the volume control of the receiver and connect it to pin 3 on the connector for the mike cable. The audio signal now passes through the 12AU7 preamp and tone-control stage to the separate amplifier.

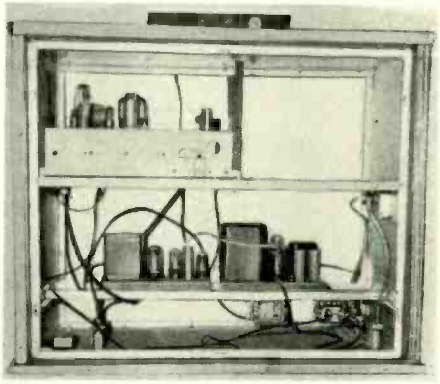

Photo A—A remote control and amplifier cabinet with front panel removed.

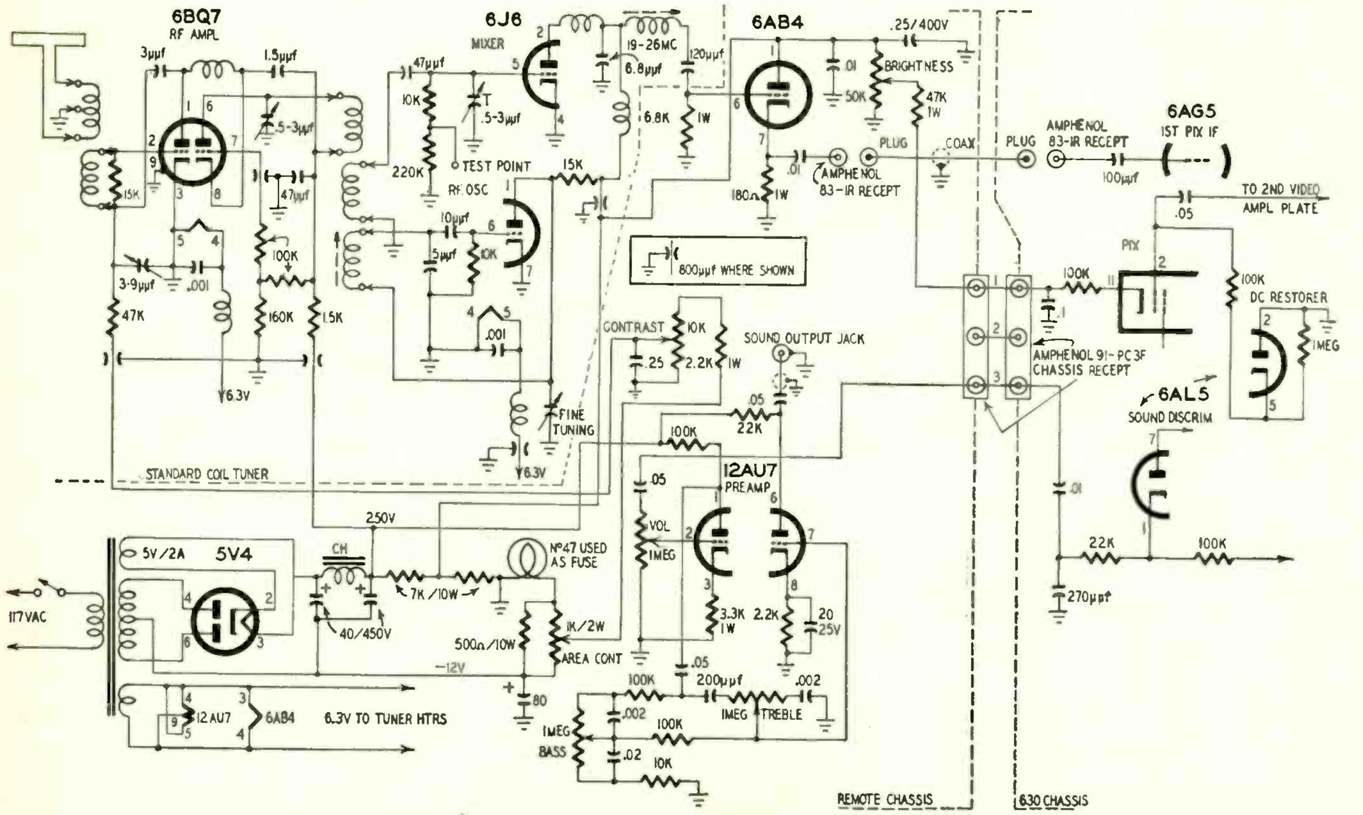

Fig. 5—The remote control unit and its connections to the TV chassis. The two chassis are grounded through the braid on the connecting cables. The No. 2 lead in mike cable is used in the circuit variation as indicated in Fig. 9.

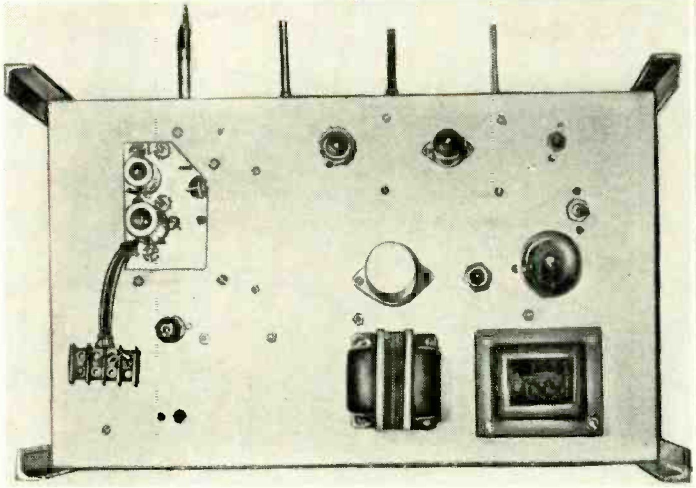

Fig. 6—Top view of control chassis. Angle irons at corners simplify mounting and servicing from the underside.

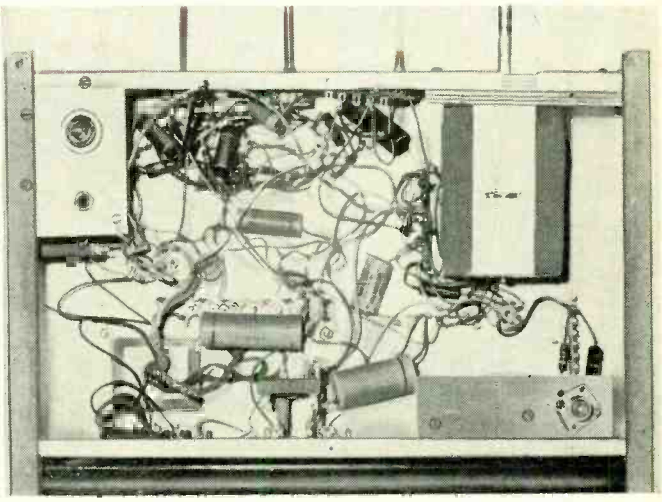

Fig. 7—Underside of the control unit. The cable connectors are located in the upper left and lower right hand corners.

The control unit in use, with the author's mother at the controls.

The third method is to move the 6AT6 a.f. amplifier and 6K6-GT a.f. output stage and all related components over to the remote chassis. On early 630 type sets, the space gained on the main chassis can be used when adding keyed a.g.c.

Remove the on–off switch from the TV receiver and wire the primary of power transformer to the interlock connector on the chassis. Then plug the TV set, amplifier and remote chassis into a.c. receptacles controlled by a 5-ampere switch at the remote location. The main on–off switch and the receptacles should be wired and installed in accordance with the local electrical code. The coaxial and three-conductor mike cables between the remote and main chassis can be run beneath the floor or through the attic in the same manner as standard electrical wiring.

Custom installations

Each custom installation should be planned carefully, paying particular attention to the type and location of the cabinets for the remote and main chassis. Do not overlook the possibility of installing the remote-control unit in an AM radio console. Prewar models of famous makes may often be purchased for as little as $10. The controls are at the correct height for easy adjusting from an easy chair. Select an a.c. type using a power transformer and examine the chassis, power supply and audio system. The audio system of many sets made in the late Thirties and Forties will prove superior to those in most TV sets. In this case, it pays to use the existing power supply and audio circuits. Space for the TV tuner can be found by removing the AM tuning capacitor and other components not required.

If you make your own cabinets, do not overlook the possibilities of using plastic laminates for finishing. Available in wood-grain as well as modern patterns, they can be used instead of expensive hardwoods.

Precautions: 1. Protect the control knobs from damage by recessing the front panel about 2 inches into the cabinet. 2. Provide ample ventilation to dissipate the heat generated in the cabinets. 3. For chair-side tuning, the controls should be about 18 inches above the floor. 4. Conceal all antenna, control, power and interconnecting cables. 5. Observe safety rules and regulations to prevent shock hazards and short circuits. 6. Seal the remote and main chassis so children cannot gain access to the insides. 7. Whenever possible, anchor the enclosures to the floor so the interconnecting cables cannot be damaged through movement. 8. The panels of the cabinets should be easily removable to simplify servicing.

Photo A shows the front view of a remote-control cabinet with the front panel removed. The base of the cabinet is attached securely to the floor by four ½-inch pipe nipples. The 117-volt wiring (No. 12 two-conductor nonmetallic sheathed cable) is brought in through one of these nipples and run to the main on–off switch on the right side of the cabinet. The remote chassis at the top and Williamson type amplifier are supported on open frames of ½-inch angle iron. END

Parts for remote control

Capacitors: 1—100, 1—200, 1—270 μμf, 2—.002-μf mica or ceramic; 3—.01, 1—.02, 4—.05, 1—0.1, 2—0.25 μf, 400 volts, paper; 2—40 μf, 450 volts, 1—80 μf, 50 volts, 1—20 μf, 25 volts electrolytic.
Resistors: 1—180, 1—2,200, 1—3,300, 1—6,800 ohms, 1 watt; 2—2,200, 1—10,000, 1—22,000, 1—47,000, 4—100,000 ohms, ½ watt; 1—500, 2—7,000 ohms, 10 watts; 1—1,000 ohms, 2 watts; 1—10,000 ohms, 3—1-megohm potentiometers.
Miscellaneous: 1—Power transformer, 500–550 volts c.t. at 50 ma; 6.3 volts, 2 amps; 5 volts, 2 amps; 1—filter choke, 10 henries, 50 ma; 1—octal, 1—7-pin miniature, 1—9-pin miniature socket; 2—coax connector, chassis type (Amphenol 83-1R), 2—coax plug (Amphenol 83-1SP), 2—reducer (Amphenol 83-168) 2—3-contact chassis type microphone connectors (Amphenol 91PC3F) 2—3-contact male microphone plugs (Amphenol 91-MC3M); 1—10 x 17 x 4-inch aluminum chassis; 1—cascode type tuner (Standard Coil Products), 1—XM-752 sound take-off coil (Standard Coil Products); 1—5V4-G, 1—12AU7, 1—6AB4 tube; 1—pilot lamp No. 47 and socket; RG-59/U coaxial cable; 3-wire shielded microphone cable (Belden 8423); hookup wire, terminal strips, knobs, hardware.

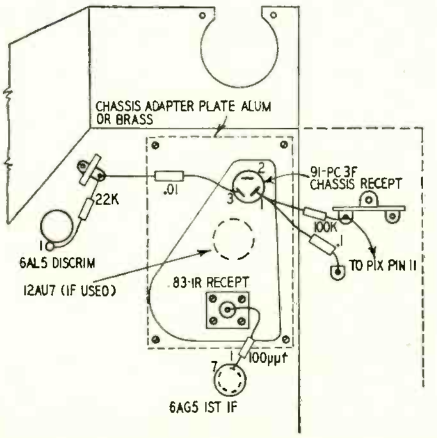

Fig. 8—The adapter plate and connections to the 630 type receiver chassis.

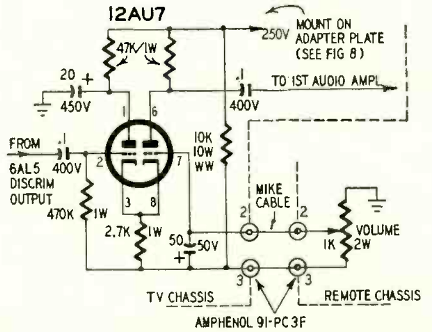

Fig. 9—Circuit used for remote volume control of original audio circuit.

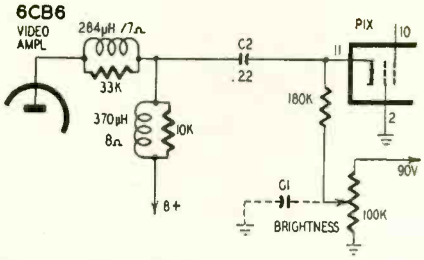

Fig. 1—The brightness control circuit in the Admiral 19E1 TV chassis.

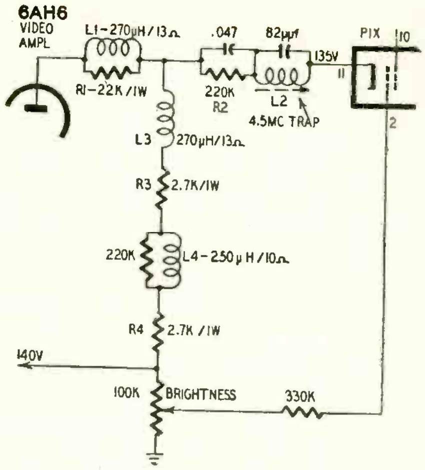

Fig. 2—Bendix T14 series chassis use this brightness control circuit.

TO reproduce a transmitted picture with the proper shading and brightness values, the television transmitter and receiver must have a common light level for use as a reference point. This point is total blackness. It is called the pedestal or blanking level and represents 75% of the peak carrier amplitude. The upper 25% region, referred to as the blacker-than-black area, contains the synchronizing pulses. Thus the black level is independent of signal variations and for proper shading it is necessary only that picture-tube cutoff represent the transmitted picture's blanking level.

Picture brightness is determined by the dc grid bias that establishes the tube's operating point. The video signal applied between grid and cathode produces instantaneous variations in brightness corresponding to the shade of picture components. However, the video is an ac signal whose average value is zero. Therefore the average grid voltage is the dc bias. Since this bias, when varied, alters the average illumination of the picture, the potentiometer used to make this change is called the brightness or, more properly, the background control.

The most common method of varying picture-tube bias is with a potentiometer, connected across a dc source, in either the grid or cathode circuit. Fig. 1 shows the simple circuit used in the Admiral 19E1 chassis. The control grid is grounded and the brightness potentiometer connected between ground and 90 volts. Thus the bias can be varied from 0 volt (maximum brightness) to −90 (well beyond cutoff). The signal from the video amplifier is fed to the cathode and will thus produce light variations on either side of the fixed brightness level. The proper setting of the brightness potentiometer is the point where black just equals visual extinction of the electron beam (this is not necessarily picture-tube cutoff).

Capacitor C1 between the arm of the control and ground is used in many receivers to shunt the ac across the brightness control, thus preventing the bias from varying.

Fig. 2 shows a variation in brightness control circuitry. Once again the brightness potentiometer is connected between ground and a positive voltage, approximately 140. However, this time the arm of the control goes to the control grid. To offset the positive grid voltage that can vary from 0 to 140, the cathode of the picture tube is direct-coupled to the plate of the video amplifier. Thus the cathode potential (approximately 135 volts) is equal to the video amplifier plate voltage. This illustrates the basic theory of biasing—*bias is the voltage on the control grid relative to the voltage of the cathode.* The bias is 50 volts when the control grid is +10 volts and the cathode is +60; when the control grid is −40 volts and the cathode is +10 and when the control grid is −90 volts and the cathode is −40.

Since the viewer has no way of knowing bias voltages and signal amplitudes, he usually sets the brightness level to suit his taste and is generally not too far off since insufficient bias prevents large signals (approximately 75% of peak amplitude) from driving the picture tube into cutoff, the screen is very bright and without proper black values. Also, the whites will drive the grid positive with respect to cathode, causing poor focus and sometimes blooming. Excessive bias will cause some of the darker values to produce cutoff and therefore shadow detail will be lost.

Brightness control defects

A fairly common complaint is failure of the brightness control to produce variations in brightness. The first check should consist of seeing whether rotating the brightness control varies the picture-tube bias through its normal range. If it does, the trouble lies within the picture tube—a poorly soldered joint in the grid or cathode pin, an open cathode or grid lead. To remove the possibility of confusion due to the above picture-tube defects and others such as internal and high-resistance heater–cathode and cathode–grid shorts, it is best to check bias with the picture-tube socket removed.

If the proper bias swing is not obtained, the individual cathode and grid circuits should then be checked. Check the voltage at the arm of the brightness control to see if it varies over the full range of the voltage across the potentiometer. The other element (grid or cathode) should be checked to see that its voltage is normal and return path to ground or some other point common with the control circuit is complete.

The Fig. 1 circuit is relatively easy to service. With the grid grounded, testing is limited to the cathode circuit. C2 being open will not affect brightness. However, should it short, the cathode voltage would rise to and remain at

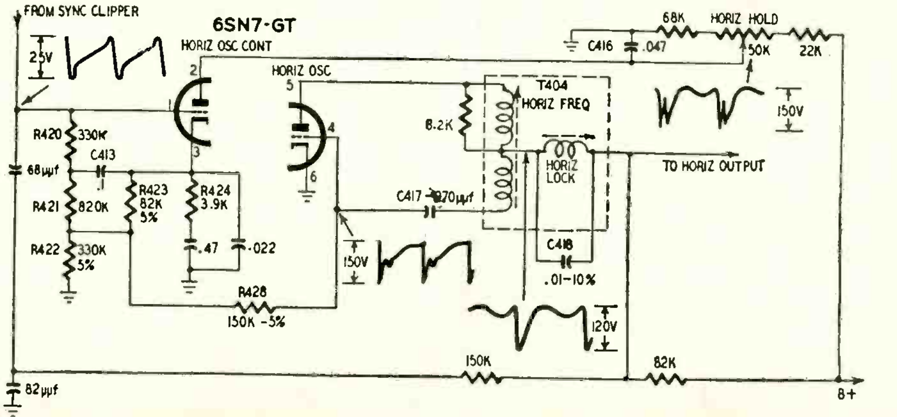

Fig 3—Horizontal oscillator and control in Admiral 19K1 TV chassis.

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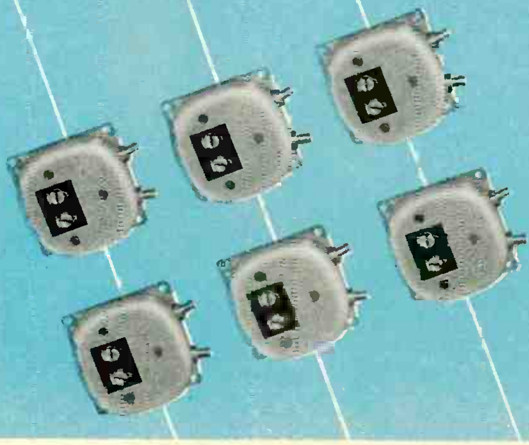

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approximately the plate voltage of the video amplifier, driving the picture tube into cutoff. If C1 shorts, it places the cathode at ground potential and, despite varying the brightness control, the screen will remain very bright with retrace lines visible.

