JANUARY

Radio-Electronics

TELEVISION SERVICING HIGH FIDELITY

HUGO GERNSBACK, Editor

Special Report: 1961 TV Receiver Circuitry

Transistor Paging Receiver For Citizens Band

Zener Diodes Simplified

'Headie-Talkie"— New Communicator

See page 4

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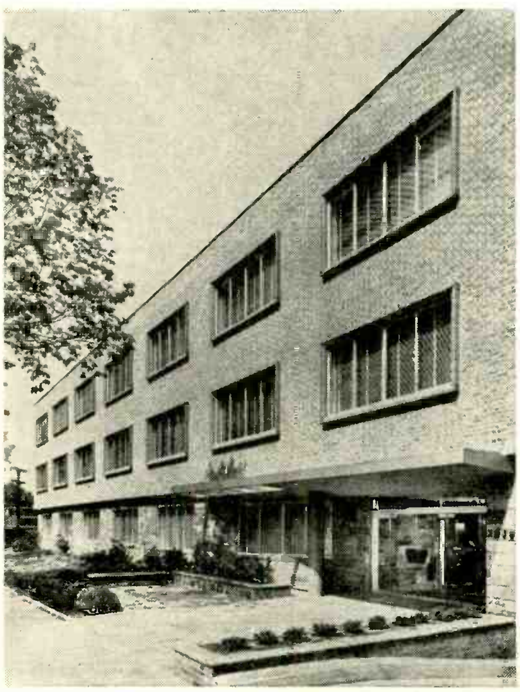

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Radio-Electronics

JANUARY, 1961

Formerly RADIO-CRAFT — Incorporating SHORT WAVE CRAFT — TELEVISION NEWS — RADIO & TELEVISION*

OVER FIFTY YEARS OF ELECTRONIC PUBLISHING

ON THE COVER

(Story on page 80)

The futuristic hat, which probably won't be seen in the Easter parade, supports the antenna for the miniature FM transmitter the young lady has in her hand. The matching master receiver is on the right. Together, they make a handy team wherever short-range wireless communication is useful.

Color original by Vega Electronics Corp.

Radio-Electronics is indexed in *Applied Science & Technology Index* (Formerly *Industrial Arts Index*)

editorial

television

radio

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Radio-Electronics January, 1961, Vol. XXXII, No. 1. Published monthly at Mt. Morris, Ill., by Gernsback Publications, Inc. Second-class postage paid at Mt. Morris, Ill.

Subscription Rates: U.S., U.S. possessions and Canada, $5.00 for one year; $9.00 for two years; $12.00 for three years. Pan-American countries $6.00 for one year; $11.00 for two years; $15.00 for three years. All other countries $6.50 a year; $12.00 for two years; $16.50 for three years.

Subscriptions: Address correspondence to Radio-Electronics, Subscriber Service, 154 West 14th St., New York 11, N.Y. When requesting a change of address, please furnish an address label from a recent issue. Allow one month for change of address.

Gernsback Publications, Inc, Executive, Editorial and Advertising Offices, 154 West 14th St., New York 11, N.Y. Telephone Algonquin 5-7755. **Hugo Gernsback,** Chairman of the Board; **M. Harvey Gernsback,** President; **G. Aliquo,** Secretary.

Advertising Representatives: Los Angeles: Harker-Husted-Coughlin, 400 South Alvarado St. Tel. DUnkirk 7-2328. **San Francisco:** Harker-Husted-Coughlin, 444 Market St., Tel. GArfield 1-0151. **Chicago:** 8631 East Prairie Road, Skokie, Ill. Tel. ORchard 5-3740.

Foreign Agents: Great Britain: Atlas Publishing and Distributing Co., Ltd., 18 Bride Lane, London E.C. 4.

Postmaster: If undeliverable, send Form 3579 to: RADIO-ELECTRONICS, 154 West 14th St., New York 11, N.Y.

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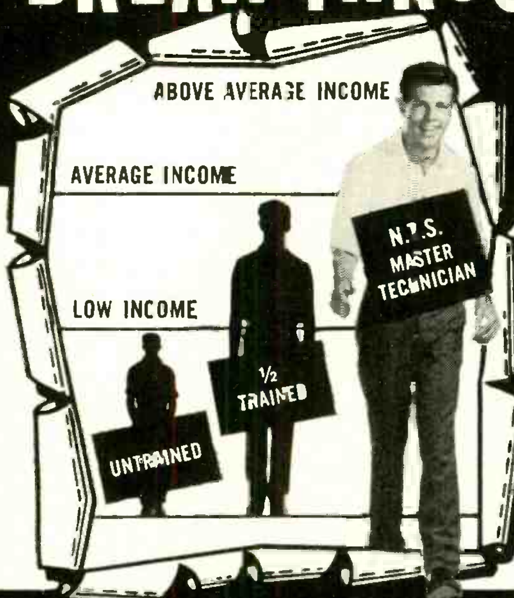

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News Briefs

Broadcasting 40 Years Old

Pioneer broadcast station KDKA of Pittsburgh celebrated its 40th birthday Nov. 2, 1960. It went on the air officially Nov. 2, 1920, to broadcast the election returns, announcing the victory of Warren Harding. Earlier, it had been operating for some time as an amateur broadcast station in the garage of Westinghouse engineer Frank Conrad. The anniversary was marked with special broadcasts, including one from the building in Westinghouse Electric Corp.'s East Pittsburgh plant from which the first broadcast was sent.

Underground Radio Sets Record

Messages have been sent more than 100 miles from a transmitter buried deep in a California mine shaft, reports Space Electronics Corp., which has been carrying on underground radio experiments for more than a year.

While the idea of underground radio is not entirely new (some work had been done by J. Harris Rogers as early as 1919), this system appears to work on a new principle. It uses the boundary layer between earth and air as a guide rather than attempting to send the signals directly through the earth.

As explained by its developers, the system works somewhat like this: A transmitting station below the earth sends out signals from a buried antenna pointed in the direction of the receiver. From the buried antenna, electromagnetic waves are generated in the media. These waves can travel in several directions, including an upward path to the earth's floor above.

In view of the discontinuity that exists between the earth—a conducting medium, and the atmosphere—a virtually nonconducting medium, a type of channel is created along the earth's surface. Favoring the direction in which the antenna is aimed, the waves travel along this channel toward the receiving site.

It is the channel formed by the discontinuity between earth and air that enables the effective transmission. This channel roughly extends from a few miles beneath the earth's surface to several miles above it. Both transmitter and receiver, however, can remain safely buried.

In addition to its obvious military applications, Space Electronics sees numerous commercial possibilities for the technique. It can, for example, offer a means of communication immune to ice and snow storms, hurricanes and tornadoes, vandalism and other hazards.

World Has New Length Standard

The international meter is now the length of 1,650,763.73 wavelengths of the orange-red line of light given out by krypton 86. The new standard replaces the platinum-iridium bar which has been kept in France as the standard meter since 1889.

The meter is the base (by Act of Congress) of American linear measurements as well as measurements in all countries using the metric system, and in all scientific laboratories in the world.

The new standard will increase the unification of systems of measurement throughout the world. In the past, it has been necessary to send meter bars to France for calibration against the standard, and it became obvious that—in spite of the care taken in calibration—some of the secondary standards were longer than others. The new standard is immediately accessible anywhere, and therefore will simplify the work of scientists.

Radio Pioneer Passes

Dr. W. R. G. Baker, radio engineer since 1920 and one of the leaders in the development of television, died Oct. 30, 1960, at the age of 67.

Dr. Baker started his engineering career with the General Electric Co. in 1916. When the company established a separate radio department in 1920, Dr. Baker was the design engineer and was instrumental in getting short-wave broadcast station WGY on the air in 1922. Later he was concerned with the high-powered experimental stations W2XAD

ELECTRONIC HIGHLIGHTS OF 1960

As another busy year of the electronics age passed, we saw 19 US space satellites launched, 12 successfully. All carried electronic instrumentation. On one single firing, two satellites were placed in orbit simultaneously. This leaves the US with 14 satellites in earth orbit, 2 around the sun, for 1960. Nine of them are still transmitting. It was a year that saw electronic medicine grow with devices to control and stimulate a weak heart. A supplemental heart was kept on time by electronic impulses. The year saw Alaska get "White Alice," a dependable radio communications system, based on forward tropospheric scatter; and BMEWS *(Ballistic Missile Early Warning System)* set up in Thule, Greenland.

For the home, there were transistor TV's, battery-powered of course; air ionizers and an upswing in FM radio, with multiplexing stereo being tested and a decision pending from the FCC on which one will be used.

JANUARY

Thermoplastic picture recording. Revolutionary method of recording TV or motion pictures combines some advantages of film with the instant recording and playback of magnetic video tape. *(March, page 6.)*

FEBRUARY

Messages from outer space? Radiotelescope set up at Green Bank, W. Va., is listening for intelligence-bearing radio signals from other planets and solar systems. *(May, page 18.)*

MAY

High-power radio deadly? Pulses of radio energy beamed from a forward-scatter radio transmitter in Great Britain can injure anyone in front of the directional antenna up to a mile away. *(July, page 6.)*

JUNE

Piezoelectricity. Two new compounds exhibiting a strong piezoelectric effect were discovered. They are zinc oxide and cadmium sulphide.

JULY

Amateurs bounce signals off moon. Amateur radio operators in San Carlos, Calif., and Medfield, Mass., communicated with each other by bouncing their 1,000-watt 1296-mc signals off the moon. *(October, page 6.)*

AUGUST

Project Echo. Transcontinental telephone conversations via radio beams reflected from satellite ECHO were demonstrated by Bell Telephone Laboratory scientists. *(October, page 6.)*

AUGUST

Reflecting ring to orbit earth? A plan for a man-made radio reflecting ring girdling the earth in the ionosphere is to be tested by the Air Force. Billions of tiny antenna doublets, each half as thick as a human hair, would be spread in the ionosphere by an orbiting satellite. Reflecting ring would be used to relay signals from point to point much as the Project Echo balloon did. *(October, page 10.)*

AUGUST

Telemetering pilots. The physical condition of a pilot and the craft he is flying will be continuously monitored from the ground. Reports on pilot's condition within a fraction of a second show whether he is going into an unsafe condition. *(October, page 6.)*

OCTOBER

Light amplifier. A true light amplifier, the apparatus uses light to stimulate light, in a manner similar to the use of feedback in radio circuit. The device is the laser, or optical maser. *(December, page 8.)*

OCTOBER

Relay satellite Courier. A more sophisticated approach to world-wide communications via space satellites is the Signal Corps delayed-repeater satellite Courier. The 500-pound sphere contains 300 or more pounds of electronic gear for receiving signals from earth, recording them on tape and retransmitting them on request. *(December, page 6.)*

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61. I Still Miss Someone, That's All Over, One More Ride, etc.

18. A new recording of these 2 ever-popular Gershwin scores

26. My Funny Valentine, Smoke Gets In Your Eyes, 10 more

40. Come to Me, That Old Feeling, Long Ago, 9 more

34. Pretty Baby, Swamp Fire, Bouncing Ball, 10 more

63. Solitude, Where or When, Dancing in the Dark, 5 more

14. Blue Moon, Fools Rush In, Don't Worry 'bout Me, 9 more

21. "Szell interprets it wonderfully," Rev. of Recorded Music

27. Rain in Spain, I Could Have Danced All Night, etc.

13. Tales from the Vienna Woods, Blue Danube, 8 others

28. Also: Song from Moulin Rouge, Ebb Tide, etc.

59. "Superbly played ...exciting listening" —Amer. Record Guide

53. Wild Man Blues, Fine and Mellow, I Left My Baby, 5 more

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3	19	40
8	20	43
9	21	46
10	26	53
12	27	55
13	28	57
14	30	59
15	32	61
16	34	63
17	38	

and W2XAF, which became famous in most parts of the world.

Possibly Dr. Baker's greatest contribution to the electronic art was the organization and direction of the two national television systems committees, the first of which recommended to the FCC the standards

for black-and-white TV broadcasting in 1941. The second, in 1953, laid the foundations for the set of engineering standards used in present color TV.

Dr. Baker was a past president of IRE, and was president of the Electronics Industries Association (EIA) for two terms. He was the recipient of many awards and honorary degrees as well as other tokens of recognition, one of the most striking of which was the naming of the television station at Schenectady, WGRB, with his initials. He was vice president of General Electric, in charge of the electronics department, at the time of his retirement in 1957.

Electronics Soothes Babies

A device that simulates the sound of a mother's heartbeat causes newborn babies to sleep better and cry less, states Dr. Lee Salk, brother of the inventor of the polio vaccine. A device embodying the principle is being developed by Sonotone, and should be on the market in the near future.

Dr. Salk found in his tests at the Elmhurst hospital—a New York City municipal institution—that, when newborn infants were exposed to the sound of the mother's normal heartbeat (72 double pulses per minute), they gained weight, slept better and cried less than babies not so exposed. The reduction of anxieties in infancy, according to generally accepted modern psychological theories, also leads to lesser chance of mental breakdown or instability in adulthood, Dr. Salk says.

No Color for Canada

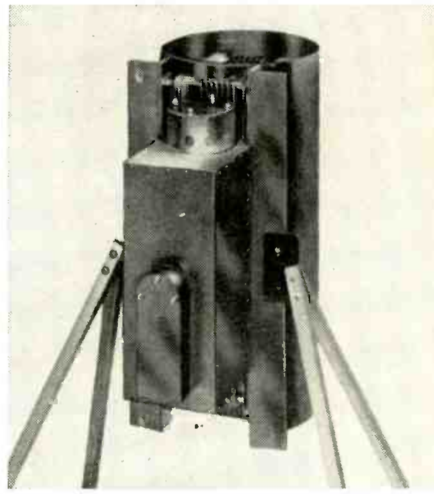
The Board of Broadcast Governors of the Canadian broadcasting system, in a statement which said in part, "the time has not yet come for color broadcasting in Canada," has declined to authorize color broadcasting in Canada. The board had been urged by the Canadian Association of Broadcasters, the Canadian

EIA and individual telecasters to authorize color broadcasting, using US standards.

The board noted that color TV had been "promoted expensively in the US since 1953, but only 500,000 color sets are in operation, compared with 52,000,000 black-and-white receivers.

Thermogen will light buoy

Three thermoelectric generators have been ordered by the Coast Guard to power off-shore light buoys and other navigational aids. The generators, according to General Instrument Corp., who developed



them, are enclosed in a 20-inch high, circular windscreen with heat-dissipating fins inside, and a square monel metal generator housing 5 x 6 x 12 inches which holds the semiconductor thermopiles which produce the current. Heated by propane gas, they are expected to operate continuously and unattended on $15 worth of gas. The system also includes a nickel-cadmium storage battery.

Future Phones to Translate

Telephones that will make it possible for people speaking different languages to talk directly to each other were predicted by Dr. Edwin G. Schneider of Sylvania in a speech to the Telephone Association of New England. The automatic language-translating phones, he said, would use advanced type of data-processing and communications devices already in existence.

More Multifunction Tubes

Following on the announcement of the Compactron (RADIO-ELECTRONICS, September 1960, page 6) come reports of new multiple tubes from Sylvania and RCA. At the EIA-IRE meeting at Syracuse late last year, N. C. John and B. Lankford of RCA described two multifunction tubes, a triode-heptode rf amplifier-converter, and pentode-triode-double-diode, intended for an if amplifier, detector and first audio. These tubes, which come in regular 9-pin envelopes, make possible a car radio with only

two tubes and one transistor. Sylvania's contribution is a 10-pin tube —a 9-pin base with an extra pin in the center (RADIO-ELECTRONICS, October 1960, page 97). The series includes a double tetrode, intended for use as an rf amplifier and oscillator–mixer in FM receivers, and a triple triode to be used as rf amplifier, oscillator–mixer and afc.

New Solid-State Device Rivals Tunnel Diode

A device that consists simply of two metallic films separated by an insulating layer may make possible a whole new family of electronic apparatus. The new instrumentality —not yet named—was discovered by Ivar Giaever of the General Electric Research Laboratory. It exhibits the "tunneling" effect of a tunnel diode, at much lower voltages. The device operates at a degree or so Kelvin, at which temperature the metallic films are superconductors.

The device is simple, according to G-E scientist Ivar Giaever:

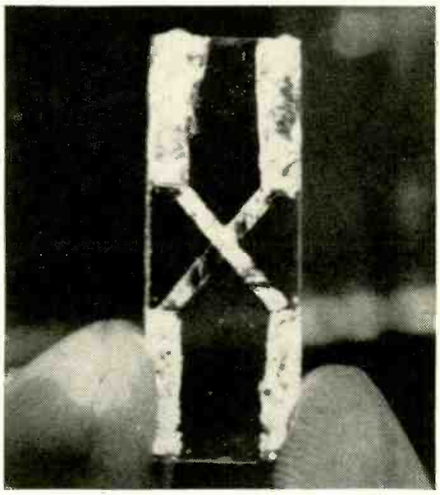
"First we evaporate or vapor deposit a strip or film of aluminum on a glass slide. We then expose this aluminum film to air for a few minutes, permitting a very thin natural oxide layer to form on the surface of the aluminum film. Finally we evaporate a lead film across the aluminum film. This sandwiches the aluminum oxide layer between the two metal films." The result is seen in the photograph. The active area of the device is the part where the two strips, separated by the insulating aluminum oxide layer, cross.

If the temperature is dropped to 1.2° Kelvin, and a voltage applied across the sandwich formed by the aluminum, lead and lead oxide, a current flows through the insulator. This "tunneling" takes place only if the insulating layer is extremely thin, say 10 atoms thick. Increasing the voltage produces a current curve somewhat like that of the tunnel diode. Between zero and 1 mv, current rises gradually. As voltage is increased further, the current curve drops steeply to about 3 mv, when it again starts to rise very rapidly.

This negative resistance effect, inventor Giaever pointed out, is independent of current direction through the device, whereas the tunnel diode is a one-way device.

While still early to predict exact applications for the device, the negative resistance effect opens possibilities as an amplifier. Since superconductivity is reduced or negated by a magnetic field, the device could be modulated by a coil wound around the center of the cross, giving a triode effect. According to Dr. Guy Suits, G-E Director of Research:

The new devices that may eventually result from a "marriage" of tunneling and superconductivity should be as different from the transistor as the transistor was from the vacuum tube, and yet they should be able to perform many of the same functions. The discovery, upon which these future devices would be based, is so recent that all of its consequences cannot be fully determined. However, it is already adding to



fundamental knowledge of both tunneling and superconductivity and has opened a new approach to the construction of versatile, microminiature electronic components. For example, it may be possible to make—in an entirely new way—a simple device that could function as a switch, diode, negative-resistance diode, triode, resistor or capacitor.

Ionosphere Satellite Up

The most extensive and intensive measurements of ionosphere characteristics and phenomena ever made are being taken by ionosphere satellite Explorer VII. These measurements are expected to increase greatly our knowledge of changes in the ionosphere, including variations due to sunlight and darkness and to solar and geomagnetic storms. The various sensors carried by the satellite are checking the concentration, distribution and temperatures or energies of the ions and electrons that make up the ionospheric belt. The satellite will also measure the quantity, momentum and energy of the particles of cosmic dust, or micrometeorites, as well as indirectly measuring the density of matter in the space through which it passes.

The satellite, which weighs 90 lbs., is 30 inches in diameter and orbits around the earth, coming as close as 258 miles at its nearest point and reaching out 1,423 miles at its most distant. It makes one revolution every 113 minutes.

Telephones Go Electronic

Tiny neon tubes and memory banks like those used in computers are the main features of a new kind of telephone central office being tried out in Morris, Ill., by Bell Telephone Labs and Illinois Bell. The neon tubes connect lines when the voltage of one line is raised 60 volts and the other lowered by the same amount.

(*Continued on page 16*)

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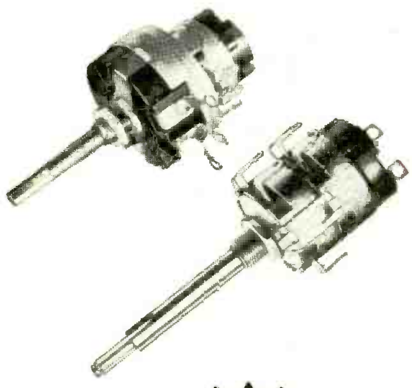

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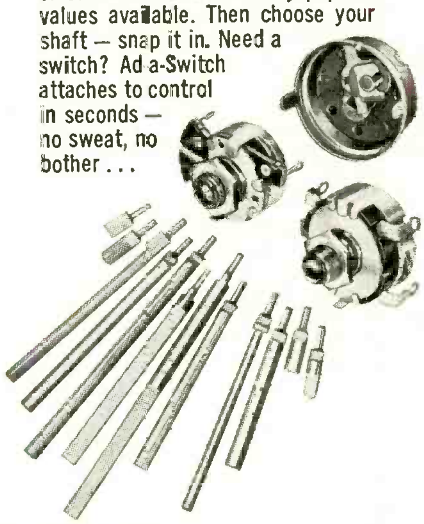

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2-13	Washington	Atlanta			Houston	
2-20			Cincinnati		Houston	Los Angeles
2-27						Los Angeles
3-6	Tarrytown	Memphis		Omaha		
3-13	Tarrytown					
3-20		Jacksonville	Cleveland			San Francisco
4-10	Boston		Cincinnati	Kansas City	El Paso	Portland
4-17	Boston	Atlanta		Kansas City	El Paso	
5-1		New Orleans	Pittsburgh	Minneapolis		Los Angeles
5-8	Union		Pittsburgh		Oklahoma City	
5-15				Milwaukee		
5-22		Memphis	Buffalo			San Francisco
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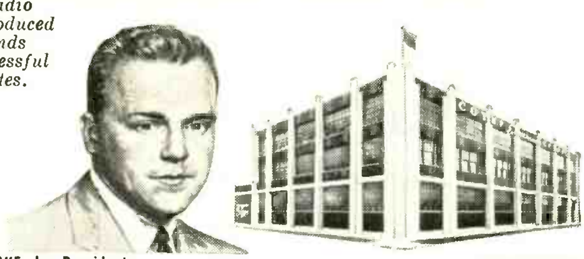

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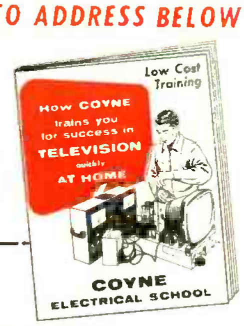

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(Continued from page 12)

The 120 volts across the tube fires it and the path conducts.

Two memory tubes perform many functions, each one of which might require special circuitry in conventional exchanges. A temporary memory (called the "scratch-pad" memory) is used in placing calls, for example. A scanner checks each telephone 10 times a second. When the user picks up the telephone to make a call, a scanner reports the event and the temporary memory checks to see that no one is trying to reach the number, then supplies dial tone, speeds up its scanning to 100 times a second, records the numbers dialed and feeds the information into the switching networks to complete the call. Each time a scanner checks a phone, it also checks the circuit for that phone. Any faults are reported in detail via teletypewriter.

The temporary memory uses a "barrier-grid" cathode-ray tube. A longer memory on photographic plates, scanned with a flying spot, stores semi-permanent information. This *stored program control*, which makes it possible to extract from the memories several sets of instructions, any one of which would call for special circuitry in conventional telephone operation, makes possible services that would have been expensive or impractical in the past. Thus the users of the Morris experimental exchange will be able to:

- Use home extension phones as intercoms by dialing two digits.
- Reach frequently called numbers by dialing only two digits instead of seven.
- Have incoming calls routed to another phone when the original called line is busy.
- Dial a code which causes all subsequent incoming calls to be automatically transferred to any other number.

The information gained from the Morris experiment will be used to set up regular commercial electronic telephone central exchanges. It is expected that the first one will be in action by 1965. END

Calendar of Events

Symposium on Thermoelectric Energy Conversion, Jan. 8–12, Statler Hotel, Dallas, Tex.

National Symposium on Reliability & Quality Control, Jan. 9–11, Bellevue-Stratford Hotel, Philadelphia, Pa.

Symposium on Space Instrumentation, Jan. 16–17, Washington, D.C.

Winter Instrument-Automation Conference and Exhibit, Jan. 17–19, Sheraton-Jefferson Hotel and Kiel Auditorium, St. Louis, Mo.

Representatives Southwest, Inc., Distributor—Representative—Manufacturer Conference, Jan. 22-26, Fort Clark Guest Ranch, Bracketville, Tex.

Cleveland Electronics Conference, Jan. 31–Feb. 2, Cleveland Engineering and Scientific Center, Cleveland, Ohio.

Winter Convention on Military Electronics, Feb. 1–3, Biltmore Hotel, Los Angeles.

Second Annual ERA Convention, Feb. 1–4, Ambassador Hotel, Los Angeles.

International Solid State Circuits Conference, Feb. 15–17, University of Pennsylvania and Sheraton Hotel, Philadelphia, Pa.

Pacific Electronics Trade Show (PETS), Feb. 26–Mar. 1, Great Western Exhibit Center, Los Angeles, Calif.

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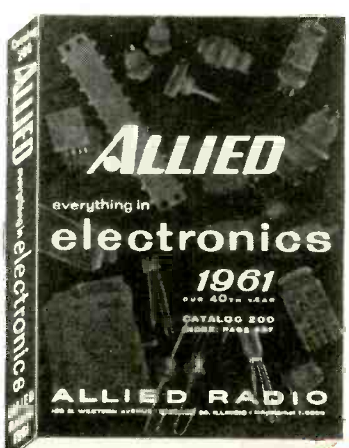

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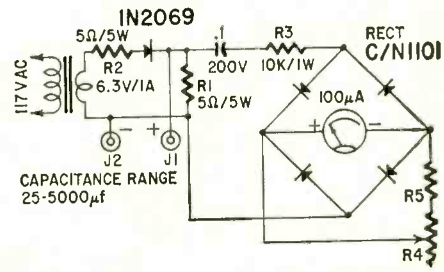
Correspondence

THE CONANT CHECKER

Editor:

My electrolytic capacitor checker story (October 1960 issue) is drawing some correspondence from those who want an extended range to measure larger capacitance values.



Therefore, I have devised the variation shown in the sketch so a high-capacitance range can be made readily available through switching.

With the values shown, I got a range of 25–5,000 μf which is good for all capacitors rated 6 volts or more.

Changing R1 to 2 ohms and reducing the value of R3 would give a range to 10,000 μf at down to 3 volts.

H. B. CONANT

Lincoln, Neb.

UNDERWATER STEREO

Dear Editor:

In your October 1960 issue you ran an item on underwater stereo, stating that this was the first time it was done. However, please note the enclosed clipping from the *Atlanta Journal & Constitution* of June 12, 1960, describing a system we had installed. [The newspaper story describes a stereo system installed in a pool. It uses two waterproofed speakers to fill the water with sound—sound that cannot be heard unless you are under the water.]

L. E. GLENN

Baker Audio Associates
Atlanta 9, Ga.

[Our apologies. Guess this makes you first with underwater stereo with a date of June 12, 1960. Or is there someone else with a still earlier installation? *—Editor*]

DISAGREES WITH THE MAJOR

Dear Editor:

I just picked up my copy of the November 1960 issue at the newsstand and my eye caught the letter from Major William Price concerning the "Philadelphia Plan."

To me, this is just another round of crying by a few individuals who have set themselves up as service technicians

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and have found that they are not technically capable of making a reasonable profit in the radio and TV service business.

Therefore, they have cried, "Organize, eliminate the part-timer, destroy service competition, then we can steal the public blind with our service charge." I do not mean to imply that the majority of our service technicians are not qualified. Most of them are! However, so are most of the part-timers. I work for Collins Radio's Microwave Div. and think nothing of having more than 7,000 tubes in one system.

But let's stick to TV service. I have been forced to limit my practice to old-age pensioners and those who have been out-and-out gypped by local "screwdriver mechanics." When I replace a tube or other part, it goes into a paper sack which my customer receives when he gets his set back. How many of you full-timers do this?

Part-timers have survived legal and verbal attacks. You can't get rid of us, so why not forget the Philadelphia plan and let us develop new ways to speed TV service. We have the time to experiment a little now and then. We can be a big help to you by taking on your dogs and low-profit jobs.

Let's not try to eliminate part-timers or full-timers. Let's all join together to eliminate dishonesty and incompetence in TV service. The Philadelphia plan is not the way to do it.

HAROLD E. YODER
Garland, Tex.

[Most technicians are not out to get rid of part-timers. They simply want the part-timer to compete on a fairer basis—in other words, pay taxes and know what he is doing. In any state that has a licensing law, part-timer's are not prevented from becoming licensed technicians. The qualification for getting a license is based on technical knowledge and skill, not on how many hours a day you work as a TV repair technician.—*Editor*]

THE RIGHT CURE?

