JANUARY

Radio-Electronics

TELEVISION • SERVICING • HIGH FIDELITY

Electronics Cools / **Build an Electronic Micrometer**

Simple Reverberator / **What's New in 1962 TV's**

GO GERNSBACK, Editor-in-chief

Biggest Electron Microscope Is Tool for Tube Improvement

See page 4

50c

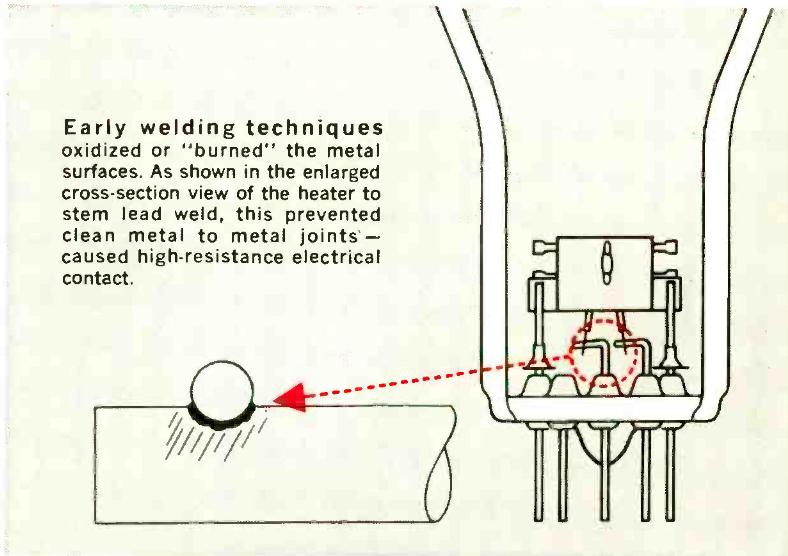
NEW CALLBACK-PROTECTION WELDED INTO EVERY SILVER SCREEN 85 TV PICTURE TUBE

Sylvania technique eliminates tube failures caused by open heater or cathode lead welds. Protects your profits.

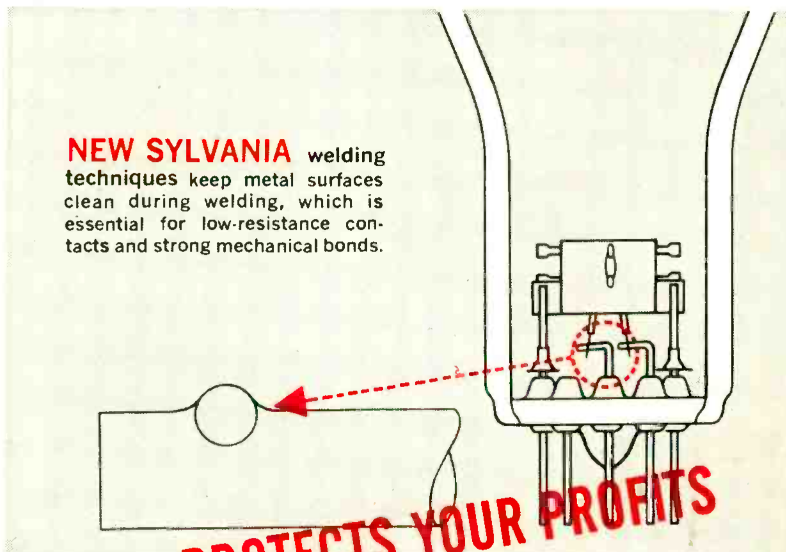
Sylvania . . . the leader in picture tube improvements . . . now gives you another built-in plus — "Controlled Atmospheric Welding"! Engineering investigations revealed that in the welding of picture tube gun parts something more than automatic controls, skilled operators and careful inspection was needed. The uncontrolled factor was the degree of oxidation occurring at the time of welding. The answer — control the atmosphere surrounding the weld at the instant it is made!

Now . . . through "Controlled Atmospheric Welding" Sylvania Silver Screen 85 TV picture tubes give you maximum assurance against callbacks. Common field problems of intermittent, poor, or open connections due to oxidized welds have been eliminated. Every year hundreds of thousands of TV picture tubes are replaced with Silver Screen 85. No wonder. It's more profitable in the long run.

Electronic Tubes Division, Sylvania Electric Products Inc., 1740 Broadway, New York 19, New York.



Early welding techniques oxidized or "burned" the metal surfaces. As shown in the enlarged cross-section view of the heater to stem lead weld, this prevented clean metal to metal joints — caused high-resistance electrical contact.



NEW SYLVANIA welding techniques keep metal surfaces clean during welding, which is essential for low-resistance contacts and strong mechanical bonds.

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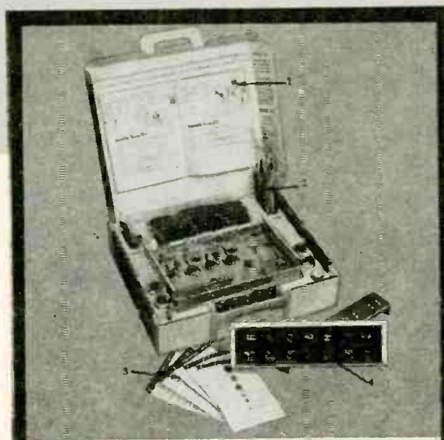


Now you can build a Multiplex Tuner that meets rigid factory standards

Now have the fun of building a genuine H. H. Scott Wide-Band FM Stereo Tuner in just a few hours . . . and save money, too. Revolutionary Scott-developed kit building techniques assure you of performance equaling Scott factory units.

The new LT-110 Scottkit features a pre-wired and tested multiplex section plus the famous silver-plated factory built and aligned front end. Sensitivity of this magnificent new tuner is 2.2 μv. IHFM. There are special provisions for flawless tape recording right "off-the-air."

Scott Wide-Band multiplex tuners are the standard of the industry. They have been chosen by leading FM stations from Boston to San Francisco. If you want to build a truly professional component choose a Scottkit. All H. H. Scott kits are backed by over 15 years experience in the design and production of superb components. Important features include front panel tape recorder output and precision illuminated tuning meter. All critical parts heavily silver plated. Unique Ez-a-Line system assures factory performance without expensive test equipment. Dimensions: 15½ W x 5¼ H x 13 D in accessory case.

These Exclusive Scottkit Features Make Kit Building Foolproof and Fun

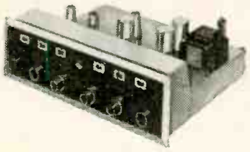
1. All assembly diagrams show parts in exact size and in **full color**, eliminating mistakes.

2. All wires cut to exact length and pre-stripped assuring correct lead placement and dress.

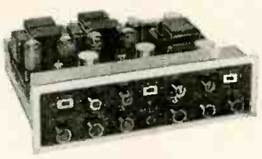
3. Exclusive Part-Charts with parts mounted in order of assembly, eliminating confusion and mistakes. **No loose bag of parts.**

4. Handsome appearance makes Scottkits completely professional in looks as well as in performance.

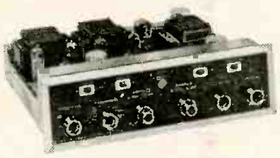
New Scott Amplifier Kits to match the LT-110



LC-21 Preamplifier Kit
Performance so outstanding this kit is used for laboratory purposes. Hum level —80 db. distortion less than 0.1%, frequency response 8 to 50,000 cps. **$99.95***
Matching LK-150 130 Watt Power Amplifier **$169.95***



LK-72 80 Watt Stereo Amplifier Kit —
Plenty of power for any hi-fi system. Complete tape recording and monitoring facilities. Oversized transformers weigh 12 pounds! Performance equal to the best pre-amp/power amp systems. **$159.95***



LK-48 48 Watt Stereo Amplifier Kit —
12 front panel controls. Gives full power down to 20 cps. Husky output transformers. All aluminum chassis and DC operated preamps. Scott quality at a best-buy price. **$119.95***

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on the cover

Story on page 42

Dr. Sandor studies cathode action with the help of the world's biggest microscope.

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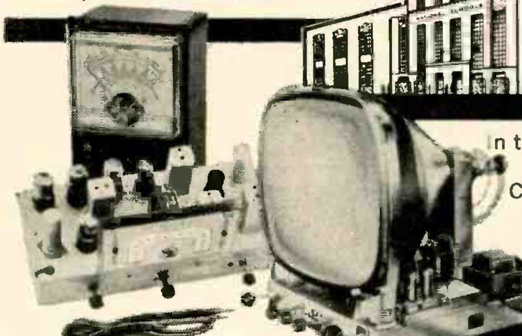

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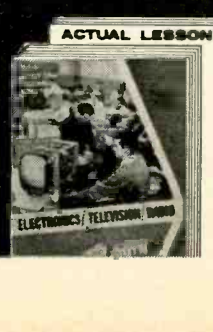

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News Briefs

Electronic Highlights of 1961

Satellite summary as of Nov. 1 shows that the US has launched 55 satellites and still has 31 in orbit around the earth and two in a solar orbit. Twelve of these are still transmitting. The Soviet Union has launched a total of 16 satellites. Thirteen are still in orbit around the earth and two are in a solar orbit. All are crammed with various types of electronic gear ranging from ordinary radio transmitters, receivers and repeaters to TV cameras, solar cells, radiation detectors and propagation measuring instruments.

Back on earth there has been a surge in transistorized CB transceivers. Pocket units with a range of up to 1 mile fall within the FCC low-power rules and can be used without an FCC license. FM multiplexing has put stereo broadcasts into thousands of homes across the US. Only a handful of stations are now broadcasting, but their number is expected to multiply rapidly.

Some new apartment houses and homes have closed-circuit TV for seeing who is at the front door.

Transistor use is ever growing, threatening tubes. Latest word is that two manufacturers are closing down tube operations, will produce only transistors in the future.

Color TV took an upswing with color manufacturers getting out of the red for the first time. Field is also getting competitive with introduction of Zenith color receiver. A Japanese import using an RCA color picture tube also appeared.

JANUARY

Electric Anesthetic. A 700-cycle signal applied to patient's temples renders him unconscious in less than a minute. When current is removed, patient awakens. There are no known aftereffects. Complete system costs only $150. *(March, page 6.)*

TV Classroom in the Sky. Educational TV programs are broadcast over a six-state area from two planes packed with TV transmitting gear. They fly at an altitude of 23,000 feet. *(March, page 12.)*

Magnetic Waveguides Around Earth. Scientists have discovered "ducts" in space around the earth that bend radar beams, channelling them in a circular path. They come back to earth thousands of miles from the transmitter site. The ducts follow lines of the earth's magnetic field. *(April, page 8.)*

FEBRUARY

Entertainment Wall. Deluxe apartments in Chicago come equipped with a living-room wall filled with AM and FM radio, stereo hi-fi and 4½ x 6-foot projection TV. The rental fee will also be deluxe. *(April, page 18.)*

Hi-Speed X-Rays. Pulsed X-ray system cuts exposure time to as little as 1 microsecond. Pulse system delivers a 20-megawatt electron beam focused on X-ray tube target. *(April, page 18.)*

5-Gigacycle Transistor. Even uhf is not safe from transistors. MADT prototype with 14-db gain at 1,000 mc has been made to oscillate at 5 gigacycles (5,000 mc). *(May, page 14.)*

MARCH

Dark Heater Tube. Operates at 20% cooler temperature than equivalent types with standard heater. New type is expected to reduce effects of ac leakage and hum and cut down on heater-cathode shorts. *(May, page 6.)*

Circuit Size Cut 90%. New manufacturing techniques combining deposited film and sputtering processes produce a microminiature circuit that looks like an ordinary transistor (except for the number of leads). Unit actually contains 4 transistors and 2 resistors. *(June, page 6.)*

Uhf Ultrasonics. New piezoelectric semiconductor operates at frequencies up to and beyond 10,000 mc. Made of a gallium arsenide semiconductor base with an extremely thin metal film deposited on it. *(June, page 8.)*

APRIL

Wireless Power. Amplitron tube which can deliver more than 1,000 kw of rf power at microwave frequencies may lead to transmission of electric power by radio. Antenna systems for minimum loss and economics of generating power for transmission are still problems. *(June, page 12.)*

MAY

Living Batteries. New source of electric power is a fuel cell that uses living bacteria. Such cells are said to offer the possibility of greater power conversion rates than existing types. Also, living batteries do not depend on high temperatures or pressures needed by existing types. *(August, page 6.)*

FM Portables Banned from Planes. Radiation from these receivers was proved to interfere with instruments. In FAA tests of many types of electronic devices, only FM receivers were found to be a potential cause of trouble. *(August, page 6.)*

JUNE

FM Stereo on the Air. Following final FCC ruling authorizing FM stereo transmission, Zenith and G-E put FM stereo broadcasts on the air. By end of the year about 15 stations were broadcasting. All use FCC-approved system which combines methods developed by G-E and Zenith. *(June, page 6.)*

Ephi to Track Tornadoes. Special three-antenna receiving system picks up static disturbances from storm centers. Triangulation pinpoints location, enables observers to track storm with extreme accuracy. *(July, page 6.)*

JULY

New Color CRT. From England comes word of a new kind of color TV picture tube—a 4-inch cylinder surrounded by a lens arrangement that rotates at about 1,000 rpm. Image produced by the experimental arrangement is projected on a mirror for viewing. *(October, page 6.)*

Solid-State IFT. Ceramic coupling unit replaces if transformers in transistor radios and could reduce price of these receivers. The device has three leads and consists of two discs of a modified zirconate compound. *(September, page 8.)*

AUGUST

Electronics and Miss Universe. They were one and the same this year as German electronic engineer Marlene Schmidt was crowned Miss Universe in Florida. Some called her electronics' answer to Marilyn Monroe. *(September, page 6.)*

Medical Electronics Convention. Devices from radio pills for telemetering data from the stomach to computers capable of analyzing and identifying 800 diseases were shown. Vladimir B. Zworykin presided at the conference. *(October, page 13.)*

SEPTEMBER

Diamond Semiconductors. These are made in the laboratory from a mixture of graphite and catalyst to which impurities such as boron, beryllium or aluminum are added to give the crystal semiconductor properties. To date only p-type crystals have been made. Experiments are continuing to develop n-type materials. *(November, page 6.)*

Ion-Engine Space Drive. Operating engine has been tested in vacuum chamber. It uses a cesium propellent diffused through a hot tungsten element and then through a system of electrodes which accelerates the ions to a very high exhaust velocity. Device cannot be used in an atmosphere, but should make excellent space drive. *(December, page 6.)*

OCTOBER

Communications Belt Around Earth. Highly controversial experiment placed 350 million tiny copper hairs into orbit 2,100 miles above earth. They are expected to form a temporary belt which can be used to reflect radio signals for long range communications. If successful, larger-scale experiments may be attempted. *(December, page 10.)*

Pay TV in Arrears?

The experimental pay-TV system in Toronto's suburb Etibicoke was stated to be losing $11,000 a week after nearly 2 years of operation. The statement was made by director Norman Robertson of Famous Players Canadian, as he resigned a directorship he had held 20 years. He accused Paramount Pictures of "milking" its subsidiary Famous Players Canadian while barraging the public with "laudatory press releases about what is happening in Etibicoke."

A Paramount spokesman in New York, repudiating Robertson's claims, pointed out that the experiment was never designed to make money. Also, losses amounted to $3,500 a week not the $11,000 charged.

Satellites for Home TV's?

Nuclear power could be used aboard television satellites to provide enough power to broadcast direct to home-style TV receivers over a large part of the earth, according to a recent study by RCA. Presently planned satellites are designed to beam low-power signals to highly sensitive relay stations on earth, where they could be stepped up to higher power and would be rebroadcast from local TV stations. Under the proposed plan, a transmitter on a satellite could broadcast direct to all home receivers in an area as large as Europe or the United States.

The reactor powering the TV transmitters would also be used to drive an electric propulsion system that would help get the satellite into space and bring it a 22,300-mile-high orbit. At that altitude it would revolve around the earth once daily and could, therefore, be made to remain over one spot. The antenna would of course be kept directed at the earth. Such a satellite, said Dr. Korman of RCA's Advanced Military Systems Office, could be developed for less than $100 million, which he

(Continued on page 10)

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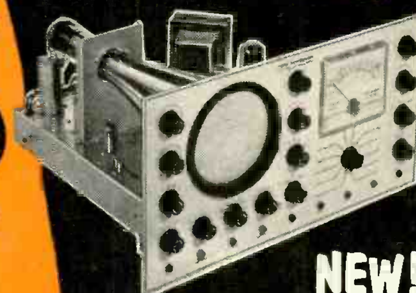

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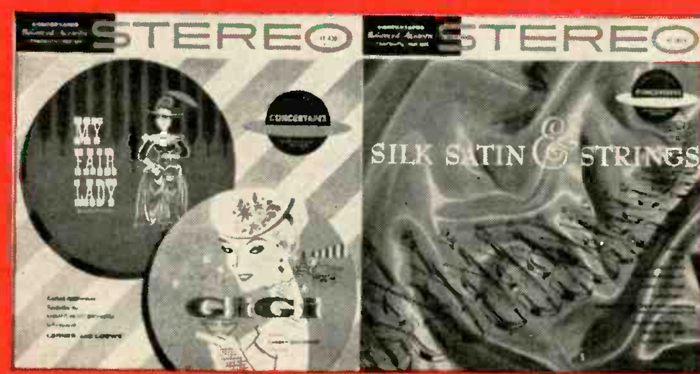
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Jazz Pizzicato

Gigi

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Waltz at Maxim's
Thank Heaven for Little Girls
The Parisians
I Remember It Well
The Night They Invented Champagne
Reprise: Gigi

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"	42.5MC 45.0MC 45.75MC	A1, A2, A3	Check for response similar t necessary, retouch A1, A2, proper response.

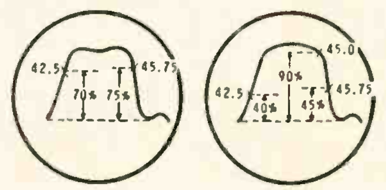
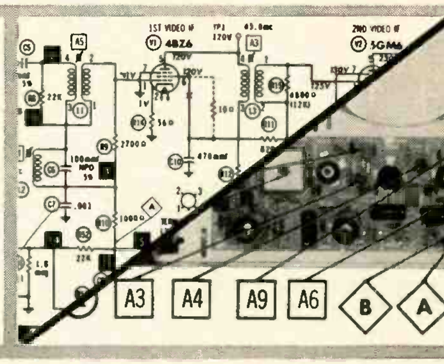


FIG.1 FIG.2



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Tell-All PARTS GUIDE

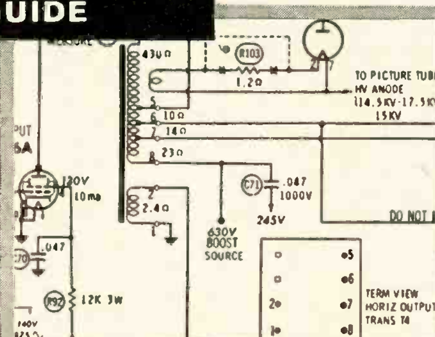
TRANSFORMERS (SWEEP CI

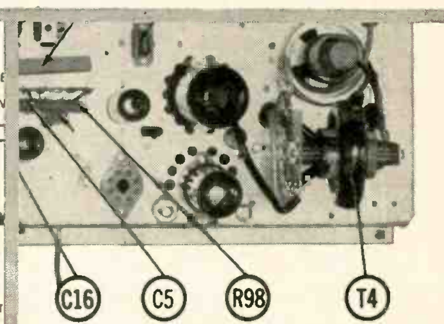
ITEM No.	USE	OLYMPIC PART No	Merit PART No	Stancor PART No	Thor PAR
		REPLACEMENT DATA			
T2	Vert. Output	TR-25791-2			
T3	Yoke Horiz. 18.4MH (92°) Vert. 40MH Rear Cover and Centering Device	CL-3600-7	MDF-92 1	DY-16A 1	Y-16
T4	Horiz. Output	TR-3599-5	HVO-131 * 2 3	HO-315 *	FLY

1 Use original rear cover and centering device, yoke damping network if
2 Drill new mounting hole(s). 3 Filament requires tw

*HORIZONTAL OUTPUT TRANSFORMER CON

ORIGINAL TERMINAL CONNECTIONS	Merit Replacement Connections	Stancor Replacement Connections	Thordarson Replaceme Connection
9	8	9	4





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2. The Standard Notation Schematic identifies components and values, shows terminal numbers and layouts, color codes, and resistance of coil windings—all invaluable helps in localizing trouble quickly.

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(*Continued from page* 6)
called "a modest sum when compared with the multibillion dollar space program now under way."

New Flat Picture Tube?

According to a report in *TV Digest,* the Navy is expected to issue —some time early next spring—a progress report on a flat nonvacuum-tube electroluminescent panel that can achieve better definition and brightness than a television picture tube. The new display panel, it is stated, could be adapted to picture-on-the-wall TV.

The new display device is being developed for the Navy by Lear, Inc. It is intended for use as an aircraft readout display that can be mounted on the windshield of the plane. The most important weakness uncovered so far, from the standpoint of the TV viewer, is that the new picture-on-the-wall "tube" alone would cost far more than the price of a complete present-day TV receiver.

IRE–AIEE to Unite?

The Boards of Directors of both the Institute of Radio Engineers and the American Institute of Electrical Engineers have voted unanimously to consider consolidation. The action took the form of resolutions stating in effect that the directors of both societies "have deemed it advisable to move actively toward consolidation of the activities of both organizations" and to appoint members of a joint committee to study the problems involved and report back. The committee consists of four members of each group.

The united society would be the largest engineering group in the world. IRE now has 91,000 members, including 17,000 students. Membership of AIEE is 66,000, including 11,000 students. There is some overlapping; 6,000 engineers are members of both societies.

Sentiment in both societies was pretty well summed up by Patrick E. Haggerty, president-elect of IRE, who said, "There are not two kinds of electrons; why should there be two societies to deal with that very same electron?"

Scientists Learn Why Worm Turns

The earth's magnetic field dictates the way the proverbial worm turns, according to Dr. Frank A. Brown of Northwestern University. He made this report at a conference on high magnetic fields sponsored by the Air Force office of scientific research at MIT.

In experiments with the flatworm Dugesia, the worms were oriented in the earth's magnetic field and a barrier to their motion set up. In the winter months, Dr. Brown observed, the worms turned to the right in the fortnight of the full moon and to the left in the fortnight of the new moon. In the spring they turned in the opposite direction—to

(*Continued on page* 16)

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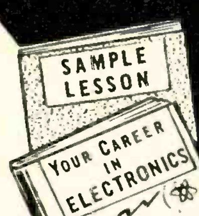

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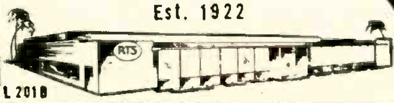

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(*Continued from page* 10)

the right in the 2 weeks of the new moon and to the left during the full-moon period. In summer they faced to the right on new and full moons and to the left at each quarter. "The kinds of magnetic response described for Dugesia appear not to be specific for this worm but simply to represent a general property of living things," Dr. Brown, who has experimented with other worms, snails and the one-celled paramecium, reported.

Considerable skepticism was expressed when Dr. Brown made his report. The skeptics were, however, challenged by Dr. Otto Schmidt, chairman of the session at which the paper was presented: "Either explain it or explain it away."

Calendar of Events

IRE, AIEE, ASQC and EIA Symposium on Reliability and Quality Control, Jan. 9–11, Statler Hilton Hotel, Washington, D. C.

ERA Annual Convention, Jan. 23–27, Hollywood Beach Hotel, Fla.

IRE Winter Convention on Military Electronics, Feb. 7–9, Ambassador Hotel, Los Angeles, Calif.

Pacific Electronic Trade Show, Feb. 9–11, Shrine Exposition Hall, Los Angeles, Calif.

IRE, AIEE International Solid State Circuits Conference, Feb. 14–16, Sheraton Hotel and University of Pennsylvania, Philadelphia, Pa.

International Exhibition of Electronic Components, Feb. 16–20, Parc des Expositions, Paris, France.

Peter Jensen Passes

The co-inventor of our present electrodynamic loudspeaker and originator of the line of Jensen speakers died Oct. 25, 1961, aged 75.

Jensen was one of the earliest of the electronic pioneers and is one

of the contenders for the title of inventor of wireless telephony. Working with Valdemar Poulsen (inventor of magnetic recording and the Poulsen arc), he transmitted voice over the Poulsen wireless equipment in the early 1900's. Staying up every night to play phonograph records for radio operators on ships at sea, he became unquestionably the world's first disc jockey.

He came to the United States in 1909 to install wireless equipment for Poulsen Laboratories. Remaining to become an American citizen, he worked with another engineer, Edwin L. Pridham to develop what became the Magnavox dynamic speaker. Later he went to Chicago and began to make speakers under the Jensen name.

When World War II broke out, Jensen resigned from his own company and took a low-salaried post with the War Production Board, obtaining sound equipment for the Armed Forces. After the war he founded Jensen Industries and began manufacturing phonograph needles.

His native Denmark recognized his contributions to electronics by making him a knight and hanging a plaque at his birth place.

Jensen Industries, now making phonograph cartridges and accessories as well as needles, is being carried on by his son Karl.

How Much Dc Restoration?

How far should dc restoration go in modern TV receivers is a question that has been bothering a standards committee of the Electronic Industries Association, reports *Television Digest*. Dc restoration—maintaining the background level—once universal in TV receivers, has been almost universally omitted during the past several years. While it is almost necessary to give true blacks and whites, TV viewers have grown accustomed to a picture in various shades of gray. Now several manufacturers have restored it, and others plan to do so in new lines (see page 50 for more on this). The viewer now often finds that his new "high-fidelity" set gives him more trouble—the brightness and contrast controls may have to be readjusted when moving from one station to another.

The black-level committee is studying a possible recommendation for the stabilization of the dc levels. Present findings are that from 30% to 50% of the dc level can be restored without causing too many tuning complications for the user, but that 50% to 70% (full black level) would give a superior picture.

First PA System Found

A loudspeaker setup roughly 2,000 years old has been found in the ruins of a Roman theater at Nora in Sardinia. The system consisted of a number of earthenware "acoustic vases," the best descriptive terms that could be applied to them by the technical writers of the time. The so-called "vases" were each about 5 feet long and open at both ends. They were tapered slightly and had a maximum circumference of 3½ feet. A number of them were placed horizontally in niches cut in the low wall that formed the front of the raised stage. Thus they acted as megaphones, amplifying the voices of the actors and directing them toward the audience.

These "vases" had been mentioned by an early writer on acoustics, but none had ever before been discovered. Apparently the wealthier theaters used bronze, which was not able to stand the ravages of time as well as the low-cost jobs employed by the little theater in Sardinia. END

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Bernhard G. Fokken, Route 2, Canby, Minn	1st	12
Kenneth F. Foltz, Broad St., Middletown, Md.	1st	12
James C. Greer, Mound City, Kansas	1st	12
Thomas J. Hoof, 216 S. Franklin St., Allentown, Pa.	1st	22
Clyde C. Morse, 7505 Sharronlee Dr., Mentor, Ohio	1st	12
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Correspondence

LET ME CORRECT MYSELF

Dear Editor:

In my "Don't be Afraid of Color TV" article in the November 1961 issue I made a howler! You do *not* run the contrast control all the way down on the *older* color TV sets! If you do, you won't have a picture.

This statement *does* apply to the later RCA models such as the CTC9, CTC10 and CTC11, and the Admiral 25A6, 25B6, but not to the older CTC4 and similar chassis. JACK DARR

MOUNTAINS OUT OF MOLEHILLS

Dear Editor:

I am surprised that Mr. Crowhurst, in his article "Does FM Stereo Follow Its On Theory?" in the October 1961 issue can make such a complicated thing out of the relatively simple Zenith time-switching approach to stereo multiplex. He spends a whole column explaining what a poor approximation a sine wave is for a square wave, a fact which has no relation to the theory in question. He fails to comment on the very strong resemblance between Fig. 1, in which a square wave jumps between the left and right signals, and Fig. 4, in which a sine wave jumps between the left and right signals. Yet this close resemblance is the key to the Zenith system. If you take a waveform such as Fig. 1 (which can be considered the output of a time-switching device) and filter out all the harmonics of 38 kc above the first, the resulting waveform will be almost identical to Fig. 4 (his Fig. 4 represents the signal desired for transmission). Adding a small amount of L + R to the resulting waveform to compensate for the fact that the first-harmonic component of a square wave has a greater peak-to-peak amplitude than the square wave itself (giving an apparent increase in L − R subcarrier) makes the conversion from Fig. 1 to Fig. 4 mathematically perfect. This is the complete mathematical explanation of the Zenith system, and a very similar discussion can explain receiver operation using a time-switching function. I do not find this approach at all hard to understand or visualize.

Ann Arbor, Mich. JAMES A. SPROWL

THE AUTHOR REPLIES

Dear Editor:

After reading Mr. Sprowl's letter twice, I am still not certain whether he understands the confusion that the mathematical explanation to which he refers has caused. What he says is quite correct, as anyone who has learned Fourier analysis knows. But on the basis of this, I have found several engineers, working on adapter design, actually putting in $2/\pi$ compensation, then finding separation lacking and putting in further compensation which was essentially compensating for the fact that the $2/\pi$ correction wasn't needed in the first place.

If the adapter circuit uses square-wave type switching—as some do—it also needs $2/\pi$ compensation, as at the transmitter when this method of modulation is used. But the use at the adapter is *not because it was used at the transmitter.* With the specified form of transmitted signal, each method is independent of the other. If the adapter circuit does not use square-wave switching, or equivalent, it doesn't need $2/\pi$ compensation.

If Mr. Sprowl understands this, I agree with him it is not difficult. But as several engineers apparently did not understand this, I concluded it must be difficult to some and needed explaining. From experience, I have found that people who protest something I explained rather carefully was not that difficult, later come to me and tell me they have discovered the difficulty and that my explanation was quite right It may be Mr. Sprowl has still not seen the difficulty. NORMAN H. CROWHURST

Audio Design Service
Bayside, N.Y.

IGNITION-SYSTEM NOTE

Dear Editor:

It might be easier to build an electronic ignition system for your car (April 1961, page 90) by using a phase inverter transistor before the power transistor to reduce the contact point current, and use the distributors that are now in use, one that grounds the contact. The basic circuit is shown here (Fig. 1), but check with Bosch Co. of Germany as they have had an ignition system using transistors for quite a while.

Another possible circuit that would be compatible with present distributors is shown in Fig. 2. It requires a bias voltage other than the battery in the car but could be added to a car without

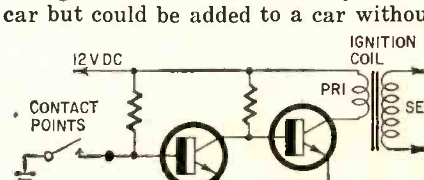
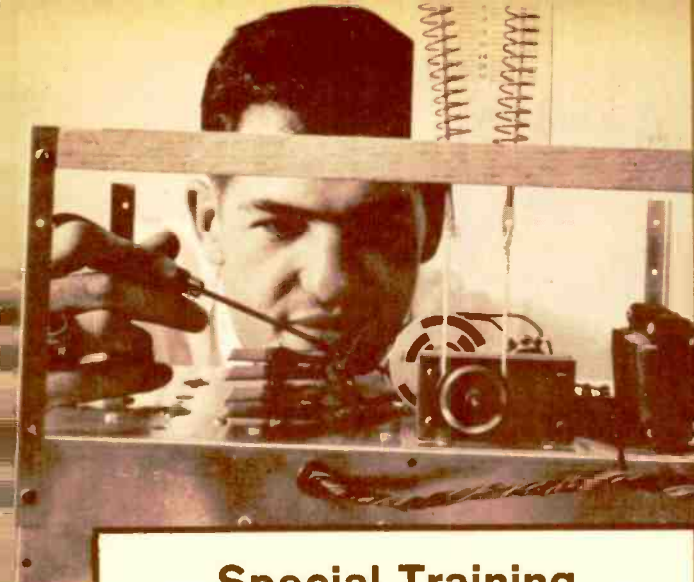


Fig.1



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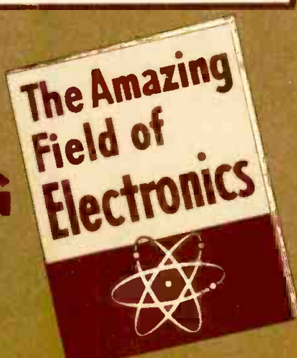

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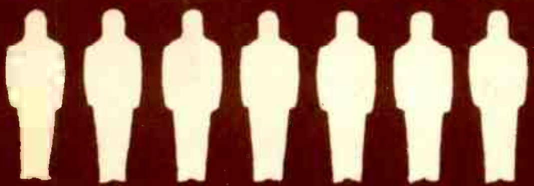

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BUILDING ELECTRONIC CIRCUITS on specially-designed plug-in type chassis, is the work of Robert H. Laurens, Hammonton, N. J. He is an Electronic Technician working on the "Univac" computer. Laurens says, "My NRI training helped me to pass the test to obtain this position."

"I OWE MY SUCCESS TO NRI" says Cecil E. Wallace, Dallas, Texas. He holds a First Class FCC Radio-telephone License and works as a Recording Engineer with KRLD-TV.

MARINE RADIO OPERATOR is the job of E. P. Searcy, Jr., of New Orleans, La. He works for Alcoa Steamship Company, has also worked as a TV transmitter engineer. He says, "I can recommend NRI training very highly."

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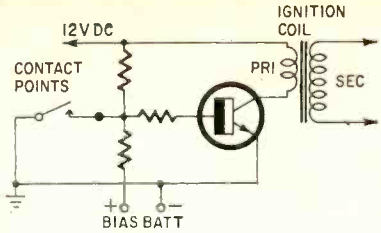


Fig.2

changing the distributor.

Seine, France ROBERT G. CASEY

[A complete ignition system—transistorized and electronic—is in the September 1961 issue, page 38.—*Editor*]

AC LINE ANTENNAS

Dear Editor:

We've just moved to a 50-apartment building. Rabbit ears for our TV give us a fair picture, with lots of snow. What is your opinion of the TV antennas that plug into the light socket?

Santa Monica, Calif. THEODORE STERN

[These things are not only useless, but some of them can be dangerous. I would not recommend them under any circumstances. They are simply sucker bait, like the static eliminators they used to sell when I was a boy.—*Jack Darr, Service Editor*]

WHY?

Dear Editor:

After reading "RFI: Invisible Killer" in the Sept. 30, 1961 issue of the *Saturday Evening Post,* I have a question to ask which has been bothering me for years.

No doubt radio-frequency interference is a problem. I'm particularly familiar with ignition static. For years I've been listening to trucks, buses and cars ruin short-wave reception because they were not equipped with ignition-noise suppressors.

Since many types of radio service are vital, why doesn't the FCC or the Government make it illegal to operate motor vehicles without suppressors?

After all, suppressors are cheap and easy to install. Doesn't anyone want to at least try to eliminate ignition static? Surely someone beside me is annoyed by unsuppressed ignition noise in radio and TV.

One simple law could make it mandatory that vehicle manufacturers install suppressors. This would help, wouldn't it? It's done in England.

Chicago, Ill. KEN GREENBERG

[Amen!—*Editor*]

MORE X-BREVIATIONS

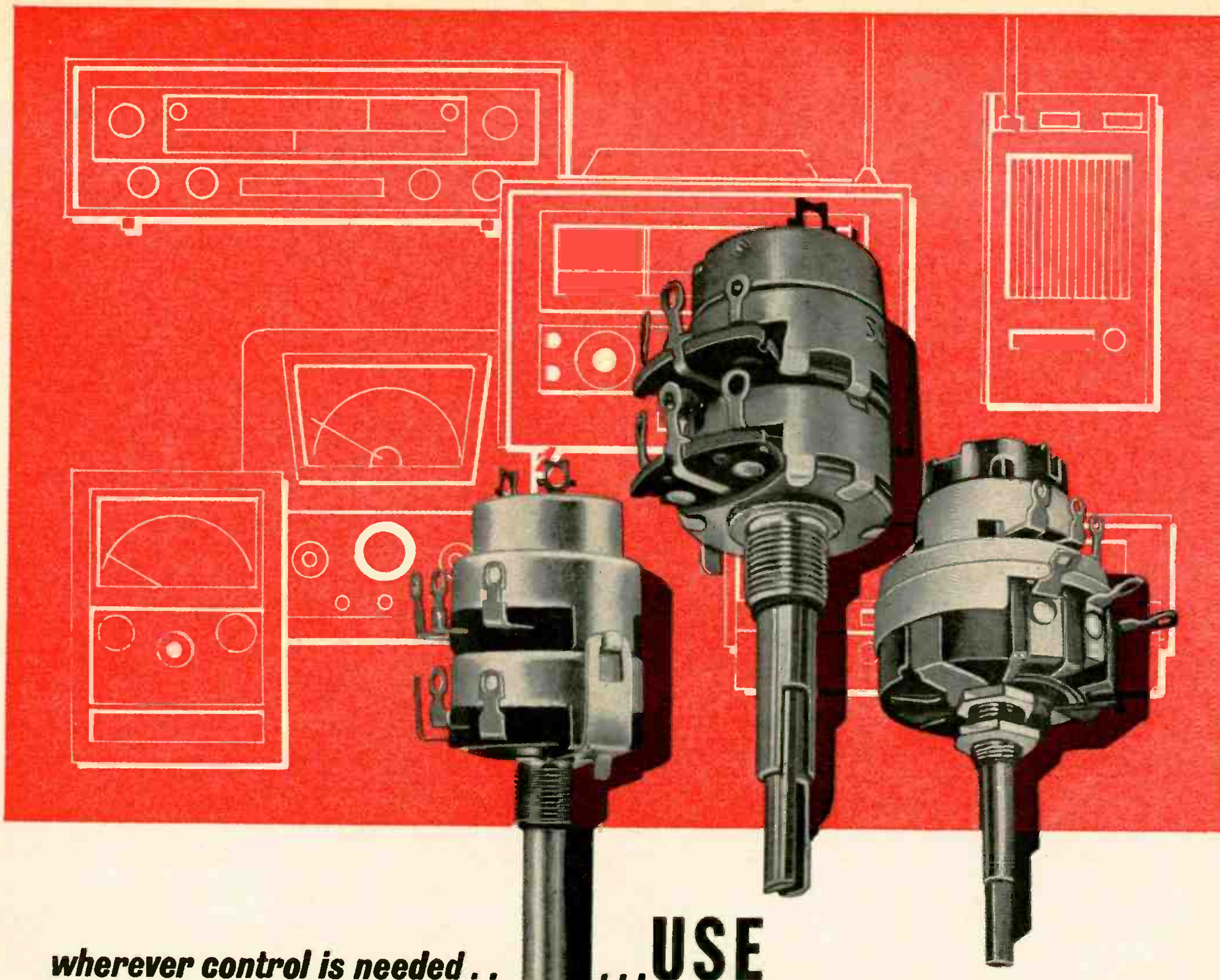
Dear Editor:

I noted with some interest Nate Silverman's letter in the September 1961 issue, dealing with X = Trans. I have always used a similar system with the following abbreviations:

Xtr = Transistor
Xfmr = Transformer
Xmtr = Transmitter
Xducr = Transducer

Wantagh, N.Y. C. H. PEARSALL, JR.

(Many thanks. Anyone else got a few to add to the list?—*Editor*) END



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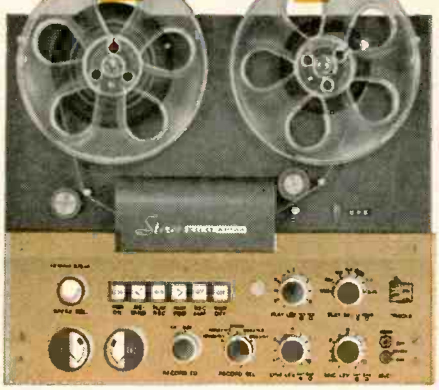

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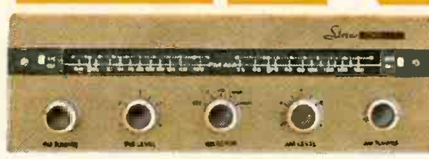

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FUTURE OF SERVICE INDUSTRY

. . . Service Technicians' Future Seems Assured . . .

DURING the past few years, electronic breakthroughs have occurred that could not have been imagined a decade ago. Beginning with the transistor revolution around 1950, in quick succession there evolved a miniaturization of most components, making possible the module type of set whereby a whole radio (minus its speaker) could be shrunk to less than 1 cubic inch.

A little later came moleculization that reduced transistors and their chief components to such a microscopic size that you could no longer see the total assembly with the naked eye. When molecular electronics is mass-produced—which will be soon—it is safe to assume that, since there are neither mechanically fashioned nor soldered connections between individual components, and since the total array of the components is so minute, it will theoretically last for generations. Neither air nor moisture will be able to get at the various parts. Because the mass and volume—hence weight—of such an array of components are so microscopic, even the most severe shocks should not damage it, unless violently crushed.

When such sophisticated electronic assemblies are then used in conjunction with printed circuits, as they surely will be, it would seem that radio and TV sets thus fashioned would last "forever" and never need servicing.

This reasoning, if we can believe the not-too-occasional letters from readers, has turned many radio-electronic technicians into prophets of doom who can no longer see any future in their business. "If," they say, "all new and upcoming sets are manufactured so perfectly that they no longer fail, what's the sense of staying in the servicing business?" Well, we answer, this reasoning is wrong.

To begin with, let us assume that the new super-receivers were to come off the assembly lines tomorrow. Then let us take inventory and this is what we find:

There are now in existence in the US alone

186,300,000 home and personal radios
41,000,000 auto radios
34,500,000 radio-phonographs
55,700,000 television sets, not including closed-circuit TV.

On a conservative basis, these 317,500,000 receivers will probably require 20 years or more of servicing before they have "worn out" or become hopelessly antiquated. Admittedly, the "average" life of a radio or other electronic device is much shorter. But, if you look around, you will see numbers of good radios 15 to 20 years old, and converted 1948 or 1949 TV sets that show no signs of an early demise. We should also not lose sight of the important fact that even today a considerable percentage of *these* tube sets never fail, if we except an occasional tube replacement. As we are writing this, on top of our desk there sits an 11-year-old, four-tube, plastic, molded-case, ac-dc radio. It is used daily, chiefly to get the news. Occasionally it runs for hours. Believe it or not, in 11 years it has *never* failed. No tube has ever been replaced. The only failure was purely mechanical: the friction tuner knob came loose and had to be tightened! We bring this up only because, if *every* set in the land had to be serviced regularly, there would not be enough servicing technicians to do the work and it would take months before every set owner could have his set serviced.

Now let us consider the new molecular sets that may soon make their appearance in vast quantities.

All the components, such as transistor, capacitors, resistors, etc., with the exception of the speaker, tuning device and volume control, will probably be mounted on a socket with pins, just as we do now with our tubes. There may be several such *component clusters* and there may be a dozen or more contact pins to a cluster. Thus, a complete amplifier stage with all its components will be in a single cluster.

Should anything go wrong, the cluster can be removed just as you remove a tube today. The service technician probably will have a new type of troubleshooting instrument which will inform him speedily *which* cluster failed and why. He will replace it with a new one, discarding the old. If this system is economically unfeasible, the cluster leads would then be soldered or mechanically fastened to the printed circuits. Service technicians would then have to unfasten such a cluster, if defective, and replace it with a new one.

TV sets, always more complex than any radio, will also require more servicing because their greater complexity, even in the future, will make for more failures. This will be true even when all TV's will be completely transistorized.

We can even foresee when future TV sets will be powered atomically. Atomic energy will furnish the necessary high-voltage supply, probably quite independent of the house current. In this manner *all* radios and TV's will be truly portable.

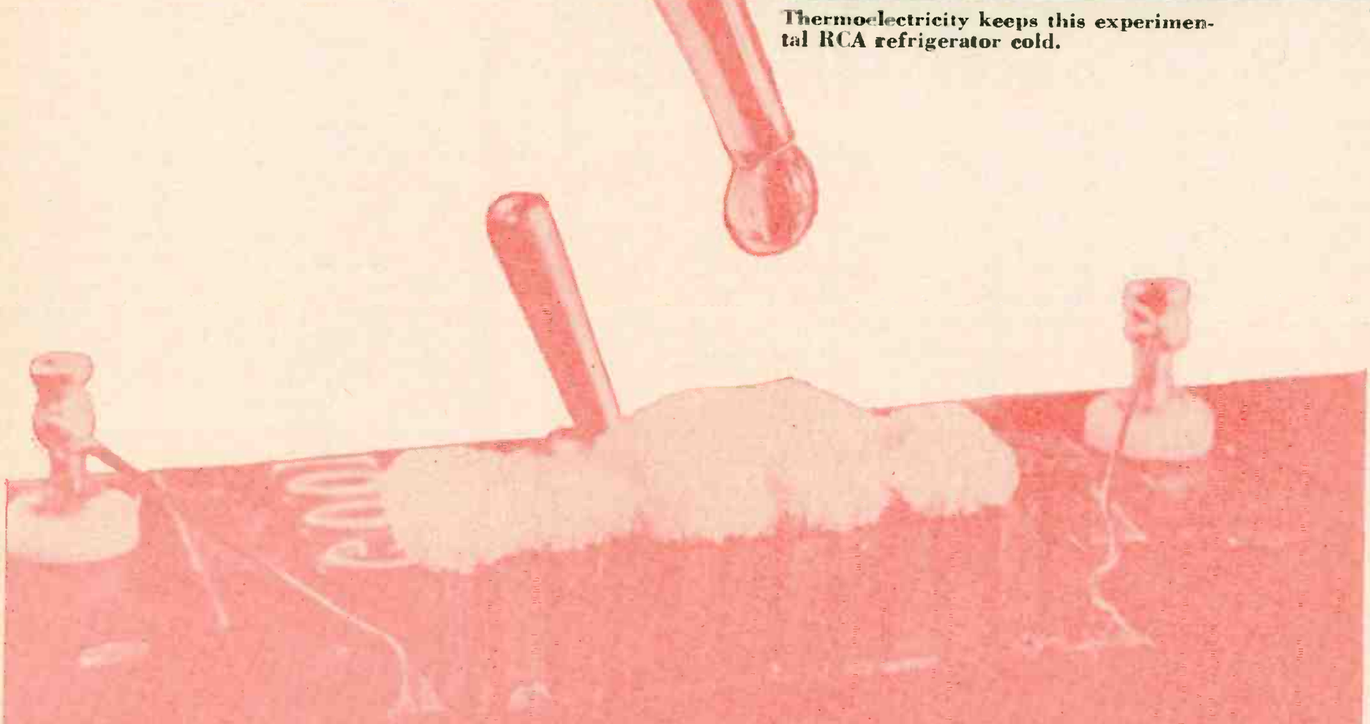
While future sets—radios, TV's and other wholly unimagined, communication, education and entertainment units may theoretically become so perfect that they may never require servicing, practically we doubt that this will ever come about.

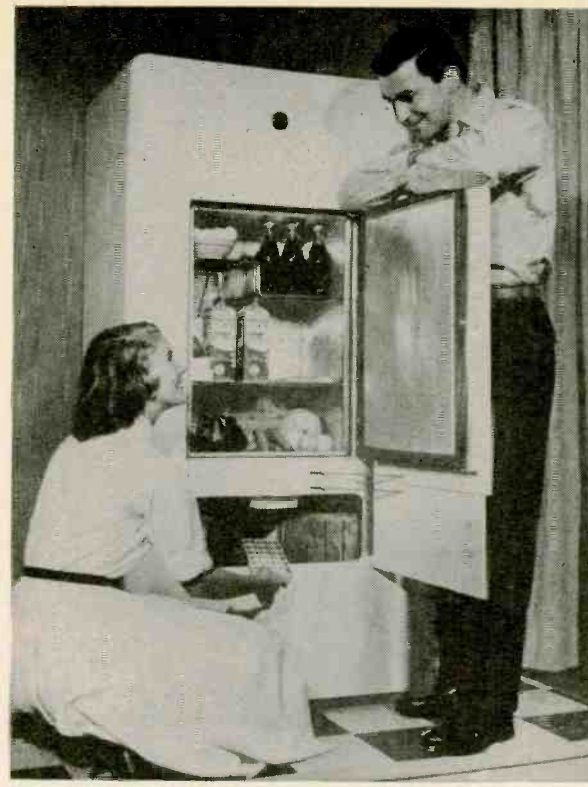
There will always be intermittents, mechanical failures in various connections, tuning devices, loud-speakers, volume controls and others, particularly devices where continuous mobility or motion is necessary.

We are convinced that the prophets of doom who see the servicing industry going to pot have misread the future completely. In our complex civilization that requires objects of many parts, be they clocks, cars, elevators, telephones, air conditioners or TV's—a goodly percentage of them must be serviced occasionally, no matter how careful their construction. Even such well constructed objects as humans with a long history of millions of years behind them must also be serviced occasionally by those well trained technicians, the medical doctors. Serviced they always will be, far into the most distant future we can foresee. —*H.G.*

electronic cooling & heating

New uses for an old principle





Thermoelectricity keeps this experimental RCA refrigerator cold.

By LAWRENCE H. OTT, Ph.D.*

DEVELOPMENTS IN THERMOELECTRICITY are making electronic headlines and are being carefully watched by specialists in many fields. Two factors are responsible for the recent upsurge of interest in this 140-year-old discovery—the growing list of applications for thermoelectric devices, and the increasing indications that we are on the brink of startling advances in this field.

Interest in thermoelectricity is following two main lines. First there are developments in the generation of electrical power. Second there is great activity in thermoelectric refrigerating systems or heat pumps.

Space satellites have created a need for special power sources. Some of the new devices being studied include thermoelectric generators, fuel cells, solar cells and thermionic converters. Main interest has been in thermoelectric generators because of their simplicity and versatility. The commercial power industry is also seeking new ways to increase power-plant efficiency and reduce their size and complexity.

In refrigeration, thermoelectricity promises important advantages over mechanical systems. These include elimination of moving parts, less noise, simpler control and adaptability to small-scale cooling applications.

Thermoelectric effects

The simplest thermoelectric effect is conductor heating by current flow, or Joule heating. However, this is an irreversible process and is not ordinarily included under the heading of thermoelectricity.

The two most important thermoelectric effects are the Seebeck effect, in which a potential difference is generated when the junction between dissimilar conductors is heated, and the Peltier effect which covers the absorption

*Senior staff engineer, Aerospace Group, Hughes Aircraft Co.

or generation of heat when a current flows across the junction between two different conductors.

Thermoelectricity is more than a century old. Thomas Johann Seebeck in 1821 was experimenting in Berlin with a bar of antimony that had a coil of brass wire wound around it and attached to its ends to form a loop. He noted that, when a junction of the bar and wire was heated, a nearby magnetic needle was affected. Two years before this event Oersted had discovered the magnetic effect of a current, and Seebeck believed that he had discovered a magnetic effect caused by heat. The idea of a current flowing in the conductors did not at first occur to him. Four years later when Ohm discovered his famous law, he used the Seebeck effect to produce small voltages.

Fourteen years afterward, Jean Charles Peltier, a French physicist, noticed that when a current flowed in a circuit of two dissimilar metals, one junction between the two was heated while the other was cooled. To us the Seebeck and Peltier effects are complementary but, at the time of their discovery, they were imperfectly understood, and it was not until 1857 that Lord Kelvin, then William Thomson, showed the exact relationship between the two and postulated a third small thermoelectric effect, now called the Thomson effect, caused by the thermal gradient in conductors.

The Seebeck and Peltier thermoelectric effects are small when ordinary metals are used, and for over a hundred years the principal uses were for thermocouples and thermopiles for temperature-measuring and heat-detecting devices. Thermoelectricity could not compete with other electrical power-producing methods such as batteries and generators as the power conversion efficiencies for thermoelectrics were generally below 1%.

The recent advances in knowledge of solid-state physics, particularly in the field of semiconductors, have brought about an upsurge of interest in thermoelectricity. All conducting materials have measurable Seebeck and Peltier effects, but certain semiconductor materials exhibit markedly greater effects than ordinary materials. They also have the proper values of electrical resistance and thermal conductivity necessary to give good performance in thermoelectric heat-transfer and power-generation applications. Both n- and p-type semiconductor materials are useful. The first can be thought of as having a surplus of free electron carriers, while the second type has a deficiency. In p-type materials the current carriers are positive carriers or "holes". In both types, the density of current carriers is very much less than in ordinary metal conductors.

Seebeck and Peltier effects

To get a working concept of the Seebeck effect, visualize the current carriers in metallic conductors as if they were a liquid, and in semiconductors as if they were a gas. When one end of a piece of n-type semiconductor is heated, the conduction electrons at this end, visualized as a gas, increase in pressure and are driven to the cold end. In this way the cold end of n-type has a greater density of conduction electrons and will show a negative potential with respect to the hot end (Fig. 1-a). In a similar way, when one end of p-type semiconductor is heated, the "hole" conductors, also visualized as a gas, increase in pressure and are forced to the cold end (Fig. 1-b). The latter then has a greater density of "hole" conductors and a positive potential with respect to the hot end. Forming a thermocouple with n-type material for one leg and p-type for the other is then an obvious way to combine them for maximum thermoelectric voltage effect.

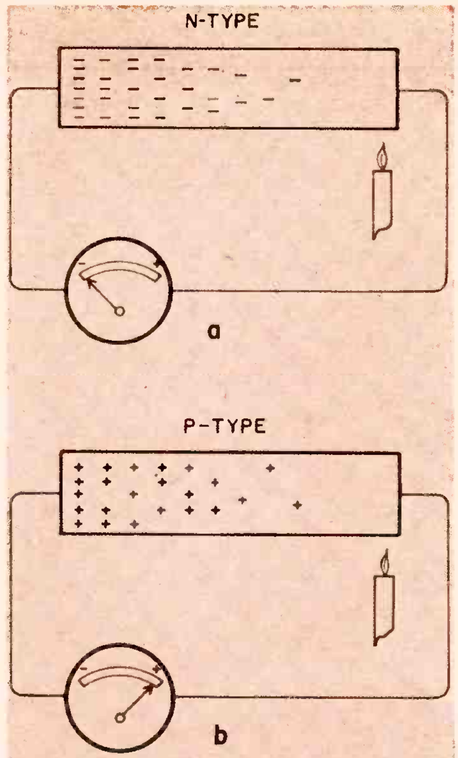


Fig. 1—Seebeck effect. Movement of electrons in semiconductor material caused by heating. a—N-type semiconductor. b—P-type semiconductor.

