IND

July 1960

Radio-Electronics

How Air Ionizers Work

HUGO GERNSBACK, Editor

Modern Industrial Oscillographs

Build a Reflex Pocket Radio

Servicing Horizontal Output Stages

Boating Made Easy With Electronics

See page 29

50c


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Model	Type	Output	Frequency Range	Impedance	Finish	List Price
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333	Ceramic	-58 db	30-12,000	High		17.90
335H	Dynamic	-56 db	50-12,000	High	TV Grey Body, Chrome Cap and Grille	26.50
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NOTE: Model 331 has momentary-on, spring-return switch, is furnished with hang-up bracket. Cable provides for audio and relay connections. All other models have slide switch with "lock-on" position, are complete with lavalier and stand adaptor with 5/8"-27 thread.

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JULY, 1960

Radio-Electronics

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EDITORIAL

ELECTRONICS

TEST INSTRUMENTS

WHAT'S NEW

INDUSTRIAL ELECTRONICS

TELEVISION

AUDIO-HIGH FIDELITY

RADIO

ON THE COVER

(Story on page 29)

Sales and service of small-boat radio and electronic equipment are fast-growing fields. Photo shows 7-inch radar and miniature depth sounder on small power boat. Equipment may also include fuel-vapor detector, direction finder and radiophone.

Color original by Raytheon

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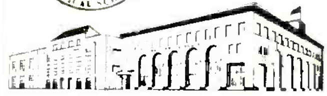

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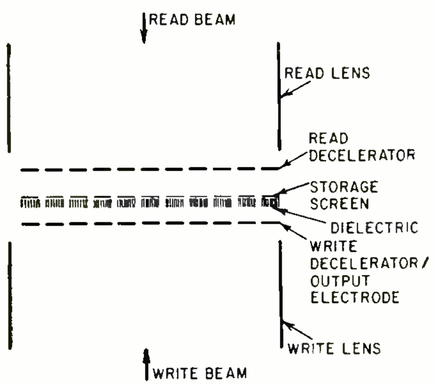
News Briefs

Dual-Gun Recording Tube

This device, which looks like two cathode-ray tubes fused together, face to face, has more than double the resolution of other types now available. The Raytheon CK7702 is said to enable bright video display with high resolution and adjustable automatic priming or erasing which can be used to generate target trails for electronic plotting of even high-speed jet planes.



The storage assembly (see diagram) is made up of three fine-mesh (750 wires per inch) screens. The center one is coated on one side with a thin layer of dielectric that can hold an impressed charge for several hours. The electron gun facing this surface is used for writing and erasing. The gun on the opposite side is used for reading the stored image.

Russians Test Color TV

First test of color TV transmissions in the Soviet Union have been announced. Experimental broadcasts were held in Leningrad through a closed-circuit system serving 12 sets.

Radio Beam Injurious

Pulses from forward-scatter transmitters in the NATO telecommunications network in Britain have been called dangerous to anyone within a mile of the beam source. A panel of British experts says that the old safety limit is much too short.

When the scatter stations were discussed more than a year and a half ago, the British Ministry of Defense stated the danger zone did not extend more than 40 or 50 yards from the transmitters. Scientists who worked on the units said that the zone should be extended to at least half a mile. The latest figures show that the zone extends for about 1 mile. Persons straying into the path of the beam could suffer eye injuries or even be "cooked," depending on how close to the source they are and how long they stay.

Remote Control at 8,001,000 Miles

A brief radio signal from the Jodrell Bank radiotelescope in Manchester, England, has turned on a 150-watt transmitter aboard the Pioneer V satellite, the most powerful transmitter ever flown in a deep-space probe. Until now, a 5-watt transmitter aboard the 94.8-pound satellite relayed telemetry data back to earth. But as distance reached the critical 8,000,000-mile point, data transmission was slowed down to about one bit of information per second. The new transmitter gets off as many as 25 bits per second. The actual turn-on took place when the satellite was 8,001,000 miles out on its expected 515,000,000-mile orbit of the sun.

The transmitter was turned on with a series of control signals. The first applied power to the transmitter's tube filaments through a current-limiting resistor, warming them for about 1 minute. This step was repeated six hours later and immediately followed by a second control signal which removed the current-limiting resistor and applied full filament voltage for several minutes. In the last step, the control signal turned on the electric converter that powers the 150-watt transmitter and the transmitter itself.

A short time after being turned on, damaged batteries aboard Pioneer V put the 150-watt transmitter out of action. Now only the 5-watt unit is still operating and its signals are still being received.

All transmissions are being triggered and received at either the 250-foot radiotelescope at Jodrell Bank or the 60-foot unit at South Point, Hawaii.

A replica of the instrument-crammed Pioneer V is shown in the photo. The transmitter uses RCA ceramic-metal tubes similar to the one held by the young lady. The transmitter is packed inside the

men 17-55

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Power for the probe comes from 4,800 solar cells in four arms jutting from the 26-inch spherical package. The solar-cell output constantly charges 28 chemical batteries, the size and shape of standard flashlight cells only a great deal more powerful. These in turn power more than 40 pounds of electronics, a receiver, transmitters and associated logic units.

Stereo Disc Sales Up

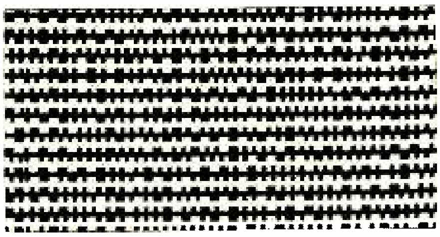
A survey of a representative group of dealers in the New York area has revealed that sales of stereo discs for the first 4 months of the year average about 20% of total album sales. The percentage varies from dealer to dealer—5% to 45%.

For the same period last year, the average was about 14%, with no store having an individual average higher than 35%.

Translating Machine

A new high-speed translator has been translating Russian into English since June, 1959, according to International Business Machines Corp. IBM developed the machine under an Air Force contract.

The machine (or system) consists of an input Flexowriter, input register, dictionary and output Flexowriter. The dictionary is a 10-inch glass disc with about 50,000 words on it in the form of a black-and-white square-wave pattern on a set of circular tracks (see photos, one



shows disc, other shows 300× enlargement of tracks). The disc spins at 1,400 rpm, thus bringing each "bit" of information on it within quick reach of a beam of light from a cathode-ray tube (35 milliseconds average). A photomultiplier tube indicates whether the scanned spot on the disc is dark or light.

(*Continued on page* 12)

A typist copies the Russian to be translated on a special typewriter that converts the characters into holes on a tape, from which they are translated into the black-and-white language of the disc. A tape reader places a set of characters in the input register. A comparator compares them with whatever the beam is scanning, then indicates in what direction the beam should move to find the information desired. This is equivalent to an individual looking at any open page in a dictionary and then flipping pages in the right direction to get to the word he wants. The beam reads sections of each track (there are 700 of them) as it skips from one to the next. When it reaches the right track, the comparator stops it so it can read the whole track and find the word (or phrase) in the register. When the proper match is found, the English equivalent is read out and sent to the output Flexowriter. At the same time, a new set of characters is fed to the input register.

At the present time, the machine translates at about 30 words per minute. This limit is caused by the relatively slow input and output rates, not by the translator itself. By the end of the year, a special reading machine and high-speed output writers will extend the machine's speed to about 1,800 words per minute.

Since the machine translates on a word-for-word basis, the output is not grammatically correct. This is a sample from an article dated December 30, 1959 that appeared in *Pravda:*

"Let us note that addition to band visible light wave only one part radiospectrum led during the last decade to creation new science—radioastronomy with/from it truly phenomenal achievements. It allows investigators penetrate in region the most stormy nonstationary physical process, performing in celestial bodies." A word analyzer and lexical buffer now under development will allow much smoother future translations.

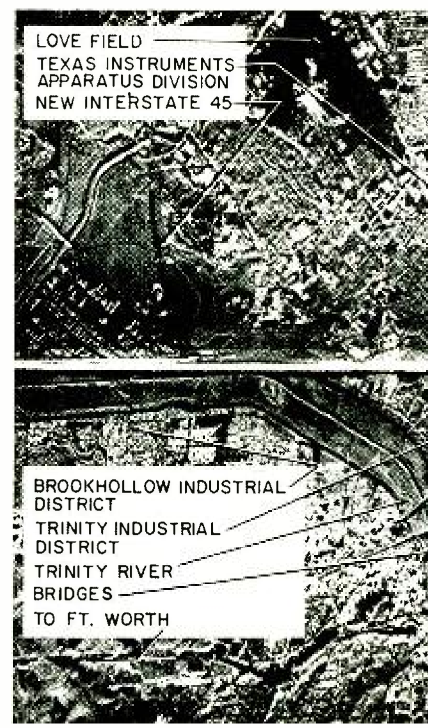
Radar Mapping

Thanks to a side-looking radar, it is now possible to get accurate aerial maps of thousands of square miles of terrain per hour in any weather in which man can fly. Developed by Texas Instruments for the Air Force, the new radar could also give near-photographic, up-to-the-minute information on troop and material movements well behind the enemy's front lines.

A sample radar map is shown in the photograph. It was made by a plane flying over Dallas, Tex. The white stripe across the center is the flight path of the plane and is a blind spot. For this picture, the sweep was 6 miles on each side of the plane. Thus an area about 12 miles by 15¼ miles can be mapped in the time it takes a plane to fly over it.

An advantage of the system for military use is that the radar map can be transmitted directly to headquarters and there need be no delay while waiting for the plane to return.

The side-looking radar, officially called the AN/APQ-55, has other advantages over ordinary photographic reconnaissance. It can isolate moving targets as a number of "radar maps" can be made of the same area in a short time. Radar maps also tend to be more accurate than standard photographic methods since the perspective of distance is adjusted electronically. Therefore, the items on the edge of the photo are in the same scale as those at the center. In an



aerial photograph, ground distances are compressed as the distance from the camera increases. Also, an aerial camera scanning a fixed angle will map less area at low altitude. The side-looking radar mapping system scans a constant ground area independent of altitude.

In nonmilitary applications, the systems have already been used to detect icebergs in North Atlantic shipping lanes. Standard radar cannot differentiate between icebergs and fishing vessels which just drift with the current. Coast Guard personnel reported that the new radar identified icebergs, growlers and field ice. It also differentiated between bergs and other stationary targets even in foggy weather.

Astronaut—19-Inch Transistor TV

A 19-inch square-cornered picture tube backed up by 23 transistors and 12 diodes is the newest thing in

(*Continued on page 16*)

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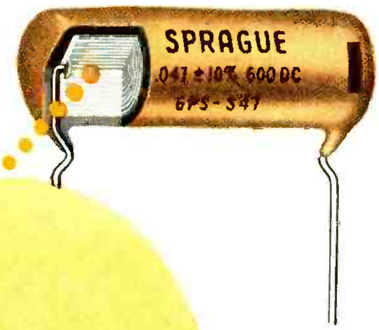

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Difilm Black Beauties are engineered to withstand the hottest temperatures to be found in TV or auto radio sets—in the most humid climates. Further, unlike straight polyester film tubulars, these capacitors operate in a 105°C environment—without derating!

Black Beauty tubulars are tough units, too—no fragile shell to break—you can't damage them in soldering. For your convenience, every capacitor is marked twice . . . no need to twist capacitor around to read rating.

Sprague Difilm "Orange Drops" are a "must" for your service kit where only an exact replacement will fit. They are the perfect replacement for dipped capacitors now used by leading manufacturers in many popular television receivers. And when a dipped tubular is called for, you'll find that Orange Drops outperform all others, safeguarding your work and reputation for quality service.

Orange Drops are specially designed for easiest possible installation. Radial leads are crimped to assure neat mounting parallel to printed wiring boards . . . extremely small size makes them fit handily in tight spots. They'll beat heat and humidity because the solid, rock-hard capacitor section, double-dipped in bright orange epoxy resin, is well protected against moisture. A perfect team-mate for Black Beauty.

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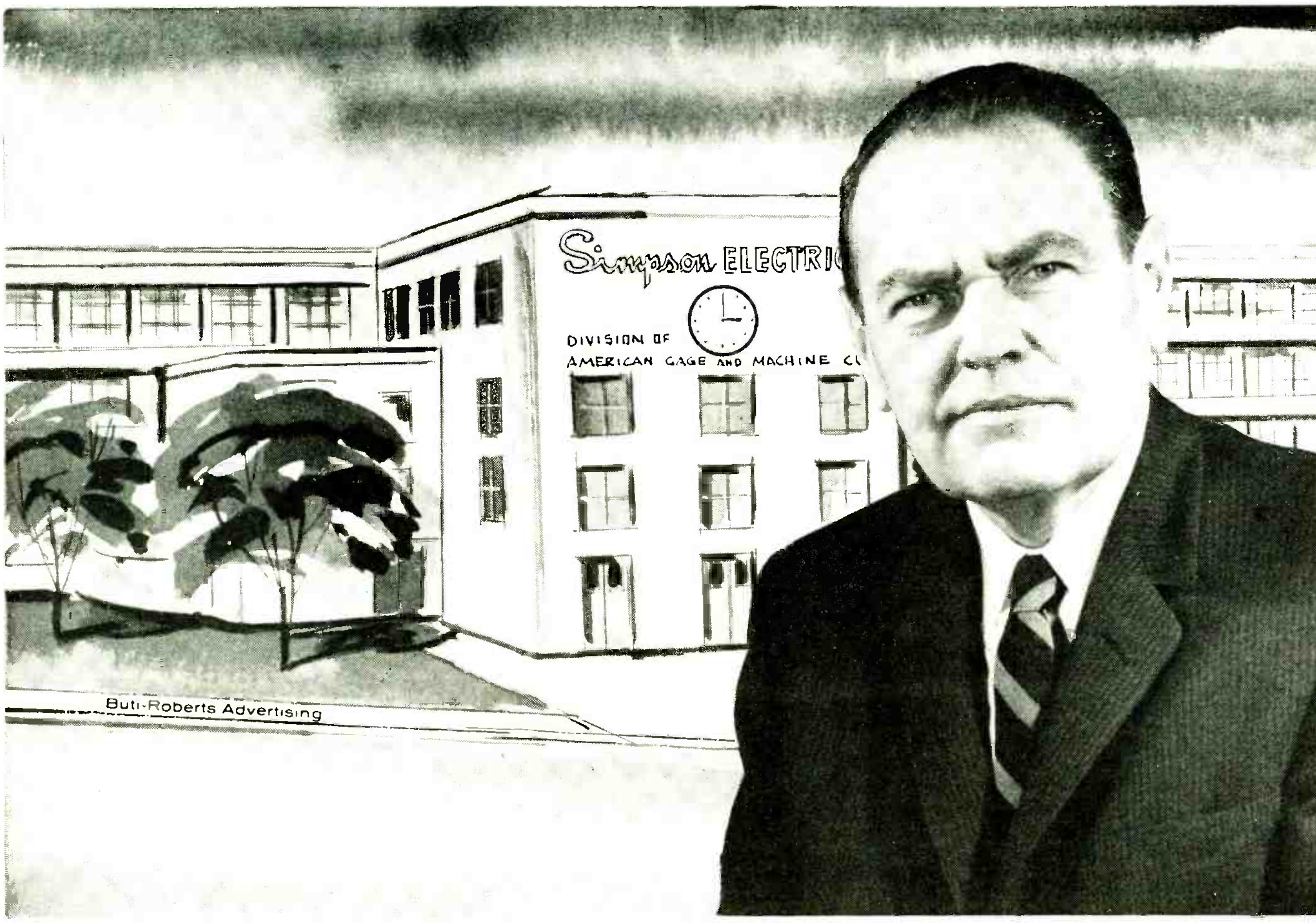
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NEWS BRIEFS (Continued from p. 12)

portable TV. It puts a home receiver picture on the screen of a battery-powered portable. The 40-pound set is made by Motorola as the model 19P1 Astronaut. The set's sensitivity is 15 μv and its noise figure reaches a maximum of 10 db—both figures approximately the same as for conventional sets.

For portable operation, the Astronaut is powered by a 5-pound silver-cadmium battery. It will operate the

set between 5 and 6 hours before recharging is necessary. The battery can be recharged a minimum of 500 times and is not damaged by complete discharge. It is automatically recharged when the set is connected to ac line power. A built-in single-pole antenna folds out of sight when not in use. The set has a fiberglass carrying case, with a front cover to protect the picture tube.

Calendar of Events

Congress of the International Federation of Automatic Control, June 25–July 9, Moscow State University, Moscow, USSR.

National Convention on Military Electronics, June 27–29, Sheraton Park Hotel, Washington, D. C.

New England Electronic Conference, June 27–29, Balsams, Dixville Notch, N. H.

1960 Music Industry Trade Show, July 10–14, Palmer House, Chicago, Ill.

Conference on Medical Electronics, July 21–27, Olympia, London, England.

Global Communications Symposium, Aug. 1–3, Statler Hotel, Washington, D. C.

National Audio-Visual Association Convention and Exhibit, Aug. 6–9, Morrison Hotel, Chicago.

Electronic Packaging Symposium, University of Colorado, Boulder, Colo., Aug. 18–19.

Western Electronic Show & Convention, (WESCON) Aug. 23–26, Memorial Sports Arena, Los Angeles, Calif.

British Radio & Television Exhibition, Aug. 24–Sept. 3, Earls Court, London, England.

International Conference on Semiconductor Physics, Aug. 29–Sept. 2, Prague, Czechoslovakia.

International Symposium on Information Theory, Aug. 29–Sept. 3, London, England.

END

Correspondence

INDUSTRIAL SERVICING

Dear Editor:

Having been a reader of Gernsback publications since the days of the Electro Importing Co., on Fulton St., I must say I have gained a wealth of knowledge. However, the electronics industry is moving so fast, I decided to specialize.

I would like to see more articles on industrial servicing, and I would also like to hear from manufacturers in regard to servicing their equipment in the New Jersey area.

JOHN I. MEYER

Union City, N. J.

WANTED: LESS CONFUSION

Dear Editor:

In the dark ages (early 1900's), many companies made vacuum tubes. Fortunately for civilization, they got together and adopted a standard numbering system. Now, all 6SN7's are the same, no matter who makes them. This is progress.

What happened to this progress when it came to diode and transistor numbering? The other day I tried to find a particular transistor in a parts catalog. The transistors from 10 companies were listed with as many different numbering systems. Insanity, stupidity, chaos—what would you call it?

I thought this was a modern, intelligent generation. How about a movement to standardize diode and transistor numbering, basing and testing? Let's get organized!

KENNETH GREENBERG

Chicago, Ill.

WHAT ABOUT THE FUTURE?

Dear Editor:

I read your editorial ("Microelectronics") in the February issue with interest since my livelihood has been derived solely by repairs to radio and television receivers for the past 15 years.

If I correctly interpreted your editorial, it would seem that the present servicing business is to be tremendously reduced—possibly in 8 to 12 years—due to commercial use of microelectronic techniques.

This brings me to the question of what program of preparation would be best for service technicians like myself—if the need for such a program exists.

I would appreciate any suggestions

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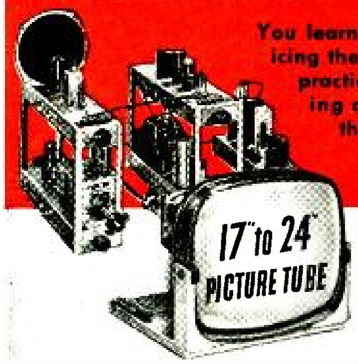

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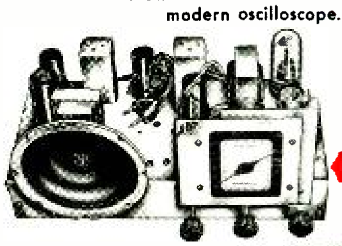

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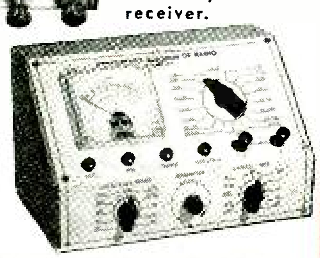

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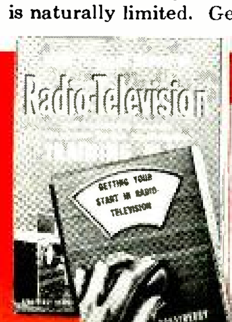

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from you on this matter as you are intimately acquainted with the scope of the electronics field.

LAWRENCE A. HALEY

Wilmington, Del.

[During the next 10 years, micro-electronics is likely to be used in only such things as missiles and satellites. Micro-electronic techniques will not go into mass production until at least the early 1970's. TV screens must be large enough to see, so extreme miniaturization would not make much sense in home TV sets.

Radios the size of cigarette filter tips are interesting to think of, but are they necessary? How would you tune one?

As semiconductors come into more common use, set operating temperatures will drop. This will reduce the amount of service needed.

It seems to us that home servicing is not going to expand greatly over any extended period of time. That is why we have started our Industrial Electronics section—to alert technicians to this expanding field. Our advice is to learn as much as possible about the industrial servicing field as it will probably play a large part in the industry as a whole. —*Editor*]

MATCHBOX RADIO

Dear Editor:

I have a few additional comments to make about the "Matchbox Radio" (June, 1960, page 58):

1. The radio *will* operate a loudspeaker. [The test report indicated that it had not been tried with a speaker.—*Editor*] In general, if you can hear a station on a headset, you can hear it on a speaker.

2. The output can be taken from between the emitter and the positive battery lead. When the phones are unplugged, the battery is disconnected from the circuit. When using a speaker, the output transformer is not necessary because this emitter circuit is low-impedance. A 3.2-ohm speaker works well; higher-impedance speakers work better.

3. Battery voltage is noncritical one way. If you increase it, the volume goes up, but you increase the chances of a thermal runaway. *This occurs unfailingly at 9 volts.* If the voltage is reduced, the volume goes down. It drives a loudspeaker on strong local stations with as little as 1.5 volts.

4. Cheap, second-choice transistors can be used in this circuit.

5. Antenna coil L is a luxury. A suitable coil can be jumble wound on any mandrel, or an old video peaking coil can be used. Any value between 200 and 300 μh will do.

A. V. J. MARTIN

Paris, France

ANTIQUE-RADIO COLLECTORS

Dear Editor:

Over the past year I have received more than 600 letters from antique-radio fans and collectors all over the country. Most of them would like to organize some sort of a club to help them reach other collectors. Also, many newcomers to the hobby would like to trade, buy or sell parts and sets, but don't know whom to contact.

I started a little over a year ago and have collected about 250 sets. This kept my typewriter (and myself) busy day and night whenever I had a spare minute. I would not like to see this happen to other collectors as it is very discouraging.

If you would like a club, *write and let me know*. A postcard is all I need.

I would like to put out a newssheet about every 2 weeks or every month, depending on how much (news and ads) there is to fill it. This means getting a mimeograph machine. For this I need *your* help. Cost of placing an ad in the sheet would be about 3 cents per word. (Of course the readership would be made up almost entirely of collectors.)

How about it fellows? If you are interested, write and let me know.

JAMES H. STEGNER

R. D. No. 1
Clearfield, Pa.

[If you *are* interested in forming an organization of antique-radio collectors, here is an opportunity. If any of you have an old (or new, for that matter) mimeograph machine

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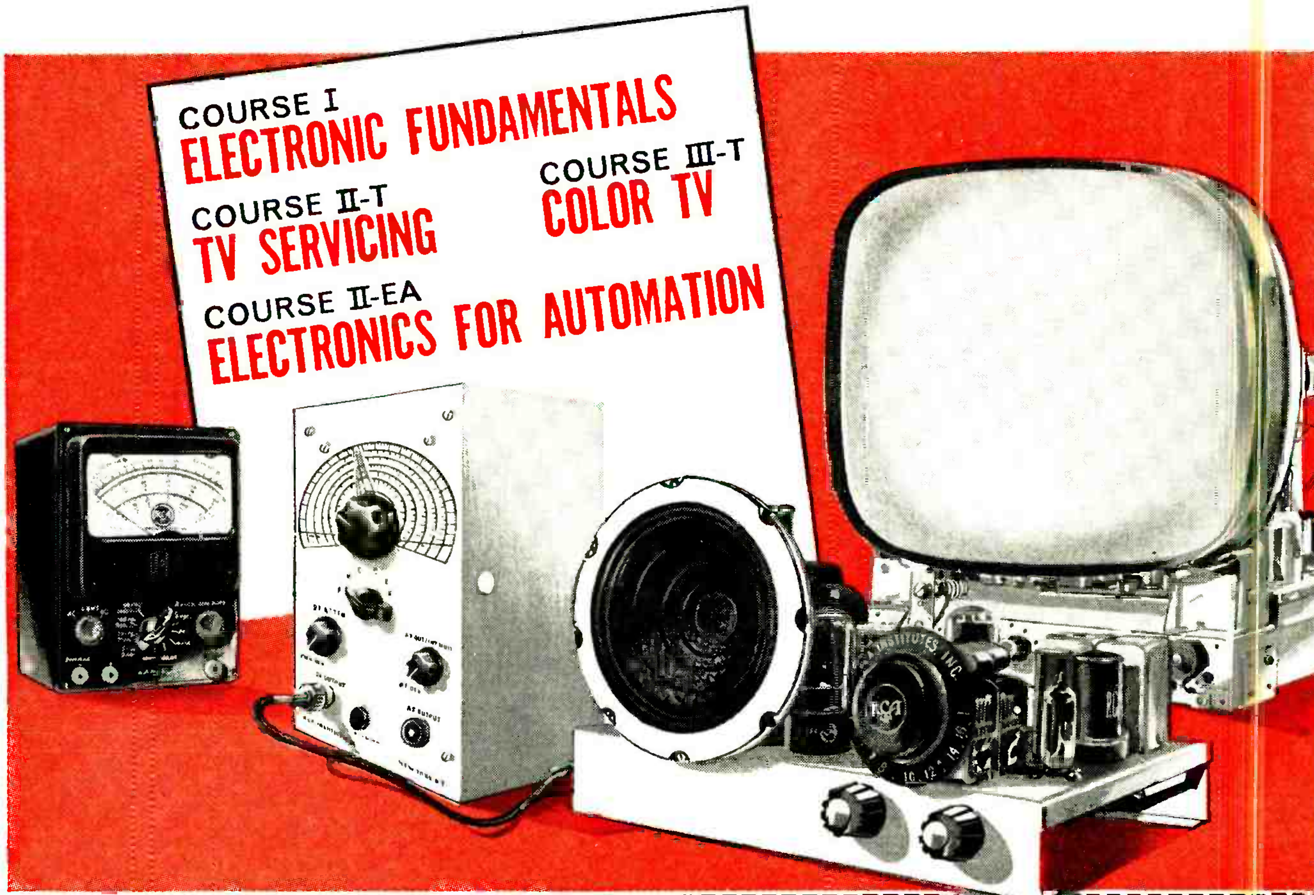

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and accessories, its use would be greatly appreciated. The question of dues or subscription is likely to come up shortly. Mr. Stegner will find that the cost in time and money of keeping in touch with several hundred collectors can be on the high side.—*Editor*]

BOB MIDDLETON REPLIES

Dear Editor:

I was somewhat surprised to see Mr. Mack's letter in the June issue because I have long doubted that anybody reads my articles, or, if they do—who gives a hoot anyhow?

If we *define* resistance as existing only in cylindrical packages with pigtail leads at the ends, I will agree with his objections. On the other hand, a 1N34 crystal diode is a semi-cylindrical package with pigtail leads, and it has *both positive and negative resistance* If we wish to buy a negative resistance, we can ask the man for a 1N34, or, better, a 1N653 tunnel diode.

Now, a tunnel diode has positive resistance, as long as we use a low voltage. If we increase the source voltage, we arrive at a point where the diode has a negative resistance. When we apply *more* voltage, *less* current flows.

A type 24 tube has positive plate resistance (about 600,000 ohms) as long as the plate is operated at a higher voltage than the screen grid. But, if the screen is operated at a higher voltage than the plate, the plate resistance becomes negative. To put it another way, the negative resistance appears as *less* current if *more* plate voltage is applied.

I see no easy way to accept these positive resistances as "real" and then turn around and assert that the negative resistances are "unreal."

It actually makes little difference whether we allow positive resistance to a crystal diode and disallow its negative resistance, as long as we realize that it does exist and can make an electronic circuit work.

To my way of thinking, I must accept negative resistance of a crystal to be as real as its positive resistance. We connect a crystal diode across an L-C circuit, and bias the diode to make this negative resistance cancel the circuit's positive resistance. The circuit oscillates. Hence, I cannot agree that "−200 ohms has no significance to us whatever."

Sure, we took a few swipes at "Eggy." But we are TV technicians—not keepers of the keys to the ivory towers. Personally, I prefer to be told that "the cat ate the canary" rather than "the feline quadruped ingested a member of the genus insula Canaris."

Mr. Mack is right; "Eggy" has a real and vital part in industry today. So does Mr. Mack. I am only asking that more thought be given to the problem of communication. Life is too short to spend 90% of it consulting the unabridged dictionary while multiton sputniks circle over our heads.

ROBERT G. MIDDLETON
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New HFS5 2-Way Speaker System Semi-Kit complete with factory-built 3/4" veneered plywood (4 sides) cabinet. Bellows-suspension, 5/8" excursion, 8" woofer (45 cps. res.), & 3½" cone tweeter. 1¼" cu. ft. ducted-port enclosure. System Q of ½ for smoothest freq. & best transient resp. 45-14,000 cps clean, useful resp. 16 ohms. HWD: 24", 12½", 10½". Unfinished birch. Kit $47.50. Wired $56.50. Walnut or mahogany. Kit $59.50. Wired $69.50

HFS1 Bookshelf Speaker System complete with factory-built cabinet. Jensen 8" woofer, matching Jensen compression-driver exponential horn tweeter. Smooth clean bass; crisp extended highs. 70-12,000 cps range, 8 ohms. HWD: 23" x 11" x 9". **Kit $39.95. Wired $47.95**

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AROUND THE WORLD IN 80 SECONDS

. . . *The Strategic Air Command's Amazing Communications Net* . . .

AS an editor, we are inclined to take electronics pretty much for granted. TV, color TV, radar, bouncing signals off the sun, we've heard about them all. You can't blame us for being a little bit hard-boiled and blasé.

But every once in a while something happens to restore our enthusiasm. Recently we were flying at 250 miles an hour 15,000 feet over Ohio in a plane of the SAC—*Strategic Air Command*. Our host picked up a microphone and called a ground station in Guam, in the Pacific. Guam answered immediately. He called another in Tokyo. Tokyo answered at once. Then in rapid succession he called Okinawa, Hawaii, Alaska, Greenland, Labrador, California, Louisiana, Massachusetts, Bermuda, Puerto Rico, England, Spain, Libya and Saudi Arabia. All answered their calls in seconds. We had talked our way around the world in less than 2 minutes.

Stunt? No—it happens regularly every day. This demonstration occurred aboard the military plane assigned to Lt. Gen. Francis Griswold, Vice Commander in Chief of SAC. (He is also an active ham, K0DWC.) We, together with a group of other editors, were en route to see SAC's remarkable world-wide communications headquarters and underground command post at Offutt Air Force Base, near Omaha, Neb.

The primary purpose of SAC's communications web is to get orders to its bombers and missiles in seconds, should this be necessary. Actually there are three separate communication networks, all converging on the underground command post in Nebraska. The first is a one-way telephone system with better than 99% reliability which connects Offutt with SAC's Air Forces around the world. It terminates at the famous "red telephone." The telephones in this system differ from conventional desk sets in one respect: They each have an acknowledgment button. In an alert, SAC headquarters may wish to pass frequent orders over the system. Yet it must be certain that the orders have been received by all. Upon receipt of a call, each station listens to the message and is asked to acknowledge it. This it does by pressing the acknowledge button. As each button is pressed, a corresponding light flashes on the central panel at the commander's desk back at Offutt.

It's impossible to describe adequately our feelings during a test. Within 10 seconds, we watched more than three score of tiny lights glimmer on one by one in acknowledgment. Lights turned on by the push of a button in Saudi Arabia, in Guam, in Greenland, in Spain!

Being primarily a wire system using commercial facilities, this network could be disrupted by sabotage or enemy action in an emergency. To backstop it, SAC has its *Commander's Net*. This is a single-sideband voice radio system, normally used as a ground-to-ground system interconnecting the commanders of the various segments of SAC. The air-to-ground demonstration mentioned earlier used this Commander's Net. Since SAC is on a continuous alert, commanders must be able to communicate instantly even when airborne. Hence commanders' planes are specially equipped with equipment similar to that at the ground stations. The performance of the single-sideband (SSB) equipment is remarkable, especially when one considers that 500 watts is the maximum power used. Despite this modest power, the system has a reliability of about 95%. It also provides almost instant world-wide communication. The Commander's Net is made up of stations at 26 locations throughout the world. Each station can operate on three different frequencies ranging from 2 to 35 mc simultaneously, if prevailing traffic should make it necessary.

One of the great advantages of the system is its relaying capabilities. Frequently, ionospheric conditions make it impossible to talk directly to some stations in the net. At the flick of a switch the operator at any one station can convert his equipment to a two-way relay station, picking up the signals from one station and retransmitting them instantaneously to another. In one demonstration we witnessed at Offutt, the operator could not reach Hawaii, although he could talk with Guam, a more distant point. He asked Guam to relay Hawaii. This was done instantly and Offutt talked with Hawaii via Guam. Except for a a slight deterioration of clarity, it was impossible to know whether communication was direct or by relay.

The third and most important communications net operated by SAC is the ground-to-air Bomber Control net known as "Short Order." This is the net which would give the "go" order to SAC's bombers in the event of an enemy nuclear attack. Short Order is also SSB. The ground stations (two are in operation and two are in construction) consist of three 45-kw and six 10-kw transmitters at each location together with 16 directional and omnidirectional antennas. The associated receiving stations use essentially similar antennas and two receivers. Operating frequencies for the 45-kw transmitters and the receivers as well as individual antennas can be selected instantly by a telephone type dialing system in the underground command post. Complete system control can be taken over by any one of the stations on a moment's notice.

Another interesting feature of the SAC command post is a closed-circuit color TV system. This chain is used to transmit the status information displayed on the panels in the operations and intelligence centers to staff officers within the SAC headquarters. Five separate program channels are available. Color is used because much of the information displayed is color-coded. A separate black-and-white closed-circuit system connects the SAC command post with the Combat Operations Center of the North American Air Defense Command (NORAD) at Colorado Springs, Colo. Through this circuit, NORAD surveillance of North America is simultaneously displayed in front of the SAC controller.

Flexibility of control is the outstanding feature of the SAC nets. This requires complex control circuits. Maintenance and repair problems are compounded and skilled service technicians are of vital importance. Much of the test gear seen at the Short Order station sites would be strange to the average service technician, although familiar to the laboratory man. Precision frequency standards, laboratory type scopes and frequency counters are standard. The not-so-old cliché that modern armies (and air forces) are made up of technicians is nowhere better illustrated than at SAC.

A taxpayer's first reaction to SAC's installation is pride and satisfaction. But this is jolted aside by General Griswold's blunt complaint that communications development has not kept pace with missile and nuclear technology advances and that progress for many years has been primarily the result of improved technology rather than real breakthrough. One reason for this, in his estimation, is the relatively small amount of money devoted to communications research compared to that spent on atomic and missile research. He cited two relatively simple problems still crying for solution: Elimination of precipitation static interference on planes and development of really good antennas for planes. —*M.H.G.*

THE TUNNEL DIODE STORY

By R. L. WATTERS* and J. V. CLAEYS*

THE tunnel diode reported in 1958 by Japanese scientist Dr. Leo Esaki, is an entirely new semiconductor device. It is like a diode because it has two terminals and like a transistor since it may be used to amplify power.

Although related to the transistor, the tunnel diode operates upon a different principle and offers advantages not found in transistors. Some of these are its very small size, extreme speed and stability under varying temperature conditions.

It is a new circuit element which may, with appropriate circuitry, function as a switch, amplifier and oscillator. Amplification and oscillation are possible well into microwave frequencies. At lower frequencies tunnel diode circuits may be simpler, smaller or more efficient than those of vacuum tubes or transistors. Let's see what this tunnel diode is and how it can be used in different circuit applications.

This new device gets its name from a mechanism called "quantum-mechanical tunneling" (until now of only theoretical interest) which describes the manner in which electrical charges move through the device. The combination of this "tunnel effect" and the fact that the device comprises a p-n junction between two regions of very heavily doped semiconductor material has led to the name tunnel diode.

Negative resistance

The property of the tunnel diode produced by the tunnel effect is the negative resistance which appears over a portion of its voltage range. A negative resistance may be defined as a circuit element in which current decreases with increase in voltage (or vice versa). This negative-resistance property is illustrated in Fig. 1, which shows the current–voltage characteristic of a typical germanium tunnel diode at room temperature. The negative-resistance region of the curve lies between points A and B.

The slope of this curve at any point is the resistance of the tunnel diode at that point. A vertical region (infinite increase in current), for example, would indicate zero resistance while a horizontal region (no increase in current) would indicate an infinitely large resistance. In addition, a region which slopes upward to the right indicates a positive resistance while a region which slopes upward to the left indicates a negative resistance. An examination of the curve of Fig. 1 shows that the region from zero to A represents a positive resistance, the region from A to B represents the negative resistance and the region beyond B again represents a positive resistance. The current–voltage characteristic of the tunnel diode, therefore, has a region of negative resistance between two regions of positive resistance.

While the tunnel diode is related to the transistor, the semiconductive material used is much more heavily doped with impurity than that used for transistors. It is almost metallic, and no hermetic seal is necessary for protection from such things as surface contamination and moisture penetration.

A p-n junction formed between a heavily doped body of p-type conductivity and a heavily doped body of n-type conductivity semiconductive material is very narrow, about one-millionth of an inch or less. It is this combination, with the proper forward bias, that allows a "tunnel" current to flow and produces the negative resistance. All we need to know about this tunnel current is that *its transit time is so short that it does not affect the maximum operating frequency of the diode.* This frequency limit is set by the junction capacitance and negative resistance of the device and the bulk resistance of the material from which it is made. A diode was recently made to oscillate at 10,000 mc. However, for known materials, the calculated maximum frequency of oscillation is 20,000 to 30,000 mc.

Now, how do we use the tunnel diode in a circuit? The current–voltage characteristic described above and shown in Fig. 1 is the key. Since the slope at any point of this curve is the resistance of the diode, this property of the diode may be conveniently determined from it. For example, the resistance at point D in Fig. 1 is $\frac{0.115}{-.00011} = -1045$ ohms.

Notice again that between A and B the diode is a negative resistance, that is, the current decreases with increase in voltage. At points A and B, however, the resistance is very high. We can see this on the curve itself. In the vicinity of A and B there is little or no change in current with changes in voltage.

The locations of points A and B of the curve are set mainly by the semiconductive material from which the tunnel diode is made. For germanium, the voltage at A is typically about .05 volt and at B 0.3. For silicon, on the other hand, the voltages are .07 and 0.4, respectively. Other materials have somewhat different values. However, all are in the forward voltage range of less than 1 volt.

Properties

To understand how to use the tunnel diode in various circuit arrangements,

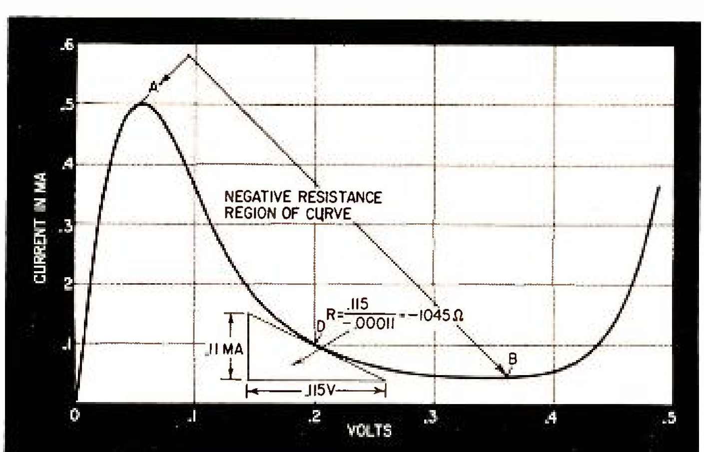


Fig. 1—Typical germanium tunnel-diode characteristic.

*General Electric Research Laboratory, Schenectady, N.Y.

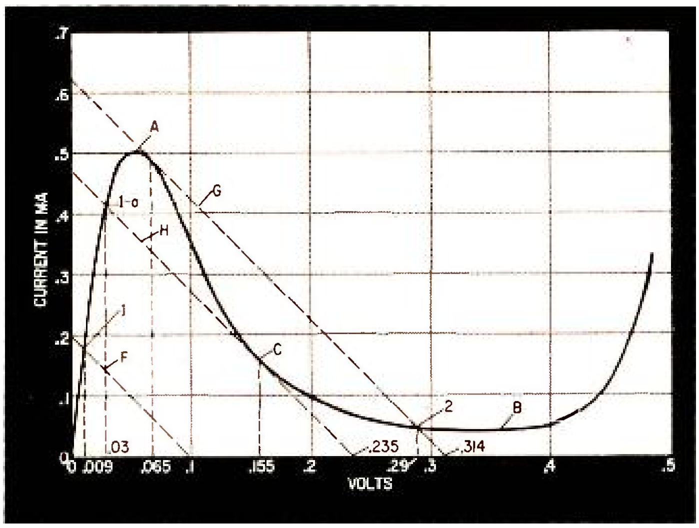


Fig. 2—Tunnel-diode characteristic with load lines for 500-ohm resistor in circuit of Fig. 3.

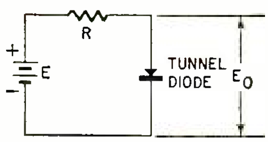
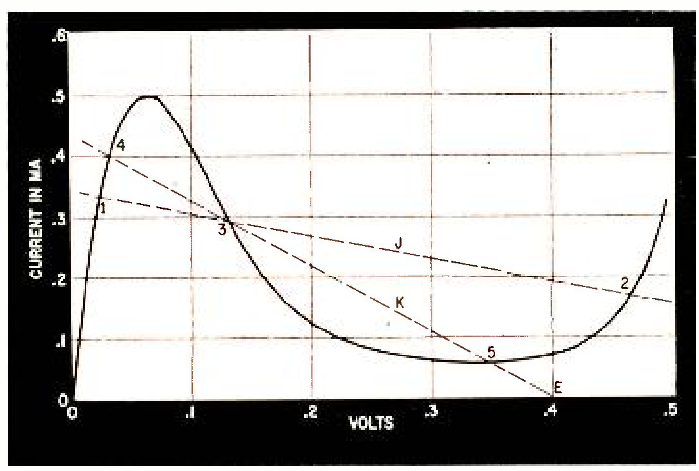


Fig. 3—Basic tunnel-diode circuit.

Fig. 4 — Tunnel-diode characteristic and load lines of switching property.



it will be useful to first explore some of its electrical properties. It will be convenient, therefore, to refer to the simple series circuit arrangement of Fig. 3. Then, in conjunction with Fig. 2, we will analyze the operation of the tunnel diode.

A current–voltage characteristic of a typical tunnel diode is shown in Fig. 2. The curren through it is shown with respect to the voltage E_0 across its terminals. Since the circuit of Fig. 3 is a simple series arrangement, the voltage E_0 at any time is equal to the battery voltage E minus the voltage drop in the resistance R. It would be very useful, therefore, also to know the current flowing in resistance R with respect to the voltage drop in it. Load line F in Fig. 2 shows just this relation and a very useful tool is available from it. The intersection of line F with the voltage axis shows the battery supply voltage E while its intersection with the diode characteristic curve shows the voltage E_0.

Load line F may be used to represent the resistance R in the circuit of Fig. 3. While the slope of this line is negative and it appears at first that there is a decrease in current with increase in voltage, it must be remembered that the load line F does not show the current flowing in the resistance with respect to the voltage supplied, as is the case for the diode characteristic. Rather, it shows the current flowing with respect to the *voltage drop* in the resistance. For this reason, this negative slope is not to be confused with the negative-resistance region (A–B) of the diode characteristic.

The slope of load line F is determined by resistance R so that, having drawn a particular load line on the diode characteristic, one can easily find the resistance (R) necessary to establish it.

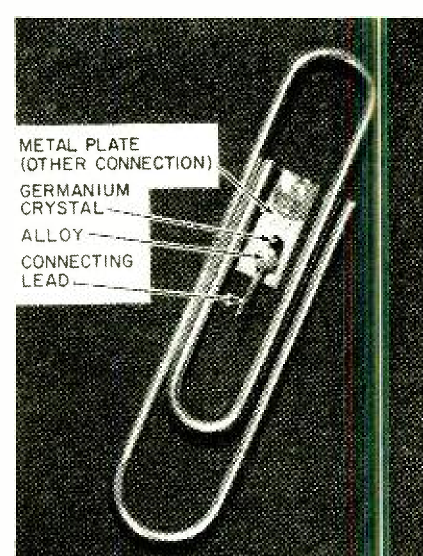
For example, to find the R necessary to get load line F in Fig. 1, the slope is found from the voltage and current values taken from the curve. Line F's slope is equal to $\frac{0.1}{-.0002} = -500$. The value of resistance R is +500 ohms since, as stated above, the negative slope does not concern us here.

For the condition shown, E = 0.1 volt, E_0 = .009 volt and the current is 0.18 ma. Therefore, with the above values, the point of operation of the diode (for the circuit of Fig. 3), will be as shown at 1 in Fig. 2. Although the slope of this load line is fixed by the resistance R in the circuit of Fig. 3, a change in the battery supply voltage will change its location with respect to the current–voltage characteristic.

Now, let us increase the battery supply voltage. As this is done the load line moves up along the branch 0-A. When the intersection (or E_0) reaches a point near A, as shown by the load line G, the intersection (E_0) jumps almost instantly to the point 2 between B and C. Point 2 represents the new value of voltage E_0.

If now we decrease the battery supply voltage E, the load line and its intersection will move toward the point C. Here it switches suddenly to the point 1-a on load line H and the lower value of voltage E_0. Notice that the slope of the load line remains the same, since resistor R was fixed at 500 ohms and only the position of the line along the voltage axis changes with change in battery supply voltage.

Load lines G and H show the battery supply voltages as 0.314 and 0.235 at the respective switching points. This shows that, as the battery voltage E was increased from zero, E_0 increased to .065 volt and then very suddenly switched to 0.29 volt. This is an increase in voltage across the diode (E_0) of 0.225 volt. Reducing the battery voltage to 0.235 volt then caused E_0 to switch suddenly from a value of 0.155 to .03 volt. This is a decrease in voltage across the diode terminals of 0.125 volt. Thus, we see that near the switching points A and C a very small change in the battery voltage produced a relatively large voltage change across the diode.



Laboratory style tunnel diode (original prototype). Semiconductor bodies are alloy and germanium crystal.

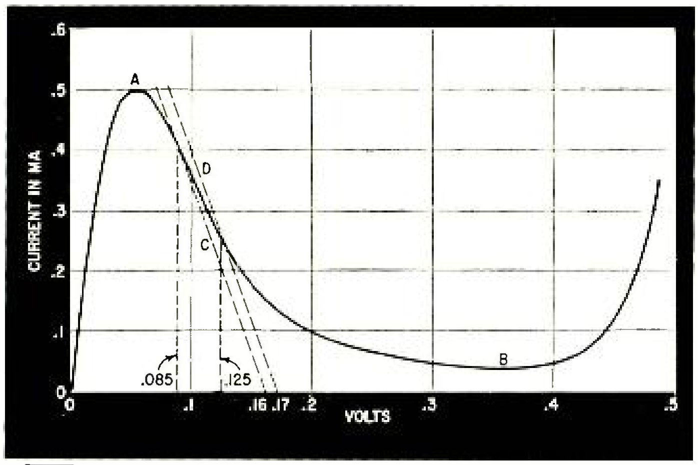


Fig. 5—Characteristic and load lines illustrating amplifying property.

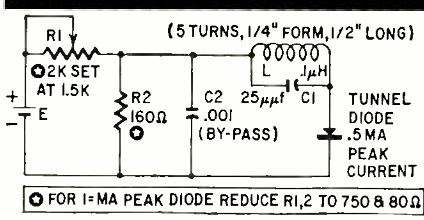


Fig. 6—Tunnel-diode oscillator circuit. Values given are for 100-mc operation. Unit may be frequency-modulated by 2,000-ohm headphone across R2.

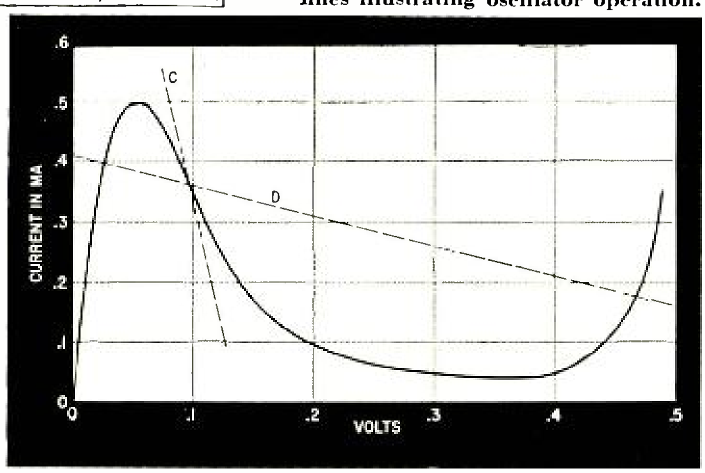


Fig. 7 — Characteristics and load lines illustrating oscillator operation.

This property of the tunnel diode indicates one area of its usefulness.

Switching

Load line J in Fig. 4 (using the circuit of Fig. 3) represents a value of resistance much higher than the negative resistance of the diode. Notice that this load line intersects the characteristic in both positive resistance regions. Thus there are *two* stable operating points for a single battery voltage E. The voltage across the diode can be either that corresponding to point 1 or that corresponding to point 2.

To show that only points 1 and 2 are stable, look at Fig. 4 and load line J. Now imagine for a moment that the current and voltage have values corresponding to point 3. If, for any reason whatsoever (motion of electrons, heat or anything else), there is a very small increase in the current, then by looking at the characteristic curve we can see that there must be a decrease in the voltage across the diode.

A look at the circuit shows us that, if this happens, there is more voltage available to send current through the resistance which causes a further decrease in the voltage across the diode. This action continues until point 1 is reached. At point 1, however, if there is to be any further increase in the current, there must also be an increase in the voltage across the diode since this is a positive resistance region. The only way the voltage across the diode can increase, of course, is for the voltage drop in resistance R to decrease. And this is possible only if the current becomes smaller. The operating point then must remain at 1 and be stable there.

The same thing would happen with any small decrease in current from that at point 3 so that the point would be then stable only at 2. This shows us that it is possible to provide a circuit arrangement which can be quickly changed from one impedance condition to another. For example, when the diode operates at point 1, it is in its low-impedance state and a relatively large current may flow. When operating at point 2, it is in a higher-impedance state and the current is limited to a relatively low value.

Selecting a load line such as K in Fig. 4 with its corresponding battery voltage E will indicate how this change may be made more significant. For example, the current at point 4 on load line K for a germanium diode of about 0.5-ma peak current is 0.3 ma and the slope indicates an impedance of about 150 ohms. However, the current at point 5 is .055 ma and the slope indicates a very high impedance. Thus, the diode can be employed to switch impedances, currents or voltages if desired.

To use the tunnel diode as an amplifier or an oscillator, we must prevent it from switching. When we look at the diode characteristic curve we realize that, for this to be done, the value of resistor R must be less than the negative resistance of the diode. That is, the load line established by resistance R must have a steeper (more vertical) slope than the slope of the negative-resistance region between A–B (Fig. 1).

Such a load line is shown as C in Fig. 5. It always has only one intersection with the diode characteristic, making it possible to have an average bias in the negative-resistance region. The slope of region A–B for a typical germanium tunnel diode having a peak current at point A of about 1 ma is about −100. Hence its negative resistance will be 100 ohms.

If now we choose a tunnel diode with a junction area 10 times as large (so that the peak current is 10 ma), we find that the slope of the region A–B is steeper and the negative resistance is reduced to only 10 ohms. From this we can see that, as the diode's peak current increases, resistance R must decrease to prevent switching.

Amplification

Now how can the tunnel diode amplify? Refer to Fig. 3 again and assume that the diode is biased somewhere between the points A and B and has a load line such as shown at C on the characteristic of Fig. 5 so that it looks like a negative resistance. This negative resistance is indicated as $(-R_o)$. Then:

(1) $e_o = \frac{e(-R_o)}{R + (-R_o)}$,

or gain $= \frac{e_o}{e} = \frac{(-R_o)}{R + (-R_o)}$

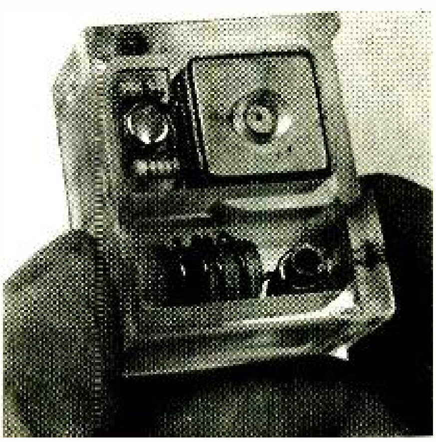
where e is a small ac voltage in series with the battery and e_o is the ac voltage across the tunnel diode.

From equation (1) we see that the gain is 1 when $R = 0$ and increases to a very large value as R approaches $(-R_o)$. This is shown graphically in Fig. 5. Lines C and D correspond to a resistance R of 150 ohms and battery voltages of 0.16 and 0.17 volts, or a change of .01 volt. At the same time we see that the voltage across the tunnel diode is .085 and 0.125 volt, respectively, or a change of .04 volt. Therefore, the gain $= \frac{.04}{.01} = 4$. We also see that, as the slopes of the lines C and D approach that of region A–B of the diode characteristic, the gain increases.

Now let us consider the circuit of

Fig. 6. This arrangement can function as an amplifier or an oscillator, depending on the resonant impedance of the L-C circuit. Assume first that R_1 is adjusted so that the diode has a negative resistance, $-R_o$, and that R_2 is smaller than R_o so that we will prevent switching. If the resonant impedance of the L-C circuit is made greater than R_o, then the circuit will oscillate. If, on the other hand, the resonant impedance is less than R_o, the circuit will amplify. Fig. 7 shows the diode characteristic with the dc load line C established by resistances R_1 and R_2 and the ac load line D due to the resonant impedance of the L-C circuit in order for the circuit to function as an oscillator.

An important thing in regard to this is that the amplitude of the oscillation will build up until the average negative resistance of the diode just equals the positive resistance of the circuit at the operating frequency. For our purposes, it is sufficient to know only that this means that the diode still has a negative resistance while it is oscillating. We can make further use of this by adding another parallel-tuned circuit, tuned to



An FM transmitter built around a tunnel diode. The microphone is in the upper right corner and the battery is covered by it. The tunnel diode is to the left of the mike.

a different frequency, in series with the oscillator tank. This circuit "sees" a negative resistance. If its resonant impedance is slightly less than the impedance of the oscillator tank, it will amplify at this new frequency. We can add still another tuned circuit and use it as an amplifier also by following the same procedure. As an example, we have had a circuit operating, using a single tunnel diode, that was an rf amplifier (100 mc), an oscillator (110 mc) and a mixer and if amplifier (10 mc)!

A few of the successful applications of the tunnel diode are as quartz-crystal controlled oscillators, utilizing the series or parallel resonance of the crystal; frequency-modulated oscillators; regenerative frequency dividers; counters; logic elements; amplifiers and combination oscillator–amplifiers. The list is growing daily. END

COVER FEATURE

ELECTRONICS GOES DOWN TO THE SEA (in small boats)

By NEWELL GARDEN*

THE outboard motor has made it possible for millions of Americans to find new recreation opportunities on the nation's waterways and oceans. Small, transistorized electronic navigation aids, either self-powered or operated with insignificant drain from the boat's 12-volt power mains, have given these boat owners new tools for enjoyment and protection.

Like the outboard motor, electronic depth sounders and radiotelephones are becoming common sights on boats in all parts of the country. Commenting on their growth in popularity, Capt. Joseph J. O'Connell of Fall River, Mass., one of the largest boat dealers in the country, notes that several years ago the prospective buyers used to ask if they really needed a depth sounder or a radiotelephone; now they raise an eyebrow if the boat they're looking at isn't electronic-equipped.