Dear Editor:

In the December, 1958, issue (page 116), Louis Sherman suggested a drastic modification to restore vertical amplitude on a Muntz model M32. The loss of deflection is obviously due to the failure of some other component in the vertical section, and altering the oscillator plate load by such a large amount to increase drive is only obscuring the real cause of the trouble.

Would it not be advisable to add an editorial comment regarding the practice of modifying the design of a circuit to cure a fault?

R. H. SHAW
Middlesex, England

[It certainly would be advisable. Circuit modifications to restore proper operation should only be made as a last resort—when no sign of any circuit defect can be located. For example, if the decrease in vertical deflection had been caused by a leaky capacitor and was compensated for by increasing drive, it would only be a matter of

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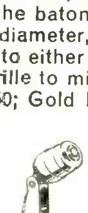
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time before the leakage increased enough to reduce the picture size once again.—*Editor*]

I LIKE REVERBERATION!

Dear Editor:

With reference to "And Now . . . Reverberation" on page 43 of the August issue, I've long felt that proper reverberation in stereo playback was at least as important as easily exploitable directional effects for an illusion of realism.

For the audiophile with an elaborate system it would be desirable, I believe, for the reverberated sound to be played back over separate amplifiers and speakers grouped down the length of the listening room on either walls or ceiling. Aeolian-Skinner of Boston did this for "dead" churches a few years ago, using a multiple-head tape delay system at 7½ ips. I've read of a system demonstrated by Phillips of Holland that was said to be most realistic. Then, too, Telefunken makes a system with magnetic heads placed around the rim of a rotating disk which is coated with a magnetic oxide. (To eliminate wear, the head is separated from the oxide an extremely fine distance.)

Most such tape systems are just too expensive for the audiophile, even one who has an elaborate system.

The problem is devising some means of achieving multiple time delays, feeding the delays simultaneously to auxiliary speakers to get the reverberation "off" the sound wall and back into the reverberation system at a lower level for proper die-away.

One major criticism directed against modern concert halls is that their reverberation period is too short and that they are too "bright"—that is, bass dies away at the same rate that treble does. A proper reverberation device should cause treble to die away at the "proper" greater rate than bass and at the same time must add no coloration to the reverberated sound by emphasizing certain frequencies in the mid-range as one would suspect a mechanical delay line might do.

Obviously, a prefabricated duplicate of Boston Symphony Hall available to the audiophile for a mere $29.95 would be the best solution. But even in this era of plastics this seems a bit remote.

E. D. HOAGLAN

Omaha, Neb.

NO ANSWER

Dear Editor:

Slightly more than two months ago I answered a prominent computer manufacturer's advertisement that appeared in your magazine. This company advertised openings for field engineers. I sent a resume of my schooling and experience in electronics but to date the letter has not even been acknowledged. I had expected to receive at the very least a brief note telling me whether I possessed the necessary qualifications for such a position.

In questioning other job seekers I found a number of them had had the same such one-sided correspondence with similar companies.

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I would like to pose a question to these companies. If you advertise for men, is it too much trouble to send a reply to those who took the time to read and answer your ad? I can see two good reasons for such a reply, the first being common courtesy. Second, the people in charge of hiring personnel are getting paid to do this job.

LAWRENCE H. MILLER
San Francisco, Calif.

[A few postcards would seem to be a justifiable investment in good will. —*Editor*]

APPLICATION OF TECHNICAL KNOWLEDGE

Dear Editor:

I, like many other service technicians, have received adverse comments from time to time concerning charges for labor in a TV repair bill. To solve my problem I no longer show the word labor, yet I itemize everything that has gone into the set, including my time. In a separate item on the statement I show the following (which connotes, but never specifically mentions labor) —Application of Technical Knowledge —followed by the appropriate labor charge.

The customer's usual retort is, "I never thought of it before in that light."

DAN R. BROWNING
Decatur, Ga.

[An excellent approach. Nothing is hidden or falsified, yet the customer is impressed with the fact that labor, in this type of work, takes knowledge, hard learned. Any other readers have an approach of their own? We'd like to hear about it if you do.—*Editor*]

EFFECTS ON INVENTORS

Dear Editor:

While reading the June, 1960, issue, I came across the article "Another Forgotten Inventor." As the title suggests, this is not the first time something like this has occurred.

These happenings are not just a blow to the inventor, they affect the entire nation. First, the nation loses the usefulness of the invention (or the art is greatly delayed, as in this case). Secondly, and in my opinion by far the more important effect, this action greatly dampens the incentive of great minds. A man who has the ability to develop something like this can develop other things equally as great, or greater.

Then there is the effect that circumstances like this have on other inventors and their decisions. I personally know that this effect is far-reaching.

With incidents like this, it is no wonder that the press is frequently mentioning the scientific advancement of other nations.

THOMAS L. BARTHOLOMEW
Washington 10, D.C.

NOTE TO READERS

If you have built a RADIO-ELECTRONICS item—amplifier, test instrument, light detector, etc., let us know about it and include a photo or two. We will select and use the best ones in this column each month.—*Editor* END

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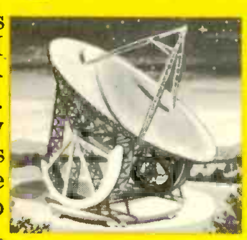

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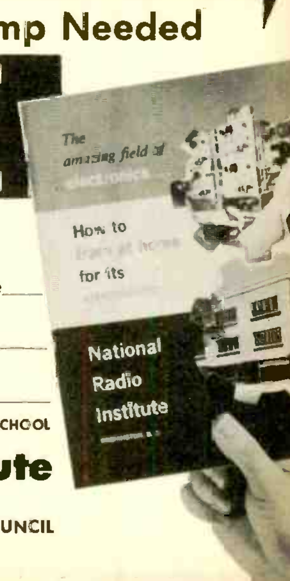

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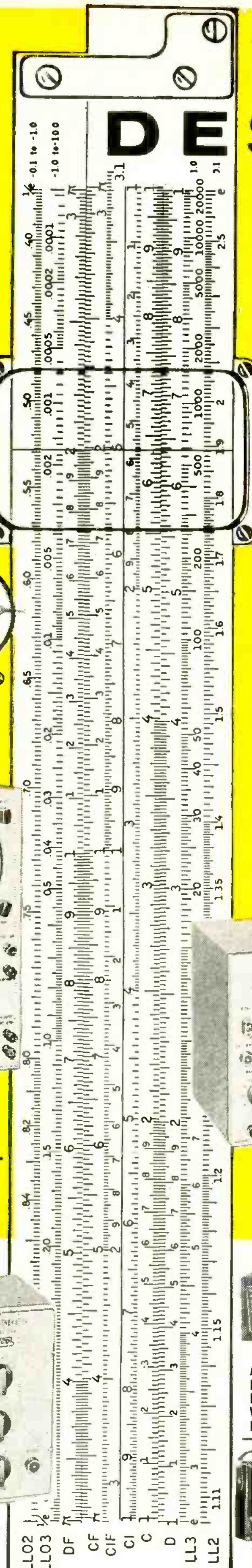

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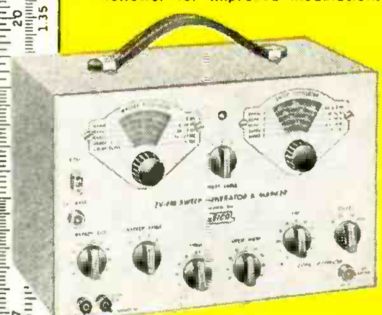

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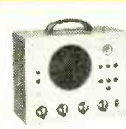

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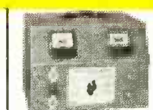

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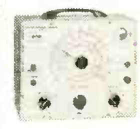

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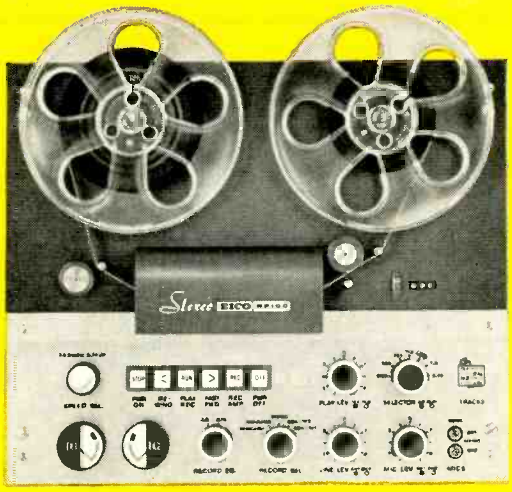

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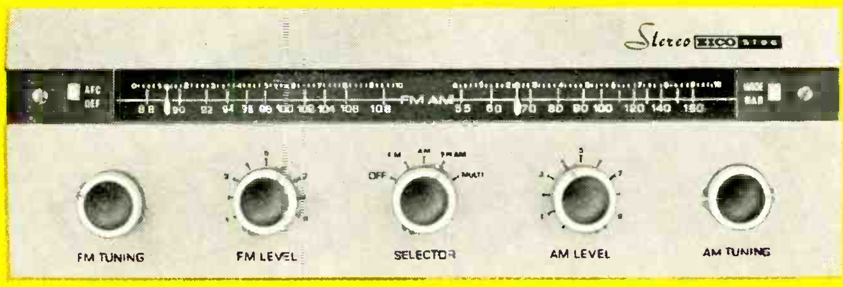

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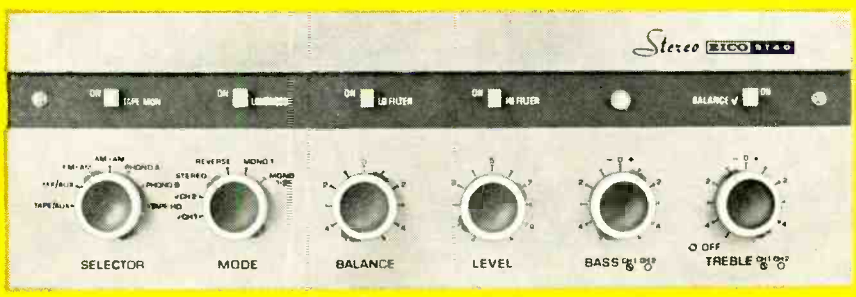

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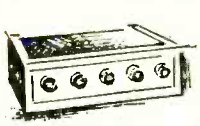

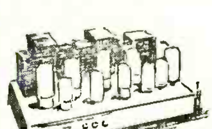

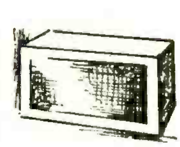

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Radio-Electronics
Hugo Gernsback, Editor

"UNDERSEA RADAR"

. . . Technically Impossible TV Programs Still Plague our Screens . . .

LAST November one of our greatest television critics, John C. Crosby, who also is the nation's best-known syndicated radio and television columnist, voluntarily changed his 14-year-old job in disgust. His parting barb at TV: "This great medium of information and education is totally dedicated to utter vacuity." He could also have added its other qualities: misinformation and general confusion.

As a recent glaring example of deliberate misinforming of the American public, let us cite a well known CBS network program, "Sea Hunt," of Oct. 29 last, starring Lloyd Bridges as the intrepid skin diver. It is produced by Ziv-United Artists, Inc.

We wish to be charitable here in not divulging all of the most improbable and infantile story of this particular episode as concocted by its naïve scripteaser. We are concerned only with the technical, or rather electronic, implausibilities of the lyrics—or should we call them liarics?

We follow Lloyd Bridges in fascination as he explores the bottom of the shallow sea, carrying in front of him—believe it or not—*a portable radar!* With bated breath we watch as the foxy Hollywoodpeckers switch to a closeup of the radar screen, showing us not the usual radar blips, mind you, but a screen filled with oblique, heavy white dotted lines! Bridges immediately knows that something terrible is going on, so he hotfoots it to the Navy in Washington, which of course has been busy underwater too, so nobody wants to talk to him, since they already have gotten wind of the undersea peril.

Back at his undersea radar hunt, he dives once more to find out what the enemy is up to. Sure enough, he soon locates a subsea "radar jammer" that breaches our "national defenses." He immediately gives battle to the jammer's lone guard, who, stupid boy that he is, touches the jammer and is knocked out by radar! He drags him to his surface boat where a convenient Navy man in full high-brass uniform helps Bridges bring the unconscious enemy radar-keeper aboard.

So much for the silly and technically impossible, plot. No wonder the Navy would be interested in undersea radar, as who wouldn't be? Our Government, we feel certain, would gladly pay many millions of dollars for a workable undersea radar—the one thing needed to track enemy submarines. Today we must rely on sound waves, that is, our audio sonar gear, which is not very efficient and does not reach very far—less than 15 miles under water.*

Unfortunately, radar today is completely useless under water, particularly sea water. High-frequency radio waves do not travel under water, any more than light waves do. Within a very short distance in the water—particularly highly conductive salty sea water—radar waves are completely absorbed. Even *above* sea water, radar becomes almost useless over short distances. This is because of the so-called "return" of the high-frequency waves. Over long distances radar of course is very efficient.

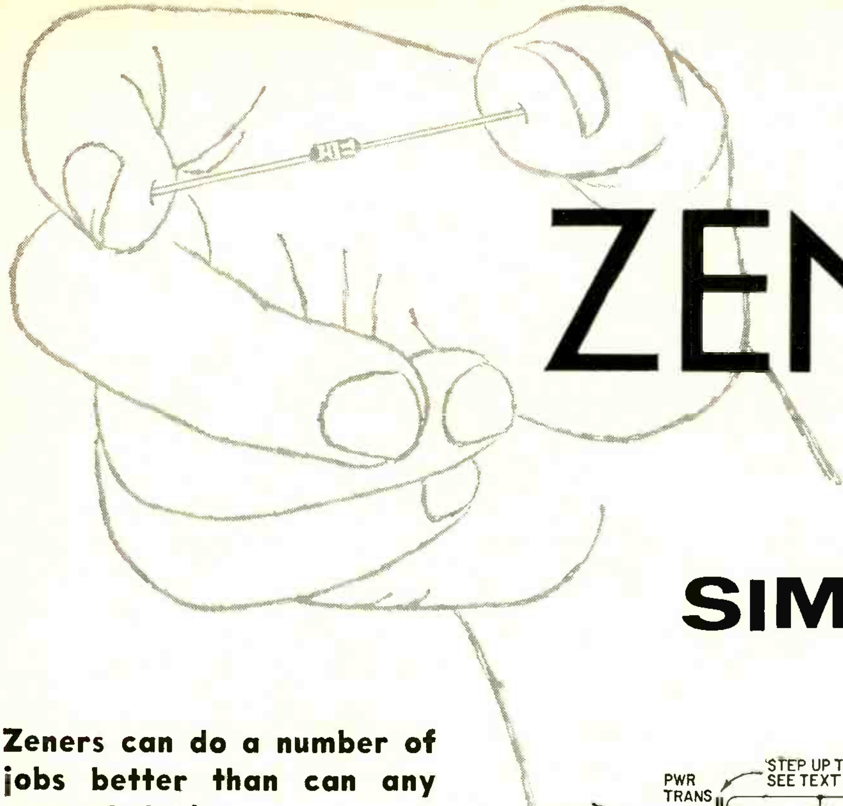
With the bewildering array of new scientific wonders and inventions of the present century, the public finds that it simply cannot keep abreast of the myriad of new technical achievements.

Television—itself a seven-day wonder—is potentially one of the greatest all-time conveyers of information and education. Yet many of its irresponsible entrepreneurs unfortunately use TV as a commercial football to sell and exploit their sometimes shoddy wares first, being concerned with the programs secondarily and incidentally.

It would seem to be elementary that *every* program should be viséd for its technical accuracy and plausibility. Alas, Madison Avenue does not follow such a logical rule. The program is treated first and last as "entertainment"—and may the devil take the hindmost.

When a program such as the "Sea Hunt" under discussion is played "straight", and deliberately misinforms millions of youngsters and grownups by televising technical impossibilities as facts, incalculable damage is done to the public. One cannot condemn the originators of such programs too severely for their irresponsibility when we realize that a modest $50 bill would pay for the services of a competent technical adviser whose duty it would be to read the script *before* taping it. It would pay big dividends and TV would greatly gain in stature.—*H.G.*

*A new sonar just announced will reach 30 miles.



ZENER DIODES SIMPLIFIED

Zeners can do a number of jobs better than can any present device.

By DONALD L. STONER

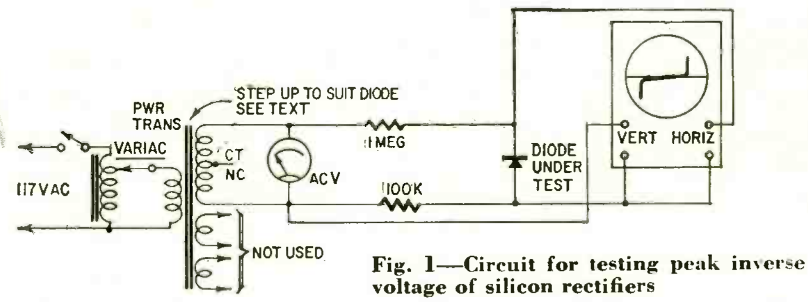


Fig. 1—Circuit for testing peak inverse voltage of silicon rectifiers

ENGINEERS and service technicians are constantly being showered with new electronic components, many of which are too costly to ever appear in mass-produced equipment. One exception is the Zener diode. These interesting devices were introduced some time ago, but only recently have they become available to the budget-conscious experimenter.

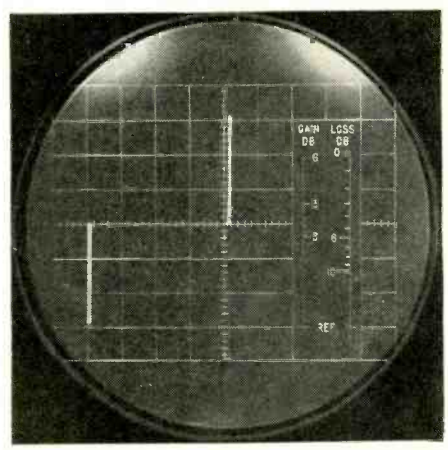
This amazing member of the diode family is the solid-state equivalent of a voltage-regulator tube. But the Zener diode takes over where the V-R tube stops (about 75 volts) and is available in steps down to 3.9 volts.

In many respects, the Zener diode is also similar to the silicon rectifier cell. Such rectifiers are rated according to their current-handling ability and peak inverse voltage (or piv) the *total* or peak voltage appearing across the diode junction when it is *reverse*-biased (negative anode). If this peak rating is exceeded, the effects may be disastrous. If sufficient current flows to overload the diode in the reverse direction, a multiplication or avalanche takes place within it. Designed to handle only a few watts of power in the forward direction, it is subjected to many times its rating by the excessive reverse current. When this happens, the silicon wafer is overheated and the crystal structure destroys itself. A device damaged in this manner shows a low resistance in either direction and is no longer useful as a rectifier.

It is a common fallacy that exceeding the piv will ruin the diode. You can prove this is an "old wives' tale" and incidentally make a handy piv checker by constructing the circuit in Fig. 1. The series resistance prevents excessive current flow in the silicon rectifier cell during reverse bias periods. The power transformer can be any type that will put out about 800 volts. The picture displayed on the oscilloscope is shown in the accompanying photograph. You can determine the piv by either calibrating the base line of the oscilloscope or measuring it on the meter. If the meter is used for measurements, it will be necessary to multiply the reading by 1.414 to determine the peak value.

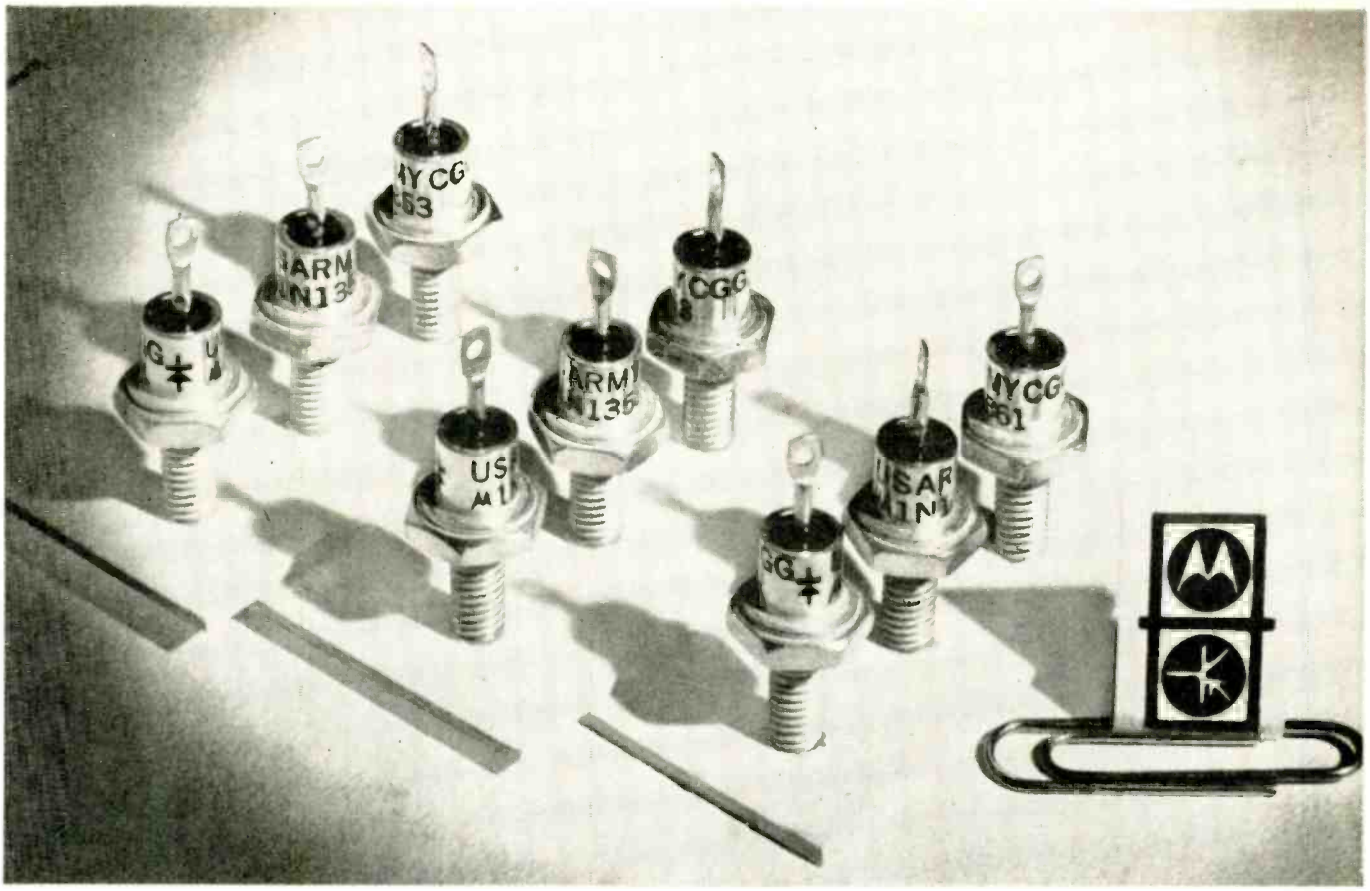
Zener diodes

When forward-biased (positive anode), the Zener diode behaves much like the silicon rectifier cell just described. Once the barrier potential (0.6 volt approximately) has been overcome, the junction resistance drops to a low value and the diode conducts large amounts of current. In the reverse-bias direction (negative anode), only a tiny amount of current can flow. However, as the reverse voltage is increased, a point will be reached where avalanche or breakdown occurs. When avalanche breakdown is reached, the normally high back resistance drops to a low value and the junction current is limited by the circuit resistance. As the voltage is increased beyond the breakdown point, the diode current increases proportionately *but the junction voltage remains essentially constant* as shown in Fig. 2. Although we might say that the piv has been "exceeded," the diode is made large enough to dissipate the generated heat without damaging the junction.



Typical Zener oscillogram for the equipment shown in Fig. 1.

Let's see how this effect can be used in a practical application. Fig. 3 shows a common method of connecting a Zener diode in a regulator circuit. The diode, in shunt with the load, draws current through resistor R, which is in series with the load. The total current through R is the sum of the Zener and load currents. If the unregulated input voltage increases, the current through both the Zener element and the load will increase. Simultaneously, however, the



Motorola

Zener diodes for military uses solve many electronic design problems.

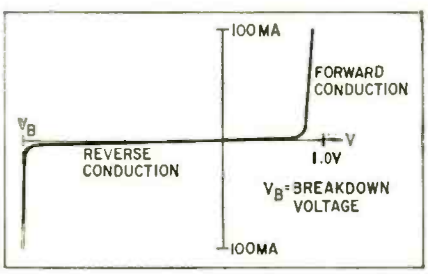


Fig. 2—Current and voltage characteristics of typical Zener diode regulator.

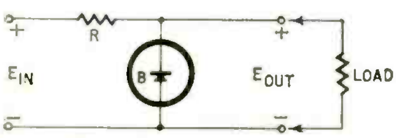


Fig. 3—Basic Zener diode regulator. . . .

diode resistance decreases and the junction current increases, thereby adjusting the voltage drop across resistor R. Load variations have a similar effect on the diode regulator. As the load current increases, or decreases, the Zener shunt element will draw less or more current respectively. The net result is substantially a constant output voltage across the load.

The ability to regulate voltage or load changes is determined by the temperature coefficient and the dynamic impedance of the diode. A change in junction temperature can shift the diode operating point. The dynamic impedance is something like a bleeder resistor connected across a power supply. The lower the dynamic resistance, the better the regulation. Temperature affects the Zener diode least in units around 5.6 volts. The dynamic impedance is reduced in larger diode sizes.

The only unknown in Fig. 3 is the correct value for resistor R. The value can be determined experimentally by substituting a rheostat for R and setting it so the Zener diode draws 20% of its maximum current rating (the customary operating point for a Zener diode).

The exact value can be calculated more accurately by using the formula:

$$R = \frac{E_{in} - E_z}{I_z + I_L}$$

To apply this formula, let's work out a typical Zener regulation problem. Assume you have a transistorized variable-frequency oscillator which operates in an automobile and must be regulated. The oscillator draws only 10 ma; thus even the smallest Zener units will be usable. We know that oscillator operation is satisfactory with a 9-volt battery. Therefore a Zener unit near this voltage is selected. A short consultation with the semiconductor catalog shows that an 8.2-volt 750-milliwatt, 1N1511, made by International Rectifier Corp., should do the job nicely.

Once the diode ratings are known, we can calculate the value of R. The automobile battery (E_{in}) will be approximately 14 volts (maximum) and E_z is 8.2 volts. The maximum Zener current (always given in the diode characteristics) is 90 ma, and therefore the normal operating point would be 18 ma (see above). All the numbers required to fill in the formula are now known and it solves like this:

$$R = \frac{14 - 8.2}{.018 + .01}$$

$$R = 207 \text{ ohms}$$

Either a 200- or a 220-ohm resistor may be used for R and the Zener current will be slightly above or below the nominal operating point, but well within the diode ratings.

The wattage of R can be determined easily, since we know 5.8 volts will be dropped across it and 28 ma, will flow through it. Multiplying these figures shows that a ½-watt resistor is more than adequate.

The Zener diode is also useful in ac regulator circuits. In this application, it is necessary to connect two units "back to back." Remember, earlier it was stated that when forward-biased the diode would conduct much the same as a silicon rectifier cell. Since this is the case, the diode would appear as a short circuit across the load during positive alterations. The design considerations for ac are somewhat more complex than dc due to the waveform. Interested readers may peruse the subject in the *Zener Diode Handbook.*[1]

Reference elements

A reference element is a group of Zener diodes with ultra-stable voltage regulation over wide temperature ranges. It is useful in computers, ultra-stable power supplies or in any application that requires the accuracy of a standard cell.

One of the most popular reference elements is the 1N430 diode. It is found in military and quality commercial equipment. Inside the 1N430 you would find three series-connected Zener diodes, one operating in the reverse direction and having a *positive* temperature coefficient. The other two diodes are forward-biased and have a *negative* coefficient. The matching technique results in a near-perfect cancellation of voltage drift caused by temperature changes. The 1N430 specifications state that it will hold the reference voltage within ±.001% per degree C over a range of −55° to +100°C. Thus the reference voltage will not vary more than ±.0063 volt (6.3 mv) over the operating range.

When supplied with a suitably regulated source of voltage, the 1N430 is usable as a secondary standard cell for meter and test equipment calibration. A circuit with near-perfect voltage stability is shown in Fig. 4. In industrial

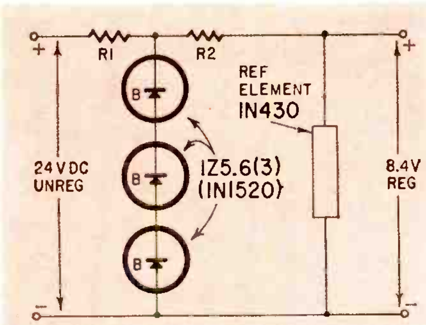


Fig. 4—A very accurate voltage standard.

equipment, where the temperature seldom exceeds +55°C (130°F), a stability of at least ±.0005%/°C could be expected!