(In some models, the grid returns to ground through a 56,000-ohm resistor shunted by a .01-μf capacitor. Blanking pulses are fed directly to the grid through a 2,700-ohm resistor and a .015-μf capacitor in series, connected to one end of the vertical deflection coil. If this .015-μf capacitor shorts, a high positive voltage will be applied to the grid, making it impossible to maintain complete brightness control.)

The circuit in Fig. 2 is slightly more involved. The voltage on the cathode of the picture tube is approximately 135. The control grid voltage can be varied from 0 to approximately 140. Should either R2, L2 or L3 open, the picture-tube cathode will float. Having no common reference point, bias is lost and brightness cannot be controlled. Should the heater of the 6AH6 open, there will be no plate current flow and the plate voltage will rise to B plus. This will raise the picture-tube cathode voltage, increasing the bias and decreasing the brightness range somewhat.

If R3 or R4 increases in value or if L4 opens, the circuit resistance increases dropping the voltage on the video amplifier plate and the cathode of the picture tube. This will upset the brightness and make it difficult or impossible to cut off the beam.

When checking for the cause of fluctuations in brightness, check for fluctuations in picture-tube bias—also for changes in the high voltage often caused by intermittent high-voltage capacitors.

No brightness control

An RCA 9T147 using a 19AP4-A came in with a dark picture and no control of brightness. The contrast control produced variations in the strength of the picture but there appeared a slight smearing in the portions that changed sharply from black to white and vice versa. The high voltage measured 12,000, as it should.

The cathode of the picture tube is connected to the center arm of a potentiometer between ground and 120 volts. Varying the brightness control produced the complete range of voltage on the cathode. The resistance of the grid circuit was as per schematic and except for some slight distortion everything seemed to be in order. I tried soldering the cathode and grid pins. The only other clue is that when I removed the cathode lead from the picture-tube base there did not seem to be any change in the picture. I have not replaced the picture tube but have checked for interelement shorts with a vtvm. What do you suggest I do now?—S. S., Port Washington, N. Y.

Your description of the defects gives

every indication of picture-tube trouble—most likely, an open cathode. Make one final check: With the socket removed, measure the bias voltage from pin 2 to pin 11 as you vary the brightness control through its entire range. You should read from a slightly positive grid to a grid negative by about 110 volts. However, most likely, the tipoff is the fact that removing the cathode lead did not affect the picture. That you received some picture is due to the grounded heater that acts somewhat like a filament.

You may heal the cathode break by using a high voltage to arc across the gap and weld the ends together. Obtain a piece of high-voltage cable (20,000-volt second-anode cable or automobile ignition lead) with an alligator clip on each end. With the set turned off, clip one end to the second anode of the picture tube or to the hot side of the high-voltage filter capacitor. The other end goes to the blade of an insulated screwdriver or other instrument with a small point.

Turn the set on, give the picture-tube heater a minute to warm up and then bring the high-voltage jumper lead close to pin 11, the cathode. As you bring it close corona will appear. Then, while gently tapping the neck of the tube with an insulated tool in one hand, bring the high-voltage lead closer until an arc flashes to the cathode pin. You may have to arc the cathode several times, but with any luck at all the repair will be made and control of brightness returns.

Picture tearing

An Admiral 19K1 chassis has a bad case of horizontal instability. The customer said the picture was tearing, but closer examination showed bending and general instability. Our first check was to replace the 6SN7-GT horizontal oscillator tube. This did not help and, following Admiral's service notes on horizontal sync adjustment, we carefully double-checked each step.

The various waveforms in this circuit seem stable and, as best we can recall, the set checks out as well as similar chassis of this type. We would appreciate any information that would help us get this set off the bench without checking and replacing every component in the sync and horizontal sweep circuits.—L. R., Springfield, Ohio.

Unfortunately in a circuit (Fig. 3) such as this there is no way of positively pointing to one component. The quickest way is the following: Try each position of the dx rangefinder and leave it where maximum stability is obtained. Then, repeat the sync adjustment. If there is no improvement, try several different 6SN7's in the horizontal oscillator circuit. Often the slightest change in interelectrode capacitances can completely stabilize the circuit. If the above does not help, carefully check the following components: R420, R421, R422, R423, R424 and R428. Not all these resistors are 5% units, but they should be. Measure each, and replace any that are out of tolerance. Regardless of how it checks, on general principles alone, replace C418, the capacitor shunting the horizontal lock coil. Use a good-quality 400-volt 10% capacitor.

Capacitor C417 is in an especially critical portion of the circuit—replace it with a 270-μμf 10% mica unit. Make a careful check of capacitors C413 and C416. Try tapping the horizontal oscillator transformer T404. If by doing this conditions become considerably worse, the adjustment slug may be cracked and the transformer should be replaced. The above checks should almost surely end the trouble.

As an additional aid, compare the signal amplitudes and general waveform with those shown in Fig. 3. Any sizable deviation could very likely indicate the circuit where the trouble is taking place.

Rf oscillator defect

An RCA model 17T153 came in that takes 15 minutes for a picture to appear. We get only channels 2 and 4 reliably in this area and when the set is first turned on channel 4 comes in perfectly on channel 3. After about 15 to 30 minutes, the picture drifts off channel 3 and can be tuned in properly on channel 4.

I believe that the trouble is a component in the tuner but have hesitated tearing it down due to the double shielding and the precise way in which it is constructed. Once the set is operating properly the trouble will not reoccur. I have replaced the rf oscillator and rf amplifier tubes but this did not cure the trouble. I would appreciate any help on this problem.—R. R., Tallahassee, Fla.

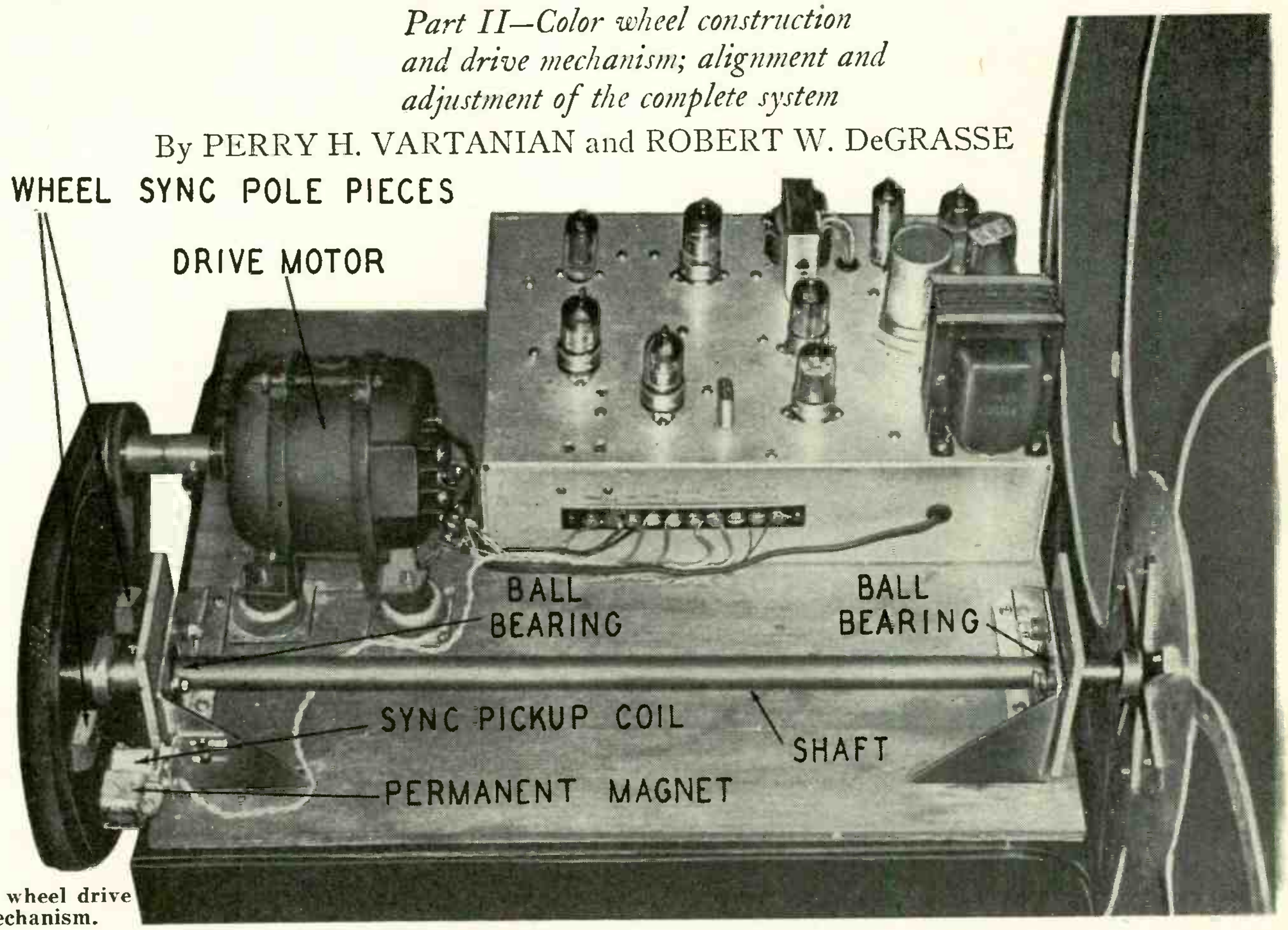
The change in tuning during the warmup period indicates very strongly trouble in the tuner section; in particular, the rf oscillator–mixer circuits. You have replaced the tubes in the tuner so the trouble narrows down to components in the circuit of the 6X8. There are several components in this circuit in which a change in value would cause the oscillator to operate on a different frequency, the most critical being in the grid circuit. Apparently, one of these components is changing in value during the 15- to 30-minute warm-up period.

The tuner is not too easy to disassemble and the parts are a little difficult to get at. However, you have no choice in the matter. Very carefully check all capacitors with a capacitor checker. If none is available, try substitution but be careful to use exact replacements. Some of the capacitors used in this circuit are temperature-compensated—most likely one of these is defective. When moving parts, carefully observe wire dressing as the distributed capacitance of the hookup is generally part of the tuned input circuit. END

COLORDAPTOR

Part II—Color wheel construction and drive mechanism; alignment and adjustment of the complete system

By PERRY H. VARTANIAN and ROBERT W. DeGRASSE



Color wheel drive mechanism.

THE color wheel, as shown in last month's article, consists of six specially curved color filters mounted on a frame of sheet aluminum. It gives two complete color pictures per rotation, operating at a speed of 600 r.p.m. The six filter segments consist of two each of the three primary colors—red, blue and green. The colors and densities of these filters must be carefully selected, so that white light, when viewed through the rotating filter wheel, appears white. Color filter material having these properties is available from Eastman and others, or the Colordaptor Co., 3471 Ramona, Palo Alto, Calif. [A Wratten No. 26 has been recommended for the red; No. 47 for the blue and No. 58 for the green. Approximately equivalent colors can be obtained in Plexiglas or Lucite plastic film.—*Editor*]

The color wheel layout is obtained by redrawing Fig. 1 to full scale. The wheel radius is equal to the distance from the drive hub (located directly above the left edge of the picture tube) to the lower right-hand corner of the picture tube. After determining the color wheel diameter, a full-size cardboard template of the color filter segment can be made and used to cut out the segments and to lay out the supporting web. The web, which has spokes approximately an inch wide, is constructed of sheet aluminum, Masonite or other light material. The segments are attached to the web with transparent tape or cement. It is important that the color filters be arranged so that they pass the picture tube in red–blue–green sequence.

An alternate method is to sandwich the color filter segments between two heavy sheets of transparent celluloid or clear plastic. Acetone or clear airplane cement is applied along the edges of the segments. The assembly is then held under pressure until the cement is dry. This construction method protects the filters and offers less wind resistance.

The color wheel drive mechanism (see photo) has two bearing supports and a shaft which extends from the front to the back of the TV set. The wheel hub fits on the front of this shaft and is held in place by a setscrew tightening into a flat on the drive shaft. Mounted on the rear of the drive shaft is a 7-inch diameter V belt pulley. On the front face of the pulley are two soft-iron pole pieces next to which the synchronizing pickup coil is mounted. The motor drives the color wheel through a 3/8 inch wide V belt and a smaller pulley. The pulley diameter ratio must be selected to give a speed of slightly greater than 600 r.p.m. V belts and pulleys are available from any refrigerator supply store; the shaft and bearings at hardware stores.

Although ball bearings were used in this design, bushing bearings should be satisfactory. The shaft diameter is 5/8 inch, which is turned down to 1/2 inch at each bearing surface. The bearings are then mounted to hold the shaft securely and prevent any front-to-back shaft motion. This is necessary to maintain constant spacing between the sync pickup coil and the rotating pole pieces.

The Colordaptor system is also adaptable to a projection type TV receiver. This simple conversion requires a color wheel only large enough to cover the lens of the projection unit. The color wheel should consist of three pie-shaped segments and the wheel should be driven at 1,200 r.p.m.—in which case the synchronizer pickup should give one pulse per revolution of the color wheel.

The color wheel drive motor should have about 1/100 horsepower for projection and 7-inch TV sets, 1/50 h.p. for 10 to 17 inches, 1/30 h.p. for 19 to 21-inch TV sets. An induction type motor, such as a two-phase capacitor unit, is excellent for this application. A series universal motor may also be used, but the a.c. supply to the motor must be adequately filtered to prevent TVI.

The drive motor speed is controlled by V7 and V8 (see schematic in Part I) to synchronize the color wheel with the TV picture. The sync pickup coil (see photo) generates a pulse which is compared with a switching signal from the plate of V4-b in phase detector V7-a. The voltage on the grid of V7-b is about −2 to −5 when the pickup coil and V4-b signals are positive at the same time. This voltage goes to zero when the two signals are out of phase.

The signal is amplified in V7-b and applied to V8 which acts as a grid-controlled rectifier and saturates the servo transformer. This in turn reduces the voltage drop in the transformer secondary winding. The servo transformer is a Stancor A-3852 universal output unit. The two plate leads are connected as a primary and the voice coil winding connected in series with the motor. Standard power transformers may also be used by connecting the B-supply winding across V8 and using the heater windings in series or parallel as a control winding.

The synchronizer pickup coil is constructed from a surplus 24-volt d.c. relay by dissassembling the relay and removing the relay contacts. The relay is then modified by bending the relay contact support at a right angle (Fig. 2). An Alnico magnet, such as used in PM speakers, is fastened to the relay with an aluminum or brass clamp. The pickup coil is then mounted so that the rotating iron pole pieces on the color wheel drive pass across the face of the pickup coil, complete the magnetic circuit and induce a signal voltage in the coil. The location of the two rotating pole pieces is shown in the photo and Fig. 2. The sync pickup coil should give a voltage of at least 5 r.m.s. when the color wheel is rotating at 600 r.p.m.

The addition of the sync pickup coil to the color-wheel drive mechanism completes the construction of the Colordaptor system. Recheck all wiring connections against the schematic.

Alignment and adjustment

Check the B-plus voltage from the power supply after the Colordaptor has been on for about 3 minutes. This voltage is set to between 200 to 225 by adjusting the 1,000-ohm 10-watt power supply series resistance.

The next adjustment, alignment of the chroma amplifiers, requires a signal generator calibrated to cover the range 2.5 to 5 mc and a detector. The detector may be a high-frequency probe on a vacuum-tube voltmeter or simply a crystal diode and a multimeter connected as in Fig. 3.

Attach the signal generator output to the grid of VI-a and the detector across L4. Set the signal generator to 3.5 mc. Adjust TC6 and then TC5 for maximum response. Set the signal generator to 4.5 mc and tune sound trap TC4 for minimum response. As the signal generator frequency is varied, a response such as shown in Fig. 4 should result. Some retuning of TC5 and TC6 may be necessary to obtain this response. If sharp peaks are obtained reduce the value of R1 or R21 to flatten the response.

Leaving the detector across L4, attach the signal generator input to the TV video detector so that the signal goes through preamplifier V9. Set TC1 at about half capacitance. The longer the twisted-pair length the lower will be the final value of TC1. Set the signal generator at 4.5 mc and tune sound trap TC2 for minimum response. Set the signal generator at 4 mc and adjust TC3 and the preamp trimmer for maximum response. Tune the signal generator to 3 mc and adjust TC1 for maximum response. Repeat these adjustments until the response curve of Fig. 5 is obtained. This curve has sharply peaked gain at 4 mc and is designed to compensate for the reduced i.f. and video bandwidth of many sets.

For TV sets having wide-band i.f. strips, reduce the value of the resistor across L2 and shunt preamp coil L16 with a suitable resistance to obtain flat response from 3 to 4.1 mc. As a final check readjust sound traps TC2 and TC4 for minimum response at 4.5 mc.

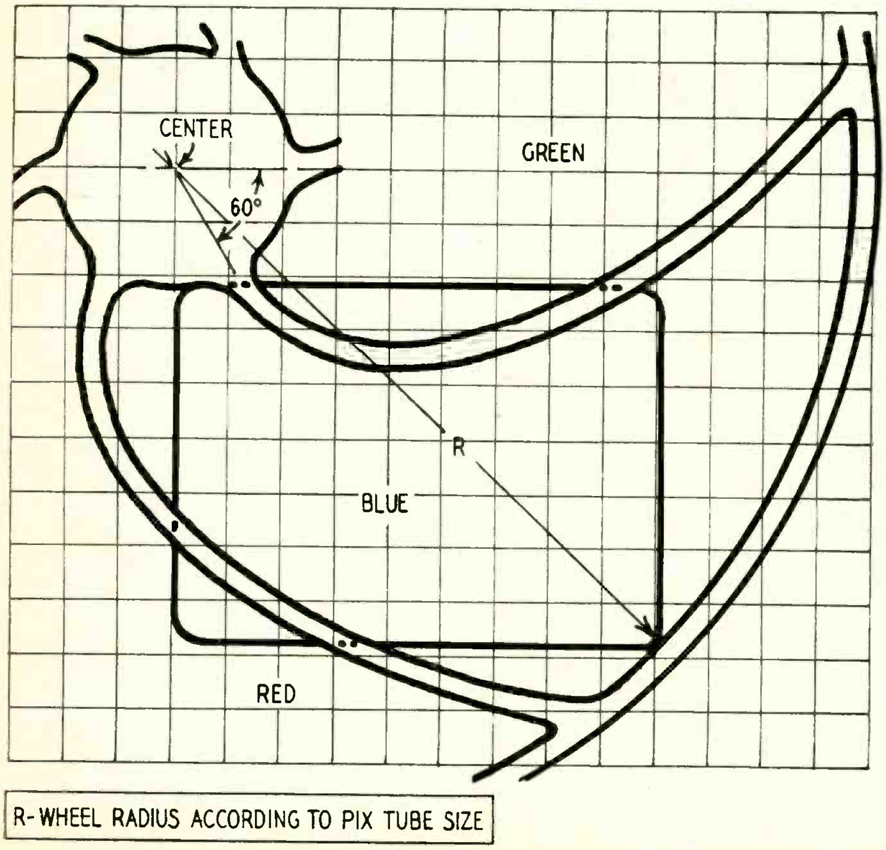


Fig. 1—Layout of the color wheel.