The Peltier effect can be understood in a similar way by visualizing the current carriers operating in a gas–liquid transformation. Now consider a piece of n-type semiconductor with a metal strip attached to each end. If we apply a dc voltage, electrons are forced to flow from the negative pole of the battery around the circuit. The electrons in the external metal conductor are visualized as a liquid and, when they pass across the junction of the semiconductor, they leave the energy levels of a liquid and enter the vapor state of a gas. This "evaporation" process absorbs heat and a cold junction results (Fig. 2-a).

At the other terminal the electrons are forced by the potential from the gaseous state in the semiconductor into the liquid state in the metal. This corresponds to a "condensation" change of state, and heat is emitted and the junction becomes hot. With p-type materials the carrier flow from metal to semiconductor is a cooling transition, and the flow from semiconductor to metal is heating. With the same direction of current flow, the heating–cooling effects at the junctions are opposite to those of n-type material (Fig. 2-b). Combining an n-type leg and a p-type leg in a circuit couple will create a hot junction and a cold junction for maximum effect (Fig. 2-c). If heat can be continuously dissipated from the hot side of the couple, that is, to a heat sink, a temperature difference can be maintained between the two junctions. In other words, we have an electrical heat pump. The temperature difference between the opposite ends depends upon the heat load to the cold side and the efficiency of the heat sink. In practice, many couples are connected in series electrically with their heat pumping capacities in parallel.

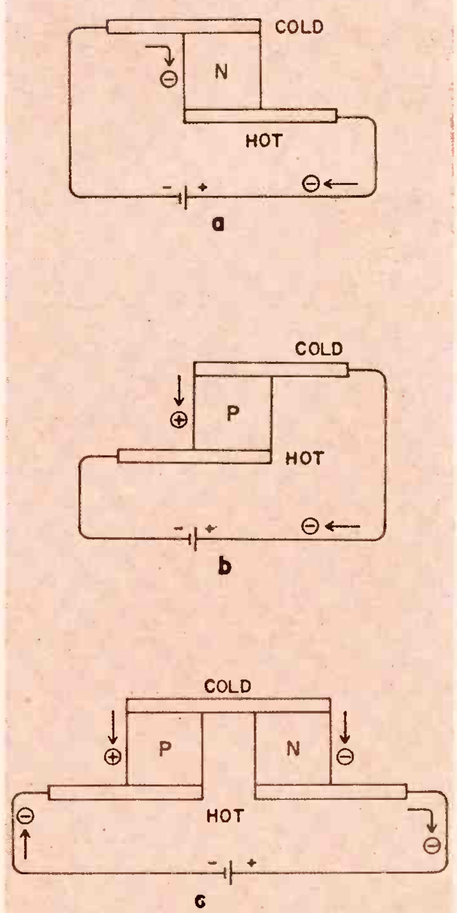


Fig. 2—Peltier effect. An applied voltage forces electrons to flow through semiconductor material, absorbing heat at one terminal and emitting heat at the other.

One of the popular misconceptions about Peltier coolers or heat pumps is that, with the passage of a current through the semiconductor materials connected in couples, heat is somehow annihilated at one junction. It is important to recognize that while a quantity of heat may be "pumped" from an object while maintaining the object below the effective environment—that is, heat is made to flow "uphill"—to do this electrical power must be expended. The amount of power may range from a

RCA

Wall of thermoelectric elements makes a room air conditioner.

Hughes

Experimental diode cooler for spot-cooling tests on electronic components.

fraction to several times the quantity of heat pumped. Thus, while Peltier devices lower the temperature of the cooled object, they require the expenditure of energy. Therefore the heat to be disposed of is larger than the heat removed from the object.

However, operating the Peltier unit in the heating cycle (that is, with current reversed), the device is more efficient than resistive heating since, in addition to the I^2R heating, there is added the heat pumped from the cold side. Thus, as a heat pump in the heating mode, it may supply up to several times more output heat than an equivalent, purely resistive, heating element.

The total amount of heat pumped is directly proportional to the cross-section area of the semiconductor material perpendicular to the direction of heat flow. Since total cross-sectional area is the important factor, it makes no difference whether the material is in many small pellets or a few large pellets. For each size of pellet there is, however, an optimum cooling current. The only geometrical influence on heat-pump performance is the ratio of length to area of cross-section. Thus for a given L/A, the smaller the element the more heat can be pumped per unit area for the same change in temperature and current.

Good thermoelectric semiconductors

A research group at Baso, Inc. in 1948 found that lead telluride, suitably doped with an impurity, was an efficient thermoelectric material. In 1955, a detailed study of bismuth telluride, a material first suggested by Goldsmid, led to the development of associated alloys used for practical thermoelectric devices.

The ideal thermoelement would possess a high Seebeck coefficient together with infinite electrical conductivity and zero thermal conductivity. The three properties are combined in a single design parameter for the material, named the figure of merit, Z, which is related to the Seebeck coefficient, S; to the electrical resistivity, p, and to thermal conductivity, k, by the equation $Z = S^2/pk$. These three properties are not independent of each other, but depend upon the number of mobile electron and hole carriers. The Seebeck voltage and the electrical resistivity are inversely proportional to the number of mobile carriers, while the thermal conductivity is approximately a linear function of the carrier density.

There is a never-ending search for better thermoelectric materials. To get optimum efficiency or maximum power output, it is necessary to find the correct mobile carrier density. Typical carrier densities for a good conductor such as copper, and a good insulator, such as quartz, are 10^{23} and 10^{9} carriers per cubic centimeter, respectively. The range for semiconductors lies between 10^{14} and 10^{20} carriers per cubic centimeter. A value of 10^{19} carriers per cubic centimeter has been found best for lead telluride, bismuth telluride and germanium telluride.

The figure of merit, the important material parameter mentioned above, is a function of temperature. Generally, it reaches a maximum value at some particular temperature and then drops off rapidly. At higher temperatures no potential difference is generated by the semiconductor material. This fact has led to extended research in materials.

The maximum efficiency of a thermoelectric device is governed by the same Carnot limitation as a reversible heat engine. That is, the greater the difference in temperature between the hot and cold ends, the higher the conversion efficiency. Present-day devices are inefficient energy converters averaging about 6%. A modern industrial power plant with turbine generator can operate with a thermodynamic cycle efficiency of 45% and an electrical generator efficiency of 95%. This results in an overall thermal efficiency of 42%.

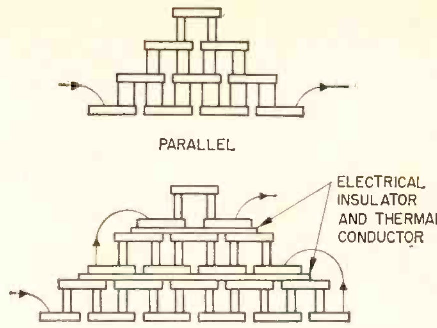


Fig. 3—Two common configurations of three-stage coolers. In such arrangements the cold junction of the first set of the thermocouples serves as the heat sink for the second, etc.

The forecast for thermoelectric generators in the next 25 years is that thermal efficiencies may reach approximately 30%. While this is lower than that achieved by the turbine-generator power plant, thermoelectricity may find its place in some areas.

Practical devices

In spite of lower efficiency, thermoelectric power generators have much to offer for certain applications. The Atomic Energy Commission has sponsored a program to develop several nuclear-fueled generators for SNAP (*S*ystems for *N*uclear *A*uxiliary *P*ower). One of the first products of this program, the SNAP-III radionuclide battery was demonstrated in January 1959. The unit weighed about 5 pounds and had an output of five watts to a matched load. The heat source consisted of a small amount of radioactive Polonium 210, and a temperature differential of about 600°F is maintained between hot and cold junctions. During the half-life of this material, the generator is calculated to deliver a total of over 9,000 watt-hours of power, or the equivalent of more than 100 pounds of the best chemical storage batteries.

A larger unit, SNAP I-A, weighing 175 pounds, has an output of 128 watts at 28 volts. This generator has 277 thermoelectronic couples imbedded in a shell enclosing a nuclear fuel package of Cerium 144. The unit is smaller than a solar-cell system and operates continuously. Provision is made to maintain the electrical output constant as the nuclear fuel decays.

The Navy is interested in thermoelectric power generators for ship and submarine use. Kerosene is the fuel source for a 5-kw generator being built that has many combinations of voltage and current outputs ranging from 500 amperes at 10 volts to 42 amperes at 120 volts. Lack of operational noise, compactness and the possibility of using nuclear fuel make thermoelectric generators advantageous for submarines.

An interesting commercial development in small thermoelectric generators is a portable unit to provide emergency power for operating a transistor radio receiver. This unit consumers 1 pint of kerosene or fuel oil in 24 hours, develops

0.75 volt and delivers 0.5 watt of power to a matched load. A built-in transistor converter changes the 0.75-volt output to the 3 to 9 volts required to operate most transistor radios.

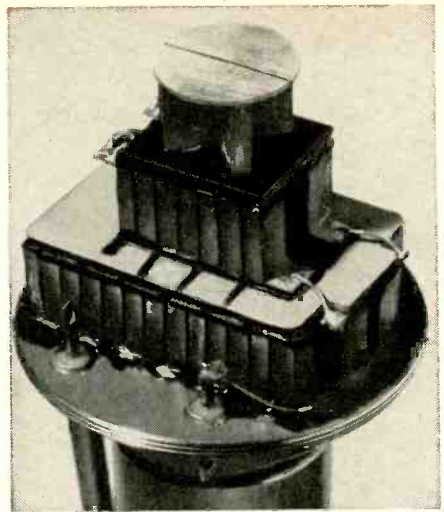
In the field of heat pumping and refrigeration there are plans to employ thermoelectric devices for small refrigerators for home, auto, boat, plane, and camping and water coolers.

One manufacturer has designs for several sizes of refrigerators with from 1 to 4 cubic feet of capacity. The smallest size is designed for a 25-watt thermal load and uses 30 bismuth telluride thermocouples 2/10 inch in diameter and ¼ inch long. The operating current is 20 amperes at 2.5 volts. The 4-cubic-foot model is designed for a 65-watt thermal load, uses 80 of the same thermocouples. The boxes are insulated with plastic foam 1 inch thick and will maintain an inside box temperature of 40°F or lower when operating in an outside ambient of 90°F.

Another manufacturer is producing small thermoelectric refrigerators for installation in all the new rooms of a Chicago hotel to provide guests with self-service ice cubes.

In medical research there have been applications for controlled cooling of particular areas of the body, for example, spot cooling of parts of the brain. These studies are leading to increased knowledge of human physiology. Such a thermoelectric cooler has been designed at Hughes Aircraft Co. and used at UCLA's Medical Research Center for experimental brain research.

Thermoelectric cooling is being used to air-condition an experimental space suit to keep an astronaut comfortable at a temperature of 80°F in environments



Hughes

Infrared detector is cooled by three-stage cascaded thermoelectric device. Operating on 2 amperes at 2 volts, the unit drops temperature from 25°C to –77°C.

up to 135°F. A thermoelectric cooler–heater unit fits into the back of the suit with the battery power source in the front.

The electronics field offers countless uses for general and spot cooling of component parts. Spot cooling is usually by direct conductive connection between the part and the Peltier cooler. Power diodes, transistors, ferrite cores, infrared cells, photocathode and photomultiplier tubes, fluorescent light sources, etc. are all temperature-sensitive components. Most solid-state devices are limited to a specific maximum temperature of operation, above which their characteristics deteriorate and reliability diminishes. So keeping temperatures down becomes important.

Infrared detector cells, important for guiding some types of missiles, have increased sensitivity and lower noise output level when operated at temperatures below that of dry ice. Obviously, it is not convenient to maintain a supply of dry ice or liquefied refrigerant in each missile. Thermoelectric coolers have been successfully developed for this important application. Such devices begin to operate the instant current is turned on. A unit operating at 2 amperes and 2 volts achieves a temperature drop from 25°C to −77°C, enough to cool an infrared detector down to its optimum operating temperature. The Hughes cooler is a three-stage cascaded device using cell loading of about 125 mw.

In the cascaded arrangement of thermocouple elements, the cold junction of the first set serves as the heat sink for the second set, and the cold junction of the latter cools the hot junction of the third set, and so on (Fig. 3). In this way a greater temperature difference can be built up between the heat sink and the final cold junction. Unfortunately, due to the temperature variation of certain material parameters, not much is gained by employing more than three stages.

Such is the current state of thermoelectric technology. The great promise of thermoelectricity is that, with some further advances which seem within our grasp, it will perform a wide variety of tasks important to man's welfare more efficiently, more simply and more conveniently than existing devices. As our knowledge of solid state phenomena increases, its future appears to be well-nigh limitless. END

"Instant-on" Circuit for ac-dc receivers

SOME NEW WESTINGHOUSE RADIO AND portable TV's incorporate an ingenious circuit which keeps the series-string tube heaters running at about quarter power even when the set is turned off. The result is that, when the set is turned on, it plays instantly with no warmup delay. At the same time, the tube heaters are spared the jolting current surge which hits them when an ordinary receiver is turned on.

The Westinghouse circuit requires an additional silicon rectifier and a dpst line switch to replace the original spst. The circuit can be added to an existing ac–dc radio with little difficulty.

Best results are obtained in sets which use a semiconductor to rectify the high voltage. Receivers with vacuum-tube rectifiers may not play instantly when turned on. However, they will play within a few seconds.

Two circuits are shown. Fig. 1 is for use in sets where the on–off switch is connected between the chassis and one side of the line. Fig. 1-a shows the original, 1-b the modified circuit. Fig. 2 is for those sets where the chassis connects directly to one side of the line with the line switch inserted in the other leg, Fig. 2-a is the original, 2-b the modified circuit. Note that the additional silicon rectifier is bridged across the main line switch and is shorted out when the switch is in the ON position. In the OFF position, the B-supply is disconnected by the other section of the switch and the filament string is supplied with a reduced dc potential instead of its normal 117 volts ac. The silicon rectifier delivers approximately 55 volts dc. This voltage across the entire heater string results in a drain about a fourth the normal filament wattage but is enough to start the set playing as soon as the B-supply voltage is applied by turning on the switch.

Assuming that the heater string draws 150 ma, the added current drain from running the heaters at quarter power when the set is off should not add more than 75¢ to $1.50 to the annual electric bill, depending on electricity rates. However, tube life should be extended greatly by continuous heater operation, so the end result may be an actual dollar saving.

The added silicon rectifier can be one of the universal 130-volt rms, 250–500-ma types. END

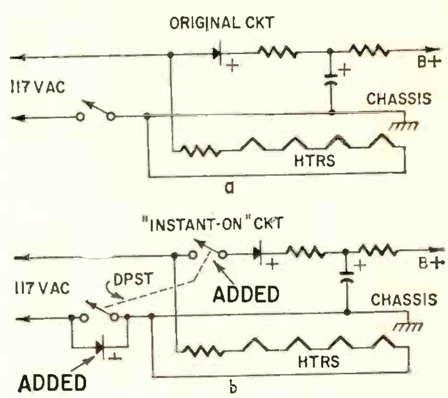


Fig.1

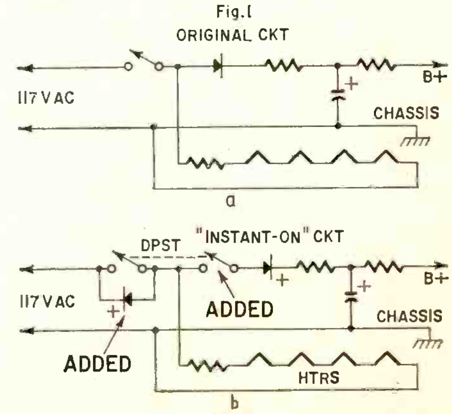
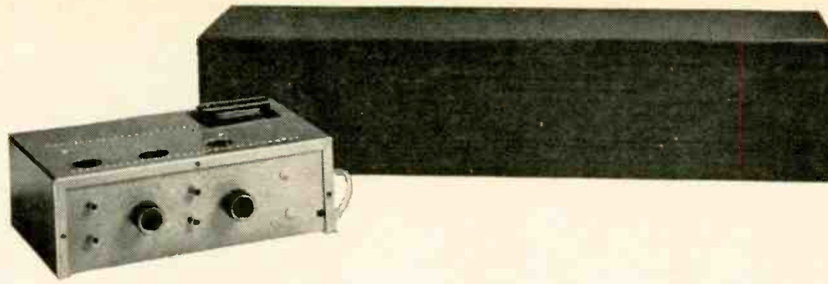


Fig.2

BUILD



A SIMPLE REVERB UNIT

An interesting project for the audio experimenter

By GEORGE MANNING LEWIS

THIS ARTICLE PRESENTS A PRACTICAL REverberator unit designed to be inserted into the builder's high-fidelity system. It can be built by the average hi-fi enthusiast or kit builder in a few hours. The materials can often be salvaged from other electronic equipment. If purchased new, the cost should not be over $20 or $25.

Introduced only about 2 years ago, several electronic devices on the market supply various amounts of reverberation when inserted into the circuitry of a monaural or stereophonic home music system.

There has been some controversy as to the value of reverberation. Some dismiss it as a worthless fad. To me, however, reverb is no mere novelty or sales gimmick, but a major advance in home music reproduction.

Little material intended to enable the electronics hobbyist or kit builder to construct a practical reverberator has been published, and some of what has been printed has come from far out in left field. The unit presented here is the product of a period of research and experiment during which several methods and devices—and several electronic circuits—were explored. It is not perfect, but it *is* a practical, easily constructed device that will give highly gratifying results with either stereo or monaural recorded material.

To keep the story simple, we are discussing primarily a monaural unit. It can be modified for use in a stereo circuit. The constructor can make the monaural unit first, leaving space on the chassis, and later add the other tube and wiring to make it a stereo instrument.

But, because of the nature of stereo and the acoustics of the average living room, many listeners find that adding reverb to only the right channel of a stereo system is adequate.

How reverberation works

Much of the tonal richness and vibrancy of a well designed (acoustically) concert hall is the result of a mixture of sounds simultaneously reaching the ear. Some of these sounds have traveled directly—in a straight line—to the listener's ear. Other portions of the same sounds have first been reflected from the ceiling, walls and even the people in the audience. This causes them to reach the listener's ear a fraction of a second later than the sound that traveled directly from the stage to the auditor.

But that is not all. Reflecting the sounds modifies their tonal quality. It alters the character of the sound—its quality, volume, duration, pitch and timbre—by altering the complex resultant of the concomitant sound vibrations. To produce reverberation electronically, it is necessary to take a portion of the audio signal from the audio signal path at some point before the power amplifier stages and to delay it for 20 or more milliseconds (about 40 or 50 milliseconds is optimum for the average living-room application—unless one likes echoes, the time delay must be less than 1.8 seconds). During this process its tonal character is modified. Then it is reintroduced into the audio signal path, being mixed with the undelayed (primary) audio signal (Fig. 1).

The problem of designing a practical reverberator unit then resolves itself into two parts: achieving the time delay and approximating the normal concert hall's ability to modify the total character of the sounds being bounced off the walls and ceiling. This may be done with a mechanical device such as a length of spring wire, through which the sound must travel before being reintroduced into the audio signal path.

Thus the reverberator unit consists of two parts: an electronic unit which is essentially a lo-fi amplifier and transducer, that builds the amplitude up and converts it to auditory sound which may be mechanically delayed; and a mechanical delay device (that also performs the character modification function) with its pickup and mixer circuitry.

Building the reverberator

The unit presented here for hobbyist construction (Fig. 2), takes a portion of the audio signal from a voltage-divider network and directs it through a triode–pentode tube (a 6BM8/ECL82) for amplification, following which the reverb signal is directed through an ordinary 1,000-ohm headphone) to which a small wire loop has been soldered in the exact center of the phone diaphragm), which converts the reverb signal to audible sound. (To distinguish between the two signal portions we now have, let us speak of this portion of the signal which has been diverted from the audio signal path as the reverb signal; the other signal as the audio signal.)

The sound is directed, by the loop soldered to the diaphragm, into a length of coiled spring wire, the other end of which is attached to a crystal cartridge which reconverts the audible reverb signal into an electronic signal. This in turn is mixed—in a 6EU7 mixer tube—with the audio signal, after which it is fed to the main power amplifier.

The use of a mixer tube as a means of introducing the reverb signal into the audio signal path is necessary to prevent feedback of the reverb signal to the voltage divider and thence to the grid of the 6BM8. That would, if allowed, create a ring-around-the-roses condition of oscillation. The choice of a 6EU7 was dictated by several considerations: It is an extremely quiet tube. Its pin connections make wiring into the circuitry of the reverb unit easy. Being a tube specifically designed for hi-fi audio application, its fidelity is

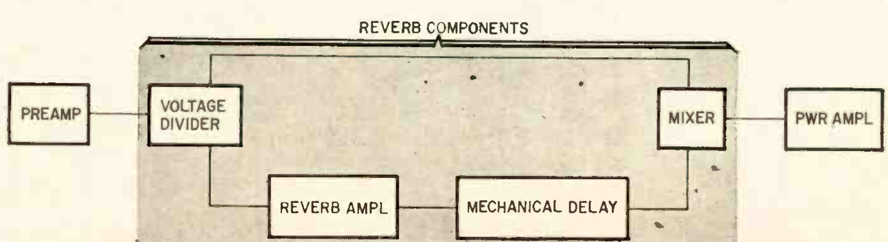
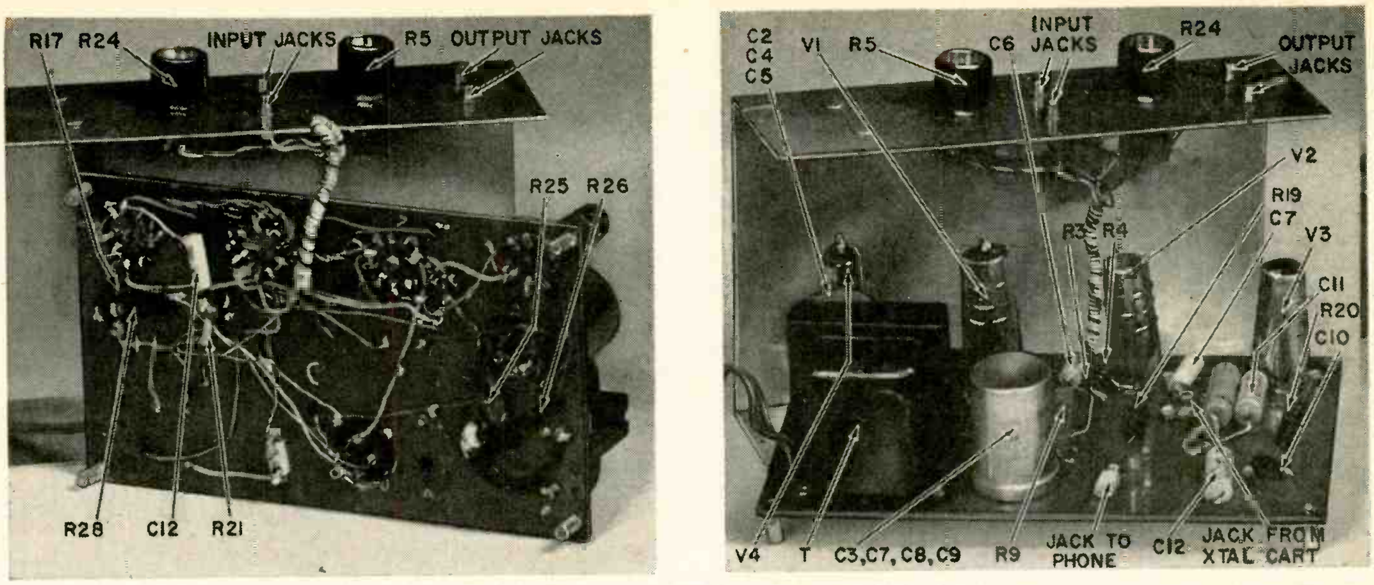


Fig. 1—How reverb unit fits into a monaural hi-fi system.



Top and bottom views of the reverb unit chassis.

extremely high and reliable. Its two triode sections are matched for identical performance.

Wired as shown in the schematic (Fig. 2), it has an overall gain of about 12, approximately equivalent to the loss of audio signal at the voltage divider. Thus this additional stage in the preamplifier part of a hi-fi rig scarcely increases the overall preamplifier signal gain, and the use of the 6EU7 as mixer makes no perceptible difference in the tonal quality or fidelity of the audio signal passing through it.

Although the 6BM8/ECL82 is not (in this country) a popular audio tube, experiments indicated that it is eminently suitable for this particular application. The triode section used as a driver, resistance-coupled to the pentode section, used as an output pentode, can produce about 4 watts of audio power, more than sufficient to energize the 1,000-ohm phone that drives the spring.

Parts placement is not too critical, but you must use every precaution against introducing hum or noise into the audio signal path. Shield the grid leads (Fig. 2), and ground to the chassis at one point only (to prevent so-called ground loops). Usual commercial (10%) tolerances in component values are acceptable. The B-plus should be liberally filtered.

The electronic portion of the unit can be constructed on a 5 x 7 x 2-inch chassis. Because I have a bookcase hi-fi rig, with components in full view, my reverb unit (see photo) was constructed on a 5 x 7 x 3/16-inch laminated paper phenolic board, so that it could be encased in a 6 x 8 x 4-inch Bud utility box.

The choice of a 6X4 for the rectifier was purely arbitrary. Any other full-wave rectifier tube or selenium rectifier bridge could be used satisfactorily. A half-wave rectifier tube or selenium stack would probably introduce hum into the audio signal.

The mechanical delay

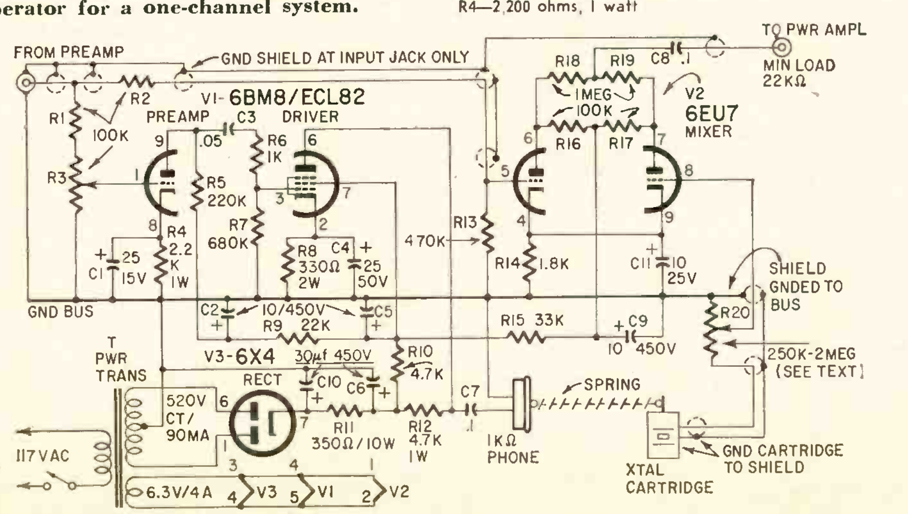
The purpose of this section is to delay the reverb signal for 20 or more milliseconds, before feeding it back into the audio signal path, and to approximate the tone character modification of concert-hall reverberation.

The actual length of the delay (as well as the amount of reverberation) is determined by several factors, including personal preference and size and acoustics of the room in which it is to be used. Hence some experiments will be needed when the unit is completed, and controls for adjustment must be provided in the design.

This is done by enclosing the unit in a plywood box (Fig. 3). The spring is attached on one end to the phone (to which a small wire loop has been soldered at the exact center of the diaphragm). The other end of the spring terminates with an eyebolt that passes through a ¼-inch rubber grommet inserted into a hole in the plywood end of the box. A wing nut is used on either eyebolt. Thus the tension of the spring may be adjusted as desired, or as experimental listening indicates. The phone is fastened with a similar grommet to the other end of the box, as the photo indicates.

The spring itself is a variable and, since no readily available springs are made to exact standards (of "springiness", sound-vibration transmitting ability, etc.), some experimenting will be needed. The one I found satisfactory was wound of No. 30 steel wire on a 3/16-inch diameter form and was purchased from a local hardware store (Belknap, general-purpose spring, S-3016-30). When purchased it was tightly

Fig. 2—Schematic of the simple reverberator for a one-channel system.



R1, R2, R16, R17—100,000 ohms
R3—100,000-ohm pot, audio taper
R4—2,200 ohms, 1 watt
R5—220,000 ohms
R6—1,000 ohms
R7—680,000 ohms
R8—330 ohms, 2 watts
R9—22,000 ohms
R10—4,700 ohms
R11—350 ohms, 10 watts, wirewound
R12—4,700 ohms, 1 watt
R13—470,000 ohms
R14—1,800 ohms
R15—33,000 ohms
R18, R19—1 megohm
R20—250,000-ohm to 2-megohm pot (see text)
(All resistors ½ watt unless otherwise stated)
C1—25μf, 15 volts
C2, C5, C9—10 μf, 450 volts
C3—.05 μf
C4—25 μf, 50 volts
C6, C10—30 μf, 450 volts
C7, C8—0.1 μf
C11—10 μf, 25 volts
Capacitors 600 volts unless noted
V1—6BM8/ECL82
V2—6EU7
V3—6X4
T—Power transformer secondaries 260-0-260 volts, 90 ma 6.3-volts, 4 amp (Stancor PC-8420 or equiv.)
1—1,000-ohm headphone (see text);
1—24-inch spring (see text); 1—crystal cartridge; 3 RCA type phono jacks;
1—utility box, Bud 6 x 8 x 4 or equivalent (or suitable chassis); 1—5 x 7-inch perforated or other construction board or breadboard; miscellaneous hardware, etc., as described in text.

wound, one coil turn touching the other, with an overall length of 24 inches. The spring was held tightly in a vise and stretched until the turns were slightly separated one from the other. Later, in refining the operation of the unit, I found it advantageous to spread the first two inches (from the phone) of the spring so that the coils were about 1/16 inch apart. This seemed to decrease the sensitiveness of the unit to room and floor vibrations.

The phone should be mounted at one end of the box near the bottom while the other end of the spring passes through the grommet near the top of the other end so that the spring is suspended at about a 20° angle from the horizontal. This is necessary, as are the damper block and the shock-mounting of the cartridge support, to prevent the spring from responding to every footstep or vibration in the room.

So constructed (Fig. 3), ordinary walking and passing outside traffic will not noticeably affect the vibrations of the spring or the operation of the unit. It can be placed at almost any convenient place for operation, except on top of a speaker cabinet.

In my experimental work several types of cartridges were used to pick up the vibrations of the spring and convert them again into an electrical signal. In actual operation it was difficult to distinguish between one of the cheaper hi-fi crystal cartridges and a common crystal cartridge such as those used in one-tube portable record players. The more sensitive cartridge, however, seemed more prone to respond to extraneous noises which affected the spring. Because of this, and since fidelity is not of primary concern here, I use in my unit an Astatic model L-12U. It has a response from 50 to 5,000 cycles, and produces a voltage output of slightly more than ½ volt rms at a 1,000-cycle note input at room listening level—more than enough to feed the mixer grid and produce a desirable amount of reverberation.

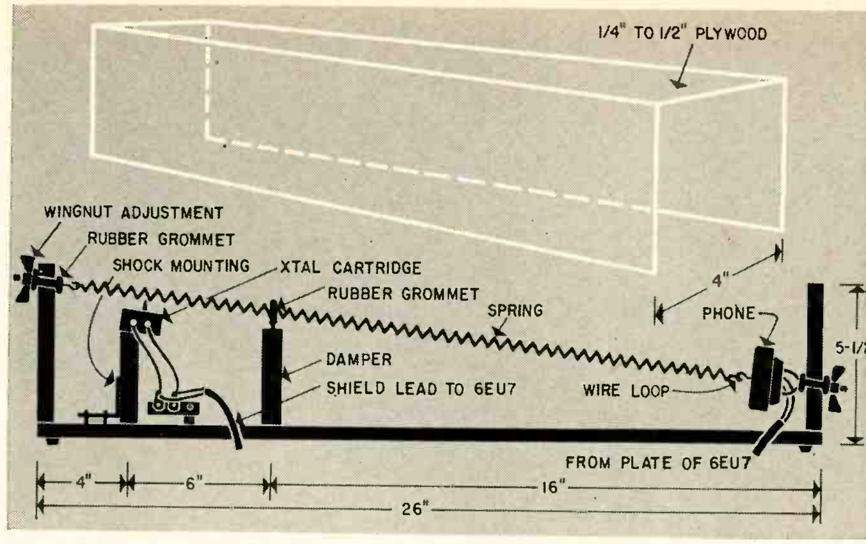
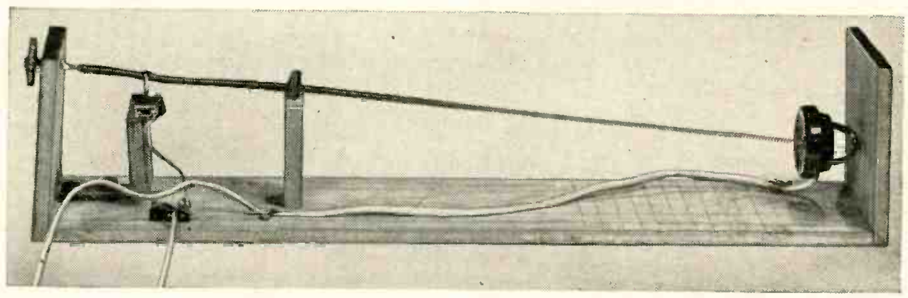


Fig. 3—Time-delay unit—construction detail.



The completed unit on its wood frame.

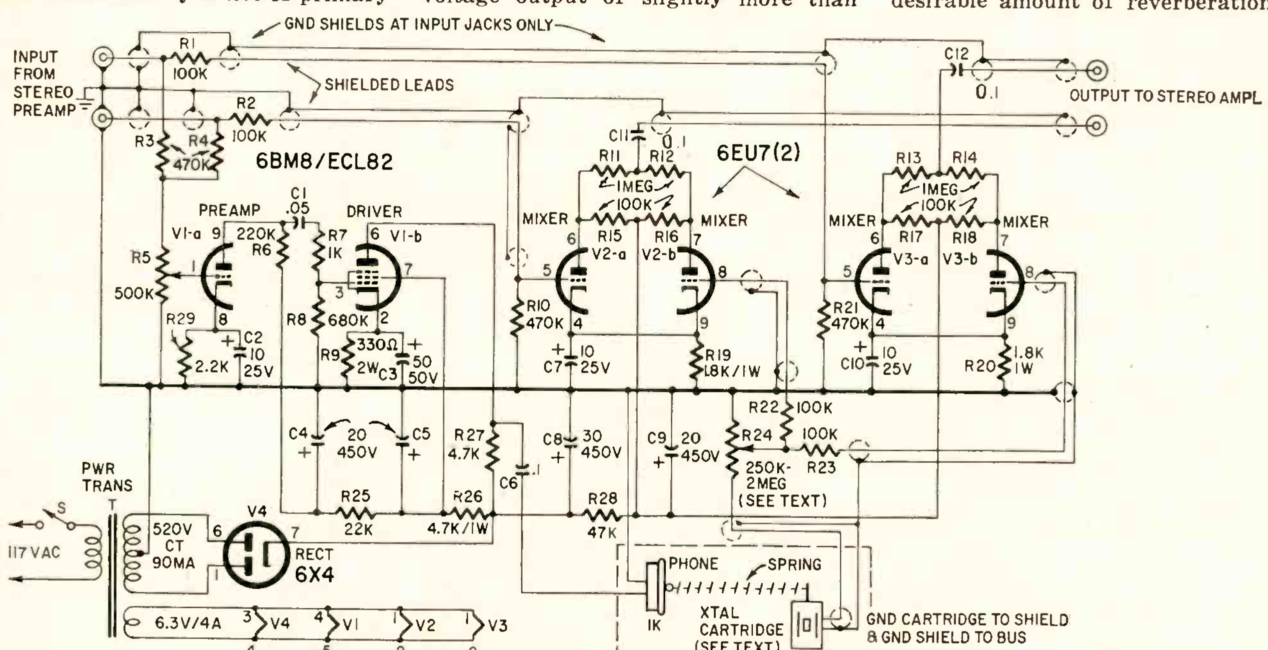
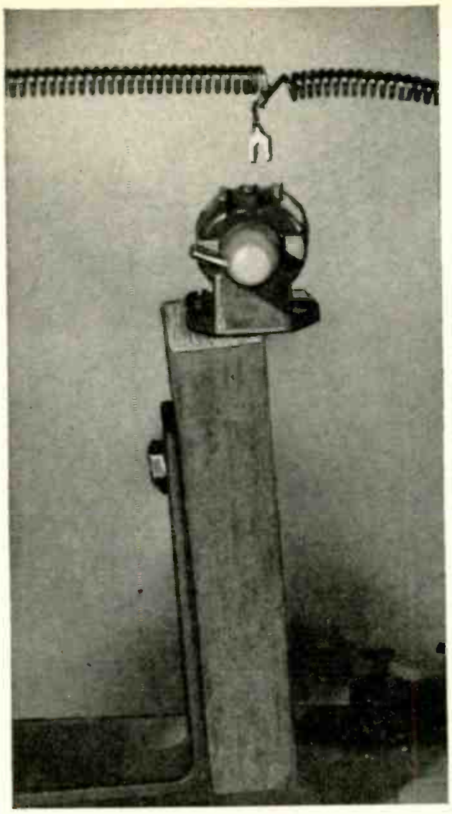


Fig. 4—A simple stereo reverberator unit.

R1, R2, R15, R16, R17, R18, R22, R23—100,000 ohms
R3, R4—470,000 ohms
R5—500,000-ohm pot, audio taper
R6—220,000 ohms
R7—1,000 ohms
R8—680,000 ohms
R9—330 ohms, 2 watts
R10, R21—470,000 ohms
R11, R12, R13, R14—1 megohm
R19, R20—1,800 ohms, 1 watt
R24—250,000 ohms to 2-megohm pot (see text)
R25—22,000 ohms
R26—4,700 ohms, 1 watt
R27—4,700 ohms
R28—47,000 ohms
R29—2,200 ohms, 1 watt
(All resistors ½ watt unless otherwise stated)
C1—.05 μf
C2—10 μf, 25 volts
C3—50 μf, 50 volts
C4, C5, C9—20 μf, 450 volts
C6, C11, C12—0.1 μf
C7, C10—10 μf, 25 volts
C8—30 μf, 450 volts
Capacitors 600 volts unless noted.
V1—6BM8/ECL82
V2, V3—6EU7
V4—6X4
T1—Power transformer; primary, 117 volts secondary, 260–0–260 volts, 90 ma (Stancor PC-8420 or equivalent)
1—24-inch coil spring, 3/16-inch inside coil diameter, No. 30 steel wire (see text)
1,000-ohm headphone, crystal cartridge, chassis, paneling, hardware, etc.
4—RCA type phono jacks



How the spring is attached to a ceramic cartridge. Damper block is also shown.

A cartridge like the Astatic model L-12U may be attached to the spring with a short piece of No. 18 solid hookup wire, soldered to the spring. Stiffen it somewhat by coating it thinly with solder, then insert it into the needle socket and secure it with the thumbscrew at the front of the cartridge. However, when using one of the high-fidelity crystal or ceramic cartridges, the spring may be affixed to the cartridge with an old discarded stylus of the spade variety (one that has a little spade or Y at one end by which it is intended to be mounted in the cartridge). This stylus can then be soldered to the spring in such a manner as to permit the stylus "Y" to fit snugly over the damper block in the cartridge (see the photo above). Be careful that the Y fits snugly over the damper block—a loose fit will affect the operation of the unit.

Mount the crystal cartridge on a block, about 4 inches from the inside of the end of the box, at right angles to the spring (so the needle will move laterally in line with the spring) and at a plane angle corresponding to the angle of the spring (in relation to the horizontal). The block should be shock-mounted. This can be done by attaching it to the base of the box with a metal 2-inch angle iron, mounted to the base of the box through two rubber grommets. The value of the reverberation control (R20 and R24 in mono and stereo versions, respectively) is selected for optimum load on the cartridge. The nominal value is around 1 megohm.

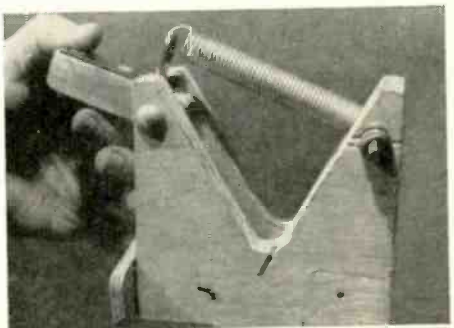
A damper block is optional, depending upon where the unit will be placed in operation. If it is subjected to much external vibration, it is well to insert the damper. It is made from a wooden block (size is unimportant) on which there is a small rubber grommet through which the spring will pass. It should be so positioned that it has a stabilizing effect but exerts no perceptible tension upon the spring, and should be located about two-thirds to three-fourths the distance up the spring from the headphone. Some experiment may be needed before it is affixed to the base of the box permanently. Since my unit was designed for a bookcase installation, the damper was found necessary and was positioned 9 inches from the headphone. It works very satisfactorily there.

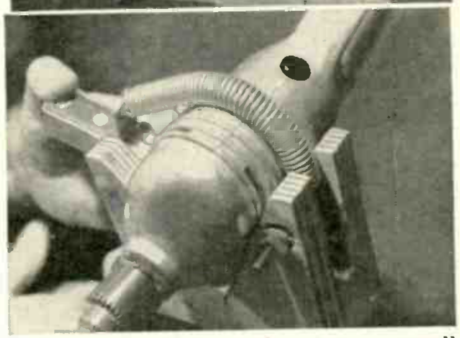
The box containing the delay part of the reverb unit (the headphone, spring and pickup cartridge) should also be mounted on rubber feet, and may be finished, painted or veneered, or left unfinished as desired. It may be constructed entirely of ½-inch plywood, or the top may be constructed of either ½- or ¼-inch plywood, as convenient.

As stated earlier, the unit may be modified for stereo. For the purist, the correct approach would be to construct two identical units, each with its own spring, and insert one in each channel. The method shown in Fig. 4 has the advantage that the period of reverberation will be the same on each channel, and is recommended.

In Fig. 4 a portion of the stereo input signal is tapped off through R3 and R4 and mixed on the grid of V1-a. The mixed stereo output of the delay line is fed to the grids of V2-b and V3-b. After amplification, it is combined with the undelayed stereo signals in the resistive matrix networks in the plate circuits of V2 and V3. Now, the output of each channel has mixed with it a delayed or reverberated sum signal whose amplitude is set by the reverberation control. END

handy drill holder





The ¼-inch utility electric drill often serves as a vise-held grinder and sander. This extremely versatile tool makes light work of grinding chores and would probably be used more often if it were possible to hold it securely in the small vises usually found in many shops. To make this possible, a drill-holder accessory is needed since the jaws of most vises are not deep or wide enough to hold the drill.

Such a holder, with a quick-change feature can be readily made with a few pieces of scrap plywood. Saw a deep V in two blocks of ¾-inch plywood. The blocks should be a little wider than your drill and perhaps a foot long. Below the bottom of the V, separate the two blocks with a smaller one; then nail all three together. Now saw out the bottom half of the block to make a rough Y. To hold the electric drill, fasten a fairly heavy coil spring to one side of the V with a bolt. Hook the other end of the spring into a small angle bracket which, in turn, is fastened to another small block of plywood. This block, which serves as a clamp-tightening trigger, is pivoted on the other side of the V. This completes the holder except for a small turn block at the base of the V to hold the trigger when the drill is centered in the V. The holder eliminates the need for a vise to hold the drill since it can be clamped or screwed directly to the work bench. It is readily portable and can be used on a job away from the shop by clamping it to any convenient upright.

Another advantage is that the drill can be clamped securely in the holder in a matter of seconds and removed just as quickly. It holds a heavy drill securely and will not damage the drill housing in any way. The device, of course, can be clamped in any vise, however small. If desired, it can be sanded and painted. —*Glen F. Stillwell*

BUILD

ELECTRONIC MICROMETER

By DAVE STONE

The electronic micrometer determines wire gauge sizes from No. 10 to No. 40; measures chassis, panel or metal stock thickness from 1 mil (.001 inch) to about 250 mils (0.250 inch); measures the diameters of resistor or capacitor leads to obtain hole drilling size for printed-circuit boards, and measures rod, dowel and machine-screw diameters.

It can also be used for unusual measurements like determining the thickness of paper or mica dielectric in capacitors, the thickness of a coat of paint on a panel or the thickness of paper insulation, to name a few.

This electronic counterpart of the standard machinist's micrometer is assembled from readily available parts and only ordinary hand tools are needed. Its overall accuracy depends upon the size of the meter and how carefully it is calibrated. A large meter with many scale divisions allows closer calibration and greater accuracy. The 2½-inch meter in the unit shown in the photographs is adequate for most electronic applications.

Operating principles

The electronic micrometer operates upon well known transformer principles. An iron-core filament transformer has a core made up of E- and I-laminations. The layer-wound winding is placed over the center E-lamination arm (Fig. 1).

The I-laminations complete the magnetic flux path after the winding is assembled. If they are removed, the induced secondary current drops considerably because the magnetic flux path is open. If the I-laminations are deliberately moved in or out, secondary current will increase or decrease in proportion to the spacing between the I-laminations and the E-lamination core.

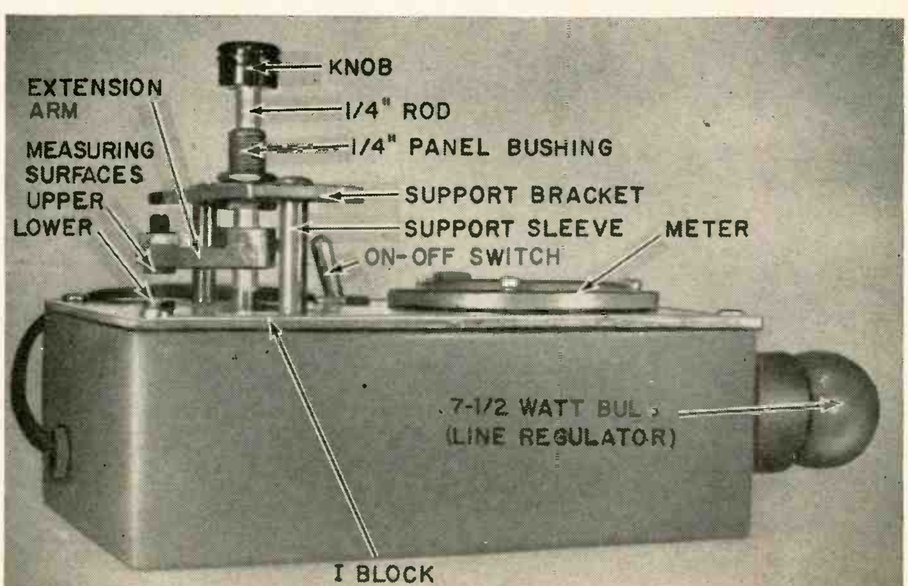
The thickness of the material to be measured determines the spacing between the two lamination stacks. The resulting secondary current is rectified by a germanium diode and fed to the indicating meter. The usual stack of I-laminations is replaced by a solid iron block of equal size. A bracket and metal rod (Fig. 2) support the block and permit it to be moved toward or away from the E-lamination stack.

An extension arm fastened to the metal rod holds a flat, ground-down bolt head. This is used as a measuring surface. An identical ground-down bolt is fastened to the chassis directly below the extension arm's measuring surface. These measuring surfaces correspond to the two flat surfaces of a machinist's micrometer. The material to be measured is placed between the flat surfaces. The combination extension arm and I-block is then lowered to contact the material and the meter indicates the thickness.

Mechanical construction

The core of the filament transformer used in this unit consists of alternately arranged E- and I-laminations. It must be taken apart to rearrange the E-laminations in one direction, and to remove and discard the I-laminations. Cut off the small metal fingers that hold the core in the U-shaped mounting strap and slide the core assembly out. Removing the laminations will be slightly difficult at first as they are tightly stacked and often varnish-impregnated. [Most medium-grade transformers are put together with two or three E-laminations in one direction, capped with an equal number of I-laminations, the same number in the other direction, and so on. A good way to remove the laminations is to knock out the center group of I-laminations with a screwdriver or small piece of strap iron or steel and a mallet or hammer. Then put the transformer on a vise with the jaws slightly open so that the center E-laminations are over the gap, and drive the E-laminations out with the strap-iron delaminating tool and hammer. Tap carefully and not too hard, and be sure the laminations are going out straight.—*Editor*] Tap the core frequently to loosen the varnish and try not to bend the laminations. The rest of the job becomes considerably easier once the first few laminations are removed.

After the laminations are pulled



Side view shows details of the mechanical portion.

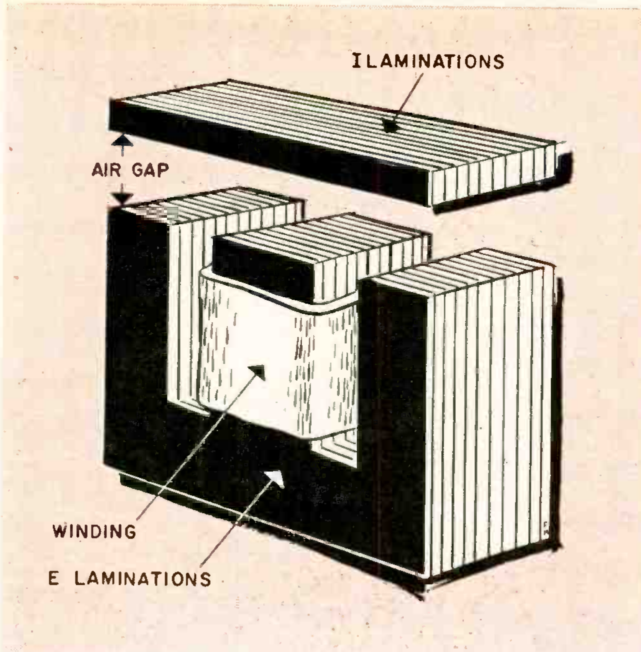


Fig. 1—Transformer core assembly.

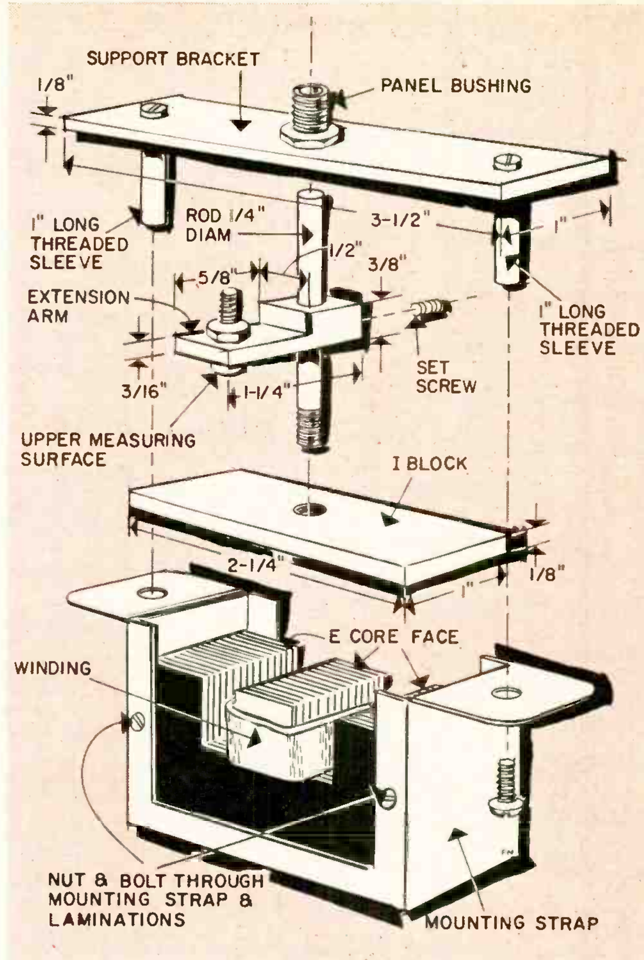


Fig. 2—Mechanical assembly of the micrometer.

apart, reassemble the E-laminations all in one direction. Put the stack back into the mounting strap without the I-laminations. Tap the face of the E-stack to drive it as far as possible into the mounting strap, and to make sure all the laminations are lined up to provide a flat surface. Drill a small hole through the strap and lamination stack on both sides and fasten tightly with a nut and bolt (Fig. 2).

Cut a 1-1/6 x 2-5/16-inch rectangular hole in the chassis and drill the mounting holes to mount the transformer temporarily directly beneath the opening. The I-block will pass through the opening and into the space left above the E-stack face. It should fit snugly, without binding, and lay flat on the core's face. Measure the exact center of the I-block and drill and tap for a ¼-20 thread.

Drill a ⅜-inch hole in the exact center of the support bracket and mount the panel bushing. Cut three or four ¼-20 threads on one end of a 2½ inch long, ¼-inch diameter brass or aluminum rod. Thread it into the I-block and tighten. File away any excess rod material that projects past the lower face of the block.

Fasten the extension arm firmly to the rod, fasten the threaded sleeves to the support bracket, insert the rod in the panel bushing and assemble it all to the chassis. The transformer's mounting bolts go through the chassis into the bottom end of the threaded sleeves to support the entire assembly rigidly.

Place the winding back on the middle E-core arm and install the lower measuring-surface bolt on the chassis directly below the extension-arm measuring surface before final assembly.

Electronic construction

The 5-volt transformer winding is connected to the 117-volt ac line through a 7½-watt 120-volt lamp bulb (Fig. 3). The lamp operates as a dropping and ballast resistor to regulate the line voltage input. Output from the transformer's 117-volt winding is rectified by a 1N69A diode and fed to a 1-ma meter. A variable shunt, potentiometer R2, is placed across the meter for calibration.

There is nothing critical about the layout of the electronic circuitry. Any standard diode may be used for the rectifier and the unit will work well with any standard 1-ma meter. Drill a hole in the case for access to the screwdriver adjustment of the calibrating potentiometer.

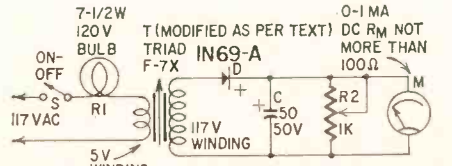
Calibration and use

Loosen the setscrew on the extension arm and slide the I-block into the transformer mounting strap so that it fits flush against the E-core face. Plug the unit into the 117-volt line and watch the meter. If the electronic micrometer has been wired correctly, the reading will be almost full scale. Adjust for full-scale deflection with R2 to obtain the zero thickness setting.