Regulated power supplies

A Zener diode may be used as the reference in regulated power supplies. In this application the output voltage is compared to the Zener voltage and corrections are made if necessary.

One of the simplest circuits is shown in Fig. 5. The Zener diode determines the base bias in the emitter-follower transistor stage. If the load voltage decreases, the bias between emitter and

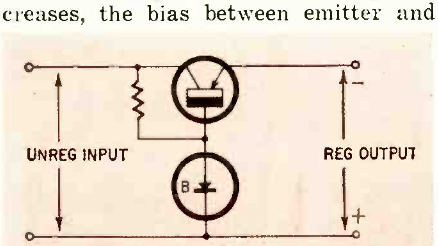


Fig. 5—Simple regulated power supply.

base is increased. This increases conduction in the transistor and returns the load voltage to its nominal value. Approximately one-tenth of the load current flows through the Zener diode. Thus a 1-watt diode and transistor could be used to replace a 10-watt Zener diode.

Although Zener diodes are not usually associated with high-voltage supplies, they may be used with transistors that have a high collector-to-emitter breakdown rating. Such a transistor

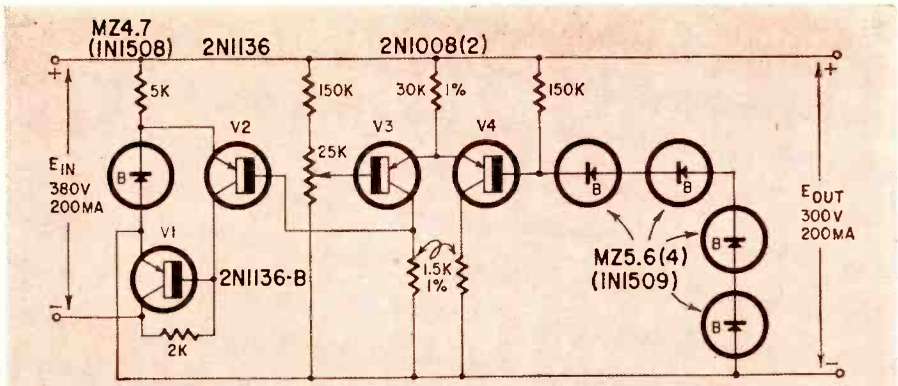


Fig. 6—A 300-volt, 200-ma solid-state regulated supply.

is the Bendix 2N1136-B, which has an E_{CE} of 80 volts and 60 watts dissipation. This transistor is used as the series element in the negative lead of a high-voltage regulated supply[2] shown in Fig. 6. The difference between the input and output voltage is 80 volts with minimum load conditions. At the 200-ma maximum power supply rating, the transistor dissipates something less than 16 watts. In operation, an increase in the load current causes a decrease in the bias of V2 through the paralleled-emitter pair (V3, V4). The action of V2, in turn, increases the bias on V1, decreasing its resistance and thereby returning the output voltage to its nominal value. A decrease in load current reverses the action, maintaining the output voltage at its correct value.

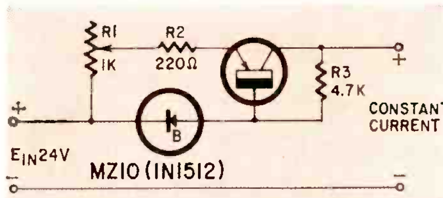


Fig. 7—Constant-current regulated supply. Values shown are for 10 ma maximum load current.

Zener diodes are also used in *constant-current* power supplies. Like constant-voltage supplies, current regulators can become highly complex. A simple circuit is shown in Fig. 7 and is optimized for 10 ma. It is handy when working with low-dissipation transistors. If the transistor should become overbiased or enter the thermal runaway region, this supply will prevent the collector current from exceeding 10 ma.

In this configuration two circuit paths exist. One is through the regular diode in series with the bias resistor. Current also flows through R1, R2 and the transistor. Any change in the current through R3 causes a change in base bias. The transistor, in turn, changes resistance to correct the current flow. The net result is that for every change in the R3 path there is an equal and opposite change in the transistor junction resistance.

Other applications

Although we have been speaking of Zener diodes in power-regulation applications, they actually have dozens of other uses. For example, think of the Zener diode as a "special" resistor which always has a fixed voltage drop across it. If a Zener diode is inserted in the cathode circuit of a push-pull audio amplifier or modulator, as in Fig. 8, it will develop a fixed bias and establish a "rock-solid" operating point. (No bypass capacitor is needed, since the diode's impedance is very low.) This may not be particularly important in class-A and -AB1 amplifiers but the scheme is very useful in class-B circuits where the cathode current varies as much as 10 to 1. Even with such wide variations, the bias will remain at a fixed value.

The Zener diode in the cathode is also useful in class-C amplifiers. This type of amplifier usually receives its bias from signal rectification and grid current. If the source of signal fails the stage loses its bias. Unless the tube is protected in some manner, its dissipation will be exceeded and it will be destroyed in a short time.

If a tube with a plate dissipation of 100 watts were to be protected (as an example), a Zener diode could be used for protective bias. It is only necessary to determine the amount of bias needed to hold down the dissipation at a given plate voltage. This

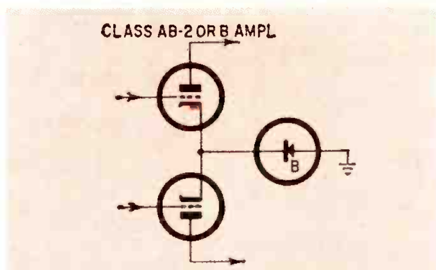


Fig. 8—Zener-diode biased audio stage.

figure may be easily determined from the tube characteristic curves. The Zener diode may also be used in the emitter circuit of a transistor to establish a stable operating point.

The Zener diode may not look like a coupling capacitor, but it can be used for one. Let's say you are cascading two common-emitter amplifier stages. If a Zener diode with a breakdown rating equal to the driver-stage collector voltage is used, a small current will be passed to bias the driven stage. Changes in collector voltage will change the bias on the driven stage directly. In effect, you have a dc amplifier with-

International Rectifier USN-1N430 silicon reference element.

out complex power-supply and voltage-divider connections. In addition, the diode has no reactance and therefore cannot affect frequency response.

Earlier it was stated that two diodes connected "back to back" would regulate both halves of an ac cycle. An examination of the waveform will show that the peaks are clipped to reduce the rms voltage. This process also increases the average level, which brings to mind an application as an audio speech clipper. Such a circuit is shown in Fig. 9. The effectiveness or "talk power" of a radio-telephone transmitter can be greatly increased by using a peak or speech clipper to raise the average modulation level. The energy content is increased, but the transmitter is not modulated beyond 100%.

The speech amplifier, part of which is shown in Fig. 9, develops approximately 30 volts of audio from a dynamic microphone. A small portion of this signal is applied to a pair of Zener diodes which clip any signal peak exceeding 3.9 volts. The harmonics produced by the clipping action are attenuated by the low-pass filter, consisting of L1, C1 and C2. The desired amount of audio signal is fed to the modulator by adjustment of R2.

Miniature voltage reference pack contains all components shown in Fig. 4.

The clipper need not be removed from the equipment to eliminate its effect on the voice energy. Simply turn R2 to its maximum clockwise position and control the audio level with R1. The Zener voltage will not be exceeded and clipping cannot occur. The amount of clipping can be regulated by reducing the setting of R2 and advancing R1.

Zener diodes are also useful in protection circuits to prevent damage due to arcing or transients. For example, have you ever connected a battery across an inductance, and then received a shock when one lead was removed? Even though the battery cannot store enough potential to shock you, the back emf due to the collapsing field of the coil will develop several hundred volts.

This effect is particularly troublesome when transistors are used to drive relays. When the transistor ceases to conduct, the back emf from the coil may be strong enough to punch through the transistor junction, thereby destroying it. A 3.9-volt Zener diode connected across the relay coil will conduct whenever that voltage is exceeded, thereby protecting the transistor.

The same problem, in a slightly different form, exists in transistorized power converters and class-B amplifiers. Even though the transistors used in this type of equipment are rated for many times the supply voltage, they often go bad due to shorted or punched-through transistors. Auxiliary equipment used on the same battery lines may feed transients (due to back emf, as above) into the equipment. Again, Zener diodes connected between collector and emitter will provide complete transient protection.

Meter movements are also easily damaged due to overload. Fig. 10 shows the circuit for a voltmeter which cannot be damaged, even if you try! The resistance of the potentiometer (R) is selected to make the basic milliameter read the right voltage at full scale. The Zener diode, which may be any convenient size, is connected to the arm. To set up the instrument, full voltage is applied to the input, making the meter read full scale. Then the potentiometer is adjusted until the meter indication just starts to drop. Now if the input voltage is increased further (which would normally pin the meter), the pointer will move up slightly, then come to a halt as the Zener diode conducts. Naturally readings below full scale will not permit the diode to conduct.

Speaking of meters, the Zener diode is also useful as a meter-scale expander. Let's say you need a meter which will accurately indicate 13 volts, for automobile regulator adjustment. If a 12-volt Zener diode is connected in series with a 2-volt dc meter, as shown in Fig. 11, it will show 12.0 volts at zero on the scale and 14 volts where 2 volts would normally be read.

Zener diodes possess many advantages over other forms of regulation devices. They are mechanically and electrically rugged and do not have the shelf life problems of batteries. Their low cost (50 cents and up) make them attractive to both the engineer and experimenter. END

REFERENCES

[1]International Rectifier Corp. *Zener Diode Handbook*.

[2]Bendix Aviation, Semiconductor Div., application report.

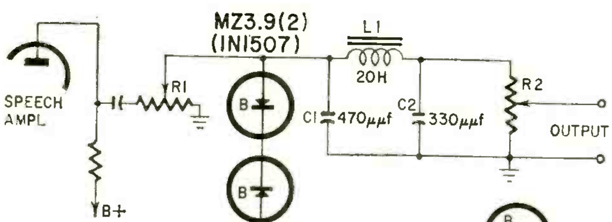


Fig. 9—Simple speech clipper for radiotelephone transmitters.

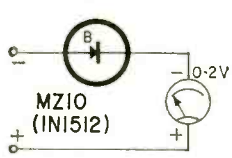


Fig. 11 — This meter expander suppresses the low end readings completely. Values shown are for a 12- to 14-volt meter.

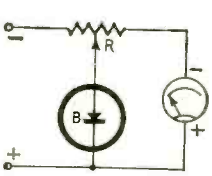
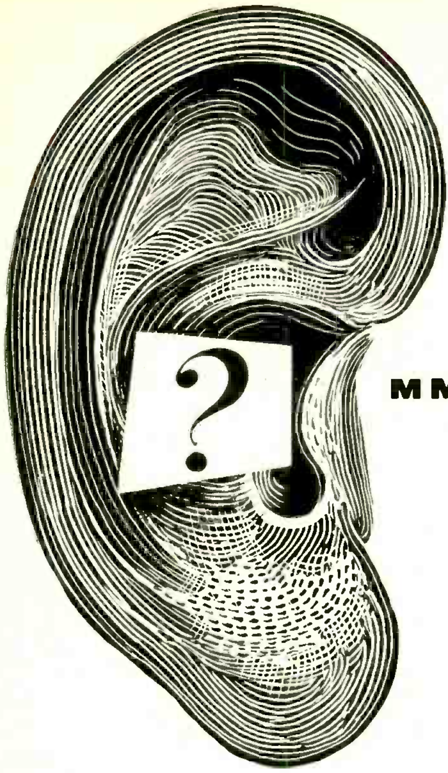


Fig. 10—Zener diode as simple meter protector.

Zeniac, a 10-watt Zener diode substitution box made by International Rectifier.



PUZZLED

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ABOUT HUM?

There are several causes and cures for induced hum in audio systems

By NORMAN H. CROWHURST

PERIODICALLY someone calls or writes in about a hum problem. By now hum is a familiar story to many of us, but it can be very puzzling the first time you run into it. Each piece of equipment is OK by itself but, when you assemble the system, a real lulu of a hum comes out of nowhere.

The real secret to tracing it rests in understanding the basic ways in which hum—or any other spurious induction, sometimes it's not hum but noise, pickup of a local AM station or something—can be induced.

Both components and connecting leads need protection against hum, in a form usually called shielding. And this is where one source of confusion arises. The requirements for shielding against different kinds of induction are quite different.

Induction can be magnetic, electromagnetic or electric. (The latter is commonly called electrostatic, but this is an obvious misnomer when you think about it. If the electric charge were static, it would not bother you. It's the changing charges that induce trouble.) Each requires its own treatment.

Magnetic induction

Magnetic induction comes from the magnetic cores of power and audio transformers, filter chokes and motors. It induces spurious "signal" in a magnetic component—phonograph pickup, input transformer or tape playback head. This induction may become apparent only when the system is assembled and the offending part(s) brought into proximity—maybe the power transformer and the phono pickup, for example.

This induction can often be minimized by careful orientation—mounting the components so the magnetic field is neutral at the point of pickup. But this is possible only if both components are stationary. A phono pickup has to move across the record and so cannot be at a magnetic-field neutral point at all times.

The alternative is magnetic shielding, either of the pickup or the radiating component, or both. Magnetic shielding material (such as Mumetal) is very expensive and not effective against very strong fields. So it is not practical to shield a large power transformer. Instead, its magnetic radiation can be considerably reduced by operating at a lower magnetic flux density. This is done by having more turns on all windings (primary and secondaries). Naturally, this means using a transformer wound specifically for the purpose. This is not something that can be done with an existing transformer.

Using an aluminum chassis instead of a steel one is another help in reducing magnetic hum. Since steel is a magnetic material, it carries the leakage flux, causing more trouble. An aluminum (or any other nonmagnetic) chassis doesn't "help" the hum radiation in this way.

It is always good practice to keep low-level input circuits (of any impedance) well away from power transformers and other hum-radiating components. This is usually taken care of in chassis layout, but it can be forgotten when assembling a system. Sometimes low-level wiring is run round the inside of a cabinet, close to the power transformer on a chassis, forgetting the power transformer is there.

Magnetic shielding on the pickup or playback head will quite effectively reduce hum pickup *that is low to begin with* (Fig. 1). The mistake is some-

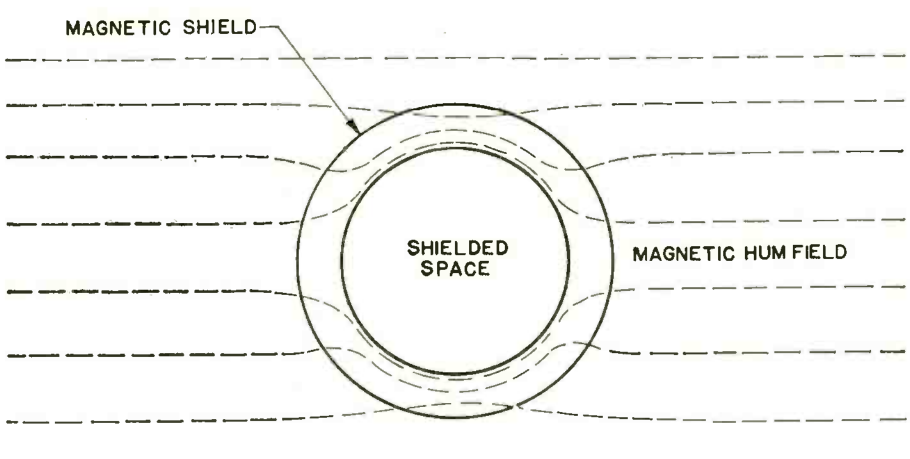


Fig. 1 — Lines of magnetic force will not penetrate a magnetic shield providing that the field is not too intense.

times made of thinking that, since a shield is 50 or 90 db (or whatever figure is given) effective, the hum *must* disappear. But these values usually depend on a hum that is small initially (in terms of magnetic flux). That is why it is wise to use an aluminum chassis and keep the components well spaced.

Very often, too, the hum-reduction figure quoted for a shield was obtained in a symmetrical test field. Practical hum fields are *not* symmetrical and a shield that gives 50 db reduction in a test field may produce less than 20 db reduction in practical operation. (Some in fact make the hum worse!)

Electromagnetic induction is the bane of low-level *low-impedance* circuits. It can best be thought of as a *current* induction, although academically this is not accurate. Use of balanced lines (ungrounded or with a center-tap ground) was the classic remedy.

A low-impedance circuit needs a low-resistance "return" path. The secret of eliminating the *effects* of this induction lies in making sure that any induction is equal in both connections. The induced signals neutralize or cancel each other. A coaxial conductor or a tightly twisted one assures this. A concentric (coaxial) cable must have a high-conductivity outer sleeve making very good contact between its strands. The best cables use a tight, tinned copper braid or twist with inert insulation (insulation that will not oxidize or corrode). The outside insulation must, of course, prevent the outer conducting sleeve from accidentally contacting other circuits.

There *must* be only one ground connection to such a low-impedance connector. In a moving-coil pickup, for example, the coil circuit should be grounded at only one point and a ground for its case or pickup must be run separately. This is to avoid having any ground current flow through the low-level low-impedance circuit, causing unwanted induction.

Electromagnetic induction can cause a small hum voltage to be developed across a pickup coil, as in Fig. 2-a. This can be stepped up by the input transformer to a new value which may be 40 times as high as the original voltage. It can usually be minimized by using a high-impedance pickup (or microphone) so that no transformer is required (Fig. 2-b).

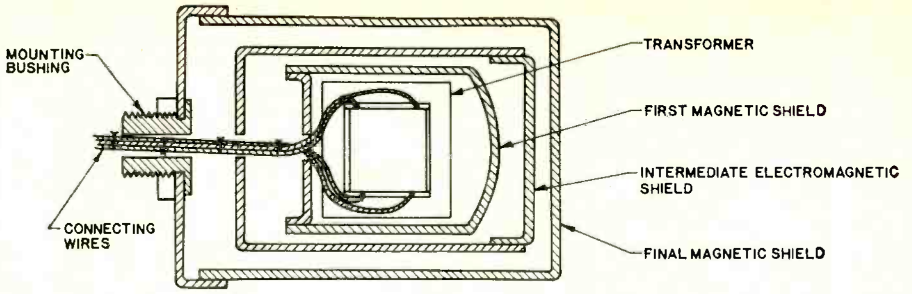


Fig. 3—In some instances, a combination of magnetic and electromagnetic shields must be used.

"Electrostatic" effects

Electric (electrostatic) induction becomes more troublesome with higher circuit impedances. It radiates from high-voltage circuits. The remedy is somewhat simpler than for the other forms—an interposed, grounded shield. For medium-impedance circuits, requiring protection against both electromagnetic and electric induction, a twin twisted and shielded connector is best.

The twin twisting takes care of possible electromagnetic induction. Few shieldings are adequate for this, unless they are used as part of a concentric cable. Then the shielding, which is connected to ground at one end only, takes care of the electric induction.

So the best cable depends on circuit impedance and the kind of induction to which the circuit is liable. But entire circuits, such as filters, sometimes need shielding to keep out unwanted pickup too. For this there are the same three forms of shielding. As well as being effective against different forms of induction, they are effective over characteristic frequency ranges.

Magnetic shields

A magnetic shield (using Mumetal or other special magnetic material) must have high initial permeability, with very low hysteresis or eddy losses. This combination of requirements means that there is an optimum thickness. If more shielding is required, several concentric shields are better than one thick one.

Even with the best possible material (Mumetal or Hy-mu 80), a magnetic shield is limited to fairly low-flux-density magnetic inductions, is most effective at lower frequencies (not more than 200 to 300 cycles) and produces not more than 20–30 db reduction per shield. Good magnetic contact between parts and seamless construction in the direction where the strongest field is encountered help to make a magnetic shield most effective.

Electromagnetic shields

The essential feature of the magnetic shield is high permeability and high resistivity (or low conductivity); the electromagnetic shield should be nonmagnetic and of maximum conductivity. For the same reason, good electrical contact between parts and seamless construction are necessary. Good materials are aluminum or copper.

The electromagnetic shield works by allowing the interfering field to induce currents in the shield, which in turn produce another field that neutralizes the original field inside and augments it outside. The important part is the inside neutralizing action. This is dependent on the conductivity of the shields consisting of Mumetal and copper (Fig. 3).

Since it is the *changing* of the interfering field that induces the currents, this type of shield becomes more effective as frequency increases. For this reason, electromagnetic and magnetic shields can complement one another. Alternating magnetic and electromagnetic shields yield a maximum effective shielding over the full frequency range. This may take the form of alternate shields consisting of Mumetal and copper (Fig. 3).

Electric shields

All that is necessary for a good electric shield is to enclose the shielded area in a metallic or conducting "cage" and to ground the cage. For this, a good ground is needed, but often a connection of several ohms can be considered good. The resistance of a ground connection is always relative. The ground connection for a couple of class-B output tubes must be really low, otherwise operation will be seriously impaired. But electric shielding is used for high-impedance circuits and when you measure circuit impedances in megohms, several hundred ohms is low.

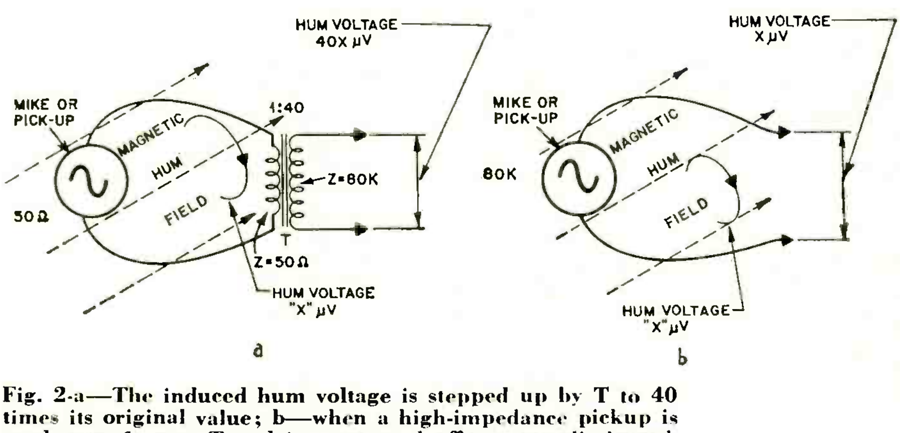


Fig. 2-a—The induced hum voltage is stepped up by T to 40 times its original value; b—when a high-impedance pickup is used, transformer T and its unwanted effects are eliminated.

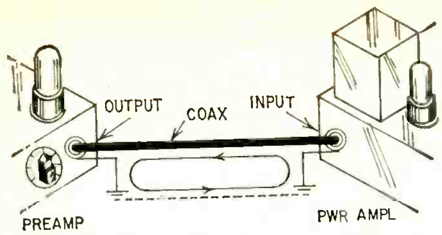


Fig. 4—Example of a ground loop.

The importance of the size of holes in an electric shield is also relative. In a miniature cable with thin insulation, the space between the braid crossings or mesh can be large enough to degrade its effectiveness for electric shielding. A wraparound shield would be more effective because of its more complete coverage, even though it might be slightly inductive, which does not matter *for this purpose.*

On the other hand, an electric shield with considerable space from the inside of the shield to the circuit to be shielded, can have holes 1/16 or even ⅛ inch in diameter, without deteriorating its electric shielding properties. In fact, perforated metal can be used to allow adequate ventilation.

Ground loops

And what is the story on ground loops? This is closely related to the matter of induction and its cure is similar. Its effect may be an unwanted hum or instability (in the form of oscillation). There are two basic forms of "bad-grounding" trouble, apart from the simple one of no ground at all. Several amplifiers exhibiting a "ticky" hum were found to be operating with the heater line completely ungrounded. A good ground connection eliminated the tick.

One form of bad grounding does not involve a loop. It happens because the ground is connected in the wrong place, or because one particular connection to the ground bus (or chassis if no bus is used) goes to the wrong place. This results in a common-impedance coupling in the ground connection which may exaggerate an inductive high-frequency (ticky) hum or cause instability.

See that all grounds from each stage are grouped together. When you come to a doubtful one, try connecting it to different points to see which minimizes the effect.

The other is the often mentioned (and almost equally often not understood) ground loop—not one ground path, but *two.* Two grounds from the same point can cause trouble in one of two ways:

The complete ground connection forms a loop (Fig. 4) and the 60-cycle field present in any building (with that supply frequency) induces currents in the loop that cause hum in the associated circuits. Opening the loop will stop this. But the loop needs to be opened in such a way as to avoid something from being grounded to the wrong place.

It may be necessary to open the ground at the best or the most convenient place and then move some ground connection from one point to another. Work it out on the basis of having the grounds from each stage grouped together and tied in sequence of stages through the system. This should eliminate the trouble.

The other way a ground loop can cause trouble is by allowing ground current to follow an "unauthorized" path. For stable hum-free operation, all power-supply filter capacitors should be at one end of an amplifier ground bus. The last stage should connect directly to this. Then each stage preceding it should have its ground connected progressively farther away (along the bus) until the first stage. The input ground should go to the first-stage ground and the chassis be grounded to the same point.

Perhaps this procedure has been followed in each of several pieces of equipment. Each has its input grounded to chassis. The units are then connected together and their chassis also make contact. This means their inputs are connected together by chassis contact and each input is connected to an earlier amplifier's output. So now we have ground loops. Follow the above-mentioned principle through the system (by the most convenient method by changing grounds) and any trouble will disappear.

Notice, however, that ground loops *do not always cause trouble.* Some amplifiers are designed well enough so that connecting their input and output grounds together has not the slightest effect, either on hum or stability. In such equipment, you can clip a lead from any ground point to any other without producing a ground loop effect. So, as we said before, handling these cases is a matter of knowing the "ground" rules. END

TRANSISTORS IN PARALLEL-T

By A. H. TAYLOR

IN the diagram, R1, R2, C1, C2, R3, C3 form a null network which balances for one frequency if its elements are in the right proportions. Although more general balance conditions are possible, in practice usually R1 = R2 = 2R3, C1 = C2 = 0.5C3, and the balance frequency is $f = \frac{1}{2}\pi R1C1$. The negative feedback from collector to base of transistor V is high and gain low except at this balance frequency.

If R3 is reduced or C3 increased slightly from the balance setting, the feedback becomes slightly positive at a slightly different frequency. Gain and selectivity are greatly increased and the amplifier can be made to oscillate if transistor gain is high enough. Positive feedback can also be applied without detuning by taking it in the right polarity from the secondary of the output transformer as shown by the dotted lines, making R8 higher or lower according to whether we want a broad amplifier, a sharp amplifier or an oscillator.

Parallel-T tube amplifiers usually have several stages, but a single transistor stage can have equivalent Q of 100 or more without unwanted oscillation. Only expensive special toroid coils tune this sharply in L-C circuits at audio frequencies. Supply-voltage variation or moderate output loading has little effect on the frequency of a parallel-T oscillator. Its *amplitude* is quite sensitive to supply-voltage variations when the feedback is kept low for good waveform; therefore, the oscillator can be amplitude-modulated easily.

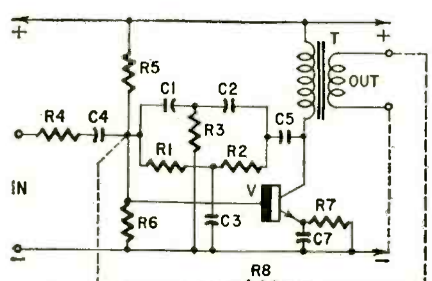
A parallel-T network having R1 = R2 = 27,000 ohms and R3 = 13,500 ohms operates satisfactorily with a variety of transistors, including the 2N35, 2N107, 2N213, 2N270, 2N382. Typical values of the other components:

C1, C2, C3 depend on frequency, see formula given.

C4 large enough so that $X_{C4} < R4$ at operating frequency.

C5 large enough so that $X_{C5} << (R1 + R2)$ at any frequency passed by C4.

C7 bypass for R7 at working frequency.



SEE TEXT FOR VALUES

R4 is more than or equal to 10,000 ohms unless signal source impedance is more than or equal to 10,000 ohms.