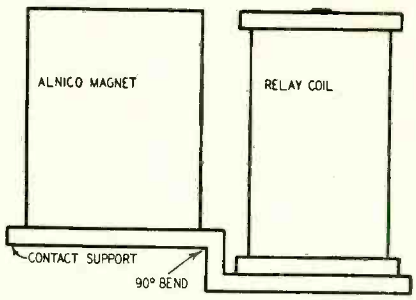


Fig. 2—Synchronizer coil construction.

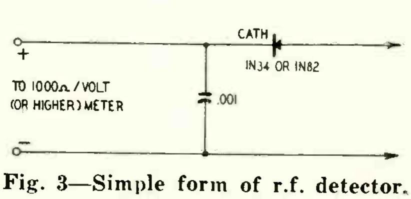


Fig. 3—Simple form of r.f. detector.

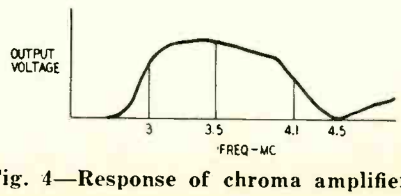


Fig. 4—Response of chroma amplifier.

This completes the alignment of the chroma amplifier circuits.

To adjust the reference channel connect the signal generator to the grid of V6-b and a voltmeter to the test point. Tune the signal generator to 3.58 mc and adjust TC11 for maximum response, keeping the test point voltage below 2 by reducing the signal generator output. Move the signal generator to the grid of V6-a and, with the signal generator at 3.58 mc, repeat the above procedure, adjusting TC12.

The reference-channel phase tritch is now checked for proper operation. Connect an oscilloscope, synchronized by the TV set vertical sync pulse, to each of the tritch plates. With proper operation the waveforms of Fig. 6 are obtained. If an oscilloscope is not available, connect a multimeter between B plus and each of the tritch plates in turn. All plates should indicate a voltage of about −20 with respect to B plus.

If the tritch is not functioning as above, disconnect the vertical sync pulse from the TV set. Cycle the tritch by momentarily shorting to ground each of the grids (V4-a, V4-b and V5-a) in sequence. Then momentarily short the V4-a grid to ground. Now the V4-b plate should be 60 volts less than B plus and the other two plates should be near B plus. Similarly shorting the V4-b grid should lower the V5-a plate voltage and raise the other two plates to B plus.

The cycle is finished by shorting the V5-a grid to ground which restores the original condition of the V4-a plate 60 volts less than B plus and the other two plates at B plus. If shorting a grid does not cause the next tube in sequence to conduct, increase the grid resistor (R7, R8 or R15) of the next tube slightly and repeat the sequence test.

The Colordaptor unit is now ready for alignment with a standard color transmission. Attach a voltmeter to the test point and adjust TC7 and crystal tuning TC9 for maximum output. Neutralizing capacitor TC8 is adjusted by observing the test-point voltage with an oscilloscope synchronized to the horizontal sweep frequency. The output

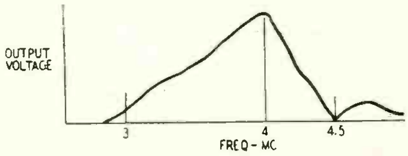


Fig. 5—Diagram shows response of the preamplifier and chroma amplifier.

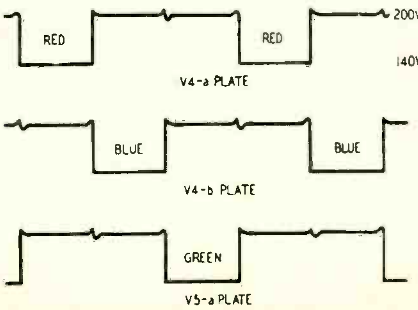


Fig. 6—Waveforms on tritch plates.

should be reduced by detuning (varying the fine-tuning control on the TV set) to get about 1 volt, as indicated on a d.c. meter, at the test point. Capacitor TC8 is now adjusted to get the oscilloscope pattern shown in Fig. 7. This waveshape indicates that the crystal is properly neutralized. If an oscilloscope is not available, a fixed capacitor of 10 $\mu\mu f$ may be substituted for TC8 since this adjustment is not too critical.

Now switch the TV set to a channel not broadcasting color and, with TC10 at minimum capacitance, increase it until less than 0.5 volt is measured at the test point. This adjustment prevents oscillation in the reference channel when no color signal is present.

The color wheel may now be started and adjusted for synchronism. Turn the R22 slider to the B plus side and adjust R23 until the color wheel goes slightly too slow—when the bars appear to go in the same direction as the wheel rotation. When the color wheel speed is correct, a white picture is seen with a clear gray bar occasionally crossing the picture. Now turn the R22 slider to the ground end. The gray bar should now go through the picture in the opposite direction to the wheel's rotation. The color wheel can now be synchronized by adjusting R22.

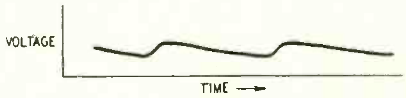


Fig. 7—Waveform shown indicates the correct neutralization of crystal.

To obtain proper phasing of the color wheel, the synchronizer pole pieces should be moved relative to the color wheel so that as the blue filter starts across the TV screen the pole pieces are just passing the pickup coil.

If proper speed cannot be obtained as above, check pulley ratios. If the wheel is too fast, additional series resistance can be added in the motor circuit.

With the color wheel properly synchronized a full color picture should now be obtainable. The color gain is controlled by R20 and will also be strongly affected by the TV set fine tuning. In an intercarrier set adjust the fine tuning until the sound interference just disappears from the picture. Attach a voltmeter to the Colordaptor test point and adjust the horizontal locking control of the TV set for maximum reference voltage. Also, retune TC9 and the reference channel, tuning trimmers TC11, TC12 and TC7 for maximum response.

The final adjustment is the color phase. With the color wheel properly synced and a color signal present, reference phase TC12 can be adjusted to obtain pleasing flesh tones and lipstick red. Capacitor TC12 gives the greatest color phase range, but TC7 and TC11 also affect color. If proper color phase is unobtainable, reverse the leads to either L3 or L4 but not both and again adjust the phase controls. END

"Silver Screen 85's" new barium "picture-guard" process deposits a lining of barium over the tube's inside walls. Increased "getter" action keeps the vacuum pure, protecting the screen and electron gun from contamination. The result: Silver Screen 85 gives a brighter picture for a longer time.

"Silver Screen 85's" new high-energy electron gun delivers 10% more light-producing electron energy to the screen. Brightness is increased an equal amount. Precision-focus keeps the picture in perfect sharpness.

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In addition to "Beat the Clock" Sylvania will use Sunday Supplements to promote the "Silver Screen 85" in your own locality. Full schedules will be run in *This Week* and *American Weekly*, plus a score of independent Sunday Supplements.

• • •

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new Records

MONITOR

Stereophonic Tapes

The number of stereophonic tapes is still small. Livingston offers the largest library; Webcor-Concertapes are also available in stereo versions; RCA has a small handful. But the introduction of the Ampex system (see "For Golden Ears Only") will no doubt encourage the issuance of more stereo tapes: in fact, announcements of coming issues have already been made by Omegatape and others.

Most present stereo tapes were made at the same time as normal tapes for disc versions and pretty much as an accessory. Very few have been recorded solely to achieve the best possible stereo effect by arranging mikes and orchestra and conducting the music with that in mind. Moreover, stereo recording is very new and still highly experimental; nobody knows much about it and techniques are still to be developed. Therefore, do not judge the eventual possibility of stereo sound entirely by the quality of many presently available tapes; it is safe to say the tapes will improve tremendously.

Stereo reproduction can produce some highly special effects completely foreign to single-channel projection. In reviewing the following tapes I have stressed these effects and coined a few phrases to describe them. "Directionality" is extremely important, at least for demonstrating the stereo effect. "Walking" describes the effect of an instrument or whole choir seeming to walk across the stage while playing. A trumpet in a Dixieland band, for example, can seem to walk from right to left or vice versa if the trumpet player swings the trumpet from one mike to the other. "Crossing over" is more violent; the instrument or voice or choir seems to change position in an instant. "Stretching" is the effect of stretching the band or orchestra (or even a single instrument) in a single row at the front of the stage. "Thinning" is a milder version of the same effect where the depth of sound is diminished in favor of stretching out. "Gapping" is an effect where part of the instruments are in left field, part in right field and none in the infield. This occurs principally during very pianissimo or soft passages involving the instruments at the extreme ends of an orchestra.

Ampex demonstration tape

So far as I know this tape is not for sale but since it will be heard frequently a few comments may be pertinent. The general plot and plan are excellent and the tape does get across the improvement possible with stereo reproduction. However, the two selections chosen are rather unfortunate to my mind. For one thing the 620 amplifier-loudspeakers, good as they are, are incapable of reproducing anything but the harmonics and distortion of the pedal organ bass underlying the opening of *Thus Spake Zarathustra*. The irony is that an organ pedal bass neither possesses any directionality in real life nor requires any; so there is no point whatever to using it, and it does show up one of the very few deficiencies of the system. Neither this nor the final selection are strong in stereo effects and moreover possess very few first-class demonstration values of any kind. So do not base your opinion of stereo or the Ampex system solely on this tape alone.

Josh White Comes A-Visiting

Livingston T-1085BN

(Specify stacked or staggered head.)

I thought this the best showoff and demonstration tape of the dozen or so I have reviewed. Presence is very complete and not unnatural either since the small group can easily be imagined to be in a big living room. Directionality is very fine throughout with no aberrations that I noticed. Josh is always on the right, the basses on the left and others fill in the middle. The mixture of solo and chorus voices with small band music is especially effective and impressive. The hi-fi quality is first rate; there is a fine gutty double bass, excellent guitar transients and some good dull drums. This is one of the exceptions which was miked for stereo effect primarily. It is especially suitable for stereo systems using a big single-channel system for the left and the Ampex for the right channels; in fact, it produces the most overwhelming effect with this combination.

Barbara Carrol Trio

Livingston T-1081BN

(Specify stacked or staggered head.)

This too is excellent because, again, it is easy to imagine a trio in a living room and the close-up perspective is natural. The polarity of this is reversed: the right channel has the heavier bass and, if you use the big speaker plus one Ampex combination, you should reverse the plugs. The gapping separates the piano from the bass and drums but the effect is impressive rather than distracting.

Lennie Herman and Mightiest Little Band in the Land

Livingston 1083BN

(Specify stacked or staggered head.)

Another top-notch demonstration tape. Traps and accordion right; sax, piano and bass left. The directionality is perhaps the least subject to changes in listening position of all the tapes tried. Even at extreme angles to one side or the other, both speakers are heard. Rather thin in the middle but the gapping is mild and the stereo effect heightened. Realism and presence very complete. Excellent with dissimilar systems, bass and big bass on the left. No aberrations noted. Hi-fi quality is first rate, good traps and good bass.

Red Onion Jazz Band

Empirical EM7-5BN

(Specify stacked or staggered head.)

Right in there with the above. Polarity normal; directional effects not so marked but excellent. Hi-fi quality is excellent, too, the big dull, damped (probably padded) bass drum does not come through on the Ampex but will come through on a mixed system with good low-frequency response.

John Halloran Choir

Now Let Every Tongue Adore Thee, Little Boy Blue, Cindy, Allelluja, Skip to Mah Lou, etc. etc.

Webcor-Concertapes 2922-1

Good presence (although the Capitol disc of Folk Songs of the New World has at least as good presence on a good single-channel system). Directionality good with the basses on the left, the sopranos on the right; some tendency for the altos, tenors and baritones in the middle to creep or walk. Depth pretty good. The music will please and the overall effect is favorable to stereo.

Disc Records

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

Musical Organ Clock

Vanguard VRS-7020 (10-inch MG)

It seems the jukebox goes even farther back than we thought. This is an extremely faithful reproduction of the elaborate musical clock organs of the 18th century. The *acoustic* intermodulation of wind and pipes is plainly audible in many spots.

Restful Good Music

Stokowski and His Symphony

RCA Victor LM-1875

The title is one of the silliest in the catalogs but the record is just what the doctor ordered to soothe the nerves of wives and children. On a fine system it can sound impressive, too. And the very legato and slow music provides a pretty

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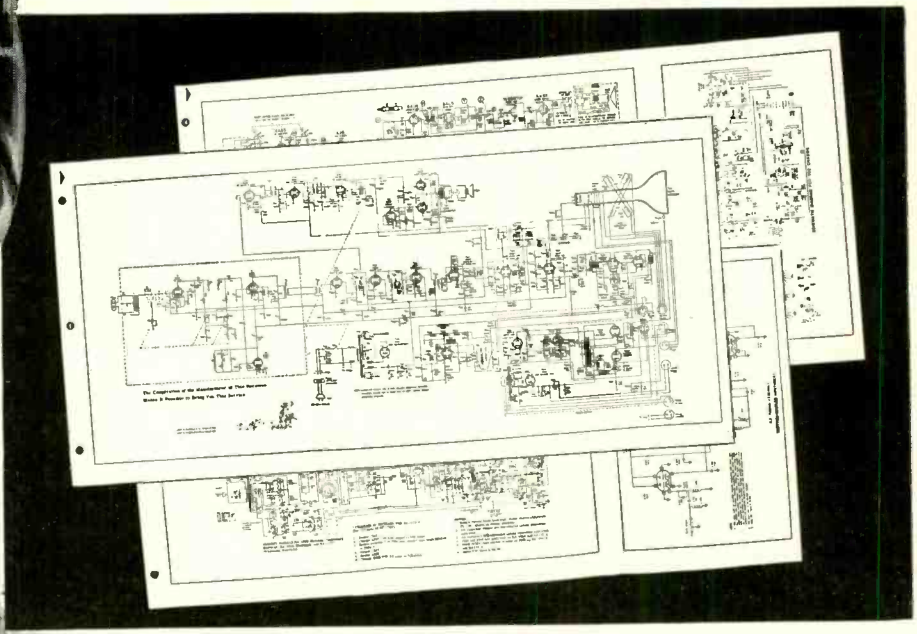

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HOWARD W. SAMS & CO., INC., 2205 E. 46th St., Indianapolis 5, Indiana

NEW RECORDS (Continued)

severe test for wow in spots. Very pleasant and soporific music, some of it seldom heard.

The Music of Purcell, Jenkins and Locke
Alfred Deller, counter-tenor
Leonhardt Baroque Ensemble and Consort of Viols
Vanguard BG-457

Ancient instruments including a "consort of viols" and the very rare counter-tenor (male alto) voice in beautifully performed examples of 17th-century English music. Good test for noise, wow and rumble, naturalness and a fine sedative for too loud and too much hi fi.

Names and addresses of manufacturers of any items mentioned in this column may be obtained by writing Monitor, RADIO-ELECTRONICS, *25 West Broadway, New York 7, N. Y.*

CORRECTION

Several readers have inquired about the discrepancy in dimensions of the port pieces in Figs. 1 and 3 of Mr. Drenner's articles on the Karlson enclosure (pages 54-56 October, 1955, issue).

The author states that the dimension given as 11¼ inches on Fig. 3 should be 10¼ inches, and the 11⅛-inch dimension in Fig. 1 is correct. Inaccuracies in sawing will vary the point where the port pieces meet the top angle and stiffeners. The port pieces can be as short as 10¼ or as long as 11½ inches without affecting the fit with the top angle. If cut to 11⅛ inches (the preferred dimension) as in Fig. 1, they butt flush with the top surface of the top-angle stiffeners. Cut them longer and they extend above the stiffeners. When cut to only 10¼ inches, the stiffeners lap over the port pieces as shown in the rear-view photo in the article.

The important port-piece dimensions are the width (8¼ inches) and the point at which the top angles contacts them above the shelf (8 13/16 inches). This dimension will be automatic if the 45° miters on the top angle are correct.

Radio Thirty-Five Years Ago
In Gernsback Publications

HUGO GERNSBACK, *Founder*

Modern Electrics	1908
Wireless Association of America	1908
Electrical Experimenter	1913
Radio News	1919
Science & Invention	1920
Television	1927
Radio-Craft	1929
Short-Wave Craft	1930
Television News	1931

Some larger libraries still have copies of ELECTRICAL EXPERIMENTER on file for interested readers.

In February, 1922, *Science and Invention* (formerly *Electrical Experimenter*)

10,000 Years Hence, by H. Gernsback.

If President Harding Spoke to 120,000,000 People.

An Interview with Nikola Tesla, by H. Winfield Secor.

Recording and Amplifying Radio Time Signals, by Arthur H. Lynch.

Collapsible Aerial for Submarine Radio.

Radio Cheers Arctic Explorers.

Receiving the Radiophone Concerts, by Robert E. Lacault.

Radio Set in a Watch Case, by Bernard Tucker.

A New 150 to 3,000-Meter Receiver, by Arthur H. Lynch.

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Better than any claims we could make is the unqualified and enthusiastic acceptance by engineers and servicemen alike. These are some of the features on which this acceptance is based:

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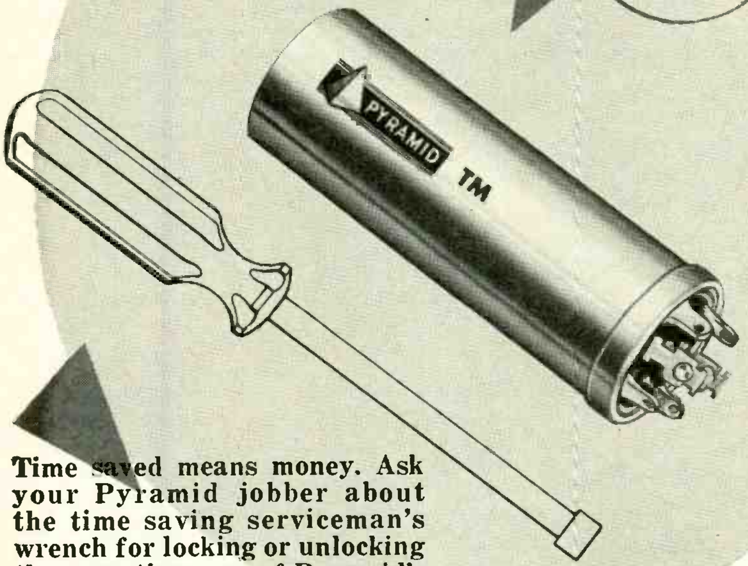

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Technicians News

NATESA PROTESTS

The following press release was received from the National Alliance of Television & Electronic Service Associations. None of the editors of RADIO-ELECTRONICS were personally present at the Indianapolis meeting, our story having been obtained by an outside reporter. Neither have we received any of the press releases mentioned, our sole information on reactions, other than a number of releases from NATESA, being one "letter to the editor" (page 16) and one item in a trade paper. Therefore we are printing the release without comment:

"Numerous press releases have been issued by a few delegates to the service unity meeting at Indianapolis who participated in the unanimous vote to accept NATESA as *the* national association, but who now are going back on their word. The phraseology of these releases bears remarkable similarity to those of a publisher of a so-called service management magazine who has long had ambitions to control the service industry through a captive association and the use of his magazine as the voice of the group.