Although depth sounders have been around since the Fathometer was invented in 1924, they have been mostly styled and priced for commercial craft or large, expensive yachts.

The introduction of transistors and higher frequencies which made possible smaller components and equipment size has opened up an entirely new market for electronic depth sounders. Today more than 20 companies offer equipment specially made for the small-boat owner.

With a depth sounder, the boat owner can find a new measure of enjoyment in a fishing trip. The electronic lead line tells him accurately and continuously just how deep the water is—correct to the nearest foot. He gets a bonus in that the character of the flash on a flashing light unit or the trace on a recording unit can give him a good indication of the bottom characteristics. Knowing whether it is sand, mud or rock and just where the dropoffs and tables are is half the battle in game fishing. Commercial fishermen have used deep-water depth sounders for years.

Aside from fishing, the electronic depth sounder helps the boatman navigate in unmarked waters as well as known waters. He can determine his position by noting the depth of water under his boat and combining this information with his bearing from a lighthouse or known point ashore.

Radios, which according to Captain O'Connell, are specified more frequently by women than men, give the boatman the convenience of quick communication with the Coast Guard in case of emergency. Although this safety tie-in is probably the real advantage of radiotelephone, the boatman can also use his radio to call the marine operator of the telephone company who can connect him with any shoreside phone. To the doctor or business executive who must be reachable for consultation, this means freedom to enjoy boating while maintaining his responsibilities.

Radio direction finders are an added convenience and safety factor for the boatman who ventures offshore or out onto the Great Lakes where night or fog might make navigation difficult. With a direction finder he can take a radio bearing on a lighthouse or lightship to find his position or he can home on the signal of a lighthouse, aviation beacon or even the signal of a radio station near his home port.

Electronic gasoline-fume detectors are adding a safety margin to operators of inboard gasoline-engined boats. Gas fumes are heavier than air and, if there is even a small leak in the system or an overflow while fueling, the fumes settle in the bilges and engine compartment, from which they must be exhausted immediately and before the engine is started. The gas detector electronically sniffs the air in the bilges. If fumes are present, a platinum wire in the detector grows warm and an infrared cell triggers an alarm.

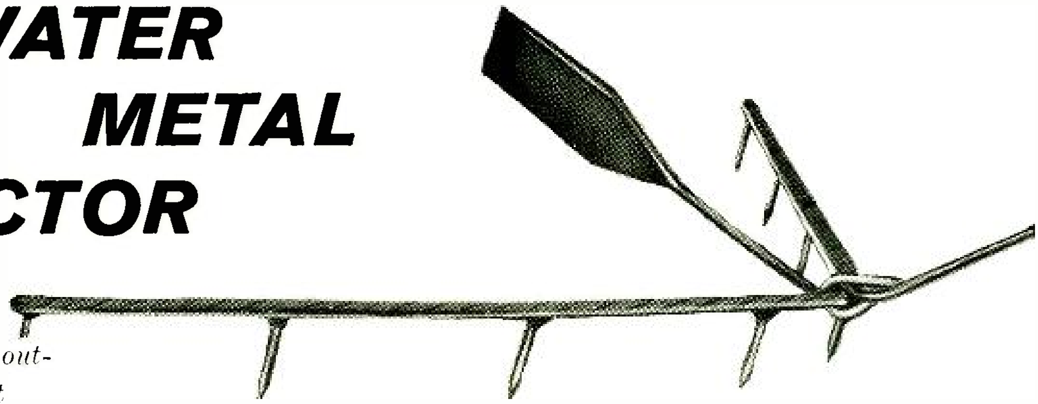
The newest electronic safety aid scaled down for small-boat use is radar, which has now been packaged in just two units. A transmitter and antenna unit is located on the cabin top or mast, and an indicator–receiver is installed in the wheelhouse. Using a 7-inch cathode-ray tube for an indicator, the new small-boat radars have good definition for navigation and collision prevention as they sweep the horizon for 12 miles. This month's cover shows how a Raytheon radar system looks in a small cabin cruiser. The new small depth sounder is also visible.

The low-cost radars for small boats take into account the shortage of power found in most pleasure craft. They can be operated from 12-, 24-, 32-, 110- or 220-volt lines. (Most of the earlier units required 110 or 220 volts.)

With all this electronic equipment available to boatmen and the boat owner adding more each year (20% more in fact), there are many new opportunities for professional electronic servicing in pleasure-boating centers to install electronic equipment and maintain it at its designed efficiency. END

*Raytheon Co., Waltham, Mass.

UNDERWATER METAL DETECTOR



Now you can locate that outboard or anchor you lost

By KENNETH RICHARDSON

FOR centuries man's imagination has been stimulated—and his urge for sudden wealth aroused, by tales of buried and hidden treasure and its discovery. From sunken Spanish or English treasure fleets of the 16th and 17th centuries to gold-carrying ships sunk in World War II, there are hundreds of authentic or semi-authentic treasure troves, not counting the pirate hoards and other land-buried or hidden wealth.

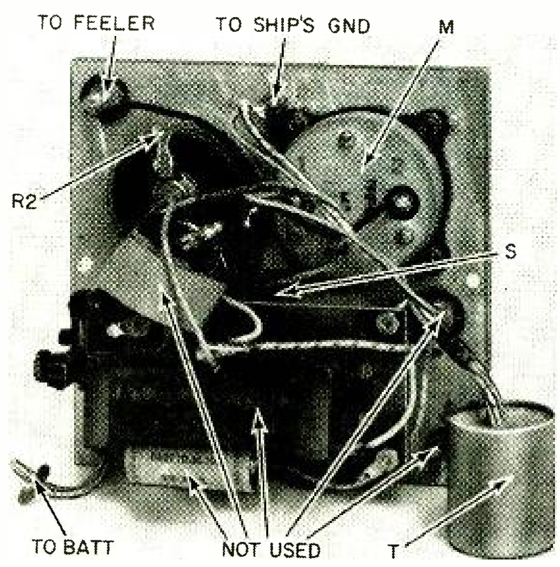
With the invention of the Hughes induction balance in 1879, a practical means of searching for such buried treasure was introduced for the first time and Hughes balance devices are still in use. Since 1929, improved methods for locating buried treasure have been available. None of these is as well suited for locating metal under water as the comparatively inexpensive electric-bridge instrument shown in the photo. It contains a battery, transformer, a sensitive meter and headphones. (The vibrator and associated parts were used in unsuccessful alternating-current experiments, and are not used in the instrument.)

Another photo shows the feeler, made of stainless steel, monel metal or copper, connected to the end of the insulated trailing cable.

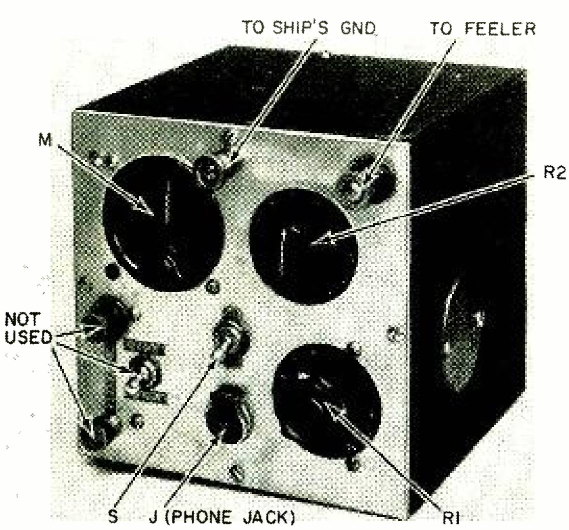
The feeler may consist of either single or multiple elements, whichever the operator prefers, in the form of pointed spikes made of the selected metal. Each type of feeler has both advantages and disadvantages. The single-element feeler composed of merely a single spike will register the greatest percentage change of current flow on the meter upon contact with a metallic object. The multiple-element feeler with the spikes (arranged in the form of a comb or rake, for example) will register proportionately less. The obvious advantage of the multiple feeler is that it covers a greater area. Personal experiment with feelers will assist the operator in determining the best type for his needs.

In the photo of the multiple-element feeler, note that the two legs of the "rake" are angled to minimize snagging underwater. Also note the small vane, which acts as a rudder to assure that the feeler scours the bottom with its spikes downward. A nylon rope is used to drag the feeler to relieve strain on the electric cable. As much of the feeler-frame surface as possible is insulated from contact with the water by tough plastic tubing and Vinylite tape. This will prevent loss of response due to leakage. Overall size may be anything from 2 feet to 6 or more, with the spikes spaced 6 to 12 inches apart.

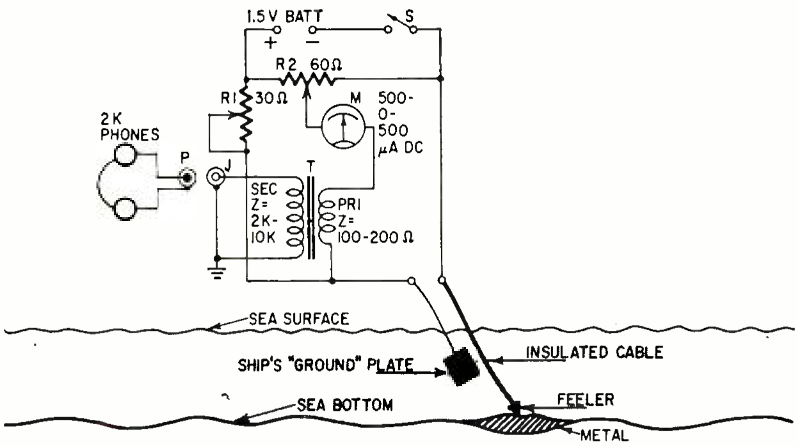
To adjust the instrument, first drop the cable to the bottom while the boat is under way, to assure that the multiple feeler, if used, scours the bottom with its spikes downward. Next, ground the instrument to the ship's engines or to an overside seaplate. Turn on the switch and set R2 to its approximate center position. Then adjust R1 until the meter centers, readjusting R2 slightly if necessary to secure perfect centering.



Interior view of metal detector.



View of metal-detector control box.



R1—pot, 30 ohms
R2—pot, 60 ohms
M—zero-center meter, 500-0-500 μa
J—phone jack
P—phone plug
T—carbon mike to grid transformer, 100 or 200 to 2,000–10,000 ohms (Triad A-1X or equivalent)
S—spst toggle
Battery—1.5-volt cell (the larger the cell, the longer the battery life)
Headphones, 2,000 ohms
Battery holder
Terminals for feeler and ground connections
Case
Feeler (see text)

Schematic of metal detector. If desired, an external shunt resistor may be used (15 to 30 ohms across R1) for salt-water use (since salt water has a lower resistance than fresh water, R1 should have a lower resistance).

In exploring any area, the operator maneuvers his boat back and forth, and the feeler sounds for metal along the sea bottom. As the feeler touches the surface of any metallic object, the meter reading will change, and a scraping sound will be heard in the headphones.

In areas of rocky bottom where the trailing method is more difficult, a weighted single spike is effective when repeatedly dropped vertically at short intervals as the boat maneuvers very slowly. These methods are suitable for locating sunken outboard motors and anchors, hundreds of which are lost annually, and also other metallic objects of value. Hulks of old wrecks containing valuable items repose in many of our bays, lakes and coastal areas. During his searching, the operator should be prepared to drop an anchored buoy immediately on the site of any strike, because of the ever changing currents and winds. We will not go into a discussion of actual salvaging operations, which may range all the way from simple skin diving in clear water to the elaborate expeditions required in turbulent and muddy areas.

The approximate locations of a vast number of wrecks are actually known, and information can be obtained by writing to the United States Coast and Geodetic Survey, Washington 25, D. C. Numerous books on the subject are also available.

An active summer is assured the seeker of hidden underwater treasure, and the United States Government will permit him to retain all finds, after taxes. END

ROUNDWORD PUZZLE

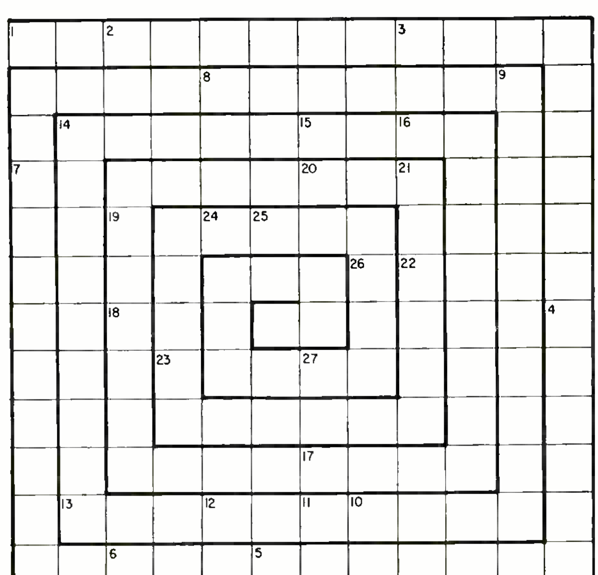
By MICHAEL L. NAHRWOLD

ARE you tired of the old across-and-down type crossword puzzle? Well, then, here is the thing for you—a *round-word* puzzle. Simply start at No. 1 and print the words on the outside squares of the puzzle, always going in a clockwise direction. The first letter of each word is always the last letter of the word preceding it. The words on the lower half of the puzzle will read backward and the words on the left half will read from bottom to top.

For example, the answer to the first definition must be a 3-letter word that represents ×1,000,000. Obviously, the correct answer is MEG and is placed in the first three boxes across the top of the puzzle—the M in the box numbered 1 and the G ending up in the box numbered 2. For our second answer we need a 7-letter word that starts with G and is a unit of magnetomotive force. GILBERT is such a word, but is it correct? As a check, is its last letter (T), which appears in the box numbered 3, the first letter of a 10-letter word that is the definition of a semiconductor? Try your luck and knowledge.

Answers on page 115.

1. ×1,000,000 (prefix)
2. Unit of magnetomotive force
3. A semiconductor
4. Feedback
5. Narrow-band frequency modulation (abbreviation)
6. .000,001 ampere
7. Section of a beam antenna
8. 4 element tube
9. Type of tweeter
10. Code (abbreviation)
11. Radio station run by the National Bureau of Standards
12. Unit of electromotive force or potential difference
13. Grid-controlled rectifier
14. Lowest class ham ticket
15. Electron coupled oscillator (abbreviation)
16. Test instrument incorporating CRT
17. Flow of electrons from tube filament or cathode
18. Net control station (abbreviation)
19. Hi-fi using 2 channels
20. Unit of resistance
21. Unit of conductance
22. First stage of a CW transmitter
23. Electromagnetic switch
24. Unmarried lady amateur (slang abbreviation)
25. Antenna used in radio direction finders
26. Male connector
27 Type of diode



Why we want them, what they do, and how they work

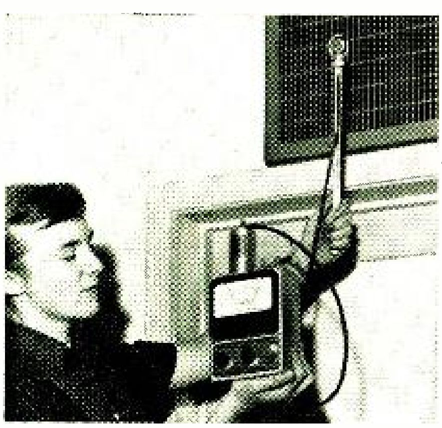
AIR IONIZERS

By HAROLD B. McKAY

AT one time, air conditioning meant filtering, cooling, dehydrating and circulating the air in a room. Placing the correct electrical charge on the air molecules must now be added to the list. The electronic repairman of the future may have to troubleshoot with the aid of sensitive instruments like the electrometer, or he may have to build an electroscope to find out if an air conditioner is really "conditioning" the air.

Recent discoveries concerning the effect electrically charged air has upon animals and humans show that negatively charged air aids good health. Why ionized air affects humans and animals has been a matter of extensive study by doctors and other researchers.

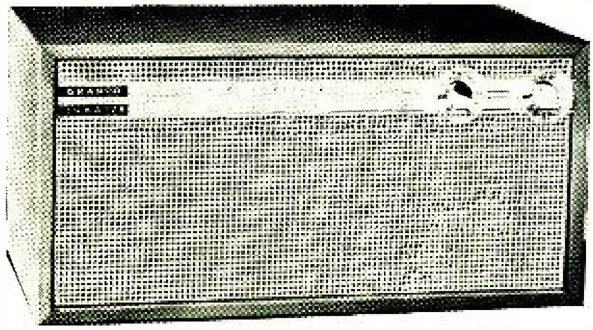
Recently, the subject has been clarified by the work of two scientists, Albert Krueger and Richard Smith of the Department of Bacteriology, University of California. They conducted experiments in which sections of the windpipe were taken from rabbits, and the effects of the charged air noted.



Electrometer and probe can be used to determine if an air conditioner is sending ionized air into a room.

The lining of the nasal passages, the trachea and bronchial tubes is surfaced with ciliary cells. These cells have tiny hairlike growths which constantly wave or beat. This action propels fluid upward toward the nose, and is nature's way of ridding our lungs of dust, bacteria, pollens and other irritants.

The experiments showed that negative air causes the fluid of these cells to become less viscous, the cilia to beat faster and thus push particles away faster. Positive air caused the cilia to slow down, the fluid to dry and the specimens to die more quickly.



The Granco Ionator, a portable health appliance a foot and a half long by about ten inches high and deep that combines mechanical filtering, electrostatic precipitation and negative ionization. Particles as small as one micron in diameter are removed from the air sucked in, and the purified air is charged with negative ions as it is returned into the room.

Some manufacturers have been quick to note these developments, and already electric heaters and air conditioners which embody ionization equipment are on the market.

Normally, when air is ionized, both positive and negative ions are generated, but circumstances may alter the balance between the polarities. The ionization of the atmosphere is constantly changing in polarity.

Ions from heaters

The Wesix Electric Heater Co. became interested when the firm's president found that electric heaters could ionize air. He learned how electric heaters could be modified so they would take advantage of this and contribute a desirable surplus of negative ions to the air.

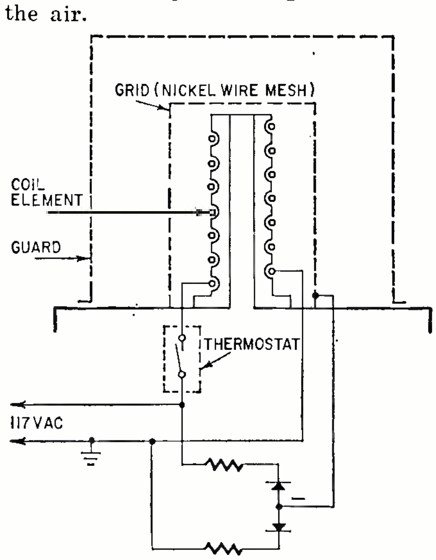


Fig. 1 — Arrangement of an electric heater modified to deliver negatively ionized air.

This was done by placing a nickel wire-mesh grid around the ceramic tube on which the heating element is wound (Fig. 1). Under the heater a small rectifier is connected to the ac line. The negative side of the rectifier is connected to the grid which surrounds the heating element.

Operation is like that of a vacuum tube. The heater element, when it reaches incandescence, generates both positive and negative ions. The positive ions are attracted to the negative grid and neutralized. The negative ions are repelled to the heater. When the ac goes through zero, the negative charge on the grid disappears. At this moment, both positive and negative ions pass through the grid. When the grid is again energized, the positive ions which got through are drawn back and neu-

This ionizer resembles a microphone. It is made by the Wesix Electric Heater Co.

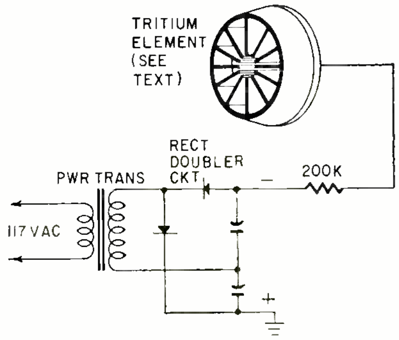


Fig. 2—Circuit for negative-ion generators.

tralized. The negative ions which are outside are repelled by the grid and pushed into the room. The ceramic tube which holds the heater and grid is slightly conductive when hot, and lets the grid charge leak off between ac cycles.

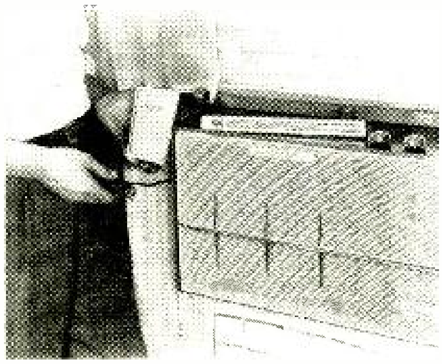
Heatless ionizer

You may not always want the heat on to get ions, so a gadget that looks like a desk microphone was developed for such cases (see photo). It consists of a small plastic disk containing a piece of titanium foil which has been impregnated with heavy hydrogen, tritium (H_3). This is a radioactive material which emits beta particles of .015 mev. It will ionize air, but the particles travel only a short distance, so there is no danger from radioactivity.

Behind the foil a flat plate electrode suppresses the positive ions and repels the negative ions into the room. The base of the desk unit contains a transformer and a voltage-doubling rectifier unit, with a circuit resembling that used in radio receivers (Fig. 2). About 900 volts of negative dc is obtained and this is connected to the plate electrode.

In addition to these devices, another manufacturer, Philco, now markets an air-conditioner which embodies an ion control device.

It consists of a power supply which



Philco's Ionitron being attached to an air conditioner.

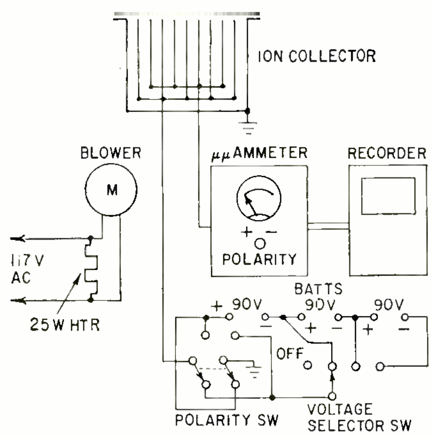


Fig. 4—Setup for measuring ion content and polarity of air.

delivers 4,000 volts dc to an ionizer tube located in the air stream (Fig. 3). The voltage is great enough to ionize the air, but not enough to form ozone or nitrogen oxides.

The polarity and count of atmospheric ions can be measured by apparatus which is fundamentally simple, but nevertheless quite delicate and expensive. All that is required is a set of plates, like an air capacitor, and a *micromicro*ammeter. In principle, a charge from a battery is placed on one set of the plates. The ions in the air carry some of this charge to the other plates, from which it is drawn off through the ammeter and measured (Fig. 4).

An electrometer can check ions emerging from a suspected source. It is a sensitive vacuum-tube voltmeter type unit which reads in micromicroamperes when used with a shunt. It can be connected to a small probe consisting of a coin-sized disk surrounded by a ring (see photo on preceding page).

These are some of the units now on the market. More will be made and within a short time many more manufacturers will be turning out ionizers—another promising new field for the electronic technician. END

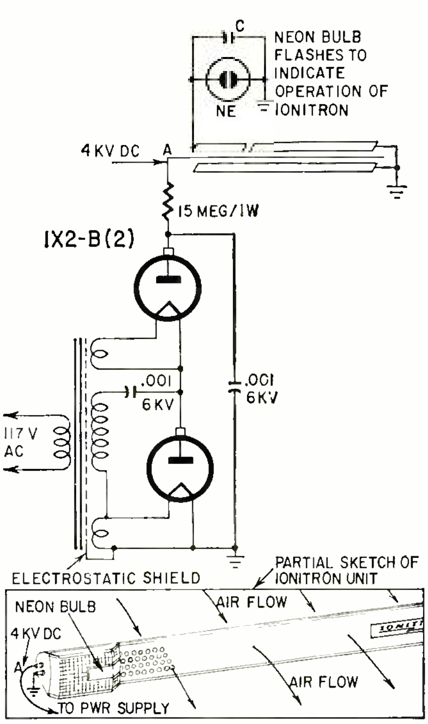


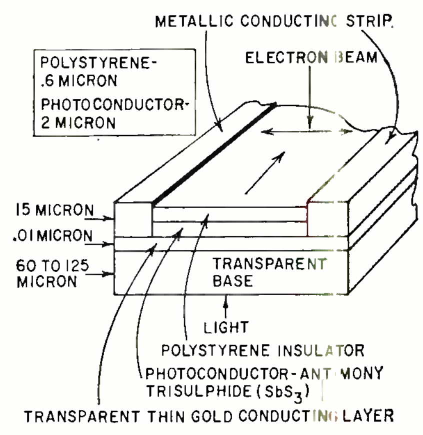
Fig. 3—Circuit of Philco's Ionitron.

ELECTRONIC CAMERA TAKES MOVIES

A NEW type of camera that is based on a combination of television and electronic printing techniques is now in the experimental stage. Developed by RCA scientists at developmental laboratories in Princeton, N. J., the electronic camera records its pictures on a strip of specially prepared reusable plastic tape.

A conventional lens system focuses the scene to be recorded on a tape made up of layers of conducting, photosensitive and insulating materials on a plastic base (see diagram). Before being exposed, the tape is given a uniform electric charge by an electron gun. When a picture is taken (one frame), the charge is driven from the tape according to the intensity of light in the scene. The result is an electrical charge pattern that corresponds to the light pattern of the image.

To view the pictures, the exposed tape is passed in front of a scanning beam from an electron gun which reads the electrical charge pattern to produce television type signals for transmission or recording on magnetic video tape. (The electrical charge will remain on the camera tape for about two weeks and can be scanned several times.) Final playback is on a TV screen. In the experimental version, the entire mechanism is enclosed in a vacuum.



As used in space satellites (the original purpose of the device), the information would be transmitted to earth where it would be recorded on magnetic video tape. For home movies—a remote possibility for the future—the exposed film would be placed in a playback device that would record the signals on magnetic tape. Then through a video tape playback, the pictures would be viewed on a standard TV receiver. END

PRINCIPLES OF MODERN RADAR

Part II—Pulse-Doppler systems eliminate many of the disadvantages of other radar systems in detecting and indicating moving targets

By JORDAN McQUAY

THE two basic kinds of radar discussed in the first part of this series were the pulse-modulated or PM and the frequency-modulated or FM. Although both provide accurate range and azimuth data, they depend on targets of fairly large size which do not move rapidly with respect to the range.

For example, PM radar is excellent for long-range detection and tracking of missiles and satellites in outer space. Although such targets may actually be traveling at high speeds, their rate of movement is not too consequential when compared to range distances of thousands of miles.

At very short ranges, ground-based PM and FM radar is ineffective in locating targets on or just above the ground—particularly when they are moving over the earth's surface.

A long-persistence PPI (*p*lan *p*osition *i*ndicator) scope provides, with successive sweeps of the radar antenna, a series of repeating echoes from moving as well as fixed targets. Close scrutiny of slight changes in the position of these echoes on the scope screen gives some indication of movements of any target. But there is no highly accurate indication of moving targets on the PPI scope of a PM radar. It is even more difficult to see target echoes when they are submerged or partially covered up by echoes from fixed objects on the terrain.

This important requirement is met by a third kind of radar. Combining certain features of both the PM and FM, it is known as pulse-Doppler or PD radar because it uses the Doppler effect effectively.

The Doppler effect was named after the man who discovered it. It is simply an apparent change of frequency of any received signal by a moving object (the object can be stationary and the signal source moving). A common example of this is the change in pitch of a whistle or bell on a train as it goes past a listener. The passengers on the train also experience this effect when listening to gate-crossing bells and such. The effect is not limited to sound or radio (or radar) signals: the light from a moving star seems to change in frequency (color). The light shifts toward the red region of the spectrum when the star recedes from us and toward the violet region when it approaches us.

Radar signals from a moving target are doubly affected by this effect. The target receives a signal that is changed in frequency and then reflects (or effectively retransmits) it to the original source. Since the target is moving with respect to the source, the frequency of the signal is changed again.

A PD radar can detect and locate all objects and targets within range—it sorts out *moving* targets with special data-processing circuitry and displays these *and only these* echoes on an indicator. A PD radar is sometimes called an MTI or *m*oving-*t*arget *i*ndicator.

A single and important advantage of PD radar is that it defines moving objects and targets clearly at greater ranges—regardless of ground clutter and echoes from fixed objects or targets —than is possible with any other kind of radar.

Although developed primarily for military surveillance, PD radar will ultimately find commercial use for similar specialized applications.

Radar components

A PD radar (see block diagram) is similar in many ways to the PM type. The principal difference is in the receiving circuit.

At an operating frequency of several hundred or sometimes thousand megacycles, the radar transmitter sends out *pulses* of microwave energy. These are directed by the antenna system toward the area being searched or scanned.

The number of such pulses per second—usually about 5,000—is called the prf (*p*ulse *r*ecurrence *f*requency). The duration of each rf pulse is extremely short—less than 1 μsec—to allow time for reflected echoes from objects or targets to be received by the PD radar.

The prf and the pulse duration are both controlled by the *timer*. It also provides trigger voltages to synchronize operation of the transmitter, receiver, indicator and other components of the radar system.

A *duplexer*—or TR switch—permits use of a single antenna for both transmitting and receiving.

Objects and targets within range of the radar and reached by the very narrow rf beam from the antenna will reflect very weak echoes—usually less than 1 μv in strength. These reflected echoes are picked up by the antenna and pass directly through the duplexer to the microwave receiver, which is broadly tuned to the same operating frequency as the radar transmitter.

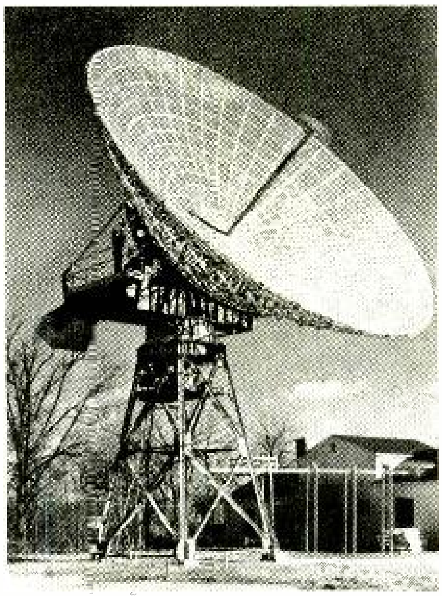
In the receiver, echo signals are mixed with a local-oscillator signal to produce an if of 30 mc (sometimes 60 mc), which then passes through several stages of broad-band (if) amplification. Automatic circuits in the receiver provide for frequency control of the local oscillator and for gain control of the incoming echo signals.

At the same time, a *coherent oscillator*—actually a second local oscillator —is operating continuously at the if (30 mc or 60 mc). It produces if control signals that have a fixed phase relationship (or phase coherence) with the if echo signals.

Both signals—if control and echo—are applied to a phase detector. It combines them into video signals having a polarity determined by the phase difference between the control signals and the echo signals.

Echoes received from stationary objects and targets produce video signals (at the output of the phase detector) with a fixed polarity. Echoes from moving targets produce video signals that change in polarity at a frequency proportional to the rate of movement of the objects or targets.

To sort out and eliminate the video



US Army

Antenna of giant PM radar used to detect and track missiles and satellites.

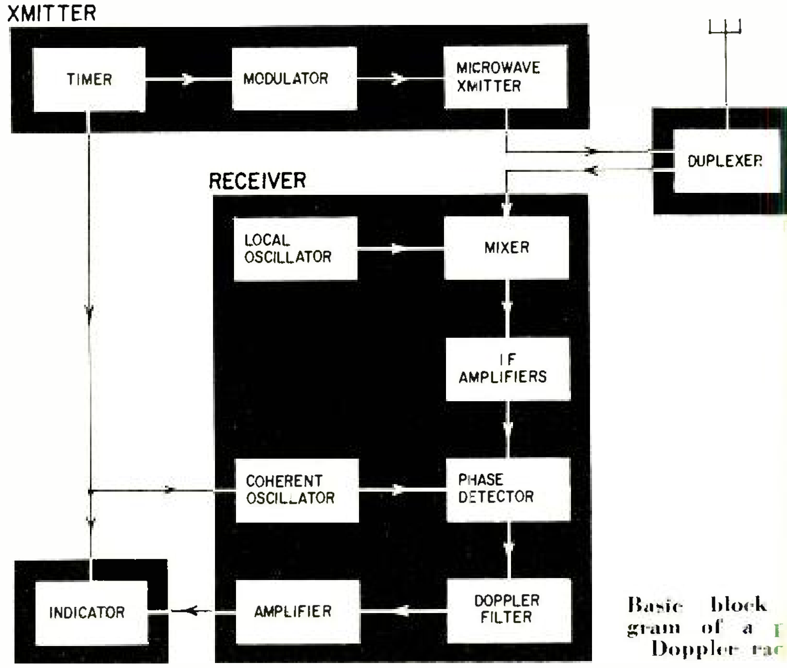
signals of fixed polarity (from fixed targets), the output of the phase detector is applied to a *Doppler filter*. This discriminates against all video signals of fixed polarity, but passes all video signals that represent moving targets. The Doppler filter is a complicated device. Something like a bandpass filter, that is extremely sensitive to signals of fixed polarity.

After suitable amplification, the video output of the Doppler filter can be utilized or displayed in several ways.

The video signals can be used to modulate an audio amplifier which produces an audible tone whenever the PD radar detects a moving object or target. A headphone enables an operator to zero in on such targets, and thus provides data for manual plotting of range and azimuth. The frequency of the audio tone is about 30 cycles per second for each mile-per-hour motion of a target. The faster the movement, the higher the pitch of the audio tone.

The same video signals can be used to activate low-frequency voltmeters or other similar indicating devices. Or they can be fed to a frequency-indicating meter or graph calibrated in miles per hour (commonly used to detect speeding automobiles).

Some types of PD radar use a PPI



Basic block diagram of a pulse-Doppler radar.

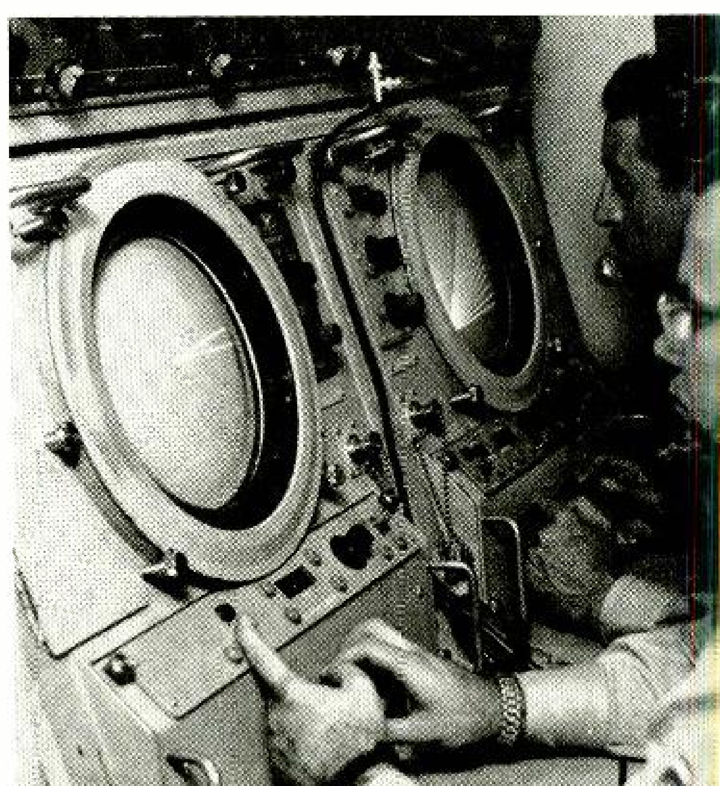
scope with a special intensifying circuit. Amplified video signals from the Doppler filter control a threshold detector. This, in turn, modulates or controls a low-voltage oscillator that intensifies a portion of the PPI scope in accordance with the video signal. Range and azimuth of each moving target are determined in the conventional manner for PPI scopes. But in this application, there are no interfering fixed echoes or ground clutter from fixed targets visible on the radar scope. Only echoes from moving targets are visible on the scope face.

Other kinds of scopes may be used similarly, but require special locally controlled intensifying circuits.

Memory systems

Echo signals exhibiting Doppler-shift frequencies can be measured rapidly only with some type of memory system that accurately "remembers" the broadcast frequency of the transmitter and compares it quickly with the frequency of the echo signals.

The memory system just described



Hughes Aircraft

PPI scope (left) of long-range surveillance PM radar displays only approximate data on moving targets.

is used for most ground-based PD radar where there is no appreciable change in frequency between successive signals. For this reason, it is called a *coherent* or "locked" system.

In the *noncoherent* system, a portion of the transmitted pulse power is stored electronically for comparison with echo signals. This comparison utilizes an echo signal reflected by a fairly large stationary target. Such an echo signal, which is not changing in frequency, is fed into a time-delay circuit prior to comparison with echo signals from moving objects and targets.

One example of a noncoherent PD radar is an airborne "side-looking" radar that scans downward, alternately, from each side of low-flying aircraft. Echo signals from stationary objects provide the reference required for frequency comparison. The radar provides a continuous picture map of the ground, about 30 miles in width, as the plane flies along. For low-speed low-altitude aircraft, this provides an intimate view of all moving objects on the earth below it.

US Army

Antenna system for medium-range military surveillance radar. Radiating element rotates beneath plastic housing.

For comparable target reporting, PD radar, utilizing either type of memory system, is generally more effective than the PM or FM types.

The performance of PD radar is evaluated according to two parameters. One is the minimum strength of echo signal from a moving target that can be detected in the absence of any fixed objects. The second factor—called sub-clutter visibility—is the ratio of the maximum strength of echo signal from a fixed target to the minimum strength of echo signal obtained from a moving target. END

AUTOMATIC RECYCLING TIMER

By L. E. FANNON

A portable timer that needs no manual reset

SEVERAL articles have appeared describing transistor timers but all require discharging the charging capacitor with a manual reset switch to allow the timer to recycle. This timer was designed for automatic recycling through a relay network operation.

Using one transistor, it has a variety of applications in photography, portable industrial controls and airborne equipment.

Ruggedness, compactness and zero warmup time are the distinct advantages of this timer over vacuum tube units. While cold-cathode timers requiring no warmup time are common, they require a line-voltage source which is objectionable in portable and airborne equipment applications.

The timer's power requirements are met by a common 24-volt supply, making it especially adaptable to remote airborne switching operations. It can be miniaturized sufficiently for model control applications.

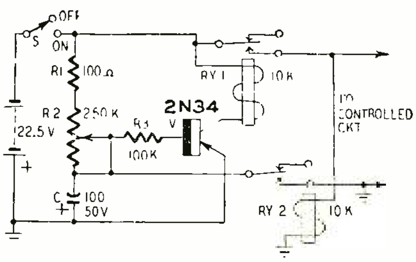
Circuit description

In the circuit (see diagram) when switch S is closed, capacitor C charges through R1 and R2 with R2 determining the desired time constant. Upon completion of the chargeup of C, current flows through R1, R2, R3 and the base-emitter paths, establishing the base bias. This results in a flow of collector current, closing the contacts of RY1 and connecting the supply voltage to the coil of RY2. This in turn momentarily connects the supply voltage to the controlled circuit. When the contacts of RY2 close, C is shorted and discharged, ending one cycle and starting another.

With values of R1, R2 and C as shown, time cycles ranging from 7 per second to 1 every 30 seconds are possible. The relay closure interval is not necessarily the R-C time constant of R2 and C, so actual measurement of the time is necessary. Resistor R3 holds base current to a minimum, aiding stability.

Total battery drain during the operation of both relays is 2.5 ma. Of course this will vary somewhat, depending on the sensitivity settings of the relays and the cycling time.

Because the coil of RY1 is in the transistor's output, the choice of collector voltage is influenced by that required for the relay's operation. Here the supply is 22.5 volts.

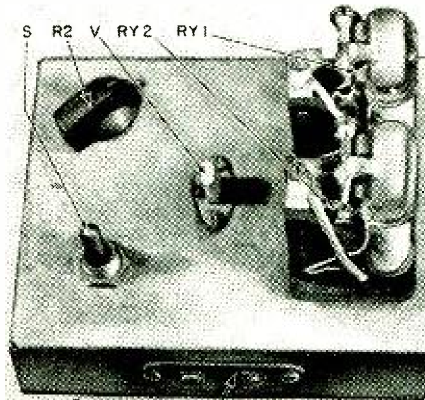


R1—100 ohms, ½ watt
R2—pot, 250,000 ohms
R3—100,000 ohms, ½ watt
C—100 μf, 50 volts, electrolytic
RY1, 2—spst, 10,000 ohms
S—spst toggle
V—2N34
Battery—22.5 volts (Burgess XX15 or equivalent)
Chassis—approximately 2 x 4 x 5 inches
Terminal Strip—2 contacts

Circuit of the transistor timer.

Two 10,000-ohm spdt relays are used in this circut. However, one dpdt relay could be used instead, with the second set of contacts serving the same purpose as RY2. This choice depends on the relay contact rating needed for carrying the controlled circuit current.

The photo shows the relays and controls mounted on the chassis. The only controls required are the switch and time control. In this unit the time control is a 250,000-ohm potentiometer. If fixed, preset time intervals are required, a decade type switch with fixed resistors can be used to establish these settings in step series.



The portable recycling timer.

Although no effort was made to miniaturize this unit, it would be possible to decrease the size of the timer greatly by using a printed circuit and printed-circuit type components. Cost-wise, this is not practical unless space is at a premium. END

TROUBLESHOOTING SWEEP CIRCUITS

Faster and easier servicing with a low-priced instrument that substitutes vertical and horizontal oscillators.

By VAL SYKES*

HORIZONTAL sweep-circuit troubleshooting is still the "tough dog" of TV servicing. With no raster visible, the non-technical user of a TV set will usually suspect the picture tube. However, a professional television technician can rapidly trace the trouble to the horizontal sweep circuits (if the trouble is there).

Most technicians attack horizontal troubles this way: First check the fuse and, if it is blown, replace it. (It is a good idea to replace the damper tube also). If the trouble is not in the damper circuit, the horizontal oscillator, discharge (if used), output and high- and low-voltage rectifier tubes are substituted. If no raster can be obtained by tube substitution, the trouble generally lies beneath the chassis.

At this point, the trouble must be tracked down to the defective stage before repairs can be made. Since any of the stages mentioned will prevent the appearance of a raster, it may not always be possible to pinpoint the trouble quickly. The Sencore Sweep Circuit Trouble Shooter was designed with such problems in mind.

The Trouble Shooter contains a stable 15,750-cycle sine-wave oscillator which uses half of a 12AU7-A dual triode. The oscillator stage is isolated from the TV set by the second half of the 12AU7-A, which reduces oscillator loading. A neon lamp on the front panel indicates that the oscillator in the Trouble Shooter is functioning correctly. The oscillator frequency depends on the L-C combination of T2 and C2 and stray capacitance (Fig. 1). Feedback to sustain oscillation is between the primary and secondary of the slug-tuned transformer, T2.

A sawtooth output signal (with a very rapid retrace period) whose amplitude is determined by R7 (the 50,000-ohm output control) is capacitively coupled to the output jack. A comparatively low-resistance control was selected to reduce variations in output signal amplitude due to the varying loads to which this unit is subjected. The output lead is safe to handle since it is isolated from B-plus by a .05-μf capacitor (C6).

Oscillator substitution

To check the horizontal oscillator in a TV set, apply the 15,750-cycle signal from the Trouble Shooter to the horizontal-output tube control grid (Fig. 2) and a raster will appear (if the set's oscillator is at fault). Working progressively backward toward the horizontal oscillator stage in the TV set will pinpoint the defective component. The Sweep Circuit Trouble Shooter should always be grounded to the TV chassis being checked. If the receiver's horizontal oscillator is normal and the trouble lies elsewhere, use of the substitute oscillator will produce no harmful effects.

Cathode-current check

The reason for measuring the cathode current of the horizontal output stage is to see if it is operating within its limits. An octal adapter socket (with test pins) is provided to make this test quick, simple and convenient. The test pins on the sides of the socket may be used for voltage measurements or for applying the oscillator output signal to the output tube's grid. The adapter automatically breaks the cathode circuit of the output tube. A three-position cathode selector switch, S1 (Fig. 1), selects the correct cathode pin for any horizontal tube used in present TV receivers. Selecting the wrong switch position will not harm the Trouble Shooter or the TV set. The meter selector switch, S2, places a 0—3-ma meter (shunted by a 10-ohm resistor and .02-μf bypass capacitor) in series with the cathode of the horizontal output tube, when it is in the cathode current position.

If the cathode current is higher than the average current for the particular tube (as indicated on the roll chart), a shorted coupling capacitor, grid resistor, horizontal output transformer or yoke may be the trouble. Lower than normal current is usually caused by bad screen components, an open output transformer or yoke. With the horizontal oscillator in the Trouble Shooter connected to the TV set and the cathode current reading high, trouble is definitely in the output section of the horizontal amplifier (if the coupling capacitor and grid resistors are good).

The cathode-current check can be used to make the proper adjustment on the horizontal linearity coil. With the Trouble Shooter set for cathode-current check, vary the setting of the linearity coil to the point where the cathode current dips. Linearity is best near the lowest cathode-current point.

Yoke substitution

If the trouble has not yet been isolated, the yoke should be checked with

Sencore SS105 Sweep-Circuit Trouble Shooter.

* Sencore design engineer.

the deflection-yoke substitution coil (T3), a special slug-tuned coil designed to withstand high pulse voltages. The yoke substitution coil is connected in place of the suspected yoke through a thick lead (Fig. 3). This lead is connected to the top terminal of the tester. The bottom terminal of the tester must be connected to the TV chassis.

The inductance of the yoke substitution coil is adjustable between 6 and 40 millihenries with the slide knob on the front panel. This inductance range was selected because it covers practically all yokes in use. This approach to deflection-yoke troubleshooting is simple but effective. If a yoke is defective, the substitute yoke will produce a bright vertical line on the CRT and restore high voltage. The substitution-yoke inductance should be varied to obtain the above result. A vertical line is produced since only vertical deflection is applied to the TV yoke when making this check. The horizontal deflection component is applied to the substitute yoke coil, thereby producing no horizontal deflection on the TV screen. If a deflection yoke has a high-voltage short (under full load) between the vertical and horizontal coils of the yoke, the Trouble Shooter will isolate the coils and produce the vertical line, showing up the defective yoke.

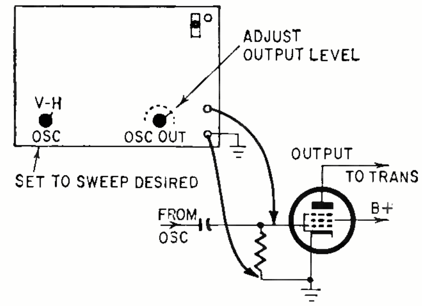


Fig. 2—Method of connecting tester to grid of output stage.

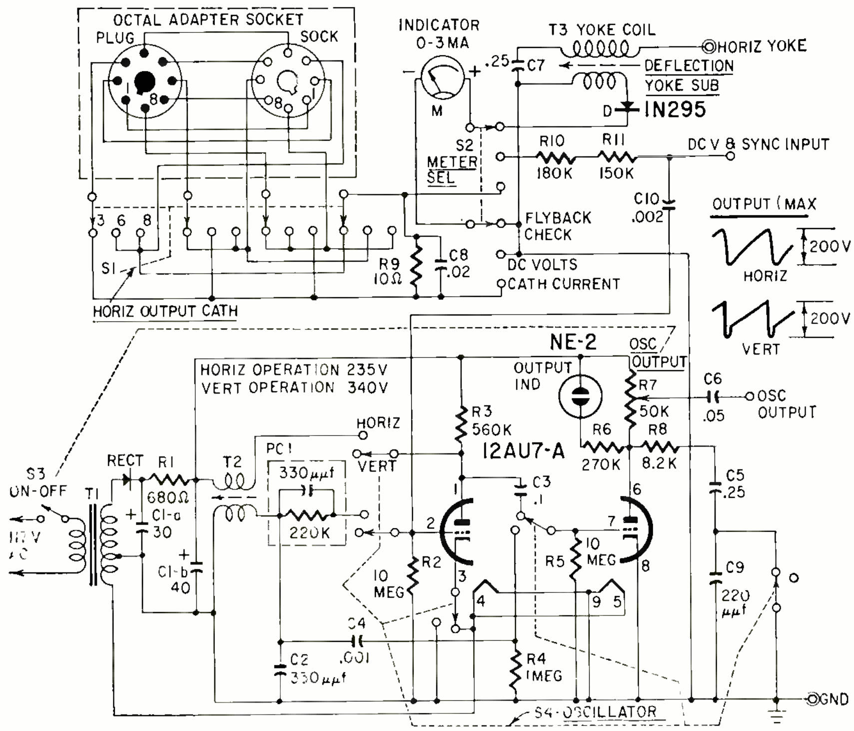


Fig. 1—Schematic of Trouble Shooter.

Voltage measurements

The sweep-circuit Trouble Shooter contains a voltmeter circuit intended for sweep-circuit voltage measurements. B-plus, screen-grid, boot-strap (B-plus boost) and cathode voltages can be measured with reasonable accuracy. Two heavy-duty multiplier resistors totaling 330,000 ohms provide safe operation and indicate voltage correctly on the center scale of the meter. For this check, the meter is connected —by the meter-selector switch—through the multiplier resistors to the dc volts jack. Sweep-circuit voltages which should be measured and their approximate values are shown on the roll chart and in Fig. 4. B-plus at the damper stage should read within 10% of that at the low-voltage rectifier. Bootstrap voltage should be in excess of 100 volts over B-plus. If bootstrap voltage is normal but no arc can be drawn at the plate of the high-voltage rectifier, the high-voltage winding of the flyback transformer is probably open. If bootstrap voltage is low, check for excessive current drain. Disconnect the circuits fed by the bootstrap voltage temporarily and see if it returns to normal. This should be done before making the flyback check explained below. Nominal screen grid voltages are indicated on the roll chart for all horizontal amplifier tubes in use today. If screen voltage is too high, screen current may also be high, and the value of the screen resistor should be checked to prevent damage to the horizontal-output tube.

Flyback check

If the above substitutions and tests still have not isolated the trouble, a horizontal transformer output check should then be made with the Trouble Shooter. The meter-selector switch is set at the FLYBACK CHECK position and the substitute deflection yoke coil connected for this check (Fig. 5).

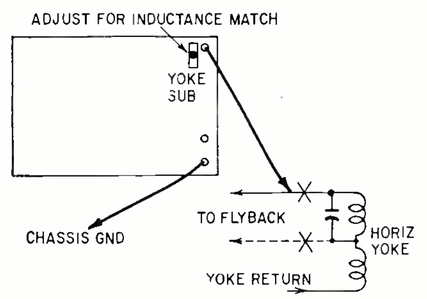


Fig. 3—Hot lead(s) to yoke are disconnected and the signal applied to the substitute yoke.

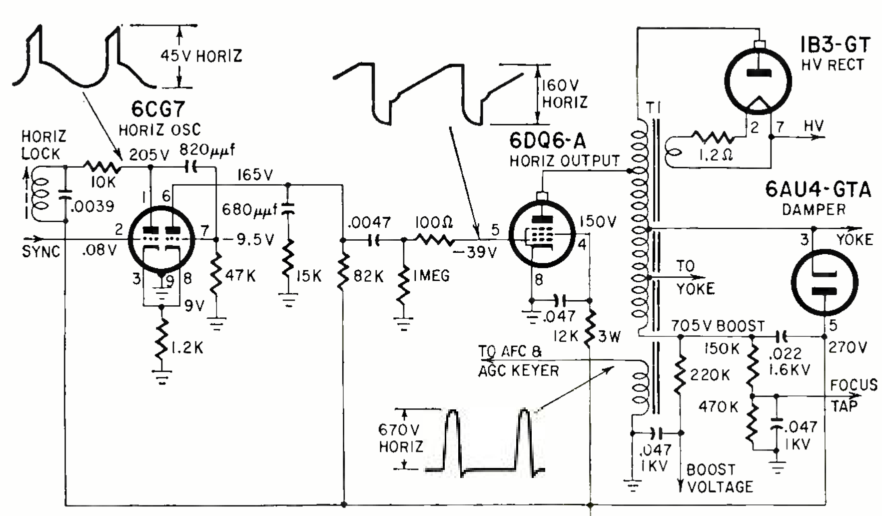


Fig. 4—Typical horizontal output stage showing voltages to be measured.

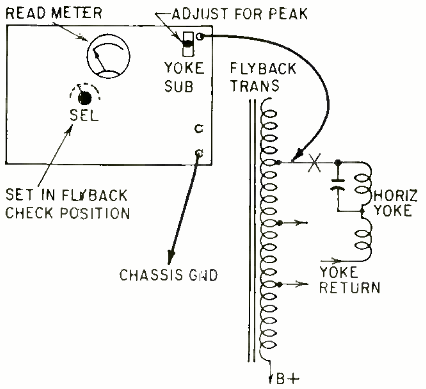


Fig. 5—Substitute yoke is connected and its inductance adjusted for maximum meter reading.

A small takeoff coil adjacent to the high-voltage yoke substitute coil picks up some of the energy from the larger coil, feeds it through a half-wave rectifier and then applies it to the meter. The amount of power fed to the yoke substitution coil from the horizontal transformer will be indicated on the flyback-check scale of the meter. Since the amount of power required to drive the yoke is dependent on the deflection angle being swept, the meter is calibrated in degrees of deflection.

It should indicate the deflection angle (or higher) of the set being checked if the flyback is good. The yoke substitution coil is adjusted for a peak reading on the meter (if no peak can be obtained, the flyback probably has one or more shorted turns). If no reading can be obtained and the screen voltage, boost circuits and yoke are good, the flyback is bad.

Vertical substitution

An additional feature of this checker is a substitute vertical oscillator circuit. It is used in the TV set when only a thin horizontal line is seen on the CRT face or if sufficient height cannot be obtained. A thin horizontal line or insufficient height indicates trouble in the vertical oscillator or vertical output stage. The Trouble Shooter will isolate the trouble to the particular stage or component at fault.

The substitute vertical oscillator is connected to the vertical output tube grid in the same manner as the horizontal oscillator. The selector switch (S4) must be in the VERT position and the same output control is used. Height wil lbe restored if the vertical oscillator in the TV set is inoperative. If there is no improvement, the trouble is in the output transformer, yoke or vertical output tube.

Remove the vertical output tube (or disconnect the plate lead). Connect the output of the SS105 to the plate connection of the tube socket. If a picture approximately 2 inches high is visible on the screen (with oscillator output set at maximum), the output tube is bad. If there is still no height, apply the Trouble Shooter signal to the yoke. The appearance of a ½-inch-high picture shows the output transformer to be bad. No height indicates the yoke is defective.

The vertical oscillator circuit in the Trouble Shooter consists of the two sections of the 12AU7-A tube connected as an amplifier and clipper (Fig. 1). Therefore, in a sense, it is not an oscillator at all, but two amplifier-clipper and shaping stages making use of the 60-cycle line frequency for the required vertical signal. Because the output signal is locked to the line frequency, there will be no rolling (nor slipping) on the TV screen.

A novel feature of this unit is the roll chart indicating voltages, currents and pin numbering of *all* horizontal output stages used in present-day TV receivers. It will not become obsolete since any new tubes can be added to the chart.

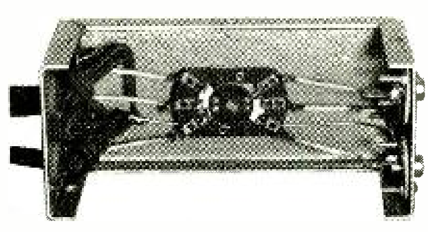
The cathode-current check can also be used in balancing output stages in hi-fi amplifiers, a must for good performance of this equipment. END

AUDIO COMPARATOR

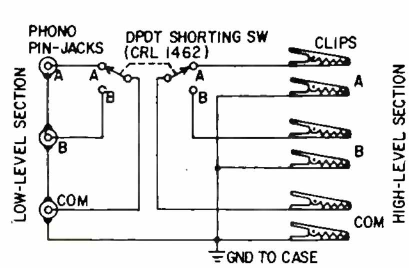
By J. E. PUGH, JR.