Position the upper measuring surface on top of the lower measuring surface and set for a snug contact between the two. Make sure the I-block is resting flat against the E-core face and the measuring surfaces contact each other without strain. Tighten the extension-arm setscrew and the unit is ready for calibration.

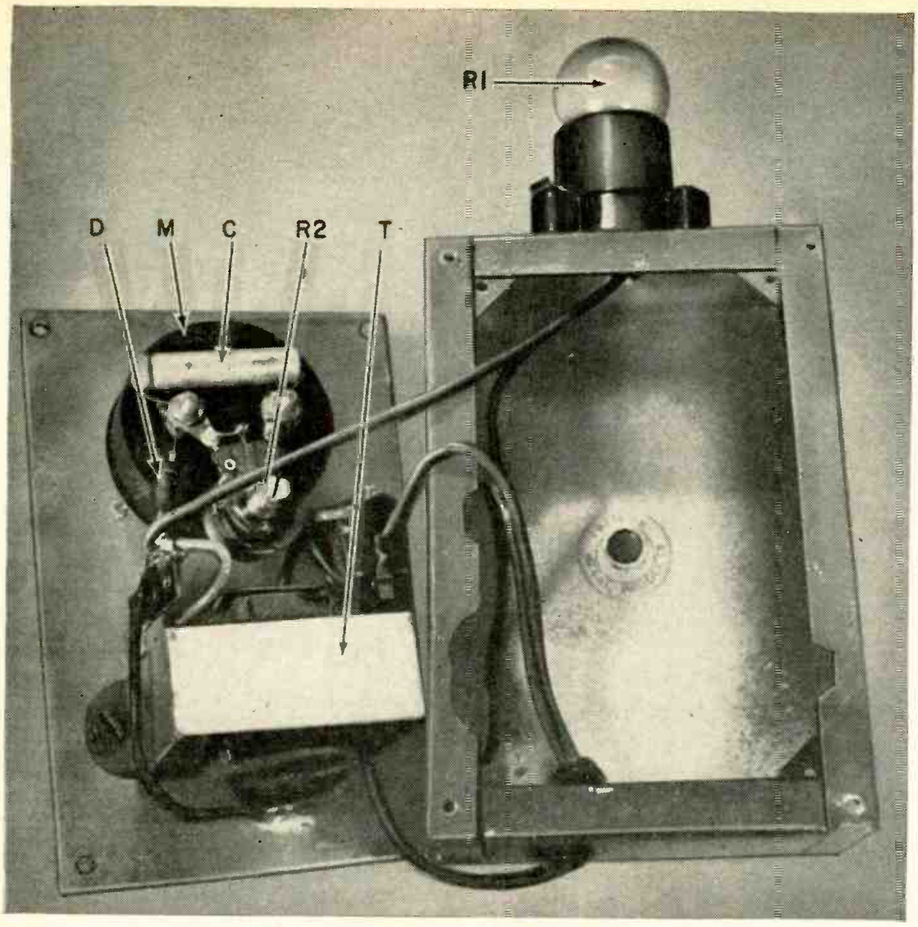
An inexpensive feeler gauge from the local auto supply store is used to calibrate the electronic micrometer. It starts with a 2-mil (.002-inch) gauge and goes up to about 250 mils with various combinations of the gauging strips.

R1—light bulb, 7½ watts, 120 volts
R2—pot, 1,000 ohms
C—50 μf, 50 volts, electrolytic
D—1N69-A
M—meter, 1 ma, dc, 2½-inch movement, internal resistance not more than 100 ohms



S—spst, toggle switch
T—filament transformer: primary, 117 volts; secondary, 5 volts (Triad F-7X)
I—block, mild steel or iron, ⅛ inch thick, 2¼ x 1 inch
Support bracket, aluminum or brass, ⅛ inch thick, 3½ x 1 inch
Extension arm, aluminum or brass block, ½ inch square, 1¼ inches long, cut down as shown
Rod, aluminum or brass, ¼ inch diameter, 3 inches icng
Threaded sleeves, standard hardware item, 1 inch long, tapped for 6-32 screws (2)
Panel bushing, ¼ inch, standard hardware item
Measuring surfaces, hex-head bolts with heads ground down to flat surface (2)
Case to suit
Miscellaneous hardware

Fig. 3—Simple electronic circuit depends on a variable transformer.



Parts layout inside the instrument.

Obtain a piece of flat aluminum foil from the kitchen to calibrate the 1-mil setting. Most flat varieties of aluminum foil are 1 mil thick.

Raise the rod, place the foil on the lower measuring surface, lower the rod to contact the foil with the upper measuring surface with slight pressure and record the reading. Repeat with the 2-mil feeler gauge and so on, for as many thicknesses desired to obtain a meter reading thickness chart.

Note that, above 60 mils or so, the meter readings decrease slowly for relatively large increases in thicknesses. This is no disadvantage for general measurements, but if greater accuracy is desired, use a larger meter with more divisions.

It is easy to use the electronic micrometer for measuring an unknown thickness or diameter. Place the material (metal stock, wire, plastic, paper, etc.) on the lower measuring surface and lower the rod until the upper measuring surface bears down upon the material. Rock the material slightly to insure that it is perfectly flat between the two surfaces, and read the meter. Refer the meter reading to the chart to obtain the material's thickness or diameter.

To measure the thickness of a coat of paint on a panel, first measure the bare panel's thickness and jot the reading down, then apply the paint. When dry, measure the thickness again and obtain the paint thickness from the difference between the first and second readings.

The calibration should be checked occasionally if the line voltage is known to vary considerably, by lowering the I-block to the E-core face. You should read zero thickness—full-scale deflection. Normally, it will not be necessary to readjust the calibrating potentiometer for long periods of time, for the regulating lamp does a good job.

The electronic micrometer is very useful for rapid measurement of many pieces of material and the meter is much easier to read than the barrel of a machinist's micrometer. It is easy to assemble, fun to construct and the end result is a useful measuring instrument. END

Because of the complete report on 1962 TV in this issue we have been forced to leave out the Service Clinic this month. It will be with us again in the February issue and with a bigger-than-usual installment

attention technicians

With this issue RADIO-ELECTRONICS is starting a special feature aimed to help speed your service work. The page to the right is actually an 8-page booklet of tube basings for the 1960 and 1961 Admiral TV receivers. A new booklet will appear each month. Each one will cover a different make of TV receiver. When clipped together you will have a complete guide to tube layouts that will easily fit into your tube caddy.

To put your booklet together, cut out the page. Fold the top down and back, keeping the cover facing you. Then fold from left to right on the line marked *fold here,* keeping the cover facing you. Staple the booklet along the left hand edge. Now run a sharp knife or razor blade along the closed top and you're finished. You now have a useful piece of service information, exclusive with RADIO-ELECTRONICS.

If you have any comments on this booklet or suggestions for other subjects that might be covered in the same format, send them to Booklet Editor, Radio-Electronics, 154 West 14 Street, New York 11, N.Y.

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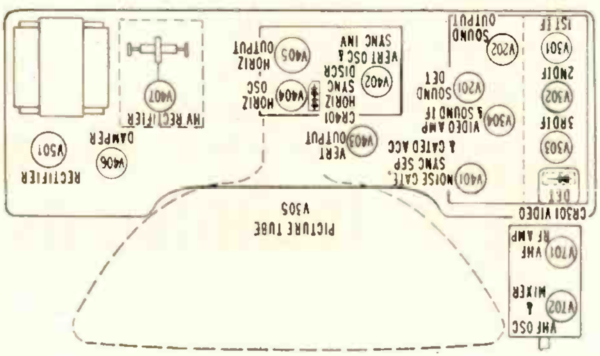

CHASSIS 20A7, B

V701—6FH5 in 20A7
V101—6CY5 in 20A7B
V702 or V102—6CG8 or 6CG8A
V201—6DT6
V202—6AS5
V301—6BZ6
V302—6BZ6
V303—6CB6A
CR301—1N87 or 1N87A (Crystal Diode)
V304—6AW8A
V305—23CP4, 23GP4 or 23HP4
V401—6BU8
CR401—93B5-4
V402—6CG7
V403—6EM5
V404—6CG7
V405—6DQ6A
V406—6AU4GTA or 6DE4
V407—1G3GT
V501—5U4GB

5

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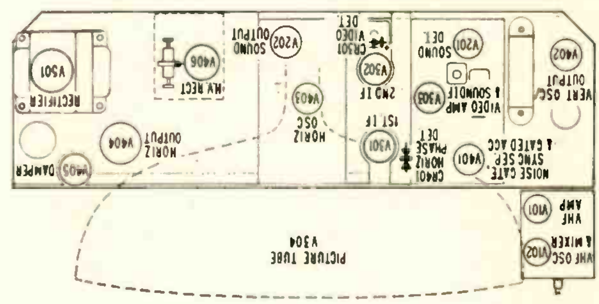

CHASSIS 15E1

V101—6FH5
V102—6CG8
V201—6DT6
V202—6CU5
V301—6BZ6
V302—6DK6
V303—6AW8A
V304—19XP4
V401—6BU8
V402—6DE7
V403—6CG7
V404—6DQ6A
V405—6AX4GTA/B or 6DE4
V406—1G3GT
V501—5U4GB
CR301—1N87 or 1N87A
CR401—93B5-6

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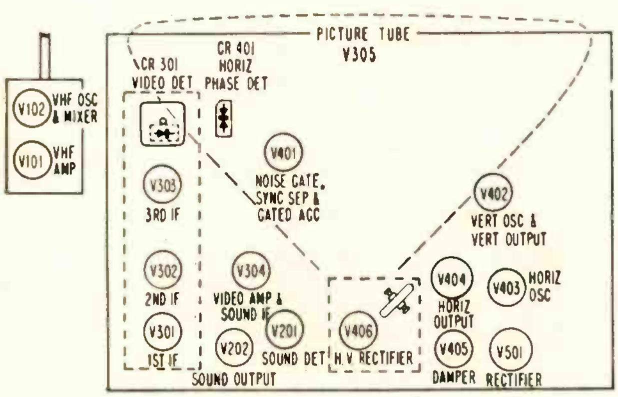

CHASSIS 20S6

V101—6CY5
V102—6CG8 or 6CG8A
V202—6DT6
V202—6AS5A
V301—6BZ6
V302—6BZ6
V303—6CB6
CR301—1N87 or 1N87A (Crystal Diode)
V304—6AW8A
V305—21CBP4A
V401—6BU8
CR401—93B5-6 (Dual Selenium Diode)
V402—6DE7
V403—6CG7
V404—6DQ6A
V405—6AX4GTA
V406—1G3GT
V501—5U4GB

8

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Radio-Electronics

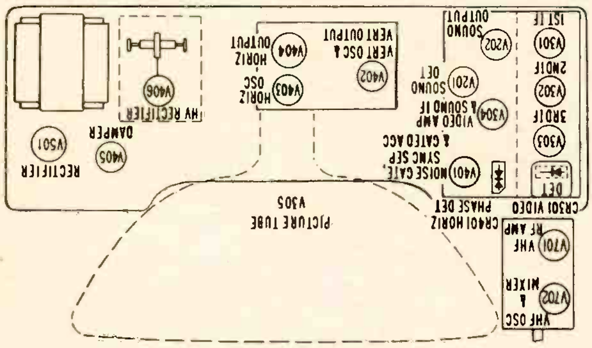
TUBE LAYOUTS

IN TV SETS

Compiled by Larry Steckler, Associate Editor

ADMIRAL

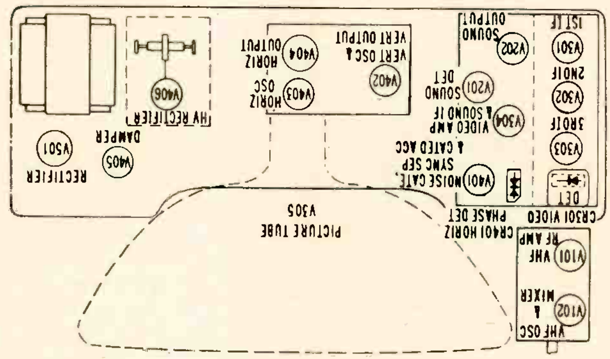
1960-1961



CHASSIS 20K7, B

V701—6FH5 in 20K7	V301—6BZ6	CR401—93B5-6 (Dual Selenium Diode)
V101—6CY5 in 20K7B	V302—6BZ6	V402—6DE7
V702 or V102—6CG8 or 6CG8A	V303—6CB6A	V403—6CG7
V201—6DT6	CR301—1N87 or 1N87A (Crystal Diode)	V404—6DQ6A
V202—6AS5	V304—6AW8A	V405—6DE4 or 6AX4GTA/GTB
	V305—23AHP4	V406—1G3GT
	V401—6BU8	V501—5U4GB

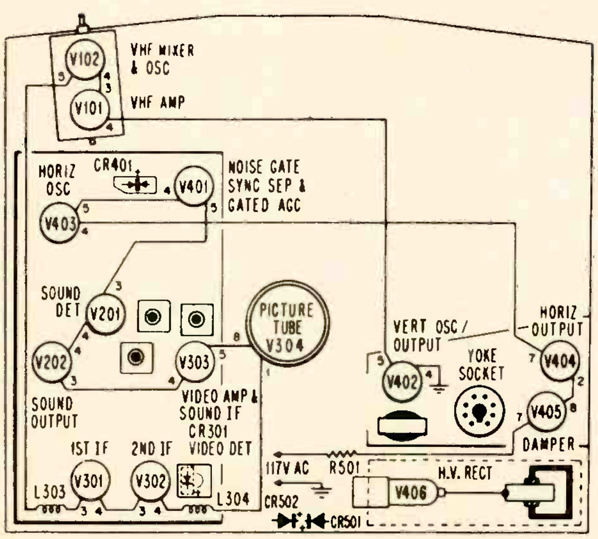
3



CHASSIS 18B7, B

V101—6CY5	CR301—1N87 or 1N87A (Crystal Diode)	CR401—93B5-6. (Dual Selenium Diode)
V102—6CG8 or 6CG8A	V304—6AW8A	V402—6DE7
V201—6DT6	V305—23CP4, 23GP4 or 23HP4	V403—6CG7
V202—6AS5	V401—6BU8	V404—6DQ6A
V301—6BZ6		V405—6DE4 or 6AX4GTA/GTB
V302—6BZ6		V406—1G3GT
V303—6CB6A		V501—5U4GB

6

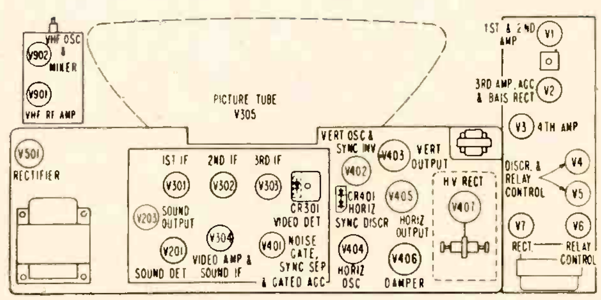


CHASSIS 15G1B

V101—2CY5	V303—6AW8A	V405—12AX4GTA/B
V102—5CG8	V304—19XP4	V406—1G3GT or 1K3GT
V201—3DT6	V401—3BU8	CR301—1N87 or 1N87A
V202—12CU5	V402—10DE7	CR401—93B5-6
V301—3BZ6	V403—6CG7	CR501—93B12-1
V302—3DK6	V404—12DQ6A	CR502—93B12-1

Series string wiring is shown including pin numbers.

2



CHASSIS 20M6

V1—12AX7	V303—6CB6	V403—6EM5
V2—6AV6	CR301—1N87 or 1N87A (Crystal Diode)	V404—6CG7
V3—6AU6	V304—6AW8A	V405—6DQ6A
V4—6BJ8	V305—23CP4, 23GP4 or 23HP4	V406—6AU4GTA
V5—6BJ8	V401—6BU8	V407—1G3GT
V6—6CG7	CR401—93B5-4	V501—5U4GB
V7—6X4	V402—6CG7	V901—6ER5
V201—6DT6		V902—6CG8 or 6CG8A
V202—6AS5A		
V301—6BZ6		
V302—6BZ6		

7

MODERN AUDIO EXPANSION

The Fairchild Compander.

Adds 6 db to the dynamic range of your records

By WARREN ROY

NO HI-FI SYSTEM CAN PRODUCE BETTER sound than that on the record being played. And a record must fall short of containing the full dynamic range of a concert orchestra—by many db. It just isn't possible to cut such a range on any practical stereo record. But the record manufacturer must still get all the music on the record, and does so by compressing the high-amplitude sections so they fit within the existing restrictions.

In an attempt to restore the full audio range, the hi-fi owner has resorted to several devices, labeled expanders, to restore the normal range of the orchestra. The earliest ones used ordinary light bulbs, connected across the amplifier output. On loud passages, more current passes through the bulb and its filament heats up. As it heats, its resistance increases and the volume of the passage being played rises.

But light bulbs are comparatively bulky and difficult to handle. Also, they do not have the particular resistance-voltage characteristics that make a good expander. However, some audiophiles are still using this basic type of expansion circuit.

Now there is a new device available to do this job. It carries the name Compander, is made by Fairchild, and is designed to work with modern stereo hi-fi systems. Unlike the simple light-bulb arrangements, it does two jobs—expansion and compression. The light bulbs have been replaced with much more modern devices too—cadmium sulfide photocells. These units, actually semiconductor devices, have a resistance characteristic that changes in direct proportion to the amount of light applied to them, and are designed specifically for this particular use.

There are four neon lamps on the Compander's front panel. They are connected to the outputs of the stereo amplifier, two for each channel. The intensity of the lights, therefore, is in direct proportion to the amplifier output. These lights are placed so they illuminate the cadmium sulfide resistors. As the lamps increase in brightness, the resistance of the cadmium sulfide units goes down.

Volume expansion occurs because the variable resistance cadmium sulfide resistors are part of a signal voltage divider. The divider is placed in series with the signal by connecting the Compander either between the cartridge and preamp input (Fig. 1) or between the preamp output and the amplifier input (Fig. 2). For compression they are placed across the input circuit.

The four lamps serve another purpose too. They let the user see just what the Compander is doing. Watch them with the Compander switched out of the circuit while a particular passage is played. Then switch the unit into the circuit and play the same passage again. The action will be obvious.

The lights are also handy for setting the dynamic sensing control that selects the point at which expansion or compression begins. You'll find that your eyes are much more sensitive to slight changes in light level than your ears are to minor changes in audio level. Because of this the lights show you just when the Compander begins to do its stuff and you can set it to the exact point desired.

As mentioned earlier, there are two lights for each channel. One lamp of each pair is marked HI and the other LO. During normal music passages only the LO light will flicker. As volume increases and the Compander goes into action, the HI light will flicker too.

It is usually more convenient to use the Compander between the preamp and amplifier. It then affects whatever music source you are using. It will be especially welcome for AM radio. Of course, if you are using an integrated amplifier you will have to connect the Compander between the cartridge and preamp.

When normal program material is being played, the Compander drops the unexpanded amplitude by 6 db. This is compensated for by turning up the amplifier level control to restore the normal listening level. Now when a loud passage comes through, the added voltage across the resistors causes them to decrease in value, thereby boosting the loud passage by as much as 6 db, depending upon the original level of the passage.

There is even a little boost on quiet passages, but it is so slight that increase cannot be heard by the average person. The user sets the exact point at which the boost begins by adjusting two front-panel DYNAMIC SENSING controls—one for each stereo channel.

When used as a compressor, the Compander works in reverse. Now it knocks all the peaks off the music so it comes through at a constant level. This is especially useful for music systems in restaurants or business locations, or wherever only background-type music is desired. END

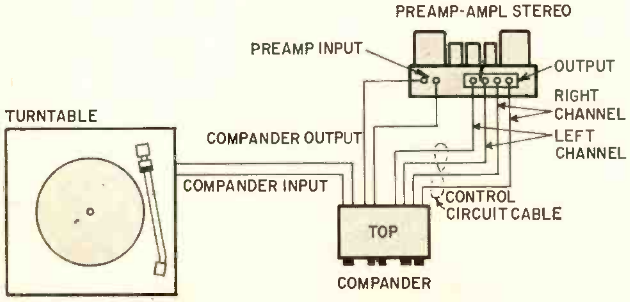


Fig. 1—Block diagram shows how Compander is connected between the phono cartridge and the preamp input.

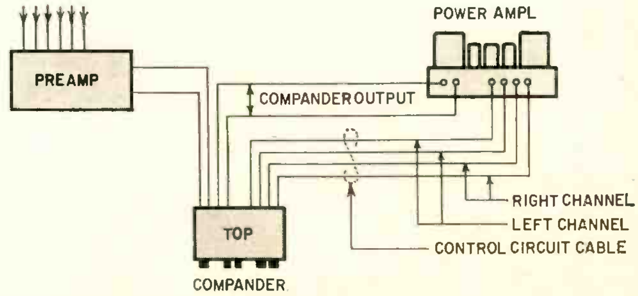
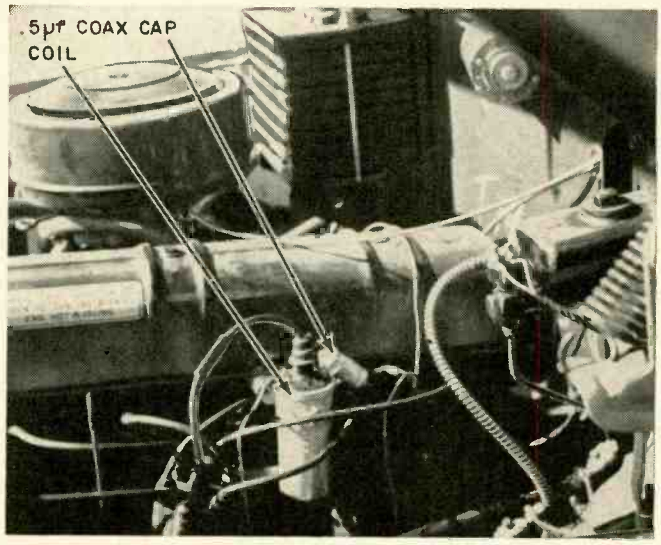


Fig. 2—If you have a separate preamp and amplifier you can connect the Compander between them.

END AUTO RADIO INTERFERENCE

INSTALLATION ON HIGH-TENSION COIL



Typical noise-stopping coax capacitor installation on high-tension coil.

Protect mobile radio receivers against interference at all frequencies from below the broadcast band to 1,000 mc

By D. GIFFORD

THE MAIN SOURCES OF AUTOMOTIVE RADIO interference are the generator, the voltage regulator and the ignition system. The heater fan motor, electric windshield wiper motor and gas gauge also cause trouble at times.

The degree of suppression required depends on the frequency or band of frequencies covered by the radio installation and the intensity of the interference. The suppression described here is effective from below the broadcast band through to 1,000 mc. It is especially useful for Citizens-band installations.

Before applying suppression techniques to any unit of the vehicle, it must be properly adjusted and in normal operating condition. Otherwise your efforts may be in vain and the suppression could conceivably aggravate any abnormal condition of the unit.

Radio interference from the generator can be stopped with a 0.5 µf coaxial capacitor (Sprague 48P18 is ideal). It is readily mounted on the end of the generator. Clean the area thoroughly (removing the paint) from the spot where the capacitor is to be mounted to get a good rf bond between the capacitor case and the generator housing. Remove the lead attached to the armature terminal of the generator and connect it to the output side of the coaxial capacitor (the side farthest from the generator armature terminal). Connect the other end of the capacitor to the armature terminal with a short direct lead. Should a capacitor already be connected to the armature terminal, it is probably a pigtail type. Remove it completely.

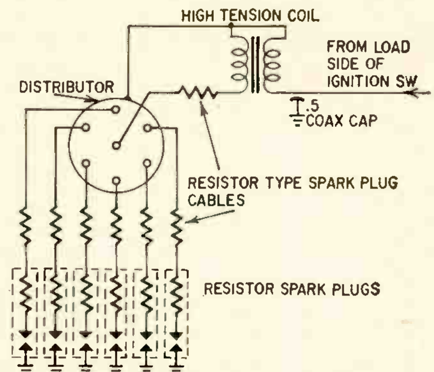
This suppression is so effective that interference from the voltage regulator that was hidden by the generator interference can be heard.

Regulator interference may occur at engine idle speed or at the point where the relay begins to chatter. If your car has an ammeter, you can spot this point by watching the quivering motion of the ammeter needle.

The point at which this interference occurs depends on several things—the condition of the battery, the idle rpm of the engine, and the generator output. Mount a 0.5-µf (Sprague 48P18) coaxial capacitor under one of the regulator mounting screws. Remove the lead from the battery terminal of the voltage regulator and connect it to the end of the capacitor farthest from the regulator. Connect the other end of the capacitor to the battery terminal of the voltage regulator with a short direct lead.

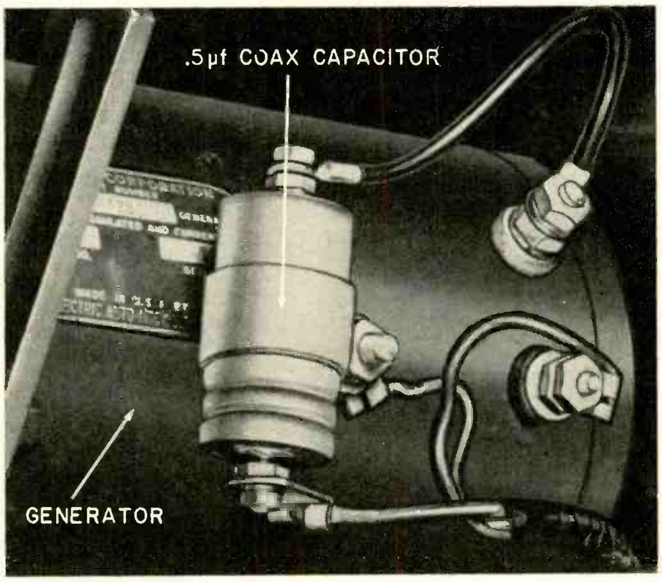
If you have a "hot" receiver installation and still have some regulator interference at 9 to 14 mc and at the second harmonic of these frequencies, install a small mica capacitor from the field terminal of the regulator to the regulator case. The capacitance of this mica capacitor depends on the frequency or frequencies affected and is determined experimentally. If there is a pigtail type capacitor already on the regulator, remove it.

Automotive manufacturers do not recommend connecting capacitors to the field circuits of the regulator or the generator. However, in my more than



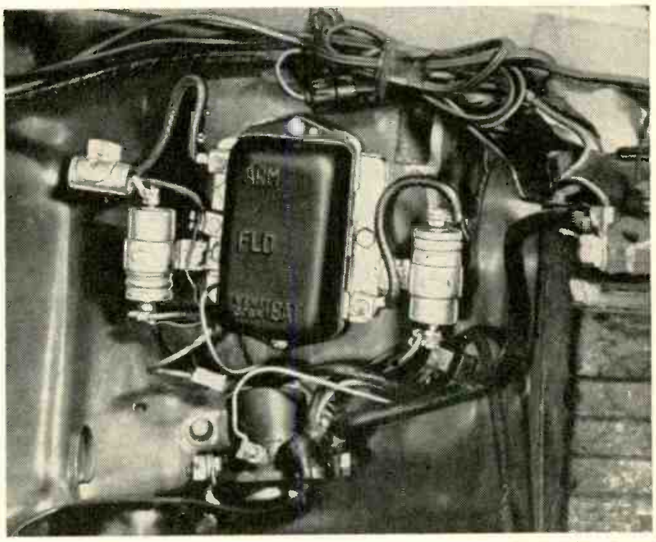
Resistor spark plugs, resistance spark-plug cables and a 0.5-µf coax capacitor at the high-tension coil will stop ignition noise.

ON GENERATOR ARMATURE



Coax capacitor connected at generator armature quiets that noise maker.

ON VOLTAGE REGULATOR



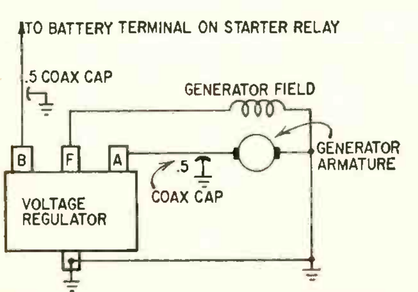
Motorola photos

To silence the voltage regulator, you'll need some more coax capacitors.

24 years' experience with interference suppression, I have yet to learn of a case where these capacitors have caused trouble or have been detrimental in any way to the operation of the regulator or the generator.

Ignition interference is another nuisance that must be dealt with. Unlike regulator or generator interference, it varies from car to car of the same make and model as well as from make to make. V8 engines are among the worst offenders. The place to start is at the spark plugs. If they are the standard type, replace them with resistor type plugs. Check the gap. It should be smaller than for standard plugs. I set the gap about .010 inch less than for standard plugs. Measure the resistance of the resistor plugs—they should be 10,000 ohms; some run as low as 6,000 ohms.

Replace the spark-plug cables, including the high-tension cable, with resistor type cable (4,000 ohms per foot). This may reduce your gas mileage slightly and prevent you from taking off like a rocket, but, if the engine is properly timed and tuned, it will present no great hardship and ignition interference will be greatly reduced if not eliminated. A 0.5-µf coaxial capacitor (Sprague 48P18) on the high-tension coil battery terminal will help considerably at some frequencies.



Coax capacitors at the voltage regulator and generator stop interference caused by these units. B, F, & A are battery, field and armature terminals.

If ignition interference is still objectionable, check the distributor rotor. If it has an aluminum contact bar, replace it with one that has a copper contact bar. This will reduce interference 10 db or more. The copper contact rotor will last much longer, too, as it will not burn or corrode as readily as the aluminum type. It also gives a cleaner spark.

Shielding the distributor cap will reduce the interference another 10 or 12 db at some frequencies, depending on make and model of the car. A simple and economical way of doing this is to cement aluminum foil around the body of the cap, being sure to bring the foil down over the rim of the cap so it contacts the distributor housing when in place. Wrap a layer of plastic electrician's tape over the foil to protect it. Commercial shielding harnesses such as Hallett (Hallett Manufacturing Co., 5910 Bowcraft St., Los Angeles 16, Calif.) are available, but I am sure the suppression outlined in this article is adequate for most if not all radio installations.

One of the things we are apt to lose sight of in dealing with interference from an automobile is that a car is essentially a broadcast station—the engine and electrical system being the oscillator and the car body the antenna.

The hand-brake cable system of the 1959 and 1960 Studebaker Lark is a lovely rhombic at 48 or 49 mc. Use ½-inch copper braid and bond the brake cable on the right side of the car to the muffler tailpipe, then to the floor of the car body.

Most car bodies are poorly bonded, rf-wise, to the car frame. Use ½-inch copper braids to bond the body to the frame at strategic points—hood, trunk lid, etc.

At some frequencies it is better not to tie the antenna transmission-line shield to the car body or frame (remember, it is the interference radiator) as this only forms a loop and may cause more interference to be fed into the receiving equipment. This also applies to bonding the receiver chassis to the car body. If the equipment operates from the car battery, it is often better to run the power leads directly to the battery than to risk forming loops by depending on the receiver chassis and the car body to be thoroughly and directly connected to the battery. It may be good enough electrically but we are dealing with rf.

Fundamentally, interference suppression simply creates a low-impedance path to ground for the rf at the source of the interference, ground being the electrical return of the source. END

SEEING IS BELIEVING IN CATHODE RESEARCH

Largest electron-emission microscope replaces abstract theory with visible reality in search for better tube cathodes

COVER STORY

By Dr. AURELIUS SANDOR*

IN THE EARLY DAYS OF THE ELECTRON-optical science (in the beginning of the '30's) I once respectfully called my professor, the famous H. Geiger of Geiger counter fame, to watch a demonstration of an oxide cathode in my laboratory. He came, and I pulled down the window shades with deep reverence. Out of the black nothingness the brilliant landscape of the "moon" appeared on the rather small phosphor screen of the cathode-ray tube, like a materializing ghost with craters, mares and criss-cross channels, brightly scintillating in their versatile texture.

But the dynamic changes of the electron emission pattern suggested more than just the topography of the moon, and the show took an even more dramatic turn when—induced by an increase in cathode-heater voltage—the craters gradually covered themselves with a dense veil and all sharp detail merged into a heavy, bright fog. The relaxed voice of the otherwise nervous professor, colored with a shade of sentimentality, was heard out of the dark: "Oh, my, Oh, my! Is this really possible?"

There was no doubt that Professor Geiger knew in all its implications the theory that was hiding behind those mirages, but he could not suppress the sincere voice of his relieved conscience, since somewhere, in a small corner of his great mind, he had not been so unconditionally sure of the reality behind that theory.

To me, as a young engineer-physicist, this was quite an experience and I still remember it with great respect everytime a new pattern of similar astronomical quality appears on our new emission microscope screen, a pattern greatly emphasized by its present large size.

Electron optics

The gadget used in the early demonstration was an early "electron emission microscope," a brother of the better known transmission electron microscope, but because of its different physics unfortunately inherently limited in resolving power. The principles of electron optics are abstract, but happily light optics offers analogies that help us to explain them. Both electron optics and the optics that uses glass lenses are based on the propagation of elementary masses which are related to electromagnetic waves. In light optics, one speaks of "photon masses" of wave character; in electron optics of "electron masses" also endowed with wave properties. The main difference between the two is that electrons are electrically charged and photons are not. So in electron optics specially shaped electric and magnetic fields have to substitute for glass lenses; we find apertured anodes and in certain designs also magnetic coils.

The emission microscope developed in our General Telephone & Electronics Laboratories in Bayside, N. Y., represents a novel approach, conceived to conform with modern research requirements. Complicated electric fields develop in the electron gun, that also accommodates the exchangeable cathode to be viewed (Fig. 1). A first and a larger second magnetic coil (lenses) surrounding the tube neck represent the actual optical elements; this objective lens and this projection lens throw a true and magnified electronic image of the ⅛-inch diameter cathode onto the full 21-inch phosphor screen. The phosphor radiates visible light from the points of impact, varying in shade according to the striking electron density.

Electron beams form images in the same way as light rays do. The focal length of electron-optically shaped fields can also be changed simply by changing the field strength value of the

The pattern on the tube face can be photographed together with other instruments showing the time, pertinent voltages and other information, for a permanent record.

*General Telephone & Electronics Laboratories Inc., Bayside 60, N.Y.

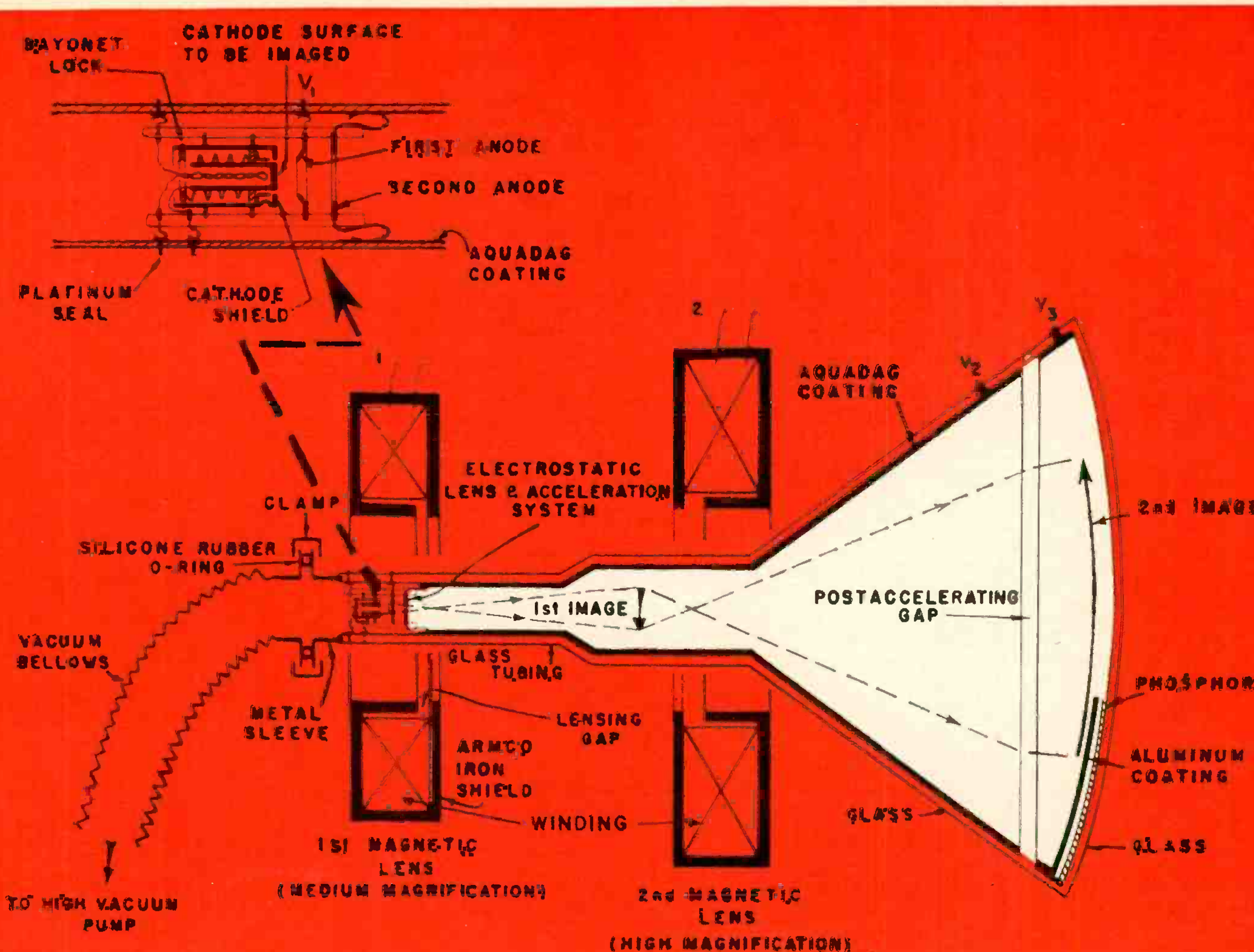


Fig. 1—Schematic of the emission microscope tube.

Fig. 2—The magnified images of cathode crystals are very sharp.

Fig. 3—The odd case of decreasing emission with increasing temperature.

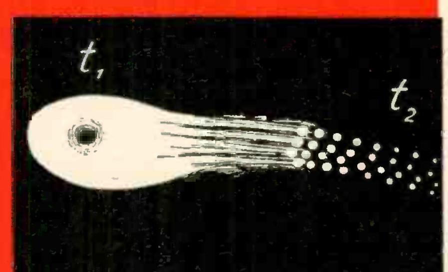


Fig. 4—Vaporization of a portion of the cathode surface.

Fig. 5—First stage in emission from tungsten dispenser cathode.

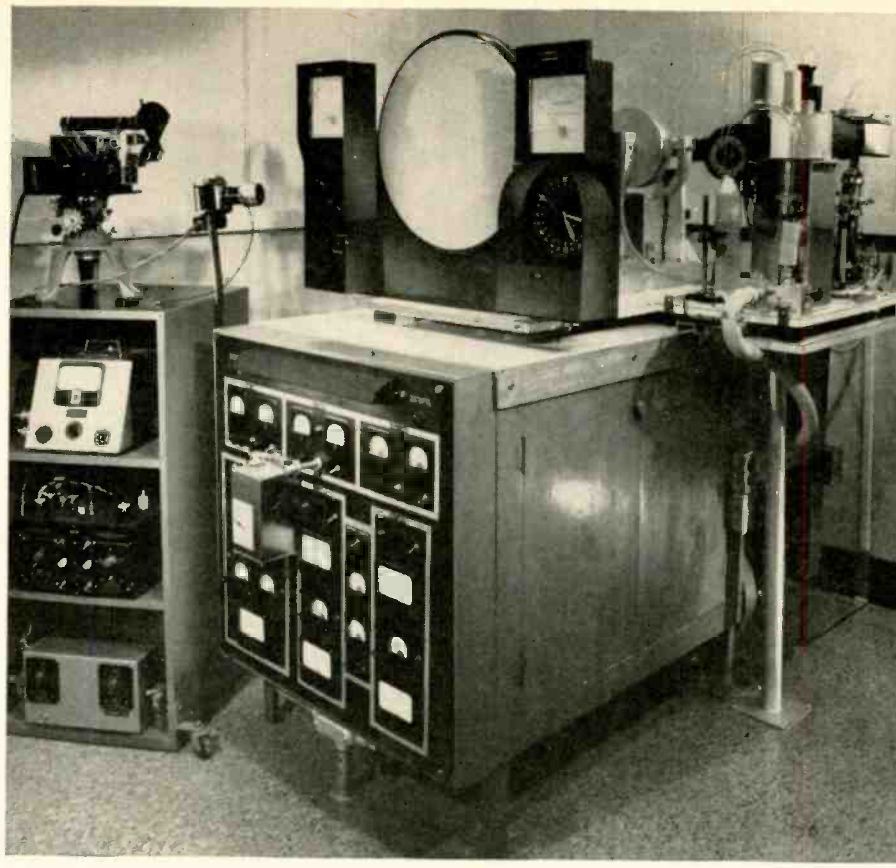
Fig. 6—More uniform diffusion as barium comes to cathode surface.

Fig. 7—The completely activated cathode.

"lenses" (potentials, currents). Correction of lens defects is of paramount importance, but corrections in electron optics are far more difficult than in light optics. Hence the resolving power of 200 milli-microns obtained on the screen with this design and amounting to only 80 milli-microns on a photographic plate in a vacuum is a result not to be sneezed at, particularly when we consider the extreme picture size. Photographers among our readers will appreciate this. Magnifications on the screen may be varied from 7 to 300 times, followed, if so required, by post-magnification with optical equipment.

The microscope tube shown in the schematic is a demountable type connected by flexible vacuum bellows to the high-vacuum pump. More sensitive cathodes are investigated in tubes that can be baked out thoroughly during evacuation before sealoff, to prevent any chemical change on the cathode from occurring by reaction with gaseous residuals.

An automatic time drive located in the box on the instrument panel (see photo) adjusts the cathode heating cycles; it takes hours to complete a series of investigations. Time-lapse cinematography is also used to record and analyze sequences of cathode development, until the desired electron activity is obtained, as can be judged from the screen pattern.



The complete electron microscope in the Bayside laboratory.

The film strip also photographs the major experimental data, such as date, time, frame number, pressure in the tube and the cathode temperature (which is derived from amplified signals of an infrared sensor positioned outside the glass envelope, opposite the glowing cathode).

If the pressure in the microscope tube rises accidentally above a permissible value, visual and acoustic alarms go off and all electric power connections are automatically cut. This is good practice, since the 15 kilovolts that are applied could destroy delicate systems in case of electrical gas discharges, and possibly initiate an implosion of dangerous dimensions.

Research on cathodes

An electron tube is only as good as its cathode; its life starts and ends with the electron source. The importance of this tube component justifies the elaborate research in this field that started half a century ago with the alkaline earth oxide cathode introduced by Wehnelt.

For some time, progress on thermionic emitters was slow because of the atomic complexity of the physics involved. Although in the '30's electron optics had put one foot in the door by making electron radiation directly visible on phosphor screens, the subject was not followed up to its full extent—researchers did not realize they had a potential tool for exploring the physics and technology of heated cathodes. In those days—and even recently—they were aiming at too high magnification of too small cathode areas. Therefore, acquainted with the non-optical cold field-emission microscope that could reproduce the image of a point only, they underestimated the early electron-optical microscope and ascribed limitations to it that did not really exist.

In the General Telephone & Electronics Laboratories the line was successfully picked up again. We worked on the philosophy that only the observation of simultaneous local events over a large cathode surface could produce meaningful conclusions that would be of value in promoting technical progress. This led to the design of the large electron microscope on the cover.

Analyzing the brightness content (related to emission intensity) and the geometry of the half-tone pattern on the luminous screen enables the cathode physicist to draw realistic conclusions about the emission mechanism. In the past, projected—and therefore speculative—conclusions were drawn about details of the active cathode surface. Diode type current measurement was the tool employed; the actual elements of emission could not be pinned down as can easily be done by direct visual observation.

At first glance, it seems surprising that a cathode, which, as you can see in any electron tube, glows perfectly evenly, does not necessarily emit electrons with comparable uniformity. But the electron pattern usually reveals extensive patchiness of varying intensities, from strongly emitting areas down to dark and dead spots on the screen. The bright spots are said to have a lower "work function." This term expresses in terms of electric charges and potentials, the force at the cathode surface that resists ejection of thermally energized electrons. The electron emission is subject to spectacular intensity variations because of the widely varying local surface properties of the cathode material, which in turn results in local work-function changes. Small differences in work-function values produce high contrasts in brightness, since a physical law, very sensitive to the work-function term, establishes the strength of the emission current.

What is being done

As shown on the cover, a 21-inch screen displays such emission patterns. The author, who in the picture is directing a photosensitive probe onto one crystal plane of a multi-crystal emitter surface, conducts studies under a contract with the Cambridge Research Laboratories of the US Air Force (Office of Aerospace Research, Bedford, Mass.) on thin-film-coated nickel cathodes. Nickel, basically having a high work function, would not lend itself to emission experiments in the rather low temperature range of from 700 to 1,100°C, so an artificial activation process has to be adopted. A thin barium film about 1,000 atomic layers thick is chemically precipitated from an organic barium solution. It is then thermally evaporated down to only a few atomic layers, until the crystal structure of the nickel gradually comes into prominence on the phosphor screen. The thin barium coating lowers the work function of the bare nickel surface.

As Fig. 2 reveals, very sharp grain structures become visible. Brightness is uniform within their boundaries, indicating the consistency of uniform work-function properties within each individual crystal face. It is due to the differences in the packing density of nickel atoms in different crystal planes that the work function varies.

Very interesting new phenomena were discovered with this potential tool in modern cathode research. Among other effects, the so-called "emission reversal" was brought into prominence. It consists of the appearance of higher emission currents at lower temperatures. This seems to contradict the law of emission. The bright crystal face near the picture center in Fig. 2 exhibits this phenomenon in a convincing manner. It was taken at 890°C, while in the picture of the same cathode at 935°C (Fig. 3), the brightness on the same crystal face is much lower.

With the help of the large-screen microscope we were able to discover that effects like this were a direct result of barium droplet formations that cover certain faces like a mesh-work and alter the straightforward concepts of uniform layer coverage.

Almost as exciting as a good love story to young people is visualizing evaporation to the physicist. It is simply fascinating to watch on the large screen how barium pools, forming on nickel with their typical "black eye" as depicted in Fig. 4, go into a most spectacular vaporization act when heated to 1,100°C. They elongate and develop a fuzzy tail structure just like a comet. The tail breaks up into round globules that constantly sweep in the direction of the higher temperature region, t_2, gradually reducing in volume till they reach atomic size and disappear. The emission microscope cannot, of course, follow the entire process down to the atomic scale, but limits the observability to its own resolving power. The smallest visible barium globule is 200 millimicrons in diameter.

Other important investigations now become feasible, such as those determining the migration paths of active materials on hot surfaces and in studying the mechanism of structural transformations to the point where the substances are completely dissipated in vacuum.

Another successful application of this new instrument is for demonstrating the emission mechanism of the modern impregnated tungsten matrix cathodes. These, also known as impregnated dispenser cathodes, can draw high currents for thousands of hours. The inventors of this important type of cathode knew its operational characteristics for some time, by empirical measurements. However, their knowledge was confined to critical points only, without knowing the actual physical phenomena connected with them.

Again, the large screen of this instrument dissipated the fog that surrounded the physical secrets of this type of cathode. What made this emitter tick suddenly became clear. An initial state of pseudo-emission is shown in Fig. 5. Residuals of the impregnant left on the surface after fabrication took the place of true dispenser action of active barium. This state is succeeded by a profuse diffusion of liquid barium through the pores of the sintered tungsten pellet, as visualized in Fig. 6.

Finally, at 1,230°C, a complete surface flooding indicates the end of the desired activation, as seen in Fig. 7. (The windmill-like figure was etched into the cathode to aid microscope centering.) Emission patchiness is a very undesirable feature since, not only does the tube characteristic change, but load conditions on the surface become nonuniform and noisiness in signal amplification increases.

These different stages of activation are a function of temperature, leading to chemical conversions in the impregnant. They start at 400°C and are followed by secondary conversions. After that, operation at 1,140°C guarantees during the tube life an adequate continuous replenishment of active barium out of the pores by surface migration along the tungsten.

These few examples may show that this new design concept in emission microscopy is in a position to expand the stagnant field of cathode research. It also lends itself to investigations on cold electron and ion emitters and may also play an important role in metallurgical research. END

WHAT'S YOUR EQ?

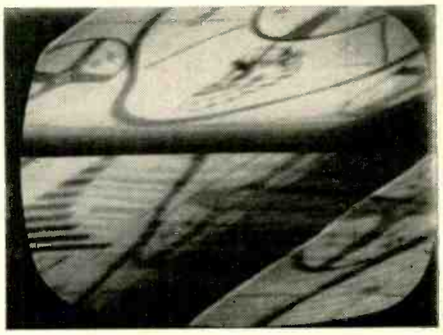
It's stumper time again. Here are three little beauties that will give you a run for the money. They may look simple, but double-check your answers before you say you've solved them. For those that get stuck, or think that it just can't be done, see the answers next month. If you've got an interesting or unusual answer send it to us. We are getting so many letters we can't answer individual ones, but we'll print the more interesting solutions (the ones the original authors never thought of). Also, we're in the market for puzzlers and will pay $10 and up for each one accepted. Write to EQ Editor, Radio-Electronics, 154 West 14 St., New York, N. Y.

Zenith 17 B20

The picture looked like the photo. This is the best that could be done. The horizontal hold would get the picture up this far; then it would flip rapidly over to the same thing, leaning the other way! This picture would be quite stable like this, holding very well. It would not come up and lock in at all.

Horizontal afc? A check of the tube showed it OK. Horizontal oscillator, afc and horizontal control tubes, OK. All parts in afc circuit good. All dc voltages OK.

Is this trouble in the horizontal afc/oscillator circuit or not? —*Jack Darr*



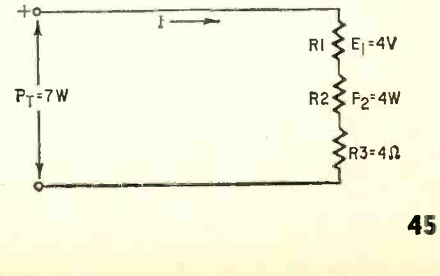
HINT: Check pulses on plates of afc.

High-Output Black Box

This Black Box has four terminals. It contains a number of resistors and capacitors so connected that, for a specified frequency or band of frequencies, the output voltage exceeds the input voltage. The box contains nothing but resistors and capacitors and the necessary wire to connect them. How do you figure this is possible?—*Richard L. Koelker*

A Puzzle In Fours

Find the values of R1 and R2 from the information given on the schematic. —*Don J. Ponce, Jr.*



By TOM JASKI

RELAYS

INSTALLING, TESTING AND MAINTAINING THEM

With special attention to modernization and modification jobs

MODIFICATION AND MODERNIZATION OF industrial plants often calls for installing relays or relay control systems in connection with existing equipment. This type of installation calls for more careful thought than even the selection and installation of relays in new plants. The new relay is often part of an important control system. Thus the reliability of the whole plant is controlled by the relay's reliability.

Many factors must be considered when installing relays. The main ones are: the most advantageous location; environmental conditions, such as dust, fumes, vibration and high temperatures; accessibility for service; the space needed and the availability of wiring runs, ducts or conduits. In each individual case, all sorts of other considerations may also enter into any decisions on just how and where to install a relay.

The best location for a relay depends on what you want to do with it. Most often it is best placed near the controlled device, avoiding heavy wiring runs.

When selecting the best place for a relay, accessibility is an important consideration. A relay is an electromechanical device, with moving parts. It is subject to wear. Thus it must be placed where it can be serviced adequately.

It is often possible to add new relays to existing enclosures or panels. If not, special enclosures may be needed. If they are installed on a 117-volt (or higher) circuit, fuses may be required by the local electrical code. Heavy fuses, designed to protect against short circuits or heavy overloads, make for greatest reliability.

In most cases it should be possible to disconnect the relay from the control circuit so that it can be serviced without having to work on "hot" wires. This is especially important when the relay is controlled by an automatic device. It might close the circuit at an inappropriate moment—say while the technician is holding the disconnected wires!

Relays should be about the last thing installed on a job, since they are more easily damaged than most devices. Such operations as drilling or sawing on metal frameworks are especially bad, since the filings might lodge in relay contact openings. If such work must be done on a relay panel, the relays already on it must be protected with a covering.

In addition to vibrations from the environment, relays have a certain self-vibration each time the armature closes. Use lockwashers on all mounting bolts! In many less expensive relays the terminal leads are taped directly to the winding. Use a terminal block for such relays, to avoid strain on the terminals.

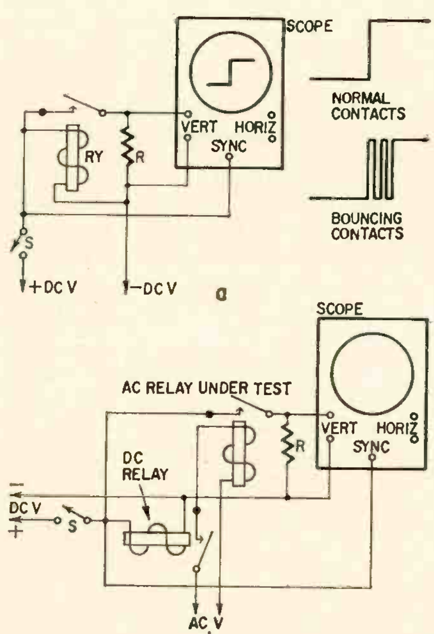


Fig. 1-a—Setup for checking dc relays. b—With ac relays another relay is needed to provide sync before tested relay closes.

Basically all such considerations are a matter of common sense and good mechanics' practice. A relay is usually one of the most important links in the control chain, and as such deserves the most considerate workmanship possible. Quality in installation will reflect in reliability of the control.

Testing relays

What is there about relays that can, and needs to, be tested? Some tests can be made quickly and simply, some require sophisticated equipment. But none are very difficult. How much testing will be done depends on the application, how much is known about the relay and how critical the operation is. Certainly before installing the relay—even one fresh from the factory—it makes sense to give it a quick test for operation. This requires only a simple setup with the right voltage for the relay coil.

Second, it is very simple to test the contacts for closure. Connect the low-ohms scale of your meter across the contacts to be closed, and check if they do indeed close with the correct voltage on the coil.