"To recognize the insincerity of the charges being made it should be recognized that NATESA had less than one-third of the total vote at the meeting. The president of NATESA is being falsely charged with dictatorship simply because he has been doing, and we are quoting one of their releases, 'three jobs' without compensation and 'there are too few persons with the initiative, time and ability to carry out the duties of *one* of these jobs, much less all three', and for that reason was re-elected in open elections five times. Would a dictator publicly offer to resign and disavow any office as did the NATESA president at Indianapolis, and in print?

"The second false charge is that made against the organizational setup of NATESA which has been in effect since the first days of NATESA. Originally, three divisions were created. These have been expanded as NATESA grew. Full recognition is given state groups. The opponents of NATESA give credit for origination of this setup to a Texas group which has such plans for the future. The 'State Supremacy' group would deprive three-fourths of all local groups of a voice since very few state groups exist. Is this an example of their lack of knowledge of the independent service industry, or are their plans insidious?

"NATESA has offered to waive its

right to challenge applications of qualified groups if they are submitted by a specified date; the NATESA president has offered to resign; NATESA, at its cost, distributed copies of the Indianapolis meeting minutes, its constitution, organizational system and other materials, to the nonaffiliates who attended the meeting; NATESA has for 5 years mailed large numbers of informational bulletins, and for 3 years each copy of *Scope*, free to over 200 nonaffiliated local groups; it has, at no cost, mailed copies of its *Here's How* brochure to help new groups organize; NATESA personnel have made personal visits to many cities at their own expense to help many new associations. Can any of the NATESA opponents make these statements truthfully? Why have these groups repeatedly refused to cooperate and reciprocate?"

TEXAS MOVE FOR UNITY

The Texas Electronic Association has resolved to contact other state service groups with a view to forming a national federation outside the National Alliance of Television & Electronic Service Associations, according to a recent report in *Retailing Daily*.

This decision was reached at the organization's quarterly meeting after a proposal that TEA join NATESA was defeated.

THE OKLAHOMA PLAN

The recently organized Television Service Association of Oklahoma has developed an organizational form that somewhat resembles a cooperative, as well as undertaking activities to raise the prestige of the service technician in the eyes of the public.

The association plans to educate the public through newspaper advertising, to raise service standards, to maintain fair prices and to guarantee work done. To put the first of these principles into effect, full-page ads in the *Sunday Oklahoman* have been taken. The ads include the TSA code of ethics.

Members of the association on joining buy one share of stock in the corporation at $50. They also agree to pay membership dues of $100 a year which are amortized in an interesting manner. Members agree to buy from the association supplier, an Oklahoma City distributor, at least 75% of parts and tube requirements, credits accrued being applied to dues.

H. O. Eales, owner and operator of Eales TV–Radio Service Co., Oklahoma City, is president of the new group. Vice presidents are F. E. Banks, Sapulpa; Ed Cones, Oklahoma City; Raymond Selby, Kingfisher. William Jones, Oklahoma City, is secretary-treasurer and Bob Armstrong, also of Oklahoma City, is full-time executive secretary.

ATLANTA ASKS POWERS

As a step toward stamping out fraud in television repairs, the city of Atlanta has authorized its attorney to draft a resolution asking for power to revoke business licenses and to present it to the 1956 Georgia Legislature.

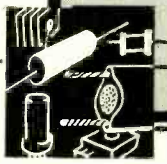
The resolution will ask for authority to revoke the city license of any radio or television service technician found guilty of fraud. At present business licenses are considered a right, not a privilege, and the city has no power to revoke them.

The action was taken after the conviction of a repairman who confessed that he had taken pay from a customer for parts that were not installed in the set. The repairman was given an 18-month suspended sentence and fined $150.

NEW SERVICE TOOL?

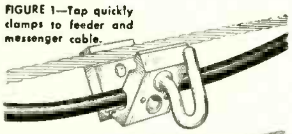
A camera can be a valuable instrument in the repair of TV receivers, especially those that screwdriver technicians or do-it-yourself owners have been operating on. This discovery was made by the Havill TV Service of Chicago. Whenever a messed-up set comes into the shop, "before" and "after" photos are taken of it. The negatives are developed and prints presented to the owner only if he complains about the cost of the job. END

new Devices



CABLE TAP, for permanent, weatherproof connections without severing cable or stripping leads. Developed to connect service drops to main feeder cables in community TV antenna systems. Coax or single-conductor, solid or stranded cables may be used. With coax, connection automatically made

FIGURE 1—Tap quickly clamps to feeder and messenger cable.



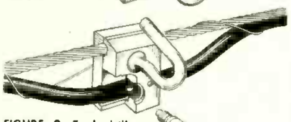


FIGURE 2—Tool drills hole to center conductor.

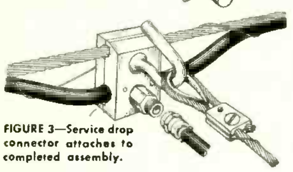


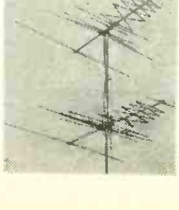
FIGURE 3—Service drop connector attaches to completed assembly.

to center and outer conductors. Shunt capacitance less than 1.5 $\mu\mu$f.—**Jerrold Electronics Corp.,** 23rd & Chestnut Sts., Philadelphia 3, Pa.

TOWERS, *models 200, 240, 400,* streamlined design, attractive taper and top section. Use 1¼-inch electrically welded

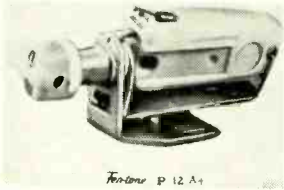
steel tubular uprights.—**Jontz Mfg. Co.,** 1101 E. McKinley, Misawaka, Ind.

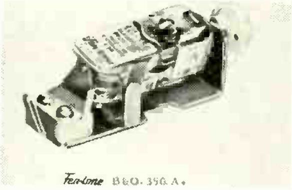
FRINGE-AREA ANTENNA, *Power-Helix,* all-channel type. Helical design with flatplane dipole system. Long element measures ½-wavelength on channel 2, receiving channels 2, 3. Next element ½-wavelength on channel 5, receiving channels



4, 5. Good gain, directivity on channel 6 by combining antenna back section with special harness to form closed loop. Good high-band reception from helical section.—**JFD Mfg. Co., Inc.,** 6101 16 Ave., Brooklyn 4, N. Y.

ANTISTATIC CARTRIDGES, *Fen-Tone B&O–350 A+,* and *P–12 A+.* Incorporate foil lam-



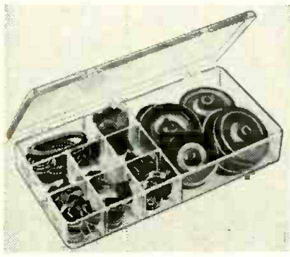


inate containing minute quantity of radium that wipes static charges off records. Contact points between jewel and record irradiated by alpha rays which ionize air around needle (makes air electrically conductive), dissipating static charges. *B&O–350 A+* is professional high-fidelity magnetic cartridge; *P–12 A+* for extended range where 300–500-mv high-impedance input is required.—**Fenton Co.,** 15 Moore St., New York, N. Y.

HI-FI AM TUNER, *model AM-80,* with meter for micro-accurate station selection. 3-position adjustable bandwidth control. Sensitivity better than 1 μv. 1 tuned rf and 2 if stages; frequency response (broad position) 3 db at 8 kc, audio section uniform response 20–20,000 cycles, built-in 10-kc whistle

filter, dual antenna inputs, loop antenna. 3 high-impedance inputs, cathode-follower output permits leads up to 200 feet, completely shielded, including bottom plate, shock-mounted construction. — **Fisher Radio Corp.,** 21-21 44th Dr., Long Island City 1, N. Y.

PHONO DRIVE KIT, *G-C P400.* 51 exact replacement drives for servicing most record changers and tape recorders such as Webcor, RCA, Crescent, V-M,



Philco, Admiral, Revere and Ampro. Complete reference chart. Packed in clear plastic storage box.—**General Cement Mfg. Co.,** 919 Taylor Ave., Rockford, Ill.

HI-FI FM TUNER KIT, *Heathkit model FM-3.* Sensitivity better than 10 μv for 20-db quieting. Modern tube lineup for high gain and stable operation. Own power supply and provision for low- or high-level output at low impedance. Matches WA-P2 preamp in color, styling, physical size. If

and ratio detector transformers prealigned, front end tuning unit preassembled and aligned. 6BQ7-A cascode rf stage, 6U8 oscillator–mixer, two 6CB6 if amplifiers, 6AL5 ratio detector, 6C4 audio amplifier, 6X4 rectifier.—**Heath Co.,** Benton Harbor, Mich.

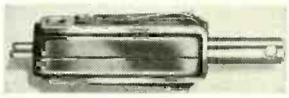
8 SPEAKER KITS: *KT-21 Imperial; KT-32 Tri-Plex, KT-21 Concerto-15; KT-22 Concerto-12; KDU-10 Treasure Chest Duette; DKU-11 Table Duette, KDU-12 Budget Duette; KTX-1*

Range Extender Supertweeter. All have special mounting brackets and wiring materials and detailed construction plans. —**Jensen Mfg. Co.,** 6601 S. Laramie Ave., Chicago 38, Ill.

NEW 7-INCH REEL, *IRISH,* 32 square inches of indexing area. Threading easy with two enlarged side openings. 28% more rigid than former standard reel; offered on all Irish

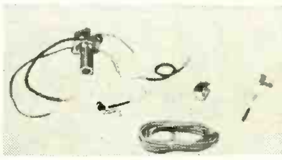
tapes. — **ORRadio Industries Inc.,** T-120 Marvyn Rd., Opelika, Ala.

PHONO CARTRIDGE, *Fonofluid Slim Jim, model TO-400* is small and light. Surpasses other Ronette models in com-



pliance, low IM distortion, frequency response, tracking, non-interaction of styli (in turnover models), constant-velocity response. Brackets and mountings to fit most record changers and arms.—**Ronette Acoustical Corp.,** 135 Front St., New York 5, N. Y.

CONVERSION KIT, *Stere-o-matic,* converts V-M Tape-o-matic tape recorder for binaural use. Includes stacked head, 1-

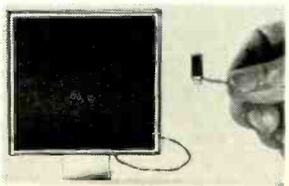


tube amplifier, hum bucking coil, pressure-pad assembly, necessary hardware and wiring.—**V-M Corp.,** Benton Harbor, Mich.

DRY RECHARGEABLE BATTERY, nickel–cadmium. Standard D to very small button type cells 10 mm in diameter. Hermetically sealed. From 4 ampere-hours to 7 milliampere-

hours. Average voltage output of 1.2; cells can be recharged as many as 200 times, depending on amount of load and depth of cycle. Useful with portable and transistorized equipment where required power is small.—**Gould-National Batteries,** E1201 First National Bank Bldg., St. Paul 1, Minn.

SELENIUM SUN BATTERY CELLS, have high self-generated output, ideal for transistor power supplies, control applications, photometric equipment and experiment. 0.14–10.5 square inches in photosensitive area, 0.1–15-mw power output in direct sunlight. Connected in series-parallel, covering area of 8 square inches, enough power generated in direct sunlight to drive typical 5-stage transistorized radio. Short-circuit current to 40 ma, open-circuit voltages to 0.5 per cell, generated in direct sunlight. Available on straight- or angle-



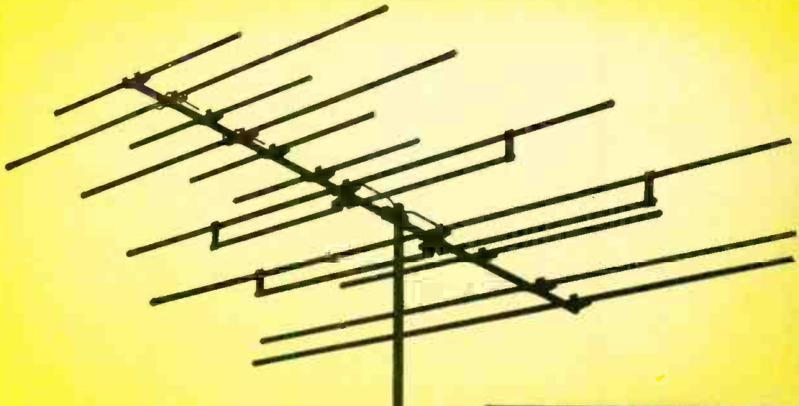
Exclusive!

The First MULTI-CHANNEL YAGI...PRE-TUNED TO CHANNELS OF YOUR CHOICE

New! **WINEGARD** *Combo*

. . . Gives You *More Gain* on Channels in Your Area

. . . Because it's *Peaked* to Channels in Your Area

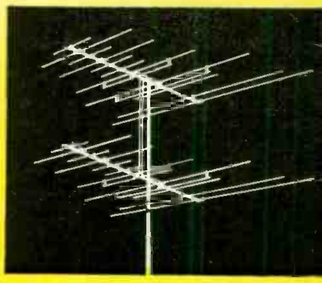


There has never been an antenna like the COMBO — the first MULTI-CHANNEL TV ANTENNA that is actually PRE-TUNED TO YOUR AREA. The Combo is factory peaked in 16 different channel combinations — one of which will give you the ultimate in performance on the specific channels you want.

This is the first logical, practical TV antenna development in years. The Winegard COMBO is guaranteed to give better performance on all channels in your area, regardless of size or number of bays of the antenna you are now using.

Another original by WINEGARD!

Designed for BLACK & WHITE AND COLOR



Single bay Combo — $29.95 **Double bay Combo — $59.95**

Available in 16 Factory Pre-Tuned Combinations

Custom-Combo Model No.	Channels Peaked for											
TC3-A	2	3	4	5	6	7	8	9	10	11	12	13
TC3-B	2	3	4	5	6	7	8	9	10			
TC3-C	2	3	4	5	6		8	9	10	11		
TC3-D	2	3	4	5	6				10	11	12	13
TC3-E	2	3	4			7	8	9	10	11	12	13
TC3-F	2	3	4			7	8	9	10			
TC3-G	2	3	4				8	9	10	11		
TC3-H	2	3	4						10	11	12	13
TC3-I		3	4	5	6	7	8	9	10	11	12	13
TC3-J		3	4	5	6	7	8	9	10			
TC3-K		3	4	5	6		8	9	10	11		
TC3-L		3	4	5	6				10	11	12	13
TC3-M			4	5	6	7	8	9	10	11	12	13
TC3-N			4	5	6	7	8	9	10			
TC3-O			4	5	6		8	9	10	11		
TC3-P			4	5	6				10	11	12	13

5 GOOD REASONS TO INSTALL THE COMBO:

1. **Pre-Peaked to Your Channels**
2. **Electro-Lens* Director System**
3. **Completely Pre-Assembled**
4. **Automatic Twin-Lock Hardware**
5. **All Aluminum and Stainless Steel Construction**

MAIL TODAY

WINEGARD COMPANY 1.
3000 Scotten Boulevard
Burlington, Iowa

Please RUSH ☐ COMBO Bulletin No. WL11135
☐ Address of nearest distributor

NAME OF FIRM ______

ADDRESS ______

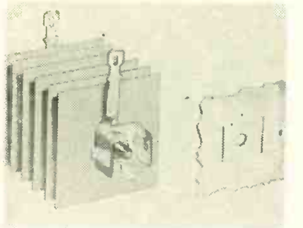
CITY ______ ZONE ______ STATE ______

SIGNATURE ______

*Patent No. 2700105

bracket mounts. Coded pigtail leads attached to sun battery electrodes facilitate connection to load.—**International Rectifier Corp.**, 1521 E. Grand Ave., El Segundo, Calif.

CLIP-IN RECTIFIER simplifies assembly. Instantaneous insertion and removal. Terminals may be used for both soldered and solderless connections, mount



is self-adjusting to all standard panel thicknesses. Adaptable to rectifiers rated from 25–195 volts a.c. and 65–750 ma dc.—**Federal Telephone & Radio Co.**, 100 Kingsland Rd., Clifton, N. J.

HIGH-TEMP RECTIFIERS, single- and 3-phase full-wave bridge selenium types delivering 20 and 100, 32 and 160 volts dc, respectively. Operates at maximum voltage–current ratings as high as 150°C without derating. Current range of 20-volt units (225 ma to 14 amps) closely approximated in others. —**Sarkes Tarzian Inc.**, 415 N. College Ave., Bloomington.

VOM PROBES permit new test with most popular types volt-ohm-milliammeters. 3 new probes; unique high-ohms unit converts R×10,000 range of vom to R × 100,000; signal-tracer and polarity-reversing probes also offered.—**Futuramic** Co., 1708 Armitage Ave., Melrose Park, Ill.

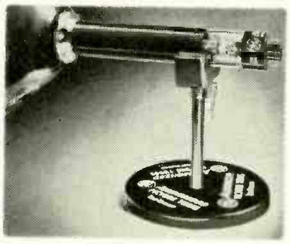
2-SET TV COUPLER, *model C-202*. High-frequency transformer type. Matched impedance of 300 ohms. Permits use of 1 antenna for 2 television sets by transferring signal to both with little signal loss. Maximum isolation between sets. Com-

pact, completely insulated with solderless connections. Mounted with 2 screws in any convenient location.—**Anchor Products Co.**, 2712 W. Montrose Ave., Chicago 18, Ill.

2-SET COUPLER, *model TV-42*, handles two TV or FM sets from one antenna. Flat from 0 to 900 mc. 300-ohm screw terminals for all connections. Resistive isolation averages better than 12 db between

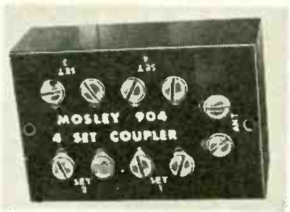
sets. May be used in reverse to mix two antennas or amplifiers into one line. 3½ x 1¾ x 1 inch.—**Blonder-Tongue Labs.**, 526-36 North Ave., Westfield, N. J.