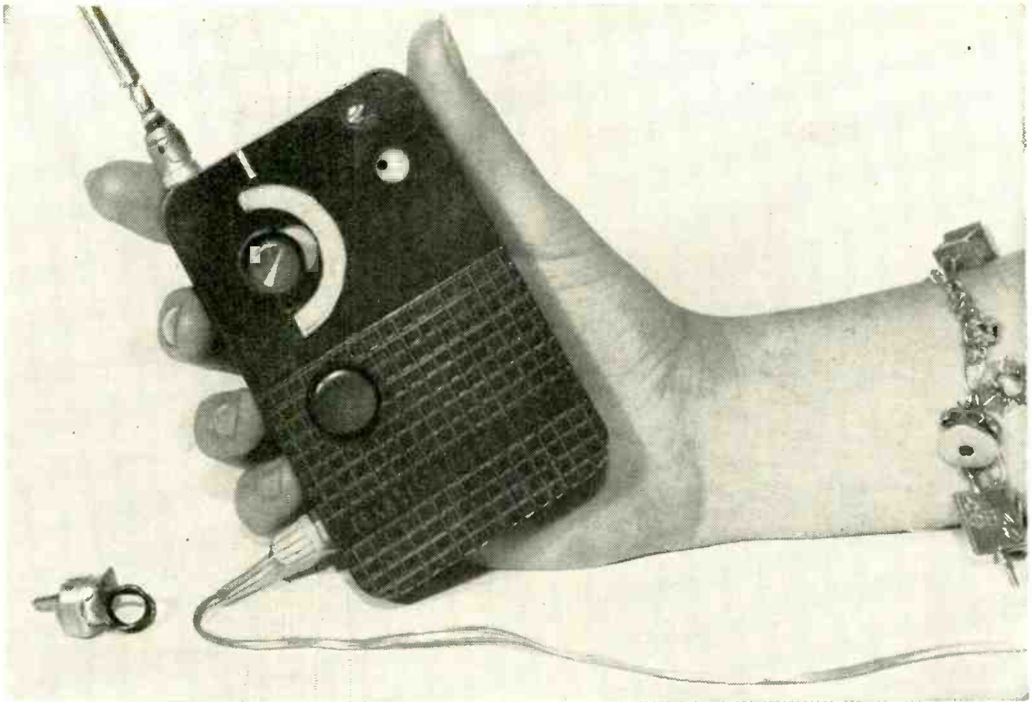
R5 = 10,000 ohms }
R6 = 2,200 ohms } for 1.8-ma I_C in a 2N213 on 12-volt supply.
R7 = 1,000 ohms }

NOTE: If the transformer has appreciable primary resistance and R1 and R2 are not varied for tuning, R5, C5, R7 and C7 may be omitted. With 2,500 ohms dc resistance in the transformer primary and R6 = 2,200 ohms, a 2N213 draws 2 ma from a 12-volt supply.

For good selectivity, the transformer must load the amplifier *lightly,* i.e., reflect a high impedance to it. About 100,000 ohms to 1,000 ohms (Lafayette TR-97 or equivalent) is suitable for driving a low-powered common-emitter stage, and this or 100,000 ohms to 100 ohms (Burstein-Applebee 18B658 or equivalent) will do for an oscillator with R8 between 2,000 and 20,000 ohms, depending on the transistor and transformer used. If R8 is low, increase R6 or use a blocking capacitor. END

References

H. H. Scott, "A New Type of Selective Circuit and Some Applications," *Proc. IRE*, Feb. 1938, page 226.
L. C. Cowles, "The Parallel-T Resistance-Capacitance Network," *Proc. IRE*, Dec. 1952, page 1712. Cowles gives a big bibliography including a Bureau of Standards circular with design curves.



Receiver exterior. Upper knob is for tuning and lower knob controls regeneration.

By I. QUEEN
EDITORIAL ASSOCIATE

Pocket VHF Receiver

PICK UP FIRE AND POLICE CALLS, AN AERONAUTICAL BAND AND THE 27-MC CITIZENS BAND WITH THIS SUPERREGENERATIVE SET

THE superregenerative receiver is a logical choice when high sensitivity at high frequencies is needed in a simple set. This one can go up to 200 mc and is small enough to fit in your pocket. With little effort (and perhaps higher voltage) you should be able to push the upper limit still higher.

A novel plug-in coil system is used. Each coil is soldered to a phono plug (see photo). With two coils, I cover the range from 110 to 165 mc. All parts except the transistor are inexpensive. It is a type 2N1143 by Texas Instruments which sells for around $12 (latest catalog price). In this set it loafs while doing an efficient job with only 4 volts at 0.5 ma. To work it at 30 mc, you need *less than 1.5 volts*. The 2N1143 has a cutoff above 400 mc.

The circuit (Fig. 1) needs little comment. When no external coil is plugged into J2, the collector tank is L2 and is wound for 26 to 30 mc (which covers the interesting Citizens and ham bands). When a coil is plugged in and shunts it, the frequency is raised accordingly. With a two-turn coil (L3), I pick up 140 to 165 mc. With three turns (L4), the range is 110 to 140 (approximately). Both coils are made of No. 16 enameled wire on ¼-inch diameter forms, turns being spread as required. Plugging in an earpiece at J3 completes the battery circuit. J3 is a modified miniature closed-circuit jack. Fig. 2-a shows the circuit of the original jack. The center contact should be bent down until it is in the position shown in Fig. 2-b. When the plug is inserted, the two upper contacts short together and power is supplied to V1 and the base of V2. The earpiece forms a current path for V2's collector. Remove the earpiece when changing coils.

For best reception, R1 is set to the highest value at which superregeneration occurs. At 30 mc, nearly maximum resistance is best. A collapsible whip antenna plugs into J1.

The band above 110 mc includes many interesting radio services. The one aeronautical band extends from about 108 to 132 mc. Planes and ground stations exchange weather reports, operational data and other messages. Generally the information is brief and routine, but recently I intercepted some real excitement. An aircraft developed landing-gear trouble during flight. For nearly an hour, the tower briefed the pilot on repair while the plane circled the air-

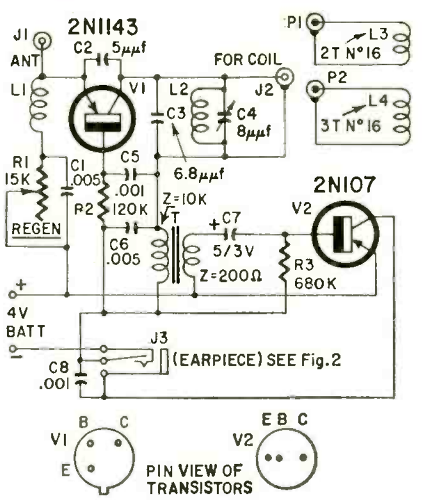


Fig. 1—Schematic of receiver.

R1—pot, 15,000 ohms
R2—120,000 ohms, ½ watt
R3—680,000 ohms, ½ watt
C1, 6—.005 μf, disc ceramic
C2—5 μμf, disc ceramic
C3—6.8 μμf, disc ceramic
C4—variable, 8 μμf max., approx.
C5, 8—.001 μf, disc ceramic
C7—5 μf, 3 volts, electrolytic
V1—2N1143
V2—2N107
L1—40 turns No. 34 enameled, on ½-watt resistor (47,000 ohms or larger)
L2—25 turns No. 22 enameled, on ¼-inch polystyrene tube or rod
L3—2 turns No. 16 enameled, air-wound (¼-inch diameter) on phono plug
L4—3 turns No. 16 enameled, air-wound (¼-inch diameter) on phono plug
T—primary, 10,000 ohms; secondary 200 ohms (United Transformer Co. SO-3 or equivalent)
J1, 2—phono jacks
J3—see text
P1, 2—phono plugs
BATT—3 1.25-volt rechargeable nickel-cadmium cells (Eveready No. N32T or equivalent)
Case, plastic, 4⅛ x 2⅝ x 1⅛ inches (Lafayette MS-302 or equivalent)
Earpiece, 1,500 ohms (dc) with plug (Lafayette MS-260 or equivalent)
Perforated phenolic board for chassis
Miscellaneous hardware, knobs and sockets

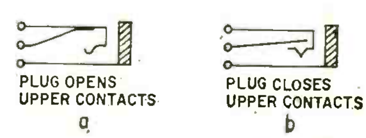
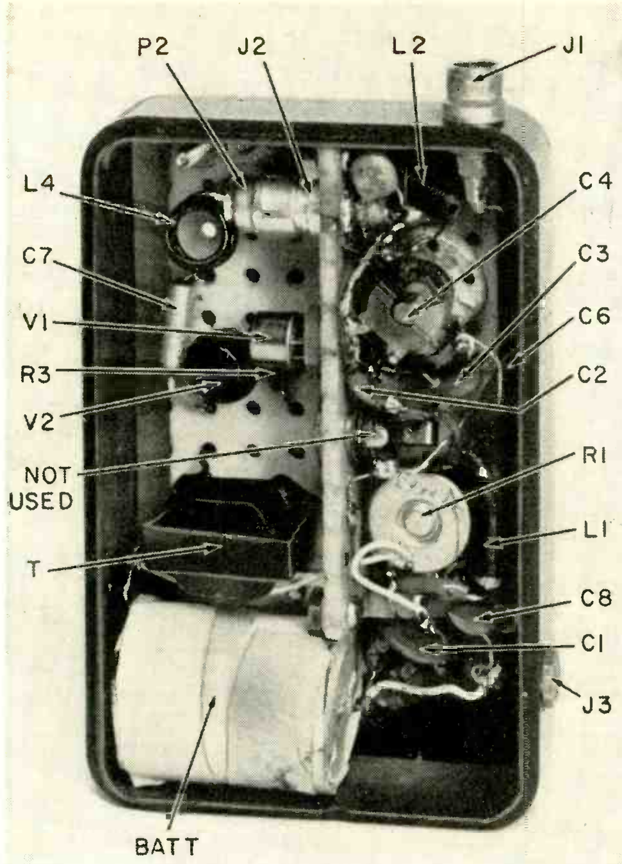


Fig. 2—J3, a–before modification; and b–after modification.



Interior of receiver.

port. After an apparently satisfactory repair, the tower wished him "Good luck" and the plane landed.

Near 155 mc I pick up local fire headquarters announcing alarms and contacting the chief at the scene of fires. Progress reports are made from the scene back to headquarters. A short time ago an odd incident occurred. Hearing fire apparatus coming down my street, I rushed for the pocket receiver. The engines stopped a few houses away. It turned out to be a small fire according to the progress reports I heard. Replies from headquarters were audible not only from my set, but *also* from the speaker mounted on the fire engine (as a sort of echo).

One ham band extends from 144 to 148 mc. I have heard stations up to several miles away. The range increases greatly as you gain height.

All parts are mounted on a 2 x 3-inch perforated board, except for J1 and 3. A small "shelf" about ½ inch wide holds J2 and transistor V1. The photo shows another earpiece jack on this shelf, but it is not needed. I use it for experimenting and measurement. J1 is at the top of the box, (Lafayette part, No. MS-302) J3 at the side.

As mentioned, you need only 1.5 volts or so for 30 mc and about 4 volts up to 175 mc. There seems to be little on the market in the way of a tiny 4-volt battery, so I use three rechargeable cells soldered together. You can also use small penlight cells.

For the coils use phono plugs that have metal grips. One end of the wire goes inside the pin, the other to the metal grip.

Centering the 30-mc band requires some care. Use about 32 turns of No. 26 enameled wire on a ¼-inch polystyrene rod or tube. Remove one or two turns at a time until you have centered the band (26 to 30 mc) within the range of the capacitor. This band is good for *coast-to-coast* reception at certain times and is *always* good for locals on both the Citizens and ham bands. For very short-distance reception, you may keep the set in your pocket (without antenna) yet hear clearly on the earpiece.

C3 shunts the variable tuning capacitor to reduce the tuning range (makes it easier to tune). If your C4 is too long (to permit closing the box cover), remove one or two plates. On my unit the plate diameter is only 7/16 inch.

For frequencies near 200 mc, increase battery voltage to 6 or 9. END

Midget receiver uses two transistors and plug-in coils to cover 26–30, 110–140 and 140–165 mc. Rechargeable batteries make it economical to use.

Unit was tested by a member of the staff of RADIO-ELECTRONICS at a location some 10 miles from International Airport in New York City. Transmissions from the tower and from planes in the air could be easily followed. When set for the 27-mc Citizens band, several local stations were picked up. How far they were from the receiver could not be determined. In all, receiver performance was excellent.

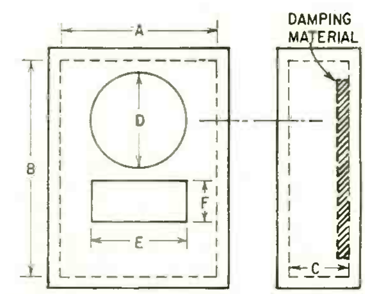
BENCH TESTED

BASS-REFLEX speaker enclosures

A BASS-REFLEX speaker enclosure is often recommended because the tuning effect of its port subdues the resonance peak and spreads the speaker resonance over a wider band of frequencies than does an enclosure without a port.

The enclosures described here were designed by Quam-Nichols for Quam speakers, but will work well with many other units.

The enclosure should be made of ¾-inch plywood or some similar heavy, well seasoned wood. Assemble with screws, not nails, and glue all edges to insure a completely rigid baffle. Use glue blocks or some other type of bracing at the inside corners. Make the back removable by fastening it only with screws placed about 4 to 5 inches apart along all four edges.

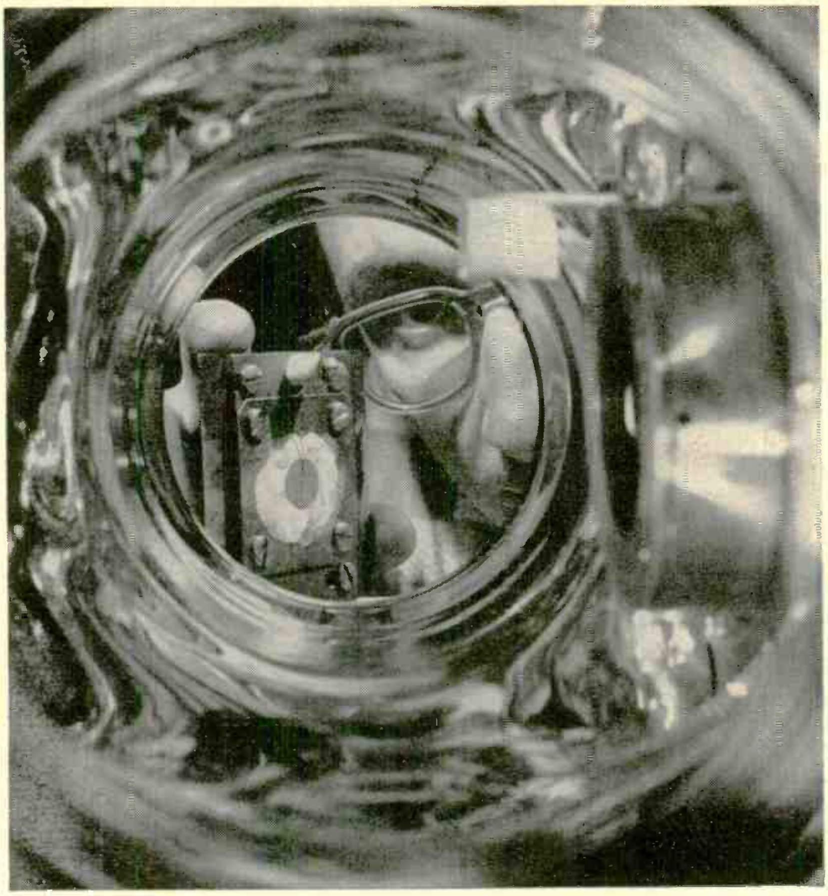


Use some kind of sound-damping material (about 1 inch thick fiber glass or Ozite) to line the baffle. This reduces resonance effects. The grille cloth should be an open-weave material that permits free passage of all frequencies.

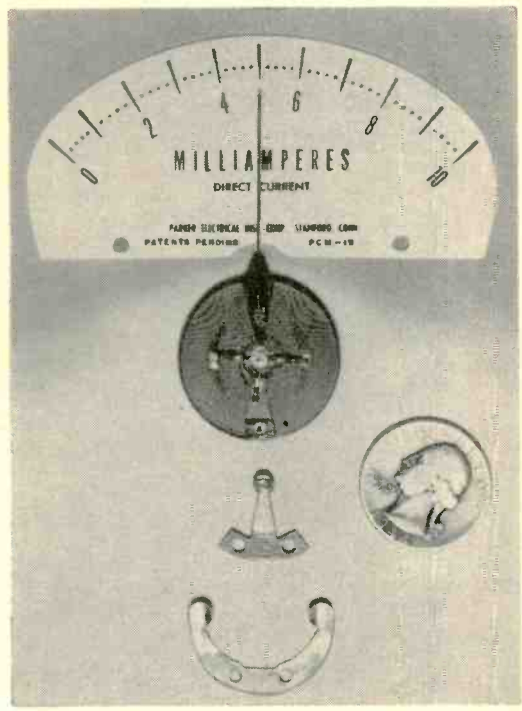
Dimensions shown in the table have been developed by the Quam Engineering Dept.

Speaker Size (inches)	Cabinet Dimensions (inches)				Vent Size (inches)	
	A	B	C	D	E	F
15	29	39½	15¾	13½	21	7¼
12	24½	32½	13¼	11	16½	5¼
10	20½	27	10	9	12½	4
8	16¾	22	9¼	7	9¼	3

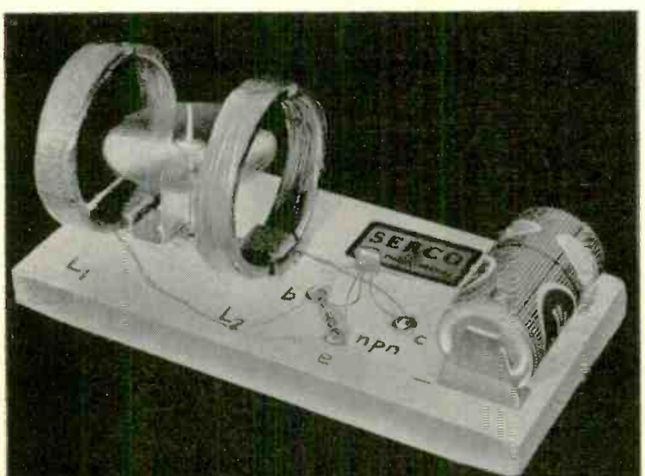
WHAT'S NEW



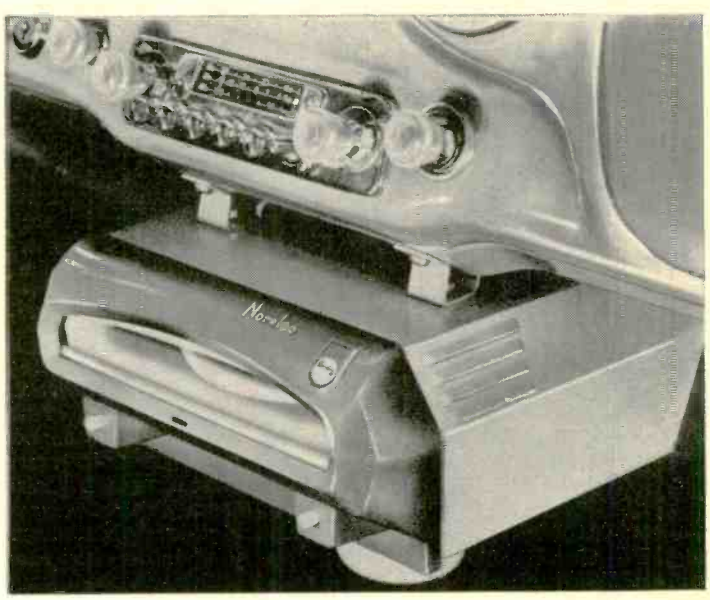
RADIATION-RESISTANT solar cell is being placed into chamber of Van de Graaf particle accelerator to test its atomic endurance. Developed by Army Signal Research and Development Laboratory, Ft. Monmouth, N. J., cell consists of a small disc of specially treated silicon and is mounted on a copper block for the test. This type of cell would be used on space vehicles, where extremes of radiation might be encountered.



METER COIL (quarter-sized, flat printed circuit in center of photo) forms heart of series of very thin panel meters. Combination of nylon bristle pointer and printed-circuit coil prevents even 10,000% overloads from damaging movement. For complete front, side views, July, page 45. Parker Electrical Instrument Co.



ELECTRONIC MOTOR runs on dc, yet needs no brushes or commutator. A switching transistor replaces them in this educational kit made by SER Inc., Waltham, Mass.



AUTOMOTIVE RECORD PLAYER handles 45-rpm records. One-hand operation—a record is pushed into the slot—designed for safety. All other operations are automatic. After record is played, it automatically slides out of the slot. Produced by Norelco, it operates off 6 or 12 volts. Car radio acts as the amplifier. An RCA automotive changer was described in December 1959, page 54.

TV DESIGNS FOR '61

A look at circuitry and design features of TV sets for 1961 reveals new and interesting circuits and construction methods that simplify servicing

By WAYNE LEMONS

THE gamut of 1961 television design runs from virtually no change to major reworking of 1960 circuits and layouts. The 19- and 23-inch picture tubes are in to stay, replacing the 17- and 21-inch types as the standard of the industry. Almost every manufacturer features wireless remote-control units. The receiving units of the remotes are mostly similar, operating in the vicinity of 40 kc so as to be least affected by the set's horizontal sweep system. The portable hand-held transmitting units are about equally divided between the transistor and "hammer-and-rod" types.

Printed and hand-wired circuitry is exactly in the same ratio as last year.

There seems to be quite an upsurge in the use of the neutralized triode as an rf amplifier in tuners. Proponents of triode design claim as much or more gain than the cascode circuit and less noise. One RCA tuner uses a 6CW4 nuvistor triode that is said to give 30% less noise than other triodes on the high channels. Pentode mixers are universally used. Oscillator drift has been cut to a minimum so that fine tuning may be set once and practically forgotten. Several tuners have a trimmer for adjusting tuner-oscillator tuning to compensate for capacitance changes due to tube changes etc.

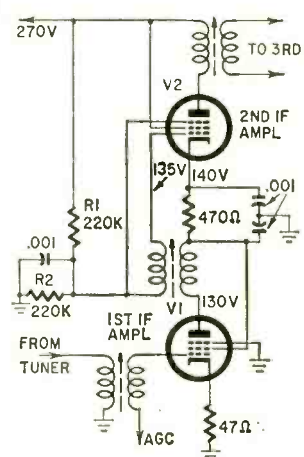


Fig. 1 — Simplified stacked if stages. R1 and R2 set bias level for V2.

"Cascode" or stacked if amplifiers are more common in 1961, and some new tubes with higher gain have been introduced for if service. The stacked if has the advantages of less current drain from the B-plus supply and better signal–noise ratio because of the regulation of the first if plate supply by the second if. A simplified schematic of the stacked system is shown in Fig. 1. The voltage division across the tubes is maintained, regardless of the respective tube condition, by resistors R1 and R2, which hold the grid voltage of V2 constant. Since the tube currents are in series, it is necessary to apply agc only to V1.

There seems to be an increase in sets using high-level contrast-control circuits—meaning the contrast is between the video amplifier plate and the cathode (or grid) of the picture tube. High-level contrast control has the advantage that the gain of the video amplifier stage is not changed and thus the signal level to the sync separators is not affected by the position of the contrast control. Fig. 2 shows one of the simplest high-level contrast-control circuits as used in Dumont chassis 120601-A.

Power supplies are nearly all of the power-transformer type. Several companies make portables with the transformerless chassis, however, and Sylvania for one uses it in all its lines. Most companies have some sort of circuit protective device in either the transformer primary or secondary circuits, a marked improvement over last year.

We found no Synchroguide horizontal oscillator circuits in anybody's black-and-white design for 1961. The closest is the circuit used last year and this year by RCA (more on that later). The multivibrator with semiconductor diode phase detectors is by far the most popular circuit, and the 6CG7 tube is the modern "standard" multivibrator replacing the 6SN7 of years past. A few companies are using a triode-pentode (6U8, 6EA8, etc.) in a combination reactance tube and Hartley electron-coupled oscillator circuit. Fig. 3 is a circuit of this type used by Zenith.

Vertical sweep circuits are almost all the oscillator-output multivibrator type with a pulse from the output tube coupled back into the input tube to sustain oscillation. One of the simplest (Fig. 4) of these is used in Emerson chassis 120507, -508, -515, -516, -541, -542. Note the similarity to a conventional amplifier circuit except for the feedback circuit enclosed in the dotted lines. In this circuit, as in most of this type, the normal bias developed by the oscillator is tapped off by the vertical linearity control and applied to the grid of the output tube to adjust circuit linearity. As in all these circuits, the controls interact so that setting one may necessitate readjustment of the other two.

High-voltage circuits are about the same as last year with some manufacturers claiming even higher output voltages. About the extreme amount claimed for black-and-white sets is by Zenith—22 kv. The shorter 1G3, 1J3,

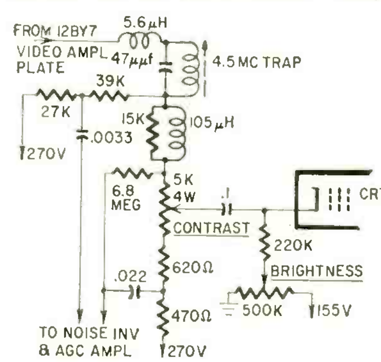


Fig. 2—High-level contrast control used in Du Mont television receivers.

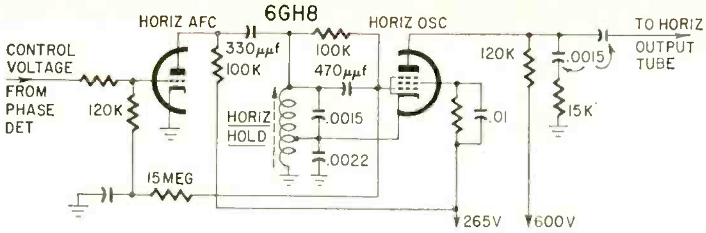


Fig. 3—Simplified diagram of Zenith's horizontal oscillator and control circuit.

etc. is used instead of the older 1B3 in many chassis. Motorola is using the 3A3 in many of its models again this year. To prevent high-voltage rectifier breakdown, many manufacturers are including a series limiting resistor (5,000 to 10,000 ohms) from the rectifier to the newer high-capacitance picture tubes.

Gated-beam sound detectors are used by most manufacturers, although G-E, DuMont and Hoffman have one or more models using a ratio detector.

Motorola is producing a large-screen (19-inch) transistor TV. (See (RADIO-ELECTRONICS, September 1960.) It operates 5 to 6 hours on a self-contained, rechargable silver–cadmium battery. The picture tube has a 12-volt heater. Only one other tube is used, a 1S2 high-voltage rectifier.

Audio amplifiers are pretty well standard with a trend toward the use of the high-sensitivity, higher-power 6BQ5/EL84 as an output tube. Since the stacked if circuit lessens the need for using the audio output tube as a voltage divider, it has just about been discontinued. However, Emerson and G-E use the circuit in some models. The output tube, in this case, is a 6CU5.

RCA is still the only manufacturer of color sets. No major changes in the circuit are evident although the convergence procedure is said to be simplified and the chassis layout changed to provide cooler operation. A new focus circuit eliminates the focus pot as a possible source of trouble.

There are some new if amplifier tubes and vertical oscillator-output tubes, and a new rectifier by Zenith, a 3DG4. More or less, the tube types you'll be seeing in the 1961 models will be familiar.

Serviceability and accessibility

Most manufacturers have improved accessibility and have provided special features to aid the service technician.

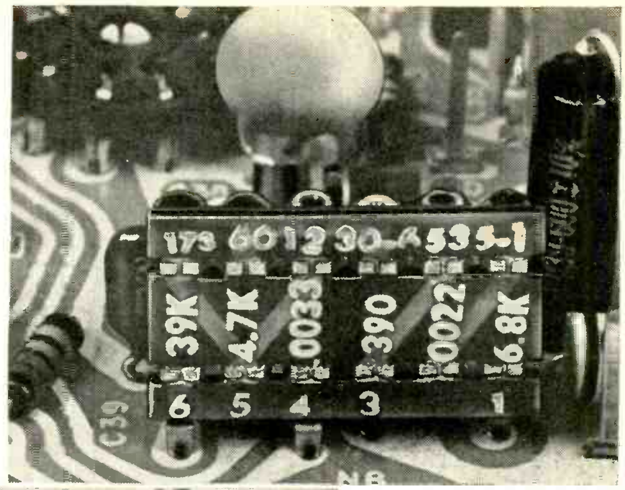


Fig. 5-a—Values of all parts and connections are clearly marked on rear of pack used in several Emerson chassis.