Other tests on relays might include coil continuity, impedance and resistance, contact resistance, contact heating with rated current, armature chatter (which might result from excessive spring tension), contact bounce (which can result in arcing), hum in ac relays and, at a more sophisticated level, the relay's operating speed.

In industry some of these things are often taken for granted. The relay was carefully selected for its characteristics, it is reasoned, so why then should we test? This is true enough in most cases. But sometimes relays are used from spare parts or surplus stock, and then it may become necessary to know more about the relay than the manufacturer publishes.

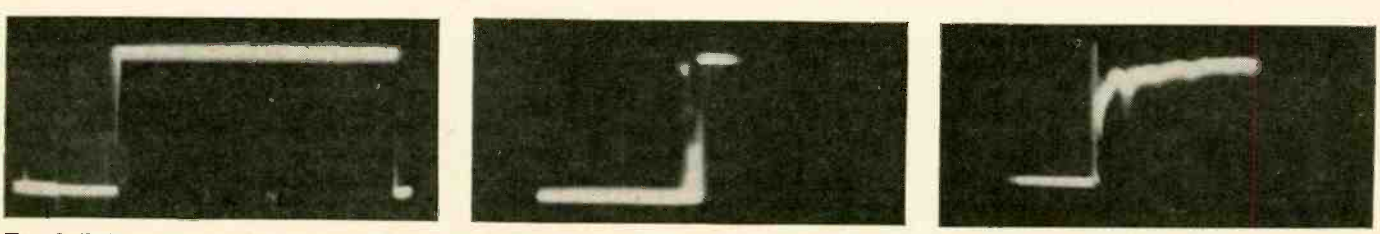


Fig. 2 (left)—How perfect contact closing looks on scope. (center)—Contact shows slight bounce. (right)—This contact is arcing.

The resistance or impedance of a coil is best measured with a Wheatstone or general-purpose bridge. The ac relay coil impedance is measured with the armature *not* attracted. This gives the lesser impedance, and the more important figure, for the greatest amount of energy must be supplied to the relay in the open position. It also gives a rough indication of the in-rush current for the ac relay, which must be considered when selecting fuses.

Armature chatter can be caused by excessive spring or contact pressure, when this does not allow the armature to be completely attracted against the core. A chattering armature can materially increase the relay holding current, thus overheating the coil in an ac relay. In a dc relay it leads to noise and premature wear of the armature hinge.

Hum in ac relays is hard to avoid entirely. There are two sources of hum, the laminations of the core and armature, and the air gap between armature and core. The former is a matter of good relay construction and not easily corrected on a relay in place. The latter may be the result of excessive return-spring tension or contact pressure. These can be adjusted on most relays. Particles of dirt or dust between armature and core can also increase hum. Another cause for hum can be undervoltage on the coil.

Fig. 1 shows how to test a relay for bouncing contacts. With a triggered scope and dc vertical amplifier, the circuit is as shown. R reduces stray ac pickup in the scope; can be from 100,000 to 150,000 ohms. With an ac scope and sync only (rather than triggered sweep), the switch must be replaced with a periodic contact made by a motor-driven switch or the relay pulse generator described earlier in the series. Bouncing contacts will show as multiple vertical deflections where only a single vertical line would show for properly closing contacts (Fig. 2).

Fig. 3 shows various ways to measure operating time with a dc scope.

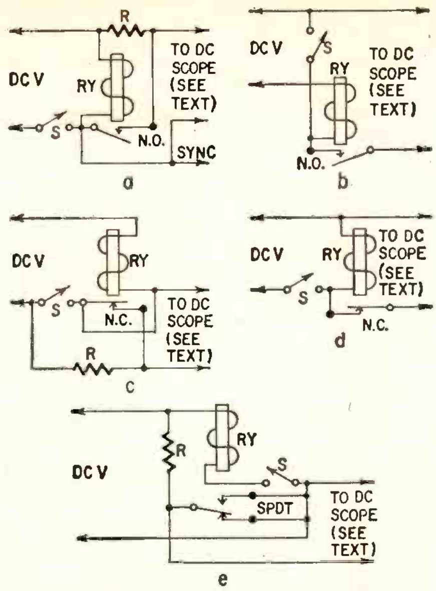


Fig. 3—Circuits for measuring relay operating time, using dc scope calibrated sweep opening. a—Closing time, N.O. contacts. b—Opening time, N.O. contacts. c—Closing time, N.C. contacts. d—Opening time, N.C. contacts. e—Transfer time, spdt contact.

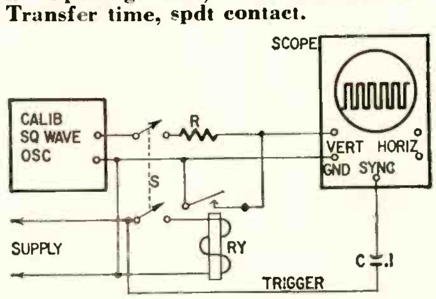


Fig. 4—How operating time is measured with an ac scope and square wave generator.

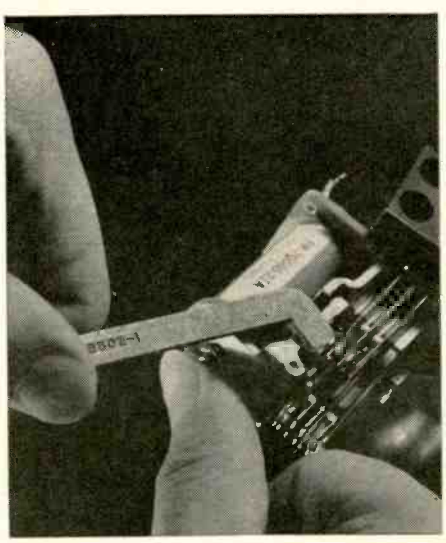
They all work in much the same way. As an example, in Fig. 3-a, as soon as the switch is closed, deflection starts and, when the relay contact closes, it shorts the vertical amplifier and deflection stops. The other circuits in Fig. 3 work the same way for different contact configurations. If the scope sweep is not calibrated, an electronic switch can be used to provide a timing trace along with the deflection by the relay. The switch amplifier must also be a dc amplifier. R in each case must be small enough to make a definite change in the voltage to the scope, big enough to avoid loading the power supply.

Fig. 4 shows how to go about this with an ac scope. Instead of a dc deflection, a calibrated square wave is fed to the relay contact and scope vertical amplifier, but a double-pole switch must be used. Operating time is then counted by the number of excursions of the beam (Fig. 5). All other arrangements in Fig. 3 can be modified in this way to operate with an ac scope; triggered sweep is still an advantage which insures the picture will be in the middle of the screen and not broken up.

Sometimes the relay contact resistance is critical. Particularly in automotive, railroad and aircraft applications, where voltages may be low and currents high, a contact resistance of even 1 ohm may make a significant difference. In that case tests with an ohmmeter may not be conclusive, and a special bridge may have to be used. If you have a meter with a high current range and known internal resistance, it will also work. The relay contact is connected in parallel with the meter. After the meter has been adjusted to deflect full scale, the relay is energized. The contact resistance can then be calculated approximately from the reduction in deflection on the meter scale and the meter internal resistance.

Many other tests of relays are made in production. These are not usually considered necessary by users in industry. Relay factories give their product life tests in which relays are operated


Straightening bent contact springs.


Bending an armature arm.


Bent gauge is used to measure stroke of armature.

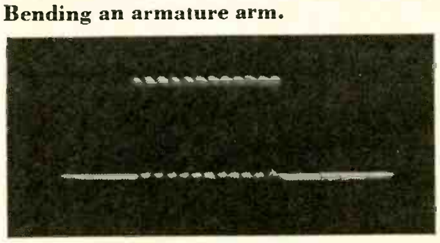


Fig. 5—Square wave measurement with 20-cycle square wave. Relay timing is shown to be 0.6 second.

until they fail or decay to some minimum standard. Heat runs are made to determine coil behavior after long hours of continuous operation at high temperatures. Relays designed for high-altitude operations must meet the problems of reduced atmospheric pressure, which may cause arc-over. These relays are tested in special altitude chambers. In general, the few basic tests described here will provide any information you may need about relays in industrial situations.

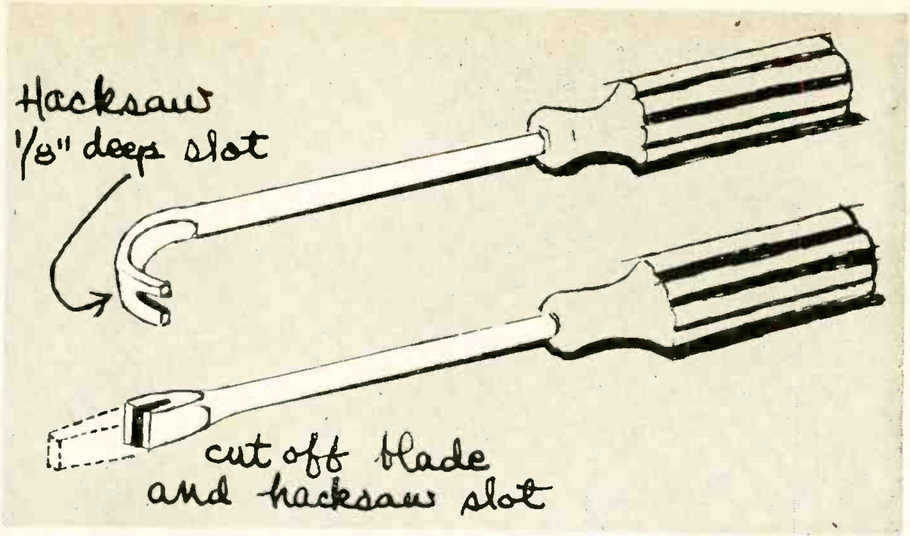


Fig. 6—Instruments for relay adjustment.

Servicing relays

Relays are easy to service and require a minimum of service compared to most electromechanical machinery. Contacts are the most likely source of trouble if they carry rated current and interrupt an inductive load. Although it may not be serious, some arcing is likely to take place. This will lead eventually to burning, pitting and coating of the contacts. The simplest and best way to clean relay contacts is to cut a thin strip of the finest sandpaper available, and drag it once or twice through the contact opening while holding the contacts closed; then turn over the sandpaper and repeat for the other contact. Too, you can do a good job with an approved burnishing tool. *Never* use emery cloth on relay contacts. Emery contains conducting particles, which may lodge in the contact springs, and then the job becomes really tough. *Never* use crocus cloth on relay contacts. Crocus cloth is made from aluminum oxide, an insulator, and you may just coat the contacts with it and worsen the problem.

Cleanliness is one of the first rules in relay service. When soot and grease can deposit on the insulating material between contacts, sooner or later they may arc over. An arc may slightly carbonize the surface of the insulating material. This will require replacing the insulation, a job requiring removing the relay at least, and its complete replacement at worst.

Another good rule to follow in relay service is: *leave well enough alone*. If relays are clean, properly operating and not arcing excessively, don't fool with them!

Salt and saline atmospheres are tough on relays. The problem is not as serious with ac relays, but dc relays soon show a tendency toward electrolysis. It is almost impossible to keep a relay dry enough to prevent electrolysis. When I took care of hundreds of relays out at sea, I would make it a practice to paint all nonmoving parts of relays with Glyptal or other available insulating varnish each trip. Usually this resulted in minimum labor on relays for months afterwards. Coil terminals should be especially well protected.

Special contacts, such as tungsten, require a hard file (such as you find in ignition kits) for dressing. But on the other hand, tungsten contacts seldom require dressing. Silver contacts may turn black. This does not reduce their contact value, and there is no point in trying to keep silver contacts bright and shiny. You'll soon find it a hopeless task anyway.

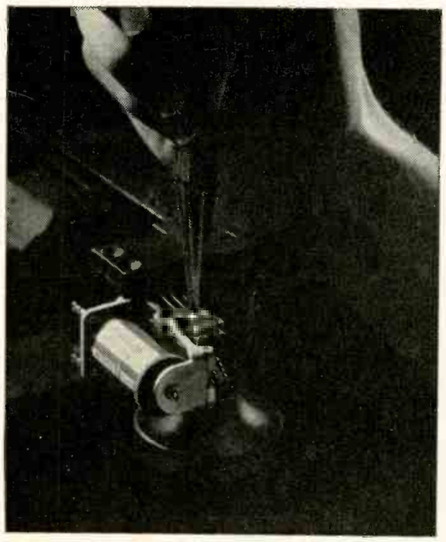
Contact adjusting tools can be made simply from modified screwdrivers. The cheap, ten-cent-store variety is best since they are usually made of relatively soft steel and will give you the least trouble with a hacksaw. Fig. 6 shows how to make such tools. Use them sparingly. A bent contact that happens to bend the wrong way is a real dog to straighten out!

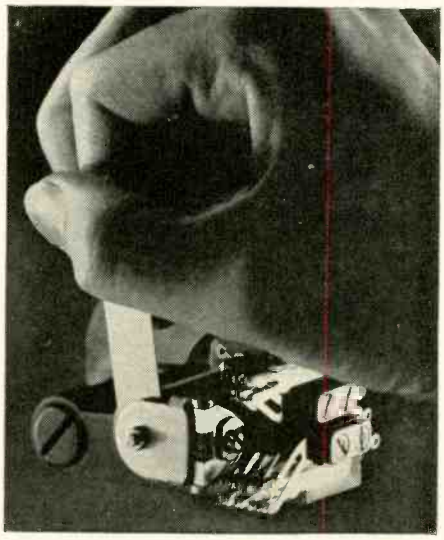
Contact pressure can be measured with small commercial gram-gages, but contact pressure is rarely critical, so long as it is not unusually far off. When contacts on a relay open and close at the same time, you can be fairly sure that the contact pressure is very nearly equal, unless one of the springs is badly distorted making its contact pressure different.

When ac relays hum badly, try cleaning between armature and core. I used to use a small strip of canvas and drag it through the opening while holding the armature down. This usually gets most of the dirt, which lodges in the rough weave of the canvas. *Never* oil relays unless the manufacturer calls for it. I have never come across a relay that needed oiling, but who knows, there may be some somewhere. Oil can raise havoc with the contacts, and in moving joints it just invites dirt to clog.

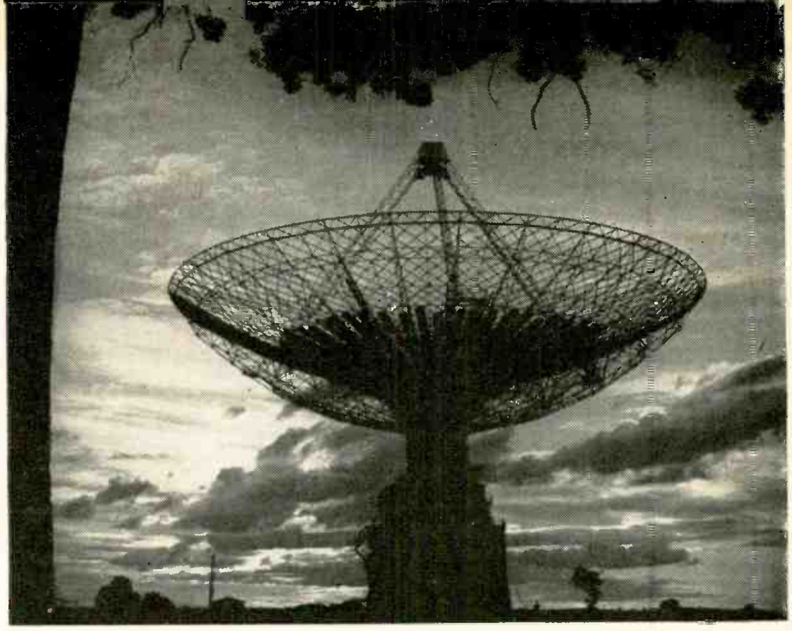
Here are some of the rules for getting along with relays. In this series we have tried to give you some practical ideas about relays, their application, selection, testing and maintenance, and perhaps you've met some relays you never saw before. Admittedly only a small part has been told of what *could* be told about relays, much of it from practical experience living with them. One cannot but wonder if Henry foresaw, more than a hundred years ago, that his simple electromechanical invention would some day be the most prolific control device in industry everywhere. END

All photos courtesy Automatic Electric


Long-nose pliers is used to adjust spring tension.

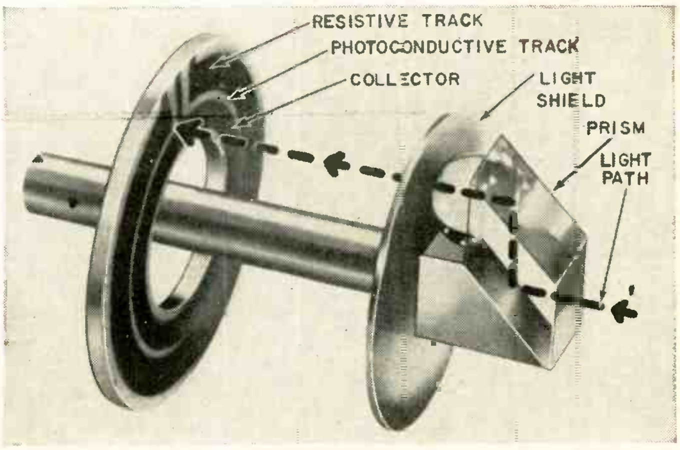

Measuring the "residual" spacing between armature and coil core.

What's New



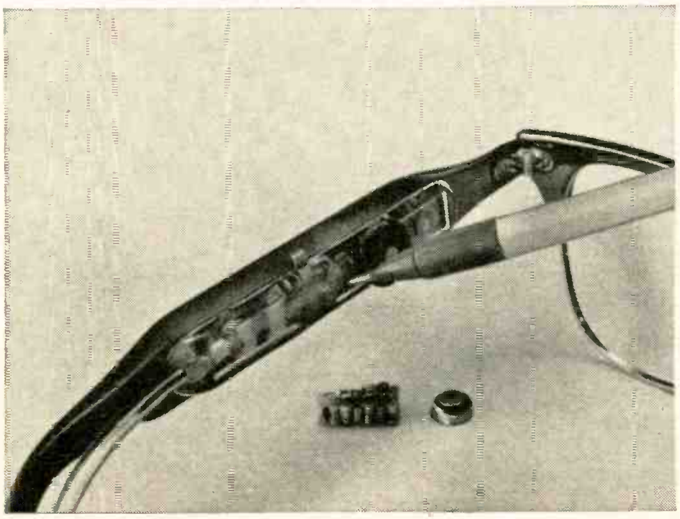
LISTENING TO THE STARS is the job of this 210-foot radio telescope, the world's second largest. It is located in Australia about 200 miles from Sydney and is intended mainly for radio study of the Milky Way and other galaxies. Though smaller than the 250-foot antenna at Jodrell Bank its greater accuracy is said to make it superior to any other instrument for detecting radio waves. The photo is from the Radiophysics Division, (Australian) Commonwealth Scientific and Industrial Research Organization.

LUNAR ROVERS Dumbo and Porkie are experimental moon exploring devices made by RCA's Astro Electronics Division. Dumbo is the large unit standing on the table. Porkie is being held by Judith Wrona. They were developed as part of a program to create locomotion techniques for getting around on the moon where wheels may not be as useful as their flat pad feet.



ELECTRO-OPTICAL POTENTIOMETER features an entirely new operating principle. A light beam passes through a prism mounted on the potentiometer shaft and on to a photoconductive track. The point the light hits is determined by the shaft setting. High conduction at this point completes a circuit between collector and resistive track. Advantages of the Duncan Electronics pot are frictionless pickup, long life, and no contact noise.

SUBMINIATURE HEARING-AID AMPLIFIER—the entire section shown in the clear plastic case—snaps in and out of specially made eyeglass frames. Made by Dictograph Products, the device can be used with a variety of frames, unlike previous versions which were built into the frames. Its gain is 33 db.



TV DESIGN '62

We're lifting the curtain on the new features of 1962 television receivers

By WAYNE LEMONS

YES, NEARLY ALL MANUFACTURERS HAVE made some changes for 1962, but you may not be able to recognize some of those changes without a score card. So let's take a fast pan across and then a look at each maker's offering individually.

First off, nearly all tuners use a neutralized triode rf amplifier. A new frame-grid triode, the 6GK5, is the most popular. Mixers are still all triode-tetrodes or triode-pentodes but some new tube types have been added. In the if sections we find many portables have only two stages but, to help compensate, higher-gain tubes are used. In other circuits you probably expected several of the much heralded 12-pin Compactrons. They are found in only one set—no, not G-E—in Admiral. The one used is a triple triode combination noise inverter, sync clipper and keyed agc.

Advertising emphasis, in many cases, is placed on "blacker blacks and whiter whites and a full gray scale in between." Basically, they're ballyhooing a circuit always found in designs around 1950 but which has fallen into neglect in the last several years. It was known as dc restoration or, as some call it, dc reinsertion.

The simplest form of dc restoration is just not to lose it in the first place. This is done by designing the video circuits to retain the dc component by direct coupling from the detector to the video amplifier to the picture tube. This is how it is done where we find it this year, in all except some Packard-Bell sets. Since they use two stages of video amplification, they prefer diode restoration—in this case a diode-connected triode, part of the 6EA8 second video amplifier.

Why have dc restoration anyhow? In simple terms, its purpose is to keep background brightness constant regardless of the video content of the picture. Without it, the background tends to vary in proportion to the average amount of video. For example, when there is a lot of white in the picture, the whole screen goes whiter just as if you had turned up the brightness control. This means dark backgrounds will be too gray. A dc restorer counteracts this by automatically increasing the picture tube bias.

Philco and Packard-Bell have switches on some models to demonstrate this action to the customer.

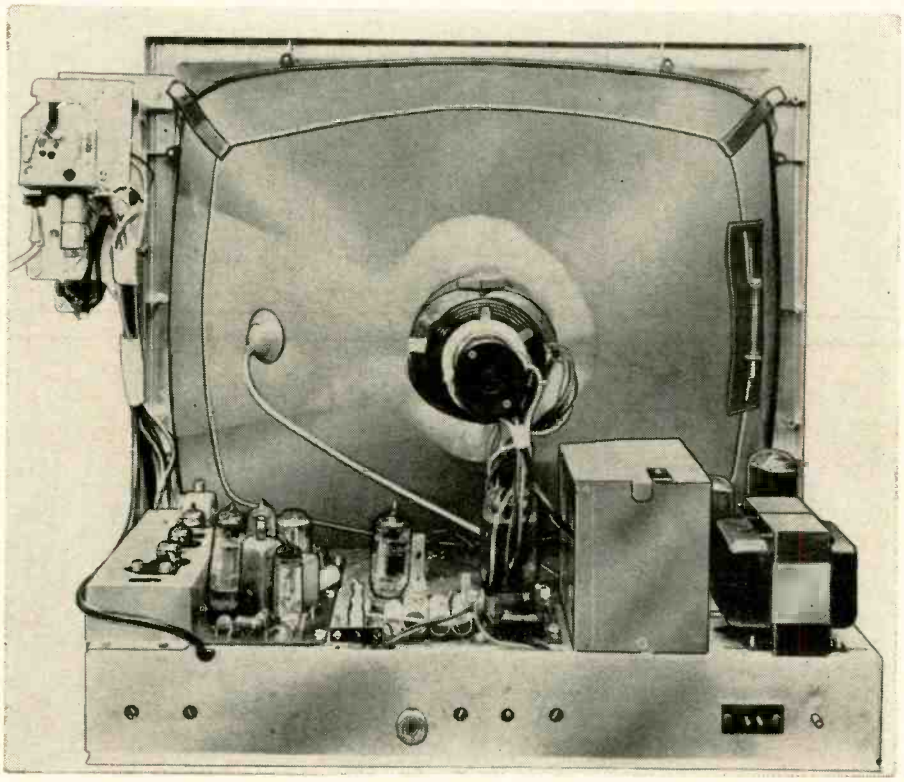
Dumont, Magnavox and RCA have models with automatic brightness/contrast controls. These circuits use a light-dependent resistor (LDR) whose resistance decreases when room light is increased. You may remember that Hoffman, who no longer builds TV's, used a similar circuit last year.

Westinghouse probably has the most startling innovation, the "instant on" circuit. There is no waiting period; as soon as you pull the switch you have picture and sound. Westinghouse's "silent sound" is another of its innovations. This is a transistor transmitter that rebroadcasts TV sound to a nearby AM radio.

Philco uses a varistor in some sets to regulate the high voltage automatically. This tends to prevent blooming when a high average value of white information is being transmitted.

Motorola is still marketing the 19-inch transistorized portable TV it introduced last year. It has some competition from Sony (Japan), who has introduced an 8-inch transistor portable.

Motorola and Packard-Bell have a customer control for varying the video response to compensate for customer preference. These tend to eliminate the snow effect in fringe areas by bypassing some of the high frequencies. Some foreign sets do this slightly in reverse. They have a two-position switch: one side accentuates the high frequencies (crispens) while the opposite position provides normal response. The clever part is the labeling. The crisp position is labeled FILM and the other LIVE. Since films (old movies at least) lose something in the transition, the crisp position sharpens up the outlines.



Admiral's 1962 chassis.

More home-entertainment units are being made this year. They feature TV, AM–FM, FM stereo and stereo phonos with stereo amplifiers of up to 100 watts of music power.

Nearly every manufacturer has wireless remotes of varying complexity, as has been the case for a couple of years now—but this year there seem to be more remote equipped portables than before.

Zenith plunged into color with both

feet, the first manufacturer to challenge RCA in several moons. In its all hand-wired version, convergence is similar to RCA, and an RCA (though labeled Zenith) all-glass picture tube is used. Both RCA and Zenith are using a new color picture tube that has about 50% more brightness, more uniform phosphors and a high-voltage connector similar to black-and-white sets.

New Tubes

There are enough new tubes to fill a small caddy—here's a list to help you make up your next order:

Triode Pentodes (Similar to 6AW8, usually used as video amplifier and sound if):

6DX8 (Zenith)
6GN8 (Zenith), 1961
6HF8 (RCA)
6JE8 (Philco)
8GN8 (Olympic)
10HF8 (RCA)
11JE8 (Philco)

Triode Pentodes (Similar to 6U8, 6EA8, etc.):

6BL8 (Motorola, Olympic)
6HL8 (Motorola, Zenith)
6JC8 (G-E)

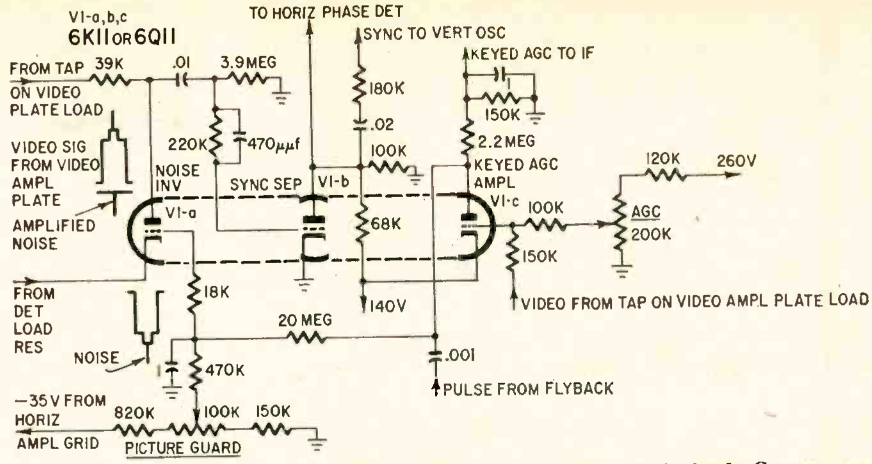


Fig. 1—Admiral uses this agc, sync and noise-inverter circuit. A single Compactron does the job.

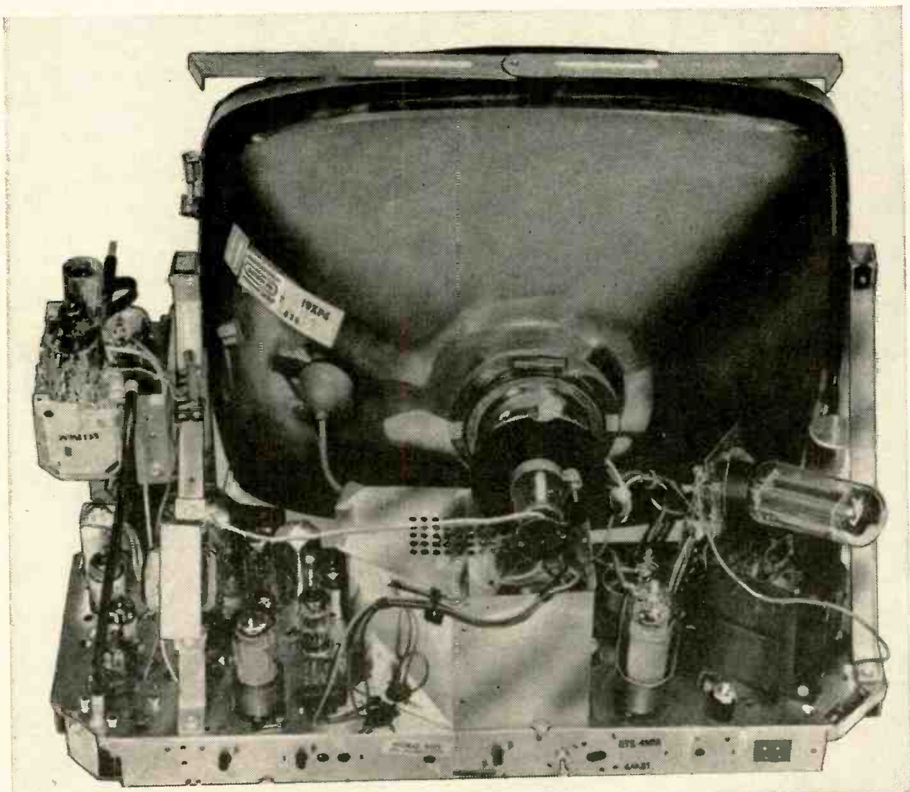
RF Triodes:

2CW4 nuvistor (RCA)
2FQ5 (Sylvania portable)
2GK5 (Admiral portable)
3GK5 (Philco portable)
6GK5 (Admiral, DuMont, G-E, Magnavox, Packard-Bell, Setchell-Carlson, Sylvania, Westinghouse)

Others

6GX6 sound detector similar to 6DT6 (RCA)
6K11 or 6Q11 Compactron (Admiral)
6FQ7 "dark-heater" dual triode (used by Admiral, Magnavox, Olympic and RCA but is interchangeable with the older 6CG7. This tube's heater operates at a rather low temperature.)
3A3 (G-E, Motorola and RCA all using it as a high-voltage rectifier in some of their black-and-white sets.)
17GW6 (RCA's new horizontal output tube in their portables).

Now that we've taken a quick overall scan of the new sets let's discuss them by make in more detail and take a look at some of the new circuits you'll be seeing this year.



Motorola uses this chassis arrangement.

Pentodes (General-purpose):

6GK6 video amplifier, audio output, vertical output (Motorola)
6HB6 video amplifier (Zenith color)
6GY6 agc amplifier (RCA)

IF Pentodes:

4EH7 (Philco)
4EJ7 (Philco)
5EW6 (RCA)
5GM6 (RCA)
6EH7/EF183 (DuMont, Zenith)
6EJ7/EF184 (DuMont, Zenith)
6FY5 (Motorola, Olympic, Zenith color)

Dual Tetrodes (similar to 'BU8):

3GS8 (Motorola)
6HS8 (DuMont, Zenith)

Vertical Oscillator-Outputs

6FD7 dual triode (Philco)
6HC8 triode-tetrode (Setchell-Carlson)
10EG7 dual triode (Sylvania)
13FD7 dual triode (Philco)

Admiral

Perhaps the most striking design feature of the new Admiral sets is the triple-triode Compactron used as a keyed agc, sync clipper and noise inverter (Fig. 1). This circuit in a slightly different form is used in portable, table and console models. Two controls adjust the circuit. The AGC control sets the no-signal bias on the first triode to control the amount of agc fed to the if and tuner.

The PICTURE GUARD control sets the bias on the third triode so that any noise above the sync tip level is clipped. Though it is called a noise *inverter*, there is *no* inversion in this triode since the input is to the cathode. The noise actually is inverted by the video amplifier stage. The noise fed to the cathode of the noise inverter is taken from the diode load resistor and amplified. This amplified noise is then mixed with the inverted noise from the video amplifier and, if the picture guard control is set correctly, is cancelled in the plate circuit of the noise inverter. Obviously, if the control is set incorrectly, part of the sync pulse would also be cancelled and the picture will be unstable.

All Admiral sets use circuit breakers that are resettable from the rear. Portable models have series-string heaters and two if amplifiers. All others are

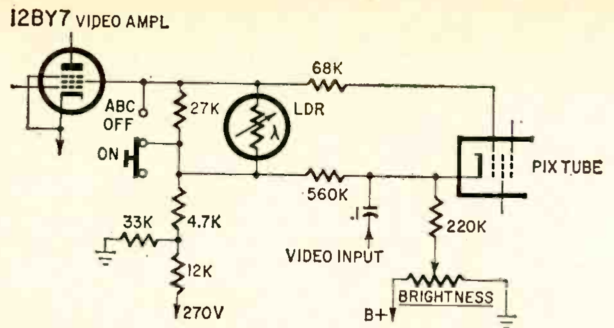


Fig. 2—DuMont's automatic brightness/contrast circuit using a light-dependent resistor.

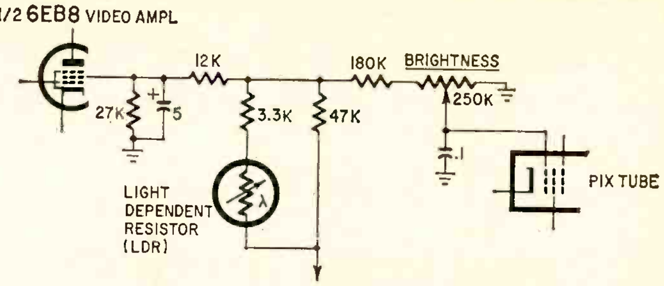


Fig. 3—Automatic brightness/contrast circuit in the Magnavox 35 and 36 series.

transformer-powered and have three if's.

All models have individual vhf channel slug adjustments that can be reached from the front of the set.

Admiral color sets are the same as the RCA CTC11 circuitwise.

ATR

According to Mr. Goffstein, general manager of ATR Electronics, this company does not believe in "planned obsolesence" but rather endeavors to improve its existing model to be as foolproof as possible.

The set has a cascode Standard Coil tuner, four video if's, two sound if's, ratio detector and push-pull audio output. Two 5U4's are used in a transformer power supply. The horizontal oscillator is a Synchroguide and feeds a 6CD6 horizontal output and 6V3 damper. Twenty-six tubes in all are used in their deluxe chassis.

DuMont

The new 800 series DuMonts are similar to last year's transformer-powered 600 and 700 series except for a few improvements. An audio output jack has been added that works independently of the volume control. It is useful for tape recording or using an external amplifier. An automatic circuit breaker with a reset button on the rear apron of the chassis has been inserted in the power transformer primary. New frame-grid rf and if amplifiers are used.

An automatic brightness/contrast circuit is included in some models (Fig. 2). Note that a light-dependent resistor (LDR) is connected across the 27,000-ohm resistor in the screen circuit of the video amplifier. As room light increases (in daylight or when lamps are turned on), the resistance of the LDR decreases. This places more voltage on the video amplifier screen, which increases the contrast. At the same time voltage on the picture tube grid is increased through the 68,000-ohm resistor and brightness is increased too.

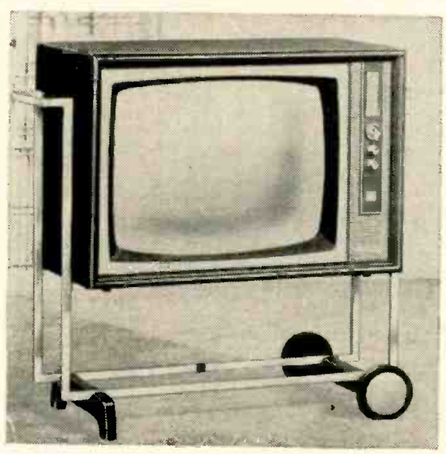
General Electric

The MV chassis is very similar to last year's M6 with these exceptions: A 6DT6 gated-beam sound detector is used instead of a ratio detector. The shielded cable from the tuner has been covered with insulated tubing. A 41.25-mc trap has been added inside a larger first if can and a 47.25-mc trap has been added inside the second if.

Tuners are similar except for the triode rf amplifier replacing last year's tetrode.

The horizontal afc diodes are silicon instead of selenium and, shortly after start of production, a 3A3 replaced the 1J3 as the high-voltage rectifier. The additional heater voltage was obtained by winding three turns around the flyback core and using a dropping resistor.

G-E's color set (chassis CW) uses an RCA CTC11 chassis.



Intenna teacart used by Packard-Bell. The frame of the cart is a dipole antenna for the TV set.

Magnavox

New Magnavox receivers are transformer-powered and use silicon rectifiers in a voltage-doubler circuit. A circuit breaker is used in the primary of the transformer.

The automatic brightness/contrast circuit shown in Fig. 3 is similar to the DuMont circuit. It is in the 35 and 36 series -02, -03, -04, -05.

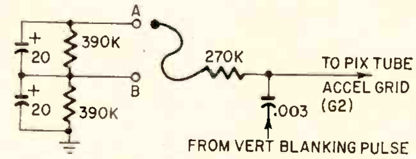


Fig. 4—Tap for CRT accelerator grid voltage may have to be changed to get proper automatic brightness action in the Magnavox 35 series. Connect it to either point A or B—whichever gives the best results.

It may be necessary to change the accelerator-grid (G2) voltage, especially if the picture tube is changed, to get the proper automatic brightness action. Do this by selecting either tap A or B, shown in Fig. 4, to give optimum results.

New Magnavox sets have 23-, 24- and 27-inch picture tubes.

Motorola

All new Motorola table and console models use a new horizontal oscillator and control circuit. They also have a "picture optimizer" for customer control of video response.

The oscillator and control circuit (Fig. 5) is different in that no reactance tube is used. The sine-wave oscillator is controlled directly by the output of the phase detector.

The oscillator is a modified Colpitts. Note the cathode feedback taken between .0033-μf C507 and .007-μf C508, across the horizontal oscillator coil. The "plate" for the oscillator is the screen. It is bypassed to ground through B-plus by 0.1-μf C509. This isolates the oscillator from the wave-shaping network, C510 and R511, in the plate circuit.

Motorola, in its circuit analysis of the control circuit, speaks of a sawtooth superimposed on a sine wave by the time constant of C506 and R506, and that the correction voltage varies the size of the sawtooth to provide control. We think it can best be understood from a service standpoint by simply saying that a positive control voltage speeds up the oscillator and a negative voltage slows it down.

Picture Optimizer

The optimizer control is connected in series with a fixed 1,500-ohm detector load resistor (Fig. 6). This results in a variable detector load resistor. Electrically, it varies the Q of the third if. Increasing the load resistance increases the Q by lowering the loading. This results in a loss of high-frequency response and reduces snow while increasing gain for fringe-area reception. Decreasing the Q gives a sharper, crisper picture for areas of higher signal strength.

Olympic

New Olympic 100 series are hand-wired, transformer-powered circuits with only two if's. The second if, however, is a new high-gain frame-grid tube. The 200 and 500 series are also

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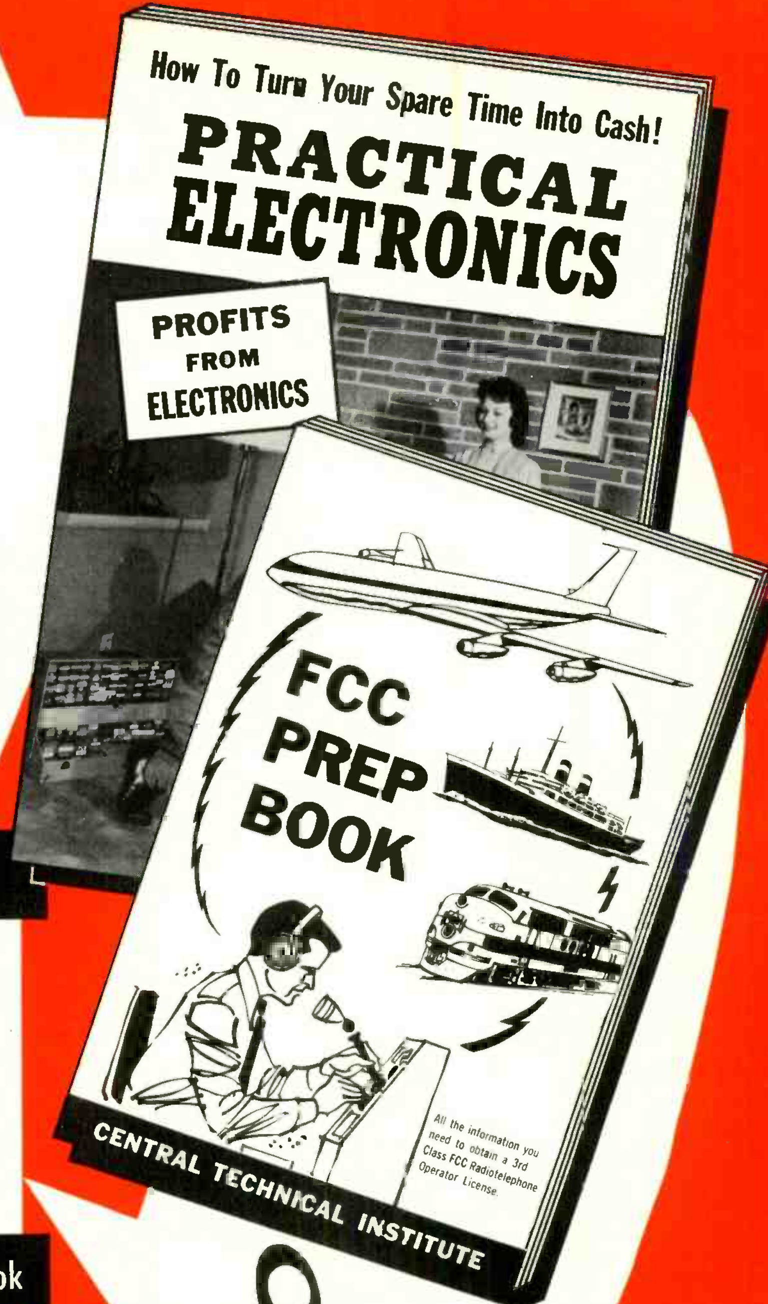

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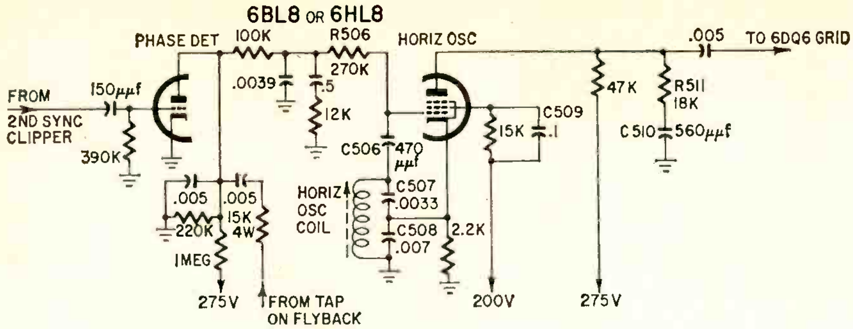


Fig. 5—New Motorola horizontal oscillator circuit.

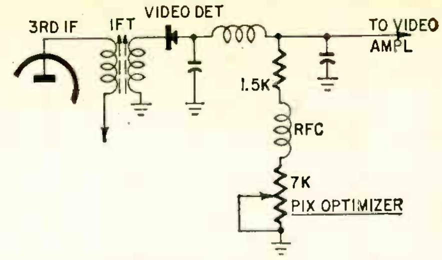


Fig. 6—Picture optimizer used by Motorola changes Q of third if to vary video response.

hand-wired and transformer-powered but have three if's, keyed agc, frame-grid rf and if tubes, noise inverter and adjacent-channel traps.

Some portable models are not transformer-powered—chassis LX and LXU. These sets only have two if stages too.

All transformer models have a 0.75-amp fuse in the secondary center tap. Heater circuits are fused with a length of No. 26 wire.

The sync and vertical oscillator circuit for the portables is similar to a circuit used last year and this year by RCA in some models (Fig. 7). The sync is fed into the cathode circuit of the oscillator. The low impedance of the cathode circuit would swamp the high-impedance sync pulse except for the diode gate in the 3AV6. This gate keeps the cathode circuit open (high impedance) until the negative sync pulse triggers the oscillator. The oscillator tube then starts to conduct, through the diode, and produces vertical sweep.

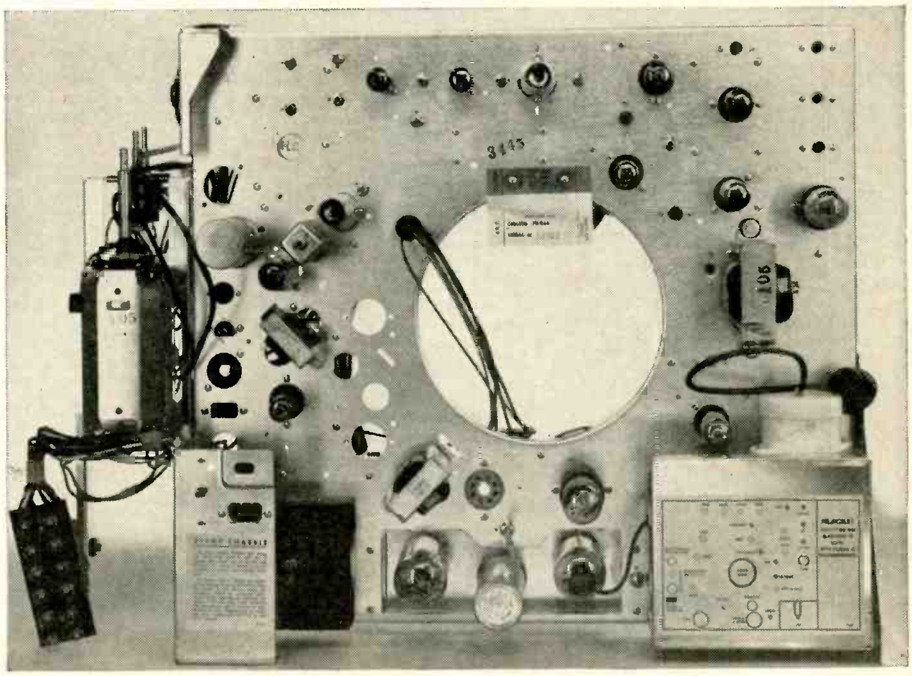
The advantages of this circuit are that only one sync stage is required because it can be triggered by a negative pulse and it is insensitive to noise and other disturbance during sweep time because of the then low impedance of the cathode circuit.

Packard-Bell

All models are transformer-powered and hand-wired. Both the 88 and 98 series use circuit breakers in the primary of the power transformer. Direct video coupling maintains the dc black level in the 88 series. In the 98 series, with two video amplifier stages, a diode-connected triode (½6EA8) is used as a dc restorer (Fig. 8).

For demonstration, the restorer may be disabled by a push-pull switch on the brightness control. With the switch open, a positive voltage through the 3.3-megohm resistor forces the diode to conduct continuously to prevent any change caused by the video input to the cathode.

Normally the negative-going video to the cathode causes the dc restorer to conduct in proportion to the average amount of video—thus on dark scenes, which have high video, the diode conducts more. This charges the .022-μf capacitor in a more positive direction. This in turn is applied to the picture-tube grid to increase brightness. The reverse holds true for scenes with low average video.


Packard-Bell uses this vertical chassis in '62.

Picture Fidelity

The PICTURE FIDELITY control is simply a high-frequency bypass in a circuit that might be compared to a simple audio tone control. A 50,000-ohm pot is used in series with a 100-μμf capac-

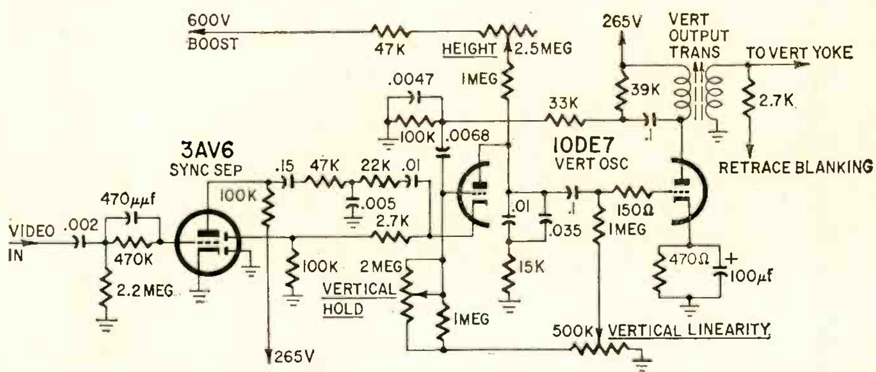


Fig. 7—Sync and vertical oscillator output circuit of Olympic LX and LXU chassis.

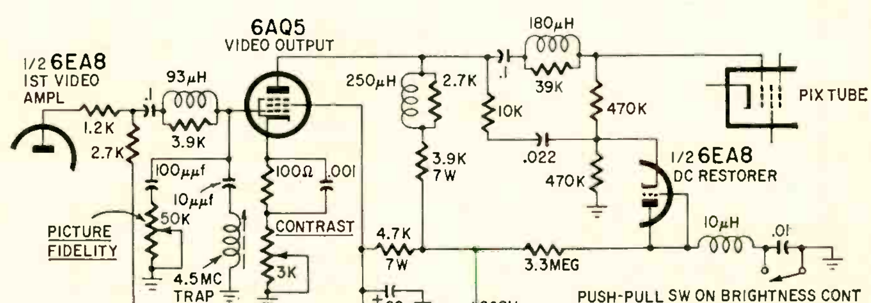


Fig. 8—Picture-fidelity and dc restorer circuit in the Packard-Bell 98 series.

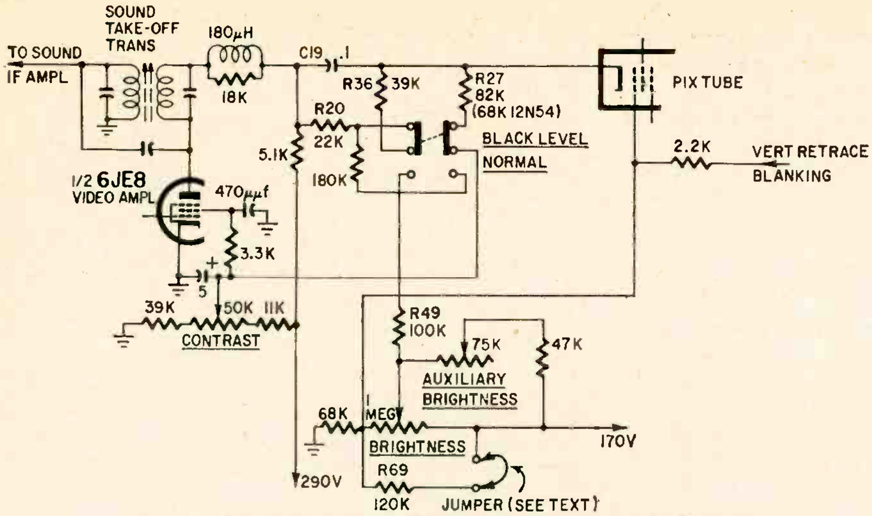


Fig. 9—Simplified Vivid Vision circuit as used by Philco.

itor. Picture fidelity will be best with the control set for maximum resistance. In fringe areas, though, snow can be reduced by setting this control for less resistance.

Intenna

A unique cart design for Packard-Bell sets features a built-in antenna, called Intenna by the manufacturer. The metal rods act as a broad-band folded dipole bent up (down in some designs) at the ends.

Philco

The new Philco portables (chassis 12J27) are series-string sets with a silicon-rectifier voltage-doubler power supply. Two high-gain frame-grid pentodes are used as if amplifiers. The video amplifier stage is dc-coupled to provide automatic black-level control.

Other Philco models are transformer-powered refinements of last year's "cool chassis" receivers.

Vivid Vision

The 12N53 and 12N54 chassis have slide switches to change from BLACK LEVEL to NORMAL. In the NORMAL position the video is ac-coupled to the crt. In the BLACK LEVEL position the circuit is dc-coupled to restore the correct background level regardless of the average amount of video present (Fig. 9). The circuit may appear unnecessarily complicated, but there are reasons.

In the BLACK LEVEL position, video capacitor C19 is shunted by R20 (22,000 ohms) and R36 (39,000 ohms) through the switch. Two resistors are used so the switch capacitance will not load either the video amplifier plate or the picture-tube cathode and cause high-frequency loss.

The other side of the switch inserts 82,000-ohm R27 from the center arm of the contrast control to the picture tube cathode to compensate for changes in brightness with a change in contrast setting. This would occur since the contrast control is in the screen circuit of the video amplifier. Increasing the screen voltage (contrast increased) will increase plate current and decrease plate voltage. This plate voltage is directly coupled to the picture tube cathode, so without compensation, an increase in brightness would result. The 82,000-ohm resistor compensates by applying a more positive voltage to the picture tube as the contrast is advanced.

In the NORMAL position, the dc coupling circuit is opened, but to maintain the correct bias on the picture-tube its cathode is connected through R36 (39,000 ohms) and R49 (100,000 ohms) to the AUXILIARY BRIGHTNESS control and the center arm of the customer BRIGHTNESS control. This compensates for the change in picture tube bias when the dc coupling from the video amplifier plate is removed.

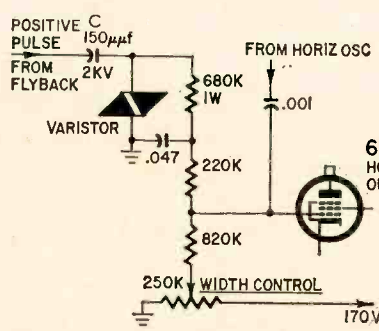


Fig. 10—Varistor regulates high voltage in Philco receivers.

Setting Auxiliary Brightness Control

1. Set switch to BLACK LEVEL.
2. Insert 0-1-ma meter in the cathode lead.
3. Turn brightness and contrast to maxium.
4. Set AUXILIARY BRIGHTNESS control for a three-quarter scale (750 μa) reading on the meter.
5. If the control goes to zero before 750 μa is reached, connect a jumper to bridge 120,000-ohm R69 across the brightness control.