TUBE NECK REST, *Nek-Rest*, eliminates fumbling for right-size prop to hold neck of TV picture tube. Easily adjusted to hold tube neck securely and



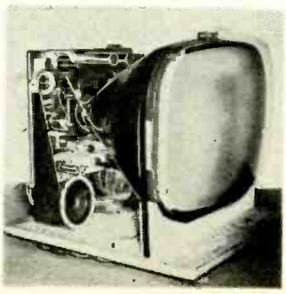
firmly at right height on service bench. Rubber wedges hold round tubes from rolling.—**General Electric Co.**, Schenectady 5, N. Y.

4-SET TV COUPLER, *No. 904*. Up to 4 TV sets can be coupled to 1 antenna with minimum interaction and radiation be-



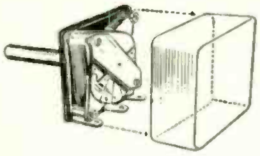
tween sets. Losses through coupler very low due to good impedance match. Satisfactory even in weak signal areas.—**Mosley Electronics, Inc.**, 8622 St. Charles Rock Rd., St. Louis 14, Mo.

TELEVISION KIT, *Arkay 14T21* 21-inch, vertical chassis. 12-channel turret tuner has 3BC5 rf amplifier and 5U8 triode–pentode mixer–oscillator. Separate oscillator frequency adjustments for each channel. Tuner may be adapted for uhf strips. Series-string heater type tubes, vertical retrace blank-



ing, reflex sound if amplifier. Brings in fringe-area signals.—**Radio Kits Inc.**, 120 Cedar St., New York, N. Y.

VARIABLE CAPACITOR, subminiature 2-section type, 1 x 1 x ⅝ inch for miniature superheterodyne circuits. Rf section 9–290 $\mu\mu f$; oscillator section 7–129 $\mu\mu f$. Sealed in plastic case.

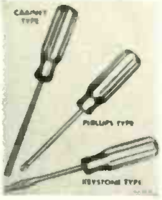


Has 2 subminiature padders ⅜ inch square. Single-gang at 365 $\mu\mu f$ also available.—**Lafayette Radio**, 100 6th Ave., New York 13, N. Y.

GENERAL-PURPOSE RELAY, *Amrecon model DOS*, for aircraft relays and industrial needs. Compact, lightweight, 15-amp contact rating at 115

volts ac or 32 volts dc noninductive load. Wide range of coil operating voltages for ac or dc.—**Ohmite Mfg. Co.**, 3681 Howard St., Skokie, Ill.

37 SCREWDRIVERS, the *Proto Ruby Line*, ruby-red handles of fire-resistant plastic. 16 keystone bits with bit widths of ⅛–$\frac{5}{16}$ inch, blade lengths 1½–9¾ inches; nineteen cabinet type with straight bits of widths from ⅛–¼ inch and blade lengths from 1½–9¾ inches; 2 Phillips type with No.



1 and No. 2 bits and blade lengths of 2⅞ and 4 inches. Conform to military specification GGG-S-121-C.—**Plomb Tool Co.**, Los Angeles, Calif.

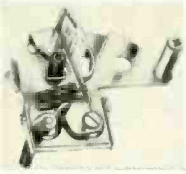
SERIES CHOPPERS, *1200 series*, for use in analogue computers, continuous recorders, dc amplifiers, servo systems. Chop-

per component has extremely low residual noise in switching circuit. Lift-off contact mechanism reduces contact bounce and chatter and extends closure stability. High degree of precision when subjected to temperature extremes, vibration and shock.—**James Vibrapowr Co.**, 4050 N. Rockwell St., Chicago 18, Ill.

TV U.H.F. CONVERTER, *model 210*, has 6AF4-A tube and 1N71 germanium crystal, 110-volt outlet for television set. Con-

tinuous tuning. Housed in wood cabinet. — **Elgin Electronic Corp.**, P. O. Box 13, Bluffton, Ind.

ROTARY CABLE STRIPPER, *model S-1*, for coax and other nonmetallic tubing up to ½-inch diameter. Standard single-

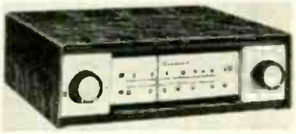


edge razor blade for cutting. Depth of cut and degree of spring tension varied through simple adjustments. Measuring scale insures correct amount of insulation and braid removed.—**Blonder-Tongue Labs.**, 526-536 North Ave., Westfield, N. J.

REPLACEMENT FLYBACKS (horizontal output) for Sylvania Nos. 241-0003, 241-0005,

241-0006 and 241-0007.—**Triad Transformer Corp.**, 4055 Redwood Ave., Venice, Calif.

AM–FM TUNER, *model HF255 Golden Star*. FM circuit uses discriminator with one limiter, afc; 5 μv for 20-db quieting, response ±0.5 db from 20–20,000 cycles. AM sensitivity 20



μv for 1-volt output, response ±4 db, 20–5,000 cycles. Distortion below 2.5% at 1-volt output.—**Rauland-Borg Corp.**, 3515 W. Addison St., Chicago 18. END

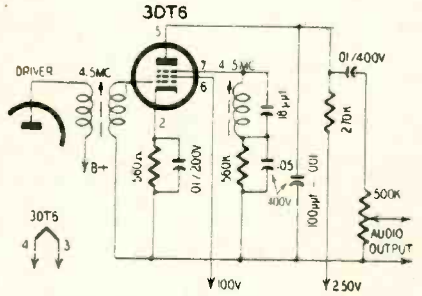
All specifications given on these pages are from manufacturers' data.

new Tubes & Transistors

3DT6, 6DT6

Seven-pin miniature types 3DT6 and 6DT6 announced by RCA are sharp-cutoff pentodes intended for use as FM detectors in television receivers. Designed so that grids 1 and 3 can each be used as independent sharp-cutoff control electrodes, these tubes may also be used in delay, gain-controlled amplifier and mixer circuits.

The 3DT6 and 6DT6 are especially suitable for use in locked-oscillator, quadrature-grid FM circuits where they can perform the combined functions of detector and limiter and are capable of providing a high audio output voltage adequate to drive a medium-power output tube such as the 6AQ5. In such a circuit (see diagram) the tubes can provide a sensitivity of 5 mv with ±7.6-kc deviation and 15 mv with 25-kc deviation.



The 3DT6 heater draws 600 ma at 3.15 volts, the 6DT6 300 ma at 6.3 volts.

970 silicon transistor

Announced by Texas Instruments, this power unit measures approximately ½ inch in diameter and ½ inch high. The mounting plate heat sink (see photo) extends outward from the transistor, covering an area 1 by ¾ inch.

Power dissipation of the n-p-n unit is 8.75 watts maximum at 25°C, with 3.5 watts maximum at 100°C. Power gain at 100°C ranges from 28 db at 1 watt output, class-A operation, to 18 db at 2.5 watts output, class-B operation.

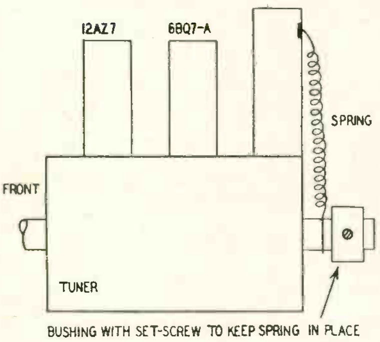
GT 34-100

A new diffused p-n-p junction transistor capable of operating at a collector voltage of 100 has been announced by General Transistor Corp., Jamaica, N. Y. Known as the GT 34-100, it is recommended for use in switching neon lights in computer circuits. END

Technotes

SNOW IN PHILCO 22B4110

This chassis came in with snow in the picture; the sound was O.K. The picture could be cleared by switching the channel selector on and off several times. Snow would then reappear at irregular intervals. I went over the switch contacts, coils and tubes with everything checking properly. Voltage and resistance checks revealed nothing.



Installing a 2-inch long spring on the rear end of the tuner switch shaft solved the problem. The spring is looped around the shaft at one end (see diagram) and is hooked in the slot at the top of the tuner. The upward tension on the tuner switch shaft eliminated the poor, snow-producing contact.—*Eino A. Hokkanen*

VERTICAL ROLL

The complaint on a Motorola set was vertical roll. The picture could be held steady for 2 or 3 minutes with the vertical hold control but would then start to roll again. Horizontal sync was steady.

Routine checking of the vertical section failed to disclose the trouble. I then noticed that just as vertical sync was lost, a faint trace of snow appeared in the picture. Replacing the 6BZ7 cascode amplifier in the tuner stopped all vertical roll and restored normal operation.—*Stanley Silvin*

RCA KCS47A CHASSIS

Frequent blowing of the fuse in the high-voltage cage may be caused by an intermittent short in the damper-tube heater circuit. This can often be cleared up by replacing the leads from the power transformer to the damper tube heater with heavily insulated moisture-proof wire. This same measure may be tried when symptoms indicate shorts in the damper circuit of other makes and models.—*Harry C. Keller*

New! SICO **Streamlined**
TUBE TESTERS

The new Model TC-55

FOR
The Experimenter or Part-time Serviceman, who has delayed purchasing a higher priced Tube Tester.
The Professional Serviceman, who needs an extra Tube Tester for outside calls.
The busy TV Service Organization, which needs extra Tube Testers for its field men.

• **You can't insert a tube in wrong socket.** Separate sockets are used, one for each type of tube base. • **"Free-point" element switching system** Any pin may be used as a filament pin and the voltage applied between that pin and any other pin, or even the "top-cap". • **Checks for shorts and leakages between all elements.** Provides a super sensitive method of checking for shorts and leakages up to 5 Megohms between any and all of the terminals. Continuity between various sections is individually indicated. • **Elemental switches are numbered in strict accordance with R.M.A. specification.** The 4 position fast-action snap switches are all numbered in exact accordance with the standard R.M.A. numbering system.

Speedy, yet efficient operation is accomplished by: Elimination of old style sockets used for testing obsolete tubes (26, 27, 57, 59, etc.) and providing sockets and circuits for efficiently testing the new Noval and Sub-Minar types.

Model TC-55 comes complete with operating instructions and charts and streamlined carrying case.

$26.95 NET

SICO
C.R.T. TUBE TESTER

The new Model TV-40

- **Tests all magnetically deflected tubes . . . in the set . . . out of the set . . . in the carton!!**
- **A complete picture tube tester for little more than the price of a "make-shift" adapter!!**

The Model TV-40 is absolutely complete! Self-contained, including built-in power supply, it tests picture tubes in the only practical way to efficiently test such tubes; that is by the use of a separate instrument which is designed exclusively to test the ever increasing number of picture tubes!

SPECIFICATIONS

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

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

$15.85 NET

SICO
The new Model TV-11
TUBE TESTER

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

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

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

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

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

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

$47.50 NET

SICO
TRANS-CONDUCTANCE TUBE TESTER

The new Model TV-12

TESTING TUBES

★ **Employs improved TRANS-CONDUCTANCE circuit.** An in-phase signal is impressed on the input section of a tube and the resultant plate current change is measured. This provides the most suitable method of simulating the manner in which tubes actually operate in Radio & TV receivers, amplifiers and other circuits. Amplification factor, plate resistance and cathode emission are all correlated in one meter reading.

★ **NEW LINE VOLTAGE ADJUSTING SYSTEM.** A tapped transformer makes it possible to compensate for line voltage variations to a tolerance of better than 2%.

★ **SAFETY BUTTON**—protects both the tube under test and the instrument meter against damage due to overload or other form of improper switching.

★ **NEWLY DESIGNED FIVE POSITION LEVER SWITCH ASSEMBLY.** Permits application of separate voltages as required for both plate and grid of tube under test, resulting in improved Trans-Conductance circuit.

TESTING TRANSISTORS

A transistor can be safely and adequately tested only under dynamic conditions. The Model TV-12 will test all transistors in that approved manner, and quality is read directly on a special "transistor only" meter scale.

Model TV-12 housed in handsome rugged portable cabinet sells for only

$72.50 NET

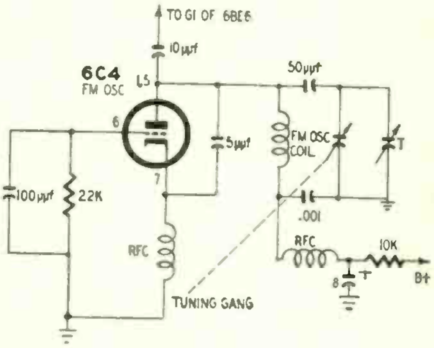
ALSO TESTS TRANSISTORS!

EXAMINE BEFORE YOU BUY!
USE APPROVAL FORM ON NEXT PAGE

TECHNOTES *(Continued)*

AM–FM MONITOR M3070

This set came in with the FM section inoperative. A check showed that the 6C4 oscillator was not working so I replaced it and the 6BE6 mixer without success. Voltages checked O.K. so I traced the oscillator circuit and found



that feedback was augmented by a 5-$\mu\mu$f capacitor between plate and cathode as shown in the diagram. The capacitor checker showed that this unit was leaky. Replacing it with a high-quality capacitor restored performance to normal.—*W. S. Ross*

SYLVANIA 1-366 CHASSIS

A continuous rumble from the speaker with the picture flashing or distorting may be caused by an intermittent condition in the mixer plate coil. The low range of the ohmmeter will show up the defect when connected across the coil.—*K. C. Henry*

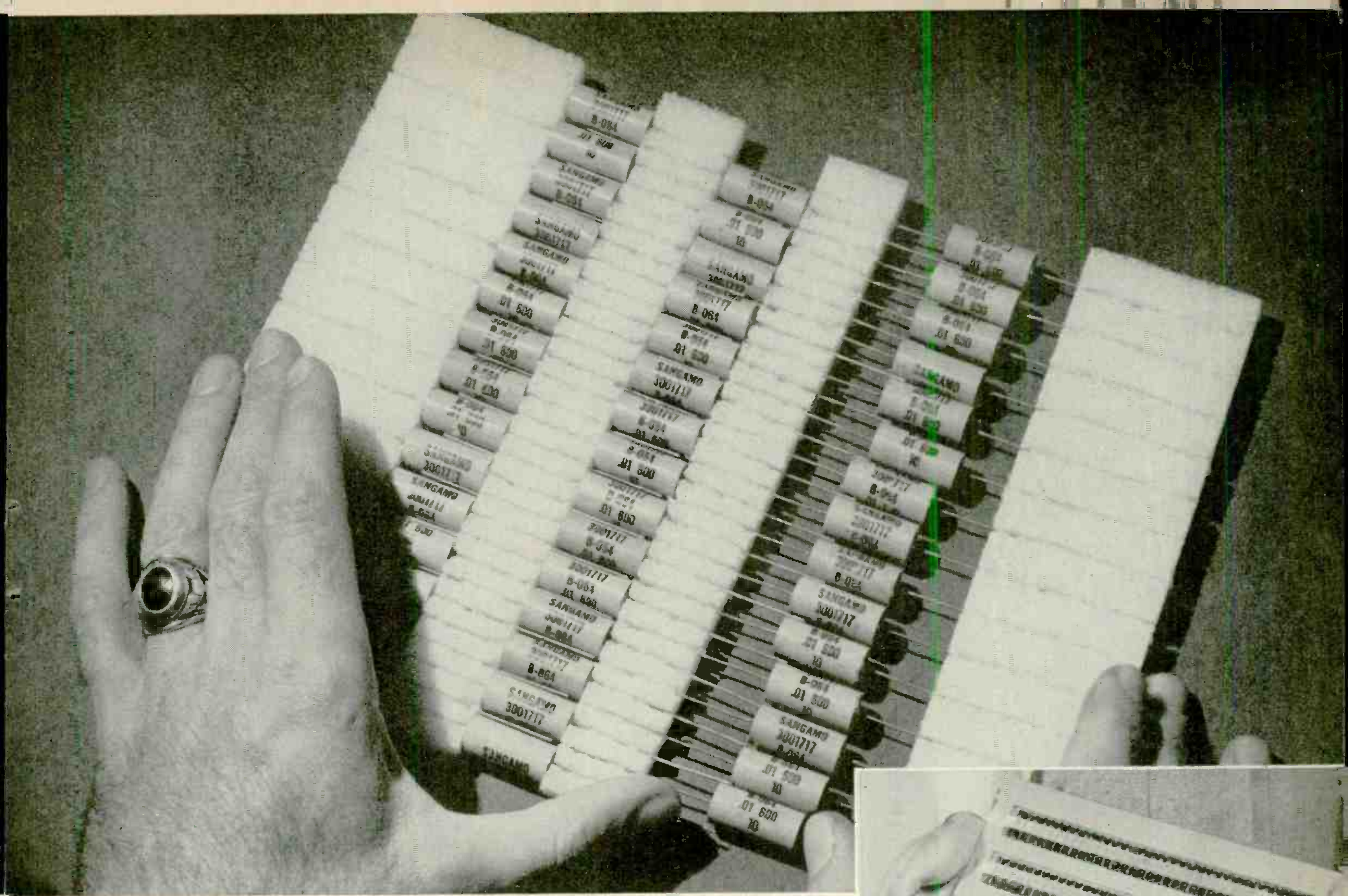
REGENCY RC-600 CONVERTER

The Regency type RC-600 was an early example of a tuned-line type u.h.f. converter. One of the greatest troubles in this unit is dirty lines.

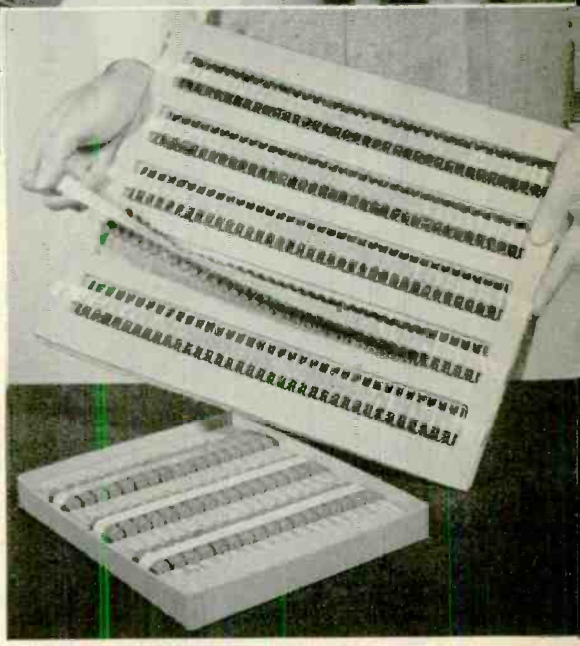
If you get any of these converters in for repair, try turning the tuning knob back and forth—sometimes the wipers will clean the lines and restore normal operation. If this does not work, pull the chassis and remove the round tuner unit from it. Unsolder both pieces of lead-in, the red B plus wire and yellow heater wire. Remove the dial string and pulley carefully, noting how it was strung up. Now take out the three 6-32 mounting screws which hold the tuner to the chassis. Carefully pull the tuner out of the chassis and place it on the bench.