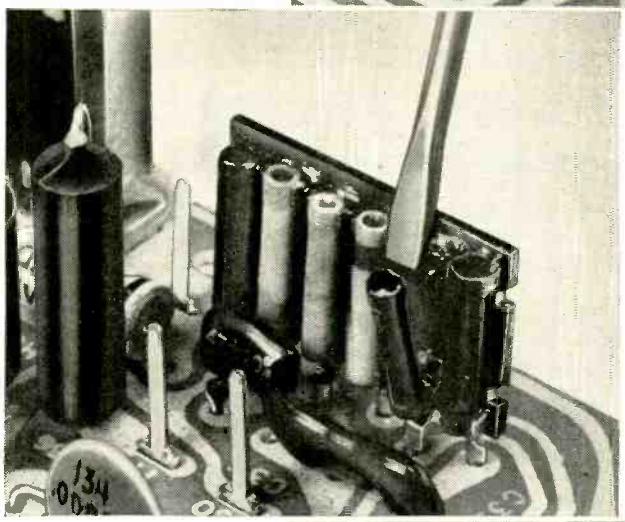


Fig. 5-b—A defective component, once located, can be pried loose with a screwdriver.

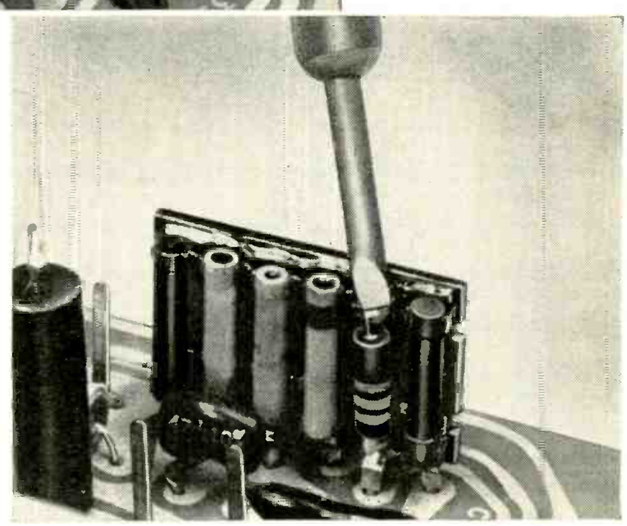


Fig. 5-c—Repair is completed by soldering standard component in pack to replace defective section.

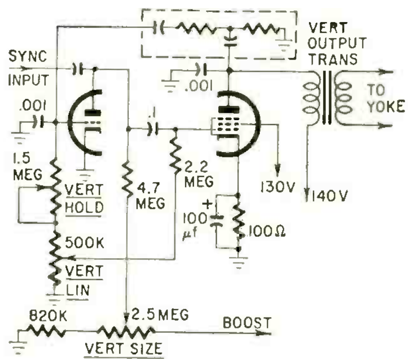


Fig. 4—Emerson's vertical oscillator and output circuit looks like an audio oscillator with positive feedback added.

Something new in packaged components is the Philco component pack (Fig. 5). In (a), the reverse side of the pack shows the value of the component and the internal connections. Fig. 5-b shows a screwdriver prying loose the defective component. Installing a replacement with a soldering iron is depicted in (c).

Other features to soothe the sting of servicing are the provisions made by some manufacturers (G-E, Motorola, Sylvania and others) whose tuners are mounted separately from the chassis. They provide for mounting the tuner on the chassis while transporting for service and while servicing.

Unfortunately, with 23-inch tubes, you just don't find them mounted on chassis it seems. Yoke extensions and test picture tubes will be needed as much or more than ever when these sets require chassis work.

Now let's take a look at the major manufacturers in alphabetical order and hit the high points of the 1961 designs.

Admiral

There are virtually no changes from last year in the 1961 chassis—same tubes, same circuits, same etched boards guaranteed for 5 years. A yoke plug on 23-inch models makes them easier to

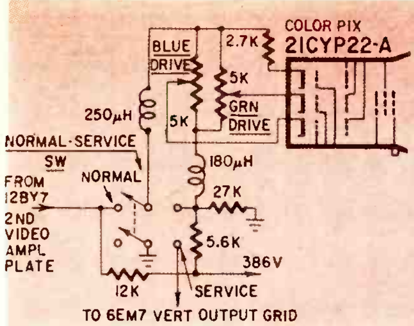


Fig. 6—Normal service switch simplifies monochrome tracking in Admiral color sets.

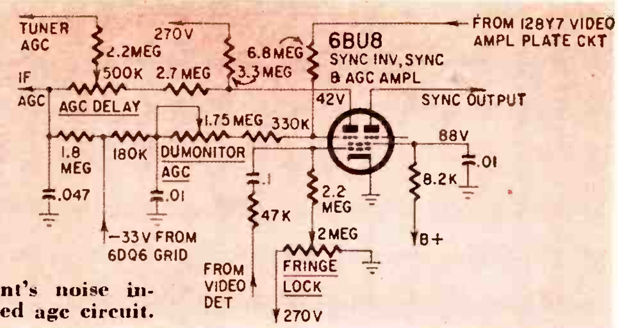


Fig. 7 — Du Mont's noise inverter and amplified agc circuit.

service. Speakers plug into terminals on the output transformer.

The tuner is separate from the chassis. Chassis layout is neat and all tubes may be replaced by pulling the back. Slide catches make the back easy to remove without tools. Portables have 19-inch tubes—circuit unchanged.

A transistorized remote-receiver model 7E2 is used with their SON-R wireless remote unit. The receiver uses seven transistors all of the same type on a PC board. A selenium half-wave rectifier supplies the necessary −12 volts to operate the receiver from the ac line.

Admiral's color receiver (built by RCA) has a special NORMAL-SERVICE switch (Fig. 6) for easier adjustment of black-and-white tracking. In the SERVICE position, the video is removed from the picture tube and there is no vertical deflection.

DuMont chassis 120601A

There is little change from last year in this hand-wired set. The power-transformer chassis uses a 5U4-GB rectifier, stacked if's and a 12BY7 video amplifier. A 6BU8 is used as a combination sync separator, noise inverter and agc amplifier. There is an AGC DELAY control for the tuner agc, a DUMONITOR overall agc control and a FRINGE LOCK control to adjust the noise inverter. The circuit is shown in Fig. 7. Even though this is *not* a keyed agc circuit, it relies on a negative dc bucking voltage from the grid of the horizontal output tube for proper agc functioning. So, if the horizontal oscillator fails, there will be buzz in the sound due to agc overload.

A 6AL5 phase detector controls a 6CG7 horizontal multivibrator. A 15,000-ohm pot acts as a width control by varying the 6DQ6 screen voltage. Fuses include: a 0.7-amp unit in the power transformer secondary, a 0.3-amp type in series with the B-plus to the damper and 6DQ6 screen, and lengths of No. 26 wire in series with the 6.3-volt heaters and the 5-volt rectifier filament.

Picture tubes used with this chassis may be either the 21CBP4-A or the 24AEP4-A.

Emerson chassis 120530C, -531D

This chassis has some interesting design features. The 6BU8 combination sync clipper, noise inverter and keyed agc is a common design choice but, in this chassis, the noise "lock" is automatically controlled and the agc (LOCAL-DISTANCE) control varies only the delay voltage to the tuner. The if agc is unaffected by the agc control. The circuit is in Fig. 8. Turning the LOCAL-DISTANCE control toward the ground end reduces the *positive* "defeat" or bucking voltage to the tuner agc line. This allows the tuner agc to go more *negative* and reduces the tuner gain for local operation.

An automatic adjustment for the noise-inverter portion of the circuit is provided by returning grid 1 (pin 7) of the 6BU8 through a 470,000-ohm resistor to the plate supply of the second if stage. When signals are strong (and noise clipping undesirable because sync might be clipped also), the plate voltage of the second if will rise (because of agc action) which in turn raises grid 1 voltage. With grid 1 positive, it has virtually no control on the electron stream inside the tube and the noise-clipping action of the circuit is nullified. With weak signals, the grid returns to near zero so that strong noise pulses (they will be negative-going at this point) will cut off the tube and remove the noise pulses from the sync output.

The Emerson circuit uses dual semiconductor diodes to control the 6CG7 horizontal multivibrator. Horizontal hold control is unusual for American sets (Fig. 9) although it has been used by several foreign manufacturers. The hold control can vary the multivibrator sync control grid from zero to about 12 volts positive. By adjusting the ringing coil so that the circuit will lock in normally with about 6 volts on the grid as supplied by the hold control, the control will then speed up or slow down the multivibrator by raising or lowering the grid voltage around this 6-volt median.

The horizontal drive control is also unusual (Fig. 10). It is a variable unbypassed 300-ohm pot in the *cathode* of the 6DQ6 horizontal output tube. Width is controlled by connecting or opening a jumper across the 3,300-ohm resistor in the 6DQ6 screen circuit.

The 120507A, -508B, -515C, -516D, -541C, -542D are transformerless chassis using a single silicon rectifier. A 1.25-amp fuse is in series with rectifier and a 1-ohm *fusible* is in series with the heater string. Picture tubes used with these chassis are 17BJP4, 21CBP4-A and 23XP4.

General Electric M6 and U5 chassis

The M6 and U5 chassis are very similar to 1960's M5 and U4. New features include a two-button remote-control system, step type remote volume-control

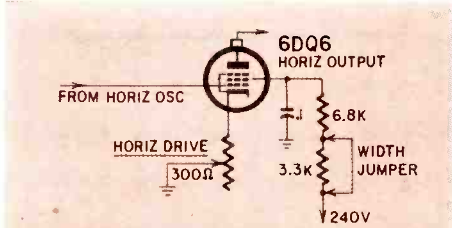


Fig. 10—Horizontal drive and width control circuits in some Emerson sets.

system, miniaturized vhf tuners, and 19- and 23-inch square-corner picture tubes. A new muting circuit opens the cathode of the audio if amplifier to quiet the receiver during power tuning. The U5 chassis has a 6BQ5 audio output tube (6AQ5 last year) to provide higher output and greater power sensitivity for more output from low-level cartridges when the phono input is used.

Three new miniaturized tuners are used in the M6 chassis. All have 6EV5 tetrode rf amplifiers. The 12- and 13-position Sarkes Tarzian tuners use a

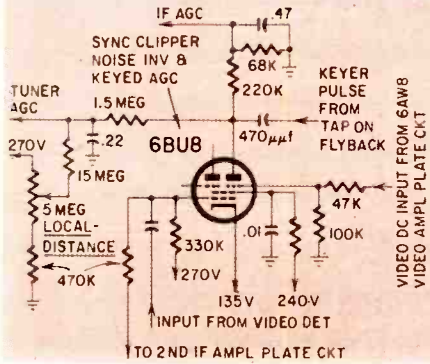


Fig. 8—Noise-free agc and sync circuit in Emerson TV receivers.

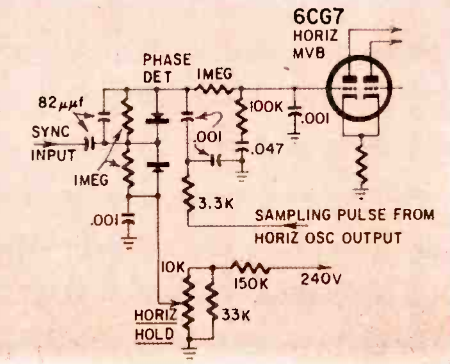


Fig. 9—Unusual horizontal hold control used by Emerson.

6CL8 converter–oscillator tube. The 12-position Oak tuner uses a 6EA8. Replacing the antenna transformers in all the new tuners is comparatively easy. The Oak tuner has a hole in the rear so that the antenna input transformer lead can be disconnected easily. Fig. 11 shows the overall oscillator adjustment that can be used to recenter the channels when an oscillator tube is replaced. The U5 chassis has a cascode miniaturized Oak tuner—except for smaller size, the same as last year's U4 tuners.

Only one size of picture tube is used with the U5 chassis—the 23KP4.

As last year, G-E's watchword in the "designer" chassis is accessibility. Almost all repair work can be done without taking the chassis to the shop. This includes even the flyback transformer if you follow the recommended procedure of separating the two halves of the transformer core to permit sliding off the high-voltage rectifier filament winding (Fig. 12). CAUTION: Do not remove the two pieces of tape that are applied to the ends of the core halves!

G-E's two-button remote changes channels and increases volume or mutes the receiver. It will also turn the set off when the tuner is moved to the uhf position (on non-uhf sets). Uhf sets may be set to turn off on any inactive channel but are shipped from the factory with the off position on channel 9. This year's remote volume is in the signal circuit instead of the screen circuit of the audio if as last year.

Mechanically, the 17- and 19-inch models are similar to the 1960 M5, having the tuner and bracket assembly attached to the chassis. The 21- and 23-inch models of this year, however, have the tuner and bracket assembly attached directly to the cabinet front. A ground strap is riveted to the tuner and this should always be attached to the main chassis; otherwise, regeneration and tweets may develop. The tuner bracket assembly may be stowed on the chassis by special hooks provided for this purpose, if it is necessary to remove the chassis for service (Fig. 13).

Bonded safety faceplates are *not* used on the 19- and 23-inch G-E models. A removable safety glass is used instead.

Hoffman chassis 351 to 359

All these models are transformer-powered. All except the 355, which has silicon rectifiers, use 5U4-GB's. All either have circuit breakers or fuses in the primary circuit of the power transformer and either continuous or step type variable focus control. Chassis 354, 357 and 359 have a "Lite Scope," a device for automatically controlling brightness, depending on ambient light conditions. (See "New Automatic TV Brightness Control," RADIO-ELECTRONICS, September 1960, for other details on the Lite Scope circuit.)

All have essentially the same, pretty straightforward, circuitry. They have keyed agc, tube type video and horizontal phase detectors. All except the 354, which has a 6BN8 ratio detector, use 6DT6 gated-beam sound detectors.

Fig. 11 — Tuner in G-E's M6 chassis. The oscillator trimmer is near the output jack.

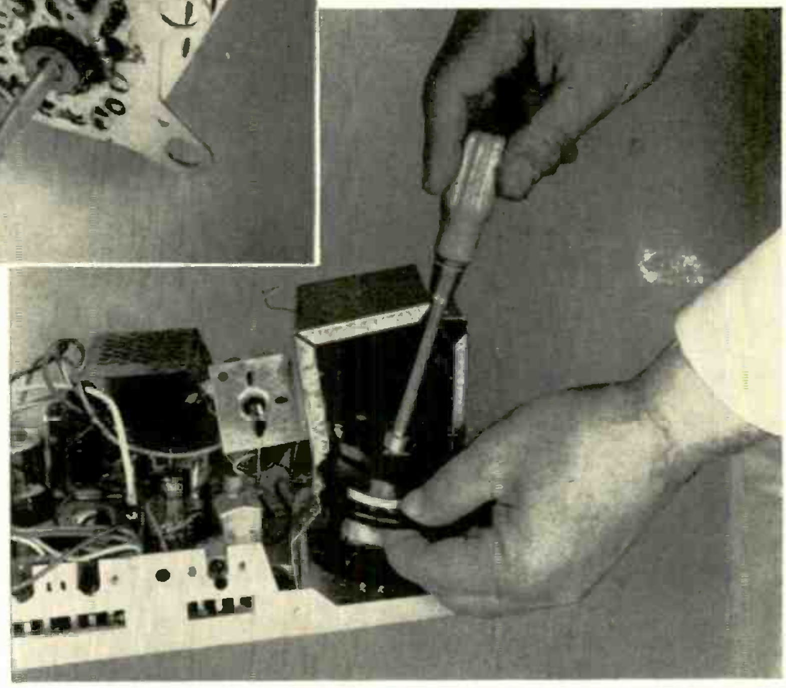


Fig. 12 — Flyback transformer in new G-E sets can be replaced without removing chassis from cabinet or pulling set to shop.

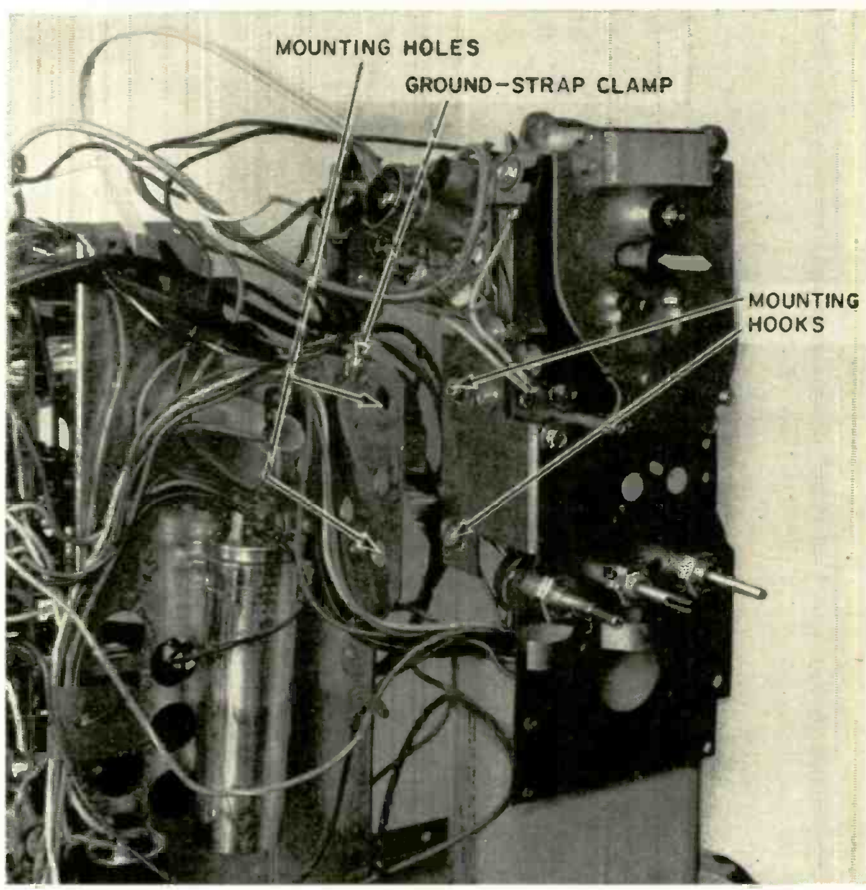


Fig. 13—G-E tuner hooks onto chassis for easy transporting.

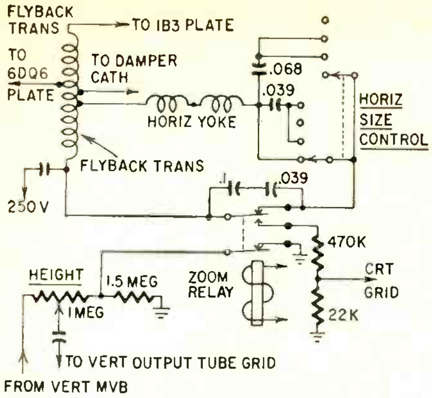


Fig. 14—Hoffman picture-magnifier circuit is controlled by wireless remote.

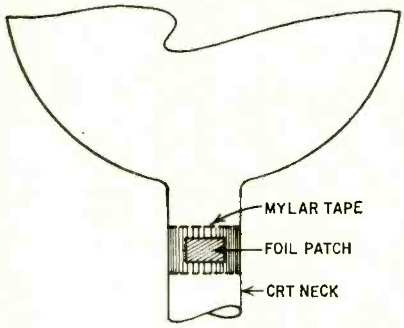


Fig. 15—Foil patch on CRT neck insures optimum horizontal linearity in Hoffman sets. Remove and re-install on replacement CRT's.

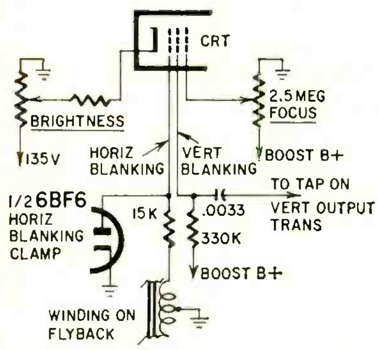


Fig. 16—Magnavox horizontal and vertical blanking circuits.

All use a double-triode direct-coupled sync separator circuit.

Hoffman remotes are similar to other wireless models except for the ZOOM position on some models. This circuit, reminiscent of "enlarging" circuits used when small round tubes were popular, increases the picture size both vertically and horizontally when the ZOOM button is depressed. Pressing the button again returns the picture to normal size. The ZOOM relay circuit is shown in Fig. 14. Note that a contact on the relay applies boost voltage through a bleeder to the grid of the picture tube; this compensates for a loss of brightness when the picture is "zoomed." Note also that the height control varies the signal output from the vertical multivibrator to the vertical output tube instead of varying the voltage on the multivibrator plate. This prevents the oscillator from changing frequency when the picture is magnified.

Hoffman sets using 19- and 23-inch picture tubes have a foil patch held in place on the neck of the tube by Mylar tape. This foil patch should be installed on a replacement picture tube to provide optimum horizontal linearity (Fig. 15).

Magnavox series 32, 33, 34

These chassis are all similar except that the 32 series has average rather than keyed agc. The 33 series is one of the few designs this year that use a vertical blocking oscillator circuit. Series 32 and 34 utilize both vertical and horizontal blanking (Fig. 16). An interesting feature of the horizontal blanking circuit is the clamping-tube diode used to prevent spurious responses in a positive direction from affecting picture-tube brightness. Vertical blanking is applied to the first anode rather than the more conventional method of applying it either to the grid or cathode of the CRT.

These are all power-transformer chassis with 5U4-GB rectifiers. They have 6CG7 horizontal multivibrators with series type semiconductor diode phase detectors. Low voltage (+135) for the if amplifiers is taken from the cathode of the 6DG6/6W6 audio output tube. The 32 series uses a 17DKP4 picture tube, 33 series either a 21DLP4 or 24AUP4, and 34 series either a 19YP4 or 23MP4.

A variable-inductance width coil is used on the 33 and 34 series. There is no width control on the 32 series.

Motorola

In addition to the first big-screen transistor TV, Motorola has added 19- and 23-inch tube sets to its 1961 line. All except 17-inch portables, models 17P6 and 17T37, are hand-wired chassis, both with and without power transformers. Circuits are similar to 1960 models. Motorola is the only manufacturer using 3A3 high-voltage rectifiers in monochrome sets. (In the 17-inch portable they use a 1S2-A.)

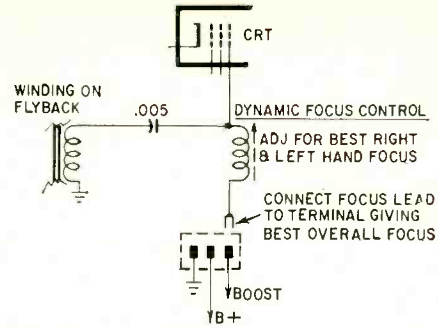


Fig. 17—Motorola uses dynamic focus control.

All models use nine-pin "double-ended" damper tubes, either the 6AL3/6AF3 or 12AF3.

All have some method of adjusting the horizontal size; most use a 5,000-ohm pot in the horizontal amplifier screen circuit.

Dynamic focus of the 23GP4 picture tube is provided in the VTS-569 chassis. Dynamic focusing is said to give better focusing on short-neck wide-angle tubes. This is done by controlling the focus voltage in relation to the position of the spot on the screen (Fig. 17). The focus-coil adjustment is made for the best left-and right-hand focus; the tap is set for the best overall focus.

All transformer-powered models use 3BZ6 first and second if tubes in a stacked if circuit. The 3-volt heaters

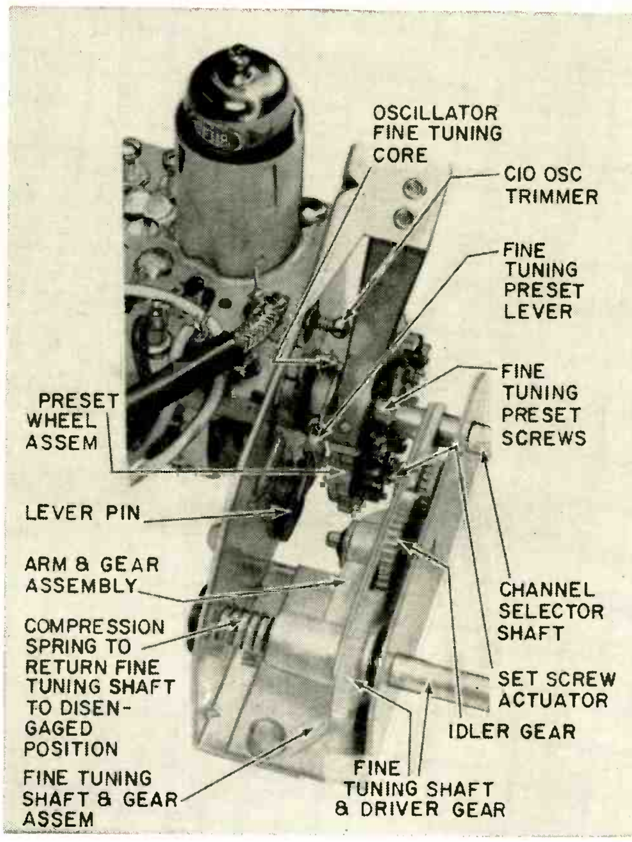


Fig. 18—Motorola fine tuning system. C10, for overall oscillator adjustment, is accessible when channel-selector knob is removed.

are connected in series across the 6-volt heater winding of the power transformer. So, in this case, if you see 3-volt tubes, it doesn't indicate necessarily that the set is a transformerless one.

Tuners on the new Motorolas are smaller and easier to service than earlier counterparts. A complete switch wafer may be replaced with comparative ease. The wafers may be crimped in the retaining bar but they can be released with a pair of long-nose pliers. An overall oscillator adjustment C10 (Fig. 18) is accessible when the channel-selector knob is removed. It may be used to recenter the high channels when a new mixer–oscillator tube is installed. Preset fine-tuning adjustments are provided on most models also.

Philco

Philco has a new tuner this year. It features shorter leads, made possible by recessing the tubes right into the tuner body. It uses a "frame-grid" amplifier tube, the 6ES8, for lower noise and higher gain. (Pin connections for the 6ES8 are the same as for the 6BQ7.) There is an individual oscillator adjustment for each channel in this switch type tuner. To remove the tuner for service, take out the Phillips-head screws from the dial plate and remove it. Then take out the two ¼-inch hex-head screws that are exposed. Now remove the if link plug and disconnect the power cable plug. Remove the two hex screws supporting the tuner at the rear and slide the tuner out (Fig. 19).

Other features of the 1961 "cool chassis" Philco are the stacked if stages and a new tube, a 6HJ8, third if and video detector. The contrast control is in the cathode of the video output tube, but in reality it doesn't affect the gain of the video amplifier tube to a large extent. It is bypassed by a 100-µf capacitor. It functions by controlling the bias on the tube which, in turn, controls the bias on the agc keyer. Thus turning up the contrast actually reduces the agc voltage, and the gain of the set is increased (Fig. 20).

A NOISE-ADJ control sets the conducting point of the noise inverter tube (half of a 6EA8). Fig. 21 is the circuit, showing the composite video and inverted noise paths through the circuit. Adjust the noise control as follows:

1. Use a weak signal; remove the antenna if necessary.
2. Shunt the noise control with an 18,000-ohm resistor.
3. Adjust the fine tuning for a slight sound beat in the picture.
4. Adjust the noise control until the picture appears watery—this is caused by the noise inverter passing some inverted sync signal.
5. Back off the noise control slightly until the picture is steady.
6. Remove the shunt resistor.

The reasons may not be apparent at first glance for the 10-megohm resistor from the center arm of the brightness control to the lower end of the grid resistor in the vertical output stage, (Fig. 22) or why the brightness control is in the ground leg of the width

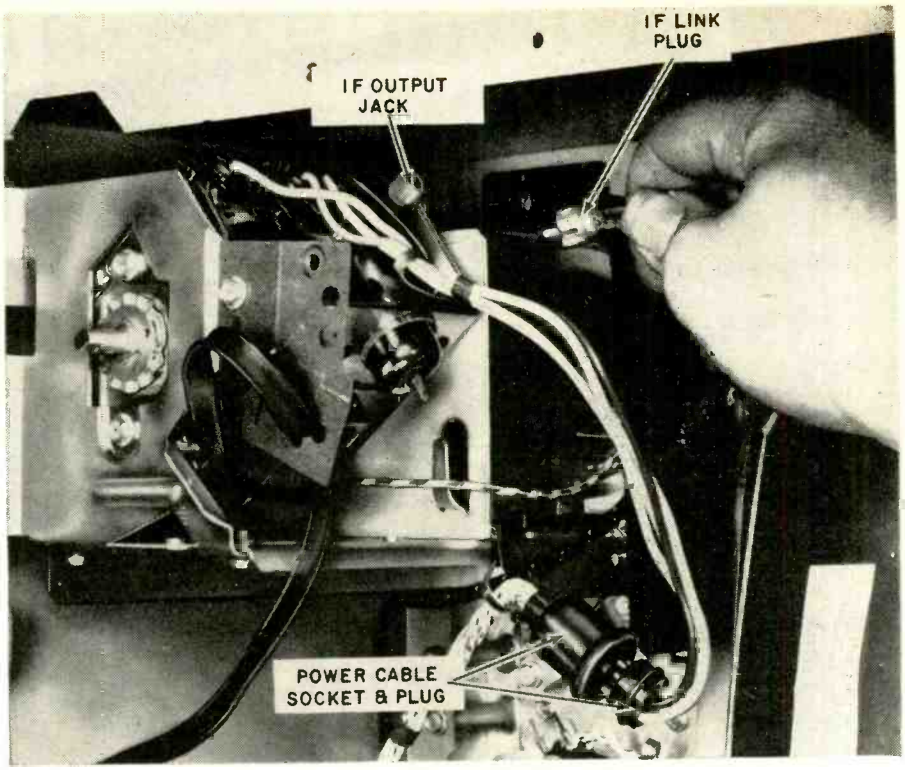


Fig. 19—Removing the Philco tuner.