Automatic High-voltage Regulation

Another refinement in some Philco models is the varistor. It is constructed so its resistance decreases as the voltage across it is increased. A typical unit will pass only 100 μa with 200 volts across it (2 megohms), but will pass 1 ma with 355 volts across it.

Fig. 10 shows the bias network of the horizontal-output stage. Basically here's how the circuit works: During horizontal retrace, a large positive pulse appears across the varistor. Since its resistance is inversely proportional to voltage, it will have low resistance and C will charge rapidly. Between pulses, the voltage will be low and the varistor resistance high. This forces C to leak off through the parallel paths represented by the grid resistances. This creates a negative voltage to bias the output tube. Suppose the high voltage goes down for some reason, the pulses from the flyback will also decrease and so will the bias to the output tube. With less bias, the output tube will have more gain and increase the high voltage. So we have regulation.

Since the bias supplied in this manner ranges around −100 volts and we can use only around −60 volts, a 250,000-ohm WIDTH CONTROL controls a positive bucking voltage to set the bias.

RCA

New RCA portables (KCS137 and 138 chassis) depart from their design in recent years by returning to series-string heaters with a voltage-doubler power supply. A new horizontal-output tube (17GW6) is said to give the additional drive needed to develop a high voltage of 20 kv.

The KCS136 chassis used in table and console models is transformer-powered with a 5U4 rectifier. The transformer has 120- and 128-volt taps in the primary. A 6GW6 is used as the horizontal-output tube and a 3A3 high-voltage rectifier supplies the 22.5-kv maximum picture tube anode voltage.

Some KCS136 chassis incorporate a light-dependent resistor (LDR) for automatic brightness control. It can be switched in or out. Dc coupling provides the correct black level in the video amplifier. Fig. 11 shows this combination automatic brightness and dc-coupled circuit.

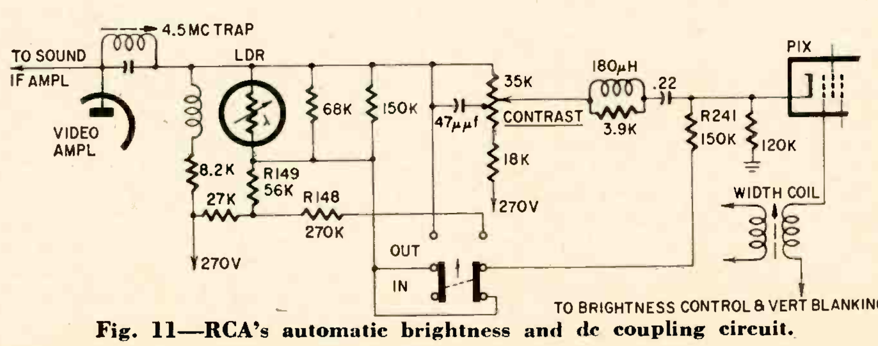
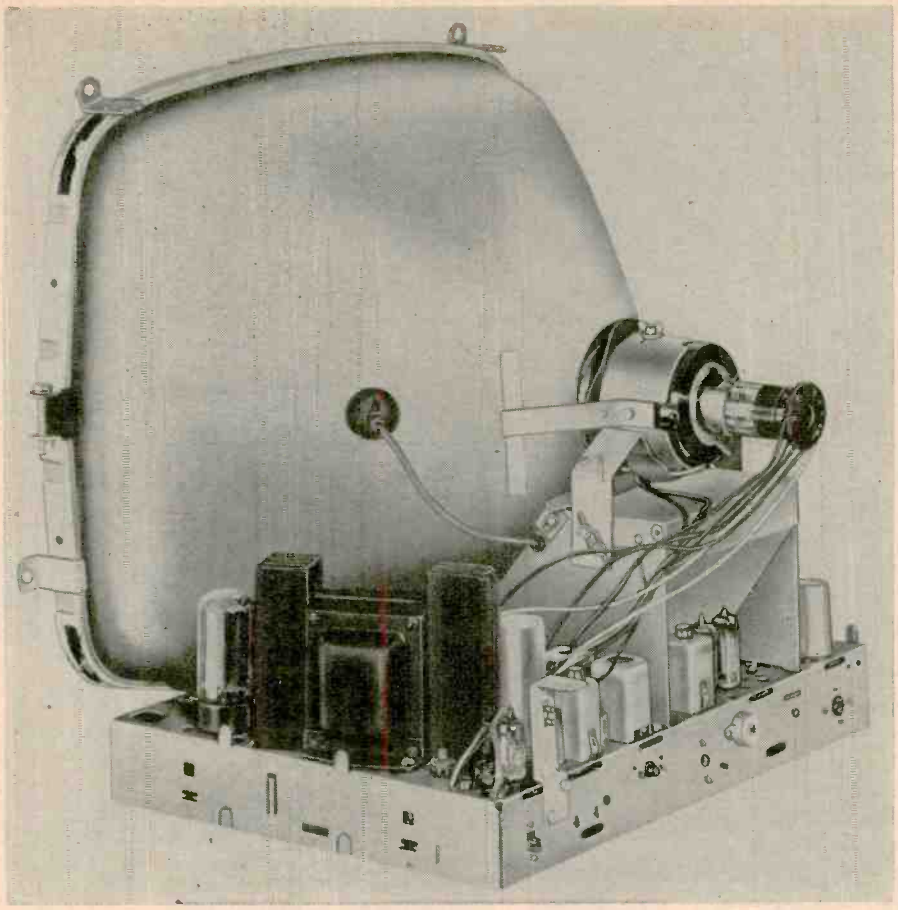
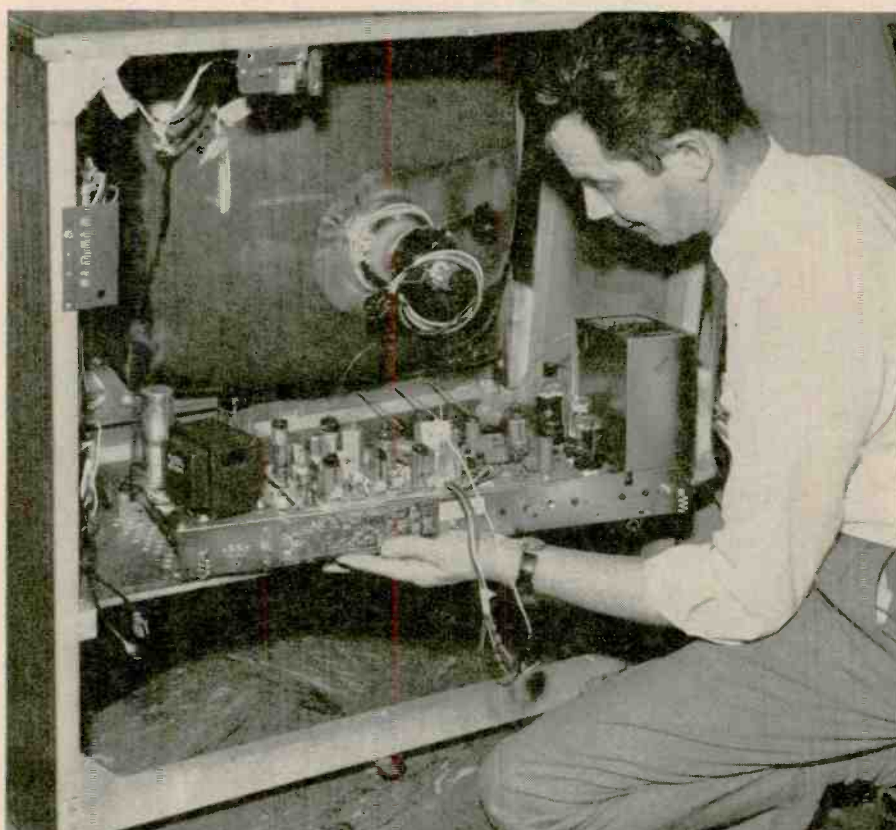


Fig. 11—RCA's automatic brightness and dc coupling circuit.

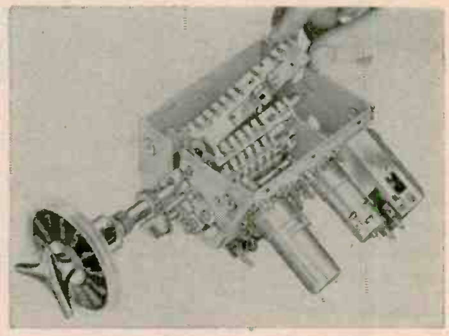


Zenith's 16H28 chassis—new for '62.



TV technician demonstrates accessibility of Sylvania GT-555 chassis.

With the LDR switched in, the dc component from the video amplifier plate is coupled through the switch to the CRT cathode. Since the LDR decreases in resistance, the CRT cathode will go less positive and brightness will



New tuner used by Zenith has provision for adding up to 4 uhf channel strips.

increase with an increase in room light.

With the LDR switched out, dc for the picture tube cathode is taken through R149 (56,000 ohms) and R148 (270,000 ohms) and R241 (150,000 ohms). The LDR is shorted by the other side of the switch.

A winding on the width coil supplies a horizontal blanking pulse to the picture tube grid. Vertical blanking is also applied to this grid.

RCA color

The principal change in the CTC11 RCA color set is the picture tube. The new 21FBP22 tube has up to 50% more brightness. All three phosphors are more evenly matched so that the red gun does not have to be driven harder. This eliminates the red border around bright, white objects. All three phosphors have about the same decay time. In the old tube, the blue phosphor decayed more rapidly (dimmed faster after being hit by the electron beam) than either red or green. This caused a yellow blur following fast movement in the picture.

Other changes are a new tuner using the 6CW4 nuvistor triode, and a circuit breaker replacing a fuse in the B-plus circuit.

Set up procedure is essentially the same as last year.

Setchell-Carlson

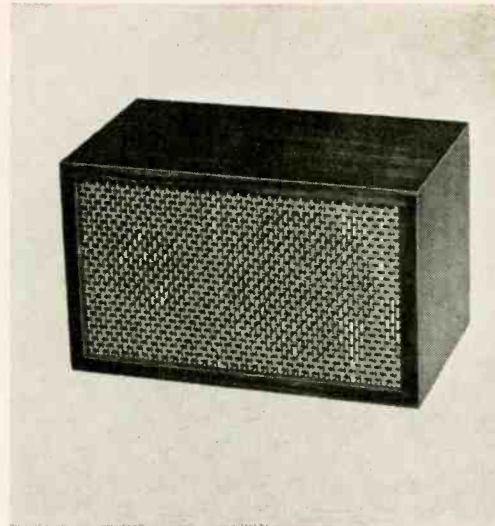
Setchell-Carlson has three chassis, all transformer-powered—the C-117 portable (also C-219 with AM radio), the 362 and the "unitized" 159.

The 159 is the same as last year except for a new tuner using a frame-grid triode (6GK5) rf amplifier. The same chassis is used with 23-, 24- and 27-inch picture tubes.

The 362 chassis has three video if stages (as do the others) and two video amplifier stages.

The power supply is the same in both the portable C-117 and the 363 chassis. It is a little unusual (Fig. 12) in that 115 volts B-plus is taken off at the lower end of the power transformer

(*Continued on page* 60)



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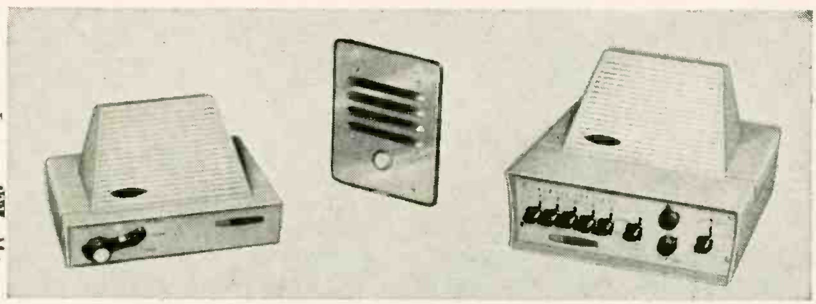

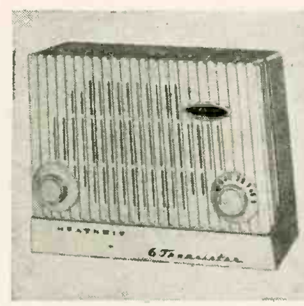

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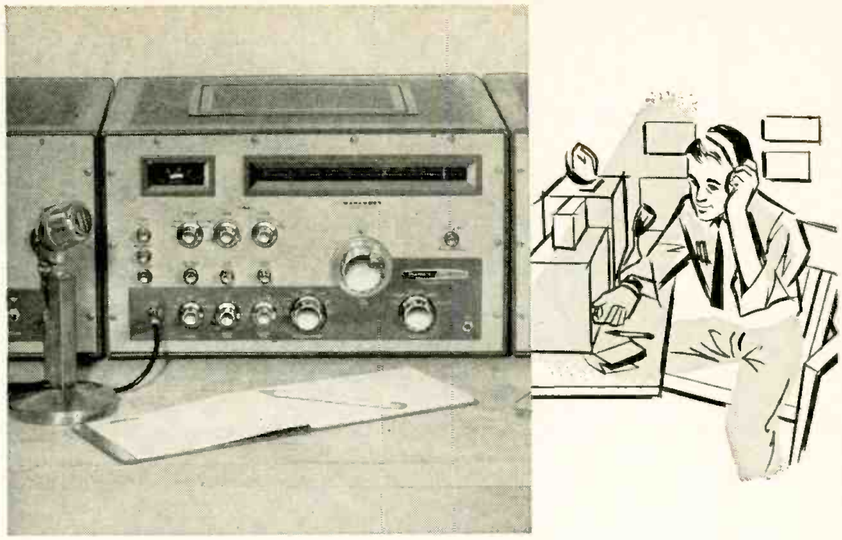

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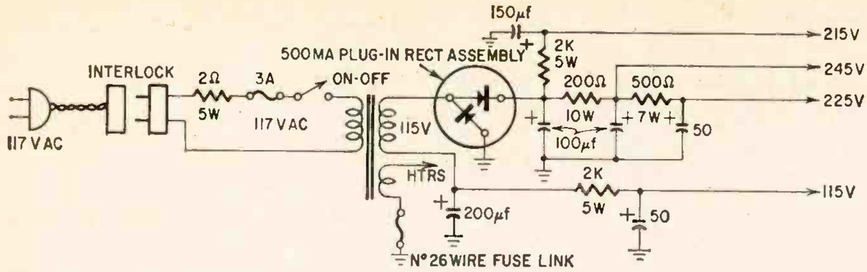


Fig. 12—Setchell-Carlson power supply uses plug-in silicon rectifiers and RC filtering.

Sony transistorized portable TV can be used almost anywhere.

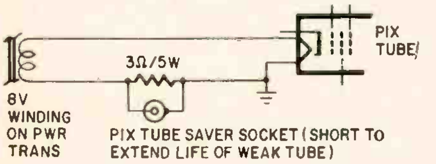


Fig. 13—Built-in booster for weak picture tube is a part of the Setchell-Carlson circuit. (Unitized chassis models only.)

(*Continued from page* 57)

secondary, at the positive terminal of the voltage-doubling capacitor.

The silicon rectifier doubler is a plug-in assembly. All chassis have keyed agc.

The 159 chassis has an unusual feature in the "picture-tube booster" circuit (Fig. 13). A resistor is used in series with an 8-volt heater winding going to the picture tube. When the time comes that the picture tube emission can be improved by more heater voltatge, a jumper can be plugged in to short the resistor.

Sony

This firm's big news is an 8-inch transistorized portable.

The set uses 23 transistors and 18 diodes; has a 20-mc if, intercarrier sound and an overall sensitivity of approximately 30 µv. The 210HB4 picture tube is aluminized and has a 90° deflection angle.

Power consumption from the 12-volt lead-acid battery is 13 watts. A built-in rectifier–charger–filter system permits operation from a 120-volt line.

Only two tubes, in addition to the picture tube, are used. These are the two 1DK1 high-voltage rectifier–doublers. They supply 6 kv for the second anode of the picture tube (Fig. 14). Note the voltage for the accelerator grid and for the video amplifier is derived from the horizontal sweep circuit through separate semiconductor diodes. The neon pilot lamp is also powered by this source.

A safety device, using two parallel diodes, prevents damage to the receiver should it be subjected to incorrect polarity when operated in an automobile. The diodes block the current if the polarity is reversed (Fig. 15).

Sylvania

Sylvania this year has gone back to

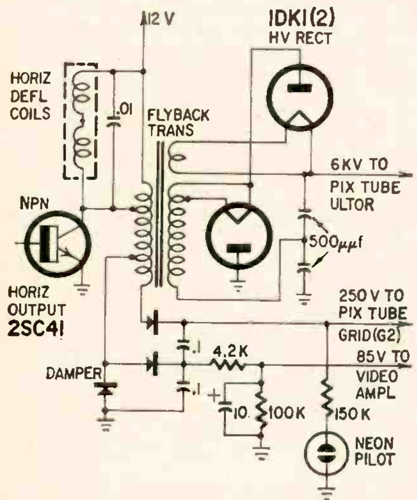


Fig. 14—Sony uses two tubes and two diodes to supply B-plus in transistor set.

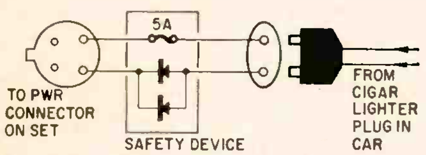


Fig. 15—This safety device prevents damage to Sony transistor TV if it is accidentally connected to wrong polarity dc.

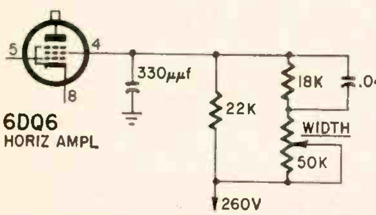


Fig. 16—Sylvania uses a combination of screen voltage adjustment and degeneration to control width.

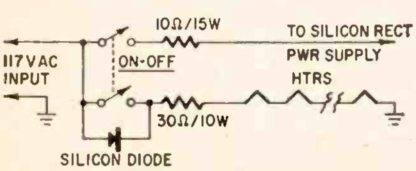
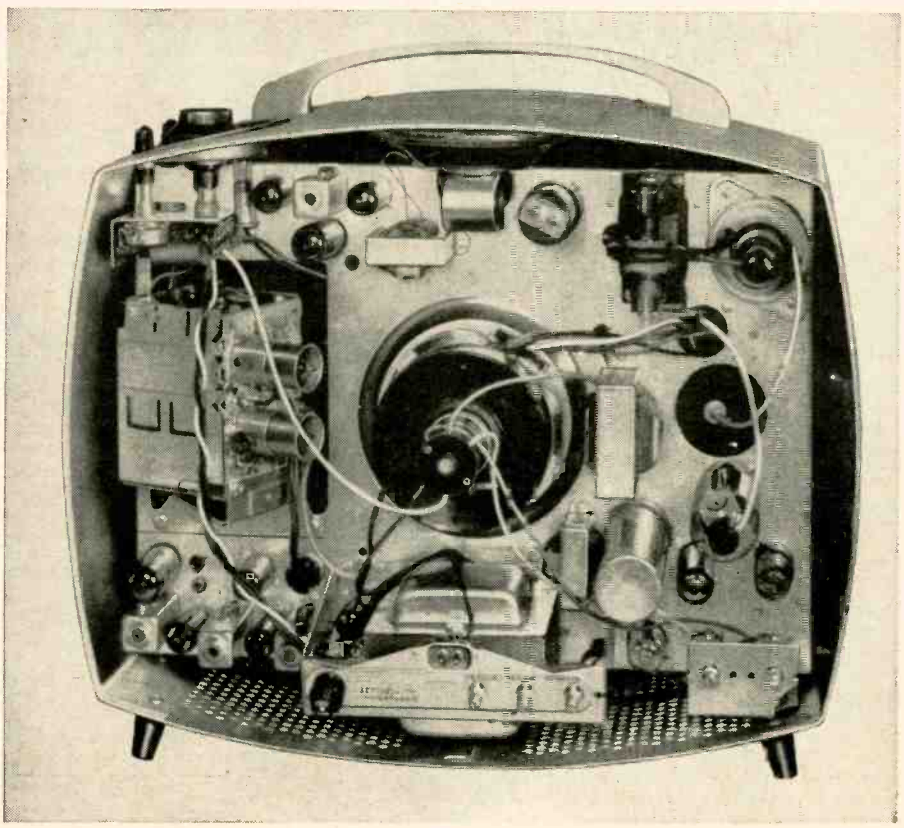


Fig. 17—Westinghouse fast-start Instant-On circuit.



Setchell-Carlson C-117 chassis.

a power-transformer chassis with 5U4 rectifier and B-plus circuit-breaker in their table and console models. They have retained their series-string portable.

The transformer chassis is easily accessible for service. Yoke and tuner plugs make it simple to remove the chassis if service underneath is necessary.

Their remote control receiver has been updated to provide more functions. It now uses two tubes (12AX7, 12AT7) instead of the one (6AW8) used previously. The frequency of operation is the same, about 8 kc, as compared to other remotes which usually operate around 40 kc.

An unusual width-control circuit is used in all models. It has both screen-voltage adjustment and screen degeneration (Fig. 16). As the WIDTH control arm is moved toward B plus, the voltage on the screen decreases. At the same time, the .047-µf screen bypass is placed in series with more resistance. This reduces the amount of screen bypassing; degeneration results and the horizontal amplifier has less gain. The main advantage, apparently, of this circuit is that the width control need not be a high-wattage pot.

Westinghouse

The new Westinghouse table and console sets are transformer-powered with a fused primary. The portable is similar to last year except that some chassis have an Instant-On feature. Fig. 17 shows how this circuit works. Note that the upper section of the dpst switch opens the ac line to the silicon-rectifier power supply but the lower section going to the heaters is bypassed by a diode. This keeps the tubes lit dimly (and drawing about 32 watts) so that the picture and sound come on instantly when the off–on switch is pulled on.

Westinghouse believes that tube life will be extended in these sets because there is no sudden surge of current. The heat generated also helps to eliminate dampness that causes component failure in some areas of the country.

Silent Sound

This is another unusual feature of this year's Westinghouse line. Silent Sound is a transistor transmitter that rebroadcasts the TV sound from the TV to any nearby AM radio (Fig. 18). This permits easy remote control of TV volume. You can turn down the volume on the TV set and listen only through your radio. A radio with an earphone plug can be used for private listening so as not to disturb other members of the family.

The circuit is extremely simple. A p-n-p transistor is used both as an rf oscillator and modulator. Sound coupled from ahead of the volume control is fed into the base circuit. Feedback for the oscillator is supplied through .01-µf C5. C6 sets the frequency to a quiet spot on the radio dial. Power for the circuit is obtained from the cathode circuit of the audio output tube. *Caution: This circuit meets FCC specifications for radiation and should not be modified in an attempt to get more range.*

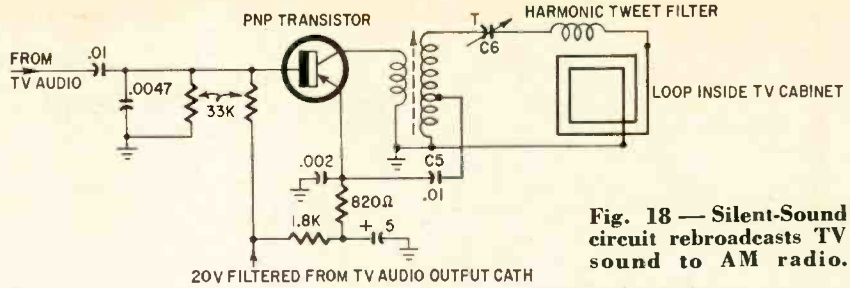


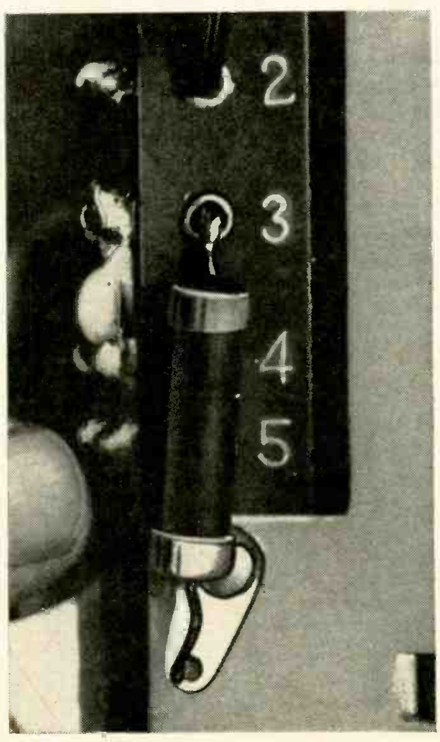
Fig. 18 — Silent-Sound circuit rebroadcasts TV sound to AM radio.

Zenith

There hasn't been too much change in the Zenith line. Some new tube types will be noticed, including frame-grid if's in some chassis. A new turret tuner has been introduced this year and is used in most black-and-white sets and in the color chassis. It should be easy to service.

Like last year, the chassis are all hand-wired and transformer-powered. The 3DG4 introduced in one model last year is standard in all '62 models.

The 16H28 deluxe chassis has a couple of interesting features. A PEAK PICTURE control, similar to Motorola's PICTURE OPTIMIZER described earlier, is located on the rear apron of the chassis. It may be set from a slight smear to an exaggerated ringing condition. The other feature is an adjacent channel in–out switch. Picture response is a little better with the switch out and it should be left here unless the customer runs into adjacent-channel sound interference (Fig. 19).



Philco's varistor is located just inside the high-voltage cage.

Philco's 6FD7 vertical output tube has standard 9-pin base and dissipates more heat by using a larger than normal glass envelope and heavier construction.

Zenith Color

This is the first new color set in several moons that hasn't been built by RCA. The Zenith set is hand-wired and uses an entirely new color detection circuit. The picture tube is an RCA (though labeled Zenith), and convergence and tracking adjustments are very similar to RCA. [A complete story on the Zenith color receiver will appear shortly, probably next month.—*Editor*]

The picture is positioned with strings. These strings go down inside the yoke assembly to turn magnetic rings much like those used on black-and-white sets. One set of strings moves the raster sideways, the other set moves it up or down.

The set has 29 tubes in all, including three frame-grid if's and two 3DG4 low-voltage rectifiers. END

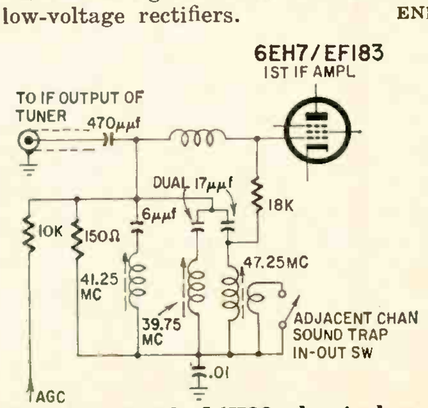
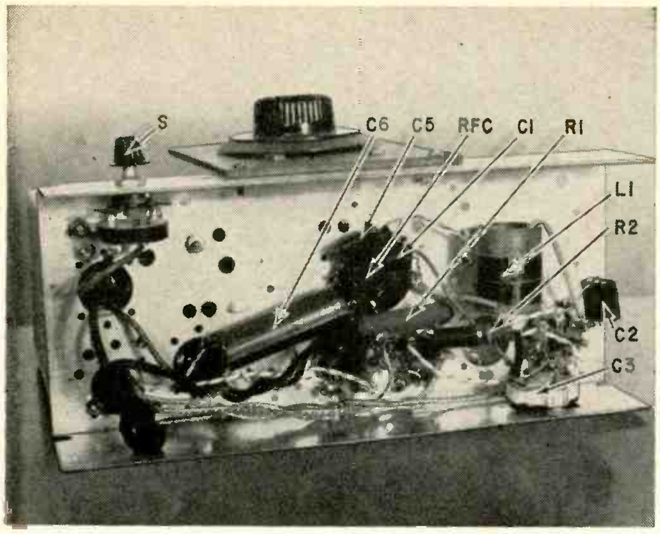
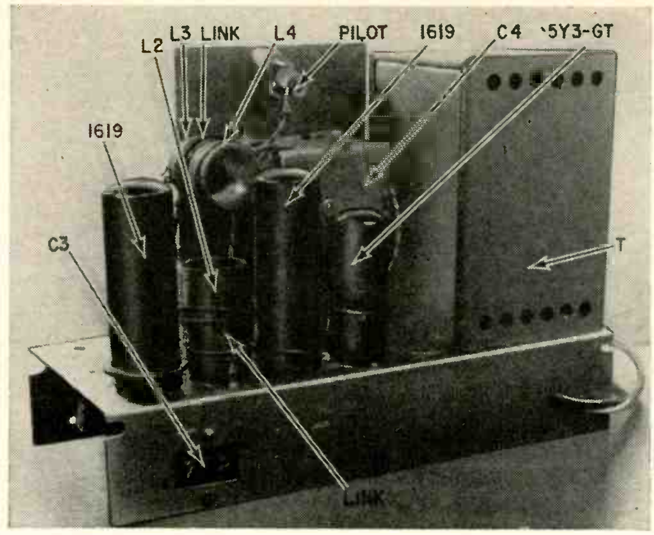


Fig. 19—Zenith 16H28 chassis has a switch to disable adjacent channel sound trap when set owner has no interference.





Top and bottom views of the intermittent checker.

SIMPLE UNIT TESTS

INTERMITTENT CAPACITORS

By JOHN A. DEWAR

Intermittent electronic equipment is one of the technician's worst headaches. Paper capacitors with loose internal connections are a common cause of this trouble. No other trouble is as hard to locate. Frequently the part fails to "intermit" when its leads are pulled or moved. "Cooking" the set is time-consuming and often ineffective. Replacing all capacitors is expensive and inconclusive. This intermittent-capacitor tester is, to me, the logical answer. The tester is basically an rf power oscillator, producing about 10 watts at around 5 mc. The capacitor to be tested is connected in series with C4 across L3. C4 is tuned to resonance with the oscillator which causes a large rf current to pass through the capacitor under test. Resonance is indicated by maximum brilliance of the pilot light across L4.

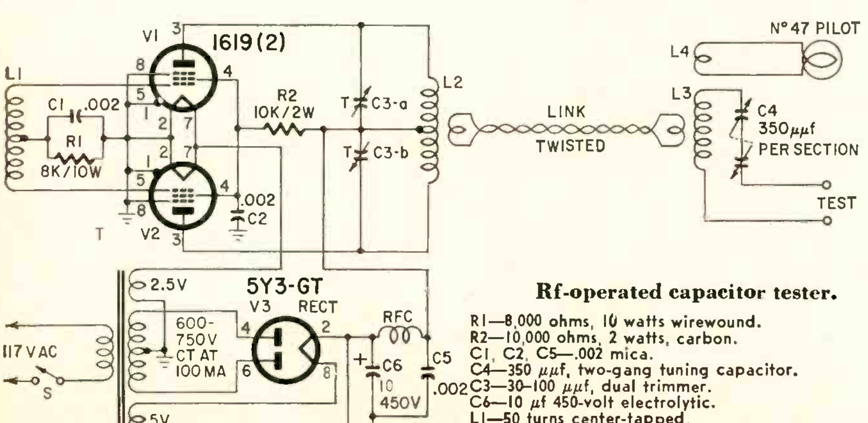
Most of the parts of the unit can be found around the shop. Surplus 1619 tubes were used because they are quick-heating. Tubes like 6L6's or 807's can be substituted by using a power transformer with a 6.3-volt winding. Power transformer T is from an obsolete radio. C4 is a two-gang tuning capacitor with the two sections used in series. The rotor is ungrounded. C3 is a dual 30–100-$\mu\mu$f trimmer from an old if transformer. The parts list covers the other components.

The only filtering required is the 10-μf electrolytic shown. C3 is adjusted for maximum output. An rf ammeter in series with a .01 capacitor on test will read a little over 1 amp. A 7-watt 117-volt lamp should light up brightly.

The tester produces enough rf to give a good sting, so it is better to shut the power off when making connections. If slow-heating tubes are used, insert a switch from the high-voltage center tap to ground. This keeps the heaters hot for instant use.

Coil and wire sizes are not critical. Since the tester is not in frequent use and therefore not a permanent bench fixture, it need not be dressed up in a fancy panel and cabinet. Layout and lead dress are not critical. Construction time and cost are small.

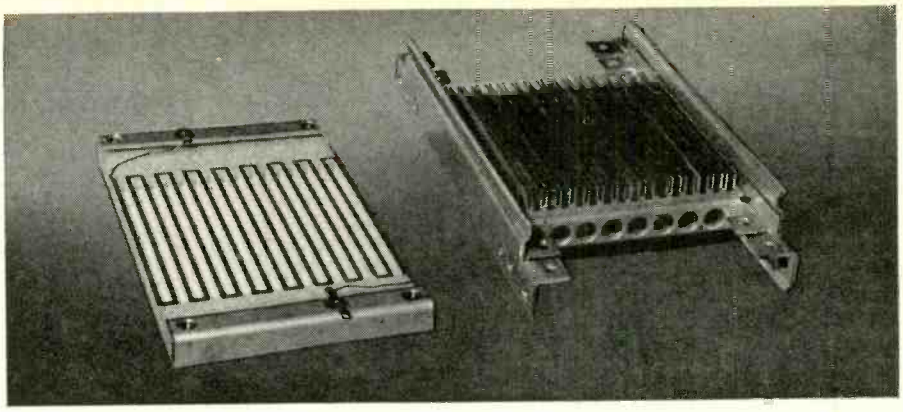
It is advisable to leave the capacitor under test for several minutes. If it has a loose internal soldered connection between the foil and pig tail, it will arc, heat up and open, causing the pilot light to go out. If the capacitor is shunted by a fairly high resistance it need not be disconnected to make the test. END



Rf-operated capacitor tester.

R1—8,000 ohms, 10 watts wirewound.
R2—10,000 ohms, 2 watts, carbon.
C1, C2, C5—.002 mica.
C4—350 $\mu\mu$f, two-gang tuning capacitor.
C3—30–100 $\mu\mu$f, dual trimmer.
C6—10 μf 450-volt electrolytic.
L1—50 turns center-tapped. (No. 30 enamel close wound)
L2—50 turns, center-tapped.
L3—20 turns.
L4 and link coupling coils—2 turns of insulated hookup wire (No. 22 enamel wire close wound on 1¼-inch forms)
RFC—45 turns No. 22 enamel on ¼-inch form.
T Power transformer, 2.5 volts 4 amps; 5 volts, 2 amps; 600—750 volts center-tapped, 100 ma.
Pilot lamp—6-8 volts 150 ma (No. 47).
V1, V2—1619 (see text)
V3—5Y3-GT

The Orthophase speaker, as it appeared at the Parts Show in Paris.



Winding the voice coil on a flat sheet makes these speakers as thin as electrostatics

FLAT VOICE COILS MAKE FLATTER SPEAKERS

By E. AISBERG and FRED SHUNAMAN

ONE OF THE SURPRISES OF THE PARTS Show in Paris last spring was an entirely new speaker. Based on a novel concept that makes possible a dynamic speaker as flat as an electrostatic, it drew the crowds away from the classic dynamics and the rare electrostatic. It was called the Orthophase and its performance was remarkable.

It is based on the same principle as the ribbon mike. A light ribbon of conductive alloy laid out in the grid design shown in the photograph is attached to an extremely light but rigid sheet of polystyrene foam. The polystyrene is channeled out so that the ribbon rests on raised portions (Fig. 1). Each section of the ribbon is placed in the field of a powerful magnet. When low-frequency current is passed through the ribbon, the entire sheet vibrates, and the amplitude of the oscillations can reach nearly ¼ inch.

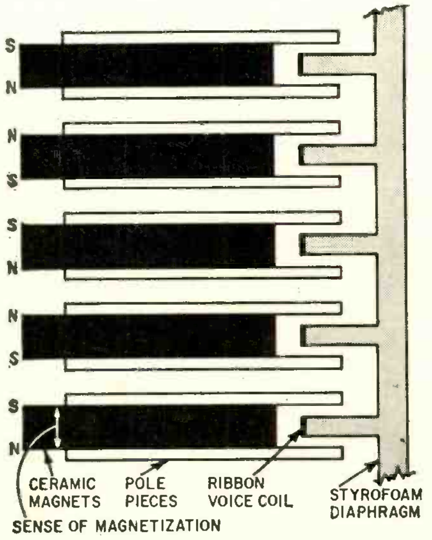
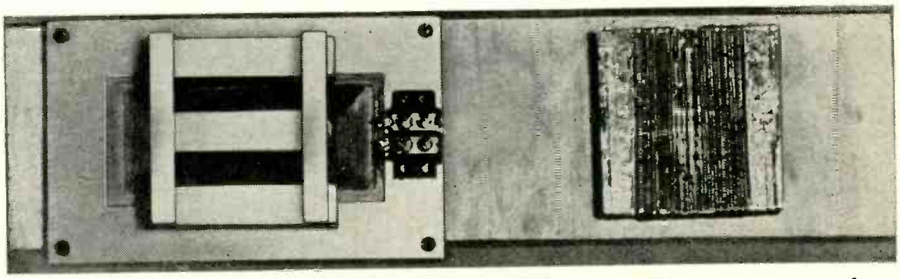


Fig. 1—Cross-section of the Orthophase



Mid-range and high-frequency speakers of the Bogen-Rich system, as they appeared in a recent demonstration model.

The diaphragm thus formed measures 4 x 5 inches. It carries 17 straight sections of the ribbon. Its response characteristic is linear within ±2 decibels from 1,000 to 25,000 cycles. The aperture angle at 15,000 cycles is 30° at 6 db down, the power is from 3 to 10 watts, the impedance 0.35 ohm.

Normally, an assembly of several Orthophase cells is used, placed side by side on a cylindrical surface to assure the best spatial distribution of the highs. One advantage to note—no baffle is needed.

A slightly different kind of flat speaker has been announced by Bogen & Rich, of Yonkers, N. Y. It also has a distributed flat voice coil. This one is made of aluminum wire cemented to a thin diaphragm of treated paper. Magnets, as seen in Fig. 2, are placed on each side of the diaphragm, with their like poles facing it. The result is a flat magnetic field over practically the whole face of the moving element. This speaker is designed to cover the range from about 1 to 6 kc. (The complete Bogen-Rich speaker system uses a unique type of cone speaker for the bass range. An 8-inch driver is coupled pneumatically to a larger piston or diaphragm of polystyrene foam.)

Another approach must be used for the region above 6 kc. At about

(*Continued on page* 66)

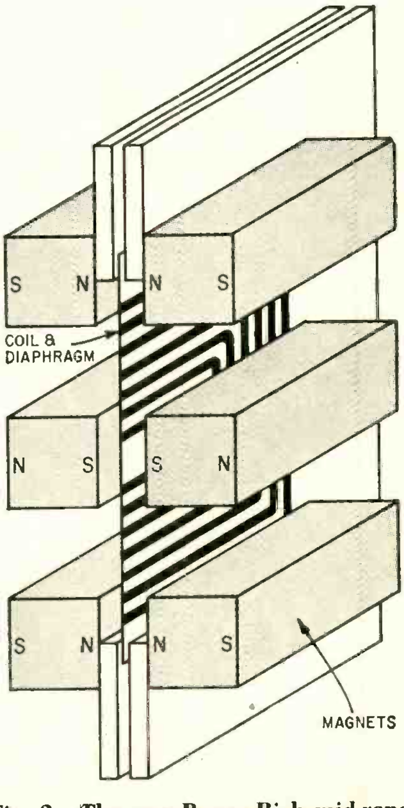


Fig. 2—The new Bogen-Rich mid-range speaker. Note that magnetic arrangement creates flat magnetic field.

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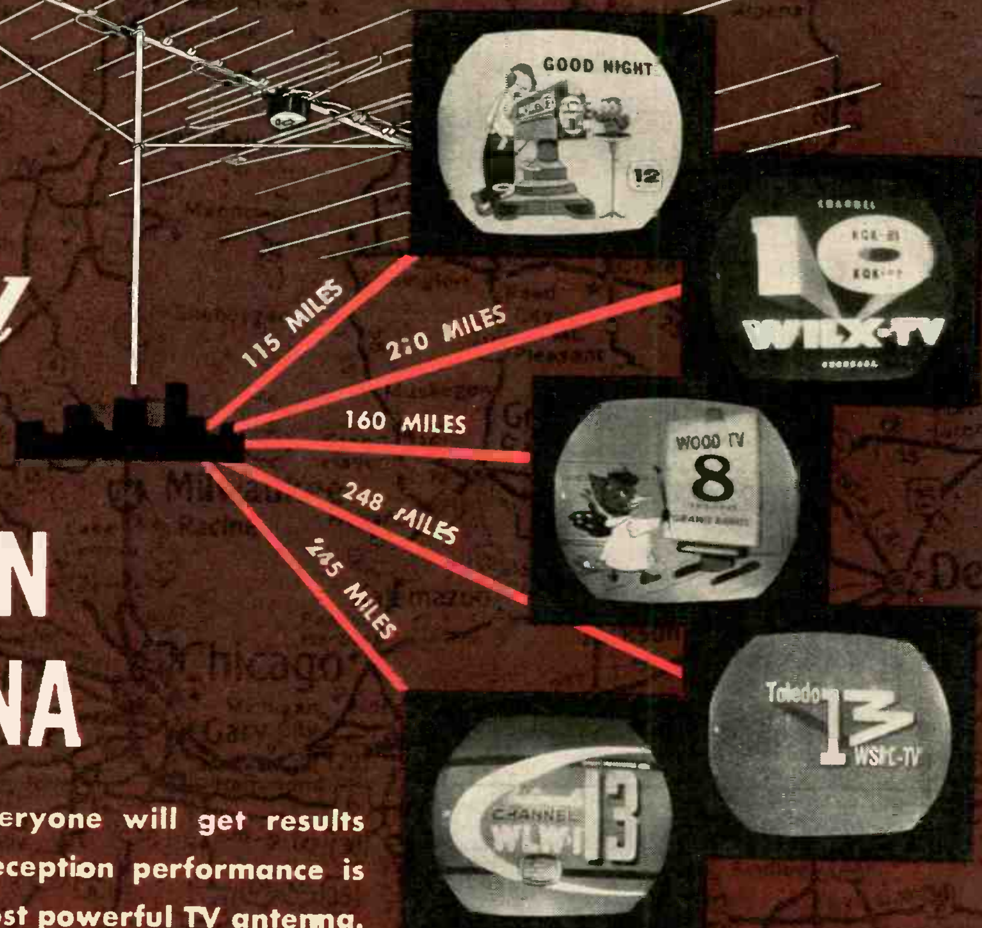

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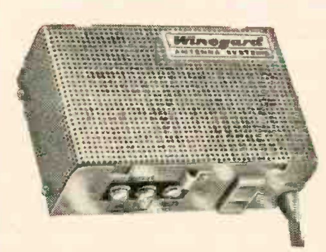
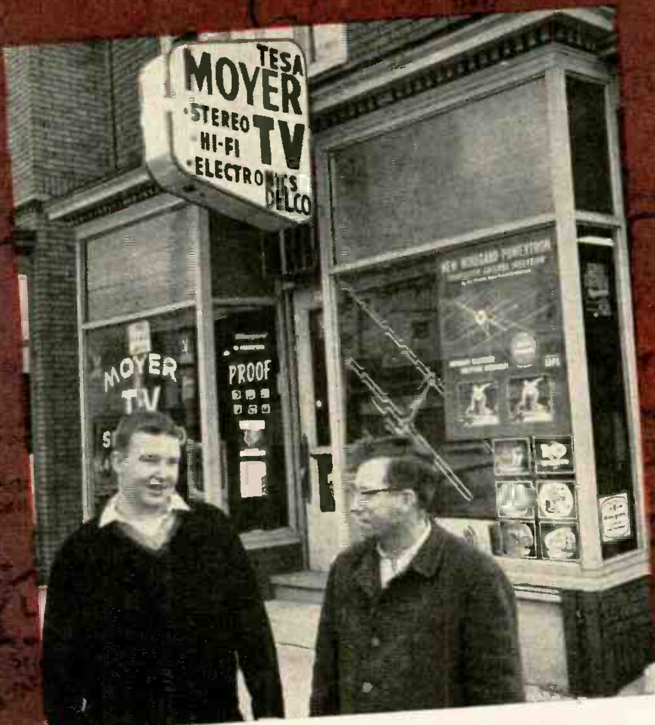


POWERTRON POWER SUPPLY IS ALL AC—SAFE, SHOCKPROOF. Transistorized Model has rectifier and filter in power supply—not in amplifier, where servicing is difficult. No nuisance batteries. Costs 27c to operate for a full year.

Read what Charles J. Milton of Moyer TV, Milwaukee, has to say about the Winegard Super Powertron...



Charles Milton and Jim Moyer
In front of Moyer TV

Of course, everyone can't get reception results like Charles Milton has experienced. Each area has its own unique reception characteristics and problems. But one thing we can promise, the Powertron will deliver more clean pictures on your TV screen than any antenna you can own.

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Burlington, Iowa

Gentlemen:

I would like to thank the Winegard Company for building the Super Powertron SP-44X.

With this antenna, reception at the local station level is perfect in both black and white and color. At medium range, the Powertron outperforms all others. Channel nine from Chicago, about 90 air miles, comes in clear and regularly. This is the Cubs baseball station and the one Milwaukeeans are willing to pay big money to get.

When the "Big Winegard", as it is affectionately called around the shop, is on long range it probes the unknown alone. All other antennas have fallen far behind. I have picked up eleven stations over 100 air miles away. The farthest of these is WWJ, Channel Four, Detroit, an unbelievable 251 miles. I have included a few pictures that I took off the TV with a Rolliflex F 3.5 at one second using Verichrome Pan.

We use the pictures in a window display and I use a set of pictures to explain the advantages of a Winegard to prospective customers. Believe me the pictures work -- and so does the "Big Winegard."

Sincerely,

Charles J. Milton

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If you have never tried a Winegard Electronic Powertron, give it a test and be agreeably surprised. Don't take our word for it—let your eyes and ears and field strength meter tell the story. For full details and spec sheets, ask your distributor or write.

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ANTENNA SYSTEMS
Winegard Co., 3013-1A Kirkwood St., Burlington, Iowa

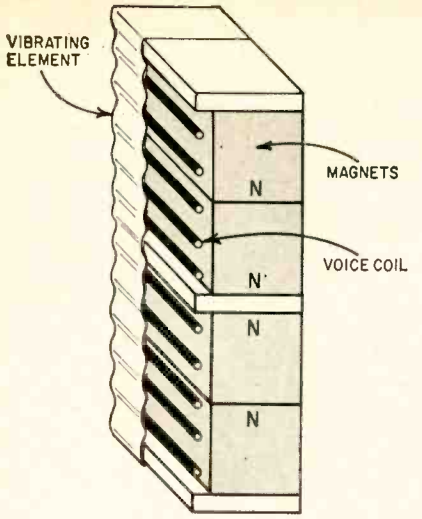


Fig. 3—The high-frequency speaker has a fixed voice coil and vibrating diaphragm.

(*Continued from page* 63)

that frequency, the resistance and reactance of the moving coil become equal, and above it the coil reactance increases rapidly, causing the unit's output to drop. A tweeter, with a flat voice coil on a solid *fixed* sheet, creates eddy currents in a thin sheet of corrugated aluminum (Fig. 3), causing it to vibrate. Output from the aluminum-sheet tweeter extends to beyond 20 kc. The aluminum-sheet tweeter is also self-damping. Its motion produces a counterelectromotive force that sets up braking eddy currents in the sheet, improving the transient response greatly.

Crossover between the treble and high-frequency speakers is automatic, since the corrugated sheet can be set into motion efficiently as the frequency rises above the 6-kc point. In some prototypes, the tweeter and treble speaker have been combined in one unit, the coil of the treble speaker supplying increasing power to the tweeter sheet as its own efficiency drops.

In this treble portion we have something that is not quite like any type of speaker now in existence. The Orthophase may be considered as a variant of the dynamic voice-coil type of speaker. This, however, uses the flat voice coil to excite eddy currents in a movable diaphragm, apparently the first use of the principle in the reproduction of sound.

Emerson, who has the American rights to the patents of the late Professor Gamzon, is working on a US version of another speaker being developed in France by C. S. F. and called the Isophase. Prototypes demonstrated in the Emerson Laboratory were about ⅜ inch thick—less than 2½ inches deep including baffling. A couple of small metal-sheathed speakers were also on display in the laboratory.

Emerson engineers point out that the principle can be as important in the microphone field as in that of speakers, and state considerable work is being done on flat-coil microphones. END

ANTENNA METER

FOR CITIZENS BAND

Build this 3-way instrument—it measures standing-wave ratio, power output and field strength

By **ALVIN MASON, 9W2203**

This simple but effective little metering device is extremely useful when handling antenna installations. It can be built and used by inexperienced citizens-banders. It indicates standing-wave ratio (SWR), power output and close-range field strength.

Most of the parts for the unit come from a radio field-strength meter, model TM-14, sold by Lafayette Radio. If you already have many of the parts, or prefer to purchase individual components, it is easy to do so.

The antenna meter (Fig. 1) contains two separate detection circuits, a switching circuit and a meter. Transformer T is home-made and is simply two straight 4-inch lengths of bare solid copper wire. They are arranged parallel to each other and 1/16 inch apart. Solder the wires directly between the two coax jacks. One end of the primary goes to the center terminal of J2 and the other end to the center terminal of J3. The secondary is made up by placing a piece of No. 14 bare, solid copper wire parallel to the primary conductor and spaced about 1/16 inch away. Support the No. 14 conductor at each end with insulated solder lugs fastened to the inside of the front of the case. One of these lugs also supports D2, R1 and C2. When constructing the transformer, make sure the primary and secondary do not short.

The unit is built into a 5¼ x 3 x 2⅛-inch case. All holes are drilled with standard-size bits with the exception of the meter mounting hole. It is cut with a chassis punch. If you don't have a punch of the proper size, use a chisel to make the hole and smooth the edges with a rat-tail file. The size of the hole depends on the meter you use.

Place a thin metal shield around the transformer (those two lengths of wire). It will prevent stray rf from throwing off actual meter readings. It also cuts down on insertion loss when the meter is connected in series with the transmission line. Make the shield out of a piece of thin aluminum or sheet metal cut to the exact length of the inside of the case. Bend it down its length and fasten it to the front and bottom of the case. It must be mounted firmly so it can't vibrate or shift, and must be at least ¼ inch from the transformer. D2, R1 and C2 are located inside the shield so that only the detected signal is fed outside the shielded area to the switch.

If you have a TM-14 meter on hand and wish to convert it into an antenna meter, start by removing all components from the case. They all have fairly long leads, making it easier to rewire them into the new circuit. Mark the polarity of the diode as it will be D1 in the new meter. The volume control is a 100,000-ohm unit with an spdt switch. The switch is not used, but the

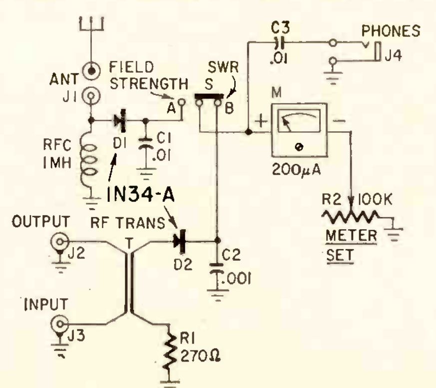


Fig. 1—Circuit of the simple little unit.

R1—270 ohms, ½ watt
R2—pot, 100,000 ohms
C1, C3—.01 µf, 600 volts, ceramic
C2—.001 µf, 600 volts, ceramic disc
D1, D2—1N34-A
J1—banana jack
J2, J3—coax connectors
J4—miniature phone jack
M—200 µa, dc
S—spdt slide switch
T—see text
RFC—1 mh
Case, 5¼ x 3 x 2⅛ inches
Sheet metal shield, see text
Miscellaneous hardware

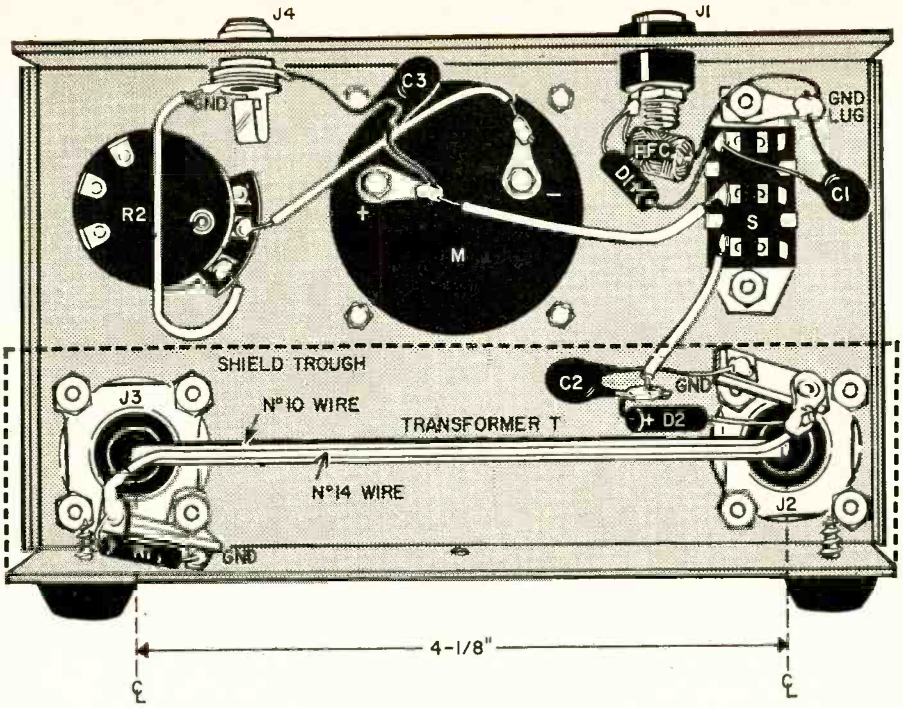


Fig. 2—Pictorial diagram shows you just where the parts go.