You will notice a draw band around the tuner. Remove the two screws that pull the draw band together. Next, take off the 6AF4 tube cover and the screws securing the other end of the draw band. Then carefully remove the top and bottom covers. This exposes the lines and other working parts.

To clean the lines, use carbon tet or preferably a cleaning fluid suitable for cleaning silver-plated contacts. Take a soft cloth, dip it into the cleaning fluid and rub briskly back and forth on the lines where the slider rubs. These are the edges closest together. Rub for at least a minute with a wet cloth, then with a dry cloth for a few seconds. This cleaning operation will generally restore



COMPRESSED GLASS SEALED TYPES—Packed in light-as-air Styrofoam which holds axial type leads straight . . . keeps shipping costs down. Capacitors are easily removed from packing to be fed to automatic fabricating machines.



PLUG-IN PAPER TUBULARS—Attached to glass filament tape, uniform rows of these Type 36 paper tubulars can be lifted from the card and fed to assembly machines. Close tolerances between leads are maintained throughout shipping in spite of rough handling. Similarly-packaged standard paper tubulars, shown in the foreground, are also available.

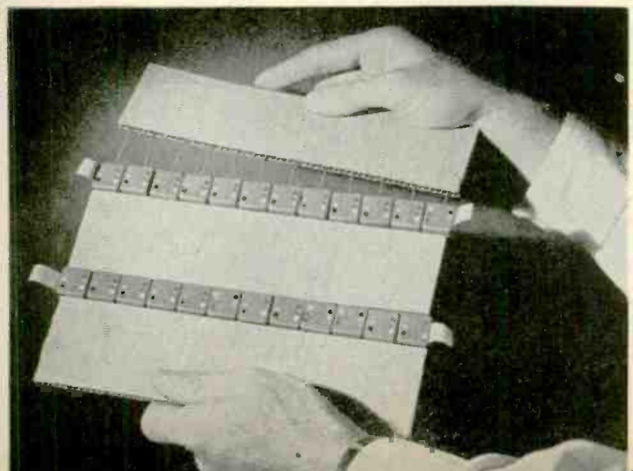
Specially packaged capacitors speed automated chassis assembly

New methods of packaging capacitors for automatic machine assembly of printed electronic circuits have been developed by the Sangamo Electric Company. With this special packaging, there's no need for time-consuming straightening of wire leads or checking if close tolerances between leads have been maintained throughout shipping and handling. This special packing makes it easy to remove Sangamo Capacitors from their containers in uniform rows, with wire leads always straight.

Here are a few examples of Sangamo packaging. Sangamo will be glad to discuss special packaging to fit your particular requirements. Write to the factory today.

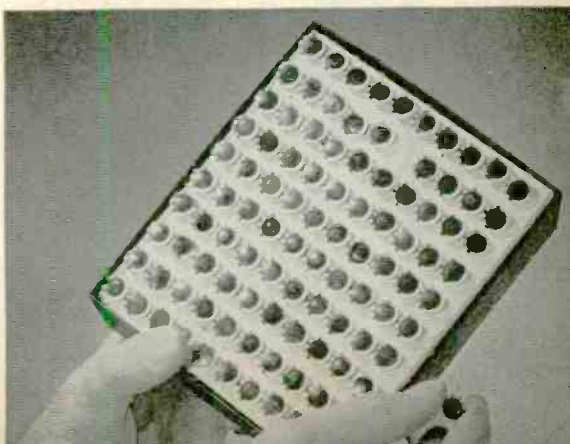
SANGAMO ELECTRIC COMPANY • Marion, Illinois

SC56-1



WIRE LEAD MICA CAPACITORS—Packaged to keep pre-trimmed leads straight in transit. Taped for ease of handling and feeding through magazine of automatic machines.

SILVERED MICA BUTTON CAPACITORS—Fixed in cardboard squares and boxed. Users like them because they may be easily stored and they provide quick identification of inventory. Color code does not chip off and terminals are kept from bending by this special packaging.



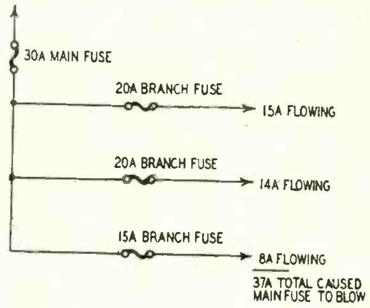
a tuner to proper operation again.—*James Fred*

FUSE TROUBLE

Not long after we'd installed a television set in an ancient farmhouse that had been wired before they passed Ohm's law that we had to run out several times because "the television set made the fuse blow." Not the branch fuse, mind you, but the main 30-amp fuse.

We finally routed the trouble with a little theory and an ammeter. Seems like three circuits fed from the main 30-amp fuse, two of them protected by 20-amp branch fuses, the third by a 15-amp unit.

Our test showed 15 amperes flowing through one 20-amp fuse, 14 amps



through the other. Thus, a total of 29 amps ran through the main 30-amp fuse.

When the video set was turned on, fed by the 15-amp branch, the 2.5 amps required passed through the protecting 15-amp fuse O.K.

But since this brought the total load on the 30-amp main fuse up to around 31.5 amps, it conked out and plunged the entire farm in darkness. Ergo—'twas the TV set doing the dirty work!

While we regretted the needless mileage piled up on these futile trips, we kept our temper, eventually landing a rewiring job on the old homestead and sold the customer several appliances.—*Stanley Clark*

WEAK SOUND—RCA KCS83

The audio was very weak in this set. After some circuit tracing and comparing with the schematic, I found that the schematic called for a screen grid resistor of 1,000 ohms in the second sound i.f. amplifier stage. The unit in the set was marked for 1,500 ohms and measured approximately 2,000. Replacing this resistor with one of 1,000 ohms brought back the sound to normal volume.—*Ray Peterson*

1954 21-INCH MOTOROLA

Complaints of poor horizontal hold and a small raster can be cleared by connecting a 27,000-ohm resistor in series with the grounded side of the horizontal hold control. This control has a 40,000-ohm stop but this is not enough resistance to prevent squegging when the control is turned too far. The 24-inch models do not show these symptoms because they have a 100,000-ohm resistor between the control and ground.
—*Wilbur Hantz*

END

radio-electronic Circuits

DIRECT-COUPLED AMPLIFIER

Except for the occasional two-tube single-ended audio circuit in a TV receiver, we rarely find a direct-coupled audio amplifier in modern audio equipment. Experimenters interested in a push-pull circuit of this type can experiment with the three-tube a.f. amplifier used in the Ferguson model 300RG, a British radio–phonograph.

This amplifier (see diagram) delivers 6 watts output with total harmonic distortion below 1%. The a.f. input signal is applied to the grid of V1 through a two-section high-pass filter that attenuates the very low frequencies and minimizes acoustic feedback and motor rumble. The amplified output of V1 is direct-coupled to V2 and fed to V3 through a 1-megohm resistor. The grid bias on V2 and V3 is the difference between the d.c. plate voltage of V1 and the voltage at the cathodes of V2 and V3.

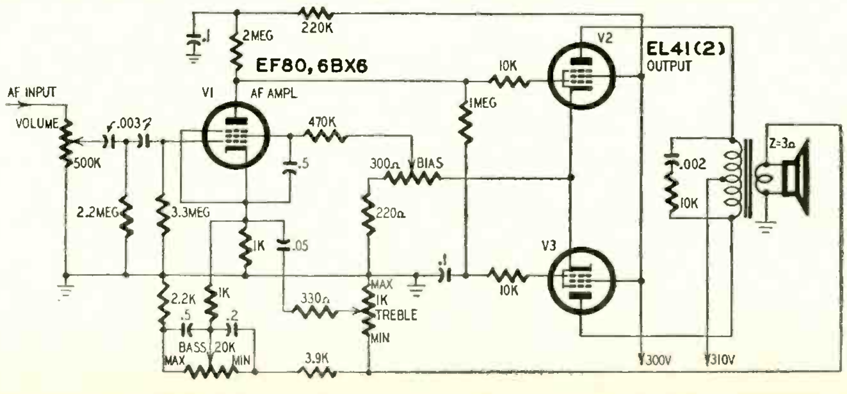
The screen voltage for V1 is tapped off a variable resistor (bias control) in the cathode return for V2 and V3. Adjusting the screen voltage with the bias control varies V1's plate current and voltage. Since V1's plate is connected to the grids of V2 and V3 the bias on the output stage is easily adjusted to the optimum value by varying the screen voltage on V1. If V1's plate current drops, its plate voltage rises and lowers the bias on the output stage. The increased cathode current passed by V2 and V3 increases the drop across the cathode circuit and raises V1's screen voltage sufficiently to restore its plate current to the original value.

For phase-inverting action, the grid of V3 is grounded for a.c. through the 0.1-μf capacitor. When the grid of V2 is fed a positive half-cycle of the signal voltage, the increase in cathode current causes the cathodes to go more positive. This is equivalent to applying a negative half-cycle of the signal voltage to V3's grid. Thus, the grids of V2 and V3 are effectively 180° out of phase.

Negative feedback is applied to the cathode of V1 through parallel paths consisting of the bass and treble controls. When the arm of the bass control is set to the maximum bass position, the 0.5-μf capacitor is shorted out and the 0.2-μf unit shunts the body of the control. We now have a voltage divider consisting of the potentiometer and the 2,200-ohm resistor. The upper portion of this divider is an impedance whose value varies inversely as the frequency. Thus, the feedback is reduced and gain increases as the frequency is lowered. Turning the control to the other end shorts the 0.2-μf capacitor and places the 0.5-μf unit across the potentiometer. Feedback now increases and gain decreases at low frequencies.

The treble control is a simple potentiometer across the feedback network with a variable voltage being applied to V1's cathode through a 330-ohm limiting resistor and .05-μf capacitor. When the control is set for minimum highs, full feedback voltage is applied to the cathode at high frequencies and response droops. The circuit is not effective at middle and low frequencies because the reactance of the .05-μf capacitor is equal to or much greater than the 1,000-ohm cathode resistor so the feedback voltage is greatly attenuated.

Setting the control for maximum treble connects the .05-μf capacitor and 330-ohm resistor across the cathode resistor of V1. These components act as a partial short circuit for the high-frequency negative feedback voltage reaching the cathode through the bass control. Connecting this R-C network across the cathode resistor also reduces degeneration and causes a rise in the response at high frequencies.



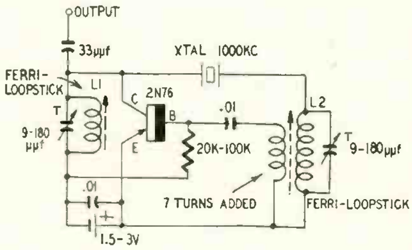
The bias on the output circuit is adjusted by disconnecting the 220-ohm resistor from ground and inserting a 100-ma d.c. meter between the free end of the resistor and ground and adjusting the bias control for proper cathode current—80 ma for EL41's.

These and other European tube types are now generally available through dealers handling foreign receivers and audio equipment.

CRYSTAL CALIBRATOR

The crystal calibrator is a useful and often indispensable instrument for the experimenter, service technician or ham. However, conventional crystal calibrators all require time to warm up.

This transistorized calibrator circuit was designed to overcome this disadvantage. The transistor requires no



warmup time and does not heat up in operation, so the calibrator can be used as a standard from the moment it is turned on.

A fairly high-gain transistor such as a 2N76 should be used for operation on low voltages. This transistor and its greater power capabilities offer an advantage if greater power output is ever desired. Two loopsticks (L1 and L2) and two small trimmers form the tuned circuits. The feedback path is through the crystal, which offers maximum feedback at its resonant frequency. The necessary phase reversal and impedance matching for the base are obtained through a seven-turn winding added to L1. Some control of the power input can be obtained by adjusting the base resistor.

Construction of the unit is well suited to miniaturization, but take a few precautions! Mount L1 and L2 at right angles or in such a way that there is no coupling between them. If very small batteries are used, the base resistor should be adjusted for minimum drain while still providing adequate output. To adjust the completed apparatus, connect a 10-ma meter in series with the battery. With the trimmers screwed about halfway down move the slugs of L1 and L2 in and out and set them to the point causing the greatest dip in input current. Adjust the trimmers for a still greater dip in current. When proper adjustment is reached, the input current will be from one-half to one-third the current that flowed when the device was not oscillating. The input with a 20,000-ohm base resistor at 3 volts was 2–3 ma. The usual final adjustment of frequency can be made by zero-beating the oscillator with WWV.—*Kai M. Klemm* END

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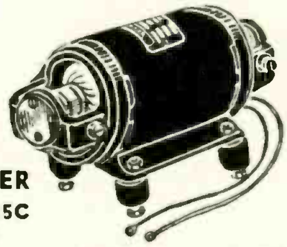

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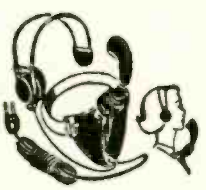

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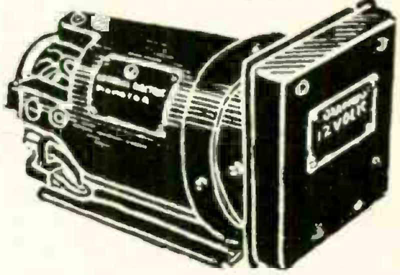

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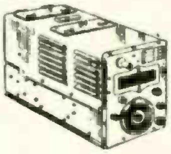

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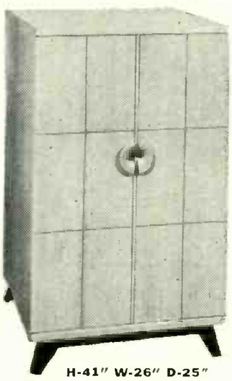

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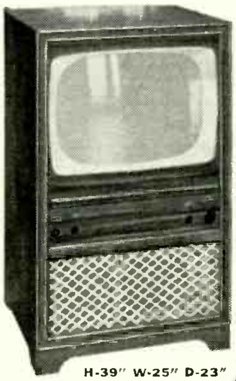

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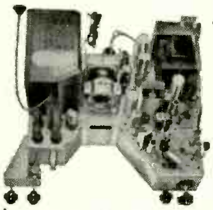

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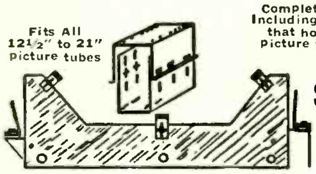

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.1 —400v	9c	.01 —1000v	14c
.25 —400v	12c	.035—1000v	16c
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Question Box

FM TUNING INDICATOR

I have seen FM tuners that use neon lamps instead of a meter or electron-ray tube as a tuning indicator. Please show a circuit of this type that I can add to my FM tuner.—J. R., New York, N. Y.

The circuit in Fig. 1 is used in the Sonocraft FM tuner. The 6J6 is a bridge type vtvm with a NE51 neon lamp connected between the plates. The input grid of the 6J6 is direct-coupled to the dc output of the FM discriminator. The voltage applied to the 6J6 grid is zero when the set is tuned exactly to the incoming carrier and is either negative or positive when the set is detuned.

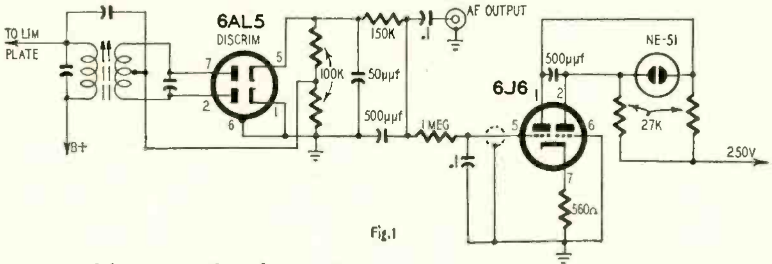


Fig. 1

The voltage applied to the 6J6 grid unbalances the plate currents and one plate swings negative while the other goes positive with respect to the balanced no-signal condition. The more negative plate of the neon lamp glows when a dc voltage is applied to it. Thus, one plate glows when the receiver is tuned above the carrier frequency and the other when it is below the carrier. Neither plate glows when the set is tuned exactly to the carrier frequency.

The circuit in Fig. 2 is used in a British FM set and was described in *Wireless World*. This circuit is similar to that in Fig. 1 but it has a lamp in series with each plate. Tuning is adjusted for equal brilliance in the lamps.

If the discriminator output voltage is positive, V1-a's plate current increases and its lamp glows brighter. At the same time, the increased drop across the common cathode resistor increases the bias on V1-b and its plate current drops and dims the lamp in its plate circuit. V1-a's lamp is dim and V1-b's lamp is bright when the discriminator output is negative.

The neon lamps are mounted about ⅝ inch apart and are covered at the sides by a light-colored opaque sleeve (white or yellow cambric spaghetti will do). The lamps are viewed from the ends through a frosted plastic diffusing screen.

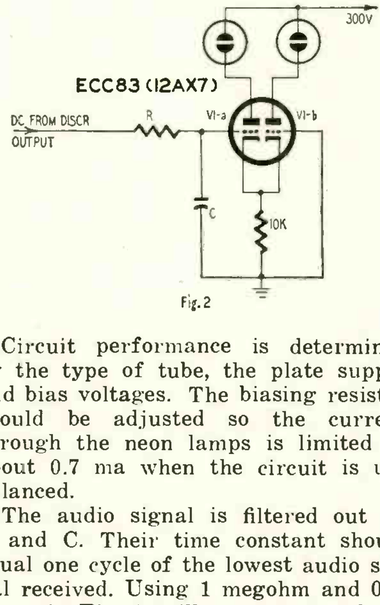


Fig. 2

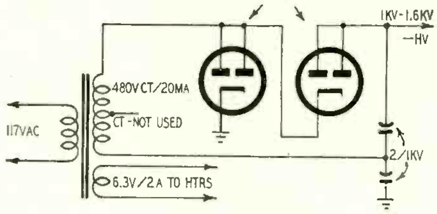
Circuit performance is determined by the type of tube, the plate supply and bias voltages. The biasing resistor should be adjusted so the current through the neon lamps is limited to about 0.7 ma when the circuit is unbalanced.

The audio signal is filtered out by R and C. Their time constant should equal one cycle of the lowest audio signal received. Using 1 megohm and 0.1-μf, as in Fig. 1, will prevent signals as low as 10 cycles from actuating the indicators. Both indicators glow when the set is not tuned to a carrier; one of the lamps will be momentarily extinguished as a carrier is being tuned in. This circuit can be added to a set with a *balanced* ratio detector but the indication will not be as sharp.