THIS simple, inexpensive instrument can be used to make rapid comparison tests on hi-fi tuners, phonographs, microphones, amplifiers, ac and dc voltage levels, the phasing of multi-speaker installations, or nearly any other use where it is desirable to compare levels or quality. It is useful in hi-fi sales and service and public address work. In addition, it can be used for switching between two or more turntables at dances or get-togethers.

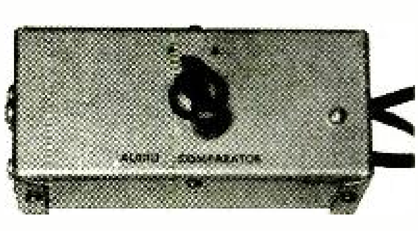
A dpdt shorting type switch (Centralab 1462 or equivalent) is used in this model for comparing any two similar components. This will take care of most applications but, if you want to compare a larger number of units, use a two-pole switch with more positions and a correspondingly greater number of connectors.



Inside view of Comparator shows simple construction.



Circuit of the Audio Comparator.



The completed unit, ready to use.

Phono pin jacks are used on the low-level section to minimize hum and noise pickup. This section of the comparator is used where the signal level is low, such as at the input of an amplifier. The high-level section uses 5-foot lamp cords terminated in Mueller type 45 clips. It is used for tests on amplifier output and speaker systems.

The parts are mounted in a 2¼ x 2¼ x 5-inch aluminum box. Accessories include two 3-foot mike cables terminated with phono pin plugs and two 25-foot lamp-cord clip leads.

To compare high-impedance, low-level components such as microphones, phonographs or tuners connect one unit to jack A, the other to jack B and the indicator to the common jack. Amplifiers are compared by connecting the input and output of each amplifier to the corresponding A and B channels. Apply the input signal to the common jack and the speaker to the common clip lead. Compare speaker quality by connecting one unit to clip lead A, the other to clip lead B, and the amplifier output to the common clip lead.

Check speaker phasing by connecting the A and B clip leads to their voice coils and a type-C or -D flashlight cell with a 5.6-ohm resistor in series to Common. Switch between speakers to see that their cones move in the same direction for correct phasing. If this test is to be made often, such as when making PA installations, install the battery and resistor in the box and use a spst toggle switch to connect it between ground and the high-level switch arm when needed. END

Test Adapters

By **ROBERT F. SCOTT**
TECHNICAL EDITOR

A series of adapters, using a multimeter as their indicating device, saves space and money

NOT so many years ago a service technician could tackle any radio or audio repair job with a tube checker and multimeter. The multimeter alone was enough to see him through a service call to a local factory or theater. Now, with TV, hi-fi audio, intercoms, transistorized equipment and electronic industrial controls —much of which must be serviced on the spot—a technician in the field may need a vtvm, battery and transistor testers and an ac ammeter. For audio servicing he may need a calibrated attenuator (microvolter) to obtain extremely low outputs from his af generator and an audio wattmeter for checking amplifiers and allied equipment.

Adding these to the normal shop complement of service equipment is a financial drain on many technicians. And the bulk puts a premium on space in the service truck.

One way to lick the space problem and reduce the financial outlay has been presented by Simpson with a new line of seven Add-A-Tester adapters for the famous 260 multimeters and the recently introduced model 270. The Add-A-Testers include an audio wattmeter, dc vtvm, audio microvolt attenuator, ac ammeter, and also temperature, battery and transistor testers. Each adapter measures 5-5/16 x 4-⅜ x 3-7/16 inches, and plugs into the bottom of the 260 or 270 vom as shown in the photograph. Adapter weight ranges from 12 ounces for the transistor tester to 2 pounds for the vtvm and ac ammeter.

The model 260 is a popular multimeter that has been made in three versions. The series I cannot be used with the Add-A-Testers. It is identified by its flat, square-cornered panel. The Series II has a raised panel with rounded corners, uses pin jacks and has a 100-μa dc range. The series III looks a lot like the series II and is distinguished by its 50-μa dc range and banana jacks.

Inexpensive adapter case kits are available for using the series II and III 260's and the 270's produced prior to June 1, 1959. Adapter case kit model 401 is optional. It consists of a modified instrument case that permits latching the Add-A-Testers securely to the underside of the multitester. The 402 case kit for the series II 260's consists of a modified case and parts necessary for adding a 50-μa dc range. This kit is necessary when using the series II instruments with the vtvm and temperature, transistor and battery testers requiring the basic 50-μa movement.

The Add-A-Tester adapters have four banana plugs arranged along the top rear so they mate with jacks on the 260/270 multimeter. Four extra pin type plugs are supplied with each adapter so they can be used with series II 260's. All adapters have a switch (or special position on the function or range switch) that permits the multimeter to be used for its normal functions without detaching the adapter.

Model 650 transistor tester

The 650 Add-A-Tester provides beta and I_{co} measurements on general-purpose low- and medium-power germanium transistors. Power transistors and silicon junction types are checked by interpolation. Beta ranges are 0 to 10, 50 and 250 and the I_{co} range is 0 to 100 μa.

The circuit of the 650 transistor tester (Fig. 1) is essentially a bridge that balances when collector current is 1 ma. The BAT ADJ control sets the voltage applied to the bridge for optimum accuracy. In the initial setup, it is set so the meter reads 25 on the 50-volt dc range. The ZERO ADJ control varies the base to provide 1-ma collector current and balance the bridge.

The basic bridge circuit for measuring beta is shown in Fig. 2. When the BETA switch is in the 250, 50 or 10 positions, predetermined values of resistance are switched into the base circuit, thus changing the base current and unbalancing the bridge. Beta is read directly from the scale corresponding to the setting of the BETA switch.

The transistor tester uses the 50-μa movement of the 260/270. In use, the transistor is plugged in and the FUNCTION switch is thrown to NPN or PNP, depending on the transistor being tested. The BETA switch is set at BAT and the BAT ADJ control is set so the meter reads half-scale on the 50-volt

Model 260 multimeter and 650 transistor-tester adapter.

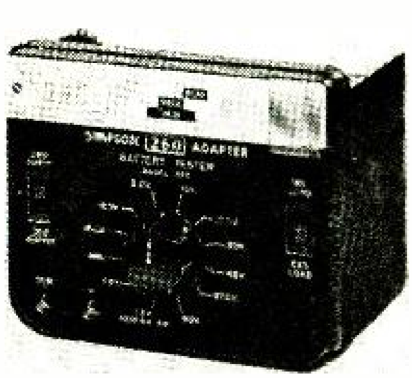
Model 651 dc vtvm adapter.

Model 652 temperature-tester adapter.

Ac ammeter adapter model 653.

Audio-wattmeter adapter model 654.

Model 655 microvolt-attenuator adapter.



Model 656 battery-tester adapter.

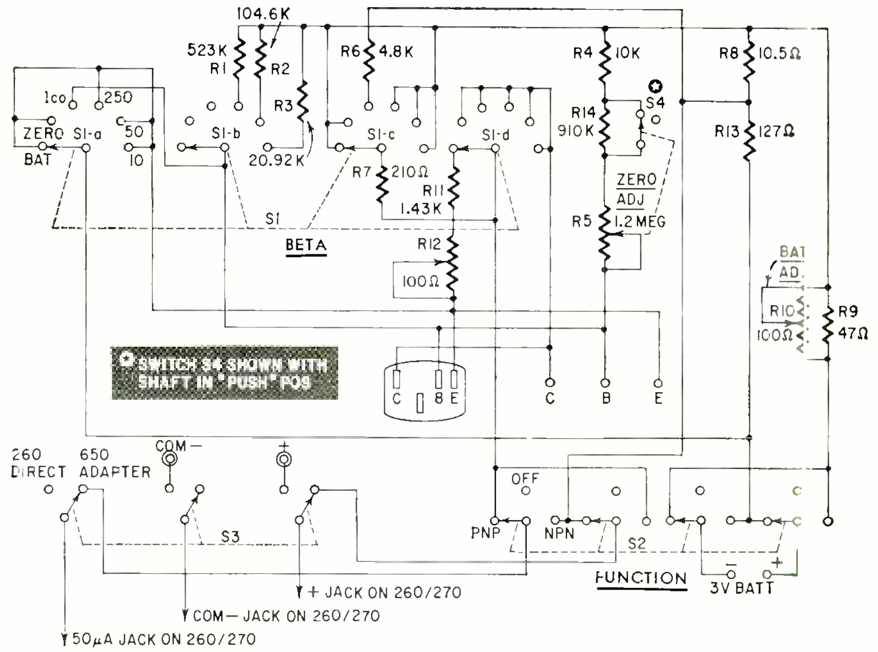


Fig. 1—Circuit of transistor-tester adapter, model 650. All adapters using 50-μa meter range have plug on short lead to connect to 50-μa jack on meter.

dc scale of the meter. The BETA switch is then set to ZERO and the ZERO ADJ control R5 is varied until the meter reads zero indicating bridge balance.

(The ZERO ADJ control is a combination pot, R5, and push-pull switch, S4. When pushed in, R14 is shorted out. The initial setup is made with the control pushed in. If the meter does not zero, the control is pulled out and the operation repeated.) If the meter still does not zero, the transistor is defective or has high leakage and must be checked as a power transistor.

When the BETA switch is advanced to I_{co}, the emitter circuit is opened and the meter reads collector current. Read the 0–10 scale on the meter and multiply by 10 for leakage in μa. Full scale is 100 μa. Compare this reading to the transistor data sheet. It should be equal to or less than the manufacturer's data.

Throwing the BETA switch to 250, 50 or 10 causes the meter to indicate beta directly on the corresponding scale of the 260/270.

Silicon transistors are checked like germanium types but the beta reading obtained must be multiplied by 1.16 for accurate evaluation.

Power transistors have high values of I_{co}, so it is not always possible to zero the meter with the ZERO ADJ control. In this case, the control is set for the lowest reading. The BETA switch is then thrown to 250 and the first reading is subtracted from the second. The difference is the beta of the transistor. When I_{co} is more than 100 μa, it is measured by switching the 260/270 to the 0–1 or 0–10-ma range and reading I_{co} on the corresponding scale.

Model 651 dc vtvm

This Add-A-Tester converts the 260/270 multimeter into a completely portable dc vtvm that meets the needs of the modern radio and electronics service technician. Its sensitivity (0.5 volt full scale on the lowest range) makes it especially useful in checking transistor circuitry and agc measurements. Its 10 full-scale ranges are 0–0.5, –1, –2.5, –5, –10, –25, –50, –100, –250 and 0–500 volts dc with an input resistance of 11 megohms. A FUNCTION switch turns the instrument on and off and selects polarity of the dc probe.

The vtvm uses a bridge type circuit with a triode-connected 1AG4 subminiature pentode. The self-contained power supply consists of two Eveready 413 30-volt B-batteries and two Mallory ZM-9 1.34-volt mercury cells in parallel for the filament supply.

The complete circuit of the 651 is shown in Fig. 3, a bridge-circuit analogy in Fig. 4. The battery voltages are equal in adjacent arms of the bridge so it is balanced and the meter reads zero when the filament–plate resistance of the tube equals the value of R17.

Voltages to be measured are applied to the grid of the tube. This unbalances the bridge and the value of the applied voltage is read directly on the meter scale specified for the setting of the 651's range selector switch. When using the 651 with the 260 multimeter, the accuracy is ±3% full scale and ±5% of the reading. With the 270 multimeter, the accuracies are 2% and 4% respectively.

The FUNCTION selecter should be set for the polarity of the voltage being measured. It is connected so the positive "side" of the voltage being measured is connected to the grid of the tube. The ZERO ADJ control should be set on each voltage range. It is adjusted so the meter pointer is exactly over the zero line with the dc probe connected to the ground terminal.

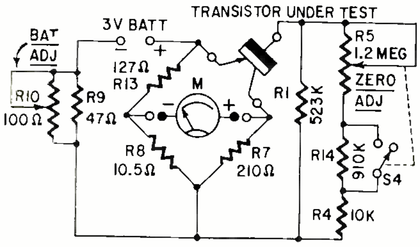


Fig. 2—Equivalent circuit of transistor tester with switch in Beta 250 position.

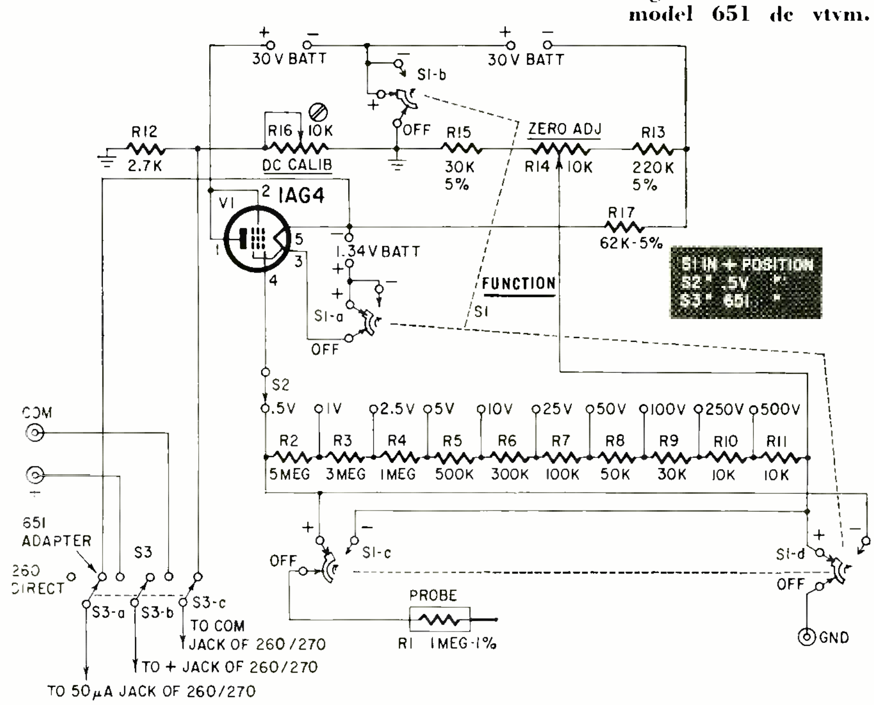


Fig. 3—Schematic of model 651 dc vtvm.

Model 652 temperature tester

This is a self-powered instrument for measuring temperatures from −50° to +250°F in two ranges. The low range goes up to 100°, the high from 100° to 250°F. Accuracy ranges from ±2° to ±4°, depending on the temperatures covered. The model 652 handles up to three temperature probes and comes with one probe with a 15-foot lead. Other probes are available with 30-, 50-, 100- and 150-foot leads.

The temperature tester is a battery-powered bridge with a thermistor probe in one arm. The probe is placed in the location where temperature is to be measured. The circuit is shown in Fig. 5. The bridge uses the 50-μa movement of the 260/270 with readings taken on the 50-volt dc scale. A slide rule across the top of the 652 converts the meter readings to temperature.

The FUNCTION switch is marked OFF, ADJ, LO and HI. It turns the instrument on and off, sets up the bridge for balancing and selects the temperature range. In the ADJ position, the battery is connected across the bridge with the probe disconnected. The METER ADJ control (R3) is set so the meter reads 25. This is half-scale when set on the 50-volt range.

When measuring temperature, the thermistor probe is substituted for R9 and calibrate pot R11. Bridge sensitivity is changed for the two ranges by varying the resistances of the three arms. On the LO range, R1 is shorted out for measurements up to 100°. R2 and R12 are short-circuited for measuring temperatures ranging between 100° and 250° on the HI range.

The meter pointer deflects off scale on the right if the temperature is below −50°F and off scale on the left if it is above 100°F on the LO range. If the pointer deflects off scale to the left on the HI range, the temperature is above 250° and the probe must be removed from the high-temperature area to prevent damaging it.

Ac ammeter model 653

This instrument measures alternating currents in ranges of 0–0.25, –1, –2.5, –12.5 and 0–25 amps with frequency response essentially flat from 50 to 3,000 cycles to cover power-frequency requirements of military and commercial supplies. Insulation is for 600 volts rms maximum.

The ac ammeter (Fig. 6) is a current transformer with a tapped primary and a secondary loaded by a precision resistor. The primary is inserted in series with the circuit being metered. Current in the primary induces a proportional current in the secondary and the 4-ohm load resistor. The current in the primary circuit is obtained by taking a reading on the 2.5-volt ac scale of the 260/270 and multiplying it by the factor indicated above the range binding post used.

Model 654 audio wattmeter

The wattmeter is designed for use in installing and servicing audio equipment. It provides noninductive 4-, 8-, 16- and 600-ohm loads for circuits being metered. Frequency response is flat from dc to 20 kc. Maximum wattages (with ambient temperature of 77°F) are 50 watts continuous and 100 watts for 2½ minutes with 4- and 16-ohm loads and 25 watts continuous and 50 watts for 2½ minutes with 8- or 600-ohm loads.

The circuit diagram of the 654 audio wattmeter is in Fig. 7. The "+" and "−" INPUT terminals on the 654 are connected directly to the corresponding terminals on the 260/270 multimeter. When the five-position LOAD SELECTOR is in the 260 DIRECT position, the test leads are connected to the multimeter so it can be used for any of its normal functions without detaching the adapter. In the other four positions of the LOAD SELECTOR, one or more of the internal load resistors are bridged across the INPUT terminals and the 260/270.

When the 654 is being used, the normal equipment load—speakers, phones,

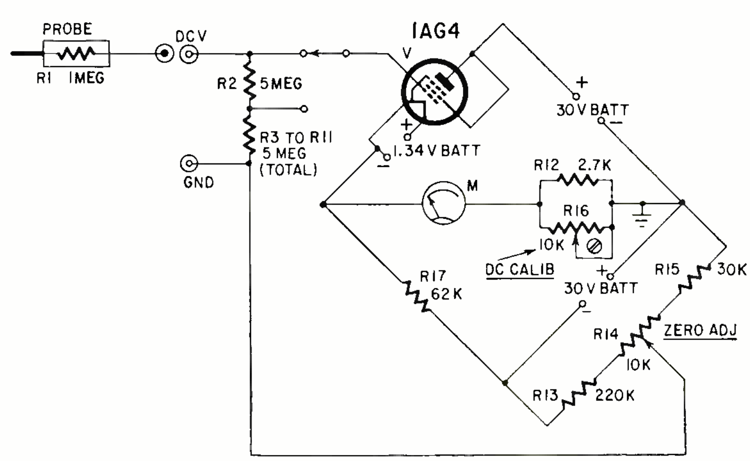


Fig. 4—Bridge circuit of 651 dc vtvm.

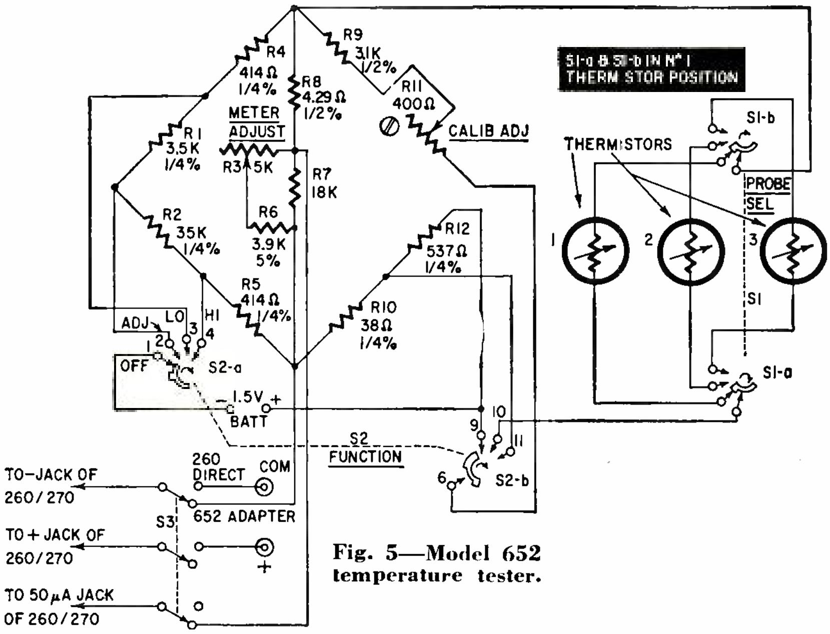


Fig. 5—Model 652 temperature tester.

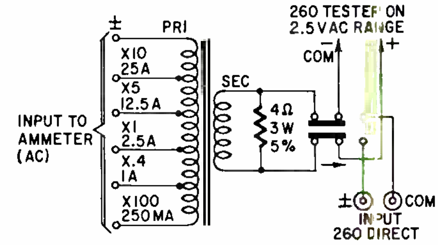


Fig. 6—Ac ammeter, model 653.

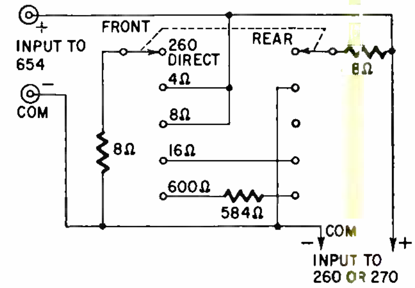


Fig. 7—Audio wattmeter model 654. Load-selector switch selects various load-resistor combinations.

lines, etc.—is removed from the output of the circuit or equipment being metered. The LOAD SELECTOR is set to the impedance matching the nominal circuit load. An audio voltage is fed into the unit being tested and the wattmeter measures the voltage across its load resistors on one of its ac voltage ranges. An attached slide rule converts the voltage reading to watts.

655 microvolt attenuator

This instrument provides calibrated low-level outputs ranging from 25 μv to 250 mv from a 2.5-volt ac or dc source. Its frequency response, essentially flat from 0 to 20 kc, makes it an excellent source of precise low voltages. It consists of an input level control—METER ADJ—and a five-position 600-ohm ladder attenuator. Each section of the ladder reduces the signal 20 db or to one-tenth of its input level. The input impedance is 2,000 ohms. An internal 600-ohm load resistor can be switched in or out, depending on the resistance or impedance of the external load circuit.

The input voltage is applied across the 2,000-ohm METER ADJ control and the 260/270 multimeter measures the voltage applied to the ladder attenuator (Fig. 8). When the ladder's input is exactly 2.5 volts, the microvolter's output is 25 μv, 250 μv, 2.5 mv, 25 mv or 250 mv, depending on the range selector switch—marked FULL-SCALE OUTPUT. When the input to the microvolter is greater than 2.5 volts—maximum input is 33 volts—the output is equal to the meter reading multiplied by the attenuation factor corresponding to the range setting.

The 600-ohm internal load resistor is used when the microvolter's output is connected to a circuit with an input impedance of 60,000 ohms or higher. When the impedance is less than 60,000 ohms but greater than 600 ohms, the 600Ω LOAD switch is thrown to OUT. An

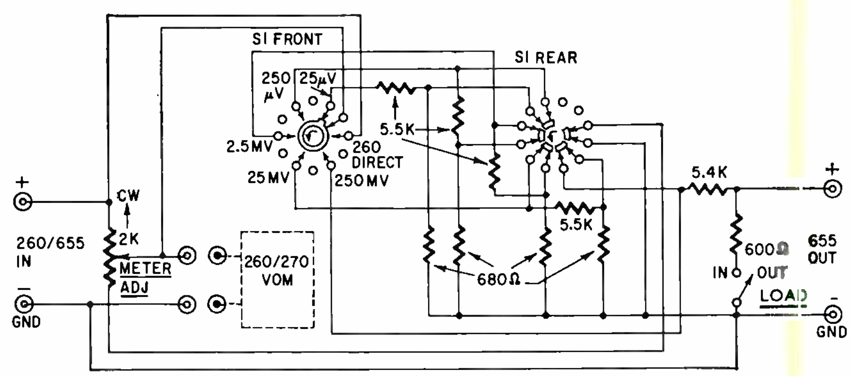


Fig. 8—Model 655 microvolter schematic.

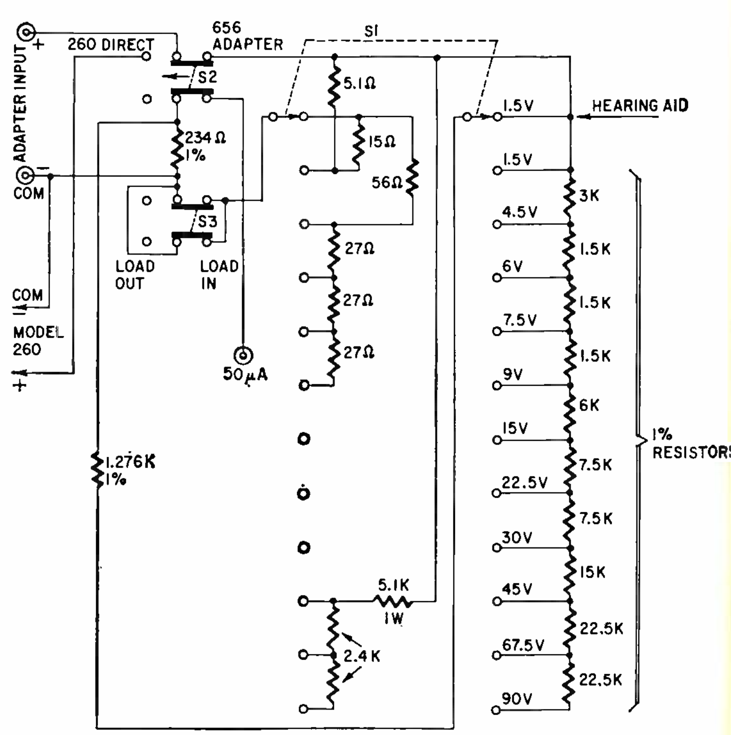


Fig. 9—Model 656 battery tester. Batteries checked under recommended load.

external resistor is shunted across the circuit so the load on the microvolter appears as 600 ohms. The value of the external shunt resistor R_X equals $600 \times R/600 - R$, where R is the input resistance (or impedance) of the circuit being supplied.

When the input resistance (or impedance) of the external circuit is less than 600 ohms, the 655's internal load resistor is switched out and a resistance sufficient to bring the load impedance up to 600 ohms is inserted in series with one of the output leads. Voltage across the external circuit's input is proportional to the 655's output or $R \times E_o/600$, where R is the resistance of the load and E_o is the output voltage of the microvolt attenuator.

Battery tester model 656

This instrument tests, under suitable load, the batteries most commonly used in radio, hearing-aid and industrial service. The adapter has 12 voltage ranges. One for small 1.5-volt hearing-aid batteries and 1.5-, 4.5-, 6-, 7.5-, 9-, 15-, 22.5-, 30-, 45-, 67.5- and 90-volt ranges for A- and B-batteries.

The 656 (Fig. 9) has a slide switch which, when in the LOAD IN position, shunts the battery under test with the manufacturers' recommended load. In the LOAD OUT position, the shunt is disconnected and the battery can be tested under normal in-circuit operating conditions. The metering circuit draws a maximum of 1 ma.

The 656 uses the 50-μa movement of the 260/270. The multitester is set up for measurements on the 50-volt dc range and readings are made on that scale. A slide rule with three basic scales is mounted across the top of the adapter's case. The top is calibrated 0 to 50, the middle is marked BAD-WEAK-GOOD (for radio and hearing-aid batteries and all B-batteries). The bottom scale is calibrated from 0 to 110% (of the selector voltage range).

In testing a battery, the adapter's range-selector switch is set to the battery's terminal voltage and the meter is read on the 50-volt dc scale. The hairline on the slide rule is placed over the meter reading on the top scale and the battery condition and percent of rated voltage are read on the middle and bottom scales of the rule. Actual battery voltage is found by multiplying the range-selector setting by the indicated percentage. END

AMATEUR CONVENTION

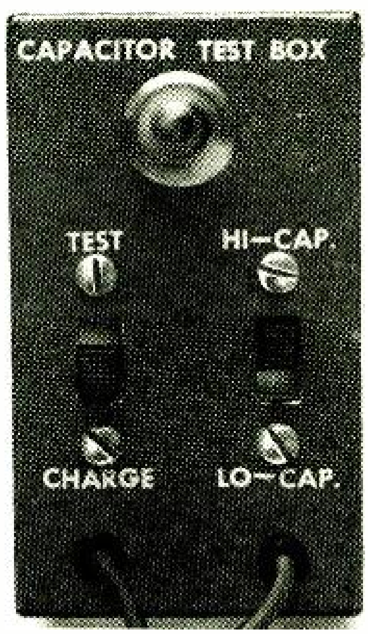
The Hudson Amateur Radio Council is holding its first annual convention at the Statler-Hilton Hotel in New York City. It will open at 10 am Saturday, Oct. 15 and close at 7 pm with a banquet. There will be technical talks, meetings, manufacturers' exhibits and prizes. The convention is being run entirely by the amateur clubs of the New York area and everyone within commuting distance is invited. For information write HARC Convention, PO Box 971, New Rochelle, N. Y.

CAPACITOR TEST BOX FINDS INTERMITTENTS

By JAMES A. FRED

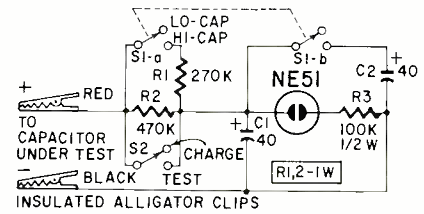
IT'S hard to locate an intermittent electrolytic with in-circuit tests. If you try shunting the suspected unit with a good electrolytic, the charging current may temporarily heal the bad one. Then when you remove the test capacitor the set appears to work normally and you still don't know what's wrong.

After running into this problem a couple of times, I decided to build an electrolytic test box that would pick up bad capacitors without healing them. The unit I devised is shown in the diagram and photos.



Completed electrolytic tester.

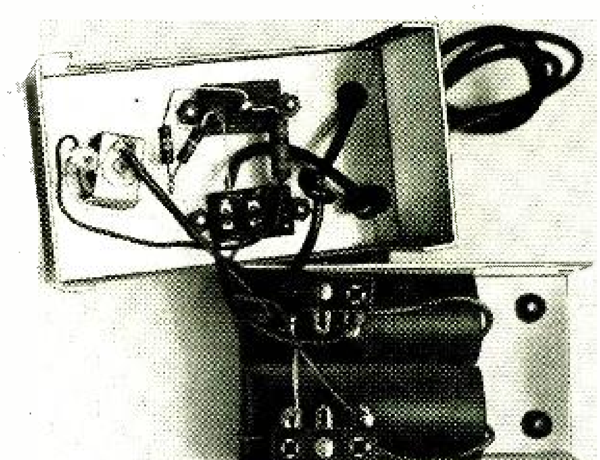
A neon lamp and its series current-limiting resistor are connected across a test capacitor. The lamp lights when the capacitor is charged. Charging resistors are switched in and out of the circuit by S2, the CHARGE-TEST switch. Switch S1 gives you either a



Circuit of simple test unit.

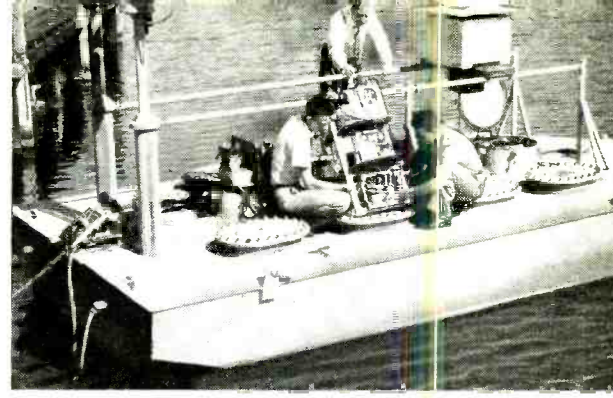
40-μf test capacitor (LO-CAP) or connects two 40-μf units in parallel to form an 80-μf unit (HI-CAP). At the same time, another section of S1 changes the value of the charging resistor—either R2 by itself (for 40 μf) or R2 and R1 in parallel (for 80 μf).

Using the checker is easy. Just set S1 for high or low—40 or 80 μf and S2 to CHARGE. Then connect the tester to the capacitor under test with its insulated test clips—of course, you have already turned on the defective radio, hi-fi or TV. Wait for the neon lamp to light. Now slide S2 to the TEST position. If the capacitor under test is bad, the fault should vanish. If the fault remains, obviously the capacitor is good. Before going on to the next electrolytic, discharge the checker by shorting the red and black test leads. END

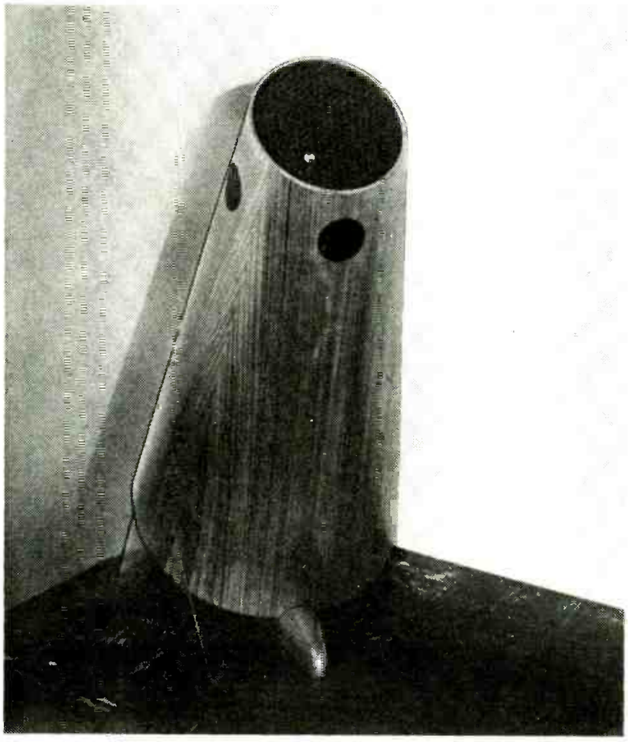


Parts layout inside checker.

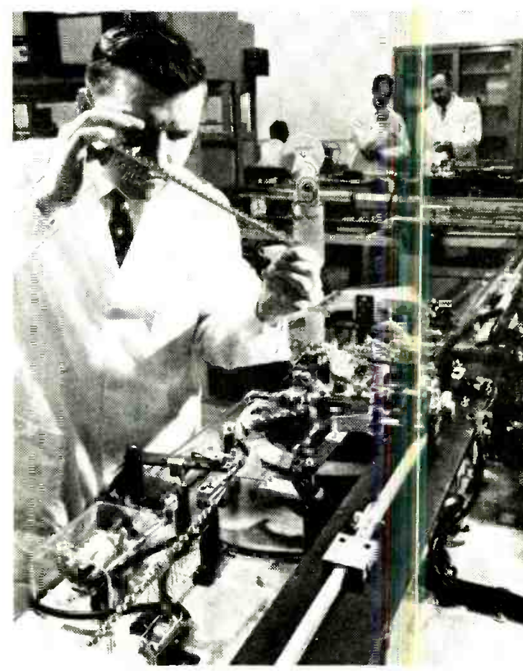
WHAT'S NEW



UNMANNED WEATHER STATION, developed by National Bureau of Standards for the Navy, transmits local data from remote ocean areas. Air and water temperature, wind speed and direction and barometric pressure are converted into three-letter groups in continental code and transmitted at 6-hour intervals on a frequency of about 6 mc.

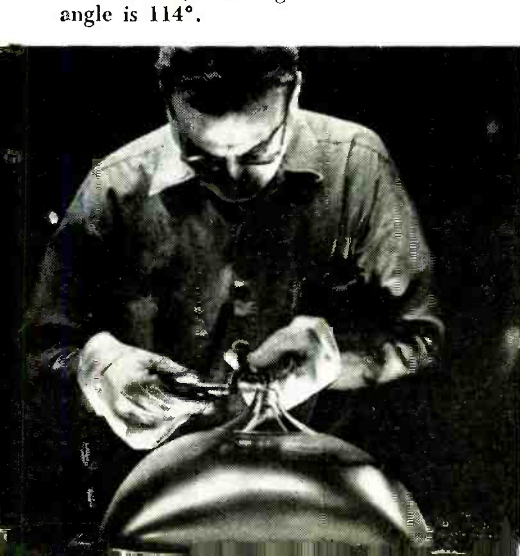


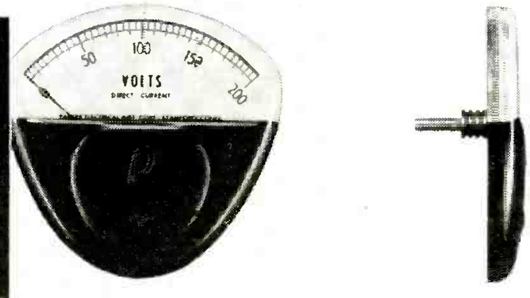
NEW SWEDISH SYSTEM combines speakers and amplifier in one cannonlike enclosure. A seven-tube two-channel amplifier and six speakers are inside the enclosure. Woofer is at bottom in bass-reflex type of enclosure backed with sound-absorbent material which acts as partition between it and middle- and high-frequency speakers. Midrange speaker is seen at top and four high-frequency speakers are mounted around top perimeter. Both high- and low-frequency channels use single-ended push-pull with EL86's and direct drive to speakers, without output transformers. Power amplifier is mounted inside base panel. Elektron Lund of Malmo, Sweden.



SQUARE-NECKED PICTURE TUBE allows corners of picture to be seen. New tube bulb, developed by Kimble Glass Co., has four channels formed in neck to allow corners of picture to pass. This improves contrast because "corner clipping" in old tube bounced electrons off tube walls and bombarded screen in random fashion, reducing contrast. Deflection angle is 114°.

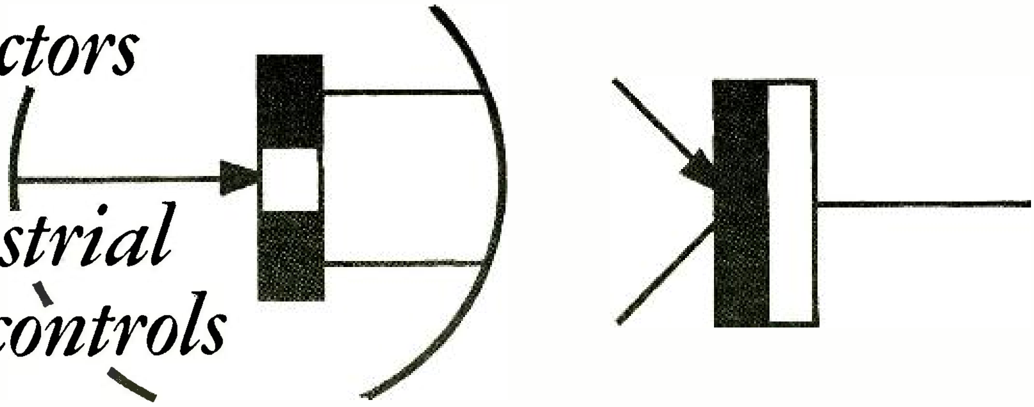
AUTOMATED ASSEMBLY SYSTEM produces 1,800 transistors an hour (higher than previous automated systems; see March, 1959 issue, page 6). Six turntables, two ovens (for alloying and bonding) and welding unit are primary components of IBM's unit. Entirely self-checking, photocell and mechanical devices reject any transistor-carrying "boats" (small carbon cylinders) that contain missing or poorly positioned parts.





PANEL METER uses printed-circuit coils and thin ceramic ring magnet. Built-in shielding eliminates need to specify type of panel meter is mounted on. Two screws projecting from back serve as both terminals and mounting screws. A 1,000% electrical overload for 1 second will not disturb accuracy. The Parker Electrical Instrument Corp. makes these very very thin units for use in a variety of circuits.

semiconductors for industrial controls



By TOM JASKI

Transistors, Unijunction transistors, avalanche diodes, Trigistors, silicon controlled rectifiers and cryostats are all usable as static switches

IN the two previous articles we discussed magnetic amplifiers and the special control systems based on logic units developed from them. Much newer, and therefore not as widely applied, is an entirely different system, based on transistors.

To build logic units we need some kind of a switch or device with two states, conducting and nonconducting. A transistor fits in because we can recognize in its operation two greatly differing states, one of very high resistance and one of very low resistance. These two operating points are shown in Fig. 1. The transistor is off at A and on at B. Essentially, the only difference in circuit values responsible for these two states is the base current.

The quality of a transistor switch depends on how well we can reduce leakage current from collector to emitter. By providing a small amount of reverse bias, we can keep the transistor cut off. Fig. 2 shows the basic circuit of a transistor switch with reverse bias applied. There are other possible circuits, but the engineers who build industrial control systems consider reliability one of their most important criteria, and careful analysis has shown that the common-emitter switching circuit is the most reliable arrangement. Fig. 2 is the basis of a fundamental logic unit. Apply a signal to the input and the transistor presents a virtual short to its output (there is no output signal). This forms a logic unit we call a NOT circuit. If we add several inputs to this circuit so a signal applied to any one of them saturates the transistor, we can say that neither a signal on 1 nor a signal on 2 will provide an output, and we call this a NOR unit (any input prevents an output). An entire control system with logic units can be based on this NOR circuit. We can, of course, include one, two or more inputs, so long as we isolate them from each other with resistors as shown in Fig. 3. Generally speaking, we reach a limit when we have about 10 inputs.

Transistor Logic units

Fig. 4 shows the logic units we can build. Fig. 4-a is a simple NOT unit, which is the NOR with a single input. If we make the units all alike and ignore some inputs, we waste some resistors, but the fact that we are making only one kind means that the units can be mass-produced. Fig. 4-b is the two-input NOR, and 4-c is an AND unit made up of two NOT units and one NOR unit. As long as no signal is applied to one of the NOT units, there is an output that prevents an output from the NOR unit. Both I and II must have an input to get an output from III.

Fig. 4-d shows a flip-flop which we can use as a MEMORY unit. Here we use a couple of 2-input NOR circuits, with the input of each one connected to the output of the other.

To examine the flip-flop's operation, let's start with a nonconducting state for both transistors, and no power on. As soon as power is applied, both transistors start to produce an output. But one will be very slightly faster, and its output will saturate the other and keep it saturated. So one stable state is intrinsic to the circuit. Assume that I is conducting, and II is nonconducting. If we apply a signal at input 2, transistor II saturates and its output stops, cutting off I. Alternate pulses at inputs 1 and 2 reverse the state of the memory unit at each pulse.

Fig. 4-e is an OR circuit made from a NOR unit followed by a NOT unit. A signal at either A or B keeps I turned off and no signal is applied to the NOT unit, so we get an output at C. But with no signal on A or B we get an output from I which cuts off the NOT unit and prevents an output at C.

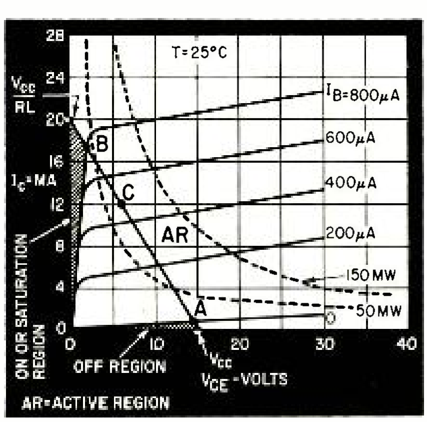


Fig. 1—Typical common-emitter characteristics of a transistor. Note the on and off regions.

Another logic unit we have not previously encountered, but possible with the NOR system, is shown in Fig. 4-f. This is constructed from one NOT and one NOR unit. As long as there is no signal on the control, there will be an output from II but, as soon as a signal is applied to the control input, the output is "inhibited". This INHIBITING GATE is a very useful tool for connecting, disconnecting and controlling.

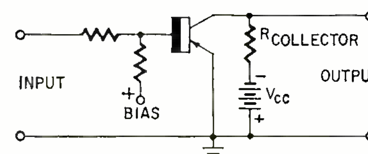


Fig. 2—Basic transistor switching circuit.

Time delay is important in logic systems. Fig. 4-g shows a time delay built around two NOR units. Normally unit I is cut off, producing an output which keeps II saturated. If we apply a short pulse to the input, both units

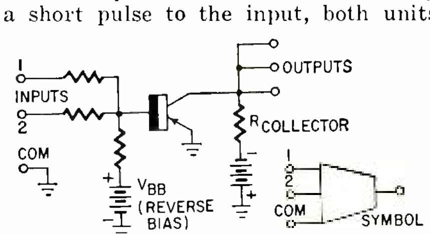


Fig. 3—Basic transistor *NOR* circuit and symbol.

momentarily saturate, but the charge stored in C2 quickly saturates II as soon as the pulse is removed and II never really gets a chance to conduct. Capacitor C1 saturates unit I until the charge on C1 leaks off, and all this time C2 holds II saturated until the job can be taken over by unit I again. Obviously, capacitor C1 in combination with the circuit resistances determines the time delay. Capacitor C2 must have the same value as C1 since it must keep II saturated until I produces a signal again.

This system of NOR circuit control

is being marketed by Westinghouse. They have also built a computer, the NORDIC, based entirely on NOR circuits. Not as prevalent at present as the magnetic type circuits, control systems of NOR circuits have great possibilities, for they can obviously be built very economically.

There are many other switching and logic circuits we can build from transistors, but not many of them can be as universally applied as the NOR unit. We have all seen two- and four-transistor flip-flops which often use diodes as well. Obviously the two-transistor NOR flip-flop is more economical.

This may be the reason why many other excellent switching devices have not yet been extensively used as industrial control systems or even for logic units.

Some of these semiconductor devices have rather startling properties, but their cost is not low enough to compete with the common transistor.

Unijunction switches

One of the interesting semiconductor static switches is the Unijunction transistor. Its symbol and construction are shown in Fig. 5. It consists of a silicon bar with a base contact at each end. An emitter junction is on the bar, somewhat closer to base 1 than base 2. Fig. 5-b shows the basic Unijunction circuit. With no emitter voltage applied, the silicon bar functions as a resistor, and the field created in the bar by the current produces a small emitter-to-base voltage proportional to

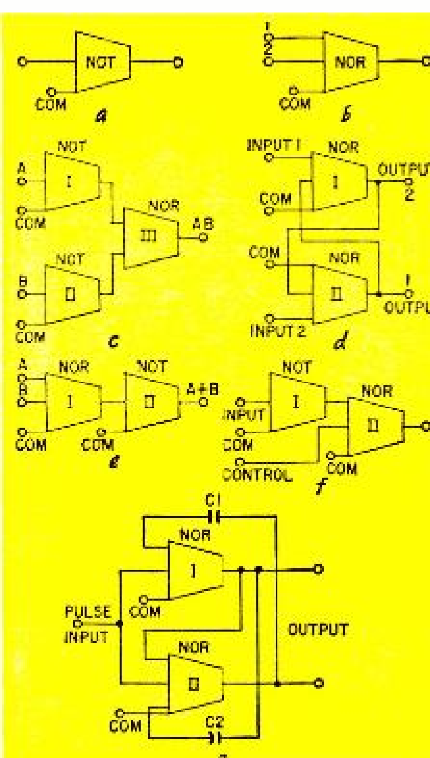


Fig. 4—*NOR* unit logic functions: a—*NOT* unit; b—*NOR* unit; c—*AND* unit; d—*MEMORY* unit; e—*OR* unit; f—*INHIBITING GATE*; g—*TIME DELAY*. Note that it uses a *3*-input NOR unit.

the current through the bar. If the voltage applied to the emitter is less than this voltage, the junction is reverse-biased and emitter current is minimal. When the voltage applied to the emitter exceeds the intrinsic voltage, "holes" are injected into the bar. They reduce the resistance of the bar between emitter and base 1. This allows a sudden increase in emitter current. Once past this point we can decrease emitter voltage and still increase emitter current. This gives us a negative resistance effect. This is shown in Fig. 6, the characteristic Unijunction curve. It clearly shows the reversal of operating mode, which we exploit as a switching characteristic. Thus it is easy to construct a bi-stable circuit, such as a flip-flop, as shown in Fig. 7. The trigger signal at X must be positive, or we must apply a negative trigger at Y, to obtain the conducting state. A negative signal at X returns the unit to the nonconducting state. Conducting resistance runs as low as from 0 to 40 ohms, nonconducting resistance as high as 1 megohm.

Many Unijunction circuits have been developed, but no generally applied logic units have yet been marketed. Obviously, the competition of inexpen-

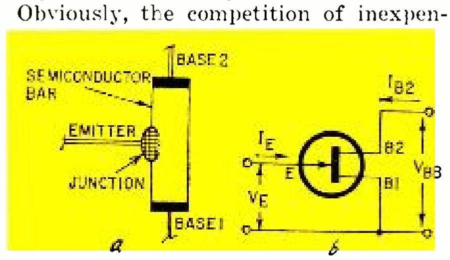


Fig. 5—Unijunction transistor: a—construction; b—schematic symbol.

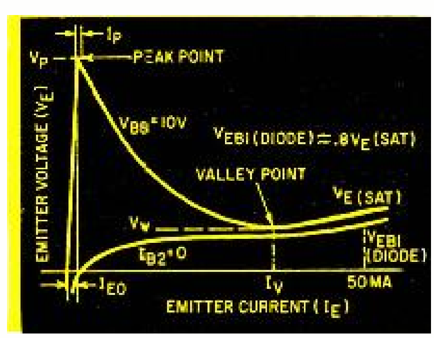


Fig. 6—Unijunction transistor's characteristic curve shows curve reversal that makes it usable as a switch.

sive transistors may hold up this development for a time.

Avalanche diode switching

We are still a long way from the bottom of the barrel. Another unusual and interesting static switch is the avalanche switch developed by Sperry Rand. It is a diode, which upon an increase of applied voltage switches (increases) the current through it so rapidly that we have no way of accurately measuring the transit time, which is on the order of a trillionth of a second. This switch uses the *avalanche* effect. Some electrons, speeded up by the increased voltage, succeed in knocking a large number of electrons out of a microscopically thin layer, creating a microplasma, which spreads rapidly throughout the layer. This special layer is an alloy formed by fusing a tiny speck of aluminum to a piece of silicon bar. The layer is estimated to be four millionths of an inch thick. The diameter of the junction is slightly over .001 inch!

The Trigistor

A third static switch is the Trigistor (see Fig. 8) a p-n-p-n device developed by Solid State Products Inc. The Trigistor has the unique characteristic that it can be turned on and off by a trigger,

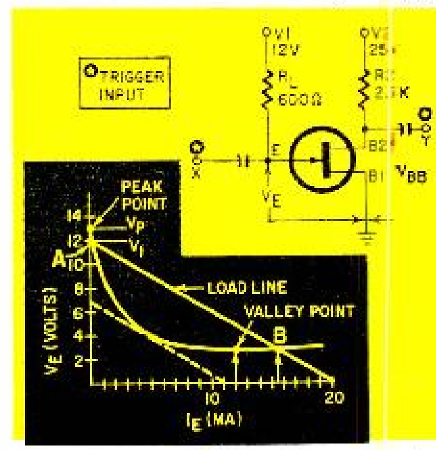


Fig. 7—Basic Unijunction transistor bistable circuit with typical emitter characteristic curve.

like any bi-stable circuit. A low-level positive trigger applied to its base turns the Trigistor on, and it remains on without base current. A negative trigger fed to its base turns it off, and it remains off without base current. This makes it possible to build flip-flops with very few components.

To understand Trigistor action we look at an analogy of two transistors, a p-n-p and an n-p-n transistor, as shown in Fig. 9. The collector of the n-p-n unit drives the base of the p-n-p unit and vice versa. The circuit has a gain which is the product of the betas of the two transistors. So long as these are both less than 1, the circuit is stable with no change in current. But once this product becomes greater than 1, regeneration keeps the process going until both transistors are saturated. When the negative trigger is applied, the gain product once again becomes less than 1, and the transistors cut off. In the Trigistor, the two transistors are fused into one device.

Silicon-controlled rectifiers

The next static switch which shows promise, particularly in the industrial electronics field, is the silicon-controlled rectifier. This device (Fig. 10) is more analogous to a thyratron but can also be operated as a switch, and a very good one at that. The silicon-controlled rectifier differs from the thyratron in that a current rather than a voltage in its control element causes conduction. Comparing the controlled rectifier with an ordinary rectifier (Fig. 11), we see that the normal rectifier has a silicon wafer forming the anode of the junction, while the controlled rectifier has an n-type silicon wafer with two p-layers diffused into its surface. This combination of p- and n-type silicon looks similar, in symbol at least, to the Trigistor. But the effect is quite different, partly because no base junction is formed and because the silicon wafer is just mounted on the stud.

Actually, the controlled rectifier is closer to the combination of an n-p-n transistor and a reverse-biased diode (Fig. 12). (Let me caution the reader that this is my own pet representation, not the manufacturer's official explanation.)

As long as the transistor is nonconducting, the voltage applied to the diode is low, because of the resistance provided by the cutoff transistor. But

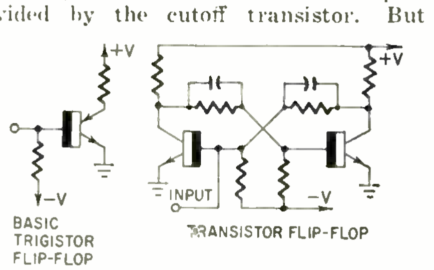


Fig. 8—Comparison between Trigistor and conventional transistor flip-flop circuit.

when a signal on its base makes the transistor conduct, even though the signal would be too small to cause the reverse breakdown of the diode, the fact that the conducting transistor now presents virtually no resistance in the circuit allows the full supply voltage to be applied to the diode, and breakdown occurs. Once this has happened, the voltage developed across the emitter junction would keep the transistor conducting and the reverse pulse required to turn the thing off would have to be as large as the supply voltage. This is almost true. To restore the controlled rectifier we must momentarily lower the supply drastically or bypass the rectifier. In my analogy, you can see this would also work, for if we momentarily allowed the diode to recover we would in effect remove the bias to the base.

The controlled rectifier has been made principally to deliver large currents. Although a number of circuits, such as flip-flops, are based on its action as a switch, their use in logic circuits is not immediately visualized. Where higher current possibilities are not important, other semiconductor devices such as the Trigistor and Unijunction transistor have definite advantages over the controlled rectifier in terms of parts required per logic unit. Nevertheless, it is an important type of static switch and may well find application as the final switching element in control systems where we have heretofore been forced to use relays or contactors.

An electrochemical switch

A fifth static switch which we do not immediately associate with industrial control, because its development has been directed primarily in the direction of computer applications, is the Cryostat. In terms of construction, it is perhaps the simplest of all. But it has some severe environmental requirements, which may hold back even computer applications. The action of the Cryostat is based on the fact that a tantalum wire which has been supercooled will drastically change its resistance with a change in the magnetic field surrounding the wire. The Cryotron operates in an open bath of helium at approximately the boiling temperature of the liquid gas, and at room pressure, 4.2° K. The Cryotron gate consists of about 250 turns of 3-mil niobium wire wound on a tantalum wire, 9 mils in diameter and 1 inch long, a very small gadget indeed. The niobium wire remains superconductive over the range of magnetic-field change that affects the tantalum wire (a relatively small range—50 to 100 oersteds). The change in current in the niobium wire, from 0 to about 200 ma, represents the signal, and this changes the resistance of the 1 inch of tantalum wire from 0 to .008 ohm. To anyone thinking in terms of the industrial control systems we have been discussing, this may seem like an insignificant change, hardly enough to base a reliable control system on, until you focus again on the word zero, which is not nearly as theoretical a word as it might seem. For superconductivity means that a wire with a current in the superconductive state maintains this current with no measurable decrease over a long period of time. Then the change of a fraction of an ohm becomes relatively enormous. Many logic elements have been built, and practical computer circuits tested. Again, the Cryostat earns its name as a *static switch*, but we will not see liquid helium flasks in a factory or steel mill for some time to come.

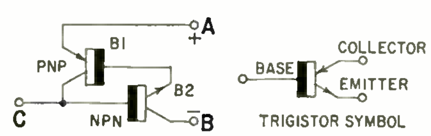


Fig. 9—Analogy between two transistors and a Trigistor.

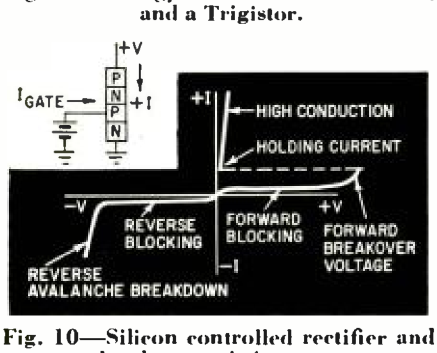


Fig. 10—Silicon controlled rectifier and its characteristic curve.