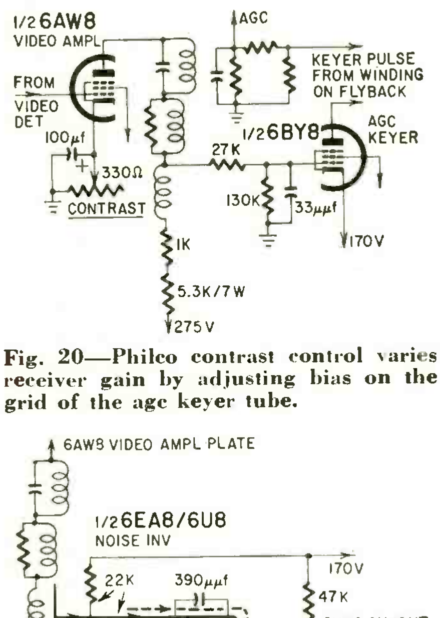


Fig. 20—Philco contrast control varies receiver gain by adjusting bias on the grid of the agc keyer tube.

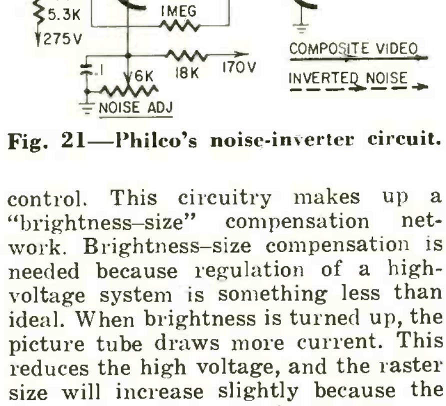


Fig. 21—Philco's noise-inverter circuit.

control. This circuitry makes up a "brightness–size" compensation network. Brightness–size compensation is needed because regulation of a high-voltage system is something less than ideal. When brightness is turned up, the picture tube draws more current. This reduces the high voltage, and the raster size will increase slightly because the electron beam is now easier to sweep.

Vertical compensation is achieved by feeding back a positive voltage to buck the normal negative bias on the vertical output tube. (The negative bias is taken from the grid circuit of the horizontal output tube.) As the brightness is increased (brightness-control arm going toward ground), there is less positive bucking voltage. This lets the grid go more negative and reduces the picture.

The brightness–width compensation would appear to be connected in reverse. As the brightness is increased, there is less shunting action by the 39,000-ohm resistor (R38). This would seem to increase rather than decrease the width because the screen voltage of the horizontal output tube is increased. However, in practice, the high voltage tends to be increased by this action faster than the width is, and compensation results. The brightness–size compensation tracking is said to be good.

This year, as in 1960, all RCA's, including portables, have power transformers. A stacked if system is used and a new tube, 6GM6, is the second if amplifier. This tube has considerably higher gain than its predecessor. Most

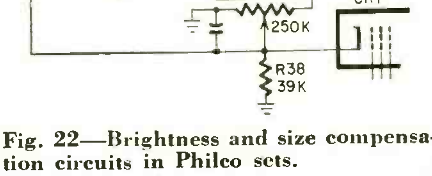


Fig. 22—Brightness and size compensation circuits in Philco sets.

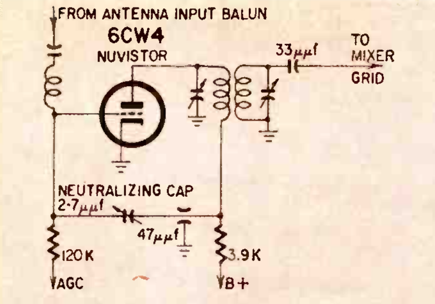


Fig. 23—Simplified circuit shows neutralized nuvistor rf amplifier in RCA tuner.

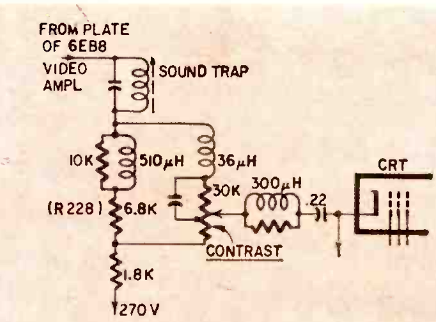


Fig. 24—Contrast control is high-level type in all RCA 1961 chassis.

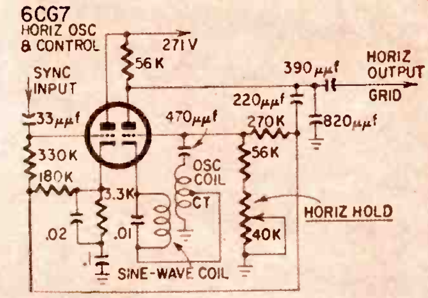


Fig. 25—RCA horizontal oscillator and control circuit.

RCA tuners are of the neutralized triode type, even on color sets. RCA claims that these tuners equal or exceed the gain of cascode types and produce less noise. One model uses the RCA nuvistor triode (6CW4). (See "Nuvistor, New Electronic Tube" in the June, 1959 issue.) Less noise is claimed for this type of construction because the tube can be heated to high temperatures for driving out impurities without damage. Fig. 23 is a simplified circuit of the "New Vista" tuner showing the method of neutralization. The neutralizing capacitor feeds an out-of-phase signal back to the grid to cancel out the grid-plate capacitance of the tube and thus prevent oscillation.

High-level contrast control is used in all models (Fig. 24). A peculiar trouble, which might be diagnosed as a defective picture tube, occurs if the 6,-800-ohm resistor (R228) opens. This increases the video amplifier's plate load resistance to above 30,000 ohms, and pictures take on a "milky" look similar to a gassy picture tube.

The horizontal oscillator, sometimes called the "synchromatic," is the same as introduced by RCA last year. (Fig. 25.) A scope is *not* necessary in the setup procedure as it was with its cousin the Synchrophase. To adjust the sine-wave coil, first short it out with a jumper and then ground the grid of the sync output tube (6EA8). Now adjust the horizontal hold control until the picture is steady or moving slowly sideways. Remove the short from the sine-wave coil and adjust it for a straight-sided picture. Remove the short from the sync circuit. The picture should lock in perfectly. If the adjustment is correct, shorting or unshorting the sine-wave coil (not the oscillator coil) will not cause the picture to go out of sync but merely shift it sideways slightly.

The Synchroguide oscillator in the RCA color sets is shown in Fig. 26. Note the use of phase-detector diodes instead of the pulse-width afc system. The left section of the 6CG7 is the oscillator control. Its plate voltage raises or lowers the oscillator bias to control the oscillator speed.

RCA seems to have the only remote that will completely turn off both the TV set *and* the remote-receiver amplifier. A pneumatic switch delays the off action for 5 seconds so that the remote operator may pass through the off position (on the tuner) and continue to select channels. However, if the operator delays more than 5 seconds, both the set and amplifier will turn off and it is then necessary to turn the set back on manually before the remote can be used again. A standby position is provided also which cuts off both picture and sound but leaves the set and the remote amplifier turned on. RCA remotes have four volume levels instead of three.

All 23-inch sets have tubes with bonded faceplates and stereo input jacks.

Sylvania 550-1, -2, -3, -7, -8, -9

These chassis are transformerless types with three 3BZ6 if's, the first two in this year's popular stacked-if circuitry. A 1N295 shunt video detector is used (Fig. 27). The shunt detector is not used much since most manufacturers seem to prefer a secondary winding on the detector if transformer and place the diode in series with the signal. When no secondary is used, as on these sets, the shunt arrangement is ideal since the diode can act as its own dc return. (A diode will block if not provided with a dc return path around it.)

An 8ET7 duo-diode-pentode is used as a combination video amplifier and horizontal phase detector. A 3CS6 is used as sync separator and noise gate. A 10EG7 is the twin-triode vertical oscillator-output tube.

The transformerless chassis has no protective devices in the heater circuit. However, a circuit breaker is used in series with the silicon-diode voltage-doubler power supply.

Sylvania's wireless remote receiver is unusual in that only one tube is used—a 6AW8. The pentode section is used as the first amplifier, feeding the triode section. The triode is connected in a reflex circuit which amplifies the remote-transmitted signal and feeds it to a diode voltage-doubler circuit which in turn biases the triode to trip the relay in its plate circuit.

This remote changes channels and turns the set off and on. (Only one button is used—the off–on switch is actuated by the channel selector.) It represents quite a departure in design from most remotes which employ several tubes. Although probably not as selective as some remotes, it has the obvious advantage of being easy on the electric bill when operated continuously, as remotes ordinary are required to do. Full details on this remote control will appear in a full-length story in an early issue.

Fig. 28 shows the 1961 Sylvania mounted in the cabinet. Fig. 29 shows the chassis removed and the tuner and control assembly mounted for transporting to the service shop when necessary.

Westinghouse

Westinghouse has 17- and 19-inch portables for 1961 with transformerless chassis. They have transformer-powered 19- and 23-inch sets. There are no 21-inch sets in the line.

All chassis use the stacked if circuit. Keyed agc is used in the 23-inch sets but all others have average type agc taken from the video detector. All have noise inverters using the triode half of a 6FV8.

Transformer sets have a 3.5-amp slow-blow fuse in the primary circuit of the power transformer. Transformerless sets have no surge protection in

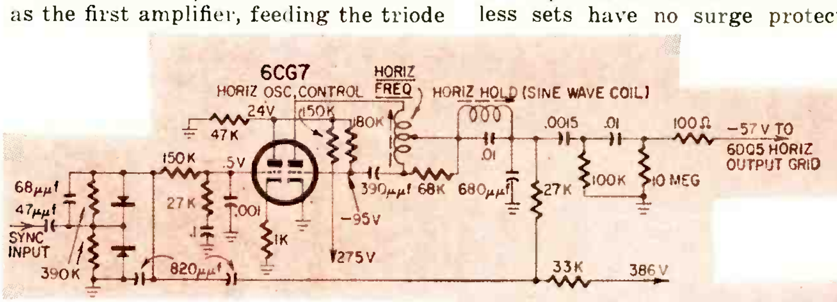


Fig. 26—RCA's color sets use Synchroguide horizontal oscillator with phase detector diodes instead of pulse-width afc system. Plate voltage of left-hand section of tube rises and falls to control oscillator grid bias and frequency.

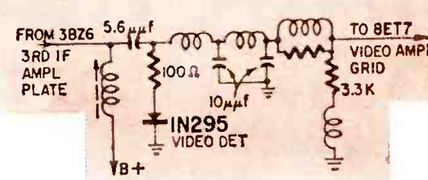


Fig. 27—Sylvania sets have shunt-type video detector circuit.

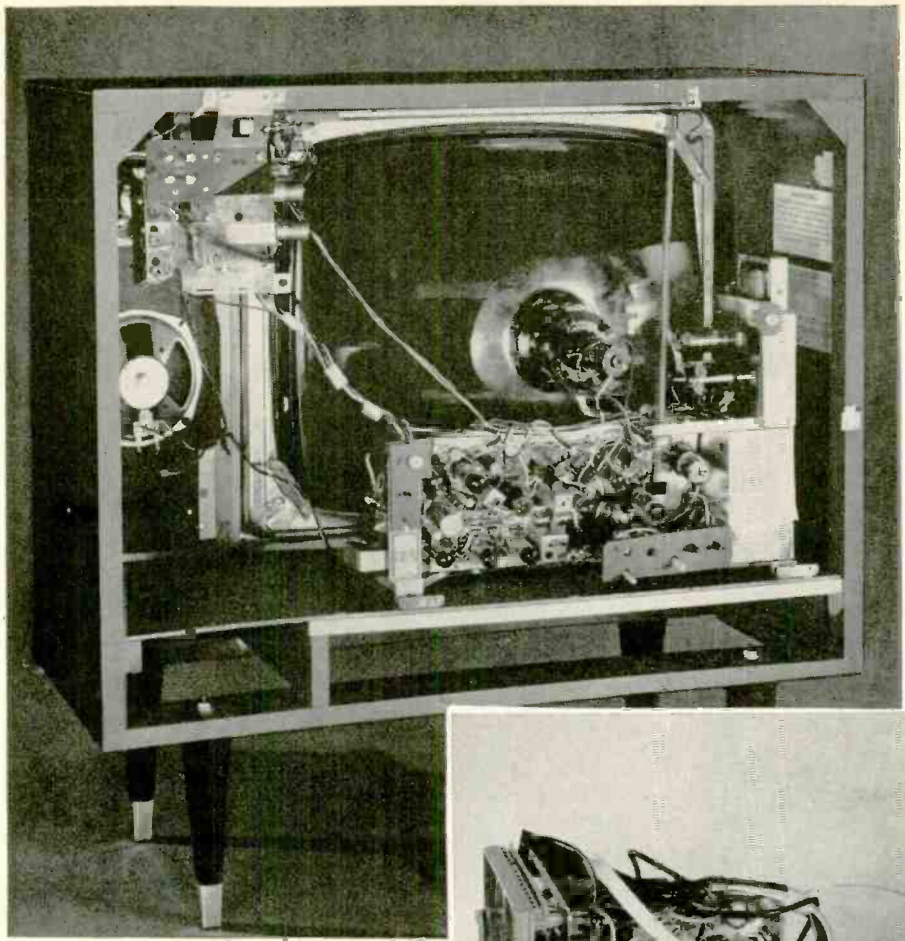
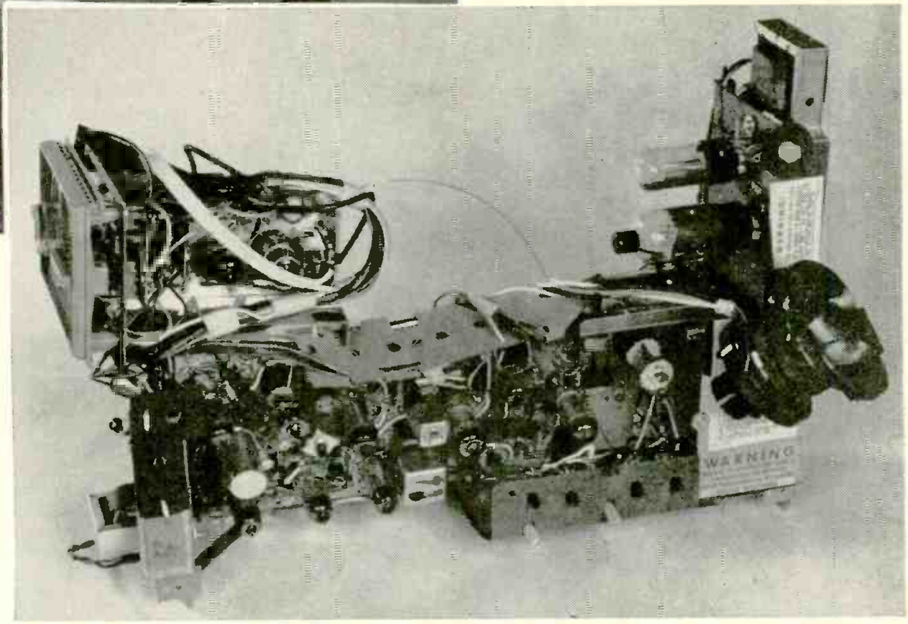


Fig. 28—Sylvania chassis mounted in cabinet.

Fig. 29—Same chassis clipped together for trip to shop for service.



the heater circuit but do have a circuit breaker in series with the voltage-doubler power supply rather than a fusible resistor.

Selenium-diode phase detectors control the horizontal multivibrator. Westinghouse sets have printed circuits and utilize their "See-Matic" board which has all parts symbols, values and connecting points printed right on it. (See "Circuit Boards Are Getting Better" in the December, 1959, issue.)

The portable sets, which incidentally are also built for Montgomery Ward and labeled Airline, can be serviced on the under side by tilting the picture tube out to expose the printed panel.

The fine-tuning gear drive mechanism (Fig. 30) permits individual fine-tuning adjustment for each channel from the front of transformer-powered sets.

Two wireless remotes are available on Westinghouse sets. One is a two-button "hammer-and-rod" type that changes channels in sequence, turns the set off or on and controls the volume in three steps. A four-button remote has a transistorized transmitter that sends modulated and unmodulated signals at 39 and 41 kc. With the four-button remote, volume can be turned either up or down, or channels may be selected in either direction.

Incidentally, on Westinghouse portables you'll find the height and linearity controls under the channel-selector knob.

Zenith

All 1961 Zenith chassis use power

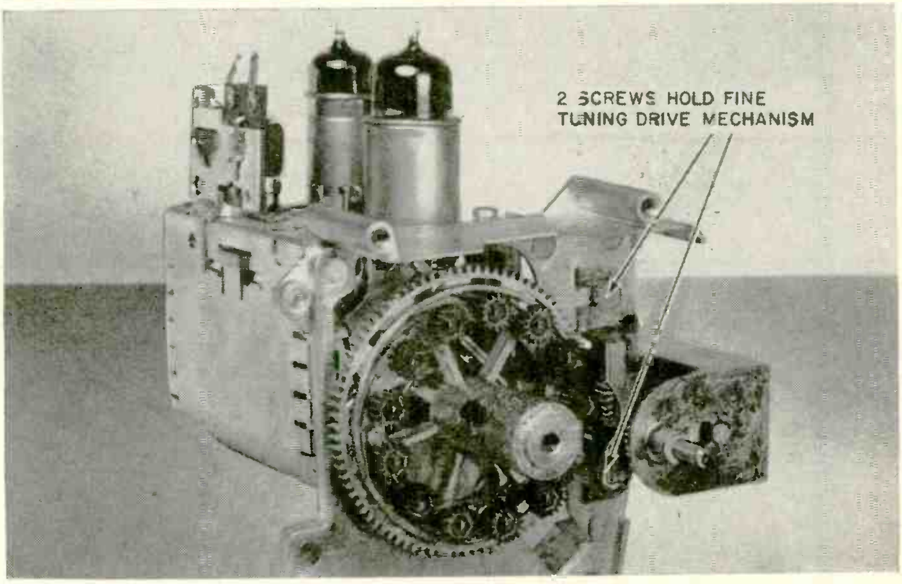


Fig. 30—Westinghouse's "memory" fine-tuning mechanism.

Because of the detailed and extensive coverage of new television trends in this article, we have been unable to print any more television material in this issue. The TV Service Clinic has therefore been omitted. We promise you an extra fat Clinic next month as compensation.

transformers and are hand-wired. All except portables have fuses in the primary circuit of the power transformer. Portables have 700-ma fuses in the center-tap ground-return lead of the power-transformer secondary. All chassis use tube rectifiers. A new rectifier tube, the 3DG4, is used in some chassis. A 5V3 may be used as a replacement if the 3DG4 is unavailable.

Zenith sets for '61 have 17-, 19-, 21- and 23-inch picture tubes. One chassis uses a 23ANP4 CRT with 22 kv on the second anode. In fact, Zenith is the only 1961 set we found that listed as much as 20 kv (on their schematics) measured at the high-voltage rectifier, although some other manufacturers do advertise chassis running up to 23 kv.

Other tube types we noted in the 1961 chassis include a 6CQ4 damper which may be replaced by a 6AX4-GTB, and a 1AU3 high-voltage rectifier similar to the 1J3. A 6EA7 or 6EM7 (interchangeable) is used as vertical oscillator output; a 6GH8, similar to the 6U8 or 6EA8, is used as a horizontal oscillator and control. A 6GN8, similar to the 6AU8 or 6AW8, is used as combination video amplifier and triode sound limiter.

An unusual horizontal retrace-blanking circuit is used in some models (Fig. 31). A blanking pulse taken from a winding on the flyback is fed through a neon lamp to the control grid of the picture tube. The neon will break down and pass the strong blanking pulse generated during flyback time. However, transients that occur during trace time are blocked because they are not strong enough to ionize the gas. Vertical retrace blanking is applied to the picture tube's first anode.

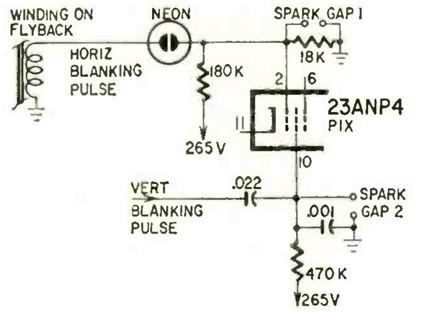


Fig. 31—Zenith's horizontal and vertical blanking circuit. Spark gaps protect other circuits against shorts in CRT.

Spark gaps protect other circuits should a short occur in the picture-tube gun. Spark gap 1 (Fig. 31) slips over pins 1 and 2 of the picture tube. If the picture tube is replaced, it should be installed on the new tube.

The 19-inch Zenith portables have a removable bottom plate, Fig. 32, so that major repairs may be made without pulling the chassis. END

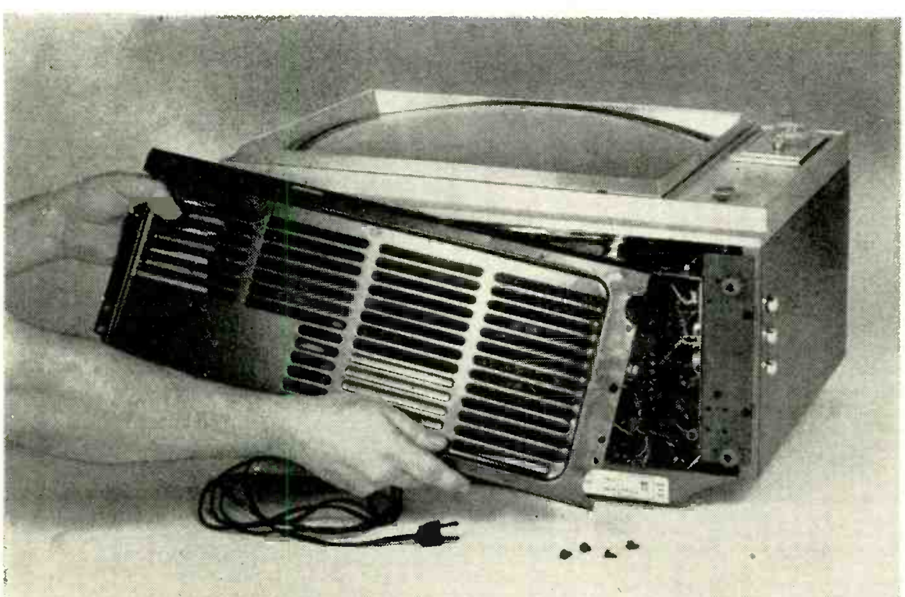
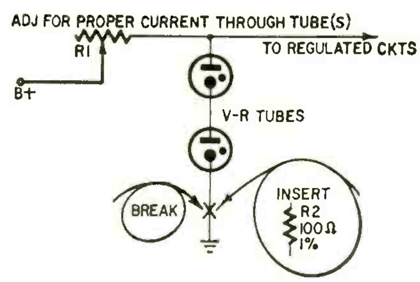


Fig. 32—The "works" in Zenith's 19-inch portables are reached by removing bottom plate.

measure V-R TUBE current

THE next time you use voltage-regulator tubes (VR105, VR150, etc.) try this stunt. Instead of connecting the cathode of the bottom tube to ground, insert a 100-ohm ½-watt resistor between cathode and ground. Now you have a method of monitoring the current through the tube (or tubes) without unsoldering leads, pulling out other tubes or anything else. Nor do you have to open any leads and insert a milliammeter. All you do is connect your voltmeter across the 100-ohm resistor and read the voltage. By Ohm's law, if there is 2 volts across the resistor, the current through it is 20 ma. If the voltage is 1.8 the current is 18 ma. Moving the decimal point one place to the right converts the voltage reading to current in mils.

This is a convenient thing to have in a circuit if you make changes later, as it is never necessary to unsolder anything to check current through the V-R tubes. Besides, a stranded wire



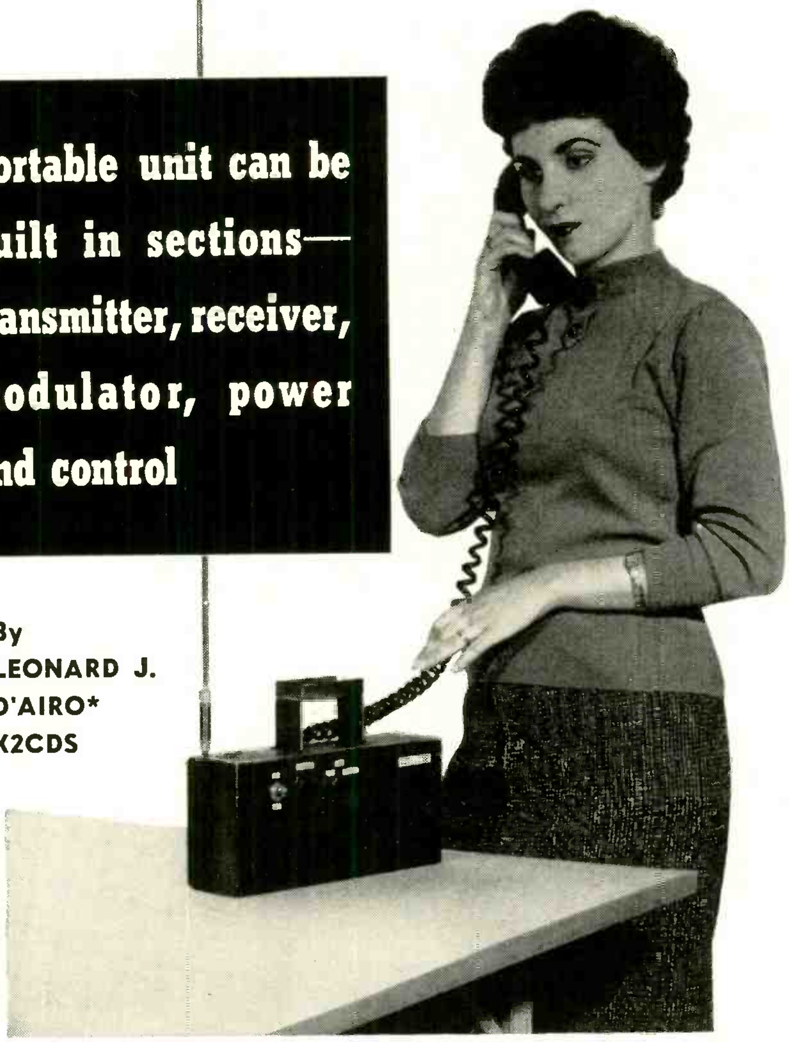
with the usual plastic insulation begins to look a bit shaggy after it has been soldered and unsoldered a time or two. My method is also convenient for setting up the proper operating conditions in the first place. Just connect a voltmeter across the 100-ohm resistor and adjust R1 for the desired current. As a rule, I do this by temporarily hooking up a wirewound potentiometer in place of R1 and adjusting it, then I replace the pot with a fixed resistor of the proper resistance. As often as not, this turns out to be a wirewound adjustable unit to permit changing its value in the event of other circuit changes.

When using the metering resistor, regulation will drop a little from perfection, as a change in current through the 100-ohm resistor varies the circuit voltage by the same amount as the change in voltage across the resistor itself. This will be insignificant except in a very few laboratory applications. The total regulated voltage is also just a little higher than before, but the extra volt or two is not too important, and the simplicity of making measurements and adjustments outweighs the small disadvantages.—*Elmer J. Kaping*

handie-talkie

COVERS THE 10-METER BAND

Portable unit can be built in sections—transmitter, receiver, modulator, power and control



By
LEONARD J. D'AIRO*
K2CDS

SINCE the FCC allocated the 11-meter band to the Citizens Radio Service, many heretofore indifferent citizens have had a sampling of the thrills and excitement of personal communications. Because of this, many Citizens banders have migrated from the Citizens Radio Service to amateur radio, the ultimate in personal communications pleasure. Taking advantage of this increase in the amateur population, many of the major manufacturers of electronic equipment are now producing transmitters and receivers to entice the new and potential radio amateur. Though there are many units to choose from, some persons still prefer to build their own or some are limited financially. Whatever the case may be, this walkie-talkie fills the bill.