HIGH-VOLTAGE SUPPLY

Please recommend a circuit to supply approximately 1,000 volts d.c. to the cathode-ray tube in an oscilloscope. I have considered using an r.f type supply to reduce weight and size. If this is recommended, please give winding data for the transformer.—T. L., Terrace Vaudreuil, P. Q., Canada

Transformers for r.f. power supplies are very difficult to construct at home without special coil-winding equipment. If you want to use this type of circuit, we recommend that you purchase a transformer and use the circuit rec-



ommended by the manufacturer.

We suggest using a 60-cycle supply designed around a small replacement type power transformer. If you can find one delivering 360 to 400 volts center-tapped, you can use it in this circuit to deliver approximately 1,000 volts d.c. By using the 480-volt center-tapped transformer specified in the diagram, you can obtain outputs up to 1,300 volts.

If the output is excessive under load, you can reduce it by using smaller capacitors or by inserting a suitable resistor in series with one side of the high-voltage winding. Ground is the positive side of the supply.

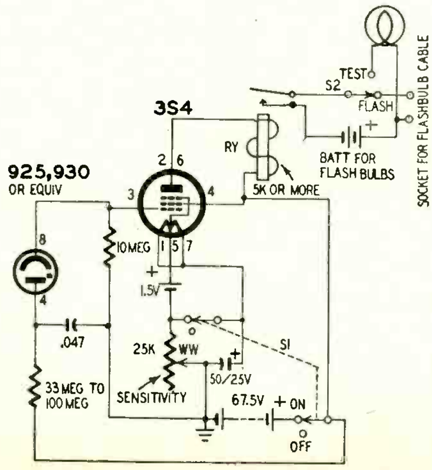
Caution: Be especially careful to avoid a shock from this supply. Short-circuit the capacitors through a resistor of about 1 megohm before working on the scope.

PHOTOFLASH SLAVE UNIT

Please print the circuit of a photoflash slave unit fired by the flash of light from the main gun on the camera. I want to include an adjustment to compensate for ambient light.—H. A. T., St. Louis, Mo.

This photoflash slave unit can be constructed very compactly in a small metal utility box or similar cabinet. Batteries may be the type used in hearing-aids and miniature portable receivers.

The sensitivity control should be initially set for minimum resistance and S2 should be turned to TEST. When S1 is closed, the relay operates and lights the pilot lamp when the tube heats up. Slowly advance the sensitivity control just to the point where the relay opens and the pilot lamp goes out. Now, throw S2 to FLASH, plug in



the extension cord for the remote flash bulb and shoot.

The phototube should be mounted on top of the slave unit or behind an opening in one side of the case. The slave should always be positioned so the light from the camera gun strikes the cathode of the phototube.

Adjust the relay contacts and armature tension for optimum sensitivity. The value of the resistor in the B-plus line to the phototube will vary with the ambient light. If the unit is to be used mostly in daylight or brightly lighted rooms, it may have to be reduced to 10 megohms or less to provide a wide range of sensitivity. If the unit is to be used for photographing accidents and the like on dark roads, it may be as high as 100 megohms.

GANGED POTENTIOMETERS

I am building the scope described in the November, 1953, issue and cannot complete it until I can find the dual potentiometers needed for the horizontal gain and sweep frequency controls. I need one ganged control with 5,000-ohm resistances in each section and another with 1- and 10-megohm sections. Please specify make and type number of suitable controls.

For another project, I need a pair of low-impedance headphones that will provide a good match to the secondary of a standard audio output transformer in a radio or TV set. Please list a source of surplus or commercial equivalents.—A. K., London, England

Assembled dual and ganged potentiometers are not generally available in the values you want but you can assemble your own from components made by several resistor manufacturers. The do-it-yourself multiple assemblies consist of a standard front section with a shaft and a rear section that fastens onto the front in much the same manner as switches that are often ganged to volume and tone controls.

For the 5,000-ohm dual control, you can use IRC PQ11-114 (front) and M11-114 (rear) sections or P. R. Mallory UF53L (front) and UR53L (rear) sections. For the sweep frequency control, you can use an IRC type PQ11-137 and M11-143 front and rear sections with resistances of 1 and 10 megohms, respectively. Equivalent types of other makes may be substituted.

Low-impedance phones are available in several makes. Permoflux high-fidelity 8-ohm dynamic headsets are available at around $30.00; Telex has three types of 6-ohm dynamic phones in the $7-10 range. C. F. Cannon Company can supply single or double headsets with 11 ohms d.c. resistance on direct order or through distributors at the same cost as their equivalent 1,000- and 2,000-ohm models. Prices start at around $1.00 for single and $2.00 for double headsets. END

Patents

MAGNETOSTRICTIVE GENERATOR

Patent No. 2,714,186

William H. Henrich, E. Norwalk, Conn.
(Assigned to Sorensen & Co., Inc.)

Ultrasonic energy is used to mix, agitate or emulsify liquid solutions. Previous ultrasonic generators were limited to a fixed frequency so that nodes or dead spots occurred in the solution. This is undesirable, because solid particles tend to accumulate at spots where there are no vibrations. This transducer has a *variable-frequency* output which eliminates dead spots.

In Fig. 1, R1 passes current from B to charge C. When the potential is high enough, the capacitor voltage breaks down the gas in the thyratron. Then C discharges through the tube and the coil L around M, a magnetostrictive core. This pulse sets the core into mechanical vibration at its resonant frequency. The flat end of M is inserted into the solution.

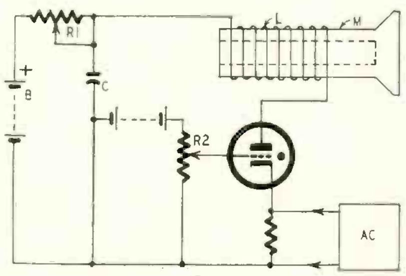


Fig. 1

Without a.c. across the thyratron cathode, the tube would oscillate at a constant frequency, as determined by R1 and R2.

The a.c. varies the pulse rate and tends to reduce dead spots in the solution. Further reduction in dead spots is effected by the special construction of the magnetostrictive core as shown in Fig. 2.

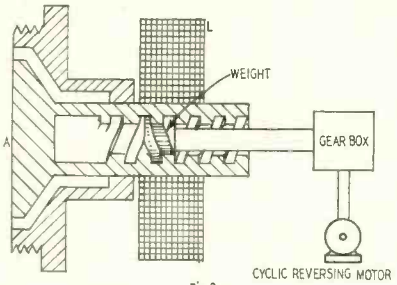


Fig. 2

The core is hollow with a flat face A supported by a flanged screw which may be inserted into a pipe or opening. Inside the core, a weight is geared to move slowly back and forth. It is driven by a motor through a gear box. Every change in the position of the weight affects the resonant frequency. The result is varying ultrasonic waves which eliminate dead spots or nodes in the medium being agitated or emulsified.

MAGNETIC SCALE-OF-TWO

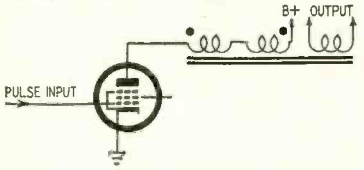
Patent No. 2,710,928

Gordon Earle Whitney, Poughkeepsie, N. Y. (Assigned to International Business Machines Corp.)

A relay or other mechanical device cannot count rapid pulses—the pulse rate must be slowed down. This can be done by a scale-of-two device. This one provides *1 output cycle* for every *2 input pulses*, thus halving the counting rate. For example, 5 such devices in series deliver only 1 output pulse for every 32 input pulses; 6 will deliver 1 for every 64 pulses.

This invention is based on a core of magnetic material having nearly rectangular hysteresis characteristics. This type of material is one that may be driven to deep positive or negative saturation with low electrical power.

The pulses are amplified by a tube. Plate current flows into 2 coils similar in size and shape but oppositely wound (indicated by dots) over the core. Although equal current flows through both coils, one has practically no magnetic effect.



This is because the core is already deeply saturated and can be driven no further. The second coil *reverses* the magnetization, so if the pulse has sufficient amplitude, the core is left *oppositely* saturated.

The second pulse reverses saturation again, this time only the first coil being effective. After the second pulse the core is left in its original condition.

The third coil over the same core transmits the pulses to additional stages. It is affected by each reversal of saturation, so it undergoes a *single* cycle for each pair of pulses. This gives the desired scale-of-two reduction.

SELF-POWERED TRANSISTOR

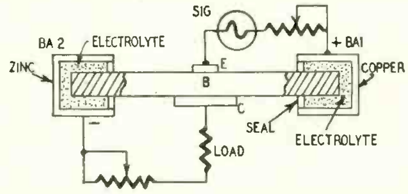
Patent No. 2,713,644

Paul Rappaport, Princeton, N. J.

(Assigned to Radio Corp. of America)

Transistors require so little operating power that even a tiny battery will supply them for a long time. To save space and cost, this transistor has its own built-in power sources to bias the emitter and collector.

The diagram shows a p-n-p junction transistor with elements E, B and C. The emitter supply is BA1, a copper cup enclosing an electrolytic mix like zinc chloride. An insulating washer seals the cup. Copper reacts with germanium to form



an electric cell with the copper cup positive. The collector supply voltage is provided by BA2. This cell is like the first except that the cup is made of zinc. This metal is *negative* with respect to germanium, as required to bias the collector negative. Thus voltaic cells of the required polarity are actually built into the transistors. END

"This one is really a 'dog'."

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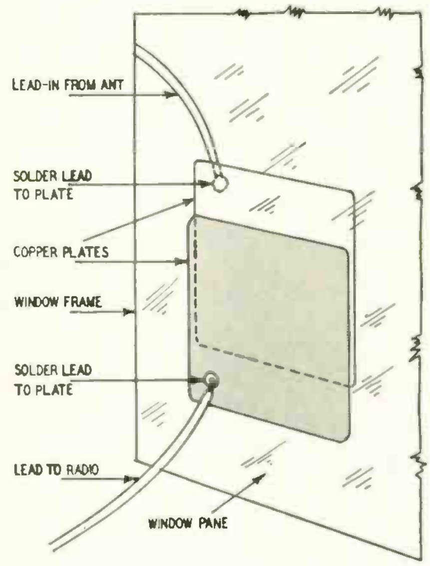
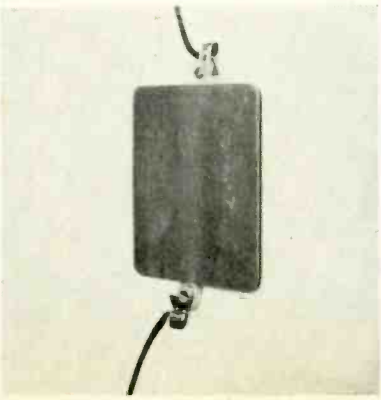
HOLELESS FEEDTHROUGH

There is no need to bore a hole through the side of the house or through the window frame to bring a radio antenna lead-in into the house. As shown in the photo and drawing, simply cement two small metal plates onto the window pane with the glass between them and then connect the lead from



the antenna to the outside plate and the lead from the radio to the inside one. Thus the metal plates form a two-plate capacitor with a glass dielectric and it passes radio-frequency energy from the antenna to the radio with little loss. Many experimenters use a small capacitor in the antenna lead anyway when experimenting with short-wave receivers, etc. For perfect safety, it is a good idea to connect a lightning arrestor between the outside section and ground.

The best size for the two metal plates can be determined by experiment. Use copper, aluminum, brass, stainless steel



or any other nonrusting metal. I used two aluminum plates 3 inches square. Each plate has a ½ x ½-inch lip with a Fahnestock clip riveted to each. If you use copper (see diagram) or brass plates, you can solder the lead wires directly to them and omit the lips and clips. I used Duco cement to bond the plates to the window pane, but any all-purpose household cement or gasket cement will do as well.

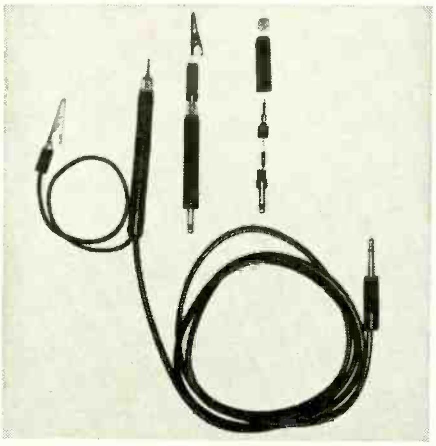
To reduce the capacitance of the pair of plates, simply offset one of the plates, as shown in the drawing.—*Arthur Trauffer*

(This old trick deserves to be used more often. If the lead-in is securely mounted above the window to prevent mechanical strain on the metal plate, it works well.—*Editor*)

UNIVERSAL TEST LEAD

One of the most annoying problems in radio work is to find immediately the proper test lead or probe for the instrument in question and the job at hand. With only a few instruments, the number of various direct, resistive, capacitive and rectifying leads, probes and clips, with invariably mismatched panel connectors, forms a bewildering and expensive collection.

The answer is simple and involves two steps. The first is to standardize on a single type panel connector and modify your instruments accordingly. A single-conductor shielded cable seems best suited for most test applications.



RG-58A/U coaxial cable, with stranded center conductor, meets this requirement admirably. Panel connectors and lead terminations can best be made using a standard phone jack and plug or standard microphone connector such as Amphenol 75-PC1M and the mating plug 75-MC1F.

Now for the second step. Fabricate as many basic test leads of desired length as are required by terminating one end with a plug to fit the standardized instrument panel connectors. Terminate the other end with a JK-26 jack. This is the popular phone cord extension jack still readily available as surplus. A length of test lead terminated in a test clip should be soldered to the cable braid and brought out the shell of the JK-26 as shown in the photograph.

The interchangeable probes then can

be made of surplus PL-54 plugs. Remove the plug shell and saw off the plug body flush with the center insulator. Using the PL-54 shell, lead terminations and single component probes can be fabricated.

If more space is required for mounting probe components, the PL-54 shell may be replaced by a JK-26 shell with no modifications. The photograph shows the various probes that can be made and also shows the method of attaching the standard solderless test-lead tip plug to the plug body. Simply slip the component lead through the tip and slide on the plug shell. Screw on the tip locking collar and this clamps the tip in place and establishes electrical contact.

In case surplus jacks and plugs are not available or if complete shielding is desired, the Mallory 100A extension jack and matching 75A phone plug may be used.

Another important advantage of this type construction is the ruggedness of the finished product — no more test leads pulling off of fragile isolating components. Outside of deliberate effort your probes become virtually indestructible.—*Roy E. Pafenberg*

VOLUME-CONTROL SWITCHES

When selecting switches to be mounted on volume controls, it is better to order double-pole, instead of the single-pole, units. The double-pole switches cost no more and are more versatile. They can be used to replace single-pole, double-pole or single-pole types with dummy lug.—*Charles Erwin Cohn*

DIODE-TRIODE TUBES

Do not discard a defective duo-diode triode tube while the triode section is still O.K. Instead, mark the tube to indicate its condition (diode weak, triode O.K.) and save it for use in one of the many amplifiers or FM and TV receivers that use only the triode section.—*J. Sareda* END

Business

Merchandising and Promotion

International Rectifier Corp., El Segundo, Calif., awarded a 1956 Ford to Harry J. Kayner of North American Aviation as first-prize winner in the company's recent Selenium Diode Contest for developing new applications for selenium diodes. Photo shows Dr. Lee de Forest, chief judge of the contest, presenting keys to the car to Kayner. Judges J. T. Cataldo, extreme right, and F. W. Parrish, International executives, look on.

Thompson Products Electronics Division, Cleveland, Ohio, designed a new shipping and display carton for its *Superrotor* antenna rotators.

Littelfuse Inc., Des Plaines, Ill., reports that Premier TV Radio Supply, Chicago, one of the first jobbers to utilize its combination display and stocking rack has doubled its fuse sales.

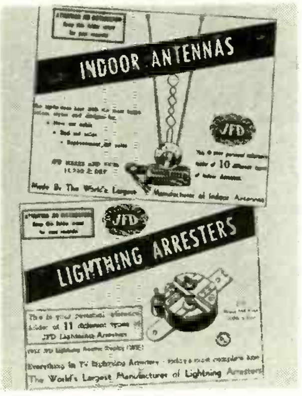
Finney Co., Cleveland, reports orders from 257 jobbers out of the 423 who received the personalized pouch promoting its new *Geomatic* TV antennas.

Radiart Corp., Cleveland, Ohio, designed a new two-color metal display

rack for its expanded line of *Vipower* vibrator-powered converters.

Klipsch & Associates, Hope, Ark., has been promoting its *Klipschorn* corner horn loudspeaker system through demonstrations in Midwestern cities by Paul W. Klipsch, in which he invited the audience to distinguish between live and recorded music. In most cases, only a fraction of the audience could do so.

JFD Manufacturing Co., Brooklyn, N. Y., designed two new product port-



folios covering its line of indoor antennas and lightning arresters. Counter displays for both lines are provided.

National Co., Malden, Mass., is offering its dealers a new hi-fi promotion package—a loose leaf binder containing complete promotional material which includes reprints from trade magazines, decals, a satin banner and a catalog of all equipment.

Electrovox Co., East Orange, N. J., is featuring a new display card for its *Walco* phonograph needles.

Telectrosonic Corp., Long Island City, N. Y., launched a national sales campaign on its new portable tape recorder which includes ads in Life magazine.

New Plants and Expansions

Daystrom Inc., Elizabeth, N. J., parent company of Heath Co. and Weston Electrical Instrument Co., has completed the sale of its former subsidiary, American Type Founders, Inc. in order to permit further expansion in the electronics field which now accounts for 85% of its sales.

Raytheon Manufacturing Co., Waltham, Mass., opened a new electronics laboratory in Wayland, Mass.

General Electric Tube Department established an electronic tube warehouse and commercial sales office in Seattle, Wash.

RCA is constructing a new $2,700,000 addition to its plant in Cambridge, Ohio, for the production of tape recorders and high-fidelity instruments.

P. R. Mallory Inc., affiliate of P. R. Mallory Co., Indianapolis, opened a new plant for the manufacture of electrolytic capacitors in Huntsville, Ala.

Oxford Electric Corp., Chicago, moved its distributor sales office and warehouse to 556 W. Monroe St.

Sylvania Electric Products is building a new 76,000-square-foot warehouse and sales office in Atlanta, Ga.

JFD Manufacturing Co., Brooklyn, N. Y., recently opened a Canadian manufacturing and sales division in Toronto.

Van Norman Co., Springfield, Mass., parent company of Insuline Corp. of America, acquired Transitron Inc., New York City. Subsequently the company changed its name to **Van Norman Industries, Inc.**, and increased its capitalization.

Cornell-Dubilier moved its Midwest sales office to 5247 W. Diversey Ave., Chicago.

Business Briefs

. . . **RCA** president Frank M. Folsom told a luncheon meeting of more than 500 suppliers of RCA and NBC that the electronics industry is expected to grow by 66% during the next 10 years to reach an annual volume of over $17 billion by 1964.