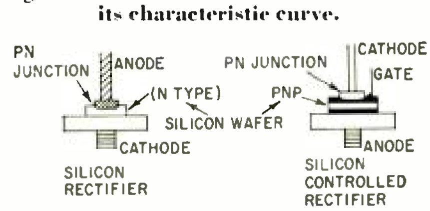


Fig. 11—Comparing standard and controlled rectifiers.

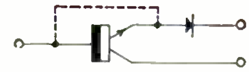


Fig. 12—The author's analogy for the controlled rectifier.

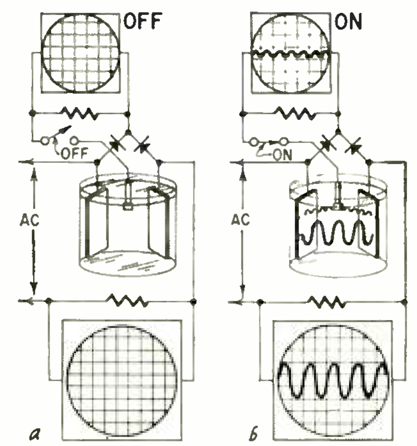


Fig. 13—Electrochemical static switch: a—off; b—on.

More likely to find application in these places is the electrochemical switch based on a discovery by Ovshinsky of the Ovitron Corp. Fig. 13 shows this switch diagramatically in its off and on positions. The switch, with dc on its firing electrode, passes an ac load, and without the voltage on the electrode presents a high resistance to the load current. No satisfactory theoretical explanation for the phenomenon has been found. Although not likely to be a candidate immediately for a series of ac logic circuits, this ac switch also has possibilities as the static equivalent of relays and contactors.

Here then, besides the well developed and widely applied static switching systems, you have seen a group of static switches, each of which may eventually come into its own in industrial electronics, and some which are on the doorstep right now. We have purposely avoided spending time on vacuum-tube and thyratron switching, since they are well known devices of yesterday as well as today. Static switching and control is today and the future. It represents a philosophy which will not only find its way into the control phases of industry, but also into the processes we use to produce machine parts. For example, electrolytic etching techniques are beginning to take the whirling lathe chucks and milling cutters out of the shop and into the museum. Not today, but certainly tomorrow, we may be producing entire machines without much more than a few streams of liquid electrolyte moving in the plant, and then the evolution of the process will allow us to do away even with them. END

OSCILLOGRAPHS IN ACTION

The inside story on an important piece of industrial electronic test equipment. How it works; where it's used; what it does

By J. H. THOMAS

THE modern oscillograph, though not an electronic instrument as such, is so often used with other electronic equipment in industry, in laboratories and on missile testing sites that it is important for the electronics technician to be acquainted with it. Far from being instruments of yesterday, oscillographs have their own area of application, sometimes overlapping that of cathode-ray oscilloscopes, but more often in applications where the oscilloscope is not the proper instrument to use. What is an oscillograph? What does it do? Where, why and how is it used? These are the questions we aim to answer.

Oscillograph history started with the basic D'Arsonval galvanometer. This is the well known moving-coil instrument, which you probably use daily. However, to label it as a galvanometer, we must think of the same instrument with a very small mirror in place of the pointer. When we direct a narrow beam of light at the mirror, the beam is reflected. As the coil turns, the reflected beam moves and we can then intercept it with a frosted-glass scale and make the instrument very sensitive by making our pointer (the beam of light) very long. Now if we use a film or light-sensitive paper in place of the scale and move it past the light beam, at right angles to the galvanometer deflection and at a constant speed, we add a time base and get a permanent record of the light-beam deflections as they occur in time. This is shown in principle in Fig. 1. In place of a moving film or paper, we can also add a second deflection to the light-beam by intercepting it again with a moving mirror, but this time moving the mirror at a constant speed at right angles to the beam deflection caused by the coil. Then we can record the trace on a still film shot such as a Polaroid camera produces. The principle is shown in Fig. 2. Here the time-base mirror is moved by a spring, while a dashpot assures constant speed.

Oscillograph advantages

The moving film (or paper) galvanometer can record long stretches of events or, by moving the film at great speed, record them with great accuracy. Ordinary galvanometers could do this job, but they would be rather large and only a few could be used in one oscillograph. So the oscillograph has specially designed galvanometers, which are very slender. They consist of a very small coil pivoted on supporting spring wires (to avoid jewel pivots and provide torque at the same time), or even simply of a single loop of wire which functions as both coil and suspension. Both types are shown in Fig. 3.

Obviously the impedance of such coils is very low. Also we need a magnetic field but, since the coil is so small we do not need the customary center core used in most D'Arsonval instruments to keep the field working on the coil homogeneous And third, it will also be clear the stiffer the suspension (the greater the tension in the suspension wires), the harder it is to turn the coil, but also the faster the coil returns to zero position. In other words, the galvanometer can be made to respond to higher frequencies as we make it less sensitive.

Photo A shows a modern galvanometer from the Heiland oscillograph. When these units respond to fairly high frequencies, they must be damped or they may oscillate at their natural frequency when suddenly deflected. Sometimes the damping is done electrically (by shunt resistors) and sometimes by filling the galvanometer case with fluid. A large number (as many as 12) of these galvanometers are placed between the poles of a strong magnet, which provides the magnetic field normally provided (in a meter) for a single coil only. This is done to save space.

The response of these galvanometers is not high compared to the oscilloscopes you are used to. For example, a *very* sensitive galvanometer may have an impedance of about 300 ohms, respond to frequencies up to say 100 cycles, and deflect an 8-inch "pointer" light beam about 1 inch for 5 μa. At the other end of the scale, we may find a galvanometer which deflects the beam an inch at the same arm length, but needs 30 ma to do it. However, this one may respond to as much as

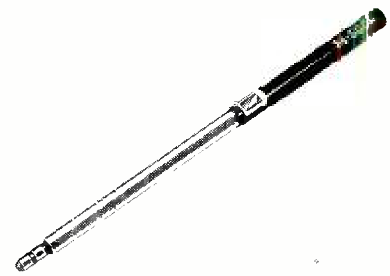


Photo A—Subminiature Heiland galvanometer.

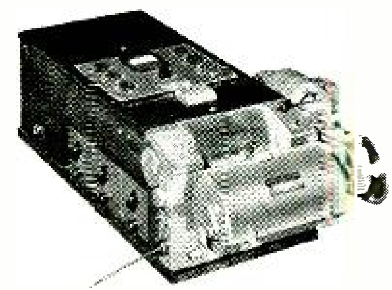


Photo B — Typical laboratory type oscillograph, the G-E PM-10-B2. Galvanometers are under small hood in center. Front part is camera film drum with its drive at right.

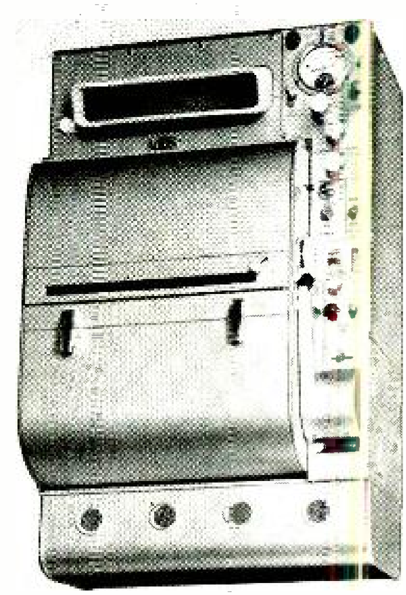


Photo C—Industrial type oscillograph. Slot at top is for viewing.

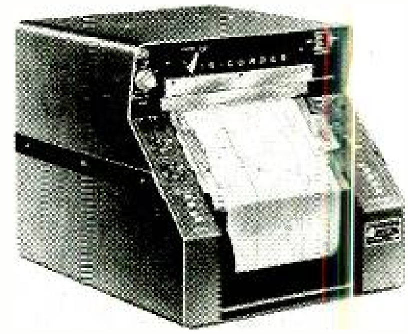


Photo D — Visicorder model 1108. Note pushbutton controls.

5,000 cycles. In between is a large selection of galvanometers of all kinds of sensitivities, frequency response and damping requirements.

How it works

Photo B shows a typical laboratory oscillograph. Here the film camera is up front, driven by the variable-speed drive at the right. The galvanometers are under the little cover in the top center, where they can be reached to adjust them. Adjustments are principally to position the trace on the film. This type of instrument can be made with as many as 24 galvanometers. The one shown has only 12.

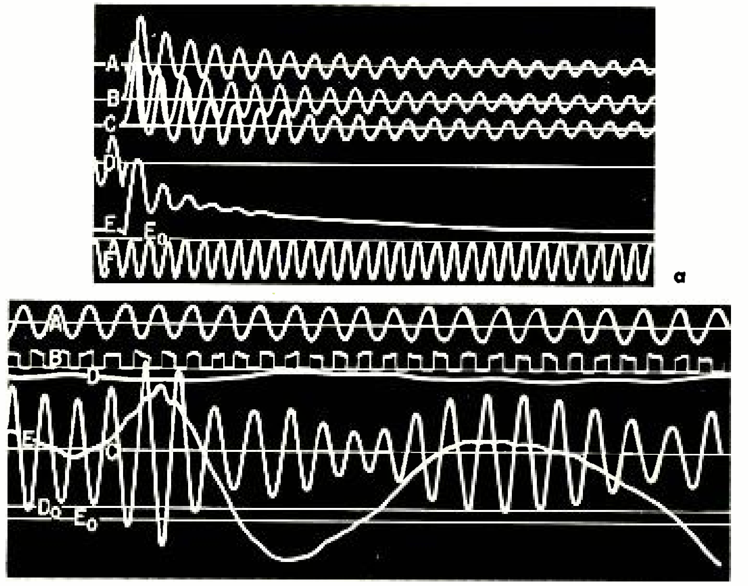
During adjustment, the light-source lamp is in series with a resistor to lower its voltage. The lamp is a very-high-intensity incandescent lamp that delivers enough light to leave a clear trace on the film. We turn it on to full brightness only while recording—this is done automatically in the instrument. Projection type lamps are used. Some manufacturers make special lamps for their galvanometers, while others used the same kind of lamps used in sound-track systems for movie projectors. Lamp life runs between 100 to 500 hours, more likely the lower figure. Replacements should be kept on hand if the oscillograph is used frequently.

Photo C shows the form of oscillograph you are likely to encounter in industry. It has all the features of the laboratory instrument, but is enclosed in a more suitable case for permanent installation. Notice the slot near the top. It is for viewing the trace as it is being recorded or adjusted. This can be done quite simply as shown (Fig. 4). Of course we need a time base too. An angular mirror is rotated at high speed. As the mirror turns, your eye sees one flat side after another, and on each side the beam appears in different places as it moves. Viewing the sides rapidly is like seeing movies; you actually see a series of single shots but their sequential display tricks your eye into seeing movement. So here too you get the effect of a continuous time base.

Another feature of oscillographs is that we can readily add a time-calibration trace. This will simply be done with a special ac voltage source deflecting one of the galvanometers. The source is accurately calibrated for frequency and thus gives us a continuous check on the film or paper (as to the film-speed constancy). For very accurate work, the timing trace is sometimes made with a square wave.

Why, where and how

Now let's see why, where and how oscillographs are used. Why is easy. We can build oscillographs which can record as many as 48 traces in a single instrument. This is almost impossible with an ordinary oscilloscope, even with electronic switches (getting 10 traces is doing quite well!).



Typical oscillograph traces: a—single-phase short circuit test on an ac generator; b—test on textile loom.

Second, as you know, scopes ("scope" = "seeing") are used most where we wish to *view* the trace, not necessarily record it. We can record from a scope screen with special cameras, but we are limited to either single shots of a few cycles or must use very special CRT's and special high-speed cameras to get a recording of any length. And then we usually end up with a single trace, or at best two or three. Not 48! Third, the oscillograph is used where the scope's extreme bandwidth is not needed or not desirable. We can set very high demands on the oscillograph galvanometers for linearity, but we cannot guarantee the same degree of linearity in scopes, particularly at lower frequencies or dc. These, principally, are the whys of oscillographs.

The next question is *where* do we use them. This is not so easy to answer, because they are used so widely. Generally speaking, oscillographs are used wherever we wish to record a number of signals simultaneously and continuously. We could use industrial recorders if we have a few signals, but not if we have very many. Also industrial recorders generally record much slower variations than oscillographs.

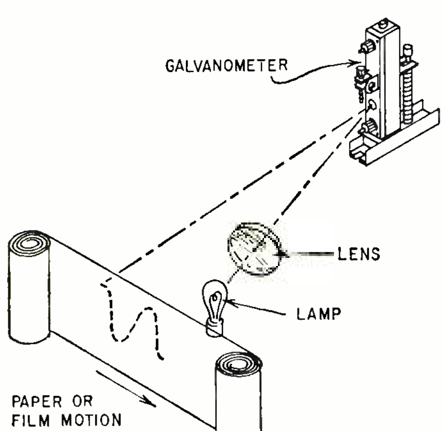


Fig. 1—Basic principle of the oscillograph.

We use oscillographs where the records must be simultaneous, where we must read data from a common time base. For example, we would use an oscillograph when flight-testing an aircraft or missile to record strain-gauge readings. The record gives a comprehensive picture of the strains the craft is subjected to.

Oscillographs are used when testing large circuit breakers to see if all the contacts (on three phases) break the current simultaneously, and how fast the current breaks. For example, modern high-speed circuit breakers should cut the arc of interruption in less than three cycles. To check how fast the breaker operates after we push the button, one trace is set up to show the current from the pushbutton. To check for bounce in the contacts and mechanism, the oscillograph is connected to a current source and transducers. In this way many things about a circuit breaker and *when* they happened in relation to time and each other can be studied.

This is a prime spot for the oscillograph. The low-frequency response and low impedance of galvanometers is of no consequence here, yet we would barely be able to see the event on a scope, let alone measure the variables!

An oscillograph can be set up to measure the flutter of aircraft trim tabs, the strain in the control cables, the temperatures of engine exhausts and the acceleration reached in a pull-out simultaneously. All these things can best be recorded with this instrument. These are just examples; we use them many other places where a large number of many variables must be recorded simultaneously.

We cannot do much about the galvanometer's low frequency response, although we can improve matters by using electronic amplification and the "stiffest" galvanometers available. But it is easy to get around the low impedance with impedance-matching transformers or such electronic aids as cathode followers. And for remote recording, oscillographs are often used in conjunction with a "carrier" system where the variables modulate an audio carrier of a few thousand cycles, which is demodulated at the receiving end and fed to the galvanometer.

These are some of the how's about oscillograph applications. Now let's talk about some special disadvantages of oscillographs, and how a very modern instrument gets around these. First, the film or photosensitive paper used must be developed and fixed. This takes time, and we must sometimes wait a while before working with the records. Second, recording the time marker takes up a useful galvanometer, and a special device can be included to avoid this and keep one more active instrument available. Third, when we draw parallel lines on our record to mark off time points, for comparison of events, we may make errors by drawing the lines slightly at a slant. So if such lines can be recorded on the paper as we record the traces, another hazard is eliminated.

The Minneapolis Honeywell Visicorder (Photo D) is a modern instrument that gets around all these things. It uses a paper that is sensitive to ultraviolet light and immediately shows a trace on the paper recorder. This requires special optical systems, because ultraviolet does not normally pass through glass very well. Not only is the record immediately available, but a special shutter operated by the drive records a timing trace on the edge of the paper. In addition, thin timing lines, coinciding with the start of the time marks, are recorded all the way across the paper.

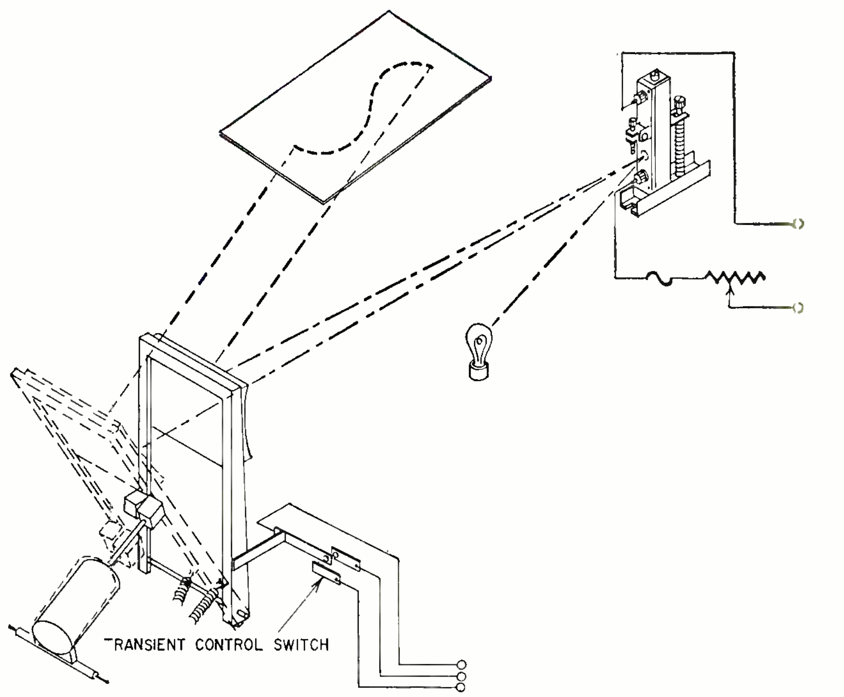
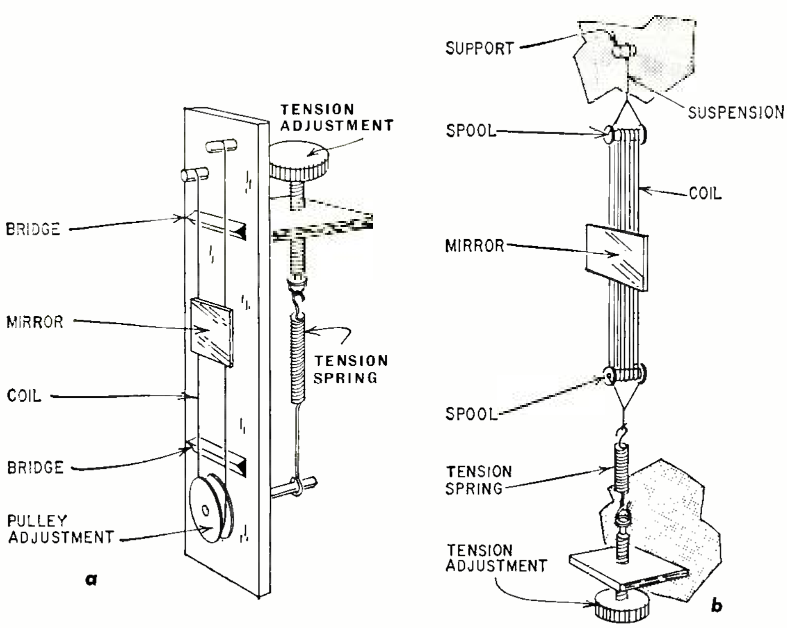


Fig. 2 (above)—Time base for single shots is obtained by moving the light beam at 90° from galvanometer deflection with a second mirror.

Fig. 3 (below)—Two types of galvanometers used in oscillographs: a—string; b—coil.



Setting up a test

Oscillographs are extremely simple to use. We must have a source of low voltage representing the variable to be measured for direct connection to the galvanometer, a variable-gain amplifier, or we must use attenuators or impedance-matching devices. Other than that, any variable voltage which represents some factor we wish to measure and within the specifications of the galvanometers is the only requirement. Thus, to record position, we might use a voltage source and a potentiometer connected to the moving object.

The variable voltage from the potentiometer wiper would be the voltage to be recorded. For strain gauges use a bridge circuit. To measure temperature variations, connect a thermocouple directly to the galvanometer. To record pressures use a transducer that converts pressure into voltage. This could be a potentiometer moved by a Bourdon tube, a bellows (Fig. 5).

For example, to measure the contact opening time of the circuit breaker, connect an actual voltage and current that would be encountered in the field to the breaker from some high-voltage high-current source. The breaker has built-in current transformers to provide the instrument current used for the breaker (usually 5 amps at nominal rating). This can again be stepped down with an auxiliary transformer to the galvanometer rating. Thus the record shows the normal 60-cycle current through the breaker, and the instant

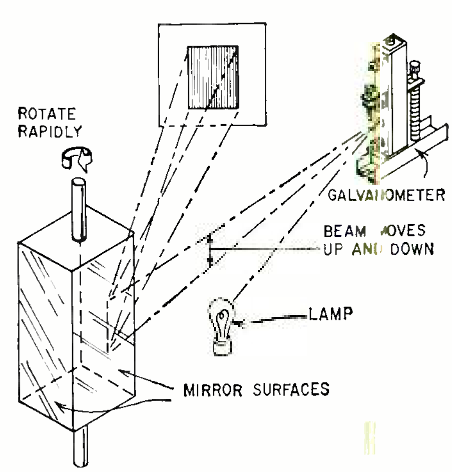


Fig. 4—Rotating mirror provides pseudo time base for viewing the trace from the galvanometer.

it ceases is the break point (Fig. 5-d). The galvanometers must be selected for the particular job. Contact bounce on the circuit breaker would be determined from the operating shaft of each section, with a potentiometer connected to the shaft, which would show then if the shaft vibrated after opening. (Most large circuit breakers rotate their contacts.) Or you could make a separate test with an accelerometer attached to the contact blade to show any reversal in movement of the blade. Remember, an oscillograph is simply a sensitive galvanometer that records whatever it measures. Use it as you would any other sensitive meter with low impedance and limited frequency response.

The oscillograph at present is an indispensable instrument for such applications as missile and aircraft tests, power-line tests, recording water levels in rivers, recording strains in giant dams or the twists in the frame of a locomotive as it rushes through a switch or poor section of rail. It is used in development of automobile bodies and frames, as a delicate instrument to record physiological variables (in EEG and EKG) and to record the shock waves from atomic bombs. It is something in the way of instrumentation you are bound to meet up with at some time or other. END

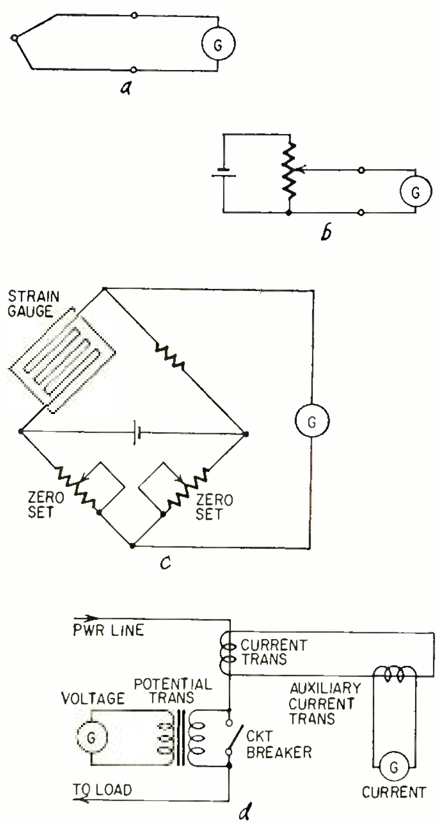
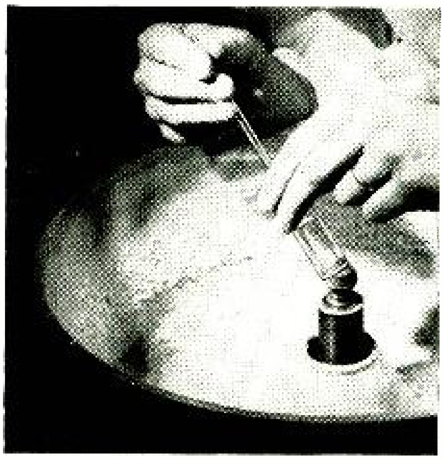


Fig. 5—Simple connections for oscillograph galvanometers: a — direct-connected thermocouple; b—position indicator with potentiometer; c — strain gauge connected in a bridge circuit; d—connections for current and voltage in a circuit-breaker test.

POLYOPTIC SEALING MAKES BETTER TUBES

A NEW, yet old method of joining the two glass parts of a vacuum tube (envelope and stem mount) has been demonstrated by the Chatham Electronics Division of Tung-Sol. It is based on the principle that if two glass surfaces are highly polished and mated they will hold together because of molecular attraction. Originally, some attempts were made to make airtight seals by using such accurately polished



and mated surfaces that true molecular bonding resulted.

The story goes that this process was first used by the French underground during World War II. They needed tubes for their radio equipment and had to make their own. However, gas for their Bunsen burners was difficult to get and they were forced to try optical polishing and mating to seal the parts of their tube envelope.

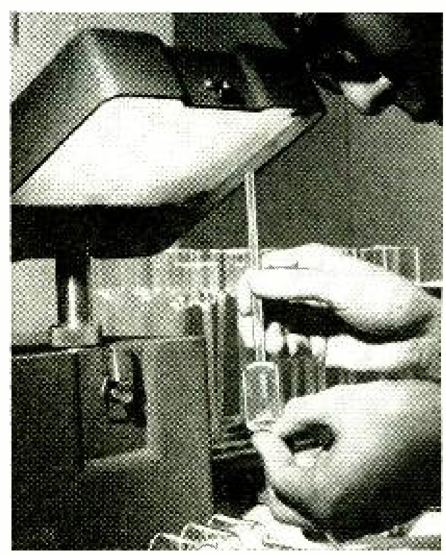
The process Tung-Sol has been working with was developed and is now used by the Compagnie Generale de Telegraphie sans Fil (CSF) of France. It is called polyoptic sealing. Briefly, the new technique calls for preparing the mating surfaces of the tube envelope and stem mount by optical polishing so the tube can be evacuated before the seal is made. This requires a polishing accuracy of a few millionths of an inch.

One step in the polishing process is shown in the first photo. Here the bulb is being given the precise contour it needs so it will mate with the polished button stem of the tube. It is done by applying the bulb to a rotating abrasive sphere coated with polishing rouge. This step is preceded by several grinding and lapping operations. The button stem is subjected to a series of similar steps.

After both bulb and stem have been polished they are checked under a monochromatic helium light to determine the exactness of the fit between the mating surfaces of the bulb and stem. If inspection reveals unacceptable parts, they are returned for regrinding and polishing. The inspection process consists of placing the surface to be checked against a standard and placing the pair under the helium light (see photo). Fringe patterns which reveal any defects appear as pink stripes (the color of helium light) separated by black bands (where the light waves interfere because of foreign particles between mating surfaces or surface irregularities).

After passing inspection, the two parts are joined and attached to an evacuation pump. Then the base is heat-sealed to the shell, the tube is sealed and the process completed.

The advantages of the process, though costly (In production, industrial tubes made by this process will cost 15% more than their conventional equivalents) are best demonstrated with a short set of figures: In tests conducted for the Signal Corps two groups of type 1288 thyratrons were made—38 by the polyoptic process and 50 by standard production techniques. Then both groups were life-tested. After 2,000 hours none of the standard-type tubes were working, but more than 55% of the polyoptic-sealed tubes were



still operating. Also, the yield of good tubes is higher under the polyoptic process—85% for polyoptic, only 60% for conventional types.

Based on the satisfactory results of the tests, Tung-Sol is continuing its study of polyoptic sealing. The results of the study are expected to reveal whether volume production using the polyoptic technique is warranted. END

SERVOMECHANISMS... how they work

Electronic circuits can control which way and how far an electric motor will turn or a piston will move

By E. L. SAFFORD, JR.*

SERVOMECHANISMS are electronic circuits that make electric motors run, open or close valves to control the amount of oil or air fed to a piston and serve in a myriad of other control and indicator applications. However, in this article we will deal only with motors and pistons that are connected to a load we want to move or position in some particular way.

The electronic circuit we use may be nothing more than a potentiometer, a couple of relays and a tube or two. Or it may be an amplifier which is just as complex as hi-fi or public-address types.

In audio work we want an amplifier to have little or no distortion. We also want plenty of power so we get excellent linearity when we operate at low power. And we want feedback to correct the response.

An ac servo amplifier has about the same requirements. It must furnish enough power to drive a motor or valve. It must have a linear response over a range of very low frequencies since its input may be only a few cycles per second. It must also have feedback, but with servos this feedback is a little different. It must indicate the *position* or *speed* of the motor gear-train output shaft or piston shaft, and not be a portion of the signal being amplified.

The input signal to a servo amplifier must identify the direction we want the motor or piston output shaft to move in and tell it how far to move. We do this with a dc signal by letting the polarity specify the direction and the amount of the voltage control the amount of movement. For an ac signal we let the phase, with respect to a reference voltage, tell the motor or piston which way to move, and again let the amount of voltage tell how far the output shaft is to be moved.

Fig. 1 shows how a simple linear potentiometer can be connected to a pair of batteries to form a bridge circuit. When the wiper is in the center, the voltage across terminals A and B is zero. If the wiper is moved to the right, A becomes negative with respect to B. If the wiper is moved to the left, A becomes positive with respect to B. This could be an input circuit for a very simple motor control unit as shown in Fig. 2. We have not called this a servo, since it has no feedback.

With the wiper centered as shown there is no voltage on the grids of the tubes. R1 is set so RY1 remains open. R2 is set so RY2 just closes. Since both motor leads are connected to the positive battery terminal, it does not run. Now we move the wiper clockwise. The bridge is unbalanced and a positive voltage is placed on the grids. V2 is not affected since it is already conducting and its relay remains energized. V1 starts to conduct and closes relay RY1. This connects motor lead A to the negative line. Lead B is connected to the positive supply so the motor runs clockwise. It will keep running till we move the wiper back to its center position.

If we move the wiper counterclockwise, a negative voltage appears on the tube grids. V1 is unaffected (it is already cut off) but V2 stops conducting. This makes RY2 open and connect motor lead B to the negative line. Since motor lead A is connected to the positive supply, the motor runs counterclockwise. Again, it keeps running until we center the wiper.

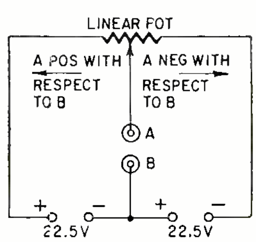


Fig. 1—Linear potentiometer and two batteries form a balanced bridge.

Position control

Fig. 3 shows how to add a second potentiometer, like the first, so it furnishes a position feedback signal to the tube grids. Now if we move the input wiper 10° clockwise, the motor output shaft also moves 10° clockwise and then stops. In other words, we can make the output shaft position correspond to the input shaft position at all times. This is basically what we want in any kind of positioning servomechanism.

If we move the input wiper to the right, a positive voltage is applied to the tube grids. V1 conducts, closing RY1. The motor runs and turns the feedback wiper in the direction that brings it nearer the positive battery terminal. As soon as this wiper has moved the same distance from center that the input wiper was turned, the voltage difference between the two wipers is zero. The relay opens and the motor stops.

If we center the input wiper again, it is nearer the negative battery terminal than the feedback wiper. Now a negative voltage with respect to ground appears on the tube grids. This makes V2 stop conducting, and RY2 opens. Now the motor runs in the opposite direction until the feedback wiper reaches the center position and no voltage difference exists. The motor would, of course, have a gear train between its shaft and the object we want to position. This may be a rotary antenna, a hydraulic valve, sonar transducer or any similar device. The feedback pot would be attached to the shaft the *object* is connected to.

The ac servo

Fig. 4 reveals the similiarity between an ordinary audio amplifier and a servo amplifier. The values shown are only indicative of those in use and not the exact values used in any one amplifier. The idea here is to control the motion

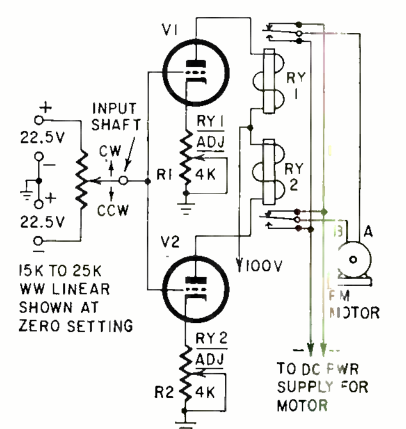


Fig. 2—Simple motor-control circuit.

* Author: *Model Radio Control*, Gernsback Library.

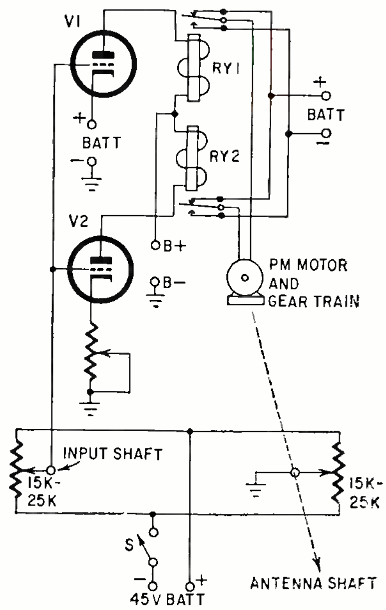


Fig. 3—Motor-control circuit with a position feedback potentiometer.

of a two-phase induction motor by controlling the phase to one winding.

If we use a synchro transformer for the input, we can provide a 60-cycle signal which can be in phase or out-of-phase with the line voltage. We can control the amount of ac voltage to the input tube grid by how far we move the input shaft from its zero position.

Note that we also have a feedback signal which will be provided by the same kind of device. The armature of the feedback synchro turns as the motor output shaft turns.

Here is how it works: With input and feedback synchros properly set in position, there is no signal to the input tube grid. The motor has only its reference winding connected to the line and does not run. If we turn the input synchro shaft a little to the right, a 60-cycle signal appears on the tube grid. This is amplified, shifted in phase slightly (by the phasing network), amplified again by the power stages and applied to the second motor winding. The phase of this signal leads the reference by about 90° and the motor runs clockwise.

As the motor runs, it turns the feedback synchro and, if we have set it correctly, it will produce a signal exactly out of phase with the input. Thus when their voltages are the same, they cancel and the motor stops running since the amplifier no longer applies any voltage to it. The output shaft has been moved to the new position.

If we move the input shaft back to its center position, its signal vanishes. The signal now applied to the input tube is from the feedback synchro and is 180° out of phase with the one we used a moment ago. When this signal is amplified and fed to the motor winding, it is a voltage whose phase is lagging the reference. Thus the motor runs in the direction that moves the feedback synchro armature back to its zero position. The motor stops when the signal to the input tube vanishes.

The hydraulic system

Fig. 5 shows the basic elements of an electrohydraulic servo system. Examine the valve–piston arrangement first. The valve consists of a rod with three metal wheellike sections fastened or cut as a part of it—C, D, and E. The rod

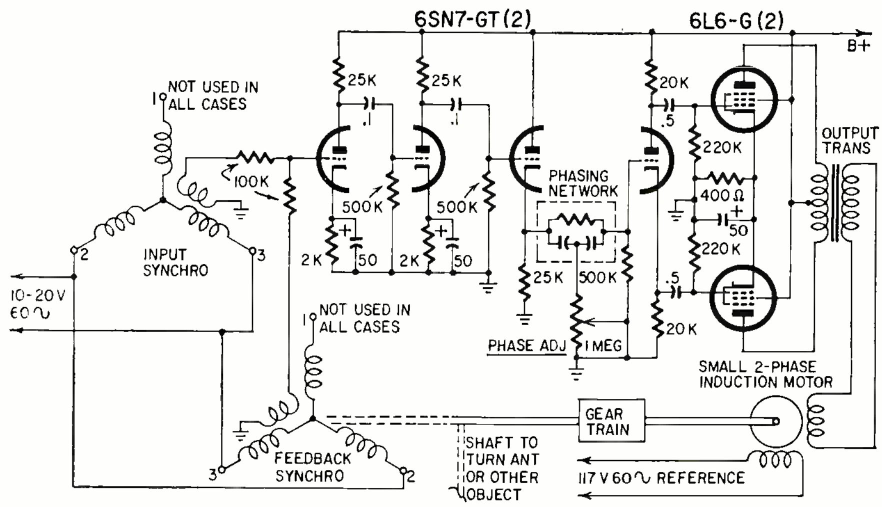


Fig. 4—A representative ac servo.

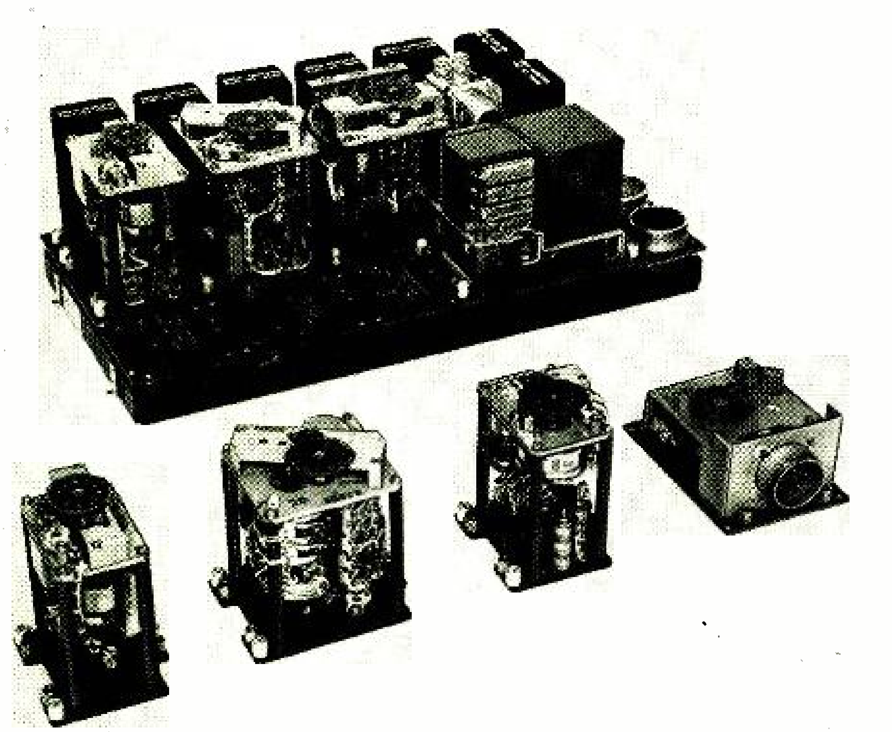
is held in place in the metal block by two centering springs. It can move up or down like a solenoid when either winding has current flowing through it.

Note that, as shown, the center part, E exactly covers the input hole where a pump, for example, is trying to force oil into the valve. C and D exactly cover the two exhaust lines so that oil in the piston cylinder cannot get out.

Now suppose the upper winding is energized, pulling the rod up. E opens the input line from the pump and also opens input B to the piston. Oil flows into the bottom of the cylinder and cannot get out since D still covers exhaust line B.

However, part C has uncovered exhaust line A and, as the oil flows into the bottom of the piston, the piston moves up, forcing oil from the top part of its cylinder out through exhaust line A. When the piston has moved enough to turn the feedback synchro enough to cancel the input signal, current to the top winding stops. The valve recenters and the piston stops moving. This same action takes place if the bottom winding is energized and the piston will move in the opposite direction.

Now let's see how we can energize one winding or the other by changing



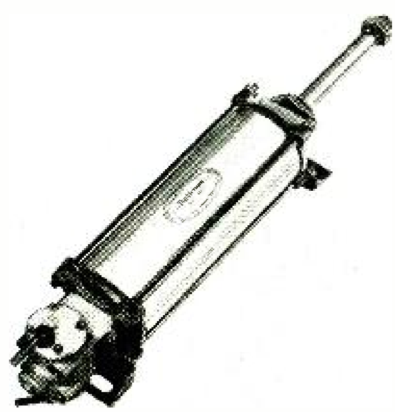
Servomechanisms Inc.

Eight servos are used in this Air Data Computer.

the phase of the input signal as we did with the ac servo. A new output stage is required. The rest of the amplifier is the same as in Fig. 4 except that the cathode follower and phase inverter are replaced by V3 and transformer T2 of Fig. 5.

V1 and V2 in Fig. 5 are biased class-B and 117 volts ac is applied to their plates. T3 and T4 are small separate transformers.

Here's how these work: Since V1 and



Bellows-Valvair

Bellows Air Motor is a typical servo-controlled device.

V2 are biased class-B, normally no current flows in either output transformer. If we apply an input signal which is in phase with the plate reference, making V1's grid positive at the

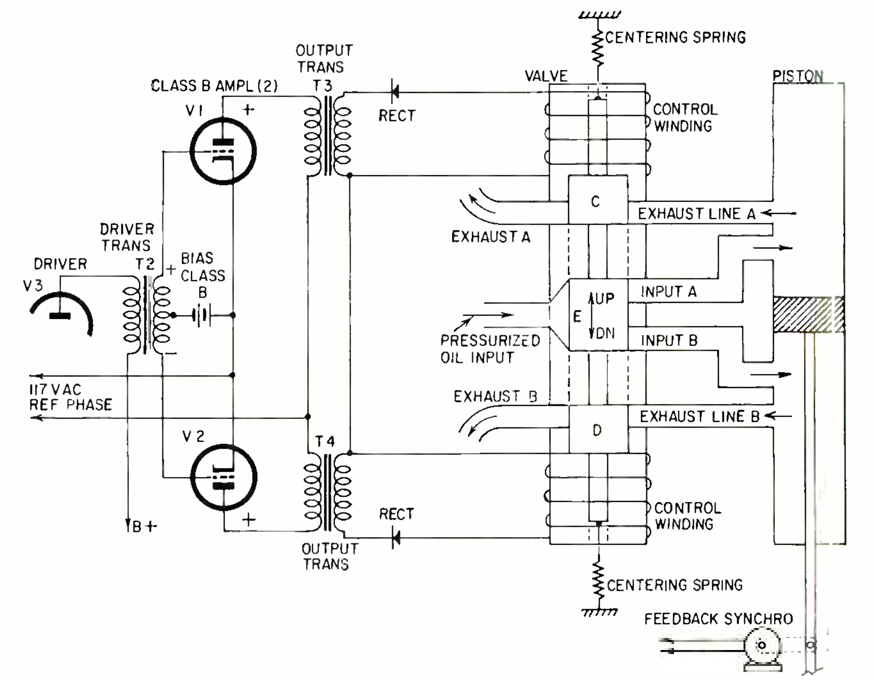


Fig. 5—Representative hydraulic servo.

same time as its plate, V1 conducts. The signal goes through T3, is rectified and causes a current to flow in the upper valve winding. V2 does not conduct with this signal because when its plate is positive, the grid is negative and, when its grid is positive, its plate is negative.

When we change the phase of the input signal by 180°, V1 does not conduct but V2 will, since now its grid will be positive when its plate is. The lower valve winding will now receive current.

Remember, only two basic servo types have been discussed. There are many others. Some of them will be described in future issues. END

NEW PORTABLE TIME STANDARD

ZENITH Radio Corp. has announced the world's first portable secondary time standard, the WWV-1. This self-powered instrument is accurate to approximately ±16 seconds per year.

The device contains a transistor receiver designed to pick up WWV or other sources of a one-second "tick." The receiver may be set at any of three switch-selected, crystal-controlled frequencies—2.5, 5 and 10 mc. Its output is fed to a decoder that removes all information except the one-second tick. The decoder includes circuitry to prevent false signals from disturbing the clock.

The tick is applied to a generator which supplies pulses of the required amplitude and duration to operate the clock.

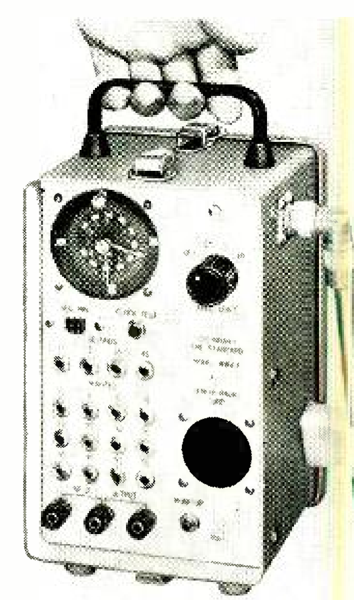
With a set of contacts using the clock's hands and a special circuit board, the unit can switch external devices on or off at 15-, 30-, 45- and 60-second intervals. Longer intervals range from five minutes to an hour or any multiple of five minutes. The time combination desired is selected by inserting special shorting plugs into jacks on the panel.

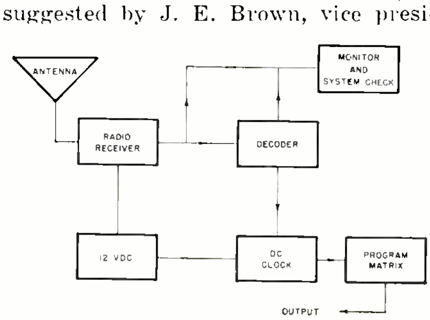
The clock used in the standard was developed by the Hamilton Watch Co., Lancaster, Pa. Its balance wheel operates a set of contacts that pulse the timepiece twice per second. According to the manufacturer, it is waterproof, shock-resistant and not affected by extremes of temperature and altitude.

An audio amplifier and speaker provide an aural check of receiver performance, as well as a means of obtaining WWV voice and code signals.

Two standard batteries will operate the radio for several months. The clock runs as long as one year on a single, separate 1.5-volt battery.

Some of the uses for the WWV-1, as suggested by J. E. Brown, vice presi-





dent in charge of engineering, are to link instruments with metering equipment to record flow, viscosity, and temperature of oil or gas moving through pipelines. Several clocks could be used to simultaneously trigger a number of measuring or recording devices such as scintillation counters or cosmic ray measuring equipment at widely scattered locations. END

Servicing the Horizontal Output Stage

A professional full-time service technician tells how the horizontal output circuit works and how he goes about fixing it

By R. D. JACQUES

LAST time we talked about horizontal oscillators (April, page 55). This month, let's work over horizontal output stage circuits. We may not get 'em all in, but we'll try.

The horizontal output stage of a TV receiver has two important functions. It generates the sawtooth currents that sweep the electron beam across the face of the picture tube, and it supplies high voltage for the picture tube. These happen simultaneously, but to make things a bit clearer we'll take them one at a time.

The horizontal output tube is always a power pentode, with a hefty current rating. It is biased to operate class-B or class-C, so that plate current flows for only a small part of the input cycle. The drive voltage (input signal) from the oscillator has a special shape. It is not a sawtooth, but a trapezoid (Fig. 1). This combination of a sawtooth and square wave is necessary because it causes a pure sawtooth wave of current to flow through the deflection yoke windings. This gives us the linear deflection we've got to have.

The plate load for this tube is a transformer which is coupled to the deflection yoke windings. The yoke is the load for the transformer secondary and the combination of the two (transformer and yoke) makes up the total load for the output tube. When the output tube is conducting, a pulse of current flows through the primary winding of the transformer. This generates a similar pulse in the secondary. Fig. 2 shows the waveform of the current pulse in the yoke. Notice the point on the waveform marked "output tube cutoff"? Right there, the peak of the sawtooth portion has been reached and the grid voltage has dropped below the operating point—the tube is cut off and plate current stops flowing.

The pulse stores energy in the form of a magnetic field in the transformer secondary. When the output tube is cut off, the field collapses back through the winding, inducing another pulse of current *in the same direction*. Thus, when the pulse was applied, the magnetic field created in the yoke started the electron beam in the CRT moving from left to right (from a theoretical resting position in the center of the screen). When it reached the right edge, the tube stopped conducting. The resultant collapse of the field generated a sharp pulse in the windings that snapped the beam all the way across the tube. Then, the field still present kept the beam moving from left to right, until it reached the center again.

At this time the output tube takes over again and begins to conduct. The next pulse moves the beam the rest of the way across the screen. The combination of these two actions gives us a linear sweep.

When the stored energy in the transformer collapses, it induces a pulse of current in the primary. The rate of change of the current during this time is very fast and causes a high (pulse) current to flow in the primary. The pulse induces a very high voltage in the primary (it acts as an autotransformer) which is applied to the high-voltage rectifier, as in Fig. 3. The total time for a complete cycle is 63 µsec. Of this, 56 µsec is used for the sweep and 7 µsec for retrace. The rest goes into the front and back porches. The inductive kick used to generate the pulse of high voltage has led to the name of *flyback* for these transformers.

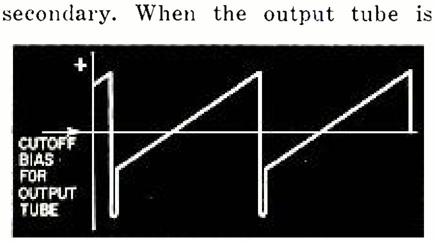


Fig. 1—Trapezoidal voltage on grid of horizontal output tube.

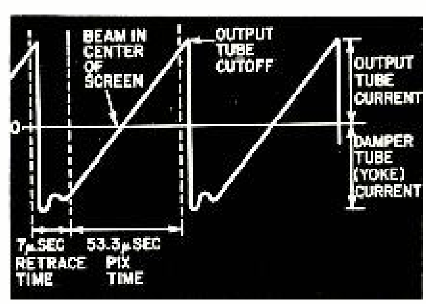


Fig. 2—Sawtooth current through yoke developed by the trapezoidal voltage.

Flyback–yoke system

The transformer–yoke system has inductance and, like any circuit having inductance, it also has a natural resonant frequency. During retrace (flyback time) the collapse of the field shock-excites the whole system into oscillation. For reasons which we will get to in a moment, the whole system is designed to be naturally resonant at the fundamental frequency of the retrace time—70 to 72 kc.

To obtain the sweep we get these oscillations. We can't get rid of them so we do something useful with them. First, we get a rapid retrace. And second, by making the whole system resonant at the retrace frequency, we increase its efficiency tremendously and get a much larger pulse of current in the primary to be made into high voltage! If we let the oscillations die out normally, it would upset the sweep and the waveform would look something like Fig. 4. This would cause ringing on the left side of the raster.

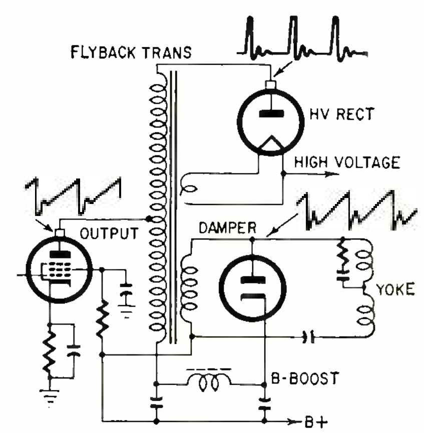


Fig. 3—How pulse from the plate of the horizontal output tube is applied to the plate of the high-voltage rectifier.

To get rid of the unwanted portion of these oscillations, we connect a half-wave rectifier across the yoke, as in Fig. 5. Now, during retrace, the pulse makes the cathode of this rectifier (the damper tube) positive, the tube does not conduct and, in effect, is not even there! After the pulse passes the zero line, it changes polarity. The next half-cycle applies a positive voltage to the plate of the damper, and it conducts heavily, shorting out the undesired halves of the pulses. This damps out the ringing and leaves us with an almost perfectly linear sweep.

So there's your circuit action. The

oscillator drives the output tube which in turn drives a tuned circuit, the flyback–yoke combination. You know what happens when a tuned circuit is thrown out of resonance—there's a drop in the stage's output. So, whenever we replace a component in the flyback or yoke circuit, we must use a replacement that will restore the whole circuit to its original resonant condition! This is the reason for using exact-duplicate yokes, flybacks, etc.

The most important sections of the circuit are the components that determine resonance—the flyback, yoke, and any capacitors which may be connected in the circuits. The high voltage generation is actually almost incidental. We can get high voltage by simply winding on more wire "above" the output tube plate, so we do!

The same thing applies to the boost voltage. When the damper tube conducts it acts like any half-wave rectifier and a positive voltage appears on its cathode. But the way the damper is set up, with the B-plus applied to its plate, the added voltage appears in series with the B-plus. This gives us a source of higher voltage (the boost voltage) used to furnish plate voltage for the vertical and horizontal output stages.

To get a dc voltage from the high-voltage pulse, we must rectify it. A special rectifier, with very wide spacing between its plate and filament, is used to prevent flashover. The filament must be above ground, so it is powered by wrapping a turn or two of wire (exceedingly well insulated wire!) around the core of the flyback. Output is taken from the filament, sometimes through a filter consisting of a large resistor and a 500-$\mu\mu$f capacitor. Many sets use the inherent capacitance between the conductive graphite (Aquadag) coating on the picture tube and the chassis as this capacitor.

Three flyback circuits

That's about all we need on the basic circuit. Now let's look at the three basic circuits used in commercial TV sets. They differ only in the yoke connections and you'll have to examine the schematic to see just which one you have.

1. The transformer circuit uses a separate secondary winding to drive the yoke (Fig. 6-a). B-plus is fed into the flyback through its secondary and the damper tube, and the high rf (the spike of voltage from the flyback action) is applied to the damper's plate. Boost voltage is developed at the damper's cathode and fed back through the linearity-coil circuit and the transformer's primary to the plate of the output tube.

2. The autotransformer circuit has only a single winding, and drives the yoke by connecting it across taps on that winding. B-plus is fed to the plate of the damper through the linearity coil. Boost voltage, of course, appears at the damper cathode and feeds the output tube plate through the flyback winding (Fig. 6-b).

3. The direct-drive circuit uses a simpler flyback that consists of only the plate and high-voltage winding as shown in Fig. 6-c. The yoke is connected in series at the lower end, back to the damper cathode and the boost voltage. Most of these can be identified by the flyback, which does not have an iron core, but either a plastic or paper form. You've noticed, of course, the identical nature of the high-voltage section of the winding on all of these circuits—all are autotransformers with the plate of the high-voltage rectifier connected to the top of the total winding.

Servicing tricks

Servicing any receiver, radio or TV should be handled back to front. Start at the output (speaker or picture tube) and work toward the antenna, repairing all troubles as you go. Servicing horizontal output stages demands a different approach. First, isolate the whole circuit in your mind—oscillator, output tube, flyback, damper, yoke and high-voltage rectifier. Now, think of this circuit as if it were a radio transmitter. Transmitter servicing is entirely different. We start with an oscillator, feed it into a power amplifier through a tuned circuit, then to an antenna. In this case, our "antenna" or load, is the yoke and the high-voltage rectifier, but the basic operation is just the same. So if we can think of the circuit as a transmitter, it'll be easier to service!

We fixed the oscillator last time. From now on we'll assume it is working perfectly and any troubles lie in the output stage. Testing in this circuit is a process of elimination. You can use any of several places as your starting point. But practically everyone makes a routine examination of the set, noting which tubes are lit, checking the high-voltage fuse, measuring the B-plus voltage and checking to see just what symptoms the set shows. Once you discover there is no high voltage, you start eliminating the various things which could cause it.

The most common causes should be checked first—the tubes. All should be replaced, checking the set each time. A good order of replacement is: high-voltage rectifier, damper, horizontal output and oscillator. If this does not bring the raster back, leave the good tubes in until you're finished and proceed with the rest of the tests.

First, see if you can draw an arc from the plate of the high-voltage rectifier with the blade of a screwdriver. (I shouldn't have to tell you that the

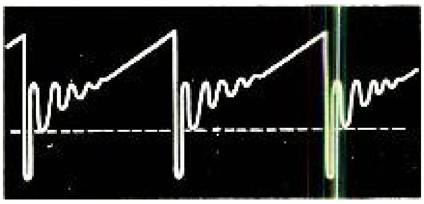


Fig. 4—Natural shape of waveform in yoke and flyback without a damper tube.

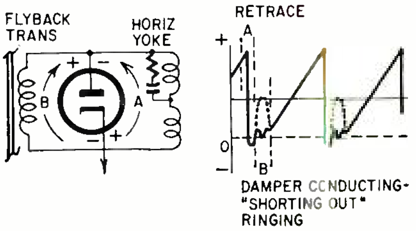


Fig. 5—Polarity of flyback pulse during retrace makes damper cathode positive so damper does not conduct. When ringing voltage starts, the damper cathode is negative and the tube conducts heavily, shorting out the ringing.