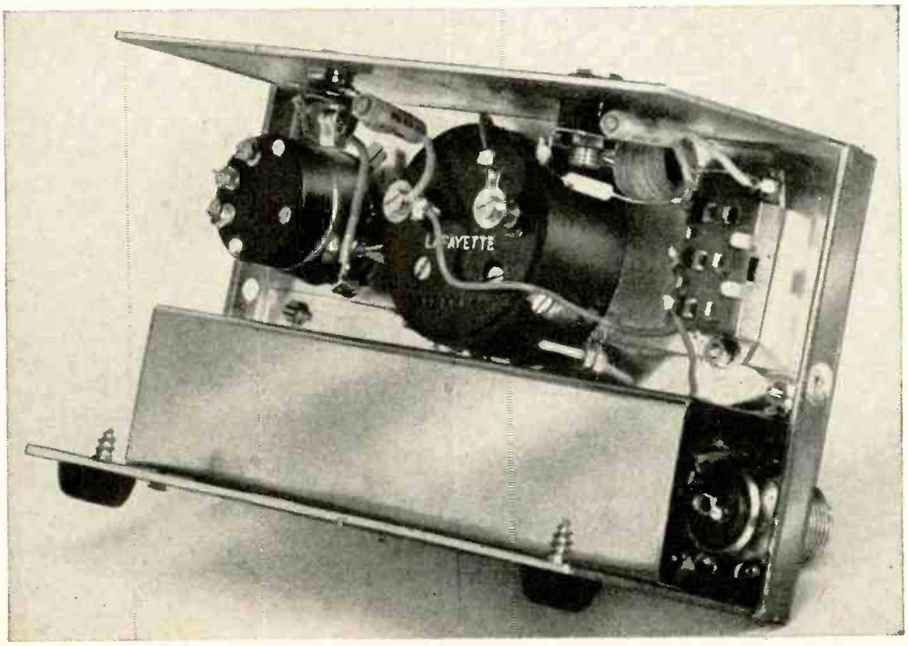
potentiometer becomes R2 in the new meter. J1, D1, RFC, C1, M, C3, R2, J4 and the telescopic antenna are all contained in the TM-14. The extra parts needed are T, J2, J3, D2, R1, C2 and S.

After the antenna multimeter is completed and checked out, connect a 1-foot length of RG-58-U coax cable with PL-259 connectors on each end to the transmitter and J3. Connect the antenna to J2. Rotate METER SET control R2 counterclockwise as far as it will go. Press the transmitter button and adjust R2 until the meter reads near center scale. Now transmitter adjustments can be made. The transmitter's final tank circuit is our first concern. The manufacturer's schematic will tell you whether this adjustment is a coil or a variable capacitor. Watch the meter carefully as you slowly tune up. Any increase in transmitter output will increase the meter reading. The amount of increase depends upon how well the transmitter is matched to the antenna. In any case, adjust for maximum meter reading.

After final power adjustments have been made, check the antenna to determine how well it performs with the power fed into it. Do this by reversing the antenna and transmitter leads. Connect the transmitter to J2 and the antenna to J3. Leave R2 set at the position used when making transmitter adjustments. Now press the transmitter button and note the new meter reading. It is a relative indication of the standing-wave ratio (SWR) in your antenna.

A good antenna will read a tenth or less of the original reading. A fair antenna will read around one-fourth while a poor one will read one-half and up.

Inside the chassis. Note the sheet-metal shield—it covers the two-wire transformer.



This can be calibrated more accurately by checking the unit on a known good antenna. Always remove the antenna multimeter from the transmission line after all tests have been completed.

When testing more than one transmitter (of different makes) on the same antenna, you may find that one unit has a much higher output than another. This does not mean that one transmitter is good and the other is bad. It simply indicates that some units are more efficient than others and that many transceivers are not made to operate at a full 5 watts input power. Many transmitters with 5 watts input power will have about 2 to 2½ watts output while others with the same input will put out 3 or more watts.

How it works

As a field-strength indicator, signals are picked up by the telescopic antenna and rectified by a detector circuit consisting of RFC, D1 and C1. From here they are fed via S to the meter and controlled by R2. The signal applied to the meter also feeds through C3 to J4. A high-impedance crystal earphone connected here is ideal for monitoring.

To read power output, the signal from the transmitter is fed into J3 and out into the antenna through J2. The current passing through the transformer primary induces a small current in the secondary. It is detected by D2.

The detected signal is also fed through switch S to the meter. Sensitivity is determined by the setting of R2. For SWR indication, reverse the input and output connections (jacks J2 and J3).

The standing-wave ratio meter circuit in the antenna multimeter uses the basic directional coupler for its operation. The circuit between J2 and J3 represents the primary of a transformer. The line closely coupled to the primary represents the secondary. The primary and secondary are coupled *electrostatically* and *magnetically*.

Current flowing in one direction in the primary produces currents in the secondary that are the result of electrostatic and electromagnetic coupling. Current flow due to magnetic coupling is dependent on the direction of current in the primary. Current flow in the secondary due to electrostatic coupling is in the form of a charge that travels in both directions from the point of coupling.

Thus, secondary current due to electrostatic coupling adds to the current developed through inductive coupling when measured at one end of the secondary and opposes it when measured at the other end.

This is a simplified form of the Monimatch SWR and power indicator. (*QST*, October, 1956).

Voltages induced in the secondary are rectified and measured on the meter. The setup is designed so the meter reads only when the rf signal is fed into the INPUT end of the coupler. Rf (reflected or otherwise) coming from the output end will not cause a reading on the meter. END

INDUSTRIAL ELECTRONIC DICTIONARY

From photoelectric pyrometer to proportional control

By ED BUKSTEIN

Photoelectric pyrometer: A temperature measuring instrument. The pyrometer is used industrially for measuring the temperature of heated or molten metal in a furnace. The heated metal emits infrared radiation in proportion to its temperature. The higher the temperature, the more infrared emission. If the metal is heated enough, it will emit visible red as well as infrared. At this point it has become red hot. At still higher temperatures the metal will emit radiation throughout the visible spectrum and is now white hot.

The circuit diagram of a photoelectric pyrometer is shown in Fig. 21. The phototube is positioned outside an opening in the furnace so it is illuminated by the infrared (and visible) radiation

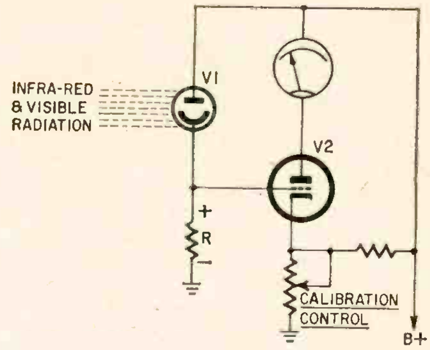


Fig. 21—Photoelectric pyrometer measures temperature of heated metal by monitoring infrared radiation.

from the heated metal. The resulting phototube current produces a voltage drop across resistor R which, in turn, increases V2's plate current. The plate milliammeter is calibrated to read directly in degrees of temperature. A relay may be connected in V2's plate circuit to turn off the furnace when the temperature has reached the required value. This modification permits control as well as measurement of temperature.

Photoelectric register control: Photoelectric device used to control the position of a strip of paper, cloth, metal, etc. with respect to the machine through which the strip is passing. One form of register control, for example, is used to wind the strip of material onto a reel. The phototube and its light source are so positioned that the edge of the strip overlaps and blocks half of the light beam. Any sideward motion of the strip either increases or decreases the illumination of the phototube. The phototube output is amplified and controls a motor that adjusts the lateral position of the reel. Sideward motion of the strip of material is matched by an equivalent sideward motion of the reel, and the strip winds evenly with each layer positioned exactly over the layer beneath it.

Photomultiplier tube: A type of phototube characterized by extreme sensitivity. A small amount of light reaching the cathode can produce a considerable amount of plate current. As shown in Fig. 22, the photomultiplier contains a number of intermediate electrodes (dynodes) between cathode and plate. Each dynode is operated at a higher positive potential than the preceding one, typically about 100 volts higher. As a result, electrons emitted from the cathode are attracted in succession from one dynode to the next. Furthermore, each dynode emits several secondary electrons for each primary electron it receives. Each electron from the cathode releases several secondary electrons from the first dynode. Each of these electrons releases several secondary electrons from the second dynode, etc. Thousands or even millions of electrons eventually reach the plate for each electron emitted from the cathode. This current gain accounts for the high sensitivity of the tube. For simplicity, only three dynodes are shown in Fig. 22, but 10 to 14 are often used in practice. Current gain typically is in the range of 200,000 to 2,000,000.

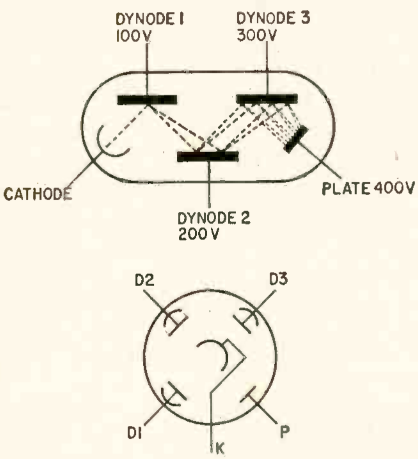


Fig. 22—The photomultiplier tube uses secondary emission to deliver high current gain.

Photo-relay circuit: On–off type of control actuated by either an increase or a decrease of illumination. In the forward-acting photo-relay shown in Fig. 21, an increase of illumination causes the relay to energize. As illumination increases, the phototube draws

(*Continued on page* 74)

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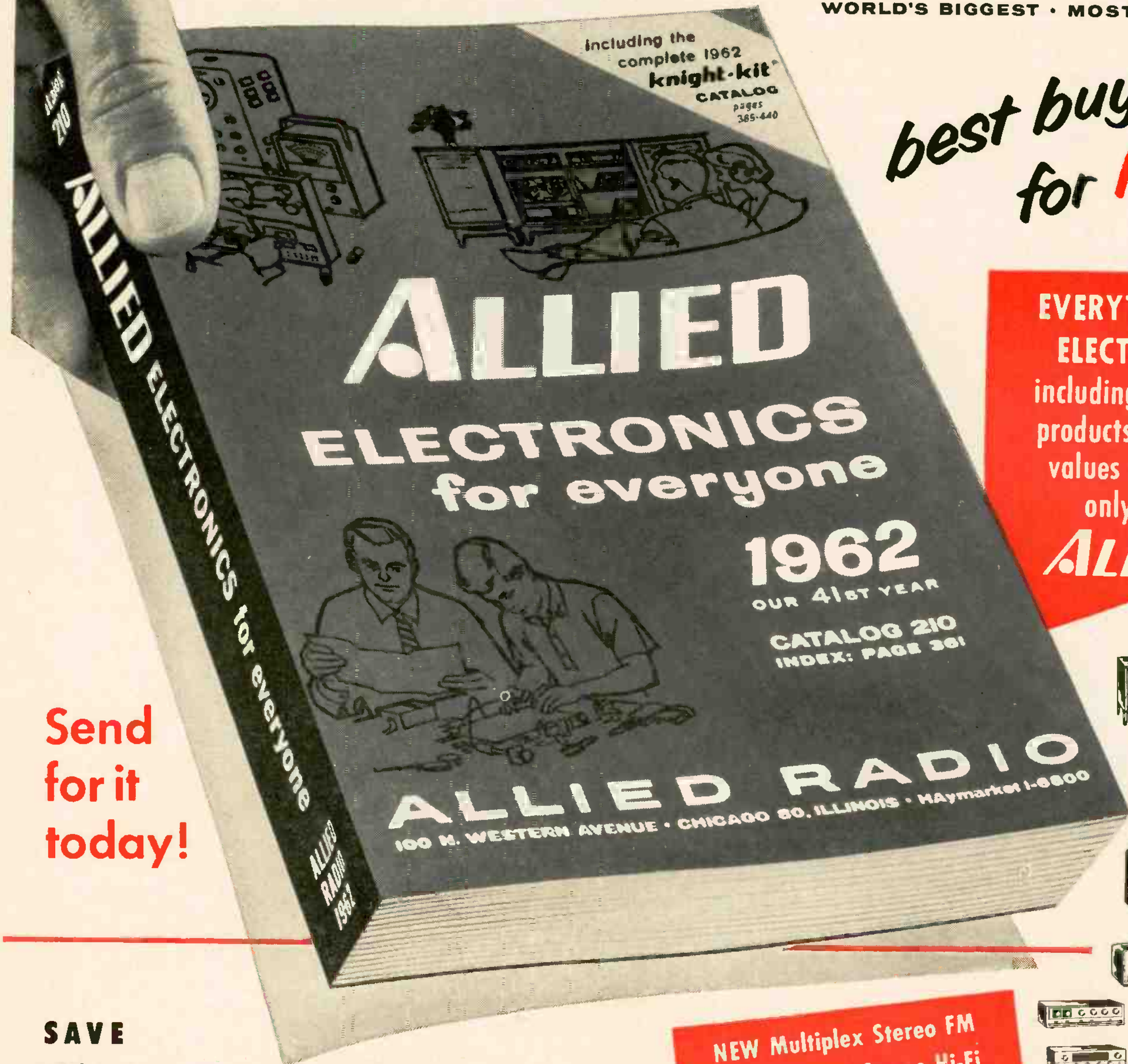

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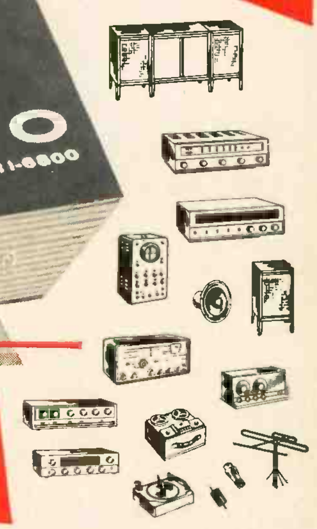

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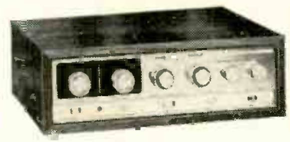

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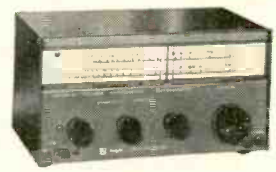

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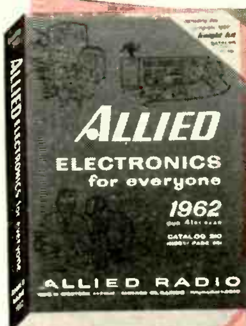

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(*Continued from page* 69)

more current and the voltage drop across resistor R increases. As a result of the greater positive potential at the grid, the triode now draws more plate current and energizes the relay. The circuit can be converted to reverse-acting operation (relay energizes when illumination decreases) by interchanging the positions of the phototube and resistor R. In this circuit, a decrease of illumination increases the voltage across the phototube. The greater positive potential at the grid causes the relay to energize. Photo-relay circuits are used as burglar and fire alarms, for turning on lights at sundown or during overcast weather, for shutting off the fuel supply to a furnace when the pilot burner accidentally goes out, for counting objects moving by on a conveyor belt, etc.

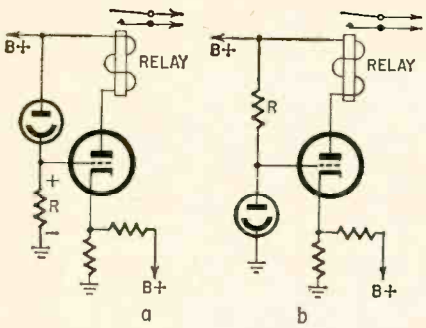

Fig. 23—The forward-acting photo-relay (a) energizes when illumination increases. Reverse-acting circuit (b) energizes when illumination decreases.

Phototube: Light-sensitive tube consisting of a chemically coated cathode which emits electrons when illuminated, and an anode usually in the form of a straight piece of wire. The spectral response (color sensitivity) of the phototube is determined by the chemical composition of the cathode coating, and tubes are commercially available for infrared and ultraviolet as well as for the visible spectrum.

Photovoltaic cell: A type of photocell that generates voltage in proportion to the amount of illumination it receives. This type of cell is used in photographic exposure meters where the photocell output is read on a meter.

Pin-hole detector: Photo-relay circuit used for detecting pin holes in sheet metal. The metal to be inspected is passed between a light source and a bank of phototubes. The presence of a pin hole allows illumination to reach the phototube, and the resulting relay action energizes a marking device to mark the location of the defect.

Pliotron: An amplifier tube (i.e., triode, tetrode or pentode).

Proportional control: A type of automatic control in which the correction is proportional to the error. The system corrects rapidly when the error is great and corrects more slowly as the error approaches zero. This form of control helps to minimize both overshoot and hunting.

TO BE CONTINUED

TEST EQUIPMENT REPORT

Lafayette KT-174 vtvm kit

By WAYNE LEMONS

THIS KIT HAS SEVERAL INTERESTING features not usually found on lower priced units. It reads both peak-to-peak and rms ac, and also has three low ac scales for making tests on circuits with very little applied signal. Testing microphones, phono cartridges, etc. becomes simple. Scope monitor terminals on the rear of the instrument let you observe the waveform while you make ac measurements. Decibels are read directly. A feature we liked was that all calibration controls can be reached without removing the cabinet.

The probe has a 1-megohm isolation resistor in its tip to minimize circuit loading when making dc measurements. A switch on the probe shorts out this resistor when measuring ac or ohms. The ac measurements are said to be accurate to approximately 4 mc with this probe. For measuring frequencies up to 250 mc, an accessory diode-detector probe is available.

The circuit

The stable time-proven 12AU7 bridge circuit is the heart of the instrument (Fig. 1). Power supply voltage changes, within limits, have little effect on the operation or accuracy of the circuit. Since the 12AU7 plates oppose each other, any change in plate voltage is balanced out. To add a further degree of regulation, however, a neon lamp is connected across the power supply. It also acts as a pilot light.

Voltages to be measured are applied (with positive polarity) to the grid, pin 2. This causes increased current flow through the 6,800-ohm common-cathode resistor which, in turn, biases the second section of the 12AU7 so that less current flows in this half. This "push-pull" action deflects the meter tied between the two plates. The two 47,000-ohm resistors provide degenerative feedback so that the circuit is virtually linear. The FUNCTION switch inserts the proper calibration controls in series with the meter. For reading negative voltages, meter terminals are reversed.

Ac voltages can't be applied to the bridge direct. They are first rectified by the two diodes in the 6BN8. When the ac goes positive, C2 (see complete schematic) is charged to the peak value through V1-b. When the ac goes negative, this diode is reverse-biased and prevents the charge from leaking off. The negative excursion passes through C2, and V1-c conducts, charging C5. Since C2 and C5 are effectively in series, the dc output represents the peak-to-peak ac.

The triode section of the 6BN8 amplifies low ac voltages before they are rectified.

All vacuum-tube diodes develop contact potential, even with no voltage applied. It usually does no harm in low-impedance detector circuits, but in a vtvm it is a problem, especially on low ac ranges. To counteract contact potential, a small amount of positive voltage is fed back through a high-resistance network to the diode plate by the AC BALANCE control.

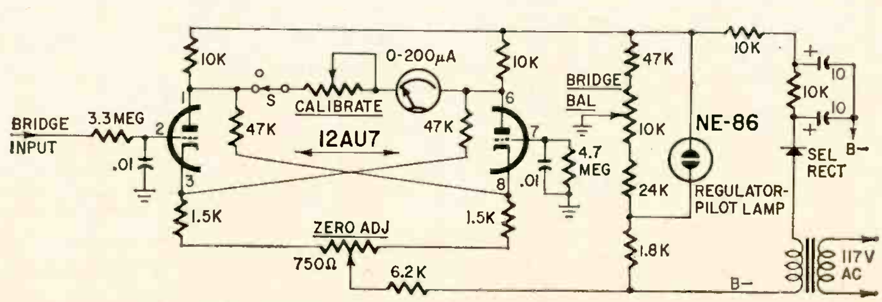

Fig. 1—Bridge circuit used in the KT-174

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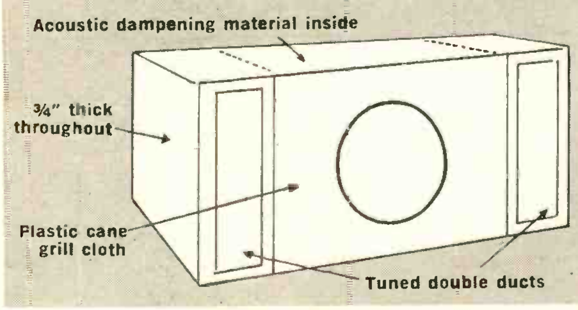

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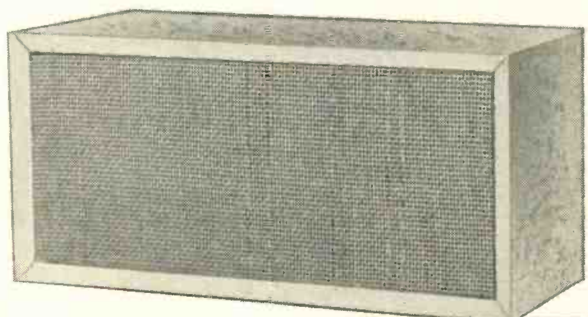

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AC ranges: LOW AC—RMS 0–50, 150, 500 mv. PEAK-TO-PEAK—0–140, 420, 1,400 mv. Accuracy ±5% of full scale. Input impedance: 1 megohm at 1 kc. Frequency response: ±1 db from 20 cycles to 300 kc from 600-ohm source. REGULAR AC—RMS—0–1.5, 5, 15, 50, 150, 500, 1,500 volts. PEAK-to PEAK: 0–4.2, 14, 42, 140, 420, 1,400, 4,200 volts. Accuracy ±5% of full scale.
Decibels: −10 to +5. Frequency response: ±1 db from 20 cycles to 4 mc from 600-ohm source.
Ohmmeter: 7 ranges: 0–1,000 ×1, ×10, ×100, ×1,000, ×10K, ×100K, ×1MEG.
Meter: 200 μa for full-scale deflection.
Tubes: 12AU7 twin-triode dc amplifier and balanced bridge 6BN8 ac full-wave peak rectifier and low ac amplifier.
Power Supply: Half-wave selenium rectifier, power transformer, fused, for operation on 105–125 volts ac, 60 cycles.
Cabinet: Metal with recessed front and "turn over" handle-stand.
Probe: Combination—dc with isolation and ac-ohms. Switch on probe. Separate ground lead.

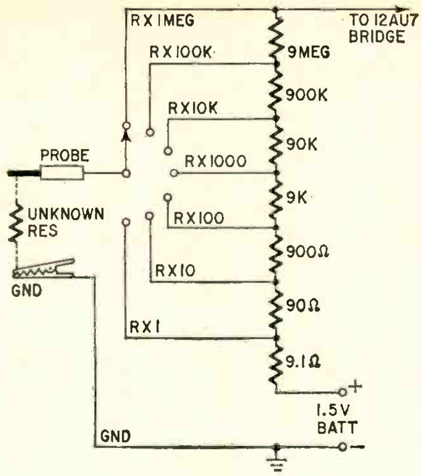
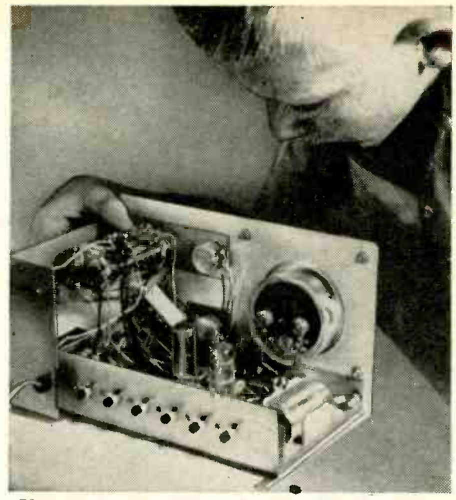


Fig. 2—Simplified ohms circuit.



Visual inspection of completed wiring before trying the completed unit.

Ohms measurements

The KT-174 uses a 1.5-volt D-cell to supply voltage for resistance measurements. The cell is connected in series with one or more resistors and the probe (Fig. 2). Regardless of where the range switch is set, if there is no resistance across the probe, no current will flow from the battery and the full voltage is applied to the 12AU7 bridge, causing the meter to read maximum. Any resistance being measured, however, divides the voltage applied to the bridge in proportion to the divider resistors and the resistance measured. Less voltage is applied to the bridge and the meter-reading is correspondingly smaller. This is the reason for the "backward" scale found on most vtvm's. The lower the resistance measured, the lower the meter reading.

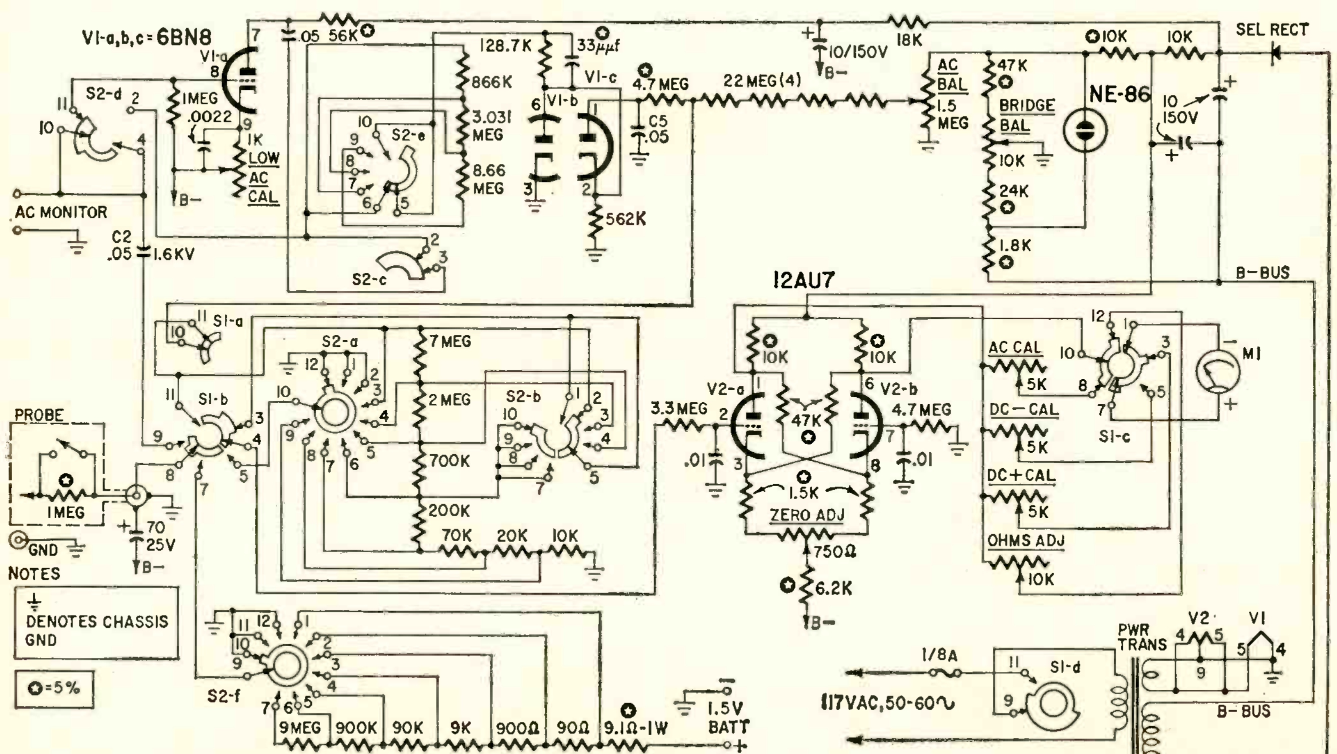
Using the instrument

It, of course, would be impossible to cover all of even a part of the many uses of the vtvm. But we might mention how we found this vtvm useful in actual service work. The low ac ranges are ideal for comparing the output of low-output devices. This includes phono cartridges, microphones and signal generators. Voltages as low as .01 volt can be read accurately and with ease. We used it to make gain checks of a preamplifier by inserting a tone at the input and reading the actual voltage gain from grid to plate. Since the frequency range is broad, you can use these ranges for measuring gain in if amplifiers and transistor radios or to tell if the oscillator is working (though of course not whether it is on the right frequency).

The 1.5-volt dc scale is our favorite for checking transistor bias for it's no trouble to read as little as .05 volt.

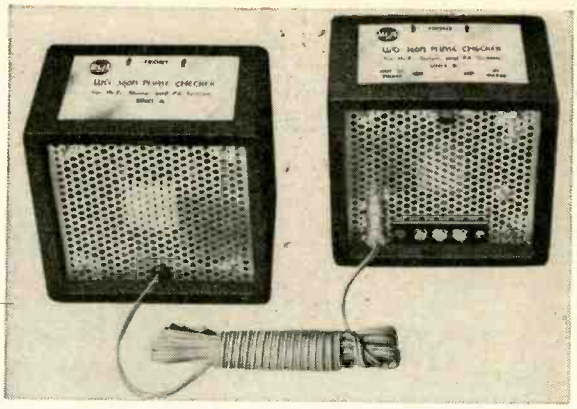
Building the kit

The kit is easy to assemble. The heavy printed board with imprinted designations almost wires itself. Our 13-year old son, who had never before assembled a kit of any sort, built this one, without a mistake, in just over 8 hours. After allowing 48 hours for tube aging, the unit was calibrated. Since then the calibration controls have not been touched. END



Complete circuit of the KT-174.

PHASE CHECKER SPEEDS HI-FI INSTALLATION



By CHESTER S. LAWRENCE

HOW MUCH TIME DID YOU SPEND PHASING the speakers on that last high-fidelity installation? Ten minutes, twenty, half an hour? And was it right when you got it "checked"? Well, you don't have to go through that again, RCA tells us. You can set them up in 5 minutes and be sure you're right the first time if you use a phase checker.

This test instrument (WG-360A) consists of two little boxes and a length of coax cable. One box (unit A) contains a 4-inch 50-ohm speaker and a phono plug for the inter-connecting cable. The other (unit B) is a bit more complex. It houses a similar speaker and phono jack. In addition, there is a dpdt slide switch, audio transformer, crystal diode and three-lug terminal strip for connecting a vom, vtvm or scope.

The unit works very simply. But let's take a closer look and make sure we understand what it does. We'll assume that we have plugged in the interconnecting cable and placed both units, side by side, in front of the same speaker of the hi-fi system. What we have done is to connect the voice coil of each unit and the primary of the audio transformer in unit B in series. (The circuit is shown in Fig. 1.) Flipping the slide switch from one position to the other reverses the polarity of one voice coil in relation to each other.

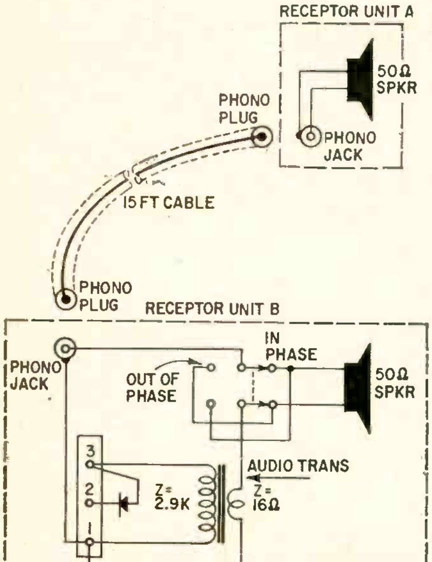


Fig. 1—Circuit of phase checker. Two units are connected with coax cable.

Now we connect the vtvm, vom or scope to the proper terminals on the rear of unit B (Fig. 2).

The audio waves from the speaker cause a similar motion in the phase-checker receptor units. When both are being driven from the same source, as is being done here, their voice coils move in phase with each other.

This movement produces a small ac output voltage across the voice coil. Naturally, this voltage varies according to the material being fed to the speaker. Assume that at some particular instant the voltage across the receptor unit voice coils is 0.1 volt.

Now we glance over at the meter we have connected to the terminal strip on unit B. If the switch on this unit is set to its in-phase position, the two voice coils are connected into a series-adding circuit, and the voltages appearing across the two voice coils are added, giving a total of 0.2 volt at the transformer primary. To insure an accurate reading, put your vom on its 0.25- or 1-volt range and turn up the gain control of the amplifier until you get a mid-scale reading on the meter.

If we now set the switch to its out-of-phase setting, the voice coils are out of phase and cancel each other. In practice, variations between the speakers cause the voltages produced in each voice coil to differ. Therefore, there isn't complete cancellation. However, the drop will be easily noticeable. On actual program material the meter reading will fluctuate but, even so, you will have no trouble judging the larger signal.

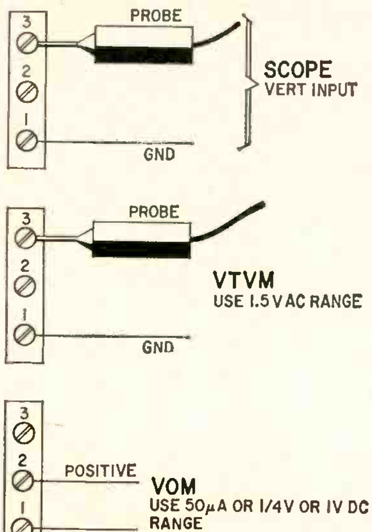


Fig. 2—How to connect meter probes when working with the unit.

Well, we're finished with the theory. Now let's see how the phase checker works on an actual installation. We place one receptor unit in front of the bass speaker for the right channel and the other receptor unit in front of the bass speaker for the left channel.

Next we hook our vom or other indicator to the proper terminals on the back of unit B, connect a monaural program source to the preamp input and set the balance control for equal output from the right- and left-channel speaker systems.

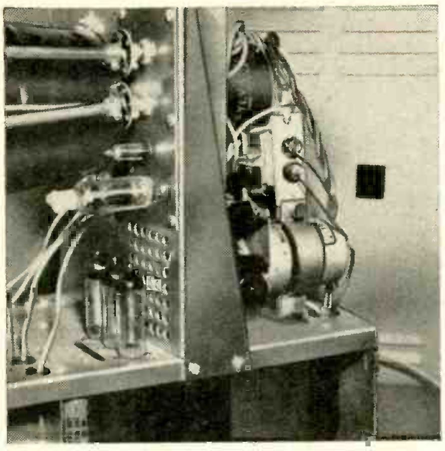
If the speaker systems are in phase, you will read the highest voltage when the switch is in the in-phase position. If you find you are getting the highest reading when the switch is in the out-of-phase position, the leads connecting to one system must be reversed.

An audio generator makes using this unit a joy, especially on installations where the speakers may not be absolutely identical. Set a signal generator for approximately 120 cycles and connect it to the amplifier input. Insert a shorted plug into the jack on unit B. Place the unit in front of one of the speakers and adjust the amplifier volume to a voltage reading of, say, 0.2 volt. Then place the unit in front of the other speaker and adjust the volume for an equal reading. You may have to go back and forth several times, adjusting both volume and balance controls before you get this straight. Once the volume is equal, check for proper phasing as before.

To check the phase of a woofer against a mid-range unit, hook up the audio generator again. This time set it to provide a sine-wave signal near the supposed crossover frequency. Using unit B as above, adjust the output frequency until each speaker is producing the same voltage. Then check for phasing as before. The phase checker works on frequencies below 4,000 cycles only. Don't try it to phase a tweeter or a super-tweeter.

The procedure sounds more complex than it really is. Once you try it you will find it takes less time to complete the procedure than to read this article. END

For a Cooler Scope



We won't say that when the Heath Co. built the OP-1 they built something as good as an $800 or $1,000 Tektronix scope. But they have come within shooting range. At Oregon Tech we do have seven or eight Tektronix scopes, but hardly enough for every student. We find the OP-1 often serves just as well.

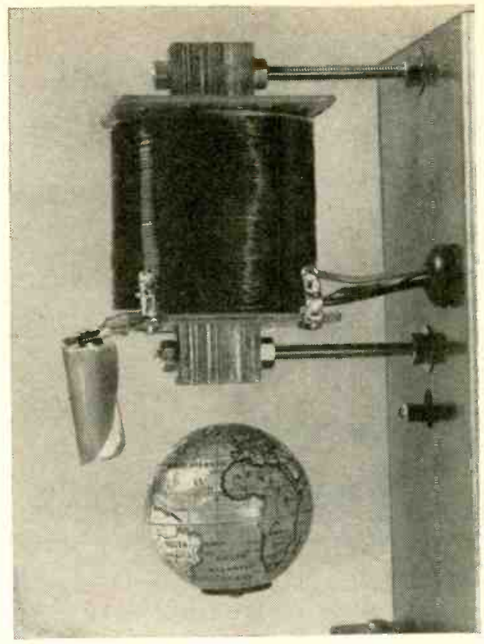
The casual user probably does not use a scope more than an hour at a time. In our case, a scope may easily be run for half a day. Under these conditions the OP-1 gets pretty hot.

Having some surplus blowers on hand, we decided to incorporate a cooling system in our OP-1's. The photo shows the details of the installation. There is enough room on the rear of the chassis to mount the blower. Adding a neatly cut hole in the cabinet housing opposite the fan exhaust and drilling a number of holes in the upright rear panel allows hot air to be pulled out from the front of the scope. The scopes run cool all day.
—*R. E. Baird and J. A. Brady*

Bacteria Batteries Improving

A new "bio battery" using bacteria to help generate electricity is reaching the stage where the Navy is planning to run ocean tests on it, according to recent reports. Batteries of this type have been constructed (See "Bugs in New Batteries," RADIO-ELECTRONICS, August 1961, page 6), but so far only insignificant amounts of power have been generated. The new battery, being developed by Magna Products, a subsidiary of Thompson-Ramo-Wooldridge, can generate enough power to operate radio beacons, signal lights and similar equipment.

With the help of bacteria or enzymes, it might become possible to produce electricity from a wide variety of fuels or oxidants, such as vegetation or raw sewage. Batteries for ocean use would find a plentiful supply of fuel in the ocean water itself, which could also serve as the electrolyte for the battery.



World remains suspended in space, with North magnetic pole upward.

PHOTOMAGNETIC TOY
IS TRUE SERVOMECHANISM

By H. SCHREIBER

IT IS DIFFICULT TO EXPLAIN TO A LAYman in a few words just what a servomechanism is. But if, instead of depending on words, we demonstrate with a functioning piece of apparatus, we get the idea across quicker. If we want the education thus acquired to remain indelibly in the spectator's memory, the best thing to do is to choose a really spectacular application for an example. (We also arouse in the layman a certain respectful admiration for the possibilities of electronics.)

The apparatus we put together to carry out these general ideas is based on a very simple principle (Fig. 1). We decided to suspend—without any visible means of support—a little sphere of sheet metal (in this case, a tiny terrestrial globe that formed part of a pencil sharpener of the type found in 5-and-10-cent stores). This was done very simply by using an electromagnet

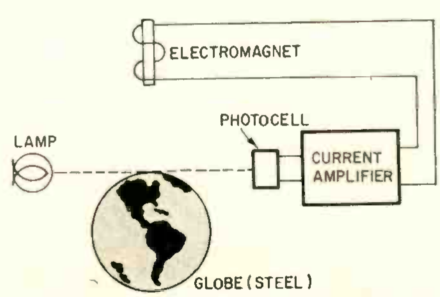


Fig. 1—As globe is attracted by electromagnet, it begins to block light beam, reducing magnetizing current.

in which the exciting current was proportional to the light falling on a photocell. This cell is so aligned with a small light bulb that the globe cuts the light beam as it is drawn toward the magnet. The light on the photocell —and at the same instant the current through the magnet—diminishes as the globe approaches the iron core that attracts it. The force of attraction drops to the point where the globe finds a position of equilibrium, where it will remain indefinitely, even though spectators attempt to jar or blow it out of place. It is even possible to spin the globe. Since friction of the air and eddy currents are the only braking effects, it rotates for a long time.

As can be seen in the photo, the North pole of the globe points upward. This is done by taking out the pencil sharpener (which was at the South pole) and replacing it with two discs of bakelite kept in place with a screw. By adjusting the position of the screw carefully, it is possible to keep the North magnetic pole (situated in northern Canada) pointing upward, a detail that never fails to surprise the curious.

How it's done

The diagram of our little demonstration apparatus is shown in Fig. 2. It is equipped entirely with semiconductors, but of course could be made with vacuum tubes or even other amplifying elements.

The power supply consists of two silicon diodes. A 1,000-μf capacitor acts

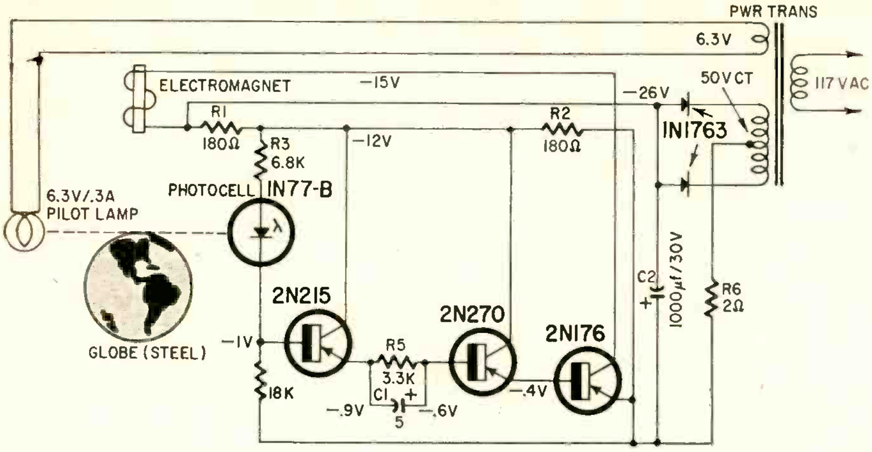
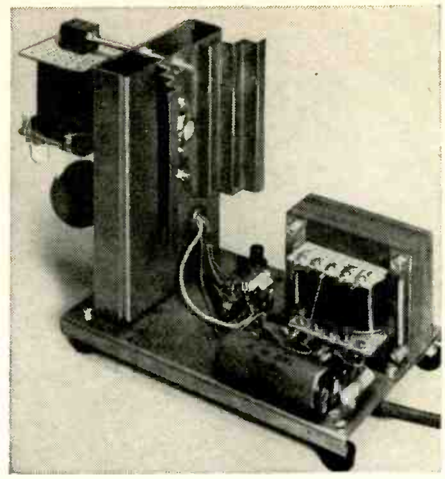


Fig. 2—Schematic. The photodiode is followed by a dc amplifier that controls the magnet. Original semiconductors were French. Diagram shows closest U.S. types.



Rear view shows the servomechanism details.

as a filter. Resistor R6 protects the diodes in case of sudden surges. R1 and R2 are a voltage divider to drop the voltage for the photodiode and the two first amplifier transistors. Part of the dark current of the photodiode flows through R4; its value is chosen to bias the base of V1 till the current in the electromagnet winding is about 50 ma when no light shines on the photodiode. To obtain a lower resting current, simply reduce the value of R4. This, of course, will reduce the amplifier gain and make a stronger light necessary.

The electromagnet winding is in the collector circuit of power transistor V3, which is preceded by two stages of amplification working in a common-collector circuit. The only peculiarity of this preamplifier is the circuit made up of R5 and C1. It is intended to compensate for the thermic time constant of the transistors.

Fig. 3 illustrates the effect of this not-too-well-known characteristic of the transistor. When a voltage (V_b) is applied to the base, the collector current (I_c) rises at first very rapidly to point A. The rise time depends only on the internal capacitances of the transistor and the reactance of the load. It is so short that it is not significant in comparison with the inertia of our little tin globe. This is not the phenomenon we observe during the following 20 or 25 milliseconds; the increase in collector current is due then to heating of the junction by the power dissipated. At point B, the heat of the junction has become stabilized; the further very slight increase is explained by warming of the case (or radiator) of the transistor. The thermic time constant of the junction is—for practically all transistors—in the order of 8 milliseconds.

To compensate for this, it is necessary only to insert an R-C circuit of the same time constant. That of the correction used here is actually 16 milliseconds, for it must compensate for the effect of the two transistors. If this compensation is not used and the emitter of the first transistor is connected directly to the base of the second, the system becomes unstable. After being put in place, the globe starts to oscillate with increasing amplitude and immediately leaves the magnet's field of attraction.

The core of the magnet has a cross-section of ½ by 13/16 inch (14 x 20 mm). Its length is 3⅜ inch (85 mm). The winding is No. 26 AWG close-wound approximately ½ inch deep. (The dc resistance of the winding is about 35 ohms.)

The voltages measured at various points on the equipment, with the globe in place, are marked on the diagram (Fig. 2). The graph of Fig. 4 shows the current in the electromagnet in terms of the attractive force, the distance between the globe and magnet core being 1 cm. Under the conditions shown, the equilibrium becomes precarious at about 26 grams (1 ounce roughly). The slightest current of air will release it from the attractive force of the magnet. Presumably the equipment could be made to work with greater weights by reducing the distance or increasing the power of the amplifier.

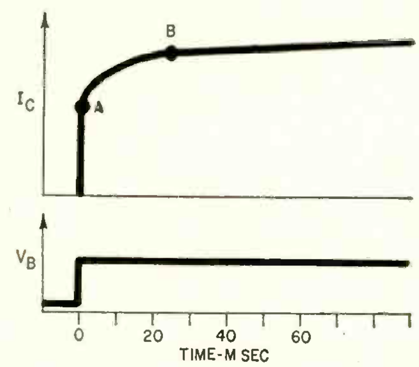


Fig. 3—To compensate for the junction's thermic time constant, series resistance R5 brings point B to the level where point A would have been without correction.

Applications

This apparatus was constructed with no other aim than to make a demonstration piece. That, of course, does not mean that there may not be practical applications of the principle on which it is based. A somewhat similar setup has been used as a frictionless bearing in an electric watt-hour meter. And maybe sometime you will want to paint a small metallic object on all its faces in such a fashion that no one can tell which of the faces it was placed on to dry! END

The apparatus described was developed at the Superior Institute of Electronics, Paris.

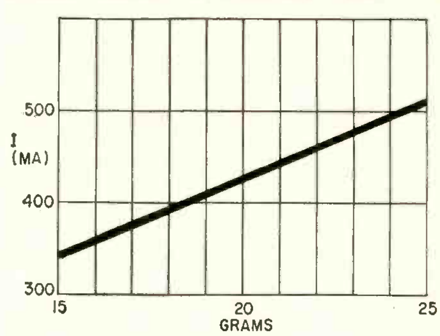


Fig. 4—Current in the electromagnet vs weight attracted, at a distance of 1 cm.

Wake Up

A new day is dawning in electronics. Transistors are here to stay... they are now being used everywhere; in radio, television, Hi-Fi, intercoms, and in nearly all new electronic equipment...

Why put off transistor circuit servicing any longer... there's gold in them thar hills. But you must be equipped to do the job fast and efficiently. Here are the tools that you will need.

NEW SENCORE TRANSI-MASTER

This Tester will analyze the entire circuit in minutes and test transistors in-circuit or out of circuit. Here is how you can pin point troubles step by step.

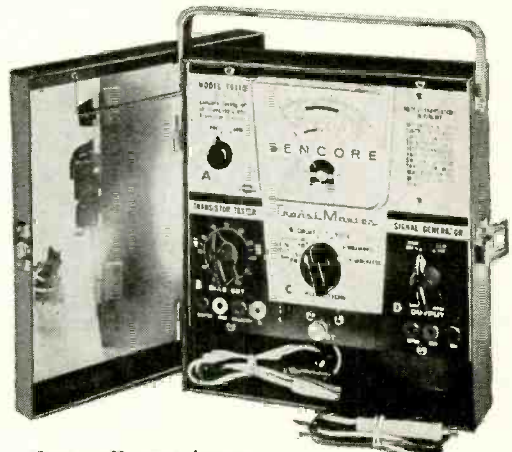
First, check the batteries with the 0 to 12 voltmeter. If the batteries are O.K., check the current drain with the 0 to 50 milliamp meter. A special probe is provided so that you do not need to break the circuit. Excessive current indicates a short; low current indicates an open stage or cracked board. All PF schematics indicate average current.

If trouble is not located by now, isolate the trouble to a specific stage by touching the output of the harmonic generator to the base of each transistor and note spot where sound from speaker (or scope where no speaker is used) stops or becomes weak. The generator becomes a sine wave generator for audio stages to help find distortion.

If trouble points to a transistor, check it in a jiffy with the exclusive in-circuit power oscillator check provided by the TR110. A special probe is also provided for this.

If the transistor checks bad in-circuit, remove it and give it an out of circuit check with the oscillator check or the more accurate DC check.

The DC check is provided for comparison reasons, experimental or engineering work and to match transistors in audio output stages. Beta (current gain) is read direct or on a good-bad scale for service work. **DEALER NET. ONLY $49.50**



Tests all transistors in-circuit or out-of-circuit

Model TR110

***It's a* COMPLETE TRANSISTOR TESTER**

- SIGNAL TRACER • VOLTMETER
- BATTERY TESTER • MILLIAMMETER

NEW SENCORE TRANSISTOR AND DIODE CHECKER

Here is a low cost tester that has become America's favorite. The TR115 provides the same DC out of circuit checks as the TR110; leakage and current gain. Beta (circuit gain) can also be read direct or as good or bad. Opens or shorts in the transistor are spotted in a minute. The TR115 checks them all from power transistors to the small hearing aid type. Japanese equivalents are listed also. This famous tester is used by such companies as Sears Roebuck, Bell Telephone and Commonwealth Edison. New circuits enable you to make service checks without set-up charts even though charts are provided for critical checks.

Model TR115
Dealer Net
$19.95

SENCORE BATTERY ELIMINATOR AND TROUBLE SHOOTER

For replacing batteries during repair.

Many servicemen say that they wouldn't service transistor circuits without this power supply. The tried and proven PS103 is a sure fire answer. It can be used to charge the nickel cadmium batteries as well. Dial the desired output from 0 to 24 volts DC and read on meter. Low ripple insures no hum or feedback. Total current drawn can also be read on the PS103 by merely flicking the function switch to milliamps. The PS103 is the only supply that will operate radios with tapped battery supplies such as Philco, Sylvania and Motorola. No other supply has a third lead.

Model PS103
Dealer Net
$19.95

Now in stock at your Authorized Sencore Distributor

ALL PARTS SENCORE MADE IN AMERICA

SENCORE
ADDISON, ILLINOIS

SHORT-WAVE FORECAST

Dec. 15–Jan. 15

By STANLEY LEINWOLL†

TYPICAL WINTER RADIO PROPAGATION CONDITIONS WILL CONTINUE THROUGHOUT the forecast period. During the daylight hours, maximum usable frequencies will remain at relatively high values, dropping off sharply after sunset.

In the Northern Hemisphere, atmospheric noise levels are at their lowest during the winter months. As a result, signal–noise ratios are high.

Although openings on the 21-mc band are expected to be fairly frequent, the 15- and 17-mc bands are expected to continue the best for long-distance reception during daylight hours.

During the evening and night hours, the 6- and 7-mc bands will be good from most parts of the world, with openings in the 4-mc broadcast band during periods when static levels are lower than usual.

Sunspot activity has now dropped to the point where dx reception on 26 mc will be the exception rather than the rule. With sunspot numbers continuing to decrease steadily, it is unlikely that there will be any 26-mc reception via the regular F-layers of the ionosphere for a number of years once the present winter period has passed.

The tables show the optimum broadcast band, in megacycles, for propagation of programs between the locations shown during the time periods indicated.

To use the tables, the listener selects the one most suitable for his location, reads down the left side to the region he wishes to hear, then follows the line to the right until he is under the appropriate time. (Time is given at the top of each table in 2-hour intervals from midnight to 10 pm, *in your local standard time.*) The figure thus obtained is the short-wave band (in megacycles) nearest to the optimum working frequency.

For example, a listener in New York City would use the Eastern USA table. He would be most likely to hear broadcasts from West Europe in the 11-mc band at 4 pm, EST.

EASTERN US to:	Mid	2	4	6	8	10	Noon	2	4	6	8	10
West Europe	6	6	6	9*	21	21	21	15	11	9	6	6
East Europe	6	6*	6*	7*	21	21	15	11	7	6	6	6
Northern Latin America	11	9	9	11	15	17	15	17	17	15	11	11
Southern Latin America	11	11	9	11	15	15	15*	17	17	15	11	11
Near East	7	7	6*	9*	21	21	15	11	9	9	7	7
North Africa	7	7	7	9*	21	21	17	15	11	11	9	9
South & Central Africa	9	7	7*	15	21	21	21	15	15	11	11	9
Far East	9	9	9	7	9	7*	9*	7*	7*	15	15	11
Australia & New Zealand	9	9	9	7	11	11	15	15	15	17	15	11

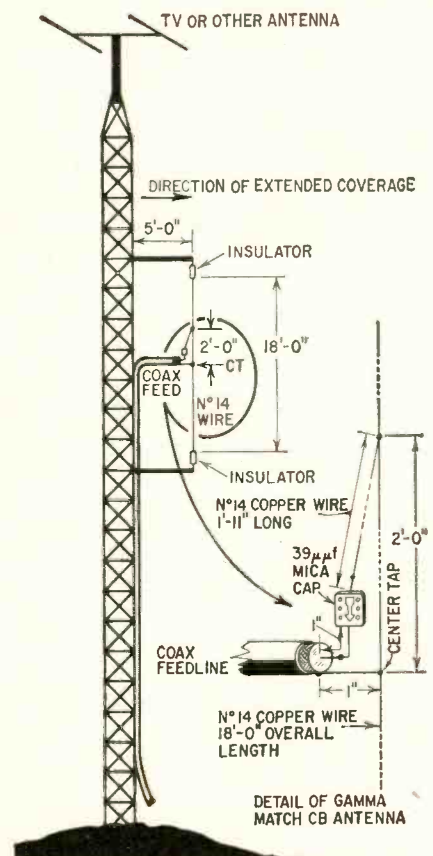
CENTRAL US to:	Mid	2	4	6	8	10	Noon	2	4	6	8	10
West Europe	6	7*	7*	9*	21	21	15	11	9*	6	6	6
East Europe	7	7	7*	9*	17	11	9*	9*	9	9	7	7
Northern Latin America	11	9	7	15	17	17	15	17	17	15	11	11
Southern Latin America	11	9	7	15	15	17*	17*	17	17	15	11	11
Near East	9	7*	7*	9*	17	15	11	9	9	9	7	7
North Africa	7	7	7*	7*	17	17	15	11	9	9	7	7
South & Central Africa	9	9	7*	15	21	21	21	17	15	11	11	9
Far East	7*	7*	7	7	9	9	7*	9*	21	21	11	9
Australia & New Zealand	11	11	9	7	11	11	15*	15	17	17	15	11

WESTERN US to:	Mid	2	4	6	8	10	Noon	2	4	6	8	10
West Europe	6*	7	7*	9*	21	17	15	7	7	6	6	6*
East Europe	7	7	7*	7*	15	15	15	9	9	7	7	7
Northern Latin America	9	9	9	9	15	15	15	17	17	15	11	11
Southern Latin America	11	9	9	11	15	15*	17	17	17	15	11	11
North Africa	7	7	7	11	21	17	15	9	9	9	7	7
South & Central Africa	9	9	7*	11	21	21	21	15	15	11	11	11
Far East	7	7	7	7	7	7	9	17	21	17	11	9
South Asia	7	7	7	7	9	15	11	11*	15	15	15	9
Australia & New Zealand	11	11	7	7	11	11	15	15	21	21	17	15

†Radio-frequency and propagation manager, RADIO FREE EUROPE.
*Reception may be very poor or impossible on this path at this hour.