. . . **RETMA** president, H. Leslie Hoffman, has asked Secretary of Commerce Sinclair Weeks to take steps to relieve the critical shortage of nickel which is threatening to curtail tube production.

. . . **Astron Corp.**, East Newark, N. J., was recently granted a patent for its process of manufacturing molded plastic capacitors. The company also recently initiated a Planning Conference at plants in Newark, N. J., to acquaint leading manufacturers from diversified industries with capacitor design and packaging for automation. END

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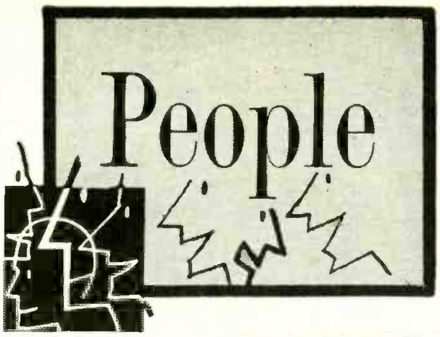


People

D. T. Schultz

David T. Schultz has been elected president and director of Allen B. Du Mont Labs., Inc., Clifton, N. J. A pioneer executive in the electronics industry, he was senior vice president and treasurer of Raytheon Manufacturing Co. before joining Du Mont.

Robert C. Sprague, chairman of the board of the Sprague Electric Co. of North Adams, Mass., was awarded the Silver Knight of Management Trophy by the National Association of Foremen

for his adherence to the association's code of ethics, loyalty to its objectives and efforts for the advancement of the free enterprise system. The photo shows him receiving the award from Harold Brafman, retiring president of the Sprague Management Club.

B. Vinkemulder

Bruce Vinkemulder was appointed distributor sales manager of Centralab, a division of Globe Union, Inc., Milwaukee, Wis. He has been active in the electronics industry for the last nine years. Before coming to Centralab he was with Carter Parts Co. and Sangamo Electric Co.

J. D. Van der Veer

John D. Van der Veer was appointed general sales manager of Tung-Sol Electric Co., Newark, N. J., succeeding George W. Keown, who was recently elected vice president of the company. **John M. Malone**, former manager of production, planning, order and service, and warehousing, was promoted to manager of initial equipment tube sales to electronics manufacturers.

W. Steinkamp

Wilbert H. Steinkamp was appointed vice president in charge of sales of Weston Electrical Instrument Co., Newark, N. J. Before coming to Weston, he was vice president and general sales manager of Beckman Instruments Inc.

H. A. Ehle

Harry A. Ehle was elected executive vice president of International Resistance Co., Philadelphia. He had been vice president of sales and advertising. **Jesse Marsten**, who joined the company in 1930 as chief engineer and is a member of the board of directors and executive committee, was elected senior vice president.

E. H. Applegate

E. H. Applegate, advertising director of the Regency Division of I.D.E.A., Inc., Indianapolis, was promoted to distributor sales manager. He will continue to direct Regency advertising.

Arthur H. (Buzz) Forbes has been named assistant distributor sales manager for Standard Coil Products Co.,

Chicago. He has been in the company's sales department since 1949. Forbes (center in the photo) is being congratulated by C. A. Swanson, general sales manager (left) and Oden Jester, assistant general sales manager (right).

Obituary

S. Arthur Loeb, chairman of the Executive Committee, Webster Electric Co., Racine, Wis., at his home in San Diego at the age of 69.

Donald S. McGhee, Rochester, N. Y., district sales manager for National Electric Products Corp. and **John H. Green**, Buffalo, N. Y., district manager for the company, both recently at the age of 59.

J. J. Hyland, electronics expert, inventor, and founder and chairman of the board of directors of Control Instrument Co., Brooklyn, N. Y., at his home at the age of 51.

Personnel Notes

. . . **Dr. Alan M. Glover**, manager of the RCA Semiconductor Operations Department, was promoted to general manager of the newly created Semiconductor Division. Until completion of the new $3 million plant in Somerville, N. J., his headquarters will be in Harrison, N. J.

. . . **Brooks A. Kafka** was appointed sales manager of the General Electric Cathode Ray Tube Subdepartment, Syracuse, N. Y. He has been manager of marketing administration for the subdepartment. **W. Jesse Harber, Jr.** was named manager of the G-E Syracuse tube plant. He had been production superintendent of the *Five-Star* receiving-tube mounting and exhaust section of the G-E Tube Plant in Owensboro, Ky.

. . . **R. F. Meinicke** was placed in charge of sales and promotion of all industrial distributor components for American Phenolic Corp., Chicago, Ill. He has been with the company since 1949. **John Upp**, formerly with Proctor Electric, joined Amphenol as head of TV accessory sales and promotion.

. . . **Cyrus T. Read** rejoined Hallicrafters, Chicago, as director of amateur relations for the Communications Equipment Division. Since leaving Hallicrafters in 1944, he has been with Montgomery Ward and Hedco Manufacturing Co.

. . . **George Zimmerman**, sales engineer of the Transformer Division of Oxford Electric Corp., Chicago, was promoted to chief engineer of the division.

. . . **Martin Clifford** was appointed vice president of Gernsback Library, Inc., New York City, the newly formed corporation for the publication of Gernsback Library Books. Clifford, an engineer and teacher of electronics, formerly headed the Book Department of Gernsback Publications, Inc.

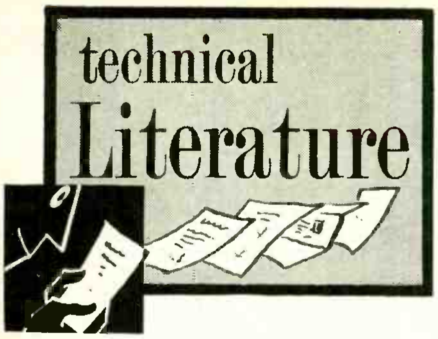
. . . **Julius Haber** of RCA succeeds Ellis Redden, formerly of Magnavox, as chairman of the RETMA Advertising and Public Relations Committee.

. . . **Don Blesh** and **William J. Gannon** joined the sales staff of Ward Products, Cleveland, Ohio. Blesh comes to the company from Superior Bearing Bronze Co. and Gannon from Garland Paint Co.

. . . **Jerry Rose** has transferred from the Industrial Sales Division of Pyramid Electric Co., North Bergen, N. J., to jobber sales where he will assist J. K. Poff, jobber sales manager and **William J. Slawson**, assistant jobber sales manager.

. . . **John M. Englisby** joined Raytheon Manufacturing Co., as assistant New York district sales and service manager. He was formerly with the Fireye division of Electronics Corp. of America.

. . . **Chris J. Witting**, former president of Westinghouse Broadcasting Co., was named general manager of consumer products for Westinghouse Electric and will be proposed for election as a vice president for the company. END



HI-FI CATALOG

This Is High Fidelity combines an illustrated information section explaining high fidelity with listings of hi-fi music systems and separate components in a 100-page booklet. Written in nontechnical language, it explains the functions of basic units used in home hi-fi music systems and shows many practical installations. What percentage of the hi-fi dollar to appropriate to each component suggested, plus tips for the budget-conscious on the selection and installation of components.

Allied Radio Corp., 100 N. Western Ave., Chicago 80, Ill.

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UNLESS OTHERWISE STATED, ALL ITEMS ARE GRATIS. ALL LITERATURE OFFERS ARE VOID AFTER SIX MONTHS.

ENCLOSURES

Bulletin No. 211 illustrates and describes do-it-yourself high-fidelity speaker enclosure kits. *Model 1B3 Centurion, 1B4 Regency, 1B5 Empire, 1B6 Aristocrat* are described in separate construction books for $1 each; *model 1B1 Patrician* and *1B2 Georgian*, for $1.50 each; *model 1B7 Baronet*, for 75 cents.

Written in an entertaining as well as instructive way and illustrated with dozens of good photos and drawings, these brochures set a new level in do-it-yourself books.

Electro-Voice, Inc., Buchanan, Mich.

THE TAPE RECORDER

207 Ways to Use a Tape Recorder outlines uses for a tape recorder at home or away, work or play. It segregates uses into classifications such as professional, educational, church, business, recreational, and shows how to record and play back, in addition to giving ways to splice in, preserve and use a tape recorder.

Magnecord, Inc., 1101 S. Kilbourn Ave., Chicago 24, Ill.

TEST EQUIPMENT

A 16-page *Catalog No. 120 Form 9115-T25* contains detailed information and photographs of test equipment for radio and black-and-white and color TV. Contains data on *models 310, 630, 630-A, 630-T, 630-NA, 666-R and 66HH* volt-ohm-milliammeters, *3412-B* tube tester, *3423* mutual conductance tube tester, TECHNICAL LITERATURE *(Continued)*

3439 color bar generator, *3438* dot generator, *3434-A* sweep signal generator and *3432-A* signal generator.

Triplett Electrical Instrument Co., Bluffton, Ohio.

MODULIZED CIRCUITS

Aerovox's bulletin *Modulized Standard Circuits* explains what a module is and gives information on modulized standard circuits, module nomenclature and accessories. Video limiters, cathode followers, video amplifiers and PRF multivibrators are among the circuits described.

Aerovox Module Div., Aerovox Corp., 1200 Jefferson Davis Highway, Arlington, Va. (Write on business stationery.)

TRANSFORMERS

Catalog *G-25* lists in 16 pages audio transformers, autoformers, chokes, deflection yokes, filament transformers, flybacks, reactors, input and output transformers, TV components, etc.

Gramer - Halldorson Transformer Corp., 2734 N. Pulaski Rd., Chicago 39, Ill.

SELENIUM RECTIFIER DATA

A 12-page booklet *Federal Selenium Rectifier Design Data Guide* gives engineers factors to be considered in the design of industrial and military rectifiers and tells why these factors are important.

Components Div., Federal Telephone & Radio Co., 100 Kingsland Rd., Clifton, N. J.

HIGH FIDELITY

Stancor's high-fidelity library contains construction information on the 8-watt Stancor-Williamson, 25-watt Stancor-Williamson Ultra-Linear and 100-watt Chicago super-range amplifiers. It contains performance curves, schematics, parts lists, chassis layouts and diagrams.

Chicago Standard Transformer Corp., 3587 Elston Ave., Chicago 18, Ill.

TEST EQUIPMENT

Catalog No. 139 contains eight pages of data on test equipment. Among the equipment described are the *models 327* tube tester, *480* ac-dc multitester, *780* sweep generator, *655 Do-All* vtvm, *AE 100* Geiger counter, *453* master multitester, *55* wide-band 5-inch oscilloscope.

Radio City Products Inc., Centre & Glendale Sts., Easton, Pa.

RADIO AND TV CIRCUIT INDEX

Supreme's *Master Index to Most-Often Needed Television and Radio Servicing Information* presents complete information for quickly finding needed diagrams and service data in all 14 *Most-Often-Needed Radio Diagrams* manuals, covering radio receivers from 1926 to 1955 sets, as well as the 9 *Television Servicing Information* volumes.

Available to RADIO-ELECTRONICS' *readers for 5 cents from Supreme Publications, 1760 Balsam Rd., Highland Park, Ill.*

END

Books

LARGE-SCREEN COLOR RECEIVER. RCA Service Co., Inc., Camden, N. J. 31 pages. 8½ x 11 inches. 75c.

Issued as a supplement to RCA's popular *Practical Color Television for the Service Industry*, this book concerns itself with a comprehensive discussion of the 21-inch RCA model 21CT662 color receiver. It is intended not as an instruction manual for the beginning technician, but for those familiar with the fundamentals of color TV.

Divided into four sections, the text opens with a description of the 21AXP22 and related accessories and gives a thorough adjustment procedure. Section II discusses the entire receiver briefly, showing a block diagram and highlighting the more interesting circuit details.

Section III explains the basic theory of high-level demodulation and covers in great detail demodulation in the 21CT662. Section IV covers the installation and servicing of the color receiver, with several service hints and a step-by-step setup procedure.

At the back of the book is a complete schematic diagram of the set supplemented with a block diagram showing many waveforms.—*JK*

TRANSISTOR ELECTRONICS, by Lo, Endres, Zawels, Waldhauer, Cheng. Prentice-Hall, Inc., Englewood Cliffs, N. J. 5½ x 8½ inches, 521 pages. $12.

Much of the valuable information in this advanced text can help technicians. It represents the combined efforts of five specialists, same of their results appearing for the first time. Many practical schematics and diagrams are given, and much of the math is at a high engineering level.

The first chapter is an excellent introduction to the subject. Transistor action is described as clearly as some books describe tubes. Physical concepts of semiconductors, junctions, holes, processing of germanium, etc. are discussed. The next two chapters analyze transistors from the viewpoint of equivalent circuits. A complete list of formulas aids the calculation of various parameters.

The following chapters stress the more practical aspects. They include bias circuits, l.f. and h.f. amplifiers, oscillators. Many schematics appear, and the text is divided into short, snappy paragraphs with subheadings. One chapter — "Physical interpretation of parameters"—describes topics not often understood clearly although frequently mentioned: transition region, diffusion, recombination, spreading resistance, breakdown voltage.

The final chapters on modulation and pulses include numerous schematics and formulas for designing converters, gates, memory network, etc.—*IQ*

CIRCUIT ANALYSIS BY LABORATORY METHODS (2d Edition), by Carl E. Skroder and M. Stanley Helm. Prentice-Hall, Inc., Englewood Cliffs, N. J. 6 x 9 inches, 376 pages. $5.75.

Students often think of lab procedure as a dull routine. This manual shows that it can be made interesting as well as instructive if the technician or student follows a plan. The book combines theory and lab and describes a variety of experiments.

The first chapters show how to plan a test or measurement, lists safety precautions and explains how to protect instruments. There are instructions for preparing a lab report. Then equipment is clearly described and explained. They include rheostats, meters, motors and generators. The text shows how to use them and how to take care of them.

SHOOT TV AND RADIO TROUBLE FAST, by Harry G. Cisin. Harry G. Cisin, Publisher, Amagansett, N.Y. 8½ x 11 inches, 40 pages. $1.50

This is written to assist the practical repairman, who may not have too much theory, to speed the process of servicing radio as well as TV receivers. The most common symptoms are listed with possible causes. Lettered keys then refer to various numbered checks that can be used to identify the defect and eliminate the trouble.

Part I consists of 11 pages devoted to troubleshooting ac-dc radios. Part II, 27 pages, to rapid TV troubleshooting. Part III gives two pages of tips on servicing printed circuits.

UNDERSTANDING HIGH FIDELITY, by Louis Biancolli and Lester H. Bogen. 3d Edition. David Bogen Co., Inc., 29 9th Ave., New York 14, N. Y. 6 x 9 inches, 57 pages. 25c.

This publication is for music lovers rather than technicians. For these home listeners there is no need to go to technical depths. On the other hand, merely recommending specific units is not enough. The basic principles of hi-fi units and systems are here described so that the reader can choose his own to fit particular needs.

This booklet has two parts: understanding hi-fi and a guide to selecting and installing equipment. The first part tells what sound is, comparing distortion to that which may occur in a photograph. It illustrates typical sound systems and goes into detail regarding changers, tuners, amplifiers, speakers, enclosures, etc. The second covers such topics as how to determine required power output, select an amplifier, conduct a listening test. Several photos show recommended placement of speakers, typical "built-in" home sound systems and custom installations. END

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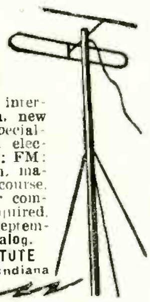

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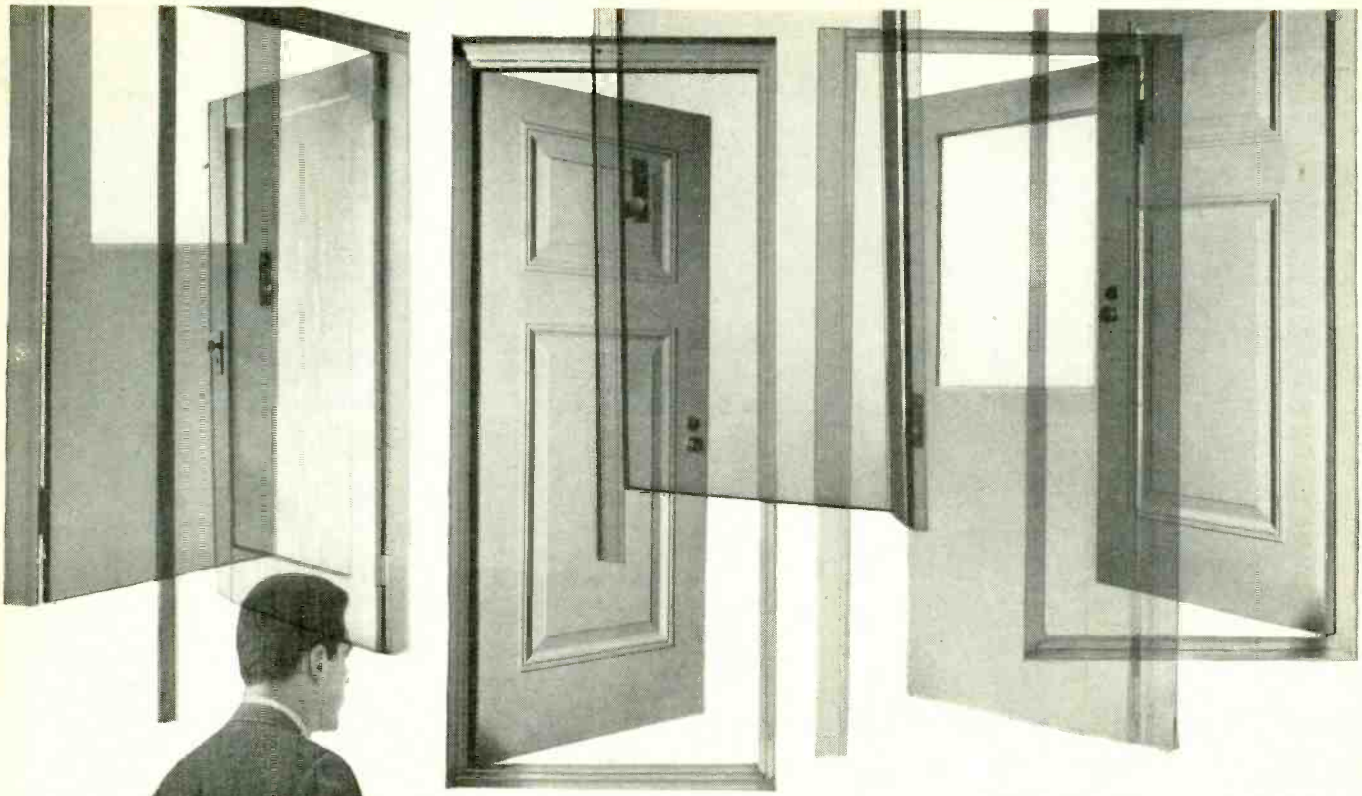

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