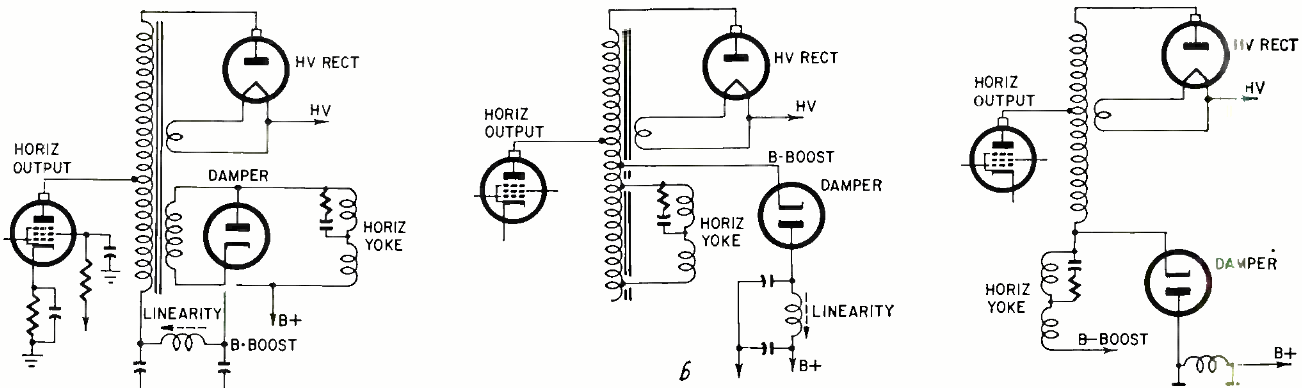


Fig. 6—The three types of horizontal output circuits: a—standard transformer; b—autotransformer; c—direct drive.

screwdriver must be insulated. Anyway, you'll remember it the second time!) Normal arc here is about ¾ inch long and a bright blue. If the output tube plate cap is exposed, you should get a very short arc there. No arc at either plate means that there is no high-voltage pulse reaching the rectifier plate. At this point, disconnect the yoke and repeat the test. If a below-normal arc appears at the high-voltage rectifier plate, the yoke may be defective. Check it for shorts and leaky balancing capacitor–resistor networks. If possible, substitute another yoke of the same inductance (the horizontal section is all you need) and see if the high voltage comes up to normal. If it does, the yoke is definitely bad. If not, the trouble may be in the flyback or the output tube.

Weak output

In many of the newer sets, test points are easily accessible—oscillator plate, output tube grid and screen, etc. Measure voltages at these points and check them against the schematic. The scope is a valuable instrument for checking this circuit. By placing its probe *close to but not touching* the plate lead of the output tube you can see if there is any pulse voltage there and after a while get a pretty good rough idea of its normal amplitude.

Weak output may be caused by low drive, open coupling capacitors or incorrectly set drive adjustments. This can be quickly checked with the scope and a voltage calibrator. Measure the peak-to-peak amplitude of the drive signal at the output tube grid. For the old 50° sets it should be about 50 volts, 65 volts for 70° sets, 75 volts for 90° and 90–105 volts for the 110° sets.

Measure the screen voltage of the output tube. A shorted tube, replaced some time before, may have damaged the screen resistor. Normal screen voltages for common tube types are: 6CD6, 175 volts; 6AU5, 6AV5, 6BQ6, 6CU6, 6DQ6, 200 volts, and the 6BG6, 350 volts. These are maximum values. In TV sets you'll find variations below this figure, but not too many. Screen voltage should never be more than the amount given or screen dissipation will be too large.

Cathode voltage should be checked if a protective resistor is used. Many circuits simply ground the cathode, but others use a small resistor (100–150 ohms) in the cathode to protect the tube against drive failure. Remember the radio transmitter? These tubes are just like final amplifiers—if operated without an input signal (drive), plate currents reach excessive heights and destroy the tube in a short while. So if you see the plate of the horizontal output tube turning red, turn the set off quick and check to see why the output tube isn't getting any drive signal!

Special testers

Several test instruments are made solely for checking flyback–yoke systems and all are worth their cost. Some are signal substituters that provide signals which can be used on the output tube grid in place of the set's horizontal oscillator. Also, with the aid of a horizontal output tube in the instrument, they will drive the flyback and yoke without the set's output tube. This test tells you definitely whether there is trouble in the flyback.

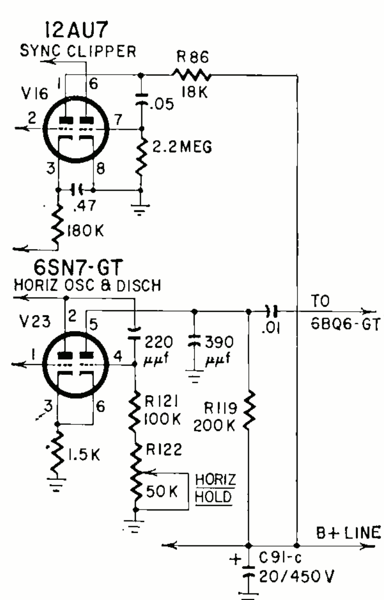
Others test components out of the circuit. They detect shorted turns in flybacks and yokes by using the resonant-circuit principle we discussed earlier. (A winding with a shorted turn will not resonate at its proper frequency, and its output will be very low.)

One instrument can even be connected directly into the horizontal output circuit and reads all quantities concerned with it. Resistance readings can be taken in the B-plus and boost circuits, screen resistors and cathode resistors measured, and all voltages checked in actual operation, by merely turning switches.

Finally, by using test adapters or by opening the cathode circuit, the plate current of the output tube should be measured. This is the most important reading as far as tube life is concerned. Maximum plate currents should be 6AU5, 6AV5, 6BQ6, 6CU6, 6BG6—100 ma; 6DQ6—140 ma, and 6CD6—170 ma. If plate current is higher, tube life will be short indeed! Too-high plate current can be caused by incorrect screen voltage, low drive on the grid, improper bias in the cathode (if used) or by a severe mismatch in the yoke circuit. Leaky or open screen or cathode bypasses can also cause troubles. Whenever any major repairs are made to the flyback system, always measure the plate current of the horizontal output tube, too much means an inevitable callback! END

Remember—Check the Tubes

This set hurt my ego. I had reached that lofty stage of my career where I considered the tiresome routine of checking all tubes in troubleshooting just a little superfluous. For a long time I had been making satisfactory, even spectacular, diagnoses by the mere use of my five senses and past years of experience. I could tell at a glance at the screen whether the tubes were good or not.



On this particular service call, I was confronted by a well banged up Sparton model 5107, looking a little disrobed with its back off and its high-voltage cage bared, left in that condition by a friendly neighbor the night before. This technically minded neighbor's opinion was that the flyback transformer was shot and, since it would take, among other things, a soldering iron to replace it, he had bowed out. There was no raster on the screen, but there was good sound. The small arc drawn from the cap of one of the 6BQ6's was about the same size as the one drawn from the 1B3, which fooled me into thinking the horizontal oscillator was working satisfactorily. I replaced all the tubes in the horizontal sweep section, and the 5U4, with no success. I examined the flyback as well as I could through its accumulation of sooty dust and finally I reluctantly told the owner that I had to concur with her neighbor's opinion and the set would have to be taken to the shop.

On my bench a tester soon showed that the flyback and yoke were OK, and I began checking voltages. After turning the set on, the 130 volts on the plate of the horizontal oscillator, V23, slowly dropped to 40. I immediately suspected filter capacitor, C91-c, and unhooked it. No luck. There was only one place left to go, the plate of sync stripper V16, since it was tied through an 18,000-ohm resistor to the same capacitor. The voltage here dropped from about 400 when the set was turned on to practically nothing. Removing this tube restored the high voltage with a cheerful crackle. It also cracked my ego.

I billed the customer for the 12AU7, an 18,000-ohm resistor, a service call and diplomatically discussed the weather instead of the flyback transformer! I also dug out the tube checker and put it back up on the front seat of my service truck, next to the tube caddy. It will be used early and often on future jobs.—*Klemm's Television*

TV Service CLINIC

conducted by
JACK DARR

MANY tests can be made on a TV set using only your eyes and powers of observation. For instance, the operating condition of the vertical oscillator and vertical sync stages can be checked out with remarkable accuracy.

Normal action on a TV set's vertical hold control should be familiar to all technicians (and set owners, too, for that matter!). When the hold control is moved in one direction, the picture should roll slowly downward until the blanking bar reaches a point about 2 inches or so from the bottom of the screen. There, it should snap out of sight, and another bar begin rolling down. Turning the control the other way should cause the picture to stand still until the critical point is reached. It should then break out and roll rapidly upward.

Unless these actions are as described, there is a possibility of trouble in the vertical oscillator, even though the set will hold a picture stationary on the screen. For instance, if the picture has no snap when rolling downward and can be rolled *slowly* upward, the vertical oscillator or sync stages are not working properly and will soon give trouble.

Loss of vertical sync (or weak sync pulses) can acount for these symptoms as can weak tubes in the vertical oscillator or sync stages. Low oscillator supply voltages are another cause.

Antenna stacking

I have two TV antennas that I would like to stack. What are the mechanics of the problem?—R. C. J., Chapel Hill, N. C.

Efficient stacking requires stacking bars cut to a half wavelength of the desired channel. The lead-in is connected to the center point of the bars, as in Fig. 1. The length of the bars can be figured from a division of the channel frequency into 300 × 10⁶, which gives the wavelength in meters. A meter is 39.37 inches. Next, the spacing of the stacking bars must be adjusted to transform the impedance of each antenna to 600 ohms at the lead-in connection point. The two 600-ohm impedances are effectively connected in parallel, matching the 300-ohm lead-in. The spacing can be adjusted most accurately by using a sweep generator, as in Fig. 2.

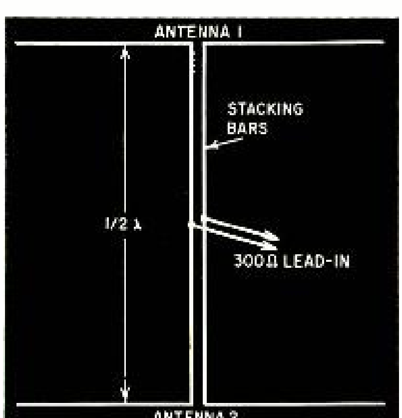


Fig. 1—A simple and effective stacking method is to use half-wave stacking bars, spaced for proper impedance transformation.

Width-coil burnout

I found the width coil in a Sentinel 416 TV charred and burned, and replaced it with the type specified for this chassis. Some previous service technician had replaced the flyback with a type designed for the 419 chassis. Now, the width coil gets hot enough to burn your fingers. I've changed all the tubes and checked both flyback and yoke for shorted turns. I put a 4.7-ohm resistor in series with the width coil, and it burned up, too! Putting a meter in series with the width coil, I can read only about 10-μa. The coil controls the width of the picture as it should.—J. I. L., Niagara Falls, N. Y.

That flyback change is the villain here! Checking the specifications of both transformers. I found quite a perceptible difference in the sections of the windings where the width coil is connected. There is at least a 30% difference between the two!

A width coil must be matched to the portion of the flyback it is connected across, just as a yoke must be matched. Your overheating is due to the fact that this mismatched coil has set up a resonance here, and is carrying a very large circulating current! (When you disconnected one end and inserted the meter, it damped the circuit so that it could not oscillate; therefore you read only a harmless 10 μa.)

If the set will operate all right without the width coil, take it out entirely! Any excess width can be controlled by making a width-control sleeve out of foil and sliding it inside the yoke. If you want to replace the coil, a good rule of thumb is this: a width coil should have a minimum inductance equal (roughly) to one-half the inductance of the section of the flyback it is shunting. Maximum inductance should be three to four times this value. You may have to do a little "Cut and Try" engineering here, to find a suitable type. I should say that the inductance of this section in the Sentinel flyback is in the neighborhood of 0.7 to 1.0 millihenry.

Shifted channels

My problem is with a Bendix Model TS17DU TV which developed trouble in the front end. Channel 13 comes in on channel 8, channel 3 is on channel 2, and channel 8 is gone entirely. The uhf channel comes in OK. Can you tell me where to look for the trouble?—J. S. T., St. Petersburg, Fla.

The schematic I have for this model shows a Standard Coil turret tuner. In this tuner, such troubles would not be possible, as each channel has its own individual oscillator coil. Defects in one will not affect others. However, there is one peculiar difficulty, which is not uncommon. If the metal insert in a plastic channel-selector knob becomes loose and turns, you can get some extremely peculiar results!

However, from the symptoms you

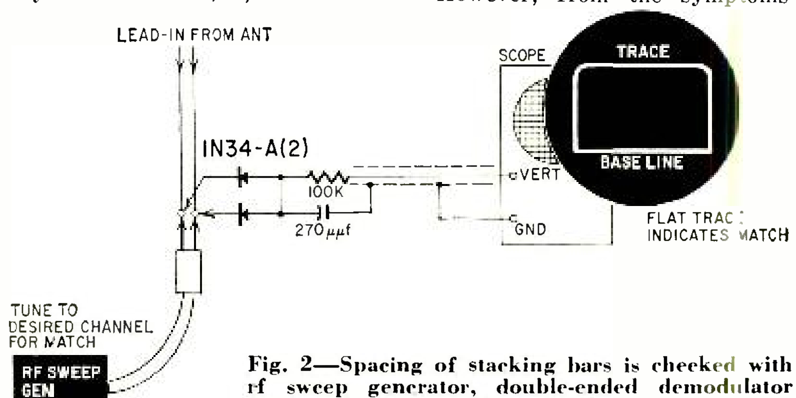


Fig. 2—Spacing of stacking bars is checked with rf sweep generator, double-ended demodulator probe and scope—at the receiver end of the lead-in.

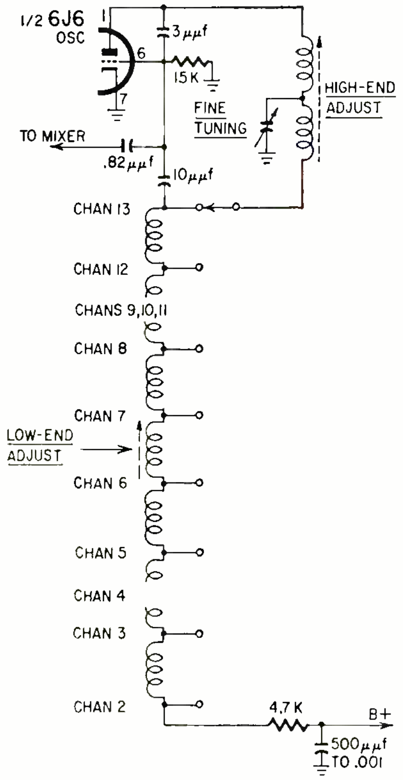


Fig. 3—Schematic of oscillator of incremental-inductance tuner. Switch (shown in channel-13 position) removes the unused coils. Fine-tuning control is effectively between grid and plate.

give, this must be an incremental-inductance tuner. Channel displacement in a Standard Coil tuner is always uniform. Each channel moves two, three, etc. channels one way or the other. You have a 210-mc channel 13 coming in on 180-mc channel 8, and 60-mc channel 3 coming in on 54-mc channel 2.

In the incremental-inductance tuners, the oscillator coils are arranged as shown in Fig. 3. Your local oscillator is far off frequency: 30 mc low on the high band, and 6 mc low on the low band. This would suggest a defective capacitor or coil. For example, if the fine-tuning capacitor were broken mechanically and jammed at maximum capacitance, the result would be somewhat similar. Other troubles might be found in the oscillator wafer of the switch. If the rectangular "drive hole" in the wafer is broken and enlarged, the wafer could get off calibration. A bad contact on the shorting portion of the switch would also leave too much inductance in the circuit (causing the oscillator to work on too low a frequency).

As you can see from the sketch, your coils are arranged in series. The total inductance of the portion left in the circuit determines the frequency of the oscillator. Therefore, either of the troubles mentioned would give you results like you observed—operation on too low a frequency.

Check all of the capacitors in the circuit. The values will be different in your tuner probably, but they will be in the same locations. Either the 3-μμf or the 10-μμf capacitor in the grid circuit would affect the frequency. So would the adjustment of the tuning slug in the small coil labeled HIGH-END ADJUST. Check the setting and adjustment of these slugs.

I remember a very mysterious case in a different make TV set. Although the set worked perfectly in the store, when delivered at the house it was completely off on all channels. Investigation disclosed the low-frequency adjustment on channel 6 (an iron slug) had slipped and fallen out of the coil. This threw all channels off adjustment.

Critical horizontal hold

We have a General Electric 14T017 portable TV with a very critical horizontal hold. The set has always been this way, according to the owner. It runs with a black bar down the middle of the picture for a while, then falls completely out of sync.—G. M., Westville, N. Y.

There have been several production changes in this model, and they center around this circuit. The first version used a 5AN8 tube (the triode section) as a horizontal phase detector. Other versions used twin selenium diodes (Figs. 4, 5). If yours has the tube, check plate resistor R252, R251, the grid resistor, the coupling capacitor C251, 180 μμf, and the coupling resistor, R255, 1 megohm, to the grid of the 7AU7. Short out the horizontal stabilizer coil, L251, and see if the horizontal oscillator will "free-wheel" with any stability at all. (You'll probably have to increase R257, 12,000 ohms, to about 15–18,000 ohms to get it to do this. Replace the original resistor when through testing).

The circuit should be capable of holding a picture almost still, floating slowly across the screen, with the stabilizing coil out. Remove the short from the coil, and adjust the slug for a stable picture. If it will not free-wheel, check C257, .001 μf, for leakage, and the plate and grid resistors in the oscillator circuit. (The 5AN8 tube should have been replaced first, of course!)

If the set uses dual-diode phase comparers, check them or better still, replace them, for a test. These units are the most common cause of horizontal instability in this set, in field experience.

While these are the most frequent offenders, don't overlook C256, the .0047-μf capacitor across the stabilizer coil. If this is leaky, it will upset the hold action badly. If you replace it, be sure to use a very-high-grade capacitor which is not temperature-sensitive.

The shaping networks in the grid circuits are also worthy of attention: R256/C255 and their counterparts (not shown) in the remainder of the horizontal oscillator circuit. Measure the resistance of R253, the 5.6-megohm resistor from the plate of the 5AN8 or the left terminal of the comparer diodes, back to the 135-volt line. Quite often we all develop a human failing to check these very large resistors, feeling that they are so big that a little drift won't bother anything. Check them carefully; large though they are, they should be within their tolerance. Too much drift will upset this very sensitive circuit. This is especially true when selenium diodes are used.

Gassy replacements

Recently I changed a 27MP4 metal tube to a 27EP4 picture tube on an RCA 27D382 with a KCS-77C chassis. I used a rebuilt 27EP4 and in less than a month the tube became gassy. I returned the picture tube for another of the same brand, and the same thing happened again. Is the picture-tube voltage too low?—J. J., Minneapolis, Minn.

The 27EP4 is one of the tube types which sometimes show a neck shadow that may be a little troublesome to work out. If the neck shadow is worked out with the *ion trap*, the beam will *erode the aperture* in the first anode and soon gas up the tube. Neck shadow should be worked out by eccentric *shimming* of the *focus unit* or by use of a thin pair of *centering magnets* mounted just behind the yoke. END

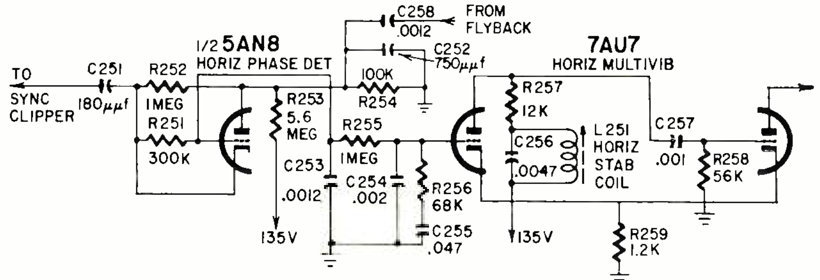


Fig. 4—Horizontal multivibrator with 5AN8 phase detector.

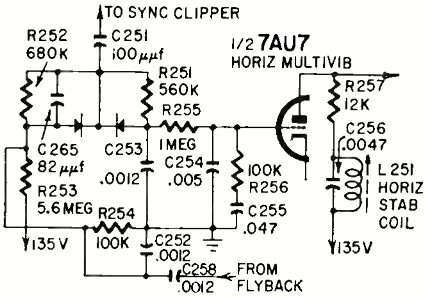


Fig. 5—Multivibrator with dual selenium diodes.

The Gibbons Substituter

By HAROLD DAVIS

Confucius say: Even the needle could be found in the haystack if one knew under what straw to look. Here's a quick way to prove where the needle isn't

IT had been a hectic day and now we were relaxing, sipping hot coffee at the greasy spoon. "You know something," he said, "servicing television is simple."

Having just finished sweating the better part of a day on a set, this was indeed news. I just grunted.

"Sure enough. I mean it. It's simple. All you have to do to fix a TV set is find the defective part and replace it." He turned the palms of his hands up in a familiar gesture.

"Yes," I answered, "and I just spent a full day doing that very simple thing."

"Okay, let's get down to business. You're an average technician, why did it take you all day to find a shorted .001 capacitor?"

I got to thinking. It was a good question. Why did it take me all day to find a shorted bypass? After a moment's silence, I answered, "Well, for one thing I got sidetracked into believing the trouble was in another section."

"Ah-h-h!" he exclaimed, raising the proverbial finger. "In other words, you spent a day proving that nothing else was wrong with the set, correct?"

I had to admit that it was.

As we got started home, he said, "Come up to my place next week. I have something I want to show you."

I had been talking with "The Q," Quincy Gibbons, a graduate of Mississippi State in 1919 and one of the most refreshing and unpredictable fellows ever to come out of the Mississippi Delta. At the first opportunity I dropped in on The Q. "Guess you came up to see the gadget?" he inquired.

"I came up to see, period."

There it is

We went into one of the front rooms that contained the usual TV accumulations. "Here's what I wanted you to see," he said, picking up the contraption shown in Fig. 1 and placing it carefully on the table.

"My gosh! what a mess," was the best I could conjure.

"Mess! you say, and you haven't seen the back!" He turned it around, displaying what can be seen in Fig. 2.

"Just wait until you see what this thing can do," he promised.

"There's one thing I'm sure it can't do—work!"

"Ah-h me," he sighed, "to think all famous people have to go through this."

"Pull up you a chair and let me indoctrinate you. You can see that this was originally an RCA portable," he announced, patting the front of the set. "Here's a block diagram that shows where I tapped into it (Fig. 3)."

"Yes," I confessed, "but Mr. Sarnoff would have a hard time recognizing it now."

"You sure die hard," he complained.

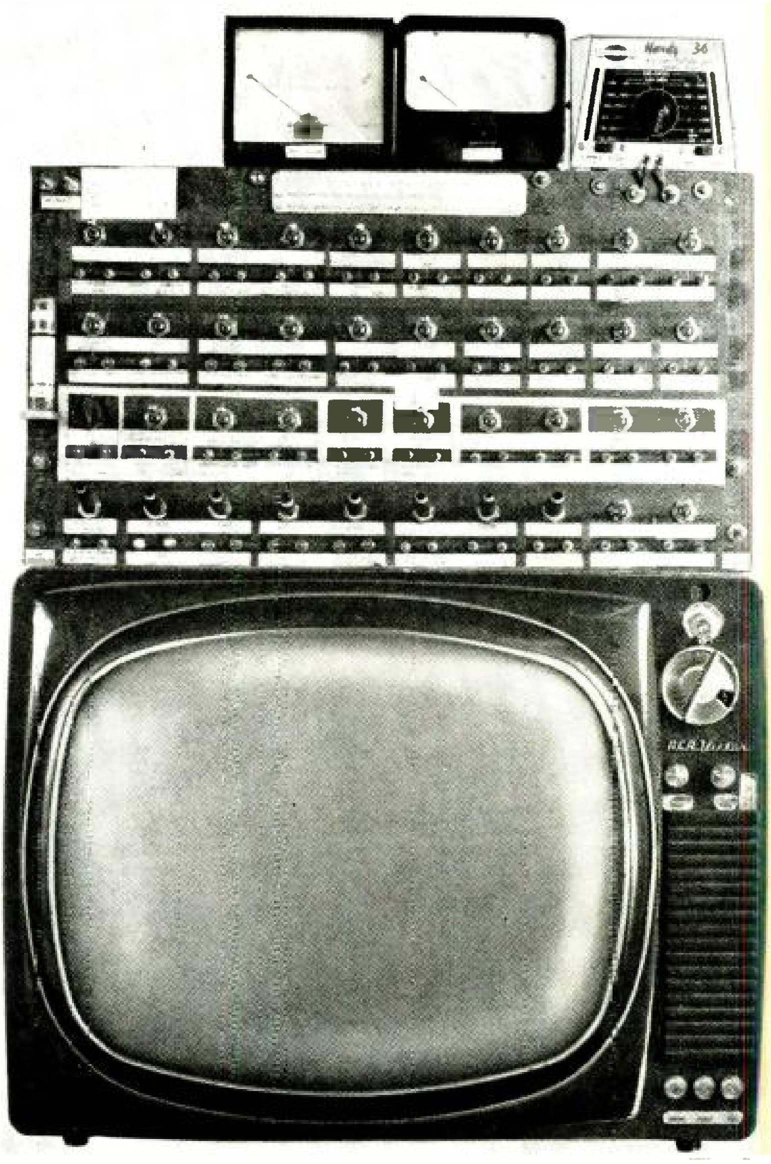


Fig. 1—"Mr. Sarnoff wouldn't recognize it."

"I chose it for several reasons. For one thing, it's in a rugged metal cabinet and has a power transformer. Now I know we don't have too much trouble with power supplies, but we have all lost time wondering if low voltage or an improperly filtered supply was contributing to instability. To find out, I flick this switch down, attach a lead here, pull the 5U4 out of the defective set and drop this test lead into the No. 2 or 8 pin. In about the same time it takes to tell it I have eliminated power supply trouble. Savvy?"

What if it isn't there?

"Except for one minor detail. Just let's suppose that when you reach for that alleged 5U4 it isn't there."

"If the job has seleniums, we just move over into another department. In addition to the regular power supply, I built in a voltage doubler using silicons. By simply connecting leads to the proper terminals, I can bridge either rectifier, any capacitor, even the large ones, sometimes used in series with the line. Now would you say I have covered the power supply rather thoroughly?" he asked.

"I concede you a point. Proceed."

"Now, let's go into something a little more difficult, the audio. By connecting here and throwing this switch I can drive the voice coil of the set under test, or I can make the test set drive this voice coil. How long would it take you to find out for sure that a voice coil was open without disconnecting it?"

"Well, I would have to screw the end off my flashlight, take out a battery, find something to use for leads and scratch the terminals. If I heard no scratch, the voice coil is open."

"But what if it were distorted? How would you show that up with a flashlight battery?"

"Okay, okay, you're building up points."

"Following the same procedure, I can substitute the output transformer—both ways, now mind you, and I can make the set under test drive this output and speaker or I can drive the output and speaker in the test set. Also, there are arrangements for two-way substitution of signals from the input of the audio and the discriminator."

"All right, now let me see you kick that rf around a little, Smart Boy."

"Works the same way." Q shrugged confidently. "If you want rf to drive the discriminator, here it is. Or, you can take rf from the test set and drive this discriminator."

"Comes now the time when we must suppose that we have neither power supply or audio trouble. We have that very rare disease known as no pix. What would you prescribe to soothe that?"

"Listen, my friend, if you are planning on sticking me, you are going to have to dig deeper. Let's assume we have a trace of snow on the screen but no picture. My guess would be the tuner, but it would take a lot of work to prove it. With this gadget I simply attach a lead to the first if amplifier's grid, throw this switch and touch the other end of the lead to the grid of the first if in the test set. If I get a picture, the trouble is the tuner. Definitely! And as much as I hate to, I will have to tear into it."

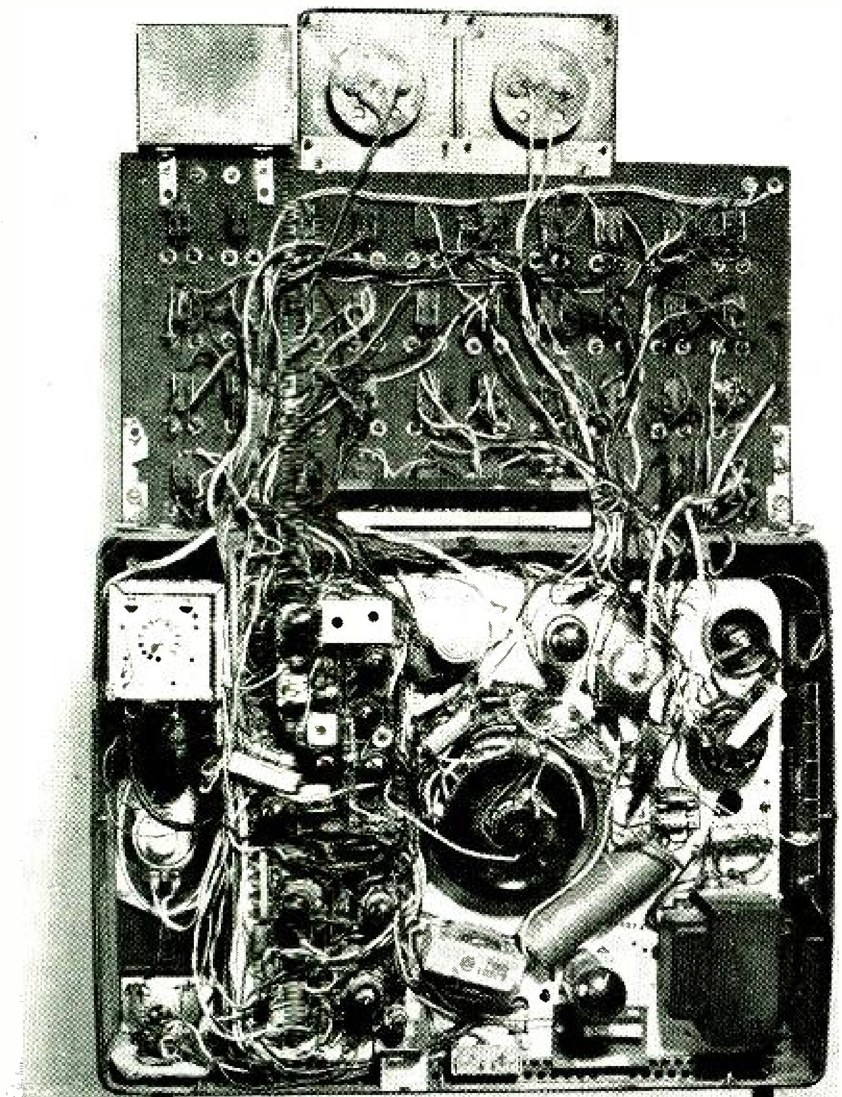


Fig. 2—"Mess! you say? Take a look at the back!"

Where do we go next?

"If the trouble hadn't been in the tuner, I would have tapped a signal off the if and fed it to the second detector. If I hadn't got a picture there, I would have kept going back tapping off the input to the video, the output of the video and finally the picture tube itself. In other words, I could have localized that trouble to an area small enough for me to make a minute search."

"Amen." I thought a minute and added, "But run a simple answer to this my way—why didn't those if's come uncranked when you were making like the AT&T with all those wires?"

"Well, Maestro, I regret that you brought up that subject, but I am prepared. Did you ever hear of the dandy art of 'doodling?'"

"Yes, that is exactly the thing we were always told not to do."

"Precisely. But this time I received a doodler's license by virtue of necessity."

"When I connected a lead that seemed to interfere with the picture or sound, I adjusted that particular stage to restore the quality."

"You may have restored the picture, but the quality part I doubt."

"Well, take a look for yourself." He snapped all the switches up, which is the normal operating condition, and sure enough he had a fair picture.

And the other switches?

"There seem to be a lot of switches you haven't wiggled yet, and we haven't talked any about high voltage, sync, vertical and horizontal, etc. For example, I see you have a terminal marked agc. What is it?"

"That's not really agc. It's a 45-volt battery hooked up through a pot so it can be varied down to .01 volt. And does that come in handy! The other day

I had a set that looked like two stations were coming in. I substituted a tuner signal and the trouble almost cleared up. When I fed a signal into the second detector, it did clear. I then substituted a battery bias and it also cleared. What do you think it was?"

"That's an unfair question for you, Q. It so happens that I have also been coached. It was the agc filter, usually a low-voltage electrolytic."

"That's right, but, why does it do it?"

"I thought you were supplying the answers, not the questions."

"Don't get me wrong," Q said. "I've never said I knew all about this business. In fact, I don't even know enough to quit." He laughed.

"Well, the reason you get double images or ghost effect when the agc filter capacitor is open or deteriorated is simple. It was put there in the first place to bypass anything that was moving on the agc line, particularly hum and picture information. When it's not effective, picture information is fed back to the grids of the rf and if amplifiers where it is delayed or out of phase and appears on the face of the picture tube as a ghost, or interfering picture. . . .

"Along this same line, I had a rough one a while back. I was getting picture information in the sound. It was caused by a strong local overloading because of not enough bias. I see I could have found it much quicker with your device."

"Yep, agc can cause a lot of trouble. That's another reason why I selected this particular RCA for my substituter, it has keyed agc and I wanted the pulse that is fed back from the flyback transformer to the agc tube. That thing always did cause me trouble. Now," Q said, "I can supply that pulse to the line and remove another doubt. I can also supply the sync pulses. Here I have the composite sync right off the second detector, and these two terminals make available the vertical pulse after it has gone through the integrator, and the horizontal at the grid of the horizontal oscillator. You know, I can run these pulses along the line and actually find defective components? How many times have you wondered about the condition of this?" He tapped a printed-circuit integrator.

"Plenty," was my answer.

"I can tell you in a few seconds. If it passes my injected signal, it is good, and vice versa." Q demonstrated with good results.

Into the sync circuits

"The rest of the gadget is almost self-explanatory. I can feed a signal both ways from the input and output of the vertical and horizontal tubes. I can substitute both the vertical and horizontal output transformers. Also either section of the yoke."

"There are bound to be some variations in circuits that would keep you from substituting the vertical and horizontal outputs," I complained.

"Granted that there are," he an-

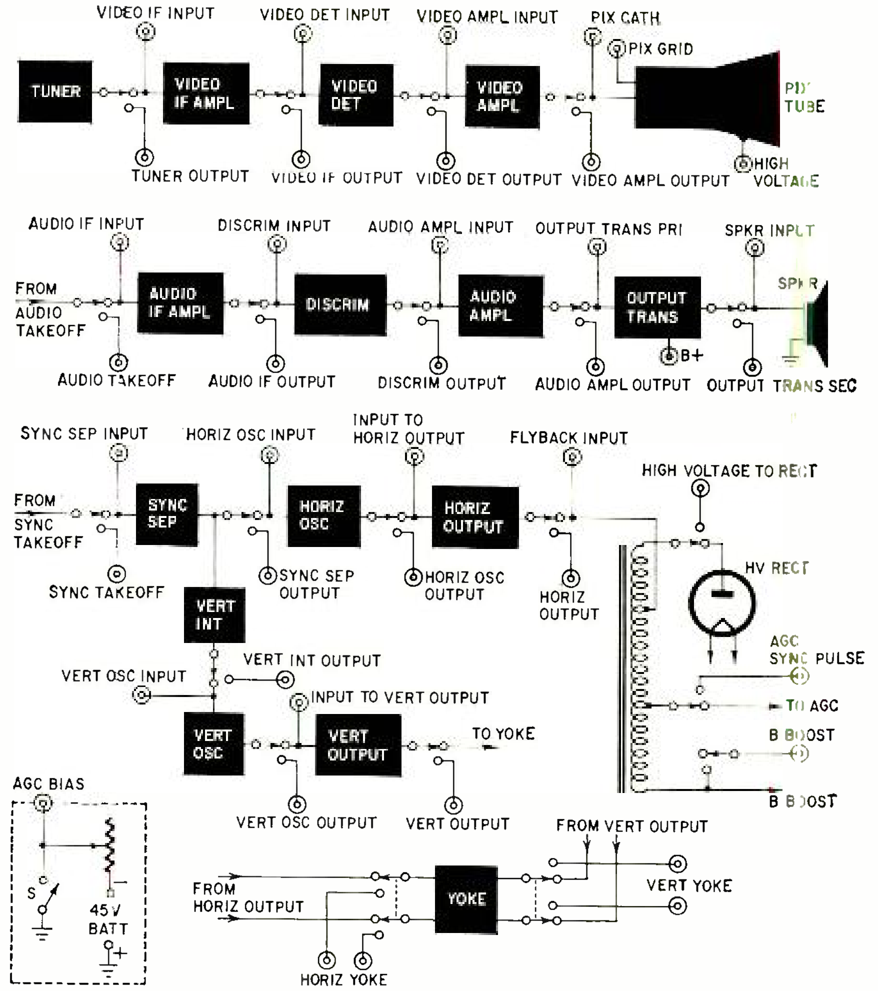


Fig. 3—Block diagram hsows where taps are made to convert TV set into a Gibbons' Substituter. Some of the more obvious features (and harder to show in a diagram) such as a power supply are not indicated.

swered, "but I will still stick to my original statement and say that, by substituting both ways, I have always been able to localize the trouble. And, fortunately flybacks and yokes don't cause much trouble."

"No," I agreed, "I don't believe I ever replaced a flyback or yoke that wasn't obviously bad."

"Right! And that about wraps it up with the exception of mentioning the width coil I've brought out. Also I didn't mention that I brought out both the grid and cathode of the picture tube. B-boost, of course. And don't forget this high-voltage terminal. It can come in handy."

"Yes, I could have used that very nicely yesterday. I had an 8-inch Emerson that wouldn't light up. The high voltage at the input of the high-voltage rectifier seemed definitely low. The low voltage was off about a third, so I replaced the seleniums but it still didn't come up. After a couple of hours of checking, I decided to replace the flyback. Then I discovered that a pin had broken off from the lug on the high-voltage rectifier socket. This is one case I know your gadget would have saved me hours.

"Is there anything extra special you've learned to do with it?"

"Yes, in a way," Q answered. "You can detect hum in a circuit by connecting to the video amplifier input. Hum will show up on the screen just as it does with a shorted tube in the circuit."

"And by the same token," I added, "you should be able to detect contamination along an agc line. By the way, what are those meters on top?"

"This one, of course, is simply an ac–dc meter across the line. The other is a high-resistance meter in the second-detector circuit. I can measure, relatively, the output of a tuner or the gain of an if by connecting the tuner in question to the first if in the gadget. Then I can go down the line measuring the gain of each if."

"I presume that it's sometimes necessary to use decoupling in the leads when interconnecting, like small capacitors or resistors?"

"Occasionally. It all depends on the situation."

"It's also necessary to ground the two sets, and that's the reason for not using a selenium job for a Substituter."

"It would be all right," Q said, "if you used an isolating transformer."

"I guess this gives me enough information to tell the boys about it. I guess I'll wrap things up and head for the post office." END

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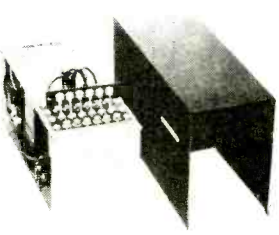

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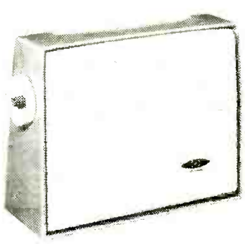

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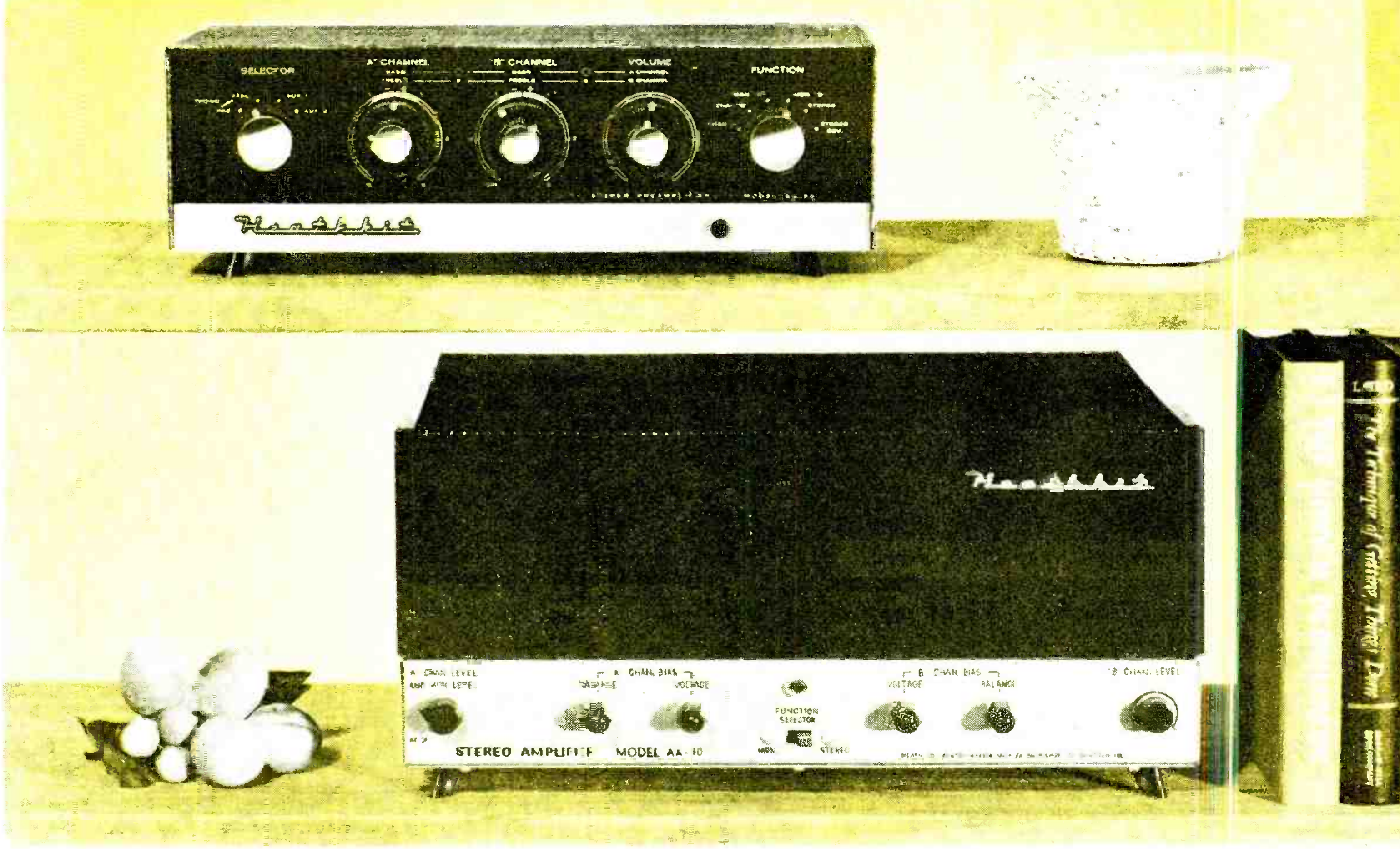

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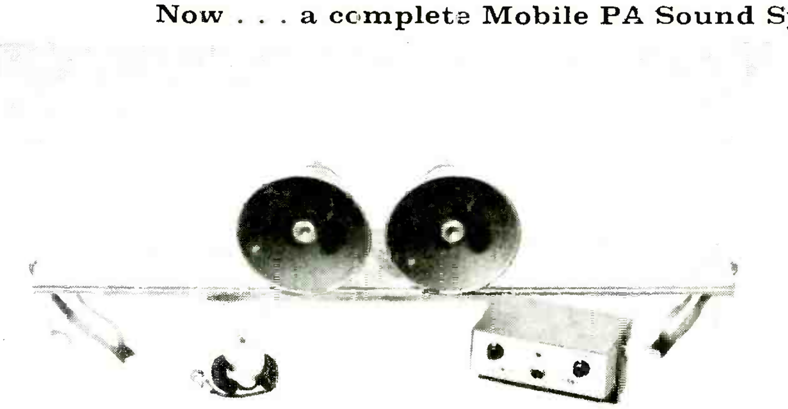

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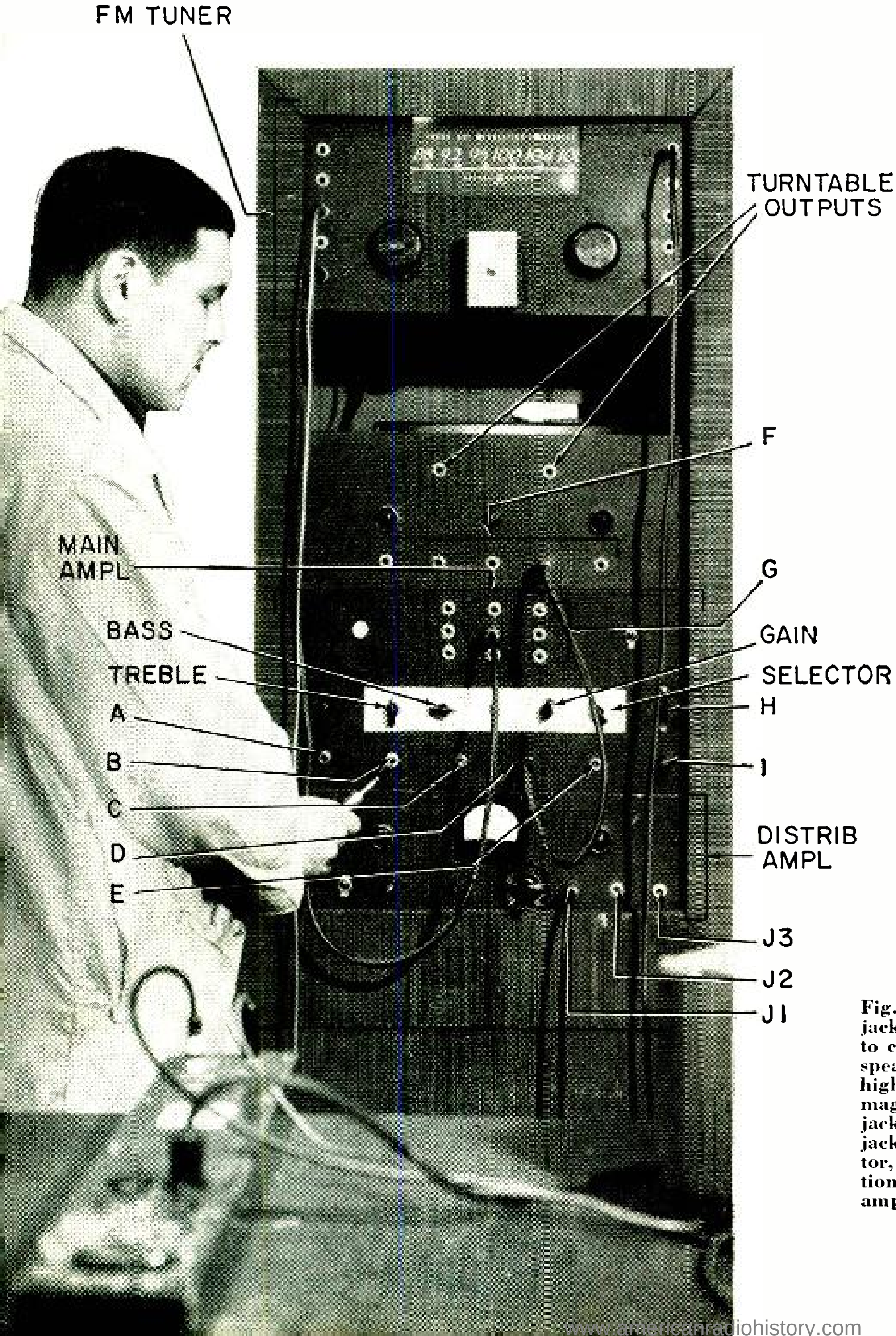
HIGH-FIDELITY TEST PANEL

By HERMAN BURSTEIN and CHARLES B. GRAHAM



TO capture a good share of the growing high-fidelity and tape-recorder service business, the service shop must have readily available test facilities at its front counter to check out any component quickly as soon as it's brought in. This is more complicated than preliminary checking of radio or television receivers which are all-in-one units and usually require only an ac socket and perhaps an antenna. Too, the typical audiophile will less often settle for "good enough" than will other service customers. With a well arranged checkout station, the progressive service shop will not only be set up to perform first-rate audio work quickly, but also to impress the customer.

The repair technician should be certain that the customer agrees with him as to the trouble when the equipment is brought in. If the technician checks the unit right before the owner's eyes (and ears) and they agree on what's wrong, serious misunderstandings which might otherwise come up later can be avoided.

If the front bench is not to be a clutter of components and cables, such a checkout station requires a carefully designed switching system through which components can be quickly connected in various combinations.

A flexible and time-saving approach to this problem has been developed by Sigma Electric Co.,* an experienced tape recorder and components servicing organization. Sigma has designed and installed a *test panel* out front at its customer service counter where sets are accepted for repair. They also have a *bench test panel* at each of three repair technicians' benches back in the shop. These audio-component test panels represent a careful approach which was worked out over a period of several years. Examination of the details of the test panels will suggest useful variations to many technicians doing test maintenance, and repair of tape recorders and audio components.

Fig. 1 shows the test panel behind the customer counter. It's a standard

*11 E. 16 St., New York 3, N. Y.

Fig. 1—Audio test panel at the counter. Counter jacks in box at lower left connect under counter to color-coded jacks on test panel. A—external speaker, B—external amplifier output, C—high-Z input, D— straight-through input, E—magnetic phono or tape input, F—color-coded jacks from counter, G—3 sets of paralleled jacks, H—tape head input, I—magnetic selector, J1—cathode follower output of distribution amplifier, J2—monitor, J3—distribution amplifier input.

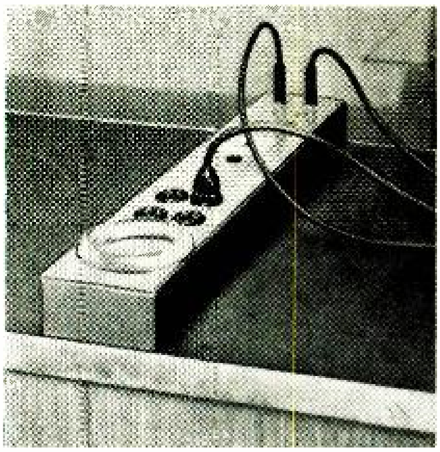


Fig. 2—Jack boxes (rear of counter unit) accept cables to connect gear for counter checking. Box jacks parallel test panel jacks behind counter.

19-inch rack holding four panels. The counter is clear except for three adjacent jack boxes (Fig. 2) wired so that each of the five color-coded jacks in each box is paralleled to corresponding jacks in the other box and connected to similar color-coded jacks on the test panel behind the counter with short runs of low-capacitance two-wire shielded cable. (Note that there are only 5, not 15 color-coded jacks on the test panel itself, since the three jack boxes are paralleled.)

When a piece of equipment such as an amplifier, tape recorder or preamp–control unit is brought in for repair, it is placed on the counter and plugged to one of the bench jack boxes with a patch cable. A number of these patch cables are always stored, loosely plugged into unwired storage jacks in the top section of the test panel. These patch cables have a standard telephone plug at one end, and either a telephone plug, RCA phono plug, or some other standard connector at the other end.

Since the jacks in the counter jack boxes, the jacks on the test panel (connected to counter jacks) and the phone plugs on the patch cables are all color-coded, the technician can use these colors as ready identification to keep connections straight. In addition, two (or, under some conditions, three) pieces of equipment can be counter tested at the same time.

Test panel

Fig. 1 includes labels for the parts of the test panel showing the jacks and facilities of each of the four rack sections. At the top is the FM tuner and two vertical rows of nonconnected storage jacks. These are simply holders for patch cables not in use.

The FM tuner is the main signal source for the shop and for the counter. The output of the tuner is fed throughout the shop via a distribution amplifier which is at the bottom of the test panel. Since this FM tuner runs continuously, it must be sturdy and drift-free.

The second rack panel from the top holds a phonograph turntable and the test panel jacks which connect to the jacks on the counter. These jacks are color-coded with spots of quick-drying enamel to match the ones on the counter.

The arm used with the turntable has a removable shell with a high-quality cartridge for playing LP's. Three extra shells are kept ready, one with a ceramic or crystal pickup, and two empty shells with small alligator clips for testing the occasional phono pickup cartridge which is brought in for checking.†

Two phonograph output jacks are paralleled out at the top of this second rack panel section. One makes the phono signal available for counter test of amplifiers; the other provides any desired phonograph material to the repair bench locations in the shop (by patching it to the input of the distribution amplifier), without taking the phonograph turntable out of front bench testing use. This panel section also includes pilot lights, fuse and switch for the turntable.

The third section of the test panel has nine jacks grouped so that three sets of three jacks each are paralleled. They are used to parallel outputs or inputs without using external multiple connectors.

†A test record made by Components Corp., Denville, N. J., has 1,000-cycle tone recorded at high level both at its outside and near its center. Playing this disc, "How's Your Stylus?," can reveal stylus condition. This material has also been released by Urania Records, Belleville, N. J., and Lafayette Radio, 165-08 Liberty Ave., Jamaica 33, N. Y.

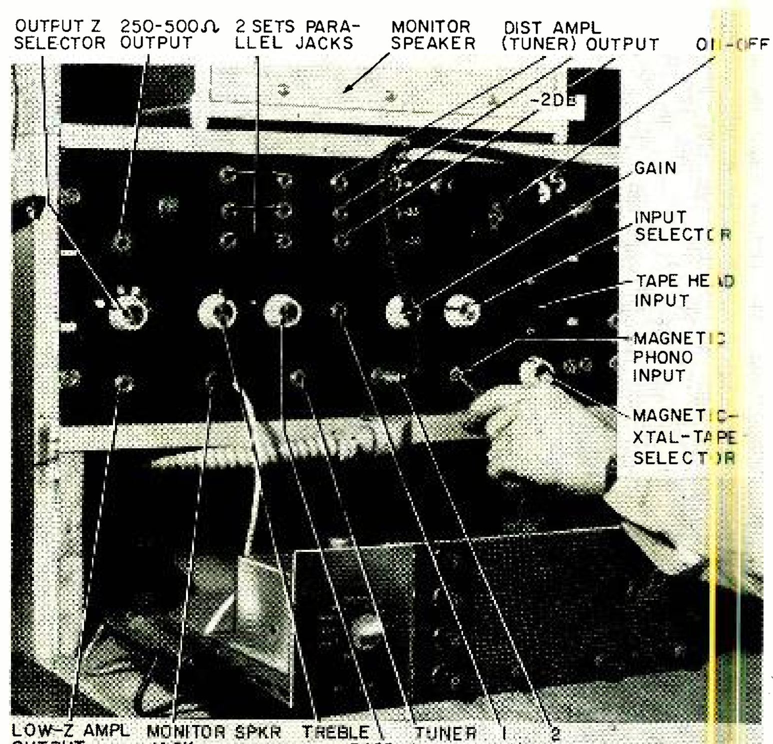
The third panel section of the test panel also mounts a standard high-fidelity amplifier combining on one chassis the preamplifier, control unit, and power amplifier modified for this application.

The gain, treble, bass and high-frequency scratch filter controls are conventional, but the selector switch has been modified to allow choice of either of two high-impedance inputs or one of four (different equalization curves) magnetic phono positions. These modifications include wiring five phone jacks on the front panel. Independent access to the loudspeaker is through closed-circuit jacks wired as shown in Fig. 3.

The three lower right-hand jacks, C, D and E, are inputs for high impedance (medium level), "straight-through" (low gain and no tone controls) and magnetic phono (pickup) or tape head, respectively. The left-hand jack, A, is an output jack, making available the output of the amplifier for testing external speakers. The next jack, B, connects only to the system loudspeaker (not shown). Jacks A and B are closed-circuit jacks connected as shown in Fig. 3 so that the amplifier feeds directly to the system loudspeaker except when one of the two jacks, A or B, is plugged into.

The output transformer of the power amplifier has several output impedance taps which are selected by the switch above jack A.

The "straight-through" input is particularly useful for demonstrating that it is the equipment under check which



External amplifier and external speaker jacks shown in direct, normal position. Either a loudspeaker or an amplifier may be plugged into these jacks for rapid checking

is at fault, and not the test panel itself. This position also prevents cascading the panel tone controls after the controls on the amplifier or recorder.