CB ANTENNA

Here's an easy-to-build Citizens-band antenna for use on the side of a tower when you want to favor one direction. It's ideal when working a mobile unit that operates primarily in one general direction from the base station. Coverage to the sides is as good as for most vertical antennas and is much improved in the forward direction. The 39-$\mu\mu$f mica capacitor cancels the reactance of the gamma match wire and thus improves the standing-wave ratio of the antenna.—*Dude Lynn*



TOWER MOUNTED-VERTICALLY POLARIZED CB ANTENNA

Mercury Signals Received

Natural radio signals have been reported from Mercury, the innermost planet of our system. The signals were picked up at the Radio Astronomy Observatory of the University of Michigan by a team consisting of Drs. William E. Howard, Alan H. Barrett and Fred T. Haddock. Chief difficulty, the radio astronomers reported, was to separate Mercury's signals from those of the sun, which were more than 3,000,000 times as powerful.

Mercury is the fifth planet from which signals have been received, various observatories having heard from Venus, Mars, Jupiter and Saturn.

A TYPEWRITER THAT CAN TYPE OUT ITS own invitation to a conference held to describe it has been announced by J. Dreyfus-Graf, who has worked for many years on the problems of developing a means of transcribing the human voice directly on paper.

The principle evolved by Dreyfus-Graf in his latest development is that of "phonetic keys" and "phonetic locks." The phonetic keys are spoken sounds, broken down into fundamentals, formants and sub-formants. The "locks" resemble those of a safe combination or Yale lock, and consist of catches which hold a typewriter key till the various "keys" that compose that letter are all received. Then all the "pins" are moved to a position that permits the key to strike.

In the drawing, which is meant to illustrate the principles rather than the mechanism, the elements of information (crests in the sound wave) and the levels of these elements are represented as pins, which, when activated by the phonetic "keys," release the type bar, which is forced up by a spring to print the letter on paper above. The pins labeled FORMANTS are numbered on the drawing to indicate different frequency ranges. The actual equipment requires three large racks, and is still in the experimental stage. How far it has advanced can be judged from the invitation at right, which was dictated directly to the mechanism. It can be translated roughly "Invitation to the conference (on) sound-writing and lock(ing principle.")

Automatic Secretary Nearer

Count Dreyfus-Graf is not alone in attempting to develop a phonetic typewriter, and work has been done in other countries. The United States is represented by RCA's Dr. Harry F. Olson, shown in the photograph speaking into a development of his own. Its scope and purpose are explained in the paragraph below:

> the ultimet object is to develop a typerighter which types in respons to words spocan into a mycrophone the output being immediately legible and yousable for intra ofis work filing and eventual transcription into conventional letters

RCA is not publicising the work now being done on the device, which may be taken as an indication that it is considered to be still in an early experimental stage. Or it may be being groomed for use with computers? END

(Above) Dr. Harry F. Olson and his experimental voice typewriter. (Right) Invitation to the conference. (Below) Simplification of the Dreyfus-Graf development, showing the combination-lock principle on which it operates.

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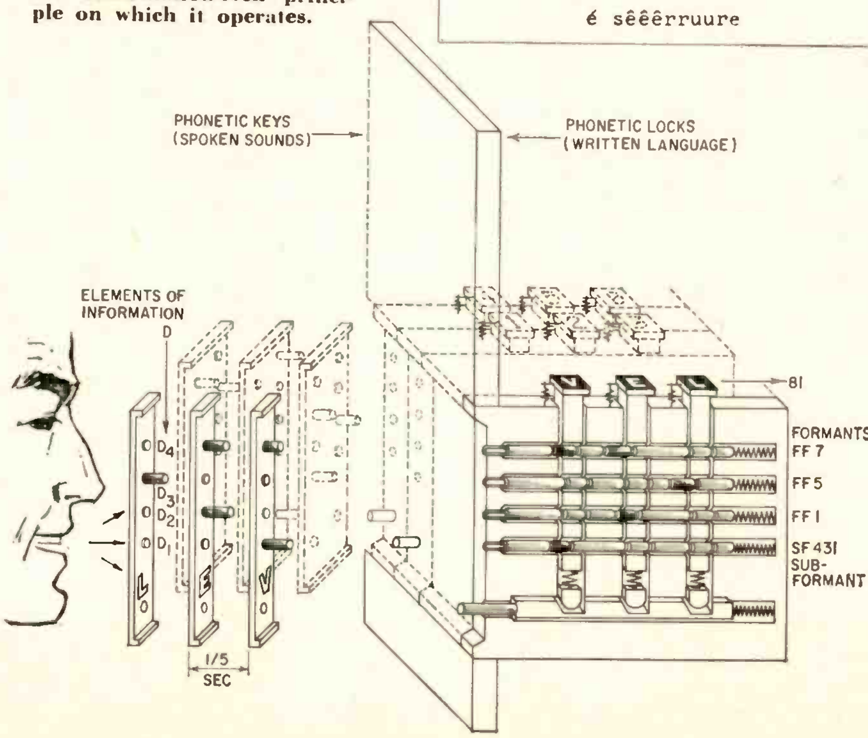


INDIVIDUAL WIDE-VIEW SCALE FOR EACH RANGE GIVES

Quick, Direct, Error-Free Readings *without Multiplying!*

New VTVM

DYNAMATIC 375

Automatic Vacuum-Tube Voltmeter

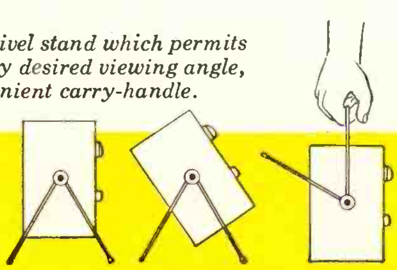
- Individual Full-Size Scale for Each Range
- Range Switch Automatically Sets Correct Scale
- Only One Scale Visible at Any One Time
- All Scales Are Direct Reading
- No Multiplying . . . No False Readings
- Includes DC Current Ranges, too

Here's another exciting first by B&K. With direct-reading single scales, this professional *automatic* VTVM makes it easier, faster than ever to read the exact answer accurately on the correct scale . . . *without reading difficulty, calculation, or chance of error.* Greatly simplifies true reading of peak-to-peak voltages of complex wave forms in video, sync and deflection circuits, pulse circuits, radar systems, etc.

All scales are direct reading. Every scale is the same full size, and only one scale is visible at any one time. *Once you set the range switch properly, it is impossible to read the wrong scale.*

The DYNAMATIC 375 utilizes a single DC-AC ohms probe, anti-parallax mirror, and other desired features . . . to make accurate measurements with utmost convenience and reliability in laboratory, factory production, or service shop.

Includes sturdy swivel stand which permits tilting "375" to any desired viewing angle, swings up as convenient carry-handle.



Ranges:	**DC Volts**	0 - 1.5, 5, 15, 50, 150, 500, 1500
	AC Volts (rms)	0 - 1.5, 5, 15, 50, 150, 500, 1500
	AC Volts (peak-to-peak)	0 - 1.5, 5, 15, 50, 150, 500, 1500
	DC Current	0 - 5 ma, 50 ma, 500 ma
	Ohms	0 - 500 ohms, 5 k, 50 k, 500 k, 5 meg, 50 meg, 1000 meg

Input Resistance: 11 megohms on all DC ranges
Accuracy: ±3% full scale AC and DC
Meter Movement: Sensitive 100 microampere
Precision Multiplier Resistors with ±1% accuracy
Anti-Parallax Mirrored Scale for precise readings
Easy-to-See Iridescent Knife-Edge Pointer
Single DC-AC Ohms Probe (supplied)
Includes 1½ volt Battery. Operates on 117 volts 50-60 cycle AC
Sturdy, handsome metal case with convenient combination swivel stand and handle. **Size:** 10¾" x 6¾" x 4" deep. Net wt: 8 lbs.

Model 375 Net, **$89⁹⁵**

See Your B&K Distributor or Write for Catalog AP18E

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B&K

What's Your EQ December Solutions

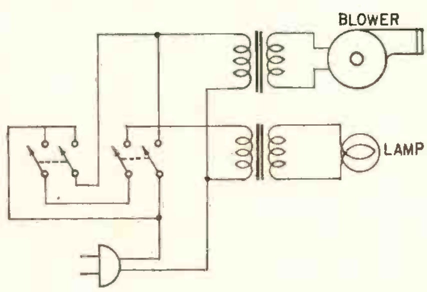
What's the Sync

The technician first thought that the trouble must be due to an open cathode but, since there was obviously grid rectification and the cathode would have to be in circuit to produce it, he discarded this idea.

The trouble was finally found to be an open 2.2-meg grid resistor. This made the tube block since there was no grid return. Measuring with the vtvm provided an 11-megohm resistance to ground and the tube operated almost normally, but of course it blocked again when the vtvm was moved to measure the plate voltage!

Correct Switching

The circuit below is so arranged that no matter which switch is thrown first, the blower will be turned on first and off last, thus assuring air cooling at any time the lamp is burning.

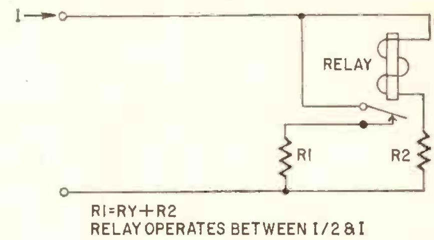


Black Box No. 5
(September)

Two ingenious solutions to Black Box No. 3 (September, 1961) have been submitted. If you remember, the puzzle was a black box with two terminals. First one dry cell was connected to it, then two dry cells. In each case, the current was the same. What was in the black box was actually a nice, solid short circuit. Therefore the current depended only on the internal resistance of the cells, which of course increased in proportion to the voltage (number of cells in series), keeping the current the same.

Reader Ray R. Stark suggests that the external cells might have been 2-volt storage cells, and that two dry cells could be contained in the black box. Then whether one wet cell at 2 volts was applied, or two wet cells at 4 volts, the difference in both cases would have been 1 volt, and the current the same, though in reverse direction.

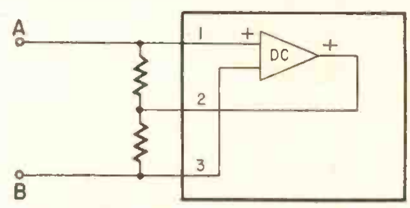
Readers W. Kaune and J. Molberg of Seattle have another solution.



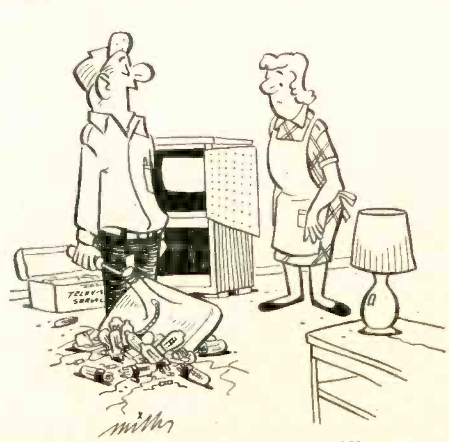
In theirs, there is a resistor, R1, in parallel with a relay and a second resistor, R2. R2 and the relay coil together have exactly the same resistance as R1. Normally closed contacts of the relay connect the circuit through R1, and the relay is supposed to operate anywhere between I/2 and I. With one dry cell applied, the current divides between the two paths. With two dry cells, 2I starts to flow. This immediately actuates the relay, opening the circuit to R1. R2 and the relay now pass the same amount of current as one cell put through the two parallel channels.

Infinite Black Box

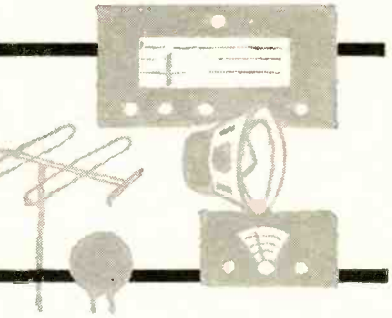
Terminals 1 and 3 are the input to a dc amplifier with a voltage gain of 1 and no phase inversion. The output of the amplifier is between terminals 2 and 3. Thus for any input between terminals 1 and 3, the same voltage



will appear at terminal 2. Both ends of R1 are then at the same voltage, no current can flow in the resistor and the input resistance is infinite. This is a good example of feedback increasing the input impedance of a voltage amplifier.



"You have a wastebasket?"

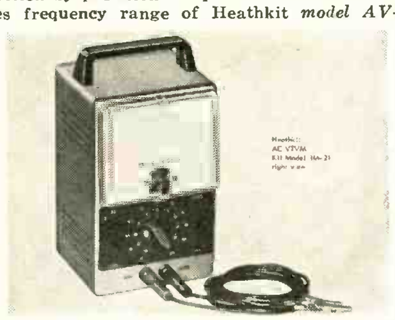


NEW PRODUCTS

TEST SOCKET ADAPTERS, *model 1449* (illus.), *model 1447*, 9- and 7-pin types respectively, simplify testing of tube pins for voltages or resistance by eliminating need for removing tube shields. Test tabs of sockets clear tops of captive or telescoping tube shields. Interelement distrib-

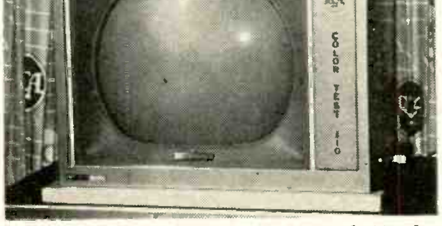
uted capacitance about 1.5 $\mu\mu f$; voltage breakdown elements exceed 1800 volts ac–dc. Insulation resistance more than 5 $\times$ 10^5 megohms.—**Pomona Electronics, Inc.**, 1500 E. 9th St., Pomona, Calif.

AC VTVM, *model IM-21*, offers frequency response 10 cycles to 500 kc ±1db, 10-megohm input impedance. Cathode-follower stage on all ranges provides high input impedance; 2-stage amplifier with about 19-db negative feedback for high output stability and linearity. Voltage division by precision components more than doubles frequency range of Heathkit *model AV-3*.



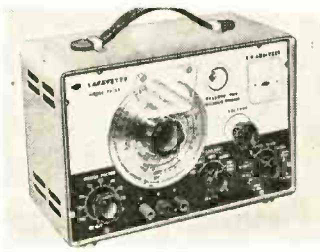
VU type ballistic damping for monitoring audio signals in tape recording and like applications. Covers .01 to 300 volts rms full scale in 10 ranges. Db scale calibrated from −50 to +50 db. 10 db steps.—**Heath Co.**, Benton Harbor, Mich.

COLOR TEST JIG, *model 11A1015*. Eliminates need to pull CRT and deflection assembly and then reconverge set after returning chassis to customer. Kit includes metal cabinet, deflection and convergence assemblies, hardware and all components for installing 21CYP22-A tri-color kinescope. 5 special extension cables available for



servicing RCA CTC-4, -5, -7, -9, -10, and -11 color receiver chassis.—**RCA Parts & Accessories**, P.O. Box 654, Camden, N. J.

CR ANALYZER, *model TE-25*, measures capacitance and resistance in 4 ranges, 1 $\mu\mu f$ to 5,000 μf and 0.5 ohms to 500 megohms; power factor of electrolytics from 0–55%. Dc voltage continuously variable to 600 volts, two ranges on meter 0–6, 0–60 ma. Ratio scales measure impedance and turns ratio of power and audio transformers in 2 ranges. Accuracy within 5%

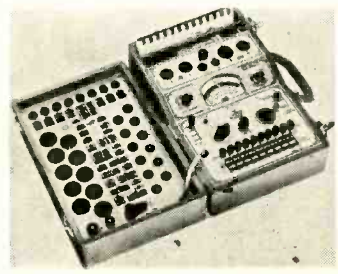


over entire range. Tube complement: 1-6R4; 1-6E5. Power requirements 117 volts 50/60 cycles alternating current.—**Lafayette Radio Electronics Corp.**, 165-08 Liberty Ave., Jamaica 33, N. Y.

CRT REJUVENATOR TESTER, *model TE-19*. Portable unit permits rapid check of black-and-white and color picture tubes, including 110° types, without removal. Fast shorts test with neon-lamp indicator. Determines CRT quality by emission test, rejuvenates all cathode-ray tubes. 4½-in. meter for direct reading. Filament voltage selector switch, 6.3 and 12.6 volts. Repairs interelement shorts and open circuits;

measures leakage. Two extra tube socket adapters for 110° deflection tubes. 105-120 volts, 60 cycles—**Lafayette Radio Electronics Corp.**, 165-08 Liberty Ave., Jamaica 33, N. Y.

TUBE TESTER, *model 107A*, tests 9-pin Novars, 12-pin Compactrons, new 10-pin tubes,



nuvistors, all standard domestic and foreign types. Mutual conductance test on prewired chassis, cathode-emission test using free-point selector system, and grid-circuit test for up to 11 simultaneous checks for leakage, shorts and grid

(*Continued on page 92*)

A PROPHECY

For men and women with a sincere desire to succeed

"In the years that have passed since my days on the faculty of RCA Institutes, I have become even more firmly convinced that the individual who continues his education . . . particularly his technical education . . . is the individual who profits both as a thinking man and as a working man. Science and industry will reward you for your talents and energy. Out of your efforts may come inventions, new products, processes and services. There is everything good yet to be accomplished in our lives and in our work. What man has done, man can do better."

David Sarnoff

Chairman of the Board,
Radio Corporation of America

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RCA Institutes Home Study School, licensed by the New York State Department of Education, offers a complete program of integrated courses for beginners and advanced students ranging from electronic fundamentals to automation. All courses are designed to prepare you for a rewarding career in the rapidly expanding world of electronics. *The caliber of the training you receive is the finest!* And you get top recognition as an RCA Institutes graduate!

(*Continued from page* 87)
emission.—**Seco Electronics Inc.**, 5015 Penn Ave. So., Minneapolis 19, Minn.

VTVM, *model 222.* Direct-reading of ac-dc voltages to 1,500 and resistances 0.2 ohms to 1,000 megohms in 5 ranges. Calibration without removal from cabinet. Electronic overload protection plus fuse, 1% ceramic resistors and zero-center scale. Input impedance 11 megohms dc, 1 megohm ac. Voltage ranges: 0–3, 15, 75, 300

and 1500, ac/dc. Response 30 cycles to 3 mc; frequencies to 250 mc readable with Eico PRF probe. Resistance measurements 0.2 to 1,000 ohms, with 1.5-volt battery supplied. Wired or kit.—**EICO Electronic Instrument Co., Inc.**, 33-00 Northern Blvd., L. I. C. 1, N. Y.

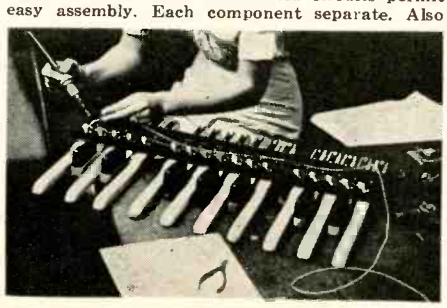
FLUTTER METER, *model 590-A-1.* Visual indication of wow and flutter on tape recorders and playback equipment, including discs of all speeds as well as 16- and 35-mm sound film mechanisms. Built-in preamp and high-impedance input attenuator accepts voltages from 1 mv to 300 volts. Flutter and wow measured through high and low-pass filters. Built-in 3,000-cycle

oscillator. Three-range filter analyzes flutter and wow components. Frequency discriminator demodulates flutter signals, read on calibrated meter. Extraneous transients do not effect stability. Scales for flutter and wow: 0.3%, 1.0% and 3.0%; significant readings down to 0.01%. Measures variations in amplitude any rate from 0 to 40 cycles.—**Amplifier Corp. of America, Instrument Div.**, 398 Broadway, New York 13, N. Y.

TWO-MANUAL THEATER-STYLED ORGAN, the *York.* Full 61-note manuals, 25-note concave-radiating pedal board and horseshoe stopboard with 40 multi-colored stop tablets. Dual expression pedals, separate vibrato on each

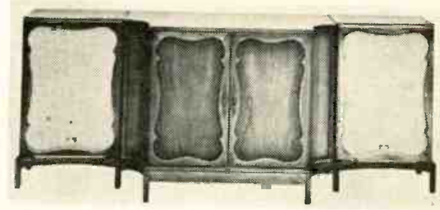
manual and independent oscillators for each note. Accessories: *Band Box* and *Orchestra Bells.* Finished or in kit form.—***Artisan Organs***, 4949 York Blvd., Los Angeles 42, Calif.

SPINET ORGAN KIT. 88 keys, 13 pedals; weighs less than 100 lb. Printed circuits permit easy assembly. Each component separate. Also



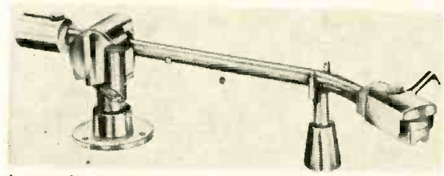
available *Concert* and *Consolette* models.—**Schober Organ Corp.**, 43 W. 61st St., New York, N. Y.

COMPONENT CABINETS. *Select-A-Style* doors for easy removal and replacement. (Illustrated) *Credenza* component cabinet and two *Medallion XII* 12-inch 3-way speaker systems.



Italian Provincial, French Provincial, Swedish Modern and Colonial styles in various wood finishes.—***University Loudspeakers, Inc.***, 80 So. Kensico Ave., White Plains, N. Y.

PLAYBACK ARM, *model 980. Dyna Lift* mechanism lifts arm at end of record. Calibrated knob dials any stylus force from 0–8 grams, accuracy ±0.1 gram. Cartridge bracket mount for adjustment of cartridge position in shell. Ground



loops eliminated by 5-wire circuit; separate fifth wire common ground for arm and turntable. Maximum compliance due to ball bearing suspensions, low fundamental resonance, low inertia and plug-in installation.—**Dyna Empire, Inc.**, 1075 Stewart Ave., Garden City, N. Y.

MICROPHONE DESK STAND, *model DS-10,* accommodates any mike with standard ⅝-27 NPSM thread. May be used with *SSP10* and *SA10* stand adapters. Knurled lock nut insures stable mounting.—**University Loudspeakers, Inc.**, 80 So. Kensico Ave., White Plains, N. Y.

MICROPHONE, *model C47D,* combines noise cancelling and unidirectional properties for

maximum discrimination against distant and off-axis noise.—**Euphonics Acoustics Corp.**, Box 2746, Rio Piedras, Puerto Rico.

PORTABLE TAPE RECORDER, *model TC-1.* All-electric self-contained *Transitape* uses 4 transistors, 1 diode. 1⅞ and 3¾ ips. Fast forward rewind; separate erase head. Full-size playback speaker, wide-range response mike, safety interlock, separate volume control and battery and recording level indicators. Input 100,000 ohms; output 3.2 ohms; wow about 0.5% at 3¾ ips; overall gain 55 db.—**Pentron Electronics Corp.**, 777 So. Tripp Ave., Chicago 24, Ill.

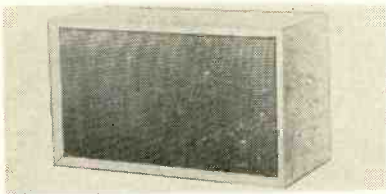
AUDIO/PA AMPLIFIER, *McMartin model LT-80.* All-transistor 8-watt continuous-duty unit for background music and PA. Peak power 20

watts, feedback circuit eliminates transistor damage if speaker load removed. No input transformer needed for telephone line input. Plug-in 600-ohm transformer optional.—**Continental Mfg. Inc.**, 1612 California St., Omaha, Neb.

PA SPEAKER, *model HP-75,* for high-power applications to 75 watts. Bell diameter 9 in, total length 8¾ in. *Molel SHP-75,* slightly smaller. All wiring connections made within cast-aluminum mounting bracket, with solderless con-

nectors provided.—**Atlas Sound Corp.**, 1449 39th St., Brooklyn, N. Y.

SPEAKER SYSTEMS AND CABINETS. *Mark I* for medium- and low-level reproduction. Houses 8-inch speaker, 1-inch voice coil. 8 ohms impedance. Cabinet 11 x 9½ x 23 in. Response 45 to 13,000 cycles. *Mark II* has 12-in. coaxial



speaker with 6.3 oz. Alnico V magnet, 1-inch voice coil, one-piece cone, 3-inch Alnico V PM tweeter. Power rating 12 watts, impedance 8 ohms. Cabinet 14 x 11½ x 23¾ in. Response 50 to 15,000 cycles.—**Cabinart Acoustical Engineering Corp.**, Haledon, N. J.

SLIM-LINE SPEAKER KIT, *model KS-1*, 5¾ in deep. 10-in woofer, 5-in mid-range, 3-in super-tweeter. Crossovers at 1,400 and 5,000

cycles; impedance 8 ohms. Also available as finished unit.—**Fisher Radio Corp.**, 21-21 44th Drive, Long Island City, N. Y.

SENSIPHONES, *model ST-M*. Separate woofer and tweeter element in each phone. Adjustable crossover networks. High-compliance cone in woofer element for low-frequency ranges;

piezoelectric ceramic tweeter for high frequencies. Crossover control box has built-in resistor network to prevent blowout. Range 20 to 20,000 cycles.—**Superex Electronics Corp.**, 4-6 Radford Place, Yonkers, N. Y.

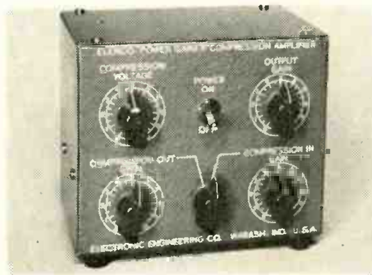
CERAMIC PHONO CARTRIDGE. Turret action to eliminate twisting lead wires and de-

couple unused needle. U-line cartridge replaces all ceramic stereo and most monaural cartridges. —**Euphonics Corp.**, Rio Piedras, Puerto Rico.

TURNTABLE-ARM COMBINATION. 33-1/3-rpm. Arm, Walnut base, dust cover, cables, overhang adjustment device and needle force gauge. Belt drive from two synchronous motors, 3.5-lb. aluminum platter, shock mount-

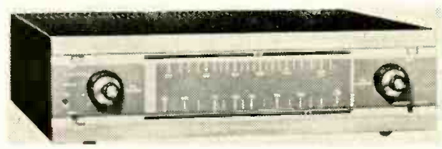
ings from top plate. Tone arm floats down to record if dropped, damping mechanism disengaged when needle touches record.—**Acoustic Research, Inc.**, 24 Thorndike St., Cambridge 41, Mass.

AUDIO COMPRESSION AMPLIFIER *Power Gainer* increases effective range of 2-way radio, amplifies low-level sounds to level equal to



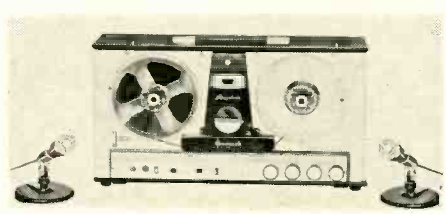
low-frequency voice sounds. For base station or mobile applications.—**Elenco Electronic Engineering Co.**, Wabash, Ind.

TUNER KIT, *model KF-90*. Built-in multiplex circuit and wide-band FM circuitry. Multiplex section reproduces full dynamic range of stereo FM without loss of response. Front-panel dimension control for varying channel separation. Dynamic sideband regulation reduces FM distortion from overmodulation or weak signals. AM



section offers sharp or broad tuning, 10-kc whistle filter and built-in loopstick antenna. Printed circuitry; rf and if transformers sweep-aligned.—**Allied Radio Corp.**, 100 N. Western Ave., Chicago 80, Ill.

4-TRACK STEREO RECORDER, *model 420*, for simultaneous recording and listening. Response 50–15,000 cycles 7½ ips, 50–10,000 cycles 3¾ ips. Signal-to-noise ratio better than 48 db, wow and flutter less than 0.25% rms, bias oscillator frequency 65 kc. Built-in 5½ x 7½-in



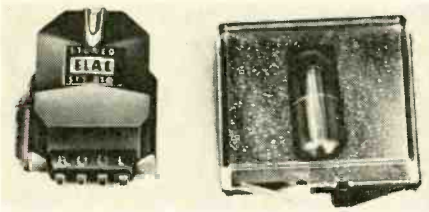
speakers with 3/16-oz magnet and 1-in voice coils. Matching *Gemark* speaker pair S-204, two 6 x 9-in dualcone speakers with 1-in voice coils, 10-oz magnets and 8-foot cables, for extended speaker separation.—**General Magnetics and Electronics, Inc.**, 134-09 36th Road, Flushing 54, N. Y.

STEREO AMPLIFIER, *model S-5000 II*, 80-watt amp/preamp unit. Presence-rise switch to increase level around 2,800 cycles by 5 db. Hum and noise ratio 60 db below 80 watts on phono channel, 1.2-mv phono sensitivity. 4 low and 8 high-level inputs; 12-db/octave scratch and rumble filter on all inputs. Friction-locked dual bass and treble controls for separate or ganged

adjustment of channel settings.—**Sherwood Electronic Laboratories, Inc.**, 4300 N. California Ave., Chicago 18, Ill.

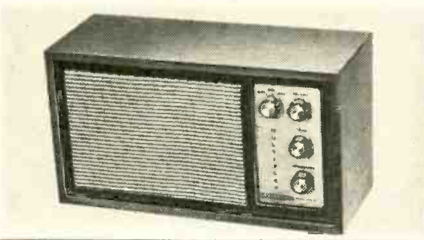
STEREO TEST RECORD provides rapid frequency-response and channel-separation tests on automatic curve tracer, or manually with spot-frequency bands. Evaluates tone arm resonance, compliance, wavelength loss and stylus wear.—**CBS Laboratories**, High Ridge Road, Stamford, Conn.

STEREO CARTRIDGE, *Stereotwin STS-200*. Moving magnet. Channel separation 25 db 1,000 to 10,000 cycles. Output 10 mv at 5 cm/sec.



Mounted diamond 0.7-mil stylus plus extra diamond stylus.—**Benjamin Electronic Sound Corp.**, 97-03 43rd Ave., Corona 68, N. Y.

FM STEREO ADAPTER KIT, Unit GRA 21-1, to accompany Heathkit GR-21 FM table radio or any FM radio. Self-contained and self-powered, has 6 × 9 in speaker and audio circuitry for matched response. Choice of FM stereo or monophonic reproduction, using speakers in radio and adapter or radio speakers alone. Master volume control for both channels. Tone controls on adapter and radio function inde-



pendently. Full-wave power supply uses silicon rectifiers and power transformer.—**Heath Co.**, Benton Harbor, Mich.

STEREO MULTIPLEX ADAPTER, *model KN-MX*. For any FM or FM–AM tuner having multiplex output jack. External control for quick

separation adjustment. Self-powered, plugs in between tuner and stereo amplifier of stereo system. All connecting cables supplied.—**Allied Radio Corp.**, 100 N. Western Ave., Chicago 80, Ill.

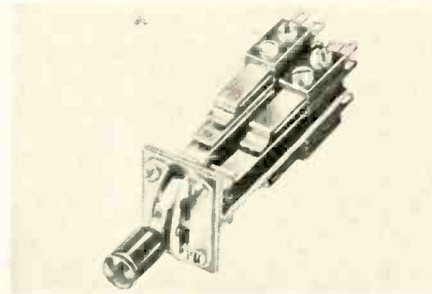
MULTIPLEX ADAPTER, *model P-400* (illus). For most tuners with multiplex jack. 2 dual-purpose tubes, 1 power rectifier, 2 high-frequency diodes. AM–FM stereo multiplex tuner,

model R-1103, with built-in multiplex: 10 tubes 3 diode detectors and rectifier.—**De Wald Radio**, Div. United Scientific Labs, 35-15 37th Ave., Long Island City 1, N. Y.

FM MULTIPLEX TUNER, *model TM-214*. Three-tube multiplex circuit with factory-set balance and separation controls. Sensitivity 2.2 μv IHFM standard, 1.3 μv for 20 db of quieting; distortion less than 0.5% at 100% modulation, signal-to-noise ratio: 70 db, monaural; 50 db, stereo. 2 tape and 2 audio outputs, 11 tubes plus rectifier and matched germanium diode detectors.

—**Radio Shack Corp.**, 730 Commonwealth Ave., Boston 17, Mass.

TELEPHONE TYPE LEVER SWITCH prevents accidental switching. Lever-Lock lightweight construction. Index bracket locks actuator for switching position and doubles as



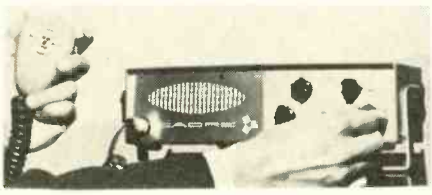
escutcheon plate. 3 amps, 300 watts max., ac noninductive load.—**Switchcraft, Inc.**, 5555 N. Elston Ave., Chicago, Ill.

CB MICROPHONE, *model 350C*. 11-inch retracted (5 feet extended) *Koiled Kord*. Hanger button and standard dash bracket permit mobile

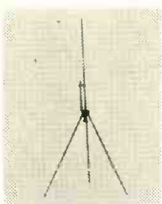
rig mounting. Response 80 to 7,000 cycles, output —54db.—**Turner Microphone Co.**, 901 17th St. N.E., Cedar Rapids, Iowa.

CB TRANSCEIVER, *model 740.* Portable. Nickel-cadmium rechargeable battery and charger. Superhet receiver: 7 transistors and 1 diode; crystal-controlled local oscillator. Sensitivity 1 to 2 μv for 10-db signal-to-noise ratio. Transmitter: 2 transistors; 100 mw input; modulation to 100%. 41-in telescoping antenna. $2\frac{1}{4}$-in PM response-corrected speaker/microphone.—**Electronic Instrument Co., Inc., (EICO)** 33-00 Northern Blvd., Long Island City, N. Y.

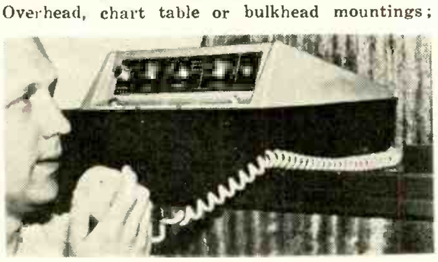
5-WATT CB TRANSCEIVER, *model 500.* Completely transistorized, for autos, trucks, aircraft and boats. Squelch and automatic noise limiter permits clear reception above engine noise. Range of 10–15 miles overland, 20 miles over water. Operates in 27-mc range with 5 receiving and 5 transmitting channels. Tunes all 23 CB channels. Modulation capability 100%, frequency stability .005%.—**Cadre Industries Corp.,** Endicott, N. Y.



CB ANTENNA. Ground-plane design with adjustable gamma-match feed system. All seamless aluminum, stainless-steel fasteners.—**Hi-Par Products Co.,** 347 Lunenburg St., Fitchburg, Mass.

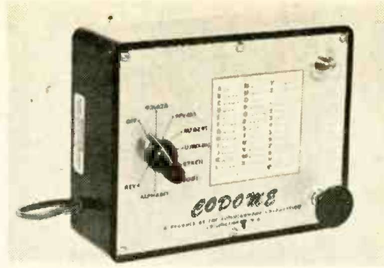


RADIOTELEPHONE, *Cruisephone 25.* 25-watt unit for outboards and other small craft. Overhead, chart table or bulkhead mountings; reversible control panel. 5 channels, rf gain control and antenna booster control.—**RCA,** 30 Rockefeller Plaza, New York 20, N. Y.



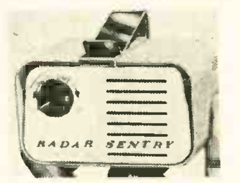
TRANSISTORIZED OSCILLATOR, *Transi-Call* accessory for sound-powered phones alerts party being called. 1000-cycle tone changes if other end open. 9-volt transistor battery, one transistor.—**Blan, The Radio Man,** 64 Dey St., New York, N. Y.

CODOME, Morse-code learning device with accompanying manual, for potential amateur ra-



dio operators or Novice licensees. 36 characters in groups of 6, with switch to select groups. Characters in each group transmitted repeatedly at random. Built-in key for practice in manual sending, flashing light accompanies audible transmission.—**Accentronome Corp.**, 117 Crestmont Terrace, Collingswood, N. J.

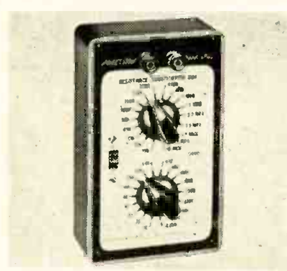
RADAR SENTRY. Audible warning of radar-controlled speed zones within ½-mile range. Dual-band circuit continuously and simultaneously monitors two special frequencies in S- and



X-microwave bands, on which radar traffic controls operate. Printed wiring, 8 transistors and two 1,000-hour mercury cells, self-testing batteries.—**Radartron, Inc.**, 232 Zimmerman St., N. Tonawanda, N. Y.

DECADE RESISTOR/DIVIDER, *model 1601*, for use with bridges and in determining resistance values in development circuits. 4 voltage-divider posts permit use as general-purpose wide-range divider, and allow setup for practical voltage ratios from .0001 to 1.0. Input resistance as divider 11 to over 110,000 ohms. 5 decades total 0–111,110 ohms, steps of 1 ohm. Tolerance ±0.5% in resistance elements (1-watt negligible inductance).—**Precision Apparatus Co., Inc.**, 70-31 84th St., Glendale 27, N. Y.

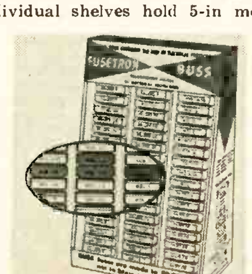
RESISTANCE SUBSTITUTION BOX, *model 1702*, for rapid direct substitution of 36 resistance values by use of two rotary switches. Re-



sistance values 15 ohms to 10 megohms; wattage dissipation of all resistors 1 watt ±10% tolerance.—**Precision Apparatus Co., Inc.**, 70-31 84th St., Glendale 27, N. Y.

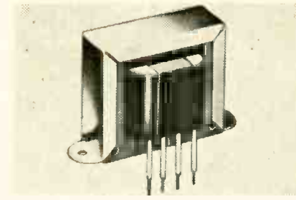
CABLE ASSEMBLY, *model 10BF10*. Molded straight 3-conductor phone plugs at both ends of 36-inch shielded cable, built-in cable clamps.—**Switchcraft**, 5555 N. Elston Ave., Chicago 30, Ill.

ELECTRONIC FUSE ASSORTMENT in metal stand for easy reference service technicians. Individual shelves hold 5-in metal boxes;



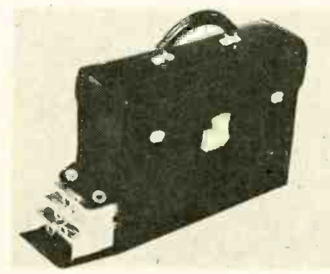
tabs indicate size and type. Large style contains 255 fuses in 30 sizes; small, 130 fuses in 26 sizes.—**McGraw-Edison Co.**, Bussman Mfg. Div., University at Jefferson, St. Louis 7, Mo.

VERTICAL OUTPUT TRANSFORMER, *part No. VO-114*. 6:1 turns ratio, primary impedance 5,000 ohms at 30 dc ma. Dc resistance 250 ohms primary, 6 ohms secondary. For direct replace-



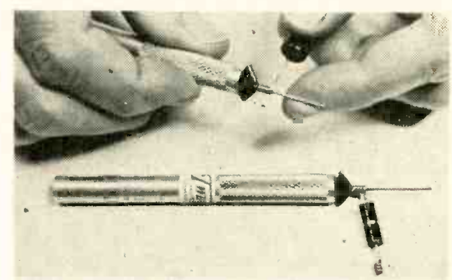
ment in Airline, Coronado, Emerson, Sonora, Sylvania, Trav-ler and Truetone sets.—**Stancor Electronics, Inc.**, 3501 W. Addison St., Chicago 18.

SERVICE TOOL KIT holds large tools, meters, etc. Three sliding metal trays with compartments for small parts. Available with out-



side pocket for manuals.—**K. Leather Products, Inc.**, 427-429 Broadway, New York 13, N. Y.

TWIRL-CON TOOL, in three sizes. For printed-circuit work, modification of surplus equipment, repair of leads broken off close to



transformer winding, lengthening pigtails, etc. Also makes pin plugs, fuse lead buttons and solderless connections.—**Twirl-Con Tools**, 101 N.E. St. Edna, Texas. END

All specifications are from manufacturers' data

NEW BUSINESS GETTERS — NEW LITERATURE

Any or all of these catalogs, bulletins, or periodicals are available to you on request direct to the manufacturers, whose addresses are listed at the end of each item. Use your letterhead—do not use postcards. To facilitate identification, mention the issue and page of RADIO-ELECTRONICS on which the item appears. UNLESS OTHERWISE STATED, ALL ITEMS ARE GRATIS. ALL LITERATURE OFFERS ARE VOID AFTER SIX MONTHS.

TRANSISTOR DATA SHEETS are explained in a 7-page booklet *How to Get More Value out of a Transistor Data Sheet*. Graphs, charts and explanatory material aid the design engineer in achieving reliability and low cost.—**Motorola Semiconductor Products, Inc.**, 5005 E. McDowell Rd., Phoenix 8, Ariz.

SILICON DIODES AND RECTIFIERS are presented in 10-page *Bulletin 514*. Semiconductors include diffused-junction silicon diodes in general-purpose, high-conductance, computer switching and standard types, as well as diffused-junction silicon rectifiers in glass, co-axial and epoxy package.—**Electron Research Inc.**, Div. Erie Resistor Corp., 530 W. 12th St., Erie, Pa.

EXTENSION SPEAKER COUNTER DISPLAY for two 4-inch extension speakers.—**Philco Corp.**, Philadelphia, Pa.

BUBBLE PACKAGE for point-of-purchase needle display.—**Duotone Co.**, Keyport, N.J.

ELECTRICAL TAPES are illustrated in an 8-page full-color catalog, giving information and specs on Plymouth and Slipknot lines. New products include vinyl electrical tape for all-temperature use, rubber insulating tape and splicing compound.—**Plymouth Rubber Co., Inc.**, Tape Div., Canton, Mass.

INSTRUCTION SHEET, *Form No. TK-303*, a 6-page booklet, details the installation of a 21CYP22A color picture tube in the RCA model 11A1015 color test jig—a cabinet and deflection and convergence assembly kit for mounting a color kinescope on the service bench.—**RCA Parts and Accessories**, PO Box 654, Camden, N. J.

SPRAY PAINTS and protective coatings are pictured and described in a 12-page catalog. New products include electronic contact cleaner-lubricant; matte finish spray for photos; varnish for oil paintings; pressure-sensitive spray adhesive and blue fluorescent spray paint.—**Krylon, Inc.**, Norristown, Pa.

FOUR-TRACK STEREO described in nontechnical terms in illustrated booklet. Scotch brand tapes and accessories also listed.—**Minnesota Mining & Manufacturing Co.**, Dept. Y1-522, 900 Bush Ave., St. Paul 6, Minn.

REPLACEMENT COMPONENTS are shown in 32-page *Catalog SE 561*. Included are ac capacitors, auto radio, ceramic, electrolytic, mica, Mylar, oil-paper and paper tubular types, as well as filters, hardware, instruments and capacitor kits. Pocket-size booklet *AFH-461* is devoted to twist-prong electrolytic capacitors only.—**Aerovox**, 740 Belleville, New Bedford, Mass.

OFFICE AND INDUSTRIAL EQUIPMENT is offered in a 31-page manual. Steel products include office desks, filing cabinets, extension ladders, tool storage carts and refuse disposal units. Also listed are wireless intercoms, telephone amplifiers, secretarial chairs and many other items.—**Precision Equipment Co.**, 8 Precision Bldg., 4403A Ravenswood Ave., Chicago 40, Ill.

SERVICING DATA described in a 4-page leaflet includes radio and television diagrams, service manuals, and other information useful to the technician.—**Supreme Publications**, 1760 Balsam Road, Highland Park, Ill.

DC POWER APPARATUS shown in detailed list. Complete specs given on power supplies, variable transformers, isolation rectifier transformers, full-wave bridge rectifiers, volt and amp meters and other products.—**Technical Apparatus Builders**, 109 Liberty St., New York 6, N. Y.

HI-FI KITS are explained in a question-and-answer brochure. Blend control, cabinet installation of preamps and tuners, kit packaging and extension of frequency ranges are among subjects discussed.—**Harman-Kardon, Inc.**, Ames Court, Plainview, N. Y.

COLOR CODES for transformers on 8½ x 11-inch wall chart include those for power audio, output and if transformers, as well as connection codings for loudspeaker leads and plugs.—**Stancor Electronics, Inc.**, 3501 Addison St., Chicago 18, Ill.

RELAY CATALOG provides illustrations, specs and other information on industrial and commercial relays. Included are general-purpose, plate circuit, industrial control, telephone, printed-circuit, sensitive, digital-counter, antenna, power and plug-in types.—**Hillburn Electronics Corp.**, Mr. E. Fieldsteel, 55 Greenpoint Ave., Brooklyn 22, N. Y.

RIGID COAXIAL TRANSMISSION LINE *Catalog 200* gives description and specs on lines of varying dimensions, with copper or aluminum outer conductors. Also listed are supporting hardware, dehydration and pressurization equipment, required electrical and mechanical specs of rigid line, and attenuation and power rating data.—**Taco**, Sherburne, N. Y.

BATTERY ENGINEERING SUPPLEMENT outlines alkaline-manganese-zinc battery system throughout the range of battery types. Also included is specification and suggested list-price table.—**Union Carbide Consumer Products Co.**, 270 Park Ave., New York 17, N.Y. END

TECHNICIANS' NEWS

HIGH COURT BACKS LICENSING

Lansing, Mich.—The State Supreme Court unanimously upheld Detroit's ordinance requiring the licensing of television service technicians. It was noted that the ordinance did not attempt to fix prices.

The ordinance was brought to court by William Murphy, a TV service dealer, who contended that having four of his competitors on the board was a threat of discrimination against him.

The court decided that the law is a valid exercise of police power and named other regulating groups which have members representing the controlled business.

WORD FROM WISCONSIN

Sheboygan County—There was a lot of activity at a regular meeting of TESA–Sheboygan at the Grand Hotel. John Bruder and Fred Leonard reported on the NATESA convention. Members turned in lists of their shelf stock. These lists will be compiled into a master list, copies of which will be given to all members. Then one member will be able to draw on the stock of another for rare parts.

Milwaukee—Once again Covic's Amerwood Hall was the meeting place for TESA–Milwaukee. After the minutes of the previous meeting were read, Mr. and Mrs. Don Miller, representing Cardinal TV, were introduced. They attended to get an idea of the association's activities as they are considering joining.

"FREE SERVICE" IN COURT

St. Louis, Mo.—The Post-Dispatch reported that Charles R. Thurber, trade practice consultant for the Better Business Bureau, told the Missouri Public Service Commission that television repairmen making "free" home service calls hold an advantage over other repairmen because television owners feel obligated to purchase parts from them.

Thurber's testimony came as hearings resumed before the commission on the petition of Videon Television Service, 379 No. Big Bend Blvd., University City, to force Southwestern Bell Telephone Co. to allow Videon to use the phrase "you pay nothing" if no tubes need changing, in the company's advertisement in the yellow pages of the telephone company directory.

The television industry, Thurber said, agreed voluntarily in 1954 to eliminate "free service" advertising. The telephone company allowed use of the "free service" phrase in the Videon company's advertisement in the 1960 directory, but refused use of it in the 1961 directory.

[Credit is certainly due the Better Business Bureau of St. Louis and to the responsible service companies in the St. Louis area who adhere to good business practices in advertising and operation. The poor public image and bad publicity heaped upon servicemen in general is the result of opportunists who utterly disregard their responsibility to the industry they represent. It is interesting to note that, of the 300 or more service companies in the St. Louis area, Videon is the only company who feels they should be an exception to responsible practices, and KTVI, channel 2, is the only one of the television broadcasting stations that prefers to reject what other advertising media adhere to. — *Editor's note — TESA–St. Louis News*]

SERVICE TECHS AT HI-FI SHOW

Philadelphia, Pa.—Visitors at the Greater Delaware Valley High Fidelity Music Show were treated to a special display run by members of the Television Service Association of Delaware Valley, Philadelphia, and TSA of Delaware County. They saw a view of their heart beats on an oscilloscope and heard them played back on a tape recording which they were given as a souvenir. Also, they were tested for their audio range.

STIRRINGS IN THE WEST

Ventura, Calif.—There's a new service group in this area, the Electronic Service Dealers Association of Ventura County. They have already set up a cooperative advertising plan that includes advertising mediums in Oxnard and Ventura. Meetings are held the second Wednesday of each month.

Officers are: Rog Wimer, president; Ray Johnson, vice president; Fred Sueyres, secretary, and Rod Wignall, treasurer.

Redondo, Calif.—A talk on FM multiplexing and transistor servicing was given by Don Paulin, field engineer for Dumont-Emerson, before a combined meeting of the South Bay and San Antonio and Los Cerritos chapters of RTA.

Covina, Calif.—Service engineers from Sencore conducted a discussion and demonstration of Sencore service instruments before the membership of the San Gabriel chapter of the California State Electronics Association.

CENTRALIZED SERVICE

Atlantic City, N. J.—Members of the Tri-State Council of TV service associations discussed centralized service at the annual Telerama convention here. Under the system, a cooperative central service shop would be established to handle all shop repair work. Dealers now operating their own shops would join together to establish the centralized shop.

In-the-house repair work would be done by individual service technicians who would maintain business phones. All shop work would be done at the central shop and billed to the individual technician. This plan would cut shop overhead drastically, while all technicians would retain their own customers and share in the profits of the centralized shop.

ELECTION RETURNS

New York, N.Y.—The Associated Radio Television Servicemen of New York held their annual election at the Central Plaza Annex. Max Liebowitz was re-elected president. First vice president is Herb Schneider; second vice president, Frank Vella; treasurer, O. Capitelli; corresponding secretary, Mark Schwartz and sergeant at arms, Richard Tice.

A TECHNICIAN'S DAY

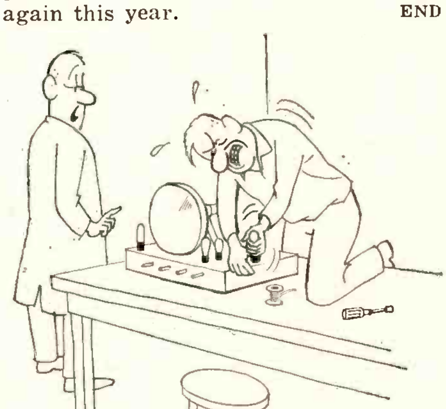
"Have you got this part for my lawn mower? What's the matter, this is a radio shop, isn't it?"

"My Space Command isn't working right, and you had better come and fix it right away. I am getting the same picture on channel 7 and channel 11." (Later she called back to say—"I am getting the same picture on my portable too on 7 and 11.")

"Just have your man stop by when he is in the neighborhood with one of those little things in a box that make the picture better."—*TSA Service News, Seattle, Wash.*

FORUM BACKS LICENSING

New York, N.Y.—Licensing TV technicians to eliminate unscrupulous self-styled repairmen was the topic of a public forum at the Hotel Diplomat. Members of the Empire State Federation of Electronic Television Associations discussed complaints and practices brought up by individuals from their communities. The group considers licensing to be one of the most desirable methods of eliminating such activities. Licenses would be issued to competent, qualified, ethical technicians and would eliminate self-styled repairmen who cannot meet the requirements of TV experience and know-how. The public was urged to write their State Senators and Assemblymen, asking them to support the licensing bill when introduced again this year. END



"Sorry, I forgot to tell you the tubes in that set screw in."

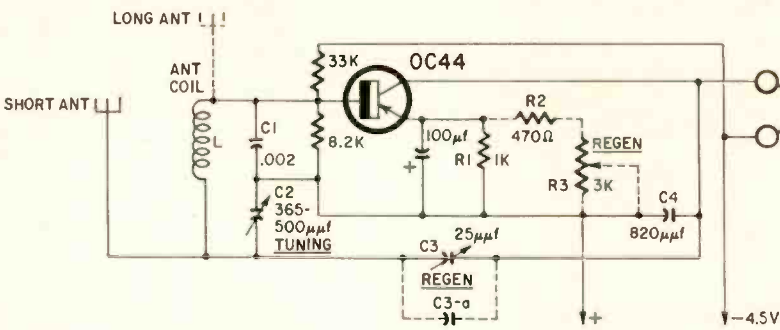
NOTEWORTHY CIRCUITS

ONE-TRANSISTOR RECEIVER

Simple transistor circuits interest neophytes and advanced experimenters alike. Here is the circuit of a high-performance regenerative receiver that appeared in *Wireless World* (London, England).

The more common regenerative sets require either a tapped tuning coil or one with a tickler winding. This circuit, based on the Colpitts oscillator, uses a capacitive voltage divider (C1 and C2) to provide the tapping point across the coil. Regeneration is controlled by feedback capacitor C3. Capacitive regeneration controls are generally quieter and smoother than resistive types, but they have a tendency to cause detuning. Some detuning occurs in this set. This is because C4 and regeneration control C3 are in series across tuning capacitor C2. You can eliminate detuning by replacing C3 with a fixed value (C3-a) and replacing emitter resistor R1 with R2 and pot (R3) in series. Now, regeneration is controlled by adjusting the emitter resistance, thus varying the collector current.

C1 is in series with C2 across the coil so the low-frequency end of the tuning range will be limited when using a nonadjustable antenna coil. You can get full tuning coverage by using an antenna coil with an adjustable ferrite core.



The set works well with a short whip antenna connected to the "hot" (collector) end of the coil. A long antenna improves reception. Connect it to the low (base) end of the coil as shown in dashed lines or to the hot end through a capacitor of around 20 μμf.

The set will cover the 140–425-kc band simply by substituting a suitable coil. For short-wave reception, use an 0C170 or equivalent high-frequency transistor and reduce the values of C1 and C2 and experiment with their ratio to obtain smooth regeneration control.