Built into a 5 x 3 x 10-inch aluminum chassis that serves as its case, the transceiver is completely self-contained. Transistors are used in the receiver and audio sections and tubes in the transmitter section. Power is supplied by subminiature storage batteries of the type used to power Radio-Sondes sent aloft with weather balloons.

The range of the set, using a 38-inch base-loaded whip antenna, is approximately 10 miles. Using a three-element beam antenna, successful communications have been made over much greater distances.

The transmitter

The unit is not a typical transceiver where one tube is used for both the transmitter and receiver. The transmitter and receiver are separate units, sharing only a common audio system. This arrangement helps avoid the complex switching often found in single-tube transceivers.

A 6C4 triode is used as a 28-mc oscillator (Fig. 1). It drives a 6AK6 rf power amplifier. Input power to the 6AK6 is about 5 watts. An International Crystal Co. type FM-1 third-overtone crystal is used to fix the operating frequency. This type is used for its small size, its exceptional calibration tolerance (.0025%) and its temperature stability (.005%).

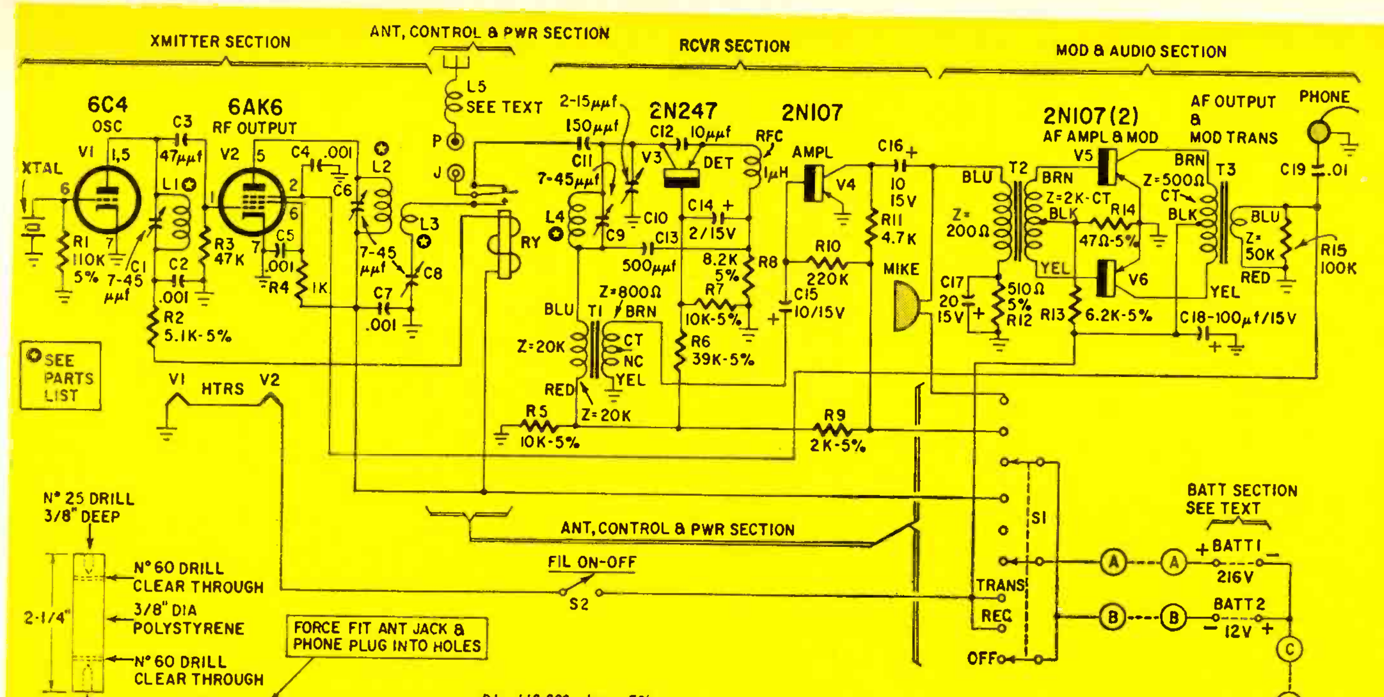
The 6C4 and 6AK6 are used instead of filamentary types like the 3A4 or 3A5 mainly for their power-handling capabilities. Also, because the receiver and audio sections operate at 12 volts, the heaters of these tubes can be connected in series to operate from the same supply. This eliminates the need for a filament dropping resistor, extra batteries or other complex circuitry. A spst toggle switch connected in series with the heater line turns the heaters off when listening only. This reduces battery drain.

The oscillator tank coil is tuned to the high side of the crystal frequency. Oscillations occur because of the feedback provided by the grid–plate capacitance within the 6C4. The output of this stage is coupled to the 6AK6 through a 47-μμf capacitor. The oscillator coil is mounted below the chassis while the final tank coil is mounted above the chassis. This setup prevents spurious oscillations in the final amplifier, since it is operating straight through. It also helps eliminate the need for neutralization. The slightest amount of coupling between the two coils would cause these unwanted oscillations.

Suppressor-grid modulation instead of plate modulation is used on the 6AK6. Since the suppressor grid draws no current, the modulator is not required to furnish any power. Therefore, a voltage amplifier can be used as the modulator, avoiding complex audio circuitry and reducing power drain.

Rf energy from the final tank coil is coupled to the antenna through a three-turn link coil. The cold end of the link goes to ground through a 7–45-μμf ceramic trimmer capacitor. It balances out any capacitive reactance in the antenna circuit. The hot end of the link goes direct to an antenna changeover relay. This is used to minimize rf loss, which would be high if a rotary or other type switch were used for changeover. The relay is in the plate circuit of the oscillator tube. It and R2 form a voltage dropping network to bring the

* Author, *Servicing Transistor Radios*, Gernsback Library.



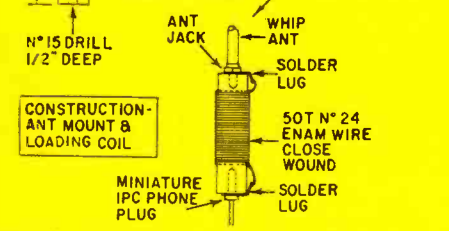


Fig. 1—Complete transceiver circuit.

R1—110,000 ohms, 5%
R2—5,100 ohms, 5%
R3—47,000 ohms, 10%
R4—1,000 ohms, 10%
R5, 7—10,000 ohms, 5%
R6—39,000 ohms, 5%
R8—8,200 ohms, 5%
R9—2,000 ohms, 5%
R10—220,000 ohms, 10%
R11—4,700 ohms, 10%
R12—510 ohms, 5%
R13—6,200 ohms, 5%
R14—47 ohms, 5%
R15—100,000 ohms, 10%
All resistors ½ watt
C1, 6, 8—7-45 μμf, ceramic trimmer
C2, 4, 5, 7—.001 μf, ceramic
C3—47 μμf, ceramic
C9—7-45 μμf, ceramic trimmer
C10—2-15 μμf variable (E. F. Johnson type 15M11 or equivalent)
C11—150 μμf, mica
C12—10 μμf, ceramic
C13—500 μμf, mica
C14—2 μf, 15 volts, subminiature electrolytic (Lafayette CF-120 or equivalent)
C15, 16—10 μf, 15 volts, subminiature electrolytic (Lafayette CF-122 or equivalent)
C17—20 μf, 15 volts, subminiature electrolytic (Lafayette CF-123 or equivalent)
C18—100 μf, 15 volts, subminiature electrolytic (Lafayette CF-126 or equivalent)
C19—.01 μf, ceramic
ANT—miniature 38-inch whip (Lafayette F-343 or equivalent)

BATT 1, 2—see text
J—miniature IPC phone tip jack
L1, 2, 4—9 turns No. 20 tinned wire, ½-inch-diameter air core, turns spaced to ¾ inch (B & W 3007 or equivalent)
L3—3 turns No. 20 tinned wire, ½-inch diameter air core, wound next to cold end of L2 (B & W 3007 or equivalent)
L4—9 turns No. 20 tinned wire, ½-inch-diameter air
L5—antenna loading coil (see text) core (B & W 3007 or equivalent)
P—miniature IPC phone tip plug
RFC—1 μh, pie wound
RY—spdt 2,500-ohm plate relay (Potter & Brumfield RS5D or equivalent)
S1—3-pole 3-position rotary (Centralab 2507 or equivalent)
T1—audio transformer: primary, 20,000 ohms; secondary, 800 ohms ct (Argonne AR-151 or equivalent)
T2—audio transformer: primary, 200 ohms; secondary, 2,000 ohms ct (Argonne AR-123 or equivalent)
T3—audio transformer: primary, 50,000 ohms; secondary, 500 ohms ct (Argonne AR-148 or equivalent)
V1—6C4
V2—6AK6
V3—2N247
V4, 5, 6—2N107
XTAL—Type FM-1 crystal, desired 10-meter band frequency (International Crystal Co.)
Telephone handset Type TS-65Y (Surplus)

oscillator plate voltage down to the required 150.

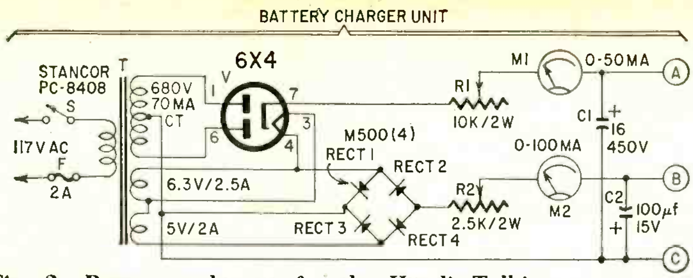
The receiver

A 2N247 drift transistor is used as a superregenerative detector, and a 2N107 as an audio amplifier in the receiver circuit. The detector circuit is typical for high-frequency operation. Feedback between the emitter and collector, through C12, causes the detector to oscillate at a frequency determined by capacitors C9 and C10 and coil L4. Although the 10-meter band is 1.7-mc wide, no regeneration control is used because the design of the detector enables it to operate smoothly over this range. The values of the components were chosen for optimum detector operation over this range. If a regeneration control is needed, it can be substituted for R8.

Audio voltage is developed across T1's primary and is coupled to the base of the 2N107 through its secondary. Because the output impedance of the detector collector is high (about 20,000 ohms) and the input impedance of the amplifier is low (500 ohms), transformer coupling must be used for proper impedance matching and maximum transfer of the audio signal. R-C coupling was tried, but the value of C had to be high to get good audio transfer. This had the effect of loading the collector output to a point where the detector became quite insensitive to small signals.

The antenna is coupled through a 150-μμf capacitor to the collector of the

Close up of the Handie-Talkie's front panel.



R1—pot, 10,000 ohms, 2 watts
R2—pot, 2,500 ohms, 2 watts
C1—16 μf, 450 volts, electrolytic
C2—100 μf, 15 volts, electrolytic
F—2 amps
M1—0-50 ma
M2—0-100 ma
RECT1, 2, 3, 4—M500 (Sarkes-Tarzian)
S—spst toggle
T—power transformer: primary 117 volts; secondary, 680 volts ct, 70 ma; 6.3 volts, 2.5 amps; 5 volts, 2 amps (Stancor PC-8408 or equivalent)
V—6X4

Fig. 2—Battery recharger for the Handie-Talkie.

2N247. The capacitor reduces the loading effect of the antenna. Capacitor C9 sets the detector's operating frequency while C10 is used for bandspreading.

Receiver sensitivity is better than 2 μv per meter for a 50-mw power output at the earphone. Reradiation from the detector is noticeable only up to about 100 feet because of the lower power at which it operates.

The audio section

Two 2N107's are used in a push-pull class-B audio amplifier circuit. Idling current is 2.5 ma, 1.4 ma of which flows through the base biasing resistors R12 and R13. Under peak audio signal, the amplifier draws up to 25 ma, delivering close to 150 mw of audio power. Although this amount of power is not required to modulate the 6AK6, at least 50 mw of audio is needed to drive the earpiece of the handset to a comfortable listening level.

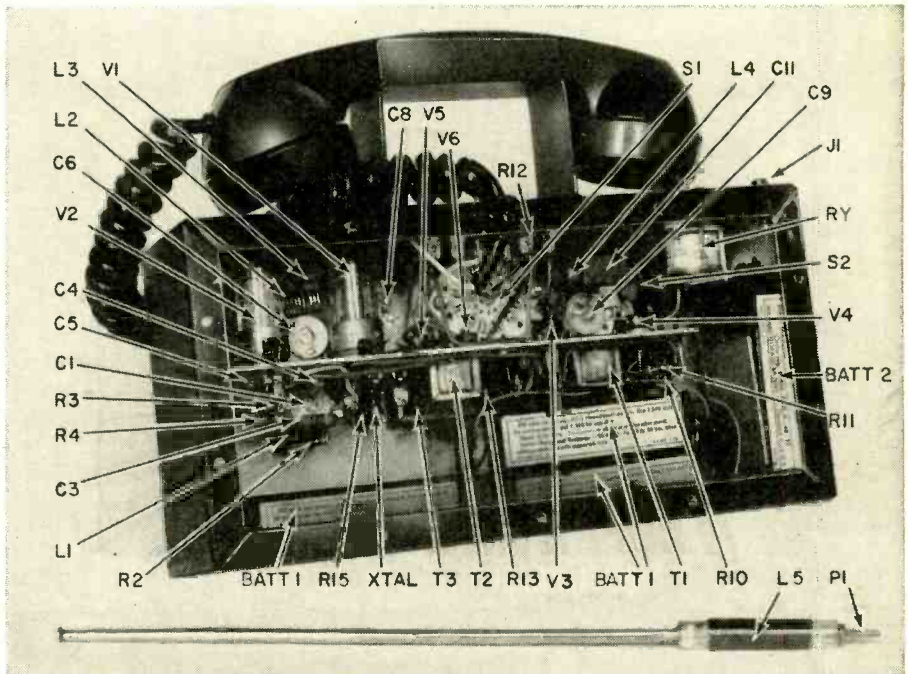
The modulation transformer, T3, is a miniature driver transformer connected backward. The secondary winding is the primary or collector load. The high-impedance primary is used as the modulation winding. It is loaded with a 100,000-ohm resistor to present a constant load to the 2N107's in the transmit and receive positions. The audio voltage developed across the resistor is more than enough to modulate the 6AK6 and drive the earphone.

Current for the microphone is obtained from the 12-volt battery through an R-C network. The resistor limits current through the microphone and keeps the modulator from being overdriven.

Power and control

A three-pole three-position rotary switch controls the unit (S1). When it is in the OFF position, all power is removed from the circuits. In the REC position, 12 volts is applied to the receiver, modulator and tube heaters. Switch S2 turns the tube heaters off when the receiver is used for listening only. In the TRANS position, power is removed from the receiver only and 216 volts is applied to the plates of the transmitting tubes. Power is continuously applied to the modulator in the REC and TRANS positions since this unit is common to the transmitter and receiver.

As mentioned at the beginning of this article, power is obtained from subminiature storage batteries. Two 6-volt batteries connected in series supply 12 volts for the receiver, modulator, microphone and tube heaters. These batteries can deliver 200 ma continuously for 3 hours. Maximum current drain in the



Internal view shows compact parts arrangement.

REC position is 160 ma; in the TRANS position, 175 ma.

Six 36-volt batteries are connected in series to supply 216 volts to the transmitter. Maximum current drain during a transmission is 28 ma. The batteries can deliver 30 ma continuously for 3 hours.

These subminiature storage batteries were chosen for four good reasons:

- Small size: Each battery measures 3⅝ x 1⅜ x ⅞ inches.
- Power output in relation to size.
- Ability to be recharged. This feature alone saves many dollars in battery replacements alone.
- Their extremely low cost.

The batteries are surplus, but are new and sealed in an airtight metal container. The cost is $1.50 per set, which includes one 6-volt and three 36-volt batteries (two sets are required). They are available from the C & H Sales Co., 2176 E. Colorado St., Pasadena 8, Calif. (BB 208 Flash AMT). Complete instructions for filling and charging the batteries are included with each set. The acid can be obtained from any local garage.

A battery charger is shown in Fig. 2. When charging the batteries (charge every 10 days, with or without use), remove them from the transceiver case. During the charge, the electrolysis action that occurs causes some of the acid to bubble out and spill over. If the batteries are charged in the case, the acid will corrode the aluminum case and will damage other parts as well.

Construction

The transmitter, receiver and modulator are all mounted and wired on an 8 x 2⅝ x ½-inch L-shaped aluminum chassis. It is mounted inside the 5 x 10 x 3 case. The transmitter portion, looking from the rear, is mounted on the left side. The modulator is in the center and the receiver toward the right. The transmit–receive switch and tuning capacitor for the receiver are mounted on aluminum brackets which are mounted on the L-shaped chassis on the receiver side. The heater switch hangs free on the extreme right side. This method of assembly allows the whole works to be removed in one unit.

The antenna changeover relay is mounted in the upper right inside corner of the case. Two ½ x ⅜-inch ceramic standoffs are used to insulate the relay from the case. The antenna jack is mounted in the same corner.

In wiring the transmitter and receiver sections, all leads, except power leads, should be as short as possible. Bakelite terminals strips can be used wherever necessary to mount components. The 2N247 detector transistor is wired directly into the circuit on top of the chassis. Sockets are used for the 2N107 transistors. All components, except the final tank coil, detector tank coil and controls, are mounted below the chassis. A short length of insulated shielded wire is used to connect the final tank link to the relay.

The six 36-volt batteries are wired in pairs and are mounted on the bottom of the case. The two 6-volt batteries are mounted upright on the right hand side of the case, below the relay and antenna jack. Brackets are used to secure the 6-volt and two 36-volt batteries in place. The remaining four 36-volt batteries are stacked and held in place by the others.

The antenna is a 38-inch whip which closes down to 9 inches. It is mounted on a 2¼ x ⅜-inch polystyrene rod on which loading coil L5 is wound. In constructing the mount (Fig. 1), drill a ⅜-inch-deep hole into one end of the rod, using a No. 25 bit. On the other end, use a No. 15 bit to drill a ½-inch-deep hole. At the bottom of each hole drill another hole at a right angle to it clear through. Use a No. 60 bit. After the holes are drilled, wind 50 turns of No. 24 enameled copper wire on the rod, threading the ends of the wire through the small holes. Force-fit the jack that comes with the antenna into the No. 25 hole. Place a lug between it and the rod. Solder one end of the loading coil to this lug. Force-fit a miniature IPC phone tip plug into the other hole and place a lug between it and the rod. Solder the other end of the coil to this lug. When the mount is completed, attach the whip and plug it into the antenna jack on the case.

Final adjustments

Set your signal generator for a 400-cycle tone and 30% modulation for aligning the detector. Plug in the antenna assembly and wrap two turns of hookup wire loosely around it. Connect this wire to the signal generator, and set it to 28 mc. With C10 fully meshed (closed), adjust C9 until the signal is heard in the earphone. The detector is now aligned and C10 should cover the entire 10-meter band from 28.0 to 29.7 mc through 180° rotation. If the detector does not oscillate, reduce the value of C11. It should be between 100 and 220 $\mu\mu$f. If the detector still fails to oscillate, check the wiring or replace the 2N247. The detector circuit is so designed that it will oscillate even if the antenna is connected direct to the detector tank coil.

After the receiver is working properly, set capacitors C1 and C6 at midpoint. Connect the dc probe of a vtvm to pin 1 of the 6AK6 and apply power. Adjust C1 for maximum negative voltage. You will notice that as soon as you reach a peak in voltage, the circuit will suddenly stop oscillating. This shows that the oscillator is functioning normally. Adjust C1 to a point just before this cutoff occurs. To make sure that the oscillator is set properly, turn the transmitter on and off a few times. Each time the transmitter is turned on, the oscillator should start. If not, then readjust C1 until it does. At the same time make sure that the relay closes when the oscillator is turned on. If the relay is sluggish, decrease the value of R2 to 3,900 ohms. If the relay snaps loudly, increase the value of R2 to 5,100 ohms.

Next, connect the dummy load (a No. 47 pilot lamp) between the antenna jack and chassis and adjust C6 and C8 for maximum brilliance. Disable the oscillator by shorting pin 6 of the 6C4 to ground. The bulb should go out. If it remains lit, the final amplifier is oscillating. The tank coils should be reoriented until the stage stops oscillating. A small negative voltage applied to the suppressor grid may help stop this oscillation. The proper value is determined by experimenting.

After the final stage is adjusted, remove the dummy load and insert the antenna. Using a grid-dip oscillator as a field-strength meter, readjust C6 and C8 alternately for maximum rf output. If a grid-dip oscillator is not available, just hang the vtvm's ac lead near the antenna and tune up. The Walkie-Talkie is ready for operation! END

TRANSFORMER IN A LINE PLUG

By MILTON WHITE

COMMERCIAL fittings for connecting small power transformers direct to power lines are not available. Here is a cheap and easy method, using an ordinary line attachment cap and a Muller No. 26 insulator that makes a first-class mounting for transformers with cores that are not more than ⅝ inch wide, the limit set by the maximum allowable width of the slot (C in Fig. 1).

Cut down a rubber line attachment cap to the form shown in Fig. 1, making the width of slot C a loose fit to the transformer core and the length of the slot at a right angle to the contact prongs (D). Expose the back ends of the screws holding the contact prongs to the body of the attachment cap (not the line connecting screws) by countersinking with a knife (a regular countersink just won't work here). These screws and countersinks are at A and B in Fig. 1. Solder the transformer's primary leads to the exposed screw ends. Put a thick coat of cement in the slot and set the transformer in place.

Splice the required length of lamp cord to the transformer's secondary leads. Tuck these splices and any slack in the primary leads into the corners formed between the transformer coils and the core. Tie a knot in the lamp cord over the top of the transformer to act as a strain relief.

Grease the outside of a Muller No. 26 insulator with Vaseline, then turn it inside out. Put a coat of cement around the line attachment cap, slip the lamp cord through the insulator (see Fig. 2), then roll the insulator back over the cap and transformer assembly.

The finished job is shown in Fig. 3, together with an excellent trouble light, a device for which the assembly described is ideal.

Fig. 4 details the construction of the trouble light, except for the position of the single turn of wire. This wire acts as a friction lock for the light shield. It is adjusted along the lamp socket so that the shield locks in the position shown. To lock the shield, pull it forward with a twisting motion. It locks securely, so it cannot be pushed straight back by hand. To release the lock, just reverse the locking action, push the shield back with a twist. END

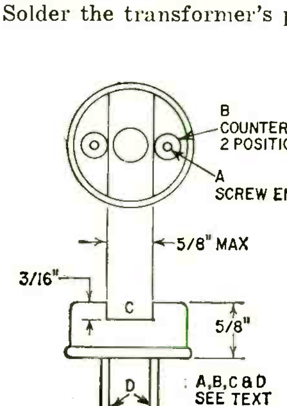


Figure 1

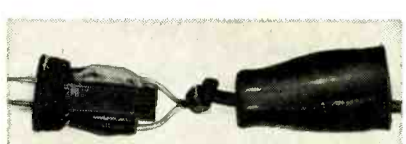


Figure 2

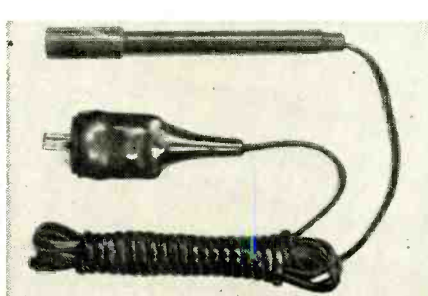


Figure 3

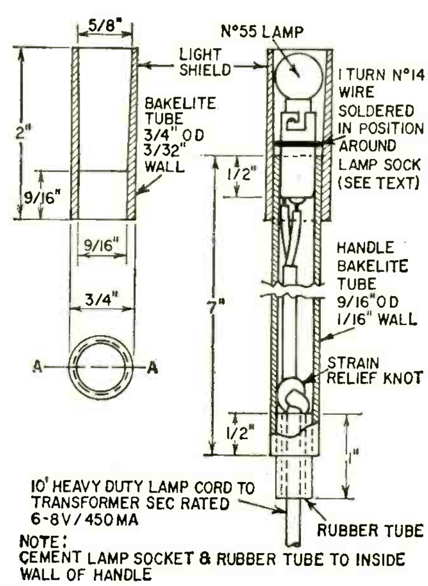


Figure 4

and now –

THE TRANSISTORIZED PORTABLE SCOPE

Using almost no tubes, this industrial unit can be powered by an external ac or dc source, or it can use built-in batteries

By TOM JASKI

IT seems that we have been waiting a long time for the transistor to fulfill all our hopes and provide us with light, portable devices of all kinds. The portable transistor TV is with us, but not so easy to come by. Now Tektronix breaks another barrier by producing the all-transistor (well, nearly all) portable oscilloscope. "Nearly all" because there are two tubes in the scope, besides the CRT, to do jobs which transistors could not do well enough. One tube is the vertical input amplifier and the other is the high-voltage supply rectifier. However, these two tubes do not materially affect battery life and they certainly do not change the scope's portability.

As a result the scope can compete specification-wise with high-quality tube models. Bandwidth is dc to 5 mc with a rise time of .07 μsec. Deflection sensitivity is variable from 10 mv to 20 volts per division (cm) in 11 calibrated steps in a 1–2–5 (10 mv, 20 mv, 50 mv, . . .) sequence. Sweep ranges from 0.5 μsec per division to 0.5 second per division (5 seconds to sweep across the tube face). The sweep circuit has 19 calibrated steps, also in the 1–2–5 sequence. The scope incorporates a calibrator for precise voltage comparison, weighs 17 pounds complete with batteries and measures 8¾ x 5¾ x 16 inches. What more can you ask for!! The model 321 costs approximately $775 (not including batteries) and rechargeable batteries are available at extra cost. So is a charger, that can be built into the instrument. But 10 size-D flashlight cells will also operate the scope, as will 117 or 220 volts ac, 50 to 800 cycles. This means that the scope can be plugged directly into a 400-cycle aircraft supply. Also 11.5 and 35 volts dc can be used (you can plug the instrument into an automobile, boat, railway, or farm dc power system). Just about as versatile as can be.

This is, of course, part of the beauty of this scope. It can be used on practically any power source or *none at all*, making it useful where before no scope could be operated. Examples are: troubleshooting and repair jobs on boats, small planes, railway work, "on location" and experimental work in inaccessible or difficult places, all kinds of applications where a scope would ordinarily either require carrying a bulky converter or running a power cord for long distances. Let us see what it takes in the way of circuitry to get this kind of performance.

Circuitry

Fig. 1 shows the block diagram. Tektronix engineers did not get tricky; it is pretty conventional except for the oscillator low-voltage supply, which is built along the lines of the usual scope or portable TV high-voltage supply.

Vertical amplifier

Fig. 2 shows part of the vertical amplifier (and calibrator). This has first a standard attenuator, then the 5718 input amplifier, one of the two tubes used in the scope. This triode, used in a cathode-follower circuit, was used to obtain the high-impedance input, stability (stabilized heater supply) and wide-band response desired. After the 5718 the amplifier consists of alternate emitter followers and amplifiers, using a number of 0C170's. The 0C170 is a European transistor, used because of its high gain, low leakage and high voltage tolerance. It is a drift transistor.