The *distribution amplifier* serves a double purpose. First, it feeds the FM tuner to shop locations in such a way that shorts occurring at one bench in the shop will not short out the rest of the system. Second, it makes the FM signal available at the front counter for checking customer equipment. As shown in simplified form in Fig. 4, it consists of a stage of voltage amplification followed by eight cathode-follower outputs. Seven of these outputs feed the primary signal to the shop locations. The eighth is connected to output jack J1 on the front panel of the distribution amplifier. Output jack J2 (for phones) is permanently connected to the VU meter and eight-position switch for monitoring the signal going to each shop location. The eight-position switch allows checking each shop location from the front panel for proper audio. The indication that all is well is obtained on the VU meter, which is also used to set the outgoing signal to a predetermined satisfactory level. J3 is

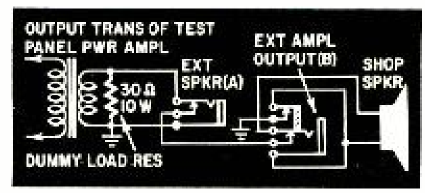


Fig. 3—Bench panel is one of three at repair benches for troubleshooting, repair, and calibration of recorders and components. Due to gradual development this panel has a few extra jacks not required in a new panel. Similar to main test panel at front of shop, repair bench panels allow more precise measurement and test procedures.

an input jack, which permits any other signal source to be fed into the distribution amplifier. This jack is a break type, so the insertion of a phone plug interrupts the normal connection from the FM tuner.

The distribution amplifier front panel also contains pilot lights, power switch and fuses for both ac and B-plus.

Bench panels

At each of three repair benches there is a bench panel (photo, p. 69) with a complete amplifier, including controls, preamplifier and a variety of jacks and switches for the convenience of the repair technician. This bench panel is capable of accomplishing most of the functions which the main test panel can, (out front at the customers' counter) and also provides several facilities not available at the front-of-the-store panel.

The bench panel has five controls. Four of them are conventional controls, bass, treble, volume and input selector (tape head, magnetic or crystal-ceramic dics pickup, tuner and other medium-level signals) while the fifth control is a selector for choosing various output transformer taps. There is a closed-circuit jack marked "speaker" which the technician may plug into should he wish to use the bench speaker which is normally driven by the bench panel amplifier. This would be useful in testing a customer's amplifier.

The bench panel has a jack which makes the output of the bench panel amplifier available for testing the customer's speaker or the built-in speaker of a tape recorder, portable phonograph or other complete unit.

The bench panel also has three jacks which make a pad available for reducing the line output by specific amounts (35 and 50 db) for checking low-level high-gain channels such as microphone or tape-recorder preamps. There are three paralleled jacks which are the output of the distribution amplifier (main test panel out front). They are paralleled so the technician may use that program for more than one purpose at a time.

Finally, there are two sets of paralleled jacks, three per set. These make

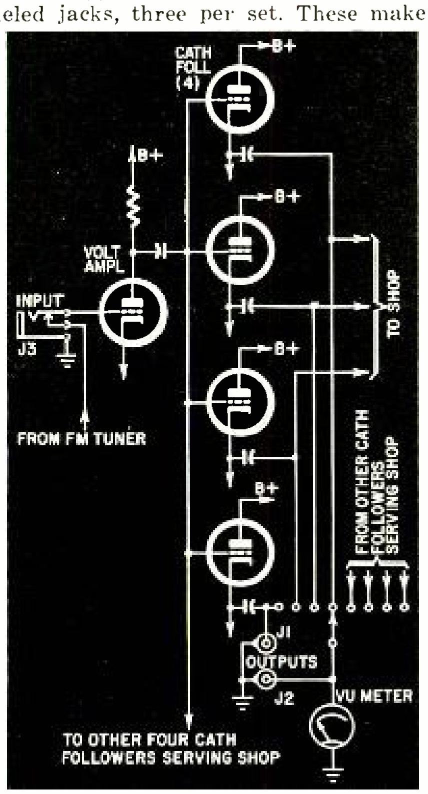


Fig. 4—Simplified schematic of distribution amplifier. Consult text.

it convenient to plug patch cords through the parallel jacks for making connections. This eliminates many of the universal adapter cords otherwise necessary for patching up temporary test setups, and provides a much neater way of plugging things together. It also helps keep the bench clear.

There's also a 1,000-cycle test tone signal at about 1.5 volts available at one of the jacks. This tone comes from the main test panel, too.

In addition to these controls and jacks, this bench panel has an on–off switch and a pilot light. In the photograph shown there are 21 jacks and 6 controls. Without sacrificing much flexibility, there could have been as few as

15 jacks and 5 controls. They are here because of special circumstances in the construction of this particular bench panel, and are not included in the other two panels.

Underneath the front bench are screw-in circuit-breaker type fuses for the ac lines. Although these cost a little over a dollar apiece, they save time and expense, considering the number of shorts occurring in customer equipment.

Cables

Two kinds of cables are used for access to the test panel, *patch* cables and *adapter* cables. The patch cables have a phone plug at each end and are used to make connections between the various jacks on the test panel. Five of these patch cables are color-coded to correspond with the colored counter and panel jacks, and one end of each patch cable is left in the panel jack of the same color.

The adapter cables allow the customer's equipment to be plugged into counter jacks. One end of each cable has a 3-circuit phone plug, while the other end may have any one of a number of connectors required to make connections to equipment brought in for service. Sigma's adapter cables include those terminating in an RCA type phono plug, in a Cannon plug such as used in certain professional tape recorders, in a pair of alligator clip leads, in banana plugs, in a five-prong speaker plug, in a six-prong speaker plug, in a plug fitting an octal socket and in pin tips. All unbalanced connectors have separate grounded shields available with alligator clips attached.

Miscellaneous other cables are kept on hand. These include a twin lead with a plug fitting the bench TV socket at one end and a clothespin connector (for screw terminals) at the other; an adapter cable for TV purposes, with a plug fitting the bench TV socket at one end and a socket matching a wall type TV antenna plug at the other; TV cheater cords; an ac extension cord with a small molded ac socket such as used in several brands of tape recorders, and an ac cord with a standard ac plug at one end and well insulated alligator clips on the other.

Typical test setups

To clarify the use of the test panel, the counter jacks and various cables, let's consider several typical instances in which a piece of audio equipment is to be checked.

Assume that a customer brings in a record changer which produces no sound. The cable from the changer terminates usually in an RCA phono plug. A Switchcraft adapter, combining a phono socket and phone plug, permits the cable to be plugged into one of the counter jacks, say the black one. The changer has a ceramic cartridge. The black patch cable is connected from the black panel jack to the input jack marked High Level 1 on the control power amplifier.

The technician makes certain that the

function switch is in position 1, so that this input is operative. Thus the record changer is connected to the control power amplifier and, in turn, to the shop speaker. A record is taken from a rack, put on the changer, and the test is on. If there is indeed no sound, the technician makes a quick check of the cable connection by pulling out the Switchcraft adapter from the bench jack, which should produce a click.

Assume that a tape recorder is brought in, one of the usual home variety with a self-contained power amplifier and speaker. This requires only a signal source. One of the color-coded patch cables, say the white one, is connected from the white panel jack to output jack 1 on the distribution amplifier, which provides the FM tuner signal. In turn, an adapter cable is connected from the white counter jack to the radio (high-level) input of the tape recorder through a suitable cable, thus feeding in the FM signal. A reel of tape and an empty reel are taken from a rack and placed on the tape recorder, a recording is made, and the tape is then played back, providing a check of the machine's performance. If the complaint concerns only the playback performance of the recorder, then a prerecorded tape is played on the machine. However, this does not involve the use of the test panel.

At this point it may be brought out that both customers just described could be served simultaneously inasmuch as the record changer is feeding a signal *into* the test panel and shop speaker, while the tape recorder is being fed a signal *from* the test panel. If a third customer came in with a tape recorder, he too could have his equipment checked at the same time without having to wait for the panel facilities to be released. Although this is an unlikely situation, it illustrates the versatility of the test panel. The third customer's tape recorder would receive the FM signal in the same manner as the other recorder, except that another set of counter and panel jacks, say red, would be used, and the FM signal would be picked up from output jack 2 of the distribution amplifier.

Assume that a customer brings in a professional tape recorder, one with separate record and playback heads and which does not have its own power amplifier and speaker. In this case, the testing requires both a signal fed into the machine and an amplifier for the signal fed out of it, bearing in mind that a three-head recorder permits simultaneous record and playback. A patch cable, say yellow, would connect the yellow panel jack to J1 (or J2) of the distribution amplifier to pick up the FM signal. The FM signal would then be fed from the yellow counter jack to the recorder by an adapter cable. The recorder output would go via an adapter cable to, say, the green bench jack, and then from the green panel jack via patch cable to one of the high-level inputs of the control power amplifier, say jack C, thereby feeding the recorder's signal into the control-power amplifier and then to the shop speaker.

As a final example, let us say that a customer brings in a power amplifier for a checkup. Again this requires a signal and an amplifier. An adapter cable connects the input of the power amplifier to, say, the black counter jack, and the black panel jack is connected by patch cable to distribution amplifier output (J1). The output of the power amplifier is connected by an adapter cable to, say, the white bench jack, and the white panel jack is connected by the white patch cable to jack B of the control power amplifier, marked "loudspeaker." When the phone plug of the patch cable is inserted into jack B, the customer's amplifier replaces the test-panel power amplifier, as was shown at bottom of page 69.

This test panel has met the challenges of time and use. It has proven itself a rapid, flexible means of checking equipment both before and after repair. It also impresses customers with the fact that they are dealing with an efficient, capable service organization.

Although the test panel is not overelaborate in view of the volume of customer traffic handled, still it might well exceed the needs and budget of the small shop. However, there is much that can be done to cut down the test panel and associated elements in size and cost without losing basic advantages. A substantial reduction can be effected by eliminating the distribution amplifier and feeding signals directly from the FM tuner to the control power amplifier via one of the latter's high-impedance inputs. The number of bench panels can be reduced from three to one. The colored-coded bench jacks and panel jacks can be reduced from five to three. The phono outputs can be reduced from two to one. And so forth. Despite these economies, the test panel will prove itself a profitable tool for the high-fidelity service shop. END

FM MULTIPLEX IN ENGLAND

FROM the research laboratories of Mullard Radio in Great Britain comes another system for FM stereo multiplexing—putting two channels of audio information on one FM transmission channel. It claims one important advantage—the FM receivers used to pick up the program material are only slightly more complex than standard sets. Of course, they do require a second audio amplifier and speaker.

The Mullard system was developed by G. D. Browne and is completely compatible with existing FM transmission. A monaural set tuned in to the new system gets a first rate monaural FM program. On the other hand, a stereo FM receiver also gets a good monaural program when tuned in to standard broadcasts.

The stereo system is described as a two-channel pulse-amplitude time-multiplex arrangement. It works by coding the two channels of stereo information just before the transmitter is modulated.

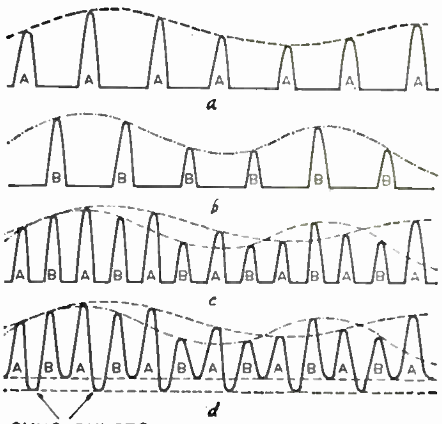
A sampling oscillator produces a 32.5-kc sinewave which divides into two sine-wave outputs that are out of phase. These outputs are fed through a half-wave rectifier to produce two sets of pulses—one set for the right channel (A) the other set for the left channel (B). These pulses are modulated by the audio signal in their respective channels and give us the waveforms shown in Figs. 1-a and 1-b. Next these two sets of modulated pulses are combined to form the signal shown in Fig. 1-c. As a final step before being sent on to modulate the transmitter, sync pulses are added as in Fig. 1-d.

The receiver, of course, has the task of separating the two signals to form the two stereo channels. First, the incoming signal is detected in the usual manner, resulting in a signal that looks like Fig. 1-d again. The sync pulses which were added to the signal just before transmission phase lock a 32.5-kc oscillator that separates the A and B signals and passes them on to their respective audio amplifiers.

The result of this process is a good stereo FM program. Crosstalk between channels is 45 db down, insuring complete separation between channels. This is especially useful in countries where the two channels might be used to carry the same program, but in different languages.

Existing receivers can be easily modified for use with the Mullard system. The set is used as is, up to the output circuit of the audio detector. At this point two tubes (a triode and a duo-pentode) are added. The triode is used as the receiver's 32.5-kc oscillator while the dual pentode forms the decoder circuit. The pentode outputs are connected to the audio amplifiers that drive the two stereo speakers.

Mullard claims clear-cut stereo with a frequency response up to 15,000 cycles in both channels, low cost, and most important, complete compatibility. END



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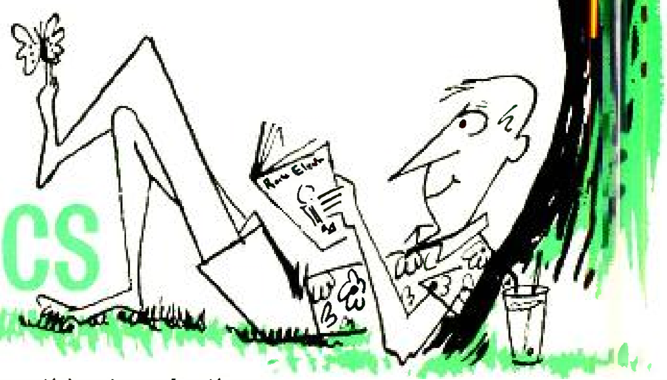

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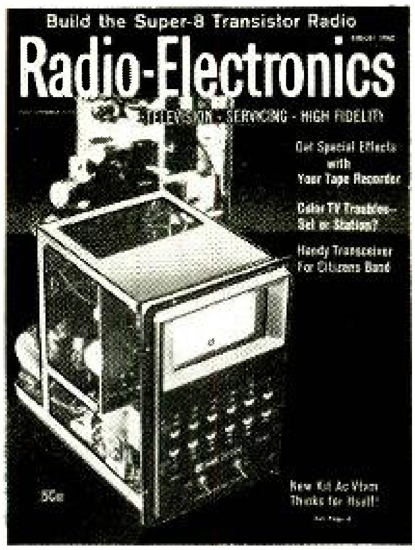

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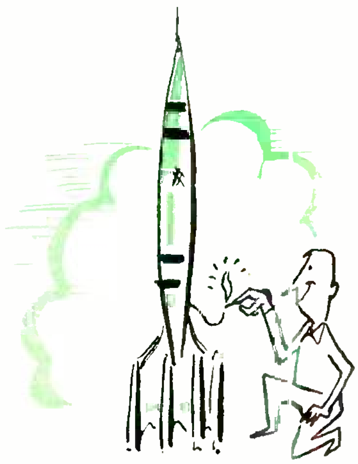

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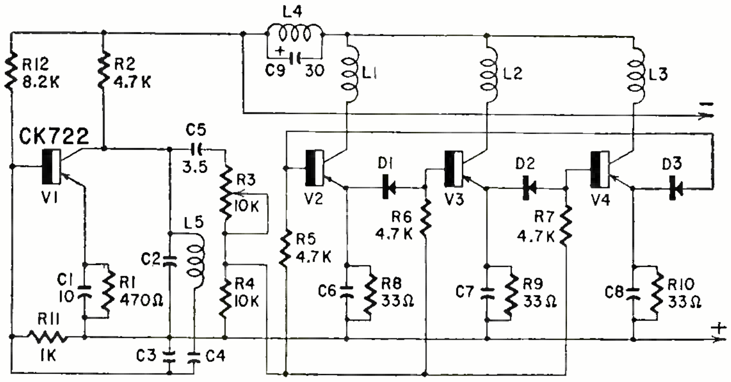
AUDIO—HIGH FIDELITY



L1, L2, L3, L4—Selsyn windings: L4 is the field and L1, L2, L3 are armature windings (see text)

C2, C3, C4, L5—Determine speed of motor. Common wire for L1, L2 and L3 is internal connection and selsyn must be disassembled to retrieve it.

Fig. 6—Three-phase power supply drives surplus selsyn.

C5 is adjusted for minimum ac voltage at V4's collector. Finally, when the amplifier is working, adjust C8 for bias according to the head manufacturer's specifications.

The oscillator transformer, which is hand-assembled, is a toroid wound on an Arnold A-066032-2 core obtainable from Arnold Engineering (610 E. Palisade Ave., Englewood, N. J.). Fig. 5-a shows how the coil is wound. Although it is very simple, be careful with the physical coil positioning. The close coupling of L1 to L2 and L3 is necessary and prevents distortion, and a coil modification may not produce an oscillator. Some 2N188-A's may require R17 to be larger than the value shown, whereas others would be burned up with this setting. If the bias oscillator is dead, check and recheck the coil polarities and then increase the value of biasing resistor R17.

At present, the toroidal core (89c each) is available only on a $10 minimum order. If you would rather use a less expensive cylindrical core, use a Miller 22A000RB1 or a Miller 6210 TV horizontal oscillator ringing coil with the coil removed. This cylindrical configuration is difficult to wind and may lead to insufficient recording bias with some heads. However, it will work.

Before any adjustment is made to the completed amplifier, the record head must be properly biased according to the manufacturer's specifications. All three resonant circuits must be tuned to the same frequency if the amplifier is to work at all. If the bias is still low after the adjustments, L4 may be increased. Like the playback amplifier, C2, C4, C6, and R13 are matched to the head to get flat response. Fortunately, these adjustments are straightforward.

Selsyn motor and power supply

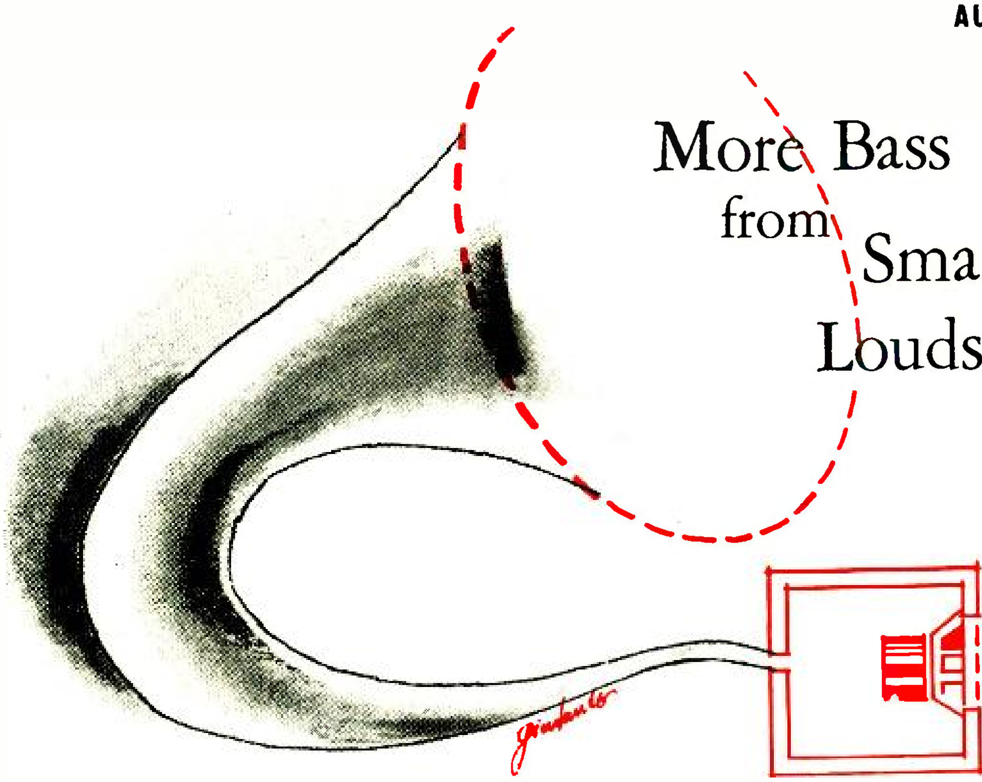
Small battery-operated recorders and phonographs have real motor problems. Small dc motors are not readily available, have low efficiency and do not operate at a constant speed. Often, hand-cranking the capstan will produce less wow and flutter than these motors. A few manufacturers are producing governor-controlled motors. General Industries markets such a motor in their battery-operated turntable. Unfortunately, the governor plays havoc with the reproduce amplifier, causing much popping and static which must be filtered and shielded.

A very common war surplus Bendix Autosyn costing about $3 is constructed like the huge three-phase industrial synchronous motors. It has a Y-connected armature winding, which is the stator, and a rotating field winding and is started like some induction motors by shorting the field winding. This motor easily pulls tape at 3.75 ips, drawing less than 40-ma current at 9 volts.

No special phase-shifting circuits are needed to get three-phase power. A simple trinary ring counter (Fig. 6) fed from an oscillator of three times the fundamental frequency powers the motor. Transistors V1, V2 and V3 in the three-phase supply circuit switch on in succession, simulating a three-phase square wave in motor windings L1, L2, and L3. Field winding L4 is in series with the collector supply and is excited by the motor current. V1 is in a standard Colpitts oscillator driving the ring counter.

Not all the component values for the three-phase supply are indicated. They depend upon the types of selsyns used and how they are loaded. They are easy to determine and their omission prevents beginners from running up a large transistor bill resulting from improper operating points. The emitter parallel R-C circuit has a time constant roughly one-fourth the period of the three-phase fundamental. The diodes steer the driving pulse from the transistor previously switched to conduction to the next one. Thus the voltage across the emitter resistor must be just high enough to let the following transistor switch on and not be blocked through the interconnecting diode. If you are moderately careful with the design, this synchronous motor configuration will behave like the costly ones, but will be more efficient.

The completed machine opens a new world of rallies, concerts, movie sound effects and fun almost impossible to enter with heavy machinery. END



More Bass from Smaller Loudspeakers

Part I—Don't be confused by the trend toward miniaturizing the loudspeaker and enclosure. This two-part article explains the operating principles of most of them

By **NORMAN H. CROWHURST**

THE popularization of hi-fi has made it increasingly desirable to get big bass from little speakers. But certain sound-propagation considerations indicate that a speaker must have a size inversely proportional to the lowest frequency it is expected to reproduce. However, the commercial urge has resulted in quite big-sounding bass coming from astoundingly small boxes.

There seem to be several ways of doing it, and the variety in the field has led to some confusion about the methods used. So here is an attempt to sort out this confusion. Three aspects of the problem appear:

1. Coupling the transducer so it can move enough air at these low frequencies without running into distortion.
2. Arranging for it to operate over a range of frequencies with as near as possible uniform efficiency.
3. Any moving diaphragm has two sides: do we utilize sound waves from both sides or only one of them?

Elaborating on these points a little: The first means we want to find a way, if possible, of moving a lot of air with a small diaphragm movement, because large mechanical movements are difficult to achieve without distortion. The alternative is to work from the other end, and get the big movement without distortion but obviously this is much more difficult.

It may be relatively easy to get large air movement for a small drive, by using resonance, which is what an organ pipe does. But we do not want all low frequencies, regardless of original source, to sound like an organ pipe; all frequencies *within a range* should be reproduced accurately and uniformly.

Second, any diaphragm has a resonant frequency due to the compliance (or springiness) of its suspension acting with its mass (or weight). Without being enclosed in any way, it will move most readily at this frequency. But the acoustic loading that the enclosure provides can control this, rendering the radiation efficiency practically constant over a range of frequencies. The point to watch is how the method of enclosing it influences the frequency range of the complete loudspeaker, as compared to its free-air resonance.

The low frequencies are radiated by big waves—much bigger than most of the loudspeaker units used to reproduce them (although the complete enclosure may be big). When the diaphragm moves forward, it momentarily produces pressure at its front and rarefaction behind it. Something has to be done to stop these two effects from cancelling before a wave is radiated.

This is the third question: Some ways use only the radiation from one side of the speaker and "lose" the other, while others find a way of turning the "phase" of one so it augments the other, instead of cancelling (at low frequencies, where it is needed).

To get the clearest possible picture of how the different methods work, we will start here and see first how the well-tried types achieve their objective, following on with the newer smaller types to see what they do.

Horns

These work by carefully controlling the propagation of the sound wave for several wavelengths (of the lowest frequency) from the loudspeaker diaphragm until it reaches the air (Fig. 1). The horn allows an intense sound wave at its throat to develop gradually into a big-volume wave at its mouth. But to do this the horn's expansion has to be very gradual (following an exponential or some similar "law" or growth rate), and it has to finish up rather more than a half wavelength long across the mouth.

Because of the high intensity of the sound wave "loaded" onto the active side of the diaphragm, which has the property of an acoustic "resistance" (at all frequencies above horn "cutoff"), the free-air diaphragm resonance is well controlled and usually does not show up at all. Also the opposition to motion produced by the horn throat is much greater than that on the other side, so the speaker delivers practically all its work into the horn. Little sound comes from the free side, and it can be left open or protected by a cover with a vent in it.

But a horn for low frequencies gets

(*Continued on page* 86)

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(*Continued from page* 81)

very big. True, it can be folded, so the narrower section is accommodated in space around the mouth area, but the mouth must still be big and the "development" requires considerable volume.

Another thing about horns: their smoothness of performance—which a good one invariably has—is dependent on the gradual expansion being continued right on after the sound leaves the horn. A horn in the middle of a room loses most of its smoothness, because of the abrupt change the wave finds when it leaves the mouth. To get the best out of a horn, it should be placed in a corner, so the room walls continue the effective horn mouth contour.

Even this is an idealization (for most listeners): the ideal corner should be *the only corner in the room*. The wave should leave the horn mouth and keep going, indefinitely. But most rooms have four sides, a floor and a ceiling, which block this indefinite progress of the wave. Even so, a horn takes a lot of beating in the larger rooms.

A horn has an acoustic cutoff frequency—related, not to any resonance effect, but to sound propagation—below which it fails to couple the sound waves from the diaphragm to the air at the mouth. This means the air load on the diaphragm disappears below this frequency, and some measure is advisable so that such low frequencies do not reach the speaker from the amplifier.

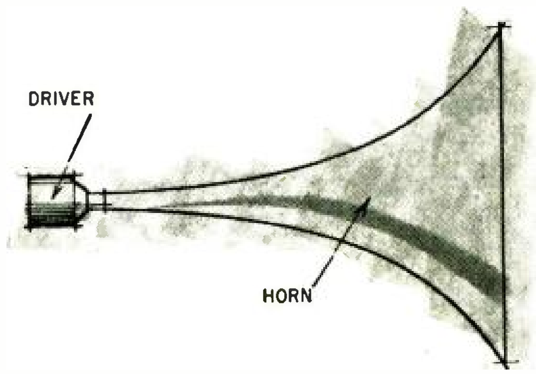


Fig. 1—The horn is relatively large compared to wavelength of lowest frequency it must radiate.

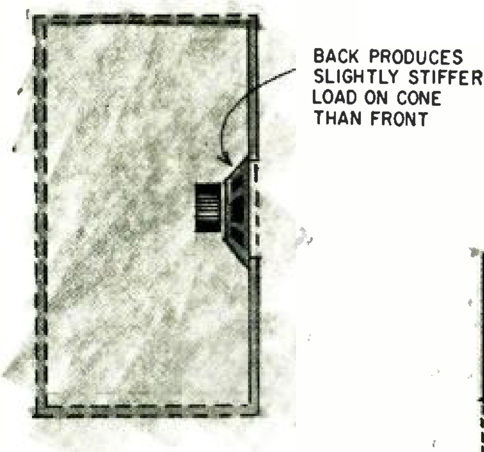


Fig. 2—An "infinite" baffle is merely a large box shutting in the speaker's rear.

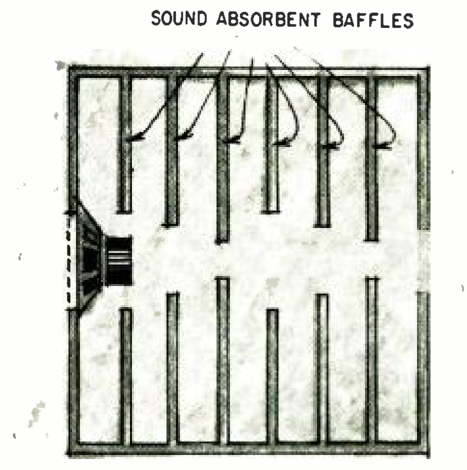
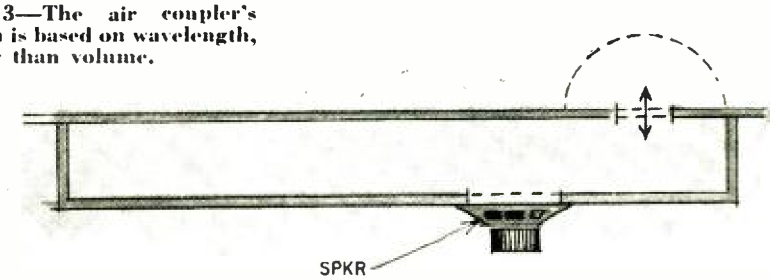


Fig. 4—Boffle is another way to eliminate back radiation.

Fig. 3—The air coupler's length is based on wavelength, rather than volume.



"Infinite" box baffle

This idea may seem rather crude to a horn man. It is simply a baffle, such as was originally used to extend the edges of the unit, brought around to enclose the back completely (Fig. 2). To be truly infinite, the box on the back needs to be infinitely large. In this hypothetical case, the loudspeaker unit radiates equally on both sides, but one side is totally enclosed in a box, while we listen to the other side. So only half the speaker's acoustic output is used.

A practical "infinite baffle" uses a box of *finite* size. The size chosen is such that the ideal is not departed from to any great extent. This has the effect of making the speaker do a little more work in compressing the air inside the box than it does in radiating sound from the front. Also the air in the box acts as an additional "spring" on the diaphragm, which raises the speaker's resonant frequency slightly.

The mechanical Q of the loudspeaker is determined by several contributing factors: amplifier damping; efficiency of the conversion of electrical into acoustical power; any mechanical resistance due to viscosity in the suspension (which has to be built in), and any acoustic resistance due to "stuffing" put into the box.

With a struggle, the resonant boom can just about be held down by all these means acting together. Then the low-frequency roll off occurs immediately below the resultant resonant frequency (speaker unit *in its box*), at a rate that is basically 12 db per octave, like an L/C high-pass filter.

So if we start with a speaker resonance of 70 cycles and the enclosure pushes this up to 90 or 100, the complete system falls off at 12 db per octave below this; will be about 12 db down at 50 cycles, 24 db down at 25 and 28 db down at 20. How can we get the response down lower? More of this anon. But whereas the horn's range depends mainly on its "acoustical dimensions," the infinite baffle is basically limited by the resonance of the unit driving it.

Air coupler

Another development that appeared some years ago was the air coupler. This utilized propagation principles to change the characteristic acoustic impedance (Fig. 3). The back of the speaker was free. Without the coupler between, half the energy would be radiated from both sides. But at the lowest frequency the coupler is a quarter-wavelength long, so the "free" effect of the tube opening into the room is converted into a "stiff" mass of air at the speaker diaphragm. In this way, it uses all its energy pushing the air in the tube and very little gets out the back.

Setting the quarter-wavelength frequency at the speaker resonance effectively loads the resonance out of existence. Careful design is needed to avoid undesirable effects at higher frequencies, where the same tube is successively half, three-quarters and more wavelengths long. The principal limit to this idea's useful application seems to be that it is essentially a built-in type, not just simply a piece of furniture.

Boffle

Mr. Hartley's Boffle ("box baffle") achieves a similar objective by a different method (Fig. 4). The back of the speaker is basically free, but it differs from the horn or air coupler in that the front feeds sound out direct, while the back is "treated" so its sound is absorbed instead of coming around to cause interference. The back of the cone meets air that is rendered extra "free" in this case, allowing the work to be done in front.

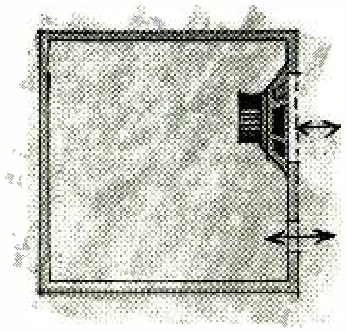


Fig. 5—Bass reflex is first attempt at radiation from front and back of cone.

The horn and air coupler use different kinds of loading on the front; the back is just normally free, by not being so loaded. The infinite baffle and the Boffle feed the wave directly from the front, in the first case loading the back with the box (which reduces efficiency) and in the second case making it extra free (which may slightly increase efficiency). In neither of them is motion of air from *both sides* used.

Bass reflex

This was the first type which attempted to use the motion at the back, instead of getting rid of it somehow. The enclosure contains a port (Fig. 5), of controlled dimensions, so the weight (technically called mass) of air moving back and forth in the port is about equal to that of the speaker diaphragm. This way, at resonant frequency, the air in the box is alternately compressing and rarefying, while the motion at both diaphragm and port is *in phase*.

This means, *at this particular frequency* (below which the system "drops dead" at about 18 db per octave), about twice as much air is moved to form a sound wave, for the same diaphragm movement. At higher frequencies, the air in the box absorbs the back radiation just like the infinite baffle. The common practice is to design the box and port dimensions to have about the same resonance as the speaker unit, so it loads down this primary resonance, much as the air coupler did.

This method produces two secondary resonance effects, rather like an overcoupled circuit in radio, resulting in a peak below and above the basic resonance frequency. Various methods have been adopted to level these resonances, such as the acoustic resistance unit introduced by Goodmans, which improved the performance of the bass-reflex type, eliminating the boom from the "boom-box."

Back-loaded horn

Although the horn protagonists won't like this, there are certain similarities between the bass-reflex and the back-loaded horn that make the comparison useful. As in the bass reflex, the higher frequencies are radiated directly from the front, and their back radiation is absorbed in the box directly behind the cone (Fig. 6). Below a certain frequency set by the acoustic crossover, the volume of this box, coupling the horn to the back of the diaphragm, ceases to absorb in this way and causes the horn to load the back more than the front. In this range the unit behaves like any other horn.

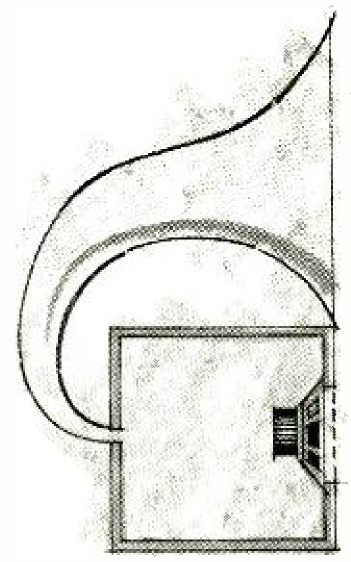


Fig. 6—Back-loaded horn radiates front of speaker for high end, horn for low end.

So the back-loaded horn radiates from the front above acoustic-crossover frequency and from the back below it. Its low-frequency cutoff is governed, as in the simple horn, by the horn's dimensions. It differs from the bass reflex in that the point where back and front both contribute is at the acoustic-crossover frequency, which is well above the lowest frequency radiated, and in that the speaker resonance is relatively unimportant.

Like any other horn, it needs placing in a corner. The corner location does help to camouflage the size of a horn. While the horn protagonist will tell you "you can always find a corner—or two for stereo," my experience with American living rooms says that corners are not always *conveniently* available. And the best of the alternative types, infinite baffle and bass reflex, can give good low-frequency performance in a practical comparison at an economy in size.

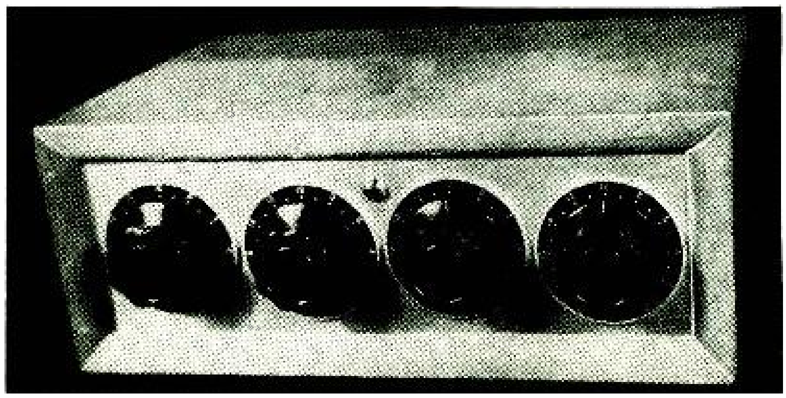
So far we have studied early steps toward smaller enclosures. Next month we will look at acoustic suspension, duct-loaded reflex, variable mass and other methods of reducing enclosure size.

TO BE CONTINUED

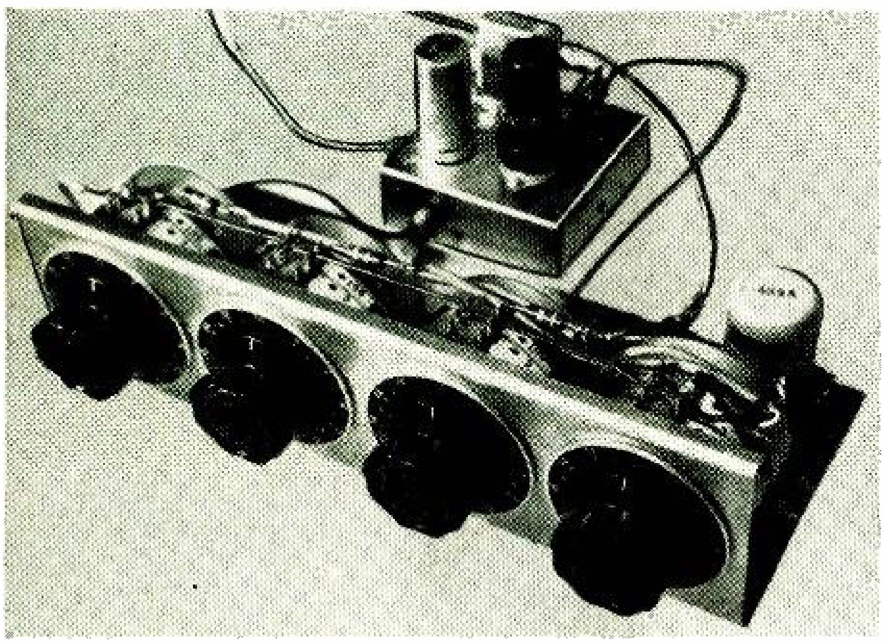
MIXING and MATCHING To AUDIO INPUTS

Use the proper circuit and you can connect 500–600-ohm lines, low-impedance microphones and multiple low-impedance sources to an amplifier's or recorder's high-impedance input

By HAROLD REED



The mixer diagrammed in Fig. 5.



Four T-attenuators, a single transformer and four resistors are all you need inside the mixer's case.

MANY hi-fi enthusiasts and audio hobbyists have tape recorders and audio amplifiers that have only a single input channel for microphones, tuners, etc. This input channel is usually of unbalanced (one side grounded) high-impedance design.

You want to feed several audio sources into this recorder or amplifier simultaneously, or have it handle low-impedance inputs. Several useful methods for doing this are discussed in this article. First let us consider how we can use a low-impedance source such as a 50- or 250-ohm microphone with such an amplifier.

What we need is some kind of matching circuit between the two devices. An

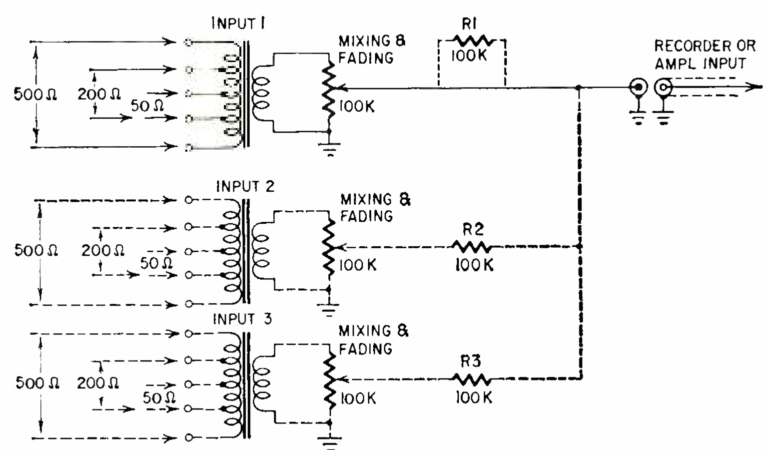


Fig. 1—Input transformers are best for matching low-impedance sources to a high-impedance input.

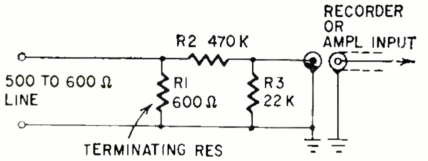


Fig. 2—Transformerless network matches 500–600-ohm line to amplifier input.

input transformer is best for this purpose, as shown in Fig. 1. Use a transformer that provides several input impedances. Miniature and subminiature transformers are also satisfactory. A volume control connected across the transformer's secondary provides mixing and fading facilities. Additional inputs with transformers and mixing–fading controls are shown in dashed lines and may be added as required. The 100,000-ohm resistors are isolating units and make interaction between the circuits negligible.

Line to high impedance

If you want to connect a 500–600-ohm line to the recorder's or amplifier's high-impedance input, try the transformerless circuit shown in Fig. 2. The line is terminated with a 500- or 600-ohm resistor, R1, which is then bridged with the resistive input R2, R3. Values for R2 and R3 are selected to provide the proper signal voltage to the input.

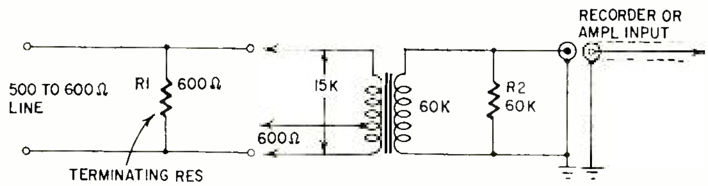


Fig. 3—For balanced matching of line to high impedance try this arrangement.

If R2's value is increased, there is a greater voltage drop across it and less voltage at the high-impedance input; decreasing R2 results in a lower voltage drop and greater signal voltage at the high-impedance input of the recorder or amplifier. If the signal voltage from the low impedance source is too low, R2 and R3 can be eliminated. This circuit, of course, unbalances the source.

Where the low-impedance line's balance must be maintained, a line-to-grid transformer should be used (see Fig. 3). The line may be terminated in an appropriate resistance and then bridged with the high-impedance tap of the transformer. This will allow several amplifiers, with high-impedance input transformers, to be bridged across the line without causing appreciable loading or mismatch. To get proper termination and correct matching for a single amplifier input, connect the line to the 600-ohm tap on the primary instead of the high-impedance tap. Of course, if you do this a 500–600 ohm terminating resistor is not needed.

To feed a 500–600-ohm line to the recorder or amplifier input without changing the signal magnitude appreciably or unbalancing the line, a 1-to-1 impedance ratio transformer provides isolation without attenuation. See Fig. 4 for the circuit.

Low-impedance mike

A convenient method for feeding a single, low-impedance microphone into a high-impedance input is to use a microphone cable transformer which has a primary tapped for 30–50 and 200–500 ohms and a secondary designed to work into a tube's grid circuit. Keep the cable on the transformer's secondary side as short as possible to minimize hum pickup. Any reasonable length of cable can be used on the low-impedance side. Use shielded cable with the shield carried straight through from the low-impedance microphone to the high-impedance input's ground.

Four-channel mixer

We would often like to feed several low-impedance microphones or lines to the audio system's high-impedance input and at the same time avoid the cost of the three or four input transformers used in Fig. 1. Several mixing circuits can be used, but one of the most satisfactory is the series-parallel system shown in Fig. 5. It lets you ground each channel, preventing hum pickup and cross-talk. Also the insertion loss for as many as four channels is only 6 db. The circuit shown is intended for four 250-ohm inputs using T-attenuators. For other impendances, determine the proper component part values with the following formulas:

The value for resistors R2 is equal to R(N − 3)/N, where R is the input impedance (250 ohms in Fig. 5) and N the number of inputs or channels (4 in Fig. 5). The output impedance, R_o, is equal to $4R(2N - 3)/N^2$, where R and N are equivalent to the values in the foregoing formula and N^2 is the number of channels squared. Parts values are included in the circuit. These values are given as derived from the equations. They are not so critical that they must be exactly as shown. Some standard value close to these figures will do.

The transformer in Fig. 5 is a low-impedance line-to-grid type. Its voltage stepup helps make up for the mixer insertion loss and with some audio systems it may be possible to connect the mixer directly to the recorder or amplifier input.

If there is not enough output from the mixer, you can insert a voltage amplifier after transformer T. If you use a standard preamp for this, any phono equalizing resistors should be removed.

When laying out and wiring any of the circuits discussed in this article, follow the usual construction techniques for shielded cable and for proper grounding. END

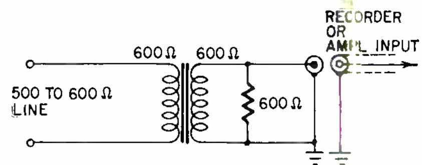


Fig. 4—Little attenuation and balanced matching are the features of this simple circuit.

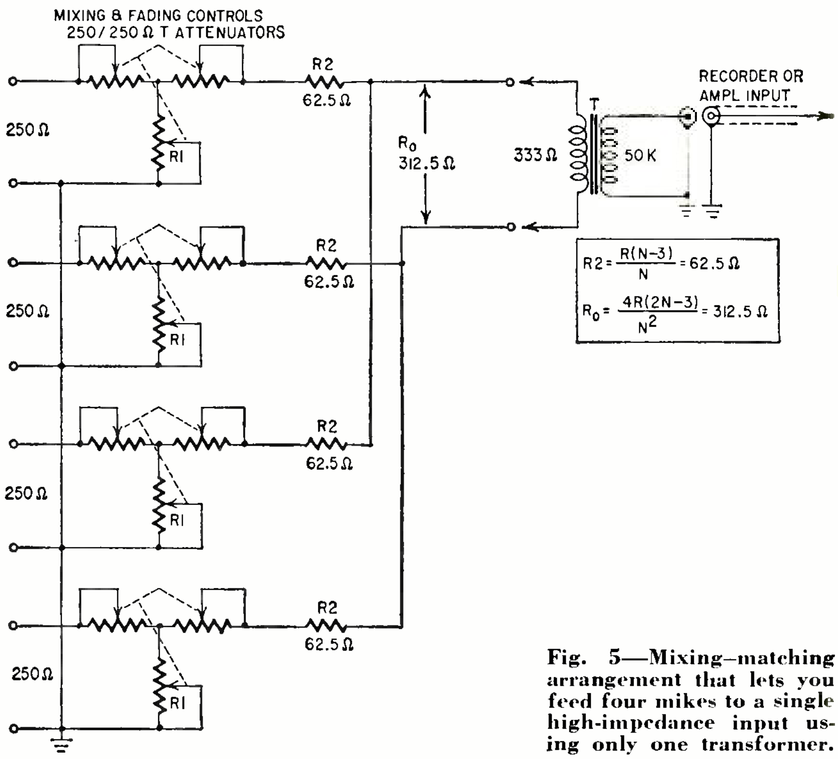


Fig. 5—Mixing–matching arrangement that lets you feed four mikes to a single high-impedance input using only one transformer.

SUPERIOR'S NEW MODEL 77

VACUUM TUBE VOLTMETER

WITH NEW 6" FULL-VIEW METER

Compare it to any peak-to-peak V.T.V.M. made by any other manufacturer at any price

Model 77 — VACUUM TUBE VOLTMETER ... Total Price $42.50—Terms: $12.50 after 10 day trial, then $6.00 monthly for 5 months if satisfactory. Otherwise return, no explanation necessary!

- Model 77 completely wired and calibrated with accessories (including probe, test leads and portable carrying case) sells for only $42.50.
- Model 77 employs a sensitive six inch meter. Extra large meter scale enables us to print all calibrations in large easy-to-read type.
- Model 77 uses new improved SICO printed circuitry.
- Model 77 employs a 12AU7 as D.C. amplifier and two 9006's as peak-to-peak voltage rectifiers to assure maximum stability.

AS A DC VOLTMETER: The Model 77 is indispensable in Hi-Fi Amplifier servicing and a must for Black and White and color TV Receiver servicing where circuit loading cannot be tolerated.

AS AN AC VOLTMETER: Measures RMS values if sine wave, and peak-to-peak value if complex wave. Pedestal voltages that determine the "black" level in TV receivers are easily read.

AS AN ELECTRONIC OHMMETER: Because of its wide range of measurement leaky capacitors show up glaringly. Because of its sensitivity and low loading, intermittents are easily found, isolated and repaired.

- Model 77 uses a selenium-rectified power supply resulting in less heat and thus reducing possibility of damage or value changes of delicate components.
- Model 77 meter is virtually burn-out proof. The sensitive 400 microampere meter is isolated from the measuring circuit by a balanced push-pull amplifier.
- Model 77 uses selected 1% zero temperature coefficient resistors as multipliers. This assures unchanging accurate readings on all ranges.

SPECIFICATIONS

• **DC VOLTS**—0 to 3/15/75/150/300/750/1,500 volts at 11 megohms input resistance. • **AC VOLTS (RMS)**—0 to 3/15/75/150/300 750/1,500 volts. • **AC VOLTS** (Peak to Peak)—0 to 8/40 200/400/800/2,000 volts. • **ELECTRONIC OHMMETER**—0 to 1,000 ohms/10,000 ohms/100,000 ohms/1 megohm/10 megohms 100 megohms/1,000 megohms • **DECIBELS**—10 db to + 18 db, + 10 db to + 38 db + 30 db to + 58 db. All based on 0 db = .006 watts (6 mw) into a 500 ohm line (1.73v).

• **ZERO CENTER METER**—For discriminator alignment with full scale range of 0 to 1.5/7.5/37.5 75/150/375 750 volts at 11 megohms input resistance.

Model 77 comes complete with operating instructions, probe and test leads. Use it on the bench—use it on calls. A streamlined carrying case, included at no extra charge, accommodates the tester, instruction book, probe and leads. Operates on 110-120 volt 60 cycle. Only.. **$42.50 NET**

Superior's New Model 80

20,000 OHMS PER VOLT ALLMETER

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Model 80 — ALLMETER ... Total Price $42.50—Terms: $12.50 after 10 day trial, then $6.00 monthly for 5 months if satisfactory. Otherwise return, no explanation necessary!

- **6 INCH FULL-VIEW METER** provides large easy-to-read calibrations. No squinting or guessing when you use Model 80.
- **MIRRORED SCALE** permits fine accurate measurements where fractional readings are important.
- **CAPACITY RANGES** permit you to accurately measure *all* condensers from .00025 MFD to 30 MFD in addition to the standard volt, current, resistance and decibel ranges.
- **HANDSOME SADDLE-STITCHED CARRYING CASE** included with Model 80 Allmeter at no extra charge enables you to use this fine instrument on outside calls as well as on the bench in your shop.

NOTE: The line cord is used only for capacity measurements. Resistance ranges operate on self-contained batteries.

• A built-in Isolation Transformer automatically isolates the Model 80 from the power line when capacity service is in use.

• Selected, 1% zero temperature coefficient metalized resistors are used as multipliers to assure unchanging accurate readings on all ranges.

SPECIFICATIONS:

7 D.C. VOLTAGE RANGES: (At a sensitivity of 20,000 Ohms per Volt) 0 to 15 75/150 300 750 1500/7500 Volts.
6 A.C. VOLTAGE RANGES: (At a sensitivity of 5,000 Ohms per Volt) 0 to 15/75 150 300, 750/1500 Volts.
3 RESISTANCE RANGES: 0 to 2,000/200,000 Ohms. 0-20 Megohms.
2 CAPACITY RANGES: .00025 Mfd. to .3 Mfd., .05 Mfd. to 30 Mfd.
5 D.C. CURRENT RANGES: 0-75 Microamperes. 0 to 7.5/75/750 Milliamperes, 0 to 15 Amperes.
3 DECIBEL RANGES: — 6 db to + 18 db, + 14 db to + 38 db, + 34 db to + 58 db

Model 80 Allmeter comes complete with operating instructions, test leads and portable carrying case. Only .... **$42.50 NET**

GENOMETER

7 Signal Generators in One!

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

- ***R.F. Signal Generator for A.M.***
- ***R.F. Signal Generator for F.M.***
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- ***Bar Generator***
- ***Cross Hatch Generator***
- ***Color Dot Pattern Generator***
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A versatile all-inclusive GENERATOR which provides ALL the outputs for servicing:

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

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

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

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

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

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

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

$47.50 NET

EXAMINE BEFORE YOU BUY!

USE APPROVAL FORM ON NEXT PAGE

SUPERIOR'S NEW MODEL TW-11

STANDARD PROFESSIONAL TUBE TESTER

Model TW-11—Tube Tester
Total Price $47.50
Terms: $11.50 after 10 day trial, then $6.00 monthly for 6 months if satisfactory. Otherwise return, no explanation necessary.

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

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

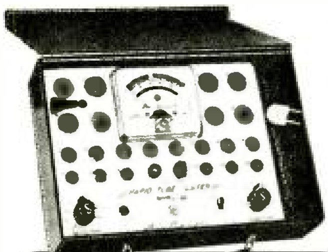
EXTRAORDINARY FEATURE

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

The Model TW-11 operates on 105-130 Volt 60 Cycles A.C. Comes housed in a handsome portable saddle-stitched Texon Case. Only **$47.50**

SUPERIOR'S NEW MODEL 82A

Multi-Socket Type TUBE TESTER



Model 82A—Tube Tester
Total Price $36.50
Terms: $6.50 after 10 day trial, then $5.00 monthly for 5 months if satisfactory. Otherwise return, no explanation necessary.

TEST ANY TUBE IN 10 SECONDS FLAT!

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

***THAT'S ALL!** Read emission quality direct on bad-good meter scale.*

SPECIFICATIONS

- Tests over 600 tube types
- Tests OZ4 and other gas-filled tubes
- Employs new 4" meter with sealed air-damping chamber resulting in accurate vibrationless readings
- Use of 22 sockets permits testing all popular tube types and prevents possible obsolescence
- Dual Scale meter permits testing of low current tubes
- 7 and 9 pin straighteners mounted on panel
- All sections of multi-element tubes tested simultaneously
- Ultra-sensitive leakage test circuit will indicate leakage up to 5 megohms

Production of this Model was delayed a full year pending careful study by Superior's engineering staff of this new method of testing tubes. Don't let the low price mislead you! We claim Model 82A will outperform similar looking units which sell for much more — and as proof, we offer to ship it on our examine before you buy policy.
To test any tube, you simply insert it into a numbered socket as designated, turn the filament switch and press down the quality switch — THAT'S ALL! Read quality on meter. Inter-element leakage if any indicates automatically.

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

SUPERIOR'S NEW MODEL 83

C.R.T. TESTER

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

TESTS AND REJUVENATES ALL PICTURE TUBES

ALL BLACK AND WHITE TUBES
From 50 degree to 110 degree types —from 8" to 30" types.

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

● Model 83 is not simply a rehashed black and white C.R.T. Tester with a color adapter added. Model 83 employs a new improved circuit designed specifically to test the older type black and white tubes, the newer type black and white tubes and all color picture tubes.
● Model 83 provides separate filament operating voltages for the older 6.3 types and the newer 8.4 types.
● Model 83 employs a 4" air-damped meter with quality and calibrated scales.
● Model 83 properly tests the red, green and blue sections of color tubes individually—for each section of a color tube contains its own filament, plate, grid and cathode.

● Model 83 will detect tubes which are apparently good but require rejuvenation. Such tubes will provide a picture seemingly good but lacking in proper definition, contrast and focus. To test for such malfunction, you simply press the rej. switch of Model 83. If the tube is weakening, the meter reading will indicate the condition.
● Rejuvenation of picture tubes is not simply a matter of applying a high voltage to the filament. Such voltages improperly applied can strip the cathode of the oxide coating essential for proper emission. The Model 83 applies a selective low voltage uniformly to assure increased life with no danger of cathode damage.