MORE TAIL-LIGHT MONITORS

I noted the tail-light monitor circuit on page 108 of the April issue and decided to send you mine. This circuit (Fig. 1) uses less than half as many parts and no harness wiring. The circuit is adapted for 6- and 12-volt cars with either negative or positive ground by using the proper pilot light and transistor. With this circuit, the light comes on when either tail light goes out. (It does not indicate which light is out but, at least, it tells you that one is not working.)

The transistor is an audio power output type like those used in auto radios. A p-n-p type is used in a car with negative ground and a n-p-n type with positive grounds. Use either a 6- or 12-volt pilot lamp with a current rating not exceeding that of the transistor.

To adjust, turn on the headlights and vary R1 until the pilot lamp comes on, then back off until it just goes out. No further adjustment should be needed. The unit can be built into a small metal box and clipped under the dashboard. The voltage drop across R2 is too small to reduce light output noticeably. I suggest mounting R2 outside the box for cooling.—*R. B. Clifton*

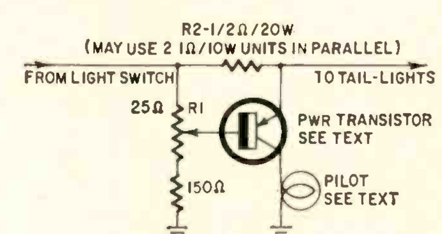


Fig. 1

Many drivers frequently overlook the colored dashboard lights used for turn,

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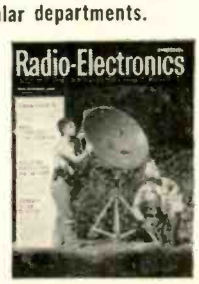

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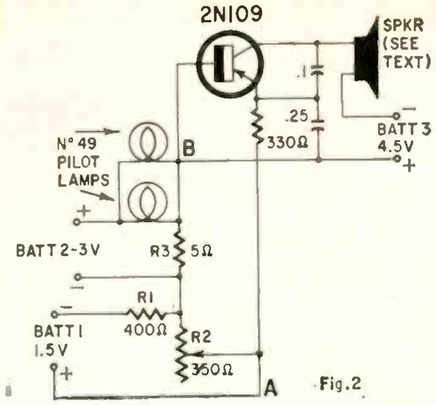

Fig.2

high-beam, ignition and oil-pressure indicators. I decided that a tail-light monitor should provide an audible signal to demand immediate attention. I haven't developed a practical circuit for my car, but the diagram (Fig. 2) shows an experimental circuit that works.

In this model I used a 3-volt battery (BATT 2) to represent the car's battery and two No. 49 (2.0-volt 60-ma) lamps as the tail lights. A 5-ohm resistor (R3) is in series with the battery and the lamps. The drop across this resistor is 0.5 volt. R1, R2 and BATT 1 are connected as shown and R2 is adjusted for zero volts (or milliamperes) between points A and B. If either lamp fails, the voltage between A and B rises to 0.25. It rises to 0.5 volt if both burn out. This small voltage triggers the transistor oscillator.

The oscillator is similar to that described by Charles Dewey in the June 1959 issue. For the speaker and oscillator tank, I used the driver element from an old (antique) horn type radio speaker. Because of the type of construction, the older elements provide higher output than the modern type.—*Robert E. Flanagan*

[Experimenters interested in the audible tail-light monitor might be able to simplify the circuit by using the car's battery for BATT 2 and BATT 3. An inexpensive audio power transistor and a small speaker and output transformer may be used in the oscillator circuit. The voltage of BATT 1 and the values of R1 and R2 can be determined experimentally. Send us details on any practical circuit that you develop from this.—*Editor*] END

We won't be able to get to that till New Year's eve.

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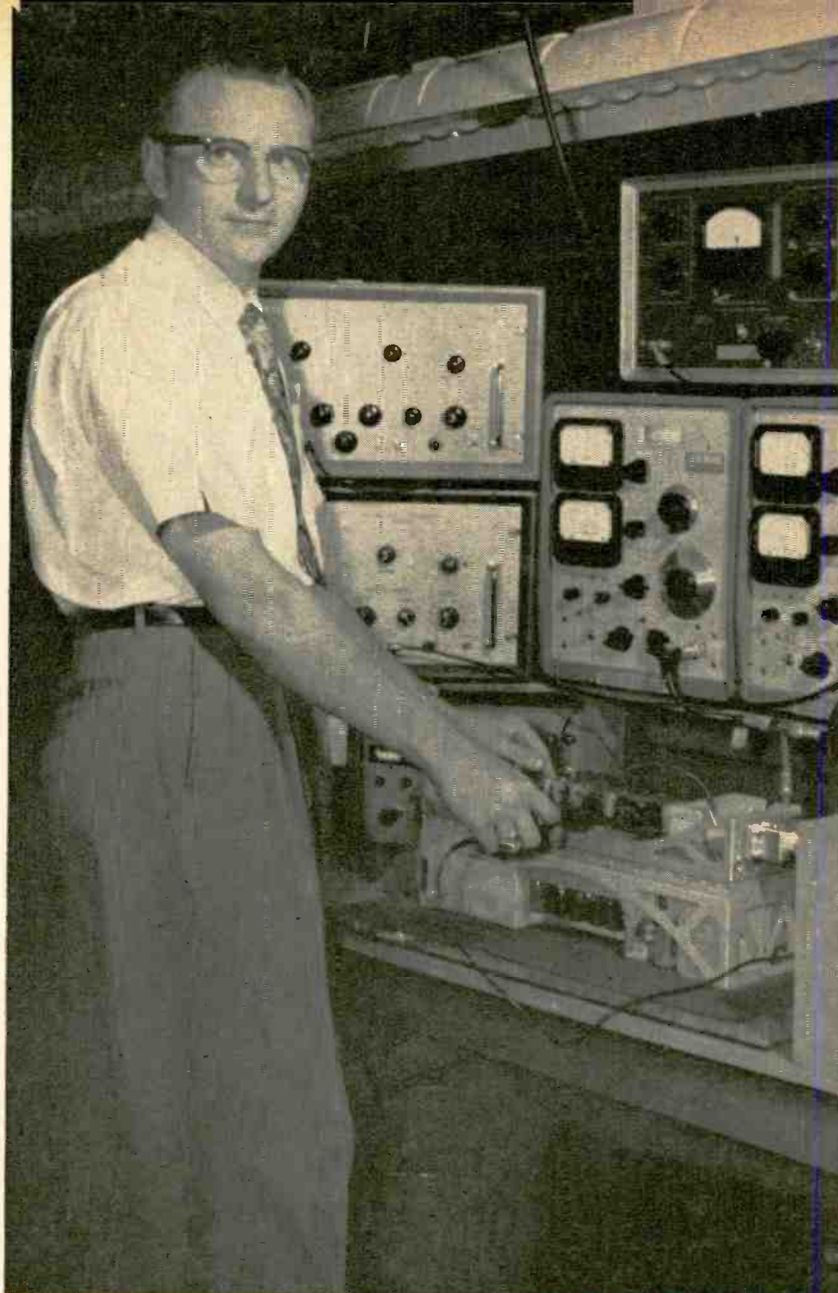

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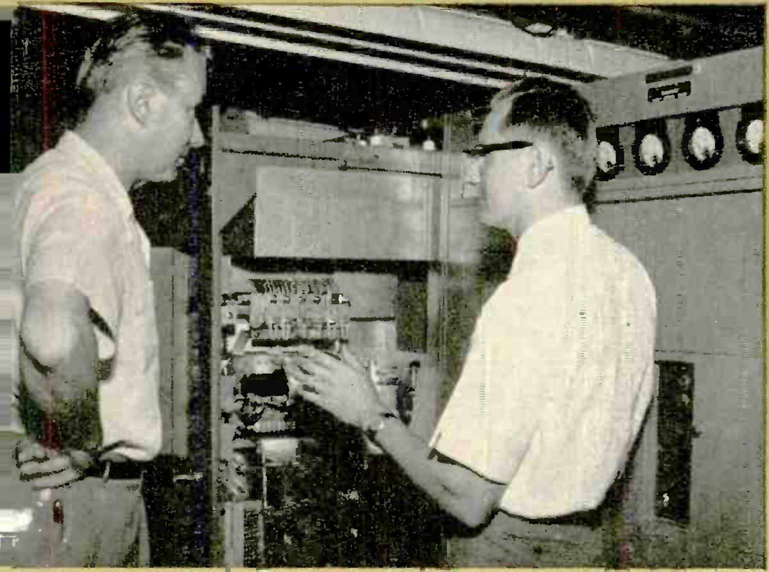

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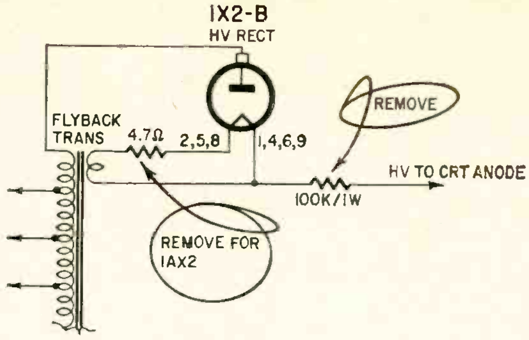


SIGNAL TRACING

Although arcing and breakdown of defective components should show up in the stage in which they are occurring, sometimes such a defect in an rf stage will not affect the signal until it has gone through the second detector. One such instance was when the 10.7-mc input if transformer of an AM–FM receiver went bad. The insulating material between the primary and secondary had broken down and tiny sparks were intermittently jumping, causing loud random noises from the speaker. Tracing the signal showed that the first place the noise became apparent was in the first audio tube although the sparks were jumping two stages ahead of the audio section. In this case, the defective transformer was located by visually sighting the tiny blue sparks.—*Alfred L. Hollinden*

WESTINGHOUSE V-2373

The trouble was no raster, sound OK. There was 15 kv on the high-voltage lead to the pix tube but a weak thin spark indicated low current. The outside man had replaced a gassy 1X2-B. On the bench all tubes checked OK.

After a while, the fault became obvious. The 1X2-B had been replaced with a 1AX2. Unfortunately, filament ratings of these two tubes are different (1X2-B—1.25 volts, 200 ma; 1AX2—1.4 volts, 650 ma).

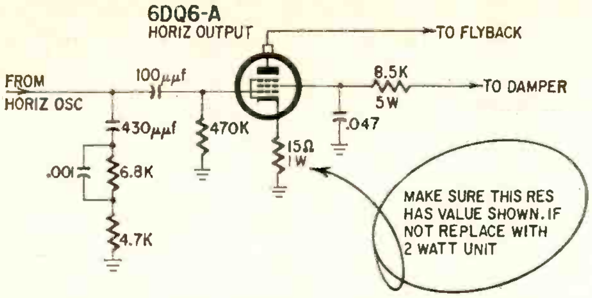
To substitute the 1AX2 for a 1X2-B, the current limiting resistor must be removed (4.7 ohms in series with the filament). At the same time, you might remove the 100,000-ohm 1-watt resistor in the high-voltage lead.—*Nate Silverman*

RCA 21CT7865

The set came in with a buzz that the volume control had no effect on. There were no bad components in the audio or sync circuits, and it looked like this job was going to be a doozy. While tapping a couple of tubes and twiddling my thumbs, I happened to move a couple of leads around. The buzz varied with the movement. Isolating the lead causing the trouble showed that the yellow lead which carries the flyback pulse from the horizontal output transformer to the plate of the agc amplifier was at fault. Changing the lead dress removed the buzz. I found that running the lead around the outside of the chassis opening for the PW200B board was best. If the lead is run across the board, you get buzz.—*Chester C. Lawrence*

MAGNAVOX CHASSIS 29 SERIES

A common complaint with this receiver is decreased horizontal size. When this happens and normal servicing does not reveal any faults, check the 6DQ6's cathode resistor (horizontal output). If off value, replace it with a



15-ohm 2-watt carbon unit. In early runs of this chassis, this resistor had a tendency to heat and change in value.—*M. L. Leonard*

TAPE RECORDER TROUBLE

A tape recorder was brought into the shop several days ago with the complaint that it was picking up signals from a local FM station. The trouble was apparently due to the tuning effect caused by inductance and capacitance in the grid circuit of the first stage, for a 10,000-ohm resistor in series with the grid cured the trouble.—*John A. Comstock*

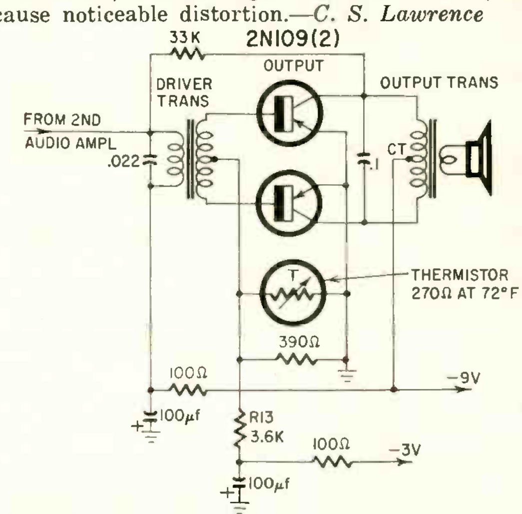
HEATHKIT FM-3A TUNER

If distortion and insensitivity on weak signals are noted, the cause is very likely in the 6AL5 detector tube. This is especially true if the no-signal background hiss cannot be heard. The tube may test good, as the trouble is excessive contact potential, which will not show up in most tests. The remedy is a new tube.—*Charles Erwin Cohn*

RCA 8-BT-10K

Complaint: Audio distortion.

Cause: Resistor R13 went up in value from its nominal rating of 3,600 ohms. It is in the bias circuit for the output transistors and as it goes up in value, the bias goes up too. As the output transistors are in a class-B circuit, a small increase in bias can make distortion noticeable. When replacing this resistor do not use a unit that measures less than 3,300 ohms, or no-signal current will become very large. However, even a slight increase above 3,600 ohms will cause noticeable distortion.—*C. S. Lawrence* END



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NEW TUBES and SEMICONDUCTORS

SEMICONDUCTORS ARE IN CONTROL AGAIN, with only one group of Novar tubes to keep them from sweeping the column this month. We start with some MADT transistors for TV if strips, look at a couple of silicon power rectifiers and go on through a backward diode, microminiature switching diode, switching transistor, power rectifiers and Novar damper tubes.

2N1745, 2N1868

Both units are p-n-p germanium micro-alloy diffused-base transistors (MADT) designed for vhf applications. The 2N1745 is intended for use as a 45-mc if amplifier in TV receivers (particularly in the first two stages) and the 2N1868 is a good final if amplifier. Both

can be used in general vhf applications to 200 mc where low-noise operation is not a major requirement.

Absolute maximum ratings for these Philco transistors are:

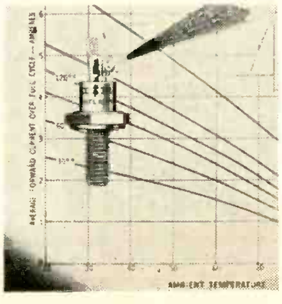
V_{CB}	20
V_{CES}	20
V_{EB}	0.5
I_C (ma)	50
P_{total} (mw)	60

Electrical characteristics are:

h_{FE} ($V_{CE}=-10$, $I_C=2$ ma) (typical)	33
PG (typical power gain) (db)	25
3-db bandwidth (typical mc)	2.4

Silicon-controlled rectifiers

Two new series of International Rectifier 3- and 5-ampere silicon-controlled rectifiers provide highly efficient

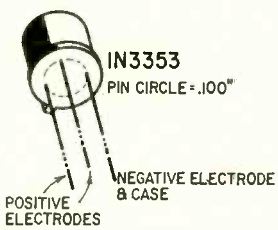


switching for computers, servomechanisms, static inverters and temperature, lighting and welding controls. The 3-ampere units, types 3RC5A to 3RC-40A, have a prv range from 25 to 400 and are are electrically, but not mechanically equivalent, to the 2N1600 to 2N-1604.

The 5-ampere series, types 5RC2A to 5RC40A, have a prv from 25 to 400 and are electrically, but not mechanically equal to the 2N1770 to 2N1777. All permit rapid firing with minimum current (2.5 ma).

1N3353

A germanium backward diode intended for use as a low-voltage unilateral coupling element for tunnel diode switching circuits and other low-level switching and uhf applications. The forward voltage at 1 ma is less than 100 mv. Two parallel positive electrode leads reduce lead inductance.



Maximum ratings for the Philco 1N3353 are:

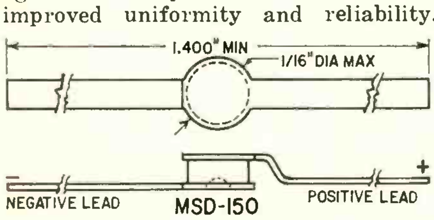
Forward current (ma)	10
Reverse current (ma)	3

Electrical characteristics are:

I_P (max peak-point current, μa)	100
V_R (typical reverse voltage when I = 1 ma)	510 mv
V_F (typical forward voltage when I = 1 ma)	80 mv

MSD-150

A microminiature very high-speed silicon switching diode for computer circuits and general-purpose applications. It incorporates an oxide passivated planar structure built in a high resistivity epitaxial layer grown on a low resistivity silicon substrate. This makes possible a diode having high conductance, fast recovery time, low leakage and low capacitance combined with improved uniformity and reliability.



Minimum conductance is 50 ma at 1 volt and recovery time is less than 2 nanoseconds.

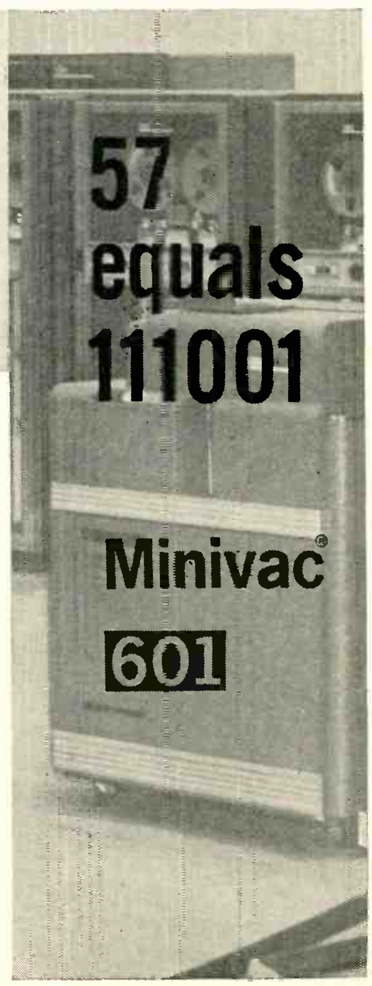
Maximum ratings of the G-E MSD-150 are:

V_R (reverse voltage)	50
I_{rect} (average rectified current, ma)	75
P_{total} (mw)	250

2N512, -A, -B

A series of p-n-p alloy-junction germanium high-power transistors for high-power conversion, high-current switching and audio amplifier output stages.

Maximum ratings for these Texas



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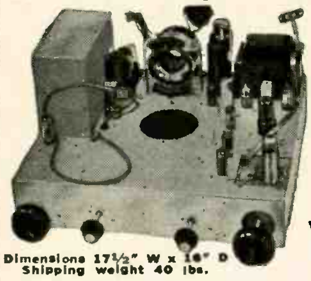

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½ WATT 10% 390k, 470k, 560k, 680k, 820k, Ω 1, 1.2, 1.5, 2.2, 4.7, 6.8, 10, 15 MEG Ω....3¢ ea.
1 WATT 10% 3.3, 10, 39, 82, 100, 120, 150, 270, 330, 390, 470, 560, 680, 820, 1k, 1800 Ω....4¢ ea.
1 WATT 10% 2700, 3300, 3900, 4700, 5600, 6800, 8200, 10k, 15k, 18k, 22k, 27k, 33k, 39k Ω...4¢ ea.
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- ☐ 4—TOGGLE SWITCHES spst, dpdt, etc. $1
- ☐ 50' ZIP CORD (2-cond) #18 brown or ivory $1
- ☐ 8—ASST. LUCITE CASES handy for parts $1
- ☐ 10—6' ELECTRIC LINE CORDS w/plugs $1
- ☐ 5—TV CHEATER CORDS w/both plugs $1
- ☐ $15—"JACKPOT" TELEVISION PARTS $1
- ☐ 1—$10 INDOOR TV ANT. hi-gain 3 sec. $1
- ☐ 100'—TWIN LEAD-IN WIRE 300Ω heav.duty $1
- ☐ 50'—FLAT 4-COND. WIRE many purposes $1
- ☐ 15—ASST. STANDARD TUNER VHF STRIPS $1
- ☐ 6—ASST. UHF STANDARD TUNER STRIPS $1
- ☐ 5—SETS SPEAKER PLUGS wired $1
- ☐ 3—AUDIO OUTPUT TRANS. 6K6 or 6V6 $1
- ☐ 2—AUDIO OUTPUT TRANS. 6K6 push-pull $1
- ☐ 3—AUDIO OUTPUT TRANS. 3Q4, 3Q5, 3S4 $1
- ☐ 10—CHOKE TRANS. 75Ω, 1 hy, 100 ma $1
- ☐ 4—50' SPOOLS HOOK-UP WIRE 4 colors $1
- ☐ 1—5" PM SPEAKER alnico #5 magnet $1
- ☐ 1—4" PM SPEAKER alnico #5 magnet $1
- ☐ 1—3" PM SPEAKER alnico #5 magnet $1
- ☐ 1—3½" TWEETER SPEAKER for Hi-Fi $1
- ☐ 3—AUDIO OUTPUT TRANS. 50L6 type $1
- ☐ 2—AUDIO OUTPUT TRANS 50L6 pushpull $1

"ONE DOLLAR" Buys

As much as $15 worth — Everything Brand New and sold to you with a money back guarantee.

DEDUCT 10% ON ANY ORDER OF $10 OR OVER
(ON DOLLAR BUYS)

Plus a FREE SURPRISE PACKAGE

- ☐ 100—ASST. ½ WATT RESISTORS some 5% $1
- ☐ 70—ASST. 1 WATT RESISTORS some 5% $1
- ☐ 35—ASST. 2 WATT RESISTORS some 5% $1
- ☐ 40—ASST. PRECISION RESISTORS 1% $1
- ☐ 35—CERAMIC 20 MMF COND. 2 percenters $1
- ☐ 35—CERAMIC 30 MMF COND. 2 percenters $1
- ☐ 300—ASST. ½ WATT RESIST'RS short leads $1
- ☐ 50—ASST. MOLDED COND. short leads $1
- ☐ 100—RUBBER FEET for cabinets best sizes $1
- ☐ 4—OVAL LOOP ANTENNAS ass't hi-gain $1
- ☐ 3—LOOPSTICK ANT. latest type adjustable $1
- ☐ 3—I.F. COIL TRANSFORMERS 262kc(auto) $1
- ☐ 3—VARIABLE COND. super 420/162 mfd $1
- ☐ 3—ASST. SIZES RADIO CHASSIS PANS $1
- ☐ 20—ASST. PILOT LIGHTS popular types $1
- ☐ 3—½ MEG. VOLUME CONTROLS w/switch $1
- ☐ 5—½ MEG VOLUME CONTROLS less switch $1
- ☐ 5—ASST. 4 WATT WIREW'D CONTROLS $1
- ☐ 10—ASST. VOLUME CONTROLS less switch $1
- ☐ 5—ASST. VOLUME CONTROLS w/switch $1
- ☐ 200'—BUSS WIRE handiest size #20 $1
- ☐ 250—ASST. SOLDERING LUGS best sizes $1
- ☐ 10—SURE GRIP 2" ALLIGATOR CLIPS $1
- ☐ 1—GOLD GRILLE CLOTH 14x14or12x18 $1
- ☐ 10—SETS PHONO PLUGS and PINJACKS $1
- ☐ 3—I.F. COIL TRANSFORMERS 456 kc $1
- ☐ 2—I.F. COIL TRANS. G.E.#RTL143, 456kc $1
- ☐ 3—I.F. COIL TRANSFORMERS 10.7mc FM $1
- ☐ 50—ASST. TERMINAL STRIPS 1, 2, 3, 4 lug $1
- ☐ 35—ASST. RADIO KNOBS, screw, push-on $1
- ☐ 100—ASSORTED KNOB SET-SCREWS $1
- ☐ 25—ASS'TED RADIO DIAL POINTERS $1
- ☐ 25—ASS'TED CLOCK RADIO KNOBS $1
- ☐ 35—ASST. SOCKETS 7 pin, 8 pin, 9 pin $1
- ☐ 25—ASST. PRINTED CIRCUIT SOCKETS $1
- ☐ 100'—FINEST NYLON DIAL CORD best size $1
- ☐ 25—ASST. PEAKING COILS popular types $1
- ☐ 2—RCA SYNCHRO-GUIDE COILS #205R1 $1
- ☐ 2—RATIO DETECTOR COILS 4.5 mc $1
- ☐ 2—RATIO DETECTOR COILS 10.7 mc $1
- ☐ 2—TV SOUND I.F. COILS 4.5mc $1
- ☐ 35—CERAMIC COND. 20-1000, 15-1500mmf $1
- ☐ 35—CERAMIC COND. 20-2000, 15-5000mmf $1
- ☐ 4—RCA 1U4 TUBES also serves as a 1T4 $1
- ☐ 3—SYLVANIA 35W4 TUBES $1
- ☐ TOP BRAND TUBES—1B3, 1X2B, OZ4, 5U4, 6SN7, 6CB6, 6U8, 6J6, 6V6, 6K6, 6X8, 6AX4, 6AC7 12AT7, 12AU7 Each $1
- ☐ 25'—INSULATED SHIELDED WIRE $1
- ☐ 20—ASST. TV KNOBS, ESCUTCHEONS, etc. $1
- ☐ 15—ASST. TV COILS sync, peaking, width $1
- ☐ 5—TV CRT. SOCKETS with 18" leads $1
- ☐ 10—ASST. RADIO & TV TUBES $1
- ☐ 10—SYLVANIA 1AB5 TUBES $1
- ☐ 1—LB. SPOOL ROSIN CORE SOLDER 40/60 $1
- ☐ 50'—HI-VOLTAGE WIRE top quality $1
- ☐ 5—HI-VOLT. ANODE LEADS with 20" leads $1
- ☐ 32' TEST PROD. WIRE deluxe (red or black) $1
- ☐ 600—ASST. HDWARE screws, nuts, riv., etc. $1
- ☐ 200—SELF TAPPING SCREWS #8 x ½" $1
- ☐ 50—ASSORTED FUSES popular sizes $1
- ☐ 50—ASST. TUBULAR CONDENSERS $1
- ☐ 50—STRIPS ASS'TED SPAGHETTI best sizes $1
- ☐ 100—ASST. RUBBER GROMMETS best sizes $1
- ☐ 15—TUBULAR CONDENSERS .047-600V $1
- ☐ 20—TUBULAR CONDENSERS .01-600v $1
- ☐ 15—TUBULAR CONDENSERS .1-600v $1
- ☐ 15—TUBULAR CONDENSERS .25-600v $1
- ☐ 3—ELECTROLYTIC COND. 50/30-150v $1
- ☐ 2—ELECTROLYTIC COND. 80/80/20-150v $1
- ☐ 10—ASST. RADIO ELECTROLYTIC COND. $1
- ☐ 5—ASST. TV ELECTROLYTIC COND. $1
- ☐ 2—ELECTROLYTIC COND. 40/40—450v $1
- ☐ 4—ELECTROLYTIC COND. 80-400v $1
- ☐ 3—ELECTROLYTIC COND. 16/16-450v $1
- ☐ 2—ELECTROLYTIC COND. 50/50-150v $1
- ☐ 50—ASST. CERAMIC COND. some in 5% $1
- ☐ 50—100KΩ ½ WATT RESISTORS 10% $1
- ☐ 50—220K ½ WATT RESISTORS 10% $1
- ☐ 50—470KΩ ½ WATT RESISTORS 10% $1
- ☐ 50—ASST. MICA CONDENSERS some in 5% $1
- ☐ 20—ASST. WIREW'ND RES. 5, 10, 20 watt $1
- ☐ 35—ASST. DISC CERAMICS best numbers $1
- ☐ 35—DISC CERAMICS 5000 mmf $1
- ☐ 25—ASSORTED MICA TRIMMER COND. $1
- ☐ 5—DIODE CRYSTALS 2-1N21 1-1N64 1-1N60 1-1N82 $1
- ☐ 4—DIODE CRYSTALS 1-1N34 1-1N60 1-1N64 1-1N69 $1
- ☐ 3—SELENIUM RECT. 2-65ma & 1-75ma $1
- ☐ 2—SELENIUM RECT. 1-100ma & 1-250ma $1
- ☐ 2—SELENIUM RECT. 1-75ma & 1-350ma $1
- ☐ 2—SELENIUM RECT 1-65ma & 1-450ma $1
- ☐ 2—SOUND DISCRIMINATOR COILS 10.7mc $1
- ☐ 1—70° FLYBACK TRANS. incl schematic $1
- ☐ 1—90° FLYBACK TRANS. incl schematic $1
- ☐ 1—SILICON RECTIFIER 750 ma 500v $1
- ☐ 2—SILICON RECTIFIERS 500 ma $1
- ☐ 3—TV ALIGNMENT TOOLS assortment #1 $1
- ☐ 3—TV ALIGNMENT TOOLS assortment #2 $1
- ☐ 3—TV ALIGNMENT TOOLS assortment #3 $1
- ☐ 3—TV ALIGNMENT TOOLS assortment #4 $1
- ☐ 3—TV ALIGNMENT TOOLS assortment #5 $1

EACH ALIGNMENT TOOL is different & valued at over $1

HANDY WAY TO ORDER—Simply tear out advertisement and pencil mark items wanted (X in square is sufficient); enclose with money order or check. You will receive a new copy of this ad for re-orders.

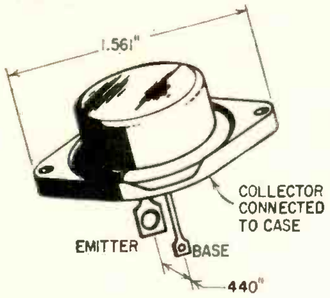
ON SMALL ORDERS—Include stamps for postage, excess will be refunded. Larger orders shipped express collect.

BROOKS RADIO & TV CORP., 84 Vesey St., Dept. A, New York 7, N.Y.

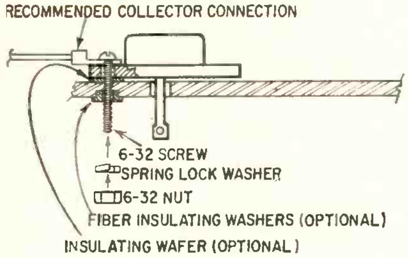
TELEPHONE COrtland 7-2359

Instruments transistors are:

I_C (amps)	25
I_B (amps)	5
P_{total} (watts)	150



RECOMMENDED COLLECTOR CONNECTION



2N512,-A,-B

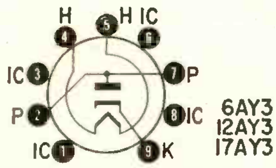
Electrical characteristics are:

	2N512,	-A	-B
BV_{CBO} (I_C=5 ma, I_E=0)	40	60	80
BV_{CEO} (I_C=500 ma, I_B=0)	30	40	45
h_{FE} (V_{CE}=2, I_C=15 A)	20	20	20

All ratings in this section are minimum figures.

6AY3, 12AY3, 17AY3

A series of half-wave vacuum rectifiers designed for use as damper diodes in horizontal deflection circuits of black-and-white TV receivers. All are in the 9-pin Novar envelope. Except for heater ratings, electrical characteristics are the same for all three. The 6AY3 has a 6.3-volt 1.2-amp heater; the 12AY3 is rated at 12.6 volts 600 ma, and the 17AY3 at 16.8 volts 450 ma.

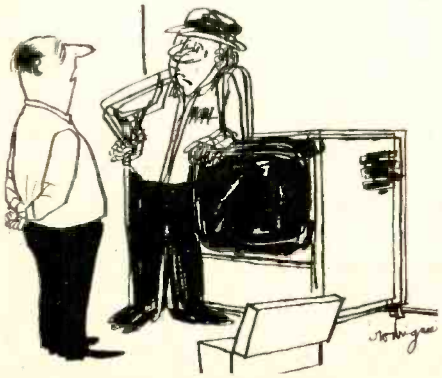


The 12AY3 and 17AY3 have an 11-second controlled warmup for use in series-string heater circuits.

Maximum ratings for these RCA tubes in damper service are:

PIV_P	5,000
I_P (peak amps)	1.1
(dc ma)	175
P_P (watts)	6.5

END



"Say, maybe it is me!"

new PATENTS

CONTROL SYSTEM

Patent No. 2,967,278

James F. Sullivan and Vincent J. Lique, Danbury, Conn. (Assigned to Intl. Instruments, Inc., New Haven, Conn.)

Transistor circuitry plus a special meter are used to close an external circuit when current falls below a minimum limit. The circuit is opened when the current exceeds a maximum. Unlike present instruments, the pointer of this meter does not have to be attracted to and held by a magnet.

In Fig. 1, V1 is a 65-kc Colpitts oscillator. L1, L2 (generating coils) are each wound with 600 turns of No. 40 wire. They act as a tank. L3, L4 (pickup coils) each have 5,000 turns of No. 45 wire.

V2, V3 receive negative bias through R2, R3,

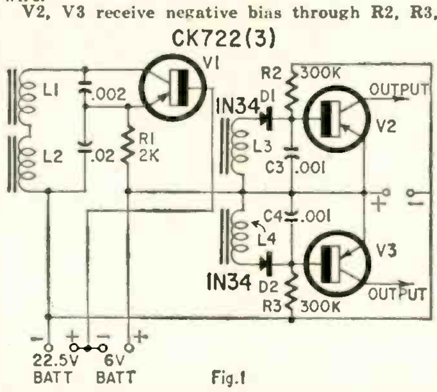


Fig.1

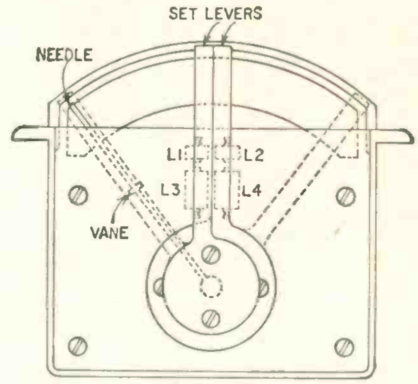


Fig.2

respectively. If the 65-kc signal is picked up by L3 (or L4), it is rectified by the diode (D1 or D2), resulting in positive bias on C3 (or C4). Normally the *positive* bias is greater, so V2 and V3 are blocked.

The meter (Fig. 2) has 2 adjustable levers which may be set to the lower and upper limits of current. One generating coil and one pickup coil are mounted on each lever. The pointer of the meter carries a magnetic vane. As the pointer deflects (beneath a lever) its vane passes between a pair of coils, shielding one from the other. The 65-kc signal disappears from the pickup coil and the corresponding transistor conducts.

The outputs (not shown) of V2 and V3 are used to energize relays for opening and closing an external circuit.

STEREO CARTRIDGE

Patent No. 2,944,118

Robert B. Gray, Erie, Pa. (Assigned to Erie Resistor Corp., Erie, Pa.)

This pickup is made of piezo-electric material. It is in the form of a bar with four arms. The junction of each pair is coated with metallic electrodes. The bar is polarized permanently by heat treatment which makes it sensitive to bending along axes X1, X2 (Fig. 1).

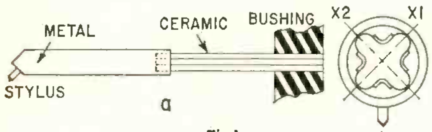


Fig.1

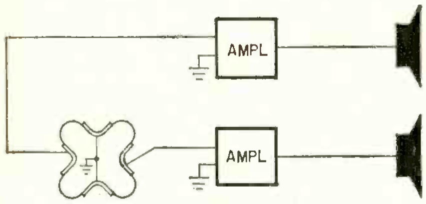


Fig.2

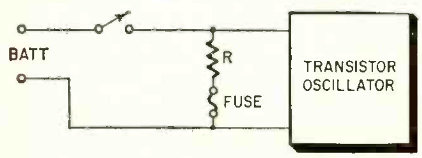
The upper and lower electrodes are grounded (Fig. 2) and output is obtained from the other electrodes. Each stereo channel of a record exerts a force on the stylus which creates a strain along the two axes. Output from the side electrodes feeds separate amplifiers and speakers. Crosstalk between channels is less than 20 db.

OSCILLATOR STARTER

Patent No. 2,970,279

Edward P. Donnelly, Jr., Seattle, Wash. (Assigned to USA as represented by Secretary of Navy)

Most transistor experimenters have noticed that it takes greater forward bias to start an oscillator than to keep it running. As an example, the inventor cites a sonobuoy transistor oscillator energized by a sea-water battery. The battery



voltage rises gradually when immersed, and under this condition the oscillator may not start at all.

In the diagram a shunt circuit (fuse and R) is placed across the oscillator power terminals. The battery voltage rises gradually, but in time there is enough power to blow the fuse. At this instant, a surge of current flows into the oscillator, assuring its operation.

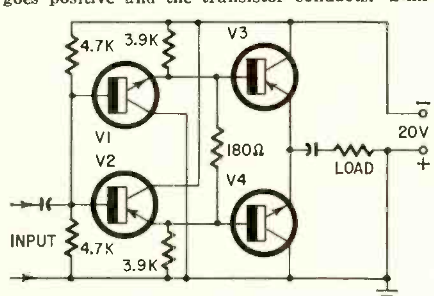
CLASS-B AMPLIFIER

Patent No. 2,955,257

James E. Lindsay, Moorestown, N.J. (Assigned to RCA)

A class-B driver feeds a class-B output stage. Complementary type transistors are used in each stage.

With *positive* input, V1 conducts and V2 blocks. The drop across V1's collector drives the base of V3 positive and blocks it. With flow through V2's emitter resistor cut off, V4's base goes positive and the transistor conducts. Simi-



lar reasoning shows that V2, V3 conduct and V1, V4 block when the input is *negative*.

One end of the load (or loud-speaker) connects the emitters of V3, V4. The other end goes to their collectors (battery impedance is zero for ac). Thus, during one half-wave of signal, the load is fed in one direction by V4. During the other half-wave, it is fed in the opposite direction by V3. END

INSULATE SPLICES FAST

I always keep a length of Alphex shrinkable tubing on the bench. It has many uses. Best one is to insulate splices. Slip a length of tubing over one of the wires to be spliced. Then make

the splice just as you always do. Now center the tubing over the splice and heat it with your soldering iron. The heat will cause the tubing to shrink, making a neat tight insulated joint.—*Larry Steckler*

SERVICE TOOL

Braze or weld the stump of an Allen wrench to the shank of an old screwdriver to make a handy tool for reach-

ing Allen setscrews in cramped locations. A set of these, in varied sizes, makes a time-saving accessory.—*Harry J. Miller*

SAVE DRILL BITS

Breakage of ¼-inch drill bits in hole saws ran high while drilling light metal chassis. When the bit went through the metal, it was difficult to keep it from breaking. We stopped this expensive annoyance by using the ¼-inch bit only to drill the center hole. Then it is removed and a piece of ¼-inch steel rod is substituted in the center of the saw.

Tapering the end slightly, drill holes with the hole saw.—*S. Clark*

CHECKING SWITCHES

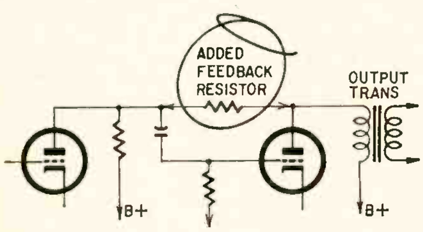
One of my friends was recently drafted, and I bought his collection of radio–TV "junk" which, among other things, included 183 miscellaneous rotary and pushbutton switches. Some are from junked ac–dc–battery radios; others are surplus.

I got tired of connecting ohmmeter leads to a pair of switch contacts, then looking up at the ohmmeter, to see if I got a reading. So, I simply hooked up the 6.3-volt winding from a power transformer to an ancient car radio vibrator and merely listened for the noisy vibrator to learn whether or not there was continuity between the switch contacts to which battery clips are connected. Also, as his vibrator takes more current than an ohmmeter, a bad switch contact is easily detected—vibrator vibrates very weakly and erratically.—*Nate Silverman*

FEEDBACK FOR AUDIO CIRCUITS

The tone quality of small radios and phonographs can be considerably improved by adding inverse feedback. Hum is also reduced and the frequency range extended.

A simple method of adding inverse feedback is to connect a 470,000- to 750,000-ohm resistor from the plate of the power output stage to the plate of the preceding amplifier (see diagram). A



higher value of resistance results in less feedback and a lower value produces more. A ½-watt rating is satisfactory for the resistor.

If you have a push-pull output stage, two identical resistors are used. The correct connection is the one which results in a loss of volume.

The difference in quality is noticeable and the slight cost and small effort worth while. There is a small loss of volume but most audio stages have plenty of gain.—*Herbert Greenberg*

END

50 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
Practical Electrics	1921
Television	1927
Radio-Craft	1929
Short-Wave Craft	1930
Television News	1931

Some larger libraries still have copies of Modern Electrics on file for interested readers.

In January, 1912, *Modern Electrics*

The Marconi Multiple Tuner.
Tuned Waves, by F. M. Doolittle.
Image Transmission.
Wireless Telegraphy and Aeroplanes.
Enclosed Combination Detector, by Stanley E. Hyde.
Telephotography, by E. Dickey.

new BOOKS

STATIC RELAYS FOR ELECTRONIC CIRCUITS. *Edited by Richard F. Blake. Reinhold Publishing Corp., 430 Park Ave., New York, N.Y. 6 x 9 in., 198 pp. $7*

The design and application of solid-state, magnetic amplifier, and other nonmechanical relays.

HOW TO LOCATE AND ELIMINATE RADIO AND TV INTERFERENCE (2nd Edition), by Fred D. Rowe. *John F. Rider Publisher, Inc., 116 W. 14th St., New York 11, N.Y. 5½x8½ in. 160 pp. $2.90.*

This practical book describes methods and equipment for reducing radiation from power lines and appliances.

LINEAR GRAPHS AND ELECTRICAL NETWORKS, by Sundaram Seshu and Myril B. Reed. *Addison-Wesley Publishing Co., Inc., Reading, Mass. 6 x 9 in. 315 pp. $9.75.*

An introduction to a graphical, mathematical method for solving networks, including applications to digital computers, switching, logic. For advanced students.

TEACH-R-MATIC STUDY COURSE NO. TV-1, by H. G. Cisin. *Harry G. Cisin, Amagansett, N.Y. 8½ x 11 in. plus rotating circular disc chart 11½-in. diameter. 11 pp. $4.90.*

New approach to teaching radio servicing uses "reinforced response" techniques. Numbered answers to multiple-choice questions in book are selected by turning disc chart, which indicates accuracy of answer.

TRANSISTOR CIRCUIT ANALYSIS, by Maurice V. Joyce and Kenneth K. Clarke. *Addison-Wesley Publishing Co. Inc., Reading, Mass. 6 x 9 in. 461 pp. $10.75.*

Mathematical analysis of amplifiers, switches, oscillators and multivibrators, for designers and advanced engineering students.

A PICTORIAL ALBUM OF WIRELESS AND RADIO 1905–1928, by Harold S. Greenwood. *H. S. Greenwood, 2341 Ivyland, Arcadia, Calif. 5½ x 8½ in. 219 pp. $3.*

A collection of photographs and reproductions of advertisements of components, radio sets, tubes and kits, from the first detectors (coherers) and early variable condensers to the first television kit. There is some explanatory text and a number of reproductions of old ads and magazine pages.

INDUSTRIAL ELECTRONICS MADE EASY, by Tom Jaski. *Gernsback Library, 154 W. 14th St., New York 11, N.Y. 5½ x 8½ in. 288 pp. $3.95.*

A complete introduction covering generators, counters and computers, controls, recorders, transducers and service instruments and practices. END

SCHOOL DIRECTORY

R-E Classified ADS

Rates—50¢ per word (including name, address and initials. Minimum ad 10 words. Cash must accompany all ads except those placed by accredited agencies. Discount, 10% for 12 consecutive issues. Misleading or objectionable ads not accepted. Copy for March issue must reach us before Dec. 11, 1961.
RADIO-ELECTRONICS, 154 West 14 St., New York 11, N. Y.

FOR SALE

Electronics

HOFFMAN silicon solar cells, type 120C. Minimum output current 23 ma, minimum power 9 mw at 10,000 foot-candle sunlight with 400-mv load. Size .788x.394x.025". Temperature range -65° to 175°C. Cells unmounted without leads. Reg net $2.40, ONLY 3 for $1.25; 6 for $2.25. Unused, postpaid. Satisfaction guaranteed! Rush check or MO. No COD. **CLARK ELECTRONICS**, 190 W. Santa Clara, San Jose 13, Calif.

PRINTED CIRCUITS. Free catalog lists hundreds of circuits. **CLOUD "9" ENGINEERING**, Brookdale, Calif.

SHORT CIRCUITS pinpointed within 5 feet or your $4.50 back. Own a patented pocket-size Dynamic Short Locator. **DYNAMICO**, 11370 SW 60th Terr., Miami 43, Fla.

REWIND electric motors yourself. Send $1.00 today; receive rewinding data for 300 single-phase motors, plus wholesale parts catalog, plus big bargain circular, by return mail. **MODERN**, Box 8715, Kansas City 14, Mo.

TRANSISTOR IGNITION—save gas, tune-ups. Points, plugs last 50,000-100,000 miles. Improved cold starting, high-speed performance. Complete negative-ground 12v system, $29.50. Special coil, $9.50. **PALMER ELECTRONICS**, Carlisle, Mass.

RADIO TOWER, 205' in 20' sections. All guy wires, Revere beacon, obstruction lights, model 1615 Revere, steel, painted CAB regulations, Like new. Manufactured by Modern Electronics Company. Original cost $4,250.00. Our price $1,500.00 FOB Vicksburg, Miss. **W. J. RUNYON & SON INC.**, 3312 Oak St., Vicksburg, Miss.

SCHEMATICS, repair information. Television $1.50. Radio 75¢. Send make and model. **SCHEMATICS UNLIMITED**, Box 65, Flushing 64, N.Y.

SCHEMATIC DIAGRAMS, exact replacement parts orders: Japanese transistor or tube radios, recorders, transceivers, electronics equipment. Give model and manufacturer, $1.00. **TECHERVICES**, CPO 849, Tokyo, Japan.

TV, RADIO tubes and parts wholesale. Brand New. List free. **R T M CO.**, 508 Clifford, Flint 3, Mich.

4MF/600V oils, 19¢. Many receiving tubes, 19¢. Motor brushes, 3¢. **MAX ABRAMSON**, 3238 Eliot Blvd., Oceanside, N.Y.

DOOR OPERATOR, $59.95. Automatic chain drive. Not a kit—highest quality. Free Literature. **DEMSCO**, Sebring 25, Ohio.

SEND FOR FLYERS listing transmitters, receivers, teletype converters, tubes, components. **SPERA ELECTRONICS**, 37-10 33 St., Long Island City 1, N.Y.

SUPERSENSITIVE directional microphone picks up a whisper at great distances. Used by investigators to record faint, distant sounds without being detected. Easily constructed for about $7. Step-by-step plans, $1.95. **DEE CO.**, Box 7263-A, Houston 8, Tex.

TELEVISION TUBES 60% off. Brand-new, no factory rejects. First line. Prepaid. **PARKWAY ELECTRONICS**, Vestal, N.Y.

APPLIANCE LAMP, range, vacuum parts wholesale. Catalog 25¢. **SECO**, 112 So. 20th St., Birmingham 3, Ala.

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3BA6	.51	6BG6	1.66	6W4	.60	12EN6	.78
3BC5	.54	6BH6	.65	6W6	.71	12EZ6	.53
3BE6	.52	6BH8	.87	6X4	.39	12F8	.66
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3S4	.61	6BY5	1.15	8AW8	.93	12SJ7	.67
3V4	.58	6BY6	.54	8BQ5	.60	12SK7	.74
4BQ7	1.01	6BY8	.66	8CG7	.62	12SL7	.80
4BZ7	.96	6BZ6	.55	8CM7	.68	12SN7	.67
4BZ8	1.10	6BZ7	1.01	8CN7	.97	12SQ7	.78
4CS6	.61	6BZ8	1.09	8CS7	.74	12U7	.62
4DT6	.55	6C4	.43	8CX8	.93	12V6	.53
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5AV8	1.01	6CG8	.77	12AB5	.55	17W6	.70
5BC8	.79	6CK4*	.70	12AC6	.49	18FW6*	.49
5BE8	.83	6CL8	.79	12AD6	.57	18FX6*	.53
5BK7	.82	6CM6	.64	12AE6	.43	18FY6*	.50
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5BR8	.79	6CM8*	.90	12AF3	.73	19BG6	1.39
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5CM8*	.90	6CS6	.57	12AL8	.95	25AV5	.83
5CQ8	.84	6CS7	.69	12AQ5	.60	25AX4	.70
5CZ5*	.72	6CU5	.58	12AT6	.43	25BK5	.91
5EA8	.80	6CU6	1.08	12AT7	.76	25BQ6	1.11
5EU8	.80	6CY5*	.70	12AU6	.51	25C5	.53
5J6	.68	6CY7	.71	12AU7	.60	25CA5	.59
5T8	.81	6DA4*	.68	12AV6	.41	25CD6	1.44
5U4	.60	6DB5	.69	12AV7	.75	25CU6	1.11
5U8	.81	6DB6	.51	12AX4	.67	25DN6	1.42
5V3	.90	6DE6	.58	12AX7	.63	25EH5	.55
5V6	.56	6DG6	.59	12AY7	1.44	25L6	.57
5X8	.78	6DK6	.59	12AZ7	.86	25W4	.68
5Y3	.46	6DN6	1.55	12B4	.63	32ET5	.55
6AB4	.46	6DQ6	1.10	12BA7	.84	32L7	.90
6AC7	.96	6DT6	.53	12BD6	.50	35B5	.60
6AF3	.73	6DT8*	.79	12BE6	.53	35C5	.51
6AF4	.97	6EA8	.79	12BF6	.44	35L6	.57
6AG5	.68	6EB5*	.72	12BH7	.77	35W4	.42
6AH4	.81	6EB8	.94	12BK5	1.00	35Z5	.60
6AH6	.99	6EM5*	.76	12BL6	.56	36AM3*	.36
6AK5	.95	6EM7	.82	12BQ6	1.06	50B5	.60
6AL5	.47	6EU8	.79	12BR7	.74	50C5	.53
6AM8	.78	6EW6	.57	12BV7	.78	50EH5	.55
6AQ5	.53	6EY6*	.75	12BY7	.77	50L6	.61
6AR5	.55	6F5GT	.39	12BZ7	.75	70L7	.97
6AS5	.60	6FE8	.75	12C5	.56	7025	.69
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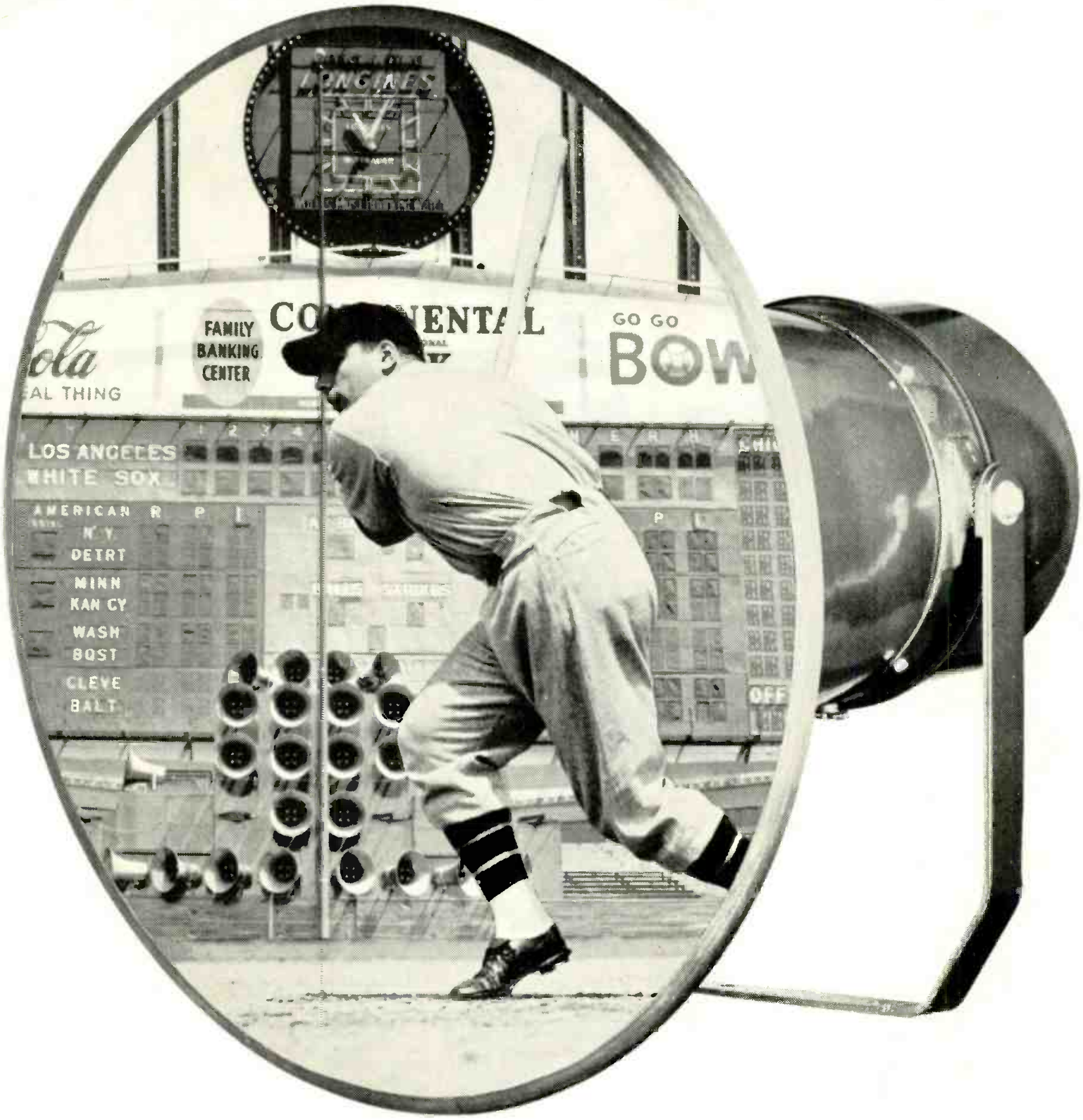

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