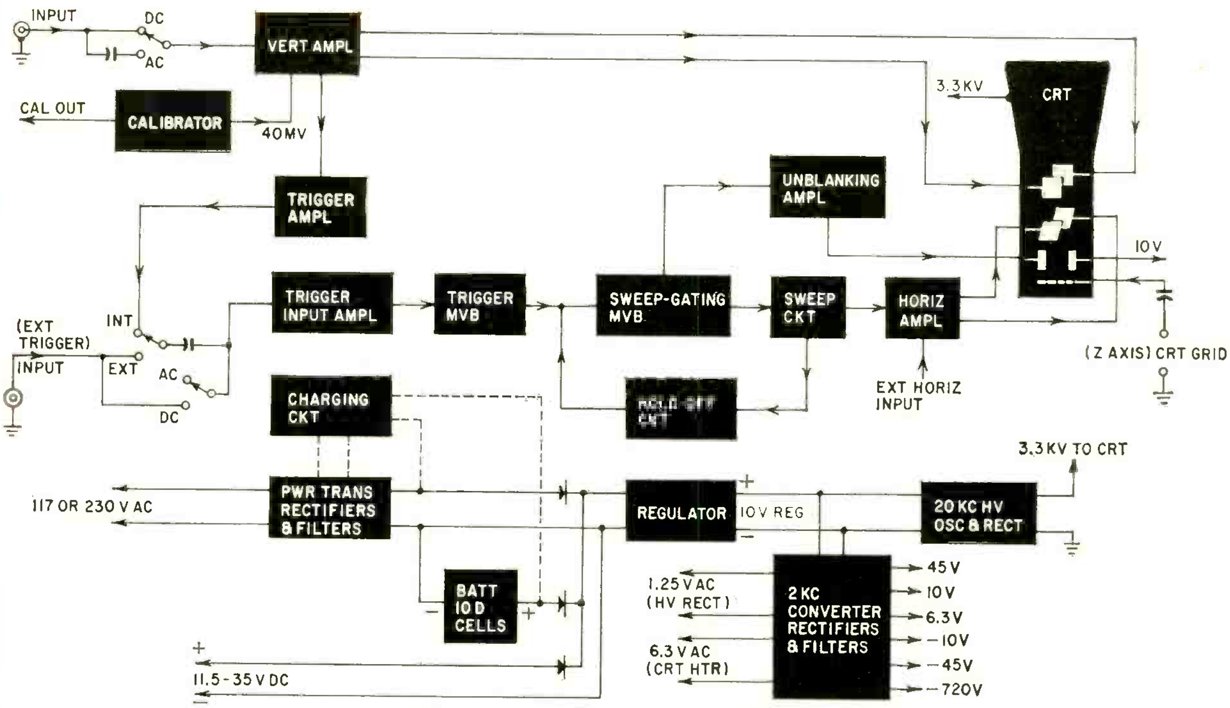


Fig. 1—Block diagram of Tektronix 321 oscilloscope.

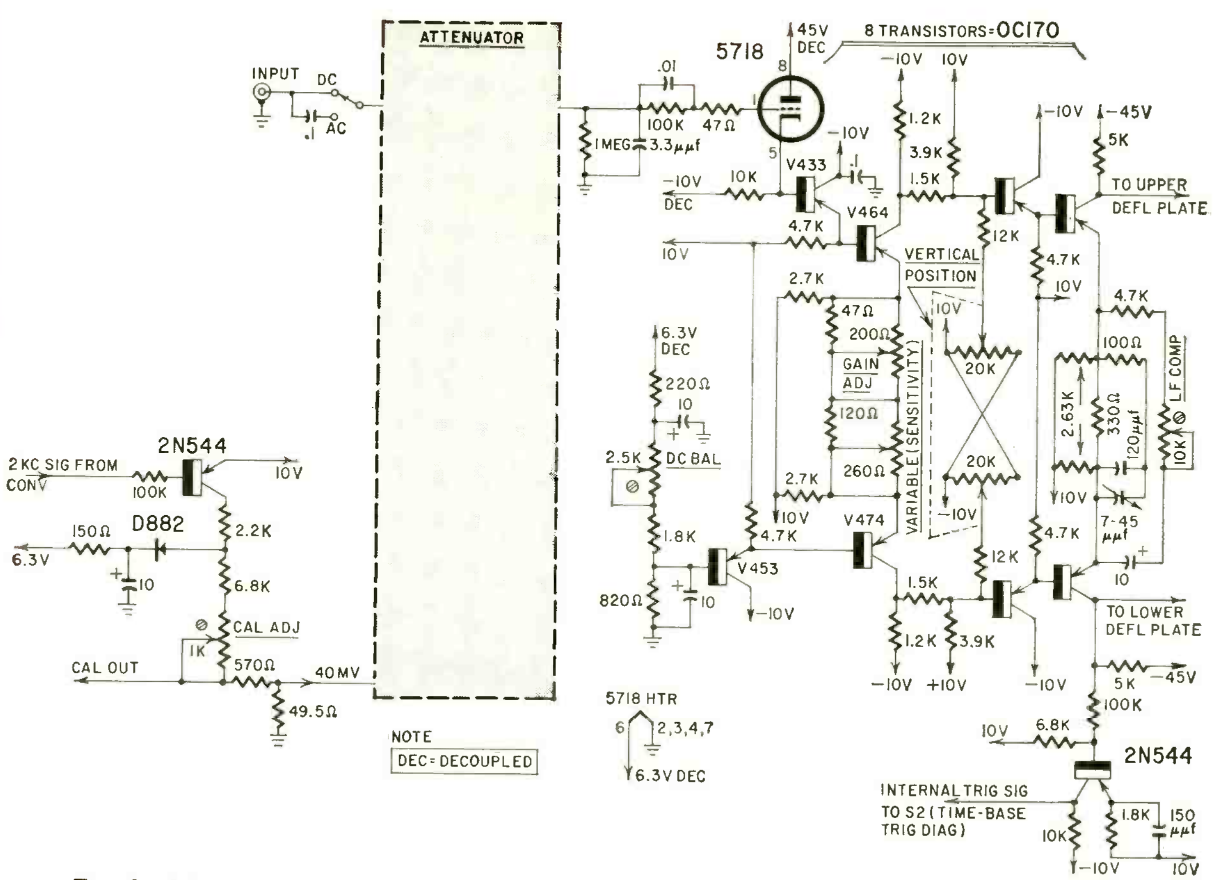
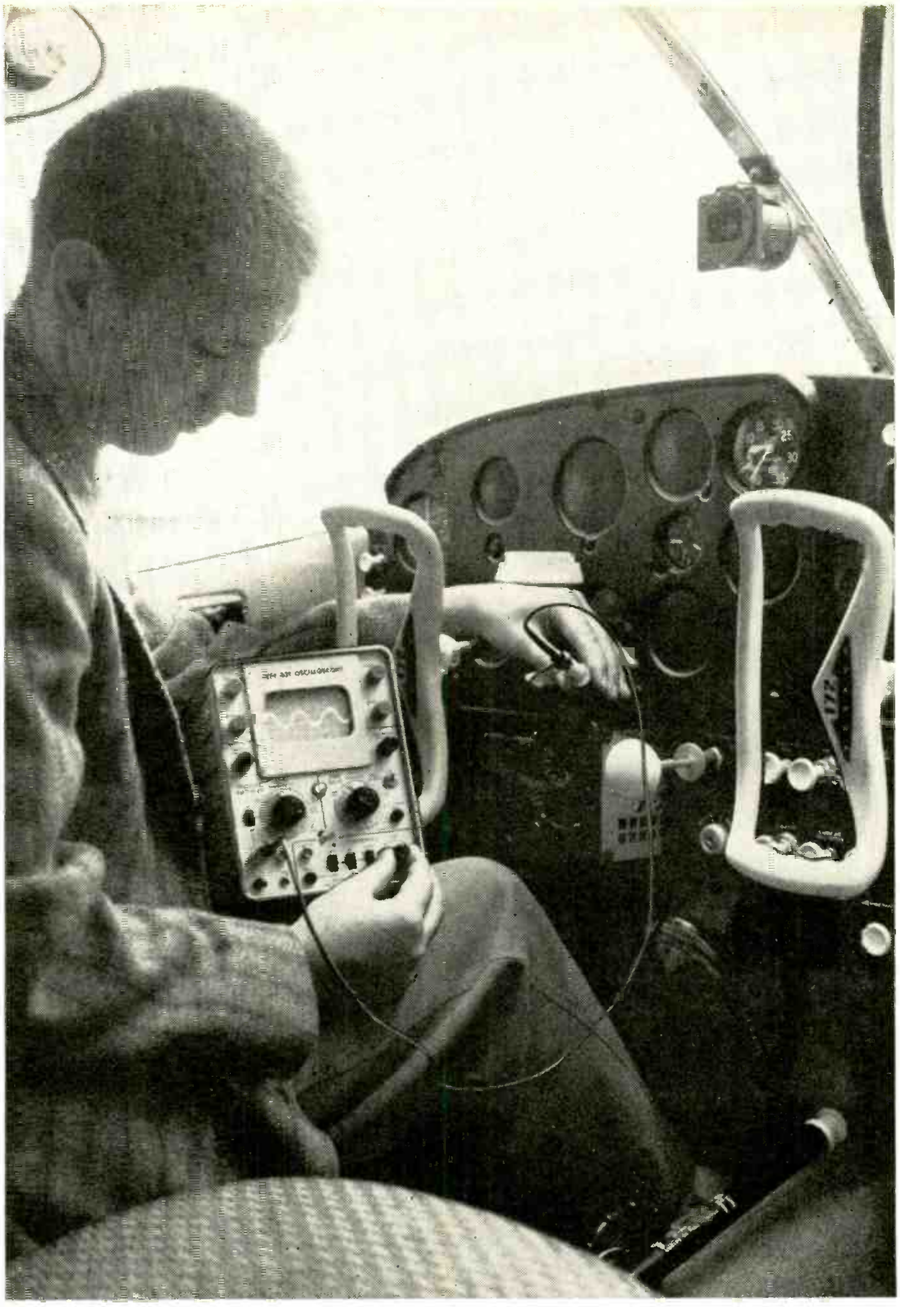


Fig. 2—Schematic of vertical amplifier and calibrator. Step type attenuator has 11 positions.



Because it has its own power supply, the scope may be used in servicing small-plane equipment.

The amplifier is completely balanced to minimize temperature effects and to obtain push-pull deflection. Vertical position is adjusted by changing the bias on the last set of emitter followers. V453 receives no signal. It serves to balance the bias on V474 against that on V464. These last two transistors form a common emitter resistor-coupled stage. The trigger takeoff amplifier is shown on the right, and on the left we see the calibrator. This is an overdriven amplifier which obtains the calibration signal (2 kc) from the converter in the low-voltage power supply.

Horizontal amplifier

The horizontal amplifier is not unusual. It consists of a set of emitter followers and a pair of amplifiers (somewhat similar to the output sections of the vertical amplifier). These are again balanced to obtain push-pull deflection and minimize temperature effects. Horizontal sensitivity is not great (1.5 volts per division maximum). In the emitter-bias circuit of the output stage a switch is used to obtain five-times-normal sweep width by effectively reducing the emitter series resistance.

The trigger amplifier (Fig. 3) is a balanced common-emitter amplifier. It can reverse trigger-signal polarity when desired. The trigger multivibrator, which shapes the trigger for the sweep circuit, is a transistor version of the well known Schmitt circuit. The trigger pulse is applied to the sweep-gating multivibrator (Fig. 4), which is also a Schmitt circuit but with a large voltage differential between the "on" and "off" triggers. This circuit holds the gate open (nonconducting) for the duration of the sweep. The "gate" is the normally conducting (closed) V153, which prevents the timing capacitor from charging.

Sweep circuit

Initially the timing capacitor (C160) is discharged, allowing a positive voltage at the base of emitter follower V163. A negative output from the Schmitt cuts down the conductivity of V153, allowing the capacitor to charge. This creates a voltage drop across the

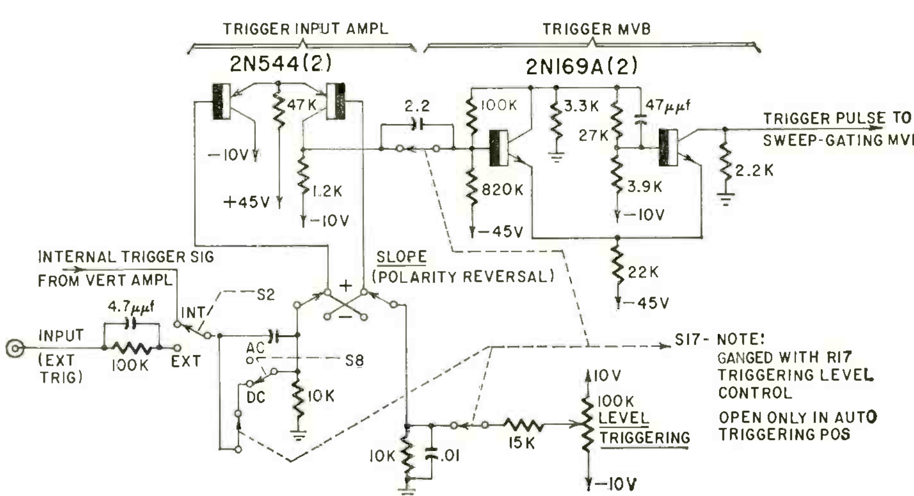


Fig. 3—Trigger-amplifier and multivibrator circuit.

timing resistor (R160), lowering the voltage on the base of V163. V161 amplifies this change in signal, and it is applied to the horizontal amplifier through another follower, V173. But the signal is also applied to the collector of V153 and, when the charging rate of the capacitor increases, V153 will conduct more heavily and thus reduce the charging rate. In this way charging of the capacitor is kept perfectly linear. S160 selects different values for R160 and C160 to get the desired sweep rate.

A portion of the sweep signal is also applied to the base of V183, the holdoff transistor. This transistor is normally conducting, holding C180 (holdoff timing capacitor) discharged. When the sweep signal is applied to V183, the capacitor begins to charge, raising the voltage on the base of V135. The Schmitt circuit changes state and once again can accept trigger pulses. When the gate closes (V153 conducts), timing capacitor C160 discharges through D153.

Unblanking

The cathode-ray tube in this instrument is a special type, containing a second set of horizontal deflection plates (above G1 in Fig. 5). One is connected to 10 volts, the other to the unblanking amplifier. Between sweeps, the unblanking plate is held at −20 volts. The beam is deflected off-screen and is not visible until a positive pulse voltage is applied to the unblanking deflection plate. A special overdriven blanking amplifier (V194, Fig. 4) provides the unblanking voltage with ultra-rapid rise time. V199 is a voltage regulator

Using scope to check out depth indicator.

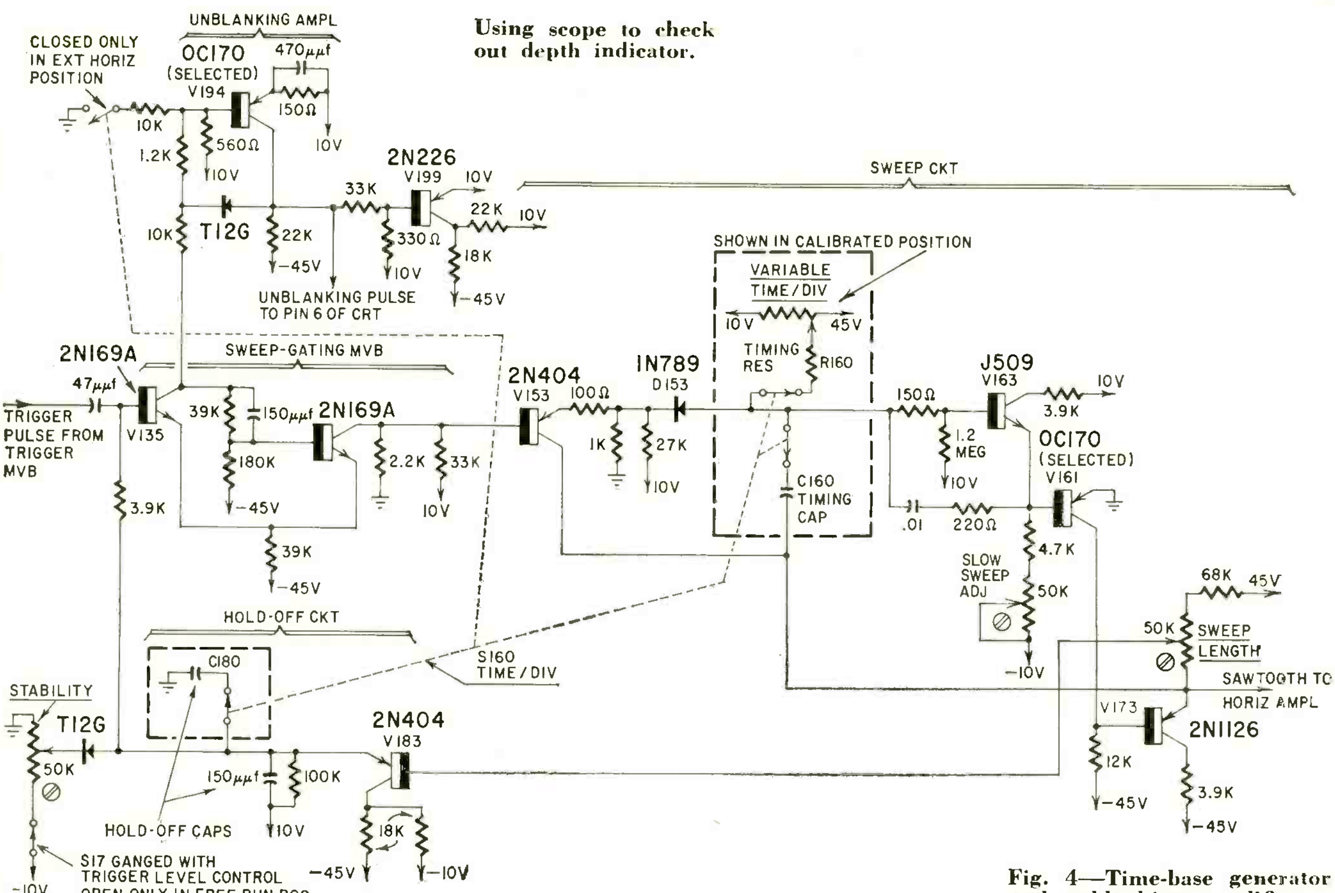


Fig. 4—Time-base generator and unblanking amplifier.

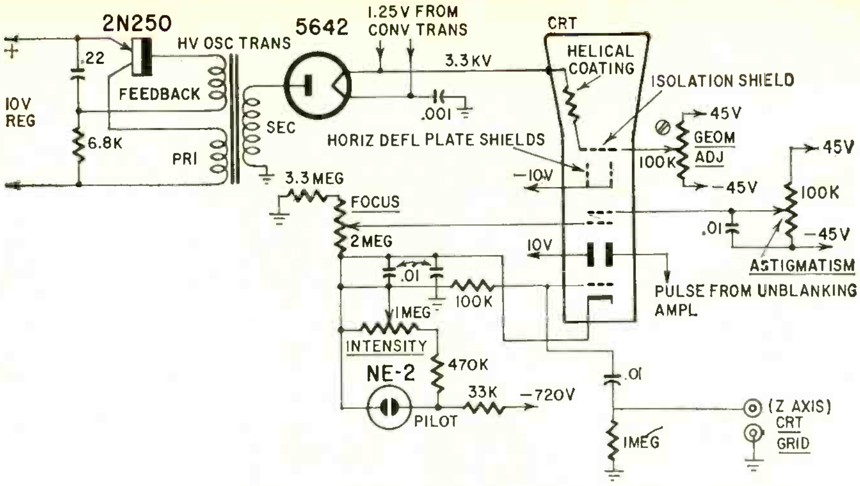


Fig. 5—Connections to cathode-ray tube. 20-kc oscillator and rectifier supplies high voltage. Standard deflection plates are not shown.

for the amplifier. The unblanking signal puts the beam back on the screen during scanning.

The low-voltage power converter is conventional and resembles the often published "transistor power supply." Operating frequency is 2 kc (the high-voltage supply operates at 20 kc). Note that voltage regulation takes place *before* the converter (Fig. 1). In this manner voltage supplied by the 117-volt ac circuits is regulated as well as the dc input voltages. In other words, whether the scope is being supplied from its own batteries, from an outside dc source or from the ac line, the converter and regulator are always operative. This makes for the least difference in the various modes of operation, as far as the amplifier and sweep circuits are concerned. The battery charger is optional. It has a current regulator with a temperature-sensing bridge. The temperature of the battery is proportional to the charging rate. Maintaining an even charging rate is important with the small rechargeable batteries used, and the regulator measures the temperature rise *above* ambient.

There you have it, a new instrument which, in spite of its price, is going to gain enormous popularity because of its portability, versatility and ease of operation. There is no sacrifice in performance for portability, and the 321 will do any job as well as most service type scopes, and perhaps a little better. It is no match for the very-high-performance types also made by Tektronix, but then it was never meant to be. And apart from the rather special CRT, the designers did not have to resort to tricks to get the response required, just good sensible design. This is a first in the scope business, and a step in the right direction to fulfill the promise of the transistor. END

PROTECT that Voltage Regulator

ALL voltage regulators and transistor versions in particular should be protected against overloads. After all, too much current through a regulator transistor and several dollars go down the drain. Some circuits recently appeared in a Texas Instruments *Application Note* (July, 1960) on using a backward diode to protect regulator circuits.

A basic circuit using a backward diode, an auxiliary transistor and two resistors to protect a voltage regulator (V2) is shown in Fig. 1. During normal regulator operation, the voltage across R1 keeps the diode from conducting and V1 operates in saturation. Thus the series control element—the collector-emitter element of V2—sees V1 as a low impedance. However, when load current becomes excessive, the diode starts to conduct in the reverse direction because of the additional voltage drop across R1. This reduces the base-emitter voltage of V1 which reduces collector current to a safe figure.

Fig. 2 is a working regulator using the protective circuit shown in Fig. 1. It demonstrates the current-limiting technique of overload protection. This circuit causes little deterioration in normal regulator performance although the saturation resistance of V1 and the resistance of R1 make the output resistance somewhat higher. Also, changes in operating temperature can shift the current level at which limiting occurs. Temperature effects can be reduced, however, by careful selection of components. Fig. 2 is set up with control R1 adjusted so current regulating starts whenever the load current exceeds 500 ma. As Fig. 3 indicates, current limiting with this circuit is very sharp once the maximum allowable load current is exceeded.

This circuit has one important disadvantage—V1 must withstand both the maximum load current and a voltage nearly equal to the unregulated input while a short-circuit load condition exists. This makes it necessary to limit the use of this circuit to low-voltage low-current regulators. But, as higher-voltage higher-power transistors become available, this same protective circuit will apply to higher-power regulators. Until then, cascade the protective circuits if the unregulated supply voltage is greater than the voltage rating of a single transistor. END

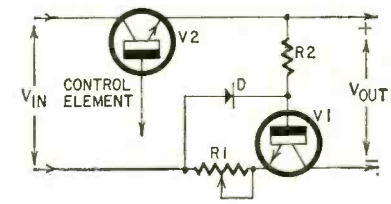


Figure 1.

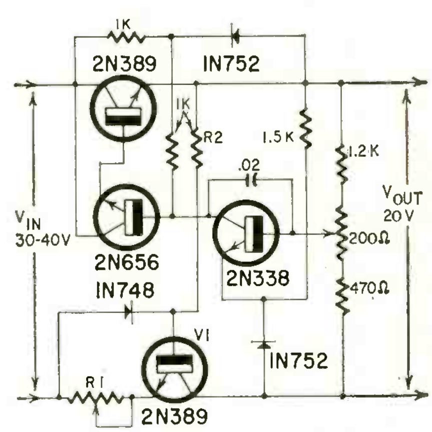
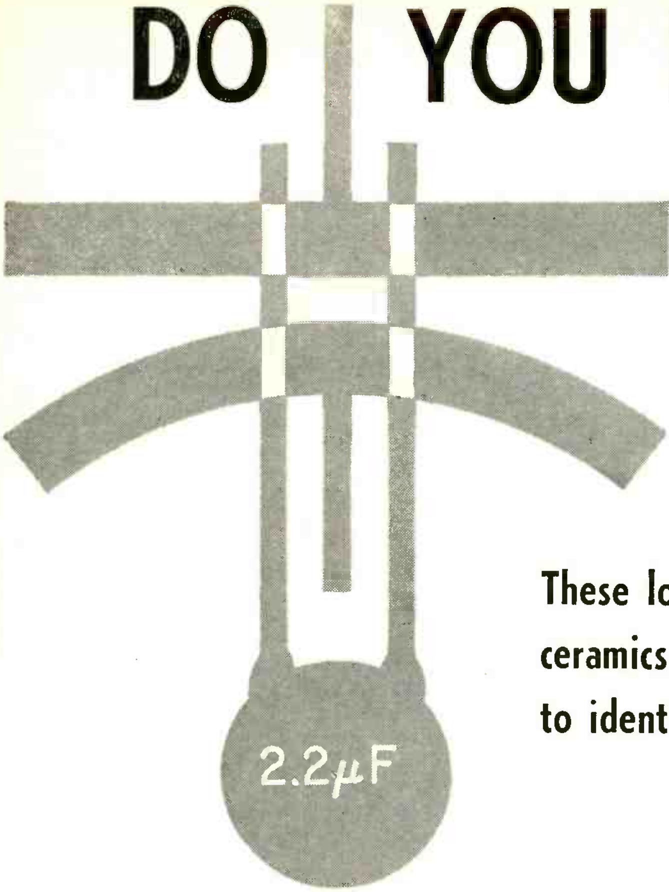


Figure 2.

Figure 3.

DO YOU KNOW THE ULTRA-KAP?



These low-voltage high-capacitance ceramics are different. Do you know how to identify and test them?

By Capacitor Engineering Dept. of Centralab *

A COMPLETELY new type of ceramic capacitor is appearing in various types of electronic equipment. Known as Ultra-Kaps†, these patented units are made of ceramic and have the same appearance as other ceramic disc capacitors. But they are engineered on an entirely different principle. It is important to understand this principle and be able to identify the units because **conventional testing techniques and replacement procedures do not apply to these capacitors.**

Ultra-Kaps are low-voltage capacitors used only in transistor and similar low-voltage circuits. They provide an extremely high capacitance for their size—50 to 100 times greater than that of standard ceramic units! In other words, from the capacitance standpoint, they are in the electrolytic rather than the usual ceramic capacitor range.

A most unusual aspect of these capacitors is their self-regulating voltage characteristic. This is the major factor in accounting for the inability to use standard testing techniques. The Ultra-Kap is constructed of a material that undergoes a molecular reorientation when an overvoltage is applied to it. This permits the current to flow through the unit, causing the capacitor to operate as a conductor rather than a capacitor. It can be likened to an electronic valve in that the current merely flows through the unit during overvoltage conditions. This temporary condition exists only while the higher voltage is applied. When the voltage is lowered, the unit again operates as a capacitor. Consequently, this capacitor doesn't "short-circuit" as others do when they are overloaded.

ULTRA-KAP SPECIFICATIONS

CAPACITANCE VS. SIZE

Approximate Diameter (inches)	Capacitance (μf) 3 VOLTS	Capacitance (μf) 10 VOLTS
9/32	0.22	.05
13/32	0.47	0.1
19/32	1.0	0.2
27/32	2.2	0.47

LEAKAGE RESISTANCE 3-VOLT UNITS

Capacitance (μf)	Leakage Resistance—ohms (at 0.5 VDC)	(at 1.5 VDC)	(at 3 VDC)
0.22	500K	50K	2.5K
0.47	350K	35K	1.8K
1.0	300K	30K	1.5K
2.2	30K	7K	0.6K

LEAKAGE RESISTANCE 10-VOLT UNITS

Capacitance (μf)	Leakage Resistance—ohms (at 3 VDC)	(at 9 VDC)	(at 10 VDC)
.05	5 Meg	1 Meg	50K
0.1	5 Meg	1 Meg	50K
0.2	5 Meg	1 Meg	50K
0.47	5 Meg	1 Meg	50K

The resulting dependability of these units, as well as their exceptionally small size, accounts for their increasing application in radio, TV and hi-fi equipment. There are approximately 7,000,000 Ultra-Kaps in use today, and there have been no known cases of electrical failure on any of them. Based on this experience, it seems likely that any unit requiring replacement is probably a victim of physical damage rather than electrical failure.

As indicated earlier, the unusual "valve effect" of these units makes it impossible to test them in the usual fashion. Industrially, ceramic disc capacitors are generally tested at twice rated voltage. If this test were applied to one of these new capacitors, the unit would act as though it were shorted, even if it were operating perfectly.

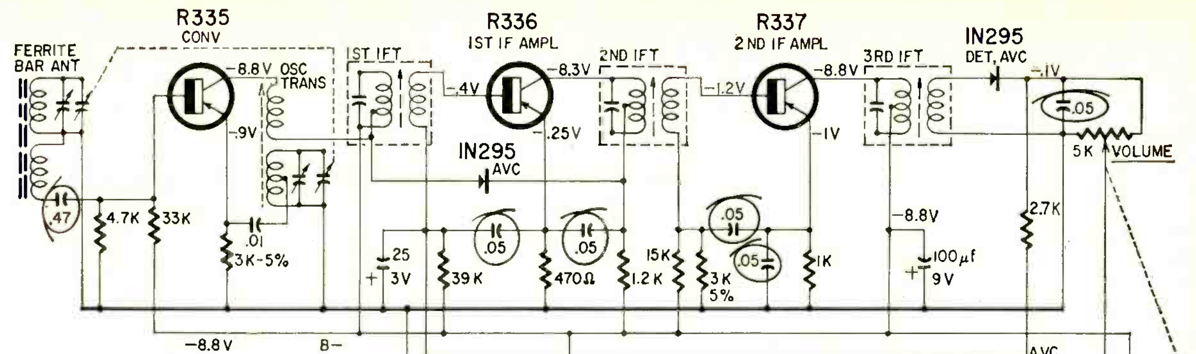