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

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- ☐ Model TV-50A .... Total Price $47.50 — $11.50 within 10 days. Balance $6.00 monthly for 6 months.
- ☐ Model TW-11 .... Total Price $47.50 — $11.50 within 10 days. Balance $6.00 monthly for 6 months.
- ☐ Model 82A .... Total Price $36.50 — $6.50 within 10 days. Balance $6.00 monthly for 5 months.
- ☐ Model 83 .... Total Price $38.50 — $8.50 within 10 days. Balance $6.00 monthly for 5 months.

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Shirtpocket Reflex for Local Listening

Tiny 2-transistor unit puts the local stations in your pocket, and it doesn't use an external antenna

By ALVIN MASON

HERE'S a simple, low-cost pocket reflex radio with a little different twist in circuitry and a big twist in performance. It has no external pickup leads and uses only two transistors.

The receiver measures only 3 x 3 x 1¼ inches and has low drain for longer battery life. The circuit is noncritical, with no rf feedback coupling to cause oscillations, yet sensitive to the very weakest signals.

Transistor V1 is a Philco rf type, chosen for its high cutoff frequency and low operating voltage.

V2 is another Philco transistor used for that extra punch in the audio output. It is a subminiature type specially selected for good performance at low voltage.

T2, also a Philco item, measures only about ½ inch square and has a shielding can to prevent stray rf coupling. Also, this shielding permits more flexible parts layout without fear of oscillations.

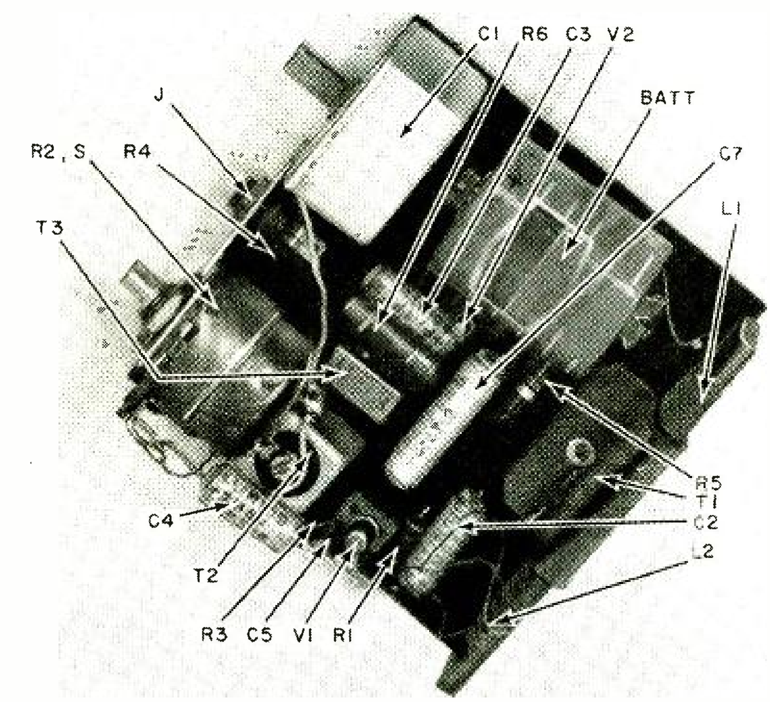
How it works

The receiver (Fig. 1) is a reflex type in which transistor V1 amplifies both the received rf signal and the detected af signal. Here's how it goes: C1 and L1 form a tuned circuit that picks up the desired rf signal. It is coupled to L2 and fed to V1 for amplification. The amplified rf signal is fed through T2 and is detected by diode D. (The rf signal cannot pass through audio transformer T3.) The detected af signal developed across R2 is fed back to V1's base, where it is again amplified. This time it is passed through T2's primary (the rf coil presents negligible impedance to the audio signal) and on to T3's primary. From there it goes to T3's secondary and on to V2 for final amplification. The amplified signal from V2 is fed to a headphone.

Construction

Construction is simple and straightforward. No special rules to follow, just good wiring practice. The set could be made smaller or larger if desired. However, if a smaller model is built, wiring may become more difficult.

A 3-inch-square piece of solid bake-



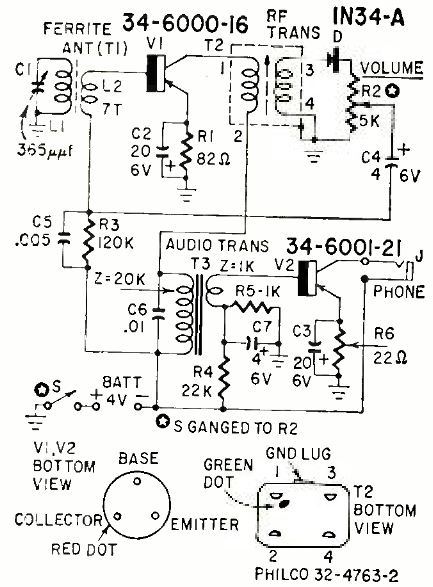
Chassis layout is compact, but not crowded.

* 2-transistor reflex
* simple construction
* shirtpocket size
* no external antenna needed

BENCH TESTED

Tests conducted by a member of the staff of RADIO-ELECTRONICS showed that the receiver has plenty of volume and picks up seven stations in Brooklyn, N. Y. There is some background hiss since af gain is high and rf gain relatively low. However, when the received station is loud enough, it overrides this interference.

Conclusion: a set to build where the extreme gain and selectivity of a 2-stage if is not needed.



R1—82 ohms
R2—miniature pot, 5,000 ohms, with spst switch
R3—120,000 ohms
R4—22,000 ohms
R5—1,000 ohms
R6—22 ohms
All resistors ½-watt 10% unless noted
C1—miniature tuning capacitor, 365 μμf (Lafayette MS-274 or equivalent)
C2, 3—subminiature electrolytic, 20 μf, 6 volts
C4, 7—subminiature electrolytic, 4 μf, 6 volts
C5—.005 μf, disc ceramic
C6—.01 μf, disc ceramic
BATT—4 volts (RCA VS308 or equivalent)
D—1N34-A
J—miniature phone jack
S—spst on R2
T1—flat ferrite antenna (L1) (Miller No. 2004 or equivalent) with 7 turns No. 22 enameled wire (wound on ground end (L2)—see text)
*T2—rf transformer (Philco 32-4763-2)
T3—audio transformer: primary, 20,000 ohms; secondary, 1,000 ohms (Argonne AR-104 or equivalent)
*V1—34-6000-16
*V2—34-6001-21
Transistor sockets (2) (Lafayette MS-395 or equivalent)
Perforated bakelite board (Lafayette MS-304 or equivalent)
Earphone (Telex type 18140 or Lafayette MS-368)
Miscellaneous hardware
**Available from authorized Philco distributors*

Fig. 1—Circuit of the reflex receiver.

lite board is used for the chassis. Or a piece of perforated bakelite can be used to avoid drilling holes for each component. All parts are mounted on one side of this board, with their leads running through to the opposite side where they are connected "printed-circuit" style. That is, all leads and connections are close to the bottom of the chassis.

The tuning capacitor, volume control and phone jack are mounted on a 3 x 1¾-inch piece of light aluminum bent over and riveted or screwed to the bottom of the chassis board. In the final wiring this metal bracket will be grounded by the return side of the phone plug so all bare leads must be kept from contacting it.

The two transistor sockets are easy to mount. Simply run the solder prongs through holes in the bakelite board and bend flat against the underside.

The battery is mounted by simply anchoring two No. 18 solid wires at each end of it and soldering directly to the terminals. This is done because the battery will seldom have to be changed. However, snap fasteners may be used to allow easier replacement.

Although wiring is simple with only two transistors, there is still the possibility of making errors. But you should have no trouble if you check each connection before proceeding to the next.

When connecting the diode, grip the leads with long-nose pliers to dissipate heat from the soldering iron. A black ring, the letter "k" or a "+" sign indicates the cathode end of the diode.

Antenna coil L1 comes with a Masonite mounting base which is considerably longer than the antenna itself. Remove this base by cutting away the cellophane-tape holders.

After the base is removed, tape up the tap that appears a few turns up from the ground end of the antenna. This tap is not used. Now wind 7 turns of No. 22 enameled wire from this spot to the ground end. Wind directly over and in the same direction as the antenna winding. You now have an antenna transformer, with the added secondary (L2) feeding V1's base.

The antenna is mounted by forming a cardboard loop about 1 inch wide around the center of the coil and fastening to the chassis.

Transformer T2 has five solder lugs which extend through holes in the chassis and are bent over. Before bending them, however, make a pencil mark on the top of the can to correspond with the green dot on its bottom. The green dot indicates proper hookup, and cannot be seen after the transformer is in place.

T3 is a subminiature audio transformer, 20,000 to 1,000 ohms impedance, with four color-coded leads. It is mounted with two twist prongs extending from its bottom. Position this transformer so that its primary and secondary windings are in proper relation to T2 and V2.

Making the case

A plastic box makes a good case. Or, if you wish to make a case like mine, simply follow the instructions in Fig. 2. This makes a very neat job and adds considerable class to the receiver.

Use a piece of cardboard big enough for the entire cutout and about 3/64 inch thick. Apply a thin coat of plastic resin cement to one side of this board; then press on a sheet of leatherette material of the design and color you desire. Work out all wrinkles and air bubbles. Now coat the other side of the cardboard with cement and leave standing till thoroughly dry—about 2 hours.

After drying, mark off each measurement according to Fig. 2. Cut out three holes for the controls, then fold along the dotted lines. Glue each section into place and clamp it by placing a small weight on top of the case.

When the case has dried, pull the lid flap down tightly and punch two holes with an icepick or punch at the points marked F. With long-nose pliers crimp each half of a stud fastener into these holes. And the case is finished.

Now use it

With all wiring completed and the battery in place you are ready for the transistors. Cut the leads of each transistor to about ⅜ inch. Make sure each lead is plugged into its proper socket terminal.

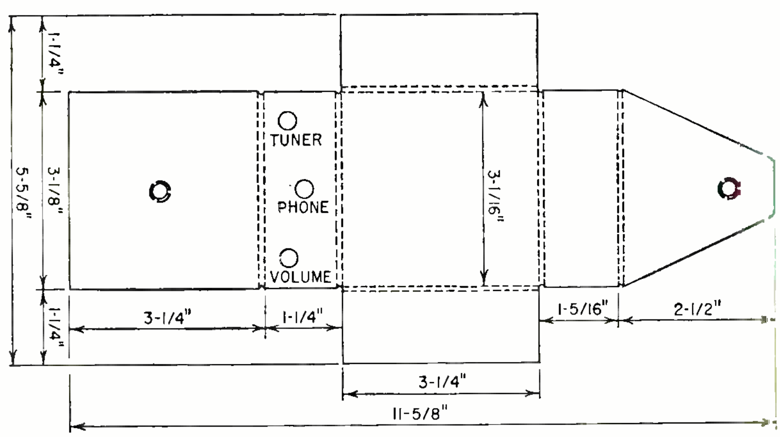


Fig. 2—Layout for the receiver's case.

Turn the switch on and advance the volume control to full power. Rotate the tuning knob. If all wiring is correct, stations should come in loud and clear.

If stations are not received satisfactorily or if no stations are heard try these tests: Touch your finger to V2's base connection. A loud plop should be heard in the earphone. Try the same test on V1's base. This time a loud squeal should be heard.

If both these tests give the listed effect, check the antenna hookup. New components are seldom defective, so these should be checked last.

In operation you will find that the antenna is somewhat directional and should be rotated slightly for best results. Also, transformer T2 has a tuning slug which may be adjusted to peak the receiver to a particular section of the broadcast band. Or this slug can be removed entirely for distributed gain throughout the band.

The unit is a great little receiver for only two transistors. And it should prove well worth the effort put into building it. END

NEW DEVELOPMENTS IN RADIO CIRCUITRY

Several manufacturers have incorporated novel circuits in their equipment

By HENRY O. MAXWELL

ENGINEERING developments and innovations in modern audio and radio equipment tend to follow cyclic patterns. For fairly long periods, circuitry in new equipment will be static. Then suddenly new circuits blossom forth from nearly every chassis. This month we discuss some of the most interesting ones we've seen recently.

Unusual FM–AM detector switching

The detectors in AM–FM tuners and receivers have become pretty much standardized as two separate circuits. The FM detector is either a ratio detector or a Foster-Seeley discriminator. The AM detector and avc circuit invariably uses a half-wave diode which may be a germanium diode, a section of a multipurpose tube or the grid-cathode circuit in the FM limiter. The two detectors are generally completely isolated and easy to spot with one glance at the diagram.

Blonder-Tongue engineers have come up with a couple of novel innovations combining the functions of many of the components in FM–AM detector circuitry. Fig. 1-a is the detector circuit in the model R-98 FM–AM radio. When S3 is in the FM position, we have a completely conventional balanced ratio detector with diodes D1 and D2 developing an audio voltage at the junction of load resistors R15 and R14. Reservoir capacitor C31 swamps out voltages developed by residual AM on the FM if signal. R18 and C32 form the audio de-emphasis network. R13 and R17 compensate for minor differences in the characteristics of the detector diodes.

Switching to AM removes D1 from the circuit and converts D2 to a conventional half-wave AM and avc detector. Fig. 1-b shows the AM detector with all inactive components eliminated for simplicity. R19 is the diode load and C27 is the rf bypass capacitor. The FM de-emphasis network remains in the audio circuit but its effect is negligible on the average AM program.

Fig. 2-a is the corresponding detector circuit in the T-88 FM–AM tuner. The tuner has an ac–dc power supply with one side of the power line connected to the B-minus bus and the chassis so its output must be completely isolated from the chassis to prevent a shock hazard on the amplifier to which the

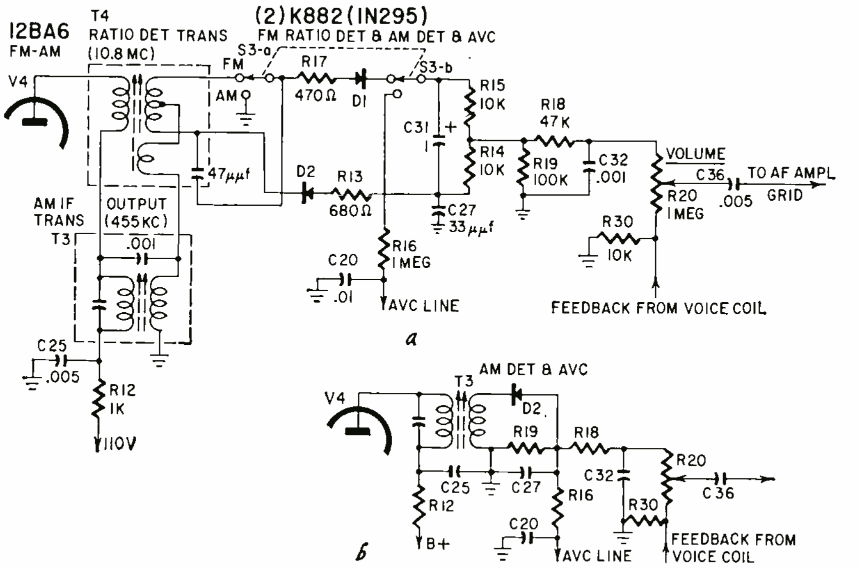


Fig. 1-a—Detector circuitry of the R-98 AM-FM radio with switch S-3 in FM position; b—simplification of circuit in AM position.

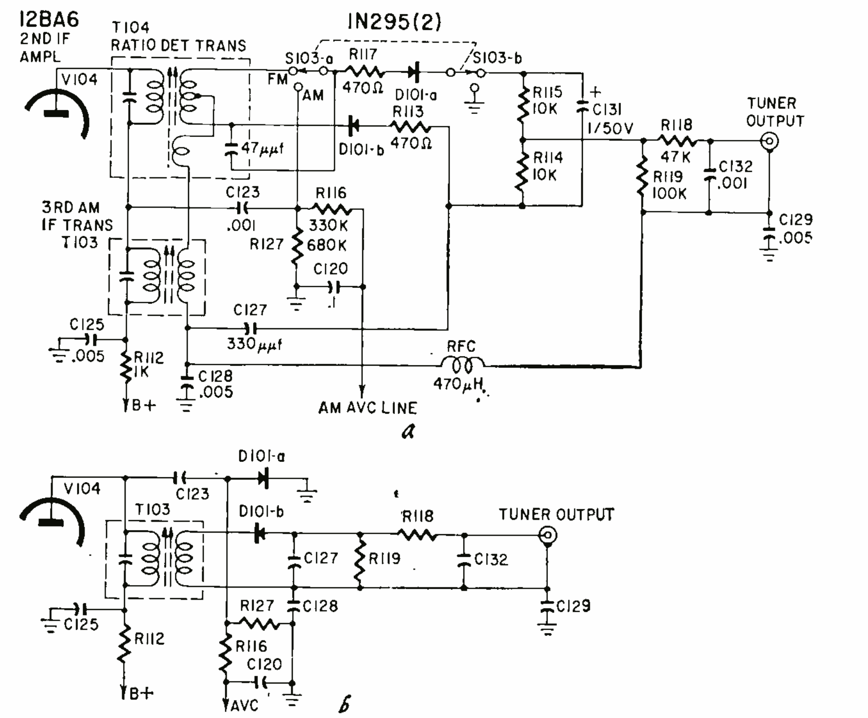


Fig. 2-a—Detector circuitry of T-88 AM-FM tuner with S103 in FM position; b—simplified AM circuit.

tuner might be connected. The ratio detector circuit is similar to that in the R-98 receiver but the low end of the tertiary winding of T104 is isolated from ground by C128 and C129 and is connected to the mid-point of the detector load resistors through an rf choke and R119. The audio output is taken from across R119.

Fig. 2-b is the simplified AM detector circuit. Diode D101-b is the AM detector developing an audio voltage across R119 which functions as the AM detector load. This circuit is isolated from the chassis and B-minus, so a separate source of avc voltage is required. D101-a is the avc diode coupled to the if amplifier plate through C123. It develops a dc voltage across R127 proportional to signal strength. This voltage is filtered by R116 and C120 and fed to the first and second if amplifier.

Novel tuning indicator

The RCA model TPM-13 AM–FM stereo combination uses the novel neon type tuning indicator shown in Fig. 3. The indicator is a NE-51 neon lamp in series with the plate of the triode section of the 19T8 operating as the indicator amplifier or control tube. (The diodes in the 19T8 are used as FM and AM detectors.)

The grid of the 19T8 is connected to the grid of the third FM if amplifier and limiter and to the AM avc line through 22-megohm isolating resistors.

Under no-signal conditions, the tube draws enough plate current through the NE-51 to cause it to glow brightly. When a signal is tuned in, the negative avc voltage developed across the AM detector load (R14 and R15) or the FM limiter grid resistor (R7) reduces the plate current drawn through the NE-51 and decreases its brilliance. The tuning controls are adjusted for minimum brilliance. The 10-megohm resistor, R16, draws just enough "keep-alive" current through the NE-51 to keep it conducting at all times. At high volume levels, the neon indicator tends to oscillate at a frequency determined by the value of C10.

6-volt hybrid radio

The Motorola model 406 auto radio is the first hybrid set we've seen that operates from a 6-volt storage battery. This set, using a 6BE6 converter, 6BA6 if amplifier, 6CR6 detector, avc and first audio, 6BF6 driver and 2N176 transistor output stage, is easily mistaken for a 12-volt model. Unlike the 12-volt versions that have a maximum of 12–14 volts available for the tubes and transistors, this set has a transistor type 50-volt B-supply for the tubes while the audio and oscillator transistors operate from the 6-volt battery.

Fig. 4 is the diagram of the power supply and audio circuits in the model 406. The power supply oscillator is a conventional circuit using tickler feedback to the base. Approximately 60 volts ac is developed in the secondary of the power transformer. It is rectified and filtered to deliver 50 volts B-plus to the tubes. This voltage is stabilized by the varistor across the rectifier.

The grid of the 6BF6 driver is biased by contact potential of the paralleled diodes (pins 5 and 6). This is a logical circuit development because cathode bias would reduce the effective plate voltage—which is already limited—and other forms of bias would be more expensive and likely to cause trouble.

Automatic rumble filter

Some of the new Zenith radio–phono combinations feature a phono rumble filter circuit that operates only during low-level passages when rumble is most noticeable. During high-level bass passages, rumble is masked by the program material so the filter is automatically bypassed to permit full-range bass to come through.

Fig. 5 is the circuit in Zenith's 11A21 chassis. The rumble suppressor consists of a two-section high-pass filter C1–R1, C2–R2 bypassed by varistor R3. (A varistor is a nonlinear semiconductive element whose resistance is determined by the voltage applied across it.) With no signal or with a low-level bass input from the record, the varistor's resistance is high and the signal takes the path of least resistance through the filter. During high-level passages the varistor's resistance is low, effectively shorting out the filter and allowing full bass to come through. END

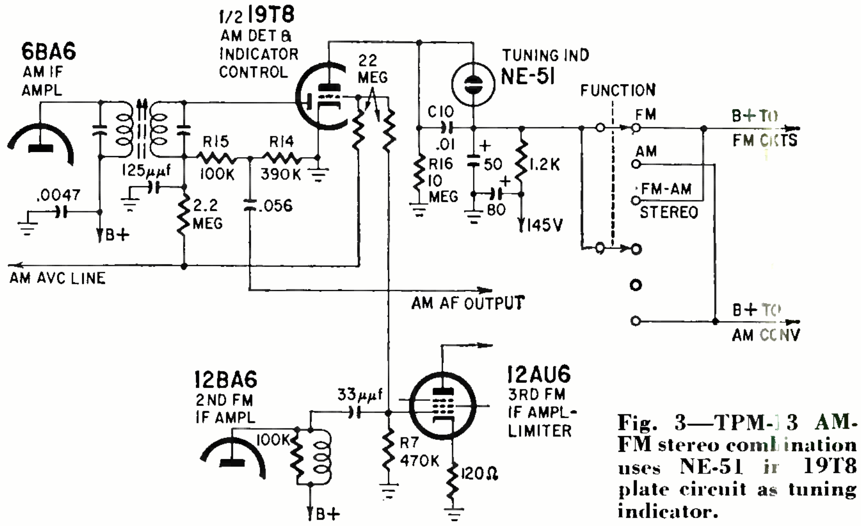


Fig. 3—TPM-13 AM-FM stereo combination uses NE-51 in 19T8 plate circuit as tuning indicator.

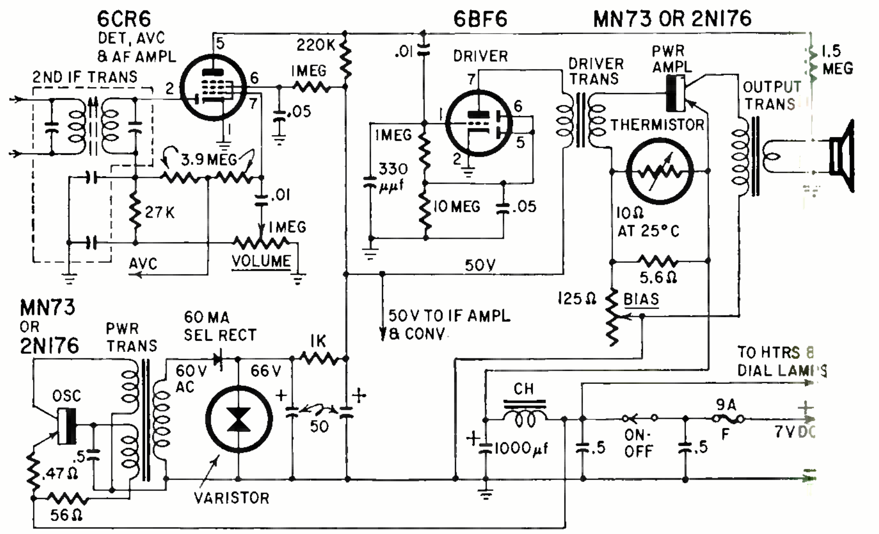


Fig. 4—Motorola 406 radio uses MN73 or 2N176 transistor to provide 50-volt B-supply.

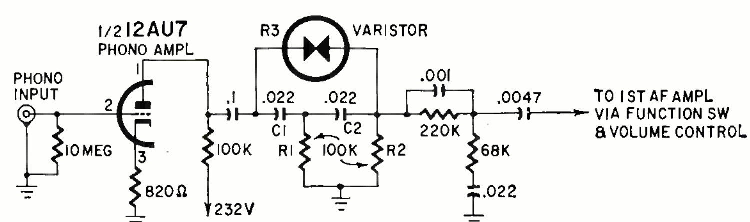


Fig. 5—Varistor short-circuits high-pass filter at high signal levels, allowing rumble filter to work only at low signal levels.

RESERVE POWER FOR SURVIVAL

Be ready in an emergency. Keep mercury batteries on hand for your transistor radio

By SOL D. PRENSKY*

EVERY owner of a transistor radio can have the added assurance provided by a survival-shelter radio by using mercury batteries as a reserve power source for the receiver. Using mercury batteries as a reserve, rather than a spare set of carbon–zinc batteries, instantly frees you from the bugaboo of poor shelf life that makes the ordinary (carbon–zinc) battery so unreliable.

The excellent shelf life of mercury batteries is not as widely known or appreciated as it should be. Instead of only the few months during which we can rely on unused carbon–zinc batteries, mercury batteries can sit on the shelf for *2 or 3 years or longer* and still be usable.

To determine which mercury battery to use for a reserve, a simplified battery listing is provided. It classifies the more popular types of transistor batteries according to their general description, and avoids the confusion generated by a multiplicity of manufacturer numbers.

In the table, the General Description and NEDA No. columns list the 7 most popular zinc–carbon types. The next four columns give the manufacturer's number of each type. The final column shows the mercury equivalents available as *direct* replacements for the zinc-carbons.

The Mercury Equivalent column contains only four entries, indicating that only four of the seven zinc–carbon battery classes are directly replaceable by mercury batteries. However, these four replacements cover at least 92 transistor radios. (A list of these radios by manufacturer model number is available from the battery manufacturers listed.)

The photo shows two mercury types, the 1.4-volt penlight and the 9-volt oval-ended, that are stocked by most dealers. The other two mercury types, the 1.4-volt size D and the 22.5 volt, are available but may have to be ordered from the manufacturer.

For the three classes for which no exact mercury replacement is available, the same principle of reserve power still can apply. The set owner can keep a replacement set of zinc–carbon batteries on hand and check or replace them periodically, or he might fit the equivalent mercury battery with alligator clips to act as a more dependable reserve than the original carbon–zinc. Or perhaps, direct replacements for these three classes may become available shortly. In any case, the problem should not be too difficult for those who realize the importance of reserve power for survival. END

*Assistant Professor, Electrical Engineering, Fairleigh Dickenson University, Teaneck, N. J.

Two typical mercury batteries: right—mercury equivalent of the 1.5-volt penlight cell; left—mercury equivalent of the popular 9-volt zinc-carbon battery.

MERCURY REPLACEMENT BATTERIES FOR PORTABLE RADIOS

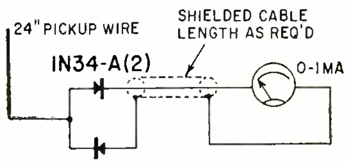
General Description	NEDA No.	Zinc–Carbon				Mercury		
		Mallory	Burgess	Eveready	RCA	Mallory	Eveready	RCA
1.5 volts, flashlight (standard size D)	13	M-13R	230	A100	VS336	RM-42R	—	—
1.5 volts, flashlight (medium size C)	14	M-14R	130	635	VS335	—	—	—
1.5 volts, penlight (size AA)	15	M-15R	930	1015	VS334	ZM-9	E-9	VS313
9 volts, cylindrical (snap contact, 1 x 1 x 1 31/32)	1600	M-1600	P6M	226	VS300A	—	—	—
9 volts, rectangular (snap contact, 1 3/8 x 1 5/16 x 2 3/4)	1602	M-1602	2M6	246	VS305	—	—	—
9 volts, oval (snap contact, 1 1/32 x 11/16 x 1 29/32)	1604	M-1604	2U6	216	VS312	TR-146R	E-146	VS312
22.5 volts, flat (flat contact, 1 1/32 x 5/8 x 2)	215	M-215	U15	412	VS084	RM-412R	—	—

How Much Rf?

IS A radio signal coming off that antenna? When this knob is turned, is there more or less signal? Such questions are commonplace to the ham operator and mobile service technician. This little untuned field-strength meter answers them, and cheaply too.

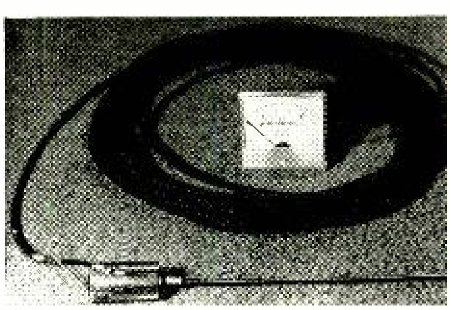
Hook a pair of diodes to a short pickup antenna, place it where the rf is to be measured and connect the rectified signal (which is proportional to the incoming rf) to a meter. The indicating meter may be mounted at the operating table and the pickup head placed 50 feet or more away.

The signal picked up by the head is rectified and carried to the indicating meter as direct current. Since the instrument performs one specific function,



determining the presence of rf, and since the cost of parts is low, there is no need of providing for plug-in features, calibration or removal of components, except the meter itself. It, of course, can be switched to other functions. Transistors, tubes and batteries are eliminated by using a diode pair. No resistors are necessary—unless a strong rf signal that might damage the meter is measured—then the usual shunting resistors for the meter should be used or a less sensitive meter connected. Capacitors are not mandatory, even on the output of the diodes. The capacitance of the shielded cable furnishes enough storage action for radio frequencies.

When the pickup head was located about 100 feet from an aerial which was



connected to a 40-watt transmitter, the meter indicated 1 ma when the transmitter's output was properly adjusted, and zero when the transmitter was improperly adjusted or the antenna disconnected from the transmitter. By placing the pickup head in a location remote from the transmitter itself, the actual radiation from the transmitting antenna can be determined.—*Irvin C. Chapel.*

INTERFERENCE— CAUSES, REMEDIES and LOCATION

Problems with TV sets and radios can generally be solved by finding out what causes the interference as the first step in eliminating it

By FORREST H. FRANTZ, SR.

ELECTRICAL interference is annoying to the broadcast listener, exasperating for the shortwave listener and frustrating to hams. Natural electrical interference cannot be controlled; man-made interference can. The effects can often be eliminated at the receiver, but in some cases interference must be eliminated at the source.

To cope effectively with electrical interference, it is important to understand how it's generated and transmitted. When the type is recognized, the source can be found and eliminated.

The causes of man-made interference fall into four general categories:

1. Switching
2. Discharges
3. Radio-frequency leakage
4. Harmonic generation

Switching noise occurs at electrical switches and commutators. Typical offenders are: light switches; thermostats on electric irons, heating pads and home heating systems; switches and flashers on advertising signs; commutators on electric motors, industrial equipment and home appliances, and poor electrical connections.

This interference is caused by arcing when an electrical circuit is opened or closed. Fig. 1-a shows the idealized waveform for switch operation, with its characteristic steep rise and fall. Fig. 1-b shows a practical waveform. The fall time is increased and current decay is irregular. The arc radiates a complex signal which contains many frequencies.

An intermittent break in a poor electrical connection can be extremely harassing because arcs are continuously struck and extinguished in a haphazard way. Arcing is a type of electrical discharge that occurs at relatively high currents (generally 100 ma or more).

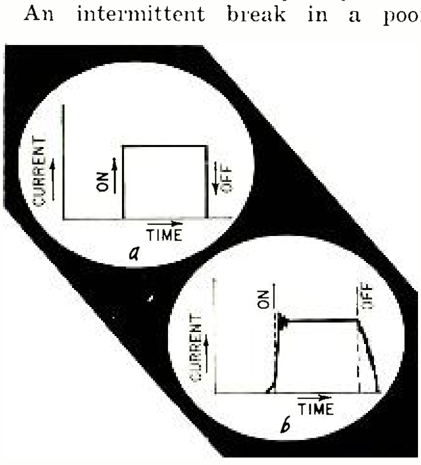


Fig. 1—Waveform of: a—ideal and b—practical switch operation.

Glow discharges such as those associated with neon and fluorescent lamps occur at intermediate currents (generally a few microamperes to several milliamperes). Glow discharge tubes are ordinarily ac-operated. The ac voltage acts as a switch for the discharge. The resulting interference looks like the waveforms of Fig. 2. The voltage increases from zero to the glow striking voltage. The tube fires and the current drops in an oscillatory manner till the voltage reaches the extinguishing value. Again a series of harmonic-rich oscillations occur as the current drops to zero. The process is repeated during the negative half-cycle. A total of four oscillatory discharges occurs during each voltage cycle, or 240 times a second with a 60-cycle line voltage!

Corona discharges usually occur at extremely high voltages and are characterized by extremely low currents. Interference picked up on automobile radios while passing near high-voltage lines is due to corona discharge. This type of discharge occurs during the voltage peaks of the ac cycle. Fig. 3 shows the waveform. This interference may contain frequencies from the audio range up to several hundred megacycles.

Radio-frequency (rf) leakage interference is generally caused by inadequate shielding of rf generators such as induction heaters, diathermy machines and high-voltage power supplies which employ rf oscillators. Occasionally, it's an interfering radio station. Interference of this type differs from the others—it is tunable.

Harmonic interference is caused by generators of nonsinusoidal waveforms. Sawtooth and square waves contain many harmonics of the fundamental frequency. Thus, a 10-kc sawtooth signal might contain troublesome harmonics at frequencies as high as a megacycle.

Remedies at the receiver

A receiver picks up signals with power levels of considerably less than a billionth of a watt. Although interference may reach a receiver by conduction through the power lines, most interference is picked up by the receiver antenna. Interference conducted to the receiver through the power lines may be radiated within the set and picked up by the receiver input circuit.

Conduction of interference to the set via the power lines may generally be eliminated by connecting a capacitor of .01 to .05 μf across the ac lines for ac–dc receivers (Fig. 4-a). The arrangement in Fig. 4-b, with a capacitor from each side of the line to ground, may be employed for ac receivers. A .05-μf capacitor has a reactance of 3.18 ohms at 1 megacycle and 0.318 ohm at 10 mc. This is a near short circuit to rf signals.

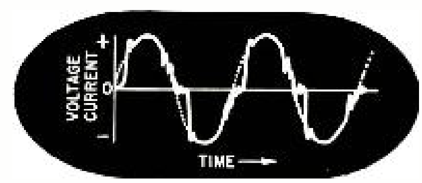


Fig. 2—Current in a glow discharge tube goes through several high-frequency oscillations each cycle.

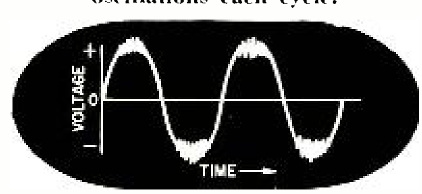


Fig. 3—High-voltage corona discharge normally occurs during voltage peaks.

Interference introduced via the antenna is another matter. If the receiver uses a loop antenna, it may be possible to take advantage of the directional characteristics of the set. The other avenue open is to locate the noise and eliminate or suppress it at the source.

The external antenna in this age of high-sensitivity receivers is frequently a piece of wire strung inconspicuously around the room. If the wire is close to a household power line or within several feet of a fluorescent lamp (and it often is), interference may be reduced by relocating the antenna wire or resorting to an outside antenna with a shielded or twisted-pair lead-in. The shield or unused wire in the case of a twisted pair should be connected to the receiver ground (Fig. 5).

An outside antenna can become a

source of noise in itself if the lead-in is not soldered to the antenna proper or if the lead-in is permitted to touch rain gutters or other metal objects.

Tunable rf signals may be reduced with a wavetrap. Two types of wavetraps and their connection modes are shown in Fig. 6. The inductance–capacitance combination is the same as you'd use in a receiver to tune to the interfering station. Set the wavetrap capacitor for minimum signal pickup. The trap of Fig. 6-a inserts a large impedance between antenna and receiver at the interference frequency. The trap of Fig. 6-b places a low impedance across the antenna and ground terminals at the interference frequency.

In a television receiver, interference signals below 50 mc may feed through the front end of the receiver and be amplified by the broad band if stages. High-pass filters which attenuate signals up to about 50 mc are available commercially. This type of filter is connected between the lead-in and the TV set's antenna terminals. The filter must be chosen to match the impedance of the transmission line—300 ohms for ribbon, 72 ohms for coax.

If TV interference is tunable, a wavetrap may be employed. A single series-resonant trap connected across the transmission line terminals as shown in Fig. 7 is preferable. (This arrangement will also work on FM receivers.) Symptoms of interference that a filter or a trap might cure are noise streaks, sound bars and herringbone patterns on the picture. TV picture pulling and FM receiver cross-talk between adjacent stations can often be eliminated with a wavetrap tuned to suppress the stronger station.

Locating the noise

If the suggested remedies applied at the receiver do not eliminate interference, you might as well get out your deerstalker and turn into a noise sleuth.

If the noise is the result of non-sinusoidal signal generation, the source is usually a piece of electronic equipment. Television receivers are primary suspects. Find out if your own TV set is causing your interference by observing if the noise exists with the set on and disappears with it off. Discharge interference will be apparent at rela-

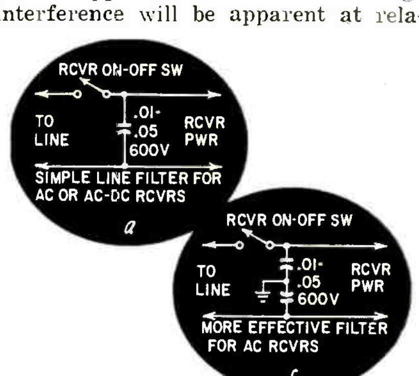


Fig. 4—Line filters for: a—ac and ac-dc and b—ac only receivers.

tively high frequencies. Sources of thermostat arc noises and appliance interference created in your home are usually obvious, since you know when these devices are being operated.

Assuming nothing this obvious, turn on a battery-operated portable radio and tune it off station. Pull the main fuse or switch on your house wiring panel. If the interference disappears

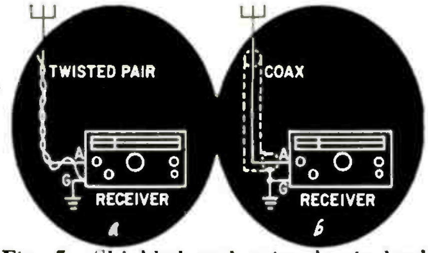


Fig. 5—Shielded and twisted-pair lead-ins reduce noise.

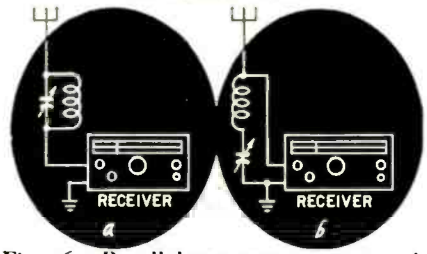


Fig. 6—Parallel-resonant wavetrap in series with antenna, b—series-resonant trap across antenna-ground terminals.

or drops significantly, the noise source is probably connected to the electrical circuit in your home. Now you can turn the main switch on and turn the other circuits off one at a time till the interference stops. From this point on, it's a matter of locating the offending appliance, lamp or defective wiring.

A battery portable radio may be useful in locating the source of the noise by actually homing in on it. For this type of work, a battery receiver with a highly directional antenna and a signal-level meter such as the Heathkit DF-1 radio direction finder is invaluable. If the noise is not being generated on your premises, scout the neighborhood with your battery-operated portable.

Remedies at the source

Remedies at the source depend, of course, on the type of interference. Noise due to motor commutator arcing may usually be suppressed with a 1-μf 600-volt capacitor connected across the line terminals at the motor. A 0.1-μf 600-volt capacitor is more practical for portable tool and vacuum cleaner motors. The motor frame should be grounded as a safety as well as a noise precaution. A .02-μf capacitor connected from each side of the line to the *grounded* frame may reduce the interference further. In extreme cases, a commercial filter (a capacitor-inductor combination) may have to be used.

Contact arcing on switches, relays and thermostats where currents of less than 3 amperes are involved may be reduced with a 0.1-μf capacitor connected across the contacts. To limit charge and discharge currents, a 100-

ohm ½-watt resistor should be connected in series with the capacitor (Fig. 8-a). The voltage rating of the capacitor depends on the circuit inductance. If the contacts control a device for which timing is important, the R-C combination of Fig. 8-a cannot be used. Instead, two 1-millihenry rf chokes of adequate current rating for the load may be connected as shown in Fig. 8-b.

To suppress fluorescent fixture interference, connect a .05-μf capacitor across the line and connect a .02-μf capacitor from each side of the line to the metal frame of the fixture. The filter should be mounted inside the grounded fixture frame. Interference from neon signs may be minimized by removing protruding points in the wiring which might allow auxiliary discharges and by cleaning switch contacts periodically. High-frequency oscillations may be damped by placing a 47,000-ohm resistor in series with each of the transformer secondary leads to the tubing (Fig. 9).

Interference from automobile ignition systems to home receivers is rarely ever bothersome. But the ignition system will introduce noise to the automobile radio if it isn't suppressed. Ordinarily a resistive suppressor in the ignition coil lead to the distributor, and a 0.5- or 1-μf capacitor from the ammeter to ground will suppress ignition noise. This, of course, assumes a properly shielded antenna lead with a good shield connection to the auto frame. A 0.5- or 1-μf capacitor should be connected across the generator to suppress generator noise. In severe cases, particularly in older cars, additional measures may be required. END

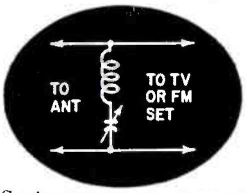


Fig. 7—Series-resonant wavetrap may be connected directly across transmission line.

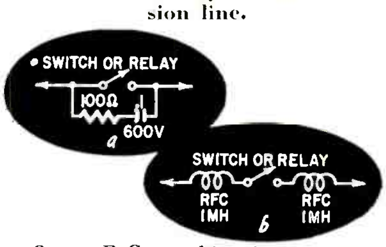


Fig. 8-a — R-C combination suppresses arcing, b—rf chokes can be used on device where timing is important.

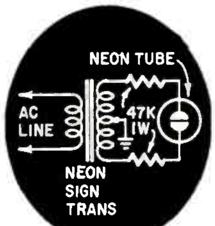
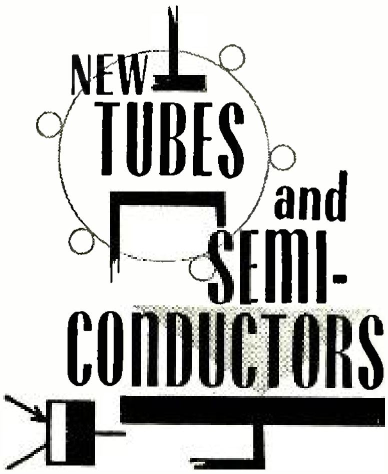


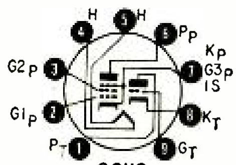
Fig. 9 — Resistors damp oscillation in neon tubes.



TUBES for audio dominate this month. Sprinkled throughout the releases are a hi-mu twin triode and two power pentodes for audio amplifiers. In between we have a TV horizontal oscillator and a group of germanium diodes.

6GH8

A multi-unit tube in a 9-pin miniature envelope. A medium-mu triode and a sharp-cutoff pentode are enclosed in the envelope and are intended for use in multivibrator type horizontal deflection oscillators in TV receivers. The



6GH8

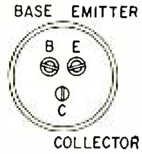
6GH8 can also be used as an agc amplifier or sync separator.

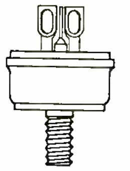
Characteristics of the RCA 6GH8 in class-A₁ amplifier service are:

	TRIODE	PENTODE
V_P	125	125
V_{G2}	—	125
V_{G1}	−1	−1
μ	46	—
R_P (k ohms)	5.4	200
I_{G2} (ma)	—	4.0
I_P (ma)	13.5	12
gm (μmhos)	8,500	7,500
V_{G1} (for 10-μa plate current)	−8	−8

2N1501, -1502

These hermetically sealed germanium p-n-p transistors are designed for a





2N1501,
2N1502

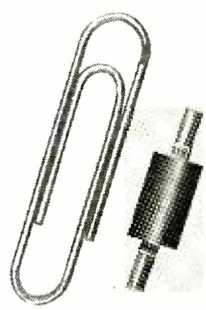
variety of uses including servo amplifiers, power conversion, voltage regulation, switching, etc.

Maximum ratings of these Minneapolis-Honeywell transistors are:

	2N1501	2N1502
V_{CB}	60	40
V_{CE} (active region) (emitter forward biased)	40	40
(Cutoff region) (emitter reverse biased)	60	40
V_{EB}	28	28
I_E (amps) (rms)	3.5	3.5
I_B (amps) (rms)	0.5	0.5

DC 7, 7A, 7B, 7C, 7D

These uhf germanium mixer diodes are designed and manufactured for 1,000-mc applications. Made by Semi-



Elements Inc., they replace two diodes that have been discontinued by G-E—the 4JB2E9 and the G7B.

All units have the following specifications:

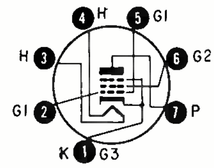
$I_{average\ dc}$ (ma)	25
$I_{peak\ dc}$ (ma)	75
Operating frequency (mc)	1,000
P_{total} (mw)	250

The table breakdown shows variations between the units:

Type	Use	Peak Inverse Voltage	Minimum Rect. Eff.	IF Impedance
DC 7	Detector and Meter	15	75%	—
DC 7A	Uhf Mixer	10		250 ohms
DC 7B	Uhf Mixer	5	50%	250 ohms
DC 7C	High-level, high-efficiency Detector and mixer	10	60% 70%	—
DC 7D	High-level, very-high-efficiency meter detector and mixer	15	85%	—

60FX5

This is a power pentode in a 7-pin miniature envelope that is designed for use in the output stages of inexpensive audio amplifiers. It is particularly suited for use in 2-tube series-string stereo amplifier systems. Because of its high power sensitivity, the 60FX5 can be driven to full output by a ceramic or crystal phono cartridge.



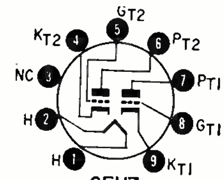
60FX5

Typical operating characteristics of the RCA 60FX5 in class-A1 amplifier service are:

V_P	110
V_{G2}	115
R_K (ohms)	62
V_{G1} (peak af)	3
I_P (zero signal) (ma)	36
(max signal) (ma)	35
I_{G2} (zero signal) (ma)	10
(max signal) (ma)	12
R_L (ohms)	3,000
Harmonic distortion (%)	8
Power output (max) (watts)	1.3

6EU7

A high-mu twin triode in a 9-pin miniature envelope especially designed for use in high-gain resistance-coupled



6EU7

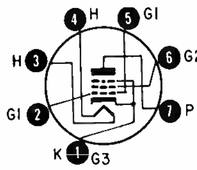
audio preamplifiers. The RCA 6EU7 has an amplification factor of 100, low hum, low microphonism, double helical heaters and a special basing arrangement that lets the circuit designer get good isolation between stereo channels.

Operating characteristics (per section) of the 6EU7 are:

V_P	100	100
V_G	−1	−2
μ	100	100
R_P (k ohms)	80	62.5
g_m (μmhos)	1,250	1,600
I_P (ma)	0.5	1.2

35EH5

A power pentode in a 7-pin miniature envelope. It is intended for use in the audio output stages of FM or AM-FM radios and audio amplifiers operating from transformerless ac or ac–dc power supplies. Two 35EH5's, a 12AX7 and a 35W4 can make up the entire tube complement of a stereo amplifier system using a series heater string.



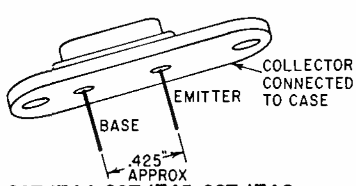
35EH5

Typical operating characteristics of the RCA 35EH5 class-A1 amplifier service are:

V_P	110
V_{G2}	115
R_K (ohms)	62
V_{G1} (peak af)	3
I_P (zero signal) (ma)	32
(max signal) (ma)	32
I_{G2} (zero signal) (ma)	7.2
(max signal) (ma)	12
R_P (approx) (ohms)	14,000
gm (μmhos)	12,000
R_L (ohms)	3,000
Harmonic distortion (%)	8
Power output (max) (watts)	1.2

CST-1744, -1745, -1746

These special-size germanium p-n-p transistors are designed for use in amplifier circuits where their improved frequency response leads to higher audio fidelity, in switching circuits where they provide faster switching and in



CST-1744,CST-1745,CST-1746

regulated power supplies where they deliver improved performance.

Maximum ratings of these Clevite Spacesaver transistors are:

V_{CE}	40
V_{EB}	45
I_C (amps)	3
I_B (amps)	2
P_{total} (watts)	12

Typical characteristics are:

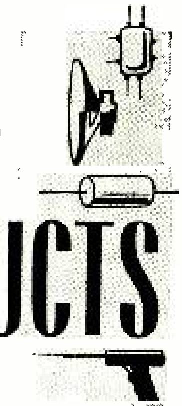
	CST-1744,	-1745	-1746
G_{PE} (power gain) (min) (db)	28	28	32
fG_{PE} (cutoff freq) (typ) (kc)	15	15	15
D (distortion) (typ) (%)	3	3	3
h_{ie} (input impedance) (typ) (ohms)	20	15	20

Semiconductor briefs

New low- and high-voltage military-type industrial transistors in 3-ampere ratings have been introduced by Motorola. The high-voltage types have collector-base voltage ratings of 120 volts and collector-emitter ratings of 100 volts. All of these new transistors are germanium p-n-p alloy junction units.

Tiny ½ x ½-inch photoconductive cells can dissipate up to 500 mw when mounted on a heat sink. Two types are available: the 504, a cadmium selenide unit that has a relatively high speed of response; and the 505, a cadmium sulphide unit. Both cells are made by Clairex. END

new PRODUCTS



MOUNTING BRACKET, *Cardio master*, converts transistor radio to auto radio. Powerful permanent magnet and adjustable holding bracket holds radio near windshield. No additional wiring, antennas or motor suppressors required.—**R-Columbia Products Co., Inc.,** 305 Waukegan Ave., Highwood, Ill.

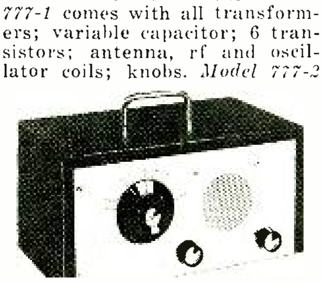
RADIO DIRECTION FINDER operates on 4 size-D cells. Built-in compass. Easy-mounting

brackets for removal from boat for personal use. Superhet. Tunes broadcast and marine bands. Carrying strap.—**Alco Electronics,** 3 Wolcott Ave., Lawrence, Mass.

MICROPHONES for amateur, mobile and Citizens band use. Tough plastic case, coiled cord (5 feet extended, 11 inches retracted). *Model 350X* (crystal): response 60 to 6,500 cycles, level —48 db. *350C* (ceramic): same

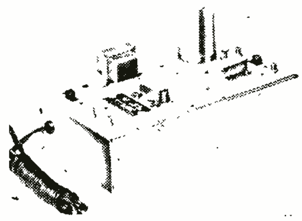
response, output level of —54 db. *350R* (carbon): response 200 to 4,000 cycles, level —38 db. All models have hanger button and dash bracket. Wired for relay operation.—**Turner Microphone Co.,** 909 17th St., N. E., Cedar Rapids, Iowa.

FM RECEIVER kit *model 777-1* comes with all transformers; variable capacitor; 6 transistors; antenna, rf and oscillator coils; knobs. *Model 777-2*



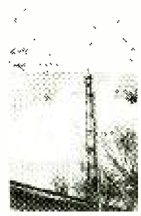
similar to above, but metal case and panel. Completed receiver has 2.5-μv sensitivity, afc, vernier tuning, push-pull output stage.—**J. W. Miller Co.,** 5917 S. Main St., Los Angeles 3, Calif.

TV-FM AMPLIFIER *model BT-3* fully transistorized. Low-channel gain 18 to 15 db. High-channel gain 19 db. FM-band



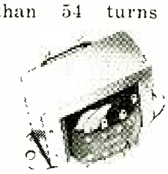
(88—109-mc) gain 15 to 9 db. Low noise, low cross-modulation. Minimum operating costs. —**Blonder-Tongue Laboratories, Inc.,** 9 Alling St., Newark, N. J.

ANTENNA covers 10-, 15-, 20-, 40- and 80-meter bands. *Hy-Tower* vertical antenna 24-foot steel tower topped by 26-foot aluminum mast. Hot-



dipped, galvanized, X-braced. No guy wires required. Vertical fed by 52-ohm coax. 90 pounds. SWR less than 2:1 on all bands.—**Hy-Gain Corp.,** 1135 N. 22 St., Lincoln, Neb.

OUTPUT TRANSFORMER for vertical deflection use covers more than 54 turns ratios.



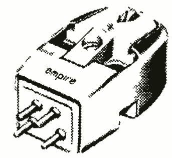
2 x 3¼ x 2 inches.—**Chicago Standard Transformer Corp.,** 3501 Addison, Chicago 18, Ill.

SOLID TANTALUM Capacitors. Sintered tantalum anodes. Hermetically sealed in subminiature metal cases. Semiconductor electrolyte. Corrosion- and leak-free. *Aerotan's* available in insulated and uninsulated cases. Operate over range of from

—80°C to 125°C.—**Aerovox Corp.,** New Bedford, Mass.

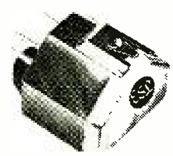
SILICON RECTIFIER line for medium-power applications handles up to 6 amperes. Available in 8 PIV ratings from 50 to 600 volts. Mounting styles ½-inch hex ceramic insulated and 7/16-inch hex.—**Cornell-Dubilier Electric Corp., Semiconductor Div.,** Norwood, Mass.

STEREO CARTRIDGE *Empire 108*. Outputs balanced to within 1 db. Response 15 to



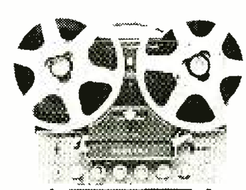
20,000 cycles ±2 db, usable output to 30,000 cycles. Channel separation 25 db, horizontal and vertical compliance 6 × 10^{-6} cm/dyne. Minute moving magnet assures low dynamic mass. Output 8 mv per channel.—**Dyna-Empire, Inc.,** 1075 Stewart Ave., Garden City, N. Y.

STEREO CARTRIDGES *C99* (shown) and *P99* fit *ESL-S310* professional tone arm and any standard changer or pickup arm, respectively. Response 18 to 20,000 cycles ±2 db. Channel separation 20 to 25 db, dynamic mass .0025 gram. Output per channel 1 mv at 10 cm/sec. Ver-



tical and lateral compliance 5 × 10^{-6} cm/dyne.—**Electro-Sonic Labs., Inc.,** 35-54 36th St., Long Island City 6, N. Y.

STEREO RECORDER *model SM-310-4* ¼-track version of *SM-310*. Records ¼-track stereo or monophonic. Plays back ½- and ¼-track tapes. All other

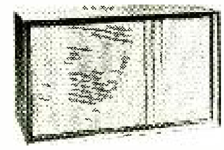


specifications same as *SM-310*.—**Newcomb Audio Products Co.,** 6824 Lexington Ave., Hollywood 38, Calif.

RECORD CHANGER *model RC-1* mixes different-size records of same speed. 4 speeds. Kit or wired. Plug-in head. 45-

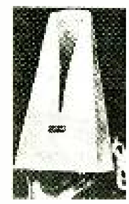
rpm record adapter and short spindle for manual use available. No stabilizer arm. Records slide gently rather than drop down spindle.—**Arkay International,** 88-06 Van Wyck Expressway, Jamaica, N. Y.

SPEAKER SYSTEM. 12-inch woofer, 8-inch midrange and horn-loaded tweeter. Lower crossover frequency 200 cycles, tweeter takes over at 3,500 cycles. *Regal 300* in 25 x 14 x



13½-inch bookshelf enclosure. Response 35 to 18,000 cycles. power-handling capability 70 watts program material, impedance 8 ohms. Midrange speaker in isolated chamber to prevent interaction with woofer rear-wave pressures.—**Electro-Voice, Inc.,** Buchanan, Mich.

SPEAKER SYSTEM for PA or stereo use. *Rocket* has approximately 20% efficiency. Response 80 to past 15,000 cycles. Impedance 8 ohms; power-

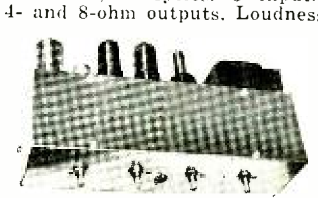


handling capability, 4 watts. Operates somewhat like horn, but has superior characteristics. Horizontal dispersion angle 140°, vertical 80°, eliminating necessity for "stereo seat." Place on furniture or hang upside down on wall.—**Karlson Associates, Inc.,** 433 Hempstead Ave., W. Hempstead, N. Y.

TONE-ARM LIFT clips onto pickup arms without tools. Spring steel with resilient plastic covering. Allows needle to

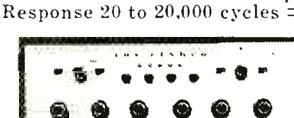
be placed in proper groove (or band) without fumbling.—**Clevite Walco,** 60 Franklin St., E. Orange, N. J.

AMPLIFIER CHASSIS *model M-2*. Flat design for low-clearance installations. Response 20 to 30,000 cycles. 3 inputs, 4- and 8-ohm outputs. Loudness



control, tone controls, program-selector switch. May be paired for stereo use. 12 watts.—**Model Engineering & Manufacturing, Inc.,** 56 Frederick St., Huntington, Ind.

AUDIO CONTROL has 10 high-level, 8 low-level inputs. Sonic null balancing for perfect stereo balancing without guesswork. *Model 400-CX*: channel blending eliminates "hole-in-middle." Center-channel output. Response 20 to 20,000 cycles ±½



db. Hum and noise more than 80 db below rated output for high-level input. Lights indicate mode of operation. Scratch and rumble filters. 10 tubes.—**Fisher Radio Corp.,** 21-21 44th Drive, Long Island City 1, N. Y.

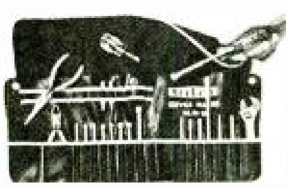
VOLTAGE REGULATOR adjusts for line-voltage changes. 4-position switch feeds line voltage direct, increases line

voltage 10%, decreases line voltage 10% and shuts off equipment. *Model LR-10* handles up to 350 watts.—**Vidaire Electronics Mfg. Corp.,** 44 Church St., Baldwin, N. Y.

SILICONE SPRAY in 6- and 16-ounce size. Nonvolatile liquid deposited by spray excellent lubricant for rubber, leather, canvas, metal surfaces, fishing

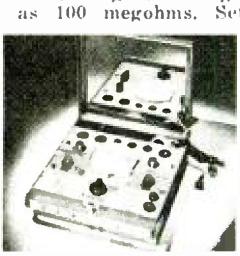
reels, etc. Stops sticking, squeaks. Repels water. Does not wash off readily. Colorless. No thickening with age.—**Krylon, Inc.,** Norristown, Pa.

TOOL KIT *model 99SM* has 99% of tools required by technicians on calls. High-carbon steel shafts, polished nickel



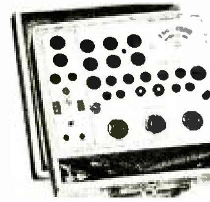
chrome finish. 23 pieces, screwdrivers, nutdrivers, reamers, pliers, extension blade and 6-inch wrench.—**Xcelite, Inc.,** Orchard Park, N. Y.

TUBE TESTER *Mighty Mite* tests for cathode emission, interelement shorts, gas, grid emission and grid leakage as high as 100 megohms. Setups



are made with help of small attached booklet (new charts provided free). 3½-inch meter glows in dark for easier back-of-set servicing. Stainless-steel mirror in case lid. Separate inner chassis removable from case for caddy or counter mounting.—**Sencore,** Addison 2, Ill.

TUBE TESTER checks quality of over 700 tube types. *Model 102-P* checks emission; for gas,

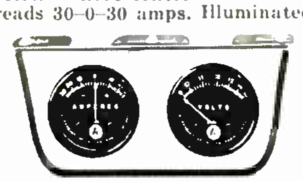


leakage and shorts. Multisection tubes each section checked separately. Tests crystal diodes, power rectifiers, pilot lamps and fuses. Oak carrying case, etched aluminum panel. New charts issued periodically. *Model AD-1* available for testing monochrome and color picture tubes for emission, shorts and gas.—**Mercury Electronics Corp.,** 77 Searing Ave., Mineola, N. Y.

TUBE TESTER *TE-15* indicates shorts and quality. Slide

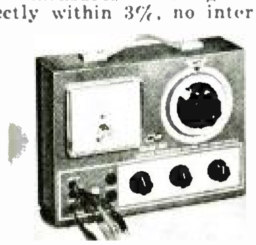
switches connect tube elements to respective circuits. Power switch for high or low line voltage. Slide-out tray contains tube charts. Meter scale calibrated 0 to 100 plus replace-?-good scale. Separate scale for diodes.—**Lafayette Radio,** 165-08 Liberty Ave., Jamaica 33, N. Y.

AMMETER-VOLTMETER for car and boat electrical system monitoring Kit *No. 83Y711,* 12-volt systems only. Expanded-scale voltmeter reads 9 to 15 volts. Zero-center ammeter reads 30–0–30 amps. Illuminated



by vibration-proof pilot lamps. Supplied with cables and information on voltage-regulator adjustments.—**Allied Radio Corp.,** 100 N. Western Ave., Chicago 80, Ill.

TRANSISTOR TESTER *model 160* measures beta (gain) directly within 3%, no interpola-



tions. Tests for leaky or open junctions. Automatically provides proper bias for 2nd base in tetrodes. Supplies metered dc for servicing transistor radios. Operates on 105 to 125 volts ac. Will not burn out transistor being tested.—**B. & K. Manufacturing Co.,** 1801 W. Belle Plaine, Chicago 13, Ill. END

All specifications from manufacturers' data.

TECHNICIANS' NEWS

NEW YORK DISTRIBUTORS FIGHT STATE LICENSING

Jobbers in Rochester, Buffalo and New York City were largely responsible for a drive to kill the proposed N. Y. State TV technician licensing law, according to an article by James C. Kinkaid, editorial director of *Jobber News* Magazine. In the April, 1960, issue of that journal, he said that the jobbers fighting the measure were confident that the State Legislature would adjourn without getting the legislation out of committee although it was supported by Gov. Nelson Rockefeller and State Attorney General Louis J. Lefkowitz. They were right, neither bill was reported out of committee when the Legislature adjourned.

The *Guild News*, organ of the Radio & Television Guild of Long Island, has published a list of the jobbers in the guild area that fought the bill and suggests that technicians not deal with these firms.

Jobber News had a list of the anti-licensing dealers throughout the state. More than 30 firms—most of them in New York City—were listed.

BBB LISTS CODE OF ETHICS

The Better Business Bureau of Greater St. Louis, Inc. (Ill.) has published "Standards of Advertising and Code of Ethics" for the service industry.

Some of the points covered in the code are:

Employ qualified (and adequately trained) personnel and use approved methods and equipment.

Advertise in a manner fair to both customers and competitors.

Render service promptly and proficiently.

Give an advance estimate and perform only authorized repairs.

Install parts of equal or better quality and performance rating. Return all parts and tubes to the customer on request, except parts in warranty or on an exchange basis.

Issue an itemized bill.

A few of the points covered in the Standards of Advertising are:

No firm shall represent itself as an authorized service company for a manufacturer when such is not the fact.

Offers of gifts or premiums shall not be used.

Bait advertising and selling practices shall not be used.

There shall be no quotation of a price or prices for service calls. It is permissible, however, to advertise prices for service contracts.

Exaggerated claims such as "Lowest prices in ——" shall not be used.

Statements comparing the advertisers service with a competitor shall not be used. An advertiser shall not attempt to discredit a competitor.

NEW LOCAL FORMED

Thirty TV service dealers in the Canton, Ohio, area have formed the Television & Electronic Service Association of Stark County (TESA Stark County).

Royal Lister has been named chairman; Bruce Sullivan, president; Robert Wood, vice president; Al Roberson, secretary, and W. O. Phillips, treasurer.

Directors are Ben Lowe, Horace Williams and Daniel A. Scipione.

The group has adopted a code of ethics including home servicing of sets where possible, service within 24 hours and presenting estimates before major repairs are made.

JOINS COUNCIL

The Radio Servicemen's Association of Trenton, N. J., has joined the Tri-State Council of TV Service Associations, according to the *Vanguard*, organ of the council. The Tri-State Council covers Delaware, New Jersey and Pennsylvania.

TESA MIAMI ELECTS

The Television & Electronic Service Association of Miami, Inc., has elected new officers. In order of their appearance in the photograph, they are: (left to right, back row) Charles D. Pierce, 2nd vice president; Roger Misleh, 1st vice president; James J. Ross, corresponding secretary; Sam Kessler, recording secretary; (front row) C. W. Minter, treasurer, and A. Edward Stevens, president.

PRESIDENT RESIGNS

Ken LaRue has resigned as president of the North Carolina Federation of Electronic Associations, Inc., according to *The Printed Circuit*. He explained that his business has recently been a great deal more inclined toward sales, instead of service, and he must correspondingly devote a large portion of his time toward sales.

As provided by their Constitution, the vice president, Charles McBroom, took over the vacated office of president.

Secretary Ray Stanley also resigned. Garland Hoke, a Director, agreed to take over as acting secretary until September.

BILL TO BE RE-INTRODUCED

The Empire State Federation of Electronic Technicians Associations (ESFETA) expects to have a television-technician licensing bill re-introduced into the next session (starting in January) of the New York State Legislature, according to Robert Larsen, executive director of Radio & Television Technicians Guild of Long Island. The Legislature closed their last session without passing a previously introduced license bill. It caused considerable debate among technicians and their suppliers.

A group of 10 Buffalo, N. Y., electronic parts distributors, opposing the bill stated that it would cut down on the supply of future electronic technicians. They claimed the apprentice clause in the bill would restrict the entry of new technicians because apprentices cannot earn a living wage. A resolution drawn up by the dealers and sent to the State Senate and Assembly stated that the proposed law would not fulfill its objectives, and TV prices would rise because of the closed shop the legislation would produce. The resolution also hit the legally necessary grandfather clause, saying that it accepts technicians who may be cheats or incompetent and gives them an implied indorsement. John A. Wheaton, of the Guild, answered this statement in a letter to *Home Furnishings Daily*, pointing out among other things that the grandfather clause is a constitutional protection needed so that individuals cannot be legislated out of their livelihood.

He went on to say that the argument against the apprentice clause actually admits "the present low level of income in the trade. The . . . license bill would provide a healthier TV service field, and a more attractive one for young people to enter".

NATESA DIRECTORS MEET

National Alliance of Television & Electronic Service Associations directors held their annual spring meeting at Tulsa, Oklahoma. As was promised by TESA Oklahoma president, H. O. Eales, a working oil well was given away. It was rolled into the room on a dolly, plugged in and presented to Vincent Lutz, past president of NATESA.

TESA's Chicago Director reminded all present that the general NATESA convention is to be held Aug. 19-21 at the Sheraton Towers Hotel in Chicago.

AREN'T YOU ON THE LIST?

RADIO-ELECTRONICS is publishing a list of *known* service associations in North America. Areas covered so far are: Pennsylvania, New York, Ohio, Iowa, North Carolina, Kansas, Arizona, Michigan, California, Ontario (Canada), Massachusetts, Missouri, Minnesota, Florida and Montana. The listings started in the August, 1959, issue, and can be consulted for the name of the Association nearest you. *If you belong to an association that has not been listed, let us know about it.*

States that seem reluctant to admit that they have any activity are Arkansas, Connecticut, New Hampshire, Oklahoma, Rhode Island and Texas. Alaska and Hawaii seem to have no activity at all.

To list an association or to find out the name of the one nearest you, write to: Associations Editor, RADIO-ELECTRONICS, 154 W. 14 St., New York 11, N. Y.

FLORIDA

TELEVISION & ELECTRONIC SERVICE ASSOCIATION OF MIAMI, INC. (TESA MIAMI)
James J. Ross, corres. sec'y
(M. Reiser, acting corres. sec'y)
119 N. W. 12 Ave.
Miami

TELEVISION & ELECTRONIC SERVICE ASSOCIATION OF ST. LUCIE COUNTY (TESA-St. Lucie County)
Leonard Appel, secretary
130 So. 4 St.
Fort Pierce

TELEVISION SERVICE DEALERS ASSOCIATION OF PALM BEACH (TSDA Palm Beach)
Roy Batton, president
407 Flamingo
W. Palm Beach

ELECTRONIC SERVICE ASSOCIATION OF BROWARD COUNTY (ESA Broward County)
Hamilton Boyd, secretary
901 N.W. 4 Ave.
Fort Lauderdale

TELEVISION SERVICE DEALERS ASSOCIATION OF ST. PETERSBURG (TSDA St. Petersburg)
Bud Fox, president
P. O. Box 2711
St. Petersburg

JACKSONVILLE ELECTRONICS TECHNICIAN SOCIETY (JETS)
Dale Andrews, president
906 San Marco Blvd.
Jacksonville

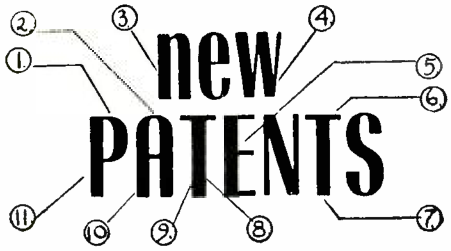
TALLAHASSEE TELEVISION & ELECTRONICS ASSOCIATION
Don Birch, secretary
213 College Ave.
(Ramm's TV Service)
Tallahassee

MONTANA

ELECTRONIC SERVICE ASSOCIATION OF BUTTE MONTANA (ESA)
Raymond G. Tuszynski, president
James Glase, corres. sec'y
Templars Hall
215 No. Main St.
Butte

RETAILERS' TAX

All "offerers of service" are required by law to register with the Illinois Department of Revenue as do retailers, according to *NATESA Scope*. They go on to say that the names of all known service offerers in the state have been turned over to the department for cross checking to see if they are registered. Anyone not found on the list will be advised to cease operations or register. After this, arbitrary bills for back taxes will be issued, followed by court judgments and levies. Serious offenders are being processed for criminal-violation prosecution. END



new PATENTS

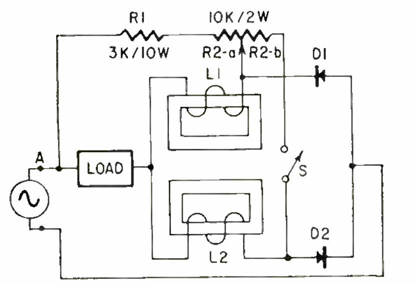
MAGNETIC AMPLIFIER

Patent No. 2,907,947

Stephan Steinitz, St. Louis, Mo. (Assigned to Vickers, Inc., Detroit, Mich.)

This amplifier's power windings serve for control as well. Power from the line flows for one half-cycle through D1 and L1. During the other half, D2 conducts flow through L2. The power is limited by the reactors.

Shunt circuit R1, R2-a acts to increase the power. This is accomplished by partly or fully



saturating the core of L1. To show this, assume that A goes positive. Current through the shunt circuit flows into both reactors in the *saturating* direction. Reducing R2-a permits greater current and therefore more power in the load. At the same time, R2-b must increase. Note that this resistor shunts both diodes, so permits current in the *desaturating* direction through the reactors.

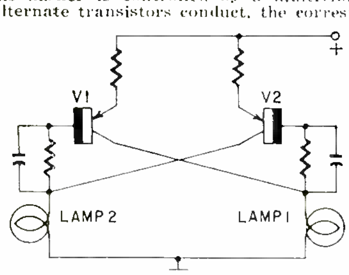
The inventor notes that a 200-watt lamp can be dimmed with a 3,000-ohm 10-watt resistor for R1 and a 10,000-ohm 2-watt potentiometer R2. Power is reduced by adjusting the potentiometer arm to the right. This increases R2-a, which reduces saturation. It also decreases R2-b, which permits greater desaturation.

ELECTRONIC FLASHER

Patent No. 2,916,670

Helmer T. Pederson, Solana Beach, Calif. (Assigned to Bill Jack Scientific Instrument Co., Solana Beach, Calif.)

This flasher is controlled by a multivibrator. As alternate transistors conduct, the correspond-



ing lights go on. For example, V1 corresponds to lamp 1, etc. The flasher can also operate with a single lamp, a resistor substituting for the other lamp.

DIODE COMPARATOR

Patent No. 2,912,582

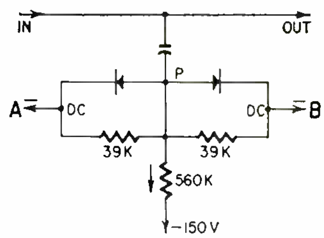
James R. Davey, Franklin Township, N. J. (Assigned to Bell Telephone Labs, Inc.)

This circuit indicates when one signal (at A) matches another (at B). The gate is symmetrical so A and B may be interchanged. The signal may be either −1.5 or −13 volts.

When signals at A and B are equal, both diodes block and permit pulses to pass from input to output. When they are unequal, one diode conducts to short out the input. The following chart illustrates this point:

A	*B*	*P*	*output*
−1.5	−13	−13	no
−1.5	−1.5	−6.5	yes
−13	−13	−18	yes

When the bias at P is more negative than A or B, both diodes block and the input is transmitted.



Otherwise (see first case in previous chart) the pulse is shorted out through a diode.

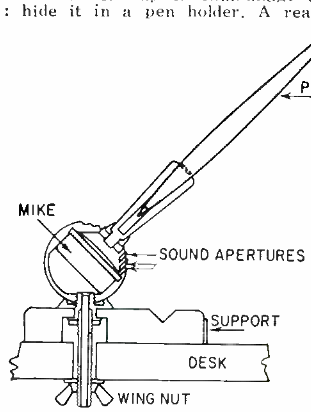
An unknown quantity may be measured as follows. Using binary notation, a "zero" may correspond to −13 volts and a "one" to −1.5 volts, and we need as many gates (see diagram) as we have digits in the unknown number. The known number is applied at B (of each gate). To make the measurement automatic, the known is varied rapidly through all possible combinations. When it is equal to the unknown number (which remains constant), a light can flash on or a relay can be energized to indicate that fact.

HIDDEN MICROPHONE

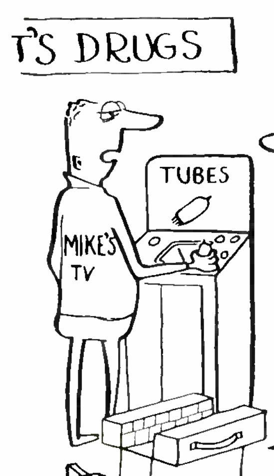
Patent No. 2,901,552

Giovanni Geloso, Milan, Italy

Here is a novel way to camouflage a microphone: hide it in a pen holder. A real pen is



inserted into the holder to make it look real. The holder is tied down on a desk as illustrated. The cable for the mike may be passed through a hole in the desk. END



"Ours is broken."

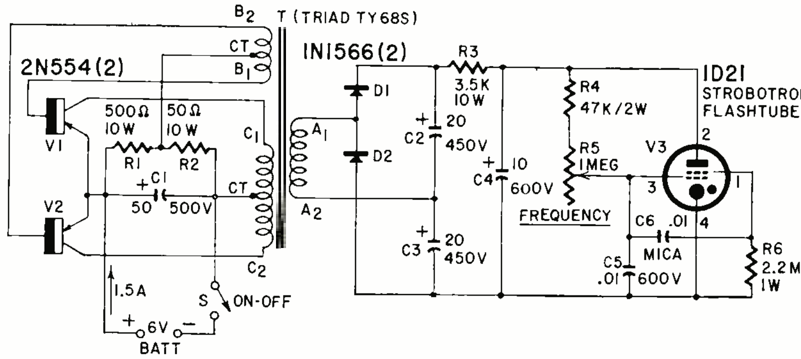
NOTEWORTHY CIRCUITS

BATTERY-OPERATED STROBOSCOPE

The diagram shows the circuit of a simple stroboscope operated from a 6-volt battery. Since no power-line connections are needed, this instrument will be useful in field applications for speed and rate measurements and for freezing machinery in motion. The strobe's flashing rate is continuously variable between 10 per second (600 per minute) and 112 (6,720 per minute).

The power supply consists of a transistor chopper with two inexpensive power transistors (Motorola 2N554), a transistor transformer (T) and a voltage-doubler circuit made up of two silicon diodes (D1 and D2, Motorola 1N1566), three electrolytic capacitors (C2, C3 and C4) and a filter resistor (R3). When the instrument is in operation, 1.5 amperes are drawn from the 6-volt battery. For short-term operation, a hot-shot battery (or some smaller type) may be enclosed in the stroboscope case.

Bright orange-red flashes are obtained from the strobotron tube (Syl-

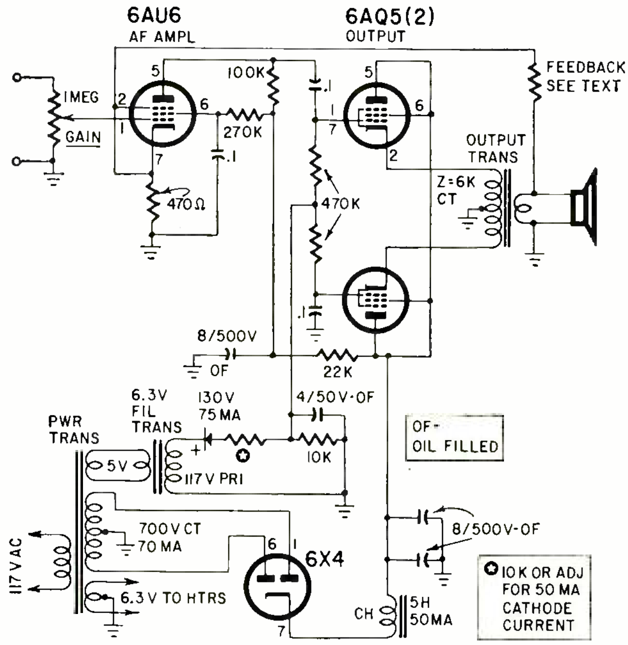


R1—500 ohms, 10 watts
R2—50 ohms, 10 watts
R3—3,500 ohms, 10 watts
R4—47,000 ohms, 2 watts
R5—pot, 1 megohm
R6—2.2 megohms, 1 watt
C1—50 μf, 500 volts, electrolytic
C2, 3—20 μf, 450 volts, electrolytic
C4—10 μf, 600 volts, electrolytic
C5—.01 μf, 600 volts, paper
C6—.01 μf, 600 volts, mica
BATT—6 volts
D1, 2—1N1566
S—spst toggle
T—power transformer, toroidal: primary, 12 volts; secondary, 250 volts, 65 ma (Triad TY68S)
V1, 2—2N554
V3—1D21
Chassis and case to suit
Miscellaneous hardware

vania 1D21). This tube takes a four-pin socket and may be mounted in a flash-gun type reflector to intensify the flashes. Potentiometer R5 is the frequency control. It regulates the flash rate of the stroboscope.—*Rufus P. Turner*

CATHODE-FOLLOWER AMPLIFIER

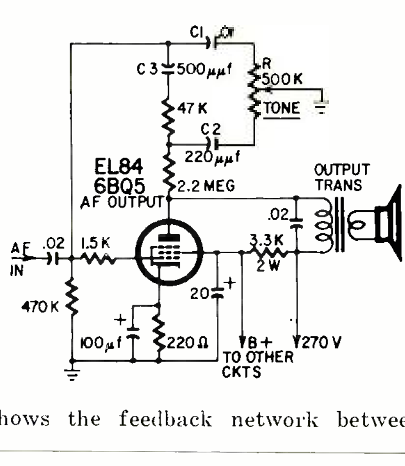
This cathode-follower amplifier is comparatively simple and inexpensive. Except for the oil-filled capacitors, if you use electrolytic capacitors in place of the specified oil-filled units, increase the capacitance somewhat. The



standard components are used throughout. The power supply may look a little unusual, but it insures safe operation by isolating the ac line from the bias supply. No hot chassis with this arrangement. Values are not critical, but primary impedance of the output transformer is about half that used in a conventional triode output stage. If desired, feedback can be added. A little experimenting will show how much.—*Richard Youse*

FEEDBACK TONE CONTROL

A clever tone control is used on some Radialva TV receivers. The diagram



shows the feedback network between the plate and grid of the audio output tube.

Tone is controlled by potentiometer R. When its arm is turned fully counterclockwise, capacitor C1 is connected between grid and ground produces treble cut. C2 is ineffective because of the pot's high resistance.

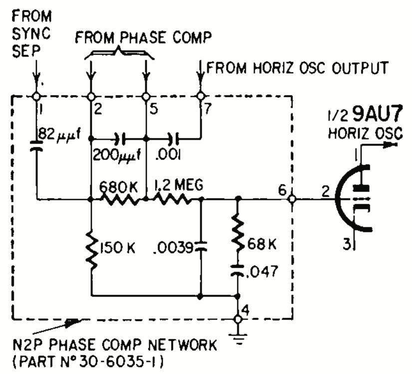
When R is turned fully clockwise, capacitor C2 is connected between feedback and ground, thus reducing feedback at high frequencies and producing treble boost. This time C1 has no effect because of the pot's high resistance. The exact operation of the circuit is somewhat complicated since the feedback network is frequency-sensitive because of C3. This capacitor produces some medium cut.—*Martin de France*

END

Technotes

PHILCO 9H25U

The set came in with very critical horizontal hold. At times the picture would float (showing the horizontal blanking bar) and the horizontal sync would lock in, it was very jittery. Re-



sistance measurements showed more than 2 megohms between the chassis and pin 2 of the 9AU7—an abnormally large reading. Circuit checks revealed the cause, the 680,000-ohm resistor between points 2 and 5 of the N2P phase-comparator network was open.—*W. G. Eslick*

BENDIX T20 CHASSIS

If you work on the tuner in these sets and when you are finished find that the set isn't working, check the two rear mounting screws on the tuner. Be sure that each one has a cup washer on it. If not, the mounting screws project too far into the tuner and sometimes short out a lead.—*Ray Baum*

MAGNAVOX CT257

Horizontal and vertical sync were both unstable. On some channels the picture would jitter horizontally and roll intermittently but for the most part the hold was almost uncontrollable.

The customer advised me that another technician replaced the picture tube recently and it was only since then that the set was behaving this way. I listened politely but quickly dismissed this explanation as another dissatisfied customer complaint.

When all else failed, the set was taken to the shop. The first point I tried to establish was whether the trouble lay in the sync circuits or the agc circuit so I hooked up an external agc bias supply. There was a slight improvement in sync stability but not enough to warrant further examination of the agc system.

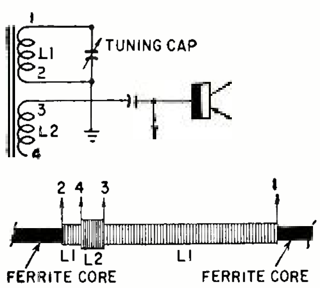
Therefore, I concentrated on the sync circuits. Every capacitor was checked by direct substitution and every resistor was okayed. The waveform at the output sync stage was obviously distorted but I could find no apparent cause for it. The previous agc test eliminated that part of the receiver as the source of trouble so I was in a quandary.

I stopped for a moment to reconsider what the customer had told me and wondered if she possibly could have been on the right track. Two points were noted: the picture tube had no Aquadag coating and the tuner shield was missing. Was it possible, I wondered, that the picture tube was radiating into the tuner and distorting the sync pulses without noticeably affecting the video quality. An old tuner shield immediately answered that one for me—as soon as it was clipped into place the sync pattern cleared up and the picture took hold.—*Frank A. Salerno*

LOOPSTICK TRACKING

Ferrite-core antennas are used almost exclusively in transistor radios. If one is replaced, it may need adjusting for satisfactory tracking.

The sketch shows the usual circuit and the physical connections to the antenna. Tracking is adjusted by removing turns from the long coil (L1) at the end away from the secondary coil (L2). Turns should not be removed



from terminal 2, since mutual coupling to the low-impedance transistor coupling coil (L2) may be upset. Take off turns at lead 1 a couple at a time.—*Lawrence Shaw* 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
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 July, 1910, Modern Electrics

A New Franch Telephote [Television] Apparatus, by Frank C. Perkins.
The Gernsback Detectorium, by A. C. Austin, Jr.
Tubular Variable Condenser, by H. Linde.
The Poulsen System of Wireless Telephony and Telegraphy, by C. F. Elwell.
High Frequency Oscillations, by Moore Stuart.
An Ingenious Wireless Transmitter.
Image Transmitting Devices, by A. C. Marlowe.
Simple Detector, by I. L. Riley.
Cleat Insulators, by Eugene Wulff.
Automatic Break Switch, by Harold Peterson.

SOLDERING-TOOL MAINTENANCE

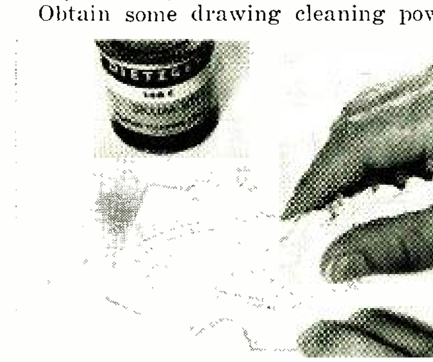
In addition to keeping your soldering gun's tip tinned, check to see if the screws or nuts that hold the tip in place are tight. Loose screws or nuts mean a poor electrical contact and reduced tip temperature and soldering efficiency. If you work with an iron, do you ever take time out to unscrew the tip or loosen the setscrew (if yours has one) and remove the tip? If this isn't done occasionally, the tip may become frozen in place and very difficult to remove. Should that happen, soak the tip in ammonia to loosen it.—*Charles A. Cunningham*

BRIGHTEN METER SCALES

Meter and instrument scales ultimately get dull and dirty-looking. Cleaning is difficult because of soft easily scratched surfaces, and the printing or lithographing.

We have found only one satisfactory way of cleaning meter faces, but it really does a good job.

Obtain some drawing cleaning pow-



der from a stationery store or one that deals in engineering drawing supplies. Then sprinkle the meter face with the powder and rub with a rotary motion using a soft cloth or piece of paper toweling. A second application may be necessary.

The result will be a beautifully and uniformly clean instrument dial.—*Edwin Bohr*

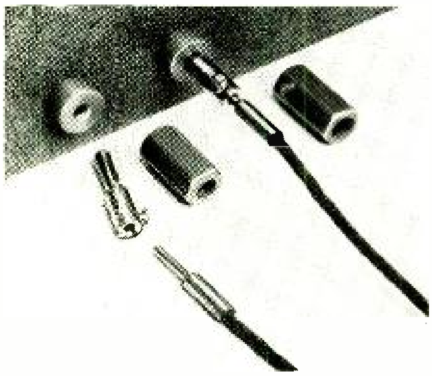
DUAL CONTROL ASSEMBLY

When replacing dual controls in a TV set with a unit assembled from a control kit, use a little lubricant between extension shafts before fastening the sections together. Some controls have a tendency to be rough when first put together. The lubricant corrects the condition.

A moment's consideration before the control is assembled will prevent the time-consuming job of taking it apart again, or turning out a job with that scratchy feeling.—*George D. Philpott*

PHONE-TIP ADAPTER

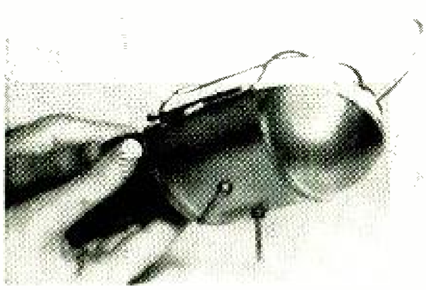
In electronic servicing and experimental work, we sometimes want to plug phone tips into banana jacks. To do this quickly and easily, some sort of adapter is needed. A simple solution



to the problem is to buy a couple of ICA solderless banana plugs and use them as adapters, as shown in the photo. You will find the openings on the back ends of the solderless banana plugs just the right size for phone tips which are locked in place with the setscrews on the banana plugs.—*Art Trauffer*

STAY-PUT TROUBLE LIGHT

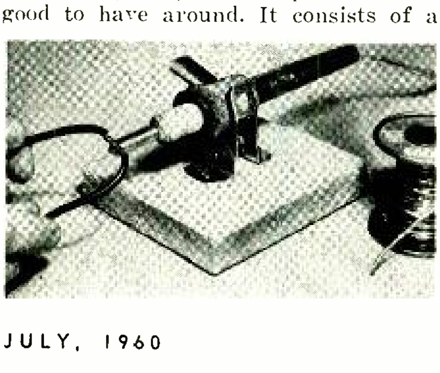
If you use a trouble light like the one shown, you know just how difficult it is to make it stay put on a flat sur-



face. Keep the light from rolling out of position by adding a couple legs. Drill two holes through the reflector and insert a 1¼-inch long machine screw in each as shown.—*John A. Comstock*

SOLDERING-IRON HOLDER

When you need both hands free for a soldering job, this simple holder is good to have around. It consists of a



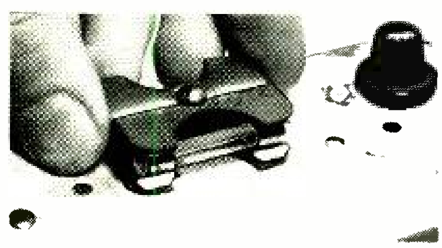
spring type broom clip fastened to a block of wood. A hole drilled in the base lets you hang the whole works on a nail driven into the shop wall, when the holder isn't in use.—*John C. Alexander*

TENT FOR LIGHTNING ARRESTER

The moisture that collects on a TV's lightning arrester during wet weather tends to short out the TV signal and impair reception. When it is mounted on the outside of a window sill or any other place where it is exposed to the weather, it's a good idea to tack a transparent plastic tent over it. Cut the tent from an old plastic bag or some other plastic material.—*Clyde A. Compton*

FUSE HOLDER FOR SPARES

A snap-on fuse holder, the kind used when replacing a pigtail fuse with an



ordinary tubular fuse, makes a good holder for a couple of spare fuses. Simply cement the holder to a vacant spot on the chassis and snap a couple of spares into it.—*Alex Carlton*

SHOCK-ABSORBING RIDE

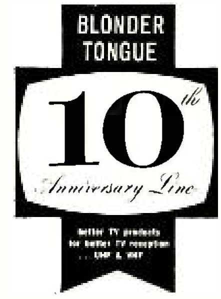
When you have to deliver a TV to a customer over a rough country road, rest the set on a partly pumped-up inner tube placed on the floor in the back of your service truck. The inner tube will absorb all of those rough jolts that could otherwise jar something loose and cause trouble. Carry one of these TV cushions and you can be sure the set will still be in operating condition when you reach your destination. For console radio–TV–record player combinations, use two inner tubes.—*Charles Abraham* END

Answer to "Roundword Puzzle," page 31

[1]M	E	[2]G	I	L	B	E	R	[3]T	R	A	N
E	M	E	N	[8]T	E	T	R	O	D	[9]E	S
L	[14]N	O	V	I	C	[15]E	C	[16]O	S	L	I
[7]E	O	T	E	R	E	[20]O	H	[21]M	C	E	S
R	R	[19]S	A	[24]Y	[25]L	O	O	H	I	C	T
E	T	C	L	A	N	I	[26]P	[22]O	L	T	O
P	A	[18]N	E	M	M	U	L	S	L	R	[4]R
M	R	O	[23]R	R	E	[27]G	U	C	O	O	E
A	Y	I	O	T	A	L	L	I	S	S	G
O	H	S	S	I	M	[17]E	P	O	C	T	E
R	[13]T	L	O	[12]V	W	[11]W	[10]C	I	T	A	N
C	I	[6]M	F	B	[5]N	O	I	T	A	R	E

BUSINESS and PEOPLE

Blonder-Tongue Labs., Inc., Newark, N. J., launched the biggest advertising program in its history in support of its new 10th-Anniversary line of TV reception improving products. A specially designed symbol identifies products in the line and space ads will be run in trade and special interest magazines, including RADIO-ELECTRONICS. A consumer program supports the company's FM and FM–AM radio line.



Jensen Industries, Forest Park, Ill., is using a series of colorful 12 x 10-inch counter cards to introduce its new Perfectone phonograph needles in sapphire and diamond tips.

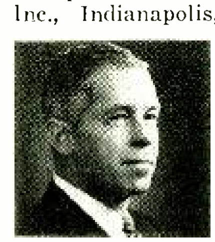
Vaco Products Co., Chicago, Ill., is offering electronic parts distributors a Walking Display attaché case for outside salesmen. It contains a series of speciality tools for electronic technicians.

Edward Crowley joined Jensen Industries, Forest Park, Ill., as assistant to the president. Previously he was executive vice president and director of Fidelitone.

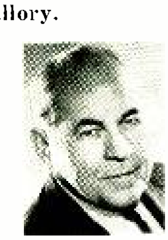
United Catalog Publishers, Inc., Hempstead, N. Y., celebrates the 25th anniversary of *The Radio-Electronic Master* this year. Arthur I. Rabb, general manager of the company, sets up a giant silver replica of *The Master* in the company's reception room as Samuel Roth, president, looks on.

Charles F. Adams (left) was elected chairman of the board of Raytheon Co., Waltham, Mass. **Richard E. Krafve** succeeds him as president. Krafve, former vice president of Ford Motor Co., joined Raytheon in the spring of 1959 as group vice president, commercial. In September, he was elected executive vice president and a director.

G. Barron Mallory, administrative vice president of P. R. Mallory & Co., Inc., Indianapolis, Ind., was elected president succeeding **Joseph E. Cain. Philip R. Mallory** was re-elected chairman of the Board of Directors. Cain was elected co-chairman of the Board of Directors and chairman of the Executive Committee, succeeding **J. F. Riely** who remains a member of the Executive Committee together with **C. Harvey Bradley** and **G. B. Mallory.**



Oden F. Jester joined Merit Coil & Transformer Corp., Hollywood, Fla., as general sales manager. He has been a sales executive in the electronic industry for many years, including such posts as radio sales manager of Stewart-Warner Corp., vice president and general sales manager of the original Utah Radio Products Co., and distributor sales manager of Standard Coil Products Co.



J. B. Farese was elected division vice president, Entertainment Tube Products Dept., for the RCA Electron Tube Div., Harrison, N. J., and **C. E. Burnett**, division vice president, Industrial Tube Products Dept., Lancaster, Pa. **Martin F. Bennett** was named vice president, distributor and commercial relations; **Carl V. Bradford**, staff vice president, Eastern distributor and commercial relations at Cherry Hill, N. J., **Harold A. Renholm**, staff vice president, Central distributor and commercial relations, Chicago; **Harold R. Maag**, staff vice president, Western distributor and commercial relations, Hollywood, Calif.

Theodore Lindenberg is now director of engineering for Astatic Corp., Conneaut, Ohio. He comes to the company from Pickering Co., Plainview, L. I., N. Y., where he served as chief engineer.

David B. Tolins was appointed manager of the newly consolidated advertising, sales promotion and merchandising activities of the Semiconductor Div. of Sylvania Electric Products, Inc., Woburn, Mass. He had been division advertising and sales manager.

Don Kirkendall was promoted to advertising manager of Electro-Voice, Inc., Buchanan, Mich., from assistant advertising manager.

Ira Molay (left), sales engineer for CBS Electronics Div., Danvers, Mass.,

was promoted to product manager, audio components. **Kenneth A. Waldron**, manager of Government sales, is now marketing manager for government and industrial products.

Stuart D. Cowan was elected vice president, commercial marketing and international services, of Raytheon Co. Waltham, Mass. He was formerly director of commercial marketing services. **John E. Gagnon, Robert L. McCormack** and **Dr. Martin Schilling** were also elected vice presidents of industrial relations, industrial components, and Government programs and planning, respectively. Gagnon had been director of employee relations; McCormack, general manager of the Industrial Components Div., and Dr. Shilling, assistant for program planning on the corporate staff. END

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.

VOLTAGE REGULATOR of the tubeless magnetic-amplifier type supplies 10 to 25 amperes at 130 volts dc (or less) for field winding of ac generators. Input is taken from generator's output, making generator self-excited. *Bulletin 3300* describes this magnetic-amplifier regulator–exciter. — **Fidelity Instrument Corp.**, 1000 E. Boundary Ave., York, Pa.

SERVICING MANUAL that shows diagrams of all of the important 1960 TV sets is described in a 4-page folder. Also covered are radio servicing manuals and a TV service course.—**Supreme Publications**, 1760 Balsam Rd., Highland Park, Ill.

RECORDING SPECTROPHOTOMETER for measuring the color of materials is described in *Bulletin GEZ-3031*. Operating principles, accessories and specifications are given in 12-page booklet.—**General Electric Co.**, Schenectady 5, N. Y.

POWER SUPPLIES, transistor-type, are described in a 4-page folder. The company's ST series covers the range from 0 to 18 volts dc at up to 6 amps to 0 to 100 volts at up to 10 amps.—**Mid-Eastern Electronics, Inc.**, 32 Commerce St., Springfield, N. J.

MINIATURE LAMPS and who makes them are listed in *Miniature Lamp Data*. Drawings of bulb shapes, bases and filament styles are also shown. Voltage, current and life information is given in tabular form.—**Chicago Miniature Lamp Works**, 1500 N. Ogden Ave., Chicago 10, Ill.

COMPONENTS to help design engineers plan and package circuitry are listed in *Quick Order Guide*. Racks, sockets, indicators and hardware are among the components listed.—**Alden Products Co.**, *Dept. QOG-96*, 117 North Main St., Brocton 64, Mass.

AUDIO FILTERS AND TOROIDS are listed in a 4-page catalog. A new standard line of encapsulated toroids is described and illustrated. Typical performance curves are shown. Information is given on how to specify style and types of leads when ordering.—**Barker & Williamson, Inc.**, Canal St. and Beaver Dam Rd., Bristol, Pa.

PUSHBUTTON SWITCHES are available in single- and double-row assemblies of from 4 to 12 stations. *Bulletin No. 7000* gives detailed specifications, photographs and dimension drawings. Switches have interlocking action and may be illuminated if desired.—**Donald P. Mossman, Inc.**, Brewster, N. Y.

FUSION-SEALED RESISTORS use tin-oxide film as resistive element and are completely moisture-proof. The film is fused to the surface of a glass rod, then the assembly is encapsulated in glass. Available in 1/8- and 1/4-watt sizes. Request data sheet *CE-2.02* on company letterhead. — **Corning Electronic Components, Corning Glass Works**, Bradford, Pa.

SEMICONDUCTOR HANDBOOK lists units by type (small-signal audio, low-speed switching, high-speed switching, etc.). Parameters of more than 750 semiconductors are given. Also covered are silicon capacitors. — **Radio Shack Corp.**, 730 Commonwealth Ave., Boston 17, Mass.

AMPLIFIERS, splitters and outlet wall plates for TV distribution systems are described in an 8-page catalog.—**Delta Electronics**, Queen Elizabeth Way, Clarkson, Ontario, Canada.

MECHANICAL FILTERS are listed on data sheet *CR-WD-1005*. Case styles are illustrated along with detailed dimensions. Frequency range covered is 250 to 500 kc. Single-sideband filters range from 60 to 455 kc.—**Collins Radio Co.**, Western Div., 2700 W. Olive Ave., Burbank, Calif.

APPLICATION GUIDE gives information on transistor use in chart and graph form. A typical graph shows transistor gain (in a practical circuit) plotted against frequency. — **Philco**, Lansdale Div., Lansdale, Pa.

MULTICOUPLER PERFORMANCE is the title and subject of this 17-page booklet. When feeding several communication receivers from a common antenna, a multicoupler is necessary to prevent mismatches and spurious signals. The problem of selecting the correct multicoupler for a particular system is covered in detail.—**Trak Electronics Co.**, **Div. C. G. S. Labs., Inc.**, 59 Danbury Rd., Wilton, Conn.

SEMICONDUCTOR SUBSTITUTION for the practicing service technician is simplified by *Semiconductor Complement Manual*. It lists radios and audio equipment by brand name and model number, all the transistors, diodes, and rectifiers in them. Next to each semiconductor the correct Sylvania replacement is listed (if one exists). The more popular European and Japanese makes are among the more than 60 brands of home and auto radios covered. — **Sylvania Semiconductor Division**, 100 Sylvan Rd., Woburn, Mass. 50¢.

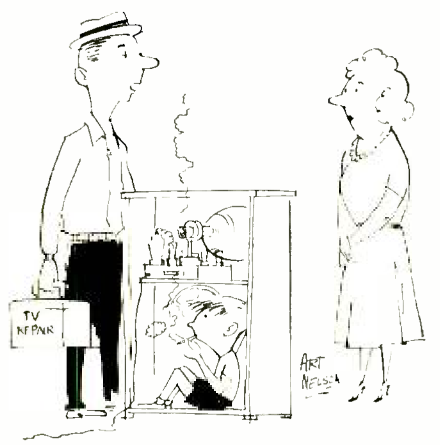
CLOSED-CIRCUIT TV equipment (cameras, lenses, monitors, control equipment, housings, and switchers) is described in a 112-page industrial catalog. Photographs of the units mentioned are shown. Write on company letterhead and request *ITV-93059*.—**Radio Corp. of America**, Closed-Circuit Television Dept., Camden, N. J.

REPLACEMENT NEEDLE chart for wall use is 22 x 24 inches. Shows several hundred common phono needles with drawing of each, grouped by manufacture of cartridge. Also shows model number of needle as indicated by cartridge maker, and list price of replacement.—**Clevite Walco**, 60 Franklin St., East Orange, N. J.

MICROWAVE WAVEGUIDE data are covered in a 14 x 21-inch wall chart called *Standard Waveguide Data Chart*. It shows military and EIA designation numbers, cutoff frequency, CW power rating, attenuation factors and mechanical dimensions. This chart can save engineers the time they formerly had to spend calculating this data.—**Narda Microwave Corp.**, 118-160 Herricks Road, Mineola, N. Y.

INDUSTRIAL INSTRUMENTS are described in a 12-page "briefalog" *No. 19-60*. Covered are high- and low-range ohmmeters, insulation testers, frequency meters, tachometers, dielectric testers, etc.—**James G. Biddle Co.**, 1316 Arch St., Philadelphia 7, Pa.

ELECTRONIC KITS for use in school science programs are detailed in an illustrated 20-page catalog—*Electronic Equipment Designed for School Systems*. Detailed descriptions of all kits are included, and the age and technical skill needed by the builder are stated.—**Arkay International**, 88-06 Van Wyck Expressway, Jamaica, N. Y. $1. END



"I've found out, ma'am, why your set's been smoking lately."

will increase their acceptability.

The Editor, RADIO-ELECTRONICS
154 West 14th St. New York 11, N. Y.

new BOOKS

diagnosis, electrotherapy and electrosurgery. Electronic readers will find the chapter on strip chart recorders and that on ultrasonics especially interesting.—*FS*

CLASS-D CITIZENS BAND CALLBOOK, 1960. International Crystal Mfg. Co., Inc., Oklahoma City, Okla. 9 x 11 in. $3.95.

This register is for persons who operate class-D, who intend getting their permit to do so or who merely like to eavesdrop on the band. It gives calls in every district, with names and addresses, and includes a map, explanation of FCC rules, plus data on antennas, tuning and frequency measurement, etc.

An application for a Citizens band permit and the complete Part 19 of the FCC rules form part of the callbook. They will help you get your name in the next callbook.—*IQ*

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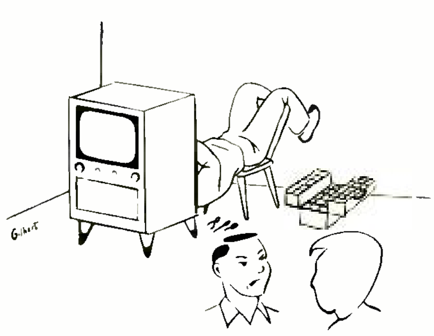


"Joe's been on car radios too long!"

the correct Sylvania replacement is listed (if one exists). The more popular European and Japanese makes are among the more than 60 brands of home and auto radios covered. — **Sylvania Semiconductor Division**, 100 Sylvan Rd., Woburn, Mass. 50¢.

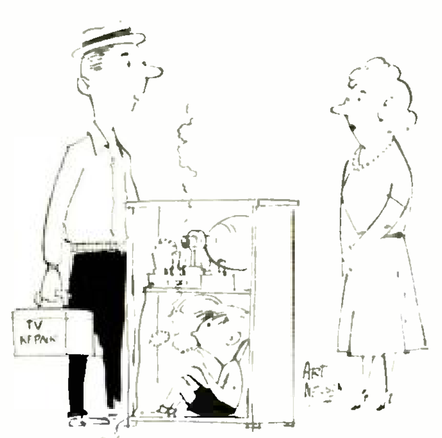
CLOSED-CIRCUIT TV equipment (cameras, lenses, monitors, control equipment, housings, and switchers) is described in a 112-page industrial catalog. Photographs of the units mentioned are shown. Write on company letterhead and request *ITV-93059*.—**Radio Corp. of America**, Closed-Circuit Television Dept., Camden, N. J.

REPLACEMENT NEEDLE chart for wall use is 22 x 24 inches. Shows several hundred common phono needles with drawing of each, grouped by manufacture of cartridge. Also shows model number of needle as indicated by cartridge maker, and list price of replacement.—**Clevite Walco**, 60 Franklin St., East Orange, N. J.

MICROWAVE WAVEGUIDE data are covered in a 14 x 21-inch wall chart called *Standard Waveguide Data Chart*. It shows military and EIA designation numbers, cutoff frequency, CW power rating, attenuation factors and mechanical dimensions. This chart can save engineers the time they formerly had to spend calculating this data.—**Narda Microwave Corp.**, 118-160 Herricks Road, Mineola, N. Y.

INDUSTRIAL INSTRUMENTS are described in a 12-page "briefalog" *No. 19-60*. Covered are high- and low-range ohmmeters, insulation testers, frequency meters, tachometers, dielectric testers, etc.—**James G. Biddle Co.**, 1316 Arch St., Philadelphia 7, Pa.

ELECTRONIC KITS for use in school science programs are detailed in an illustrated 20-page catalog—*Electronic Equipment Designed for School Systems*. Detailed descriptions of all kits are included, and the age and technical skill needed by the builder are stated.—**Arkay International**, 88-06 Van Wyck Expressway, Jamaica, N. Y. $1. END



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SERVICING HI-FI AND FM IN THE CUSTOMER'S HOME, by Milton S. Kiver. Howard W. Sams & Co. Inc., 1720 E. 38 St., Indianapolis, Ind. 8½ x 5½ in. 158 pp. $2.95.

Service technicians will find this book helpful. A wide range of rapid tests are described for all kinds of hi-fi equipment. For example, Chapters 2 and 4 show the best way of using a vtvm and a small probe detector to troubleshoot amplifiers and AM–FM receivers in the home. Also covered are printed circuits, stereo units and transistor preamplifiers.—*LS*

MOST-OFTEN-NEEDED 1926-1938 RADIO DIAGRAMS and Service Information. Compiled by M. N. Beitman. (Reprint of book copyright 1941.) Supreme Publications, 1760 Balsam Road, Highland Park, Ill. 8½ x 11 inches, 240 pages. $2.50.

The rising interest in classic radios has prompted large numbers of inquiries for schematics of receivers manufactured before the '40's and going back to battery sets. These have been hard and expensive to obtain, being largely photocopied from out-of-print volumes. In view of the increasing demand, Supreme Publications has reprinted its Volume I, going from 1937 back to the early Atwater Kents.

The collector of ancient radios will find this work very useful, though he may be surprised to find that the manufacturers omitted values in some of the oldest schematics.—*FS*

CIRCUIT THEORY OF LINEAR NOISY NETWORKS, by Hermann A. Haus and Richard B. Adler. Technology Press of MIT and John Wiley Sons, Inc., 440 Fourth Ave., New York 16, N. Y. 6 x 9 in. 79 pp. $4.50.

Much work is needed and is being done to minimize noise in radio circuits. To control anything, one must first understand and measure it. These authors have worked out methods for expressing the noise performance of networks and amplifiers, including those with negative resistance. A knowledge of higher mathematics is required.—*IQ*

MEDICAL ELECTRONICS, by Edward J. Bukstein. Frederick Ungar Publishing Co., 131 E. 23rd St., N. Y. 10, N. Y. 6 x 9 in. 168 pp. $3.50.

Mr. Bukstein, known to readers of this magazine as the author of a number of articles, is an instructor of advanced electronics and approaches medicine from the electronic side of the fence. The book, therefore, pays most attention to things electronic, although it does describe in detail the recording of biological potentials and of nonelectrical physiological phenomena, as well as devoting a chapter to electro-

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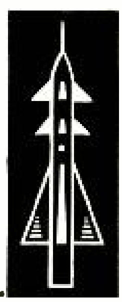

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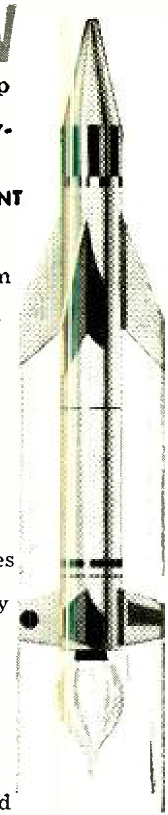

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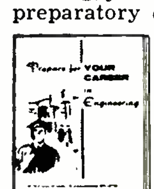

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diagnosis, electrotherapy and electrosurgery. Electronic readers will find the chapter on strip chart recorders and that on ultrasonics especially interesting.—*FS*

CLASS-D CITIZENS BAND CALLBOOK, 1960. International Crystal Mfg. Co., Inc., Oklahoma City, Okla. 9 x 11 in. $3.95.

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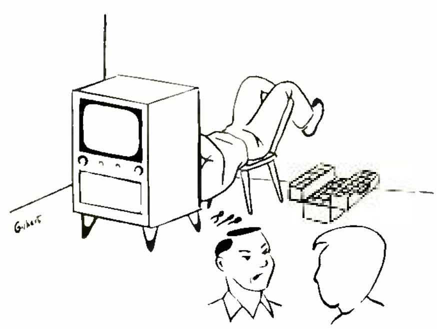

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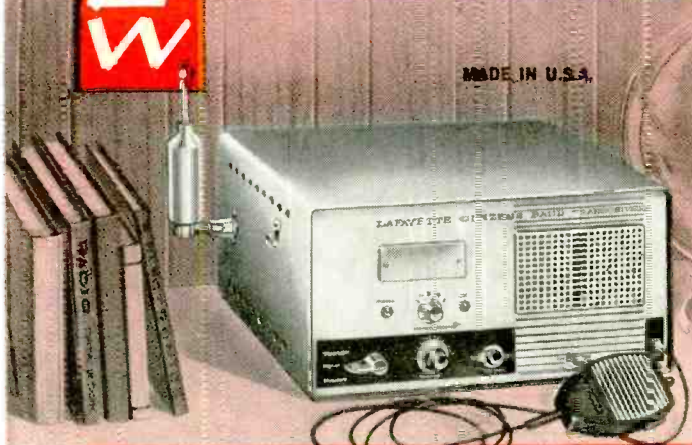

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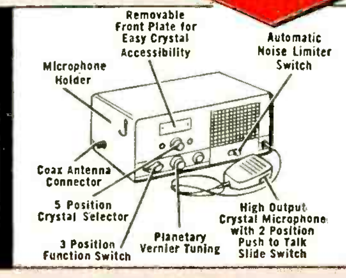

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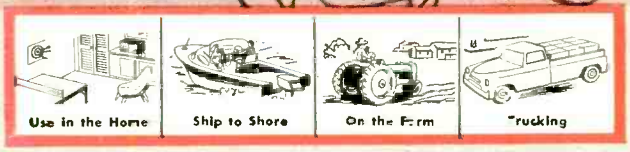

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↓ (illus. shows upper section of Magic Carpet)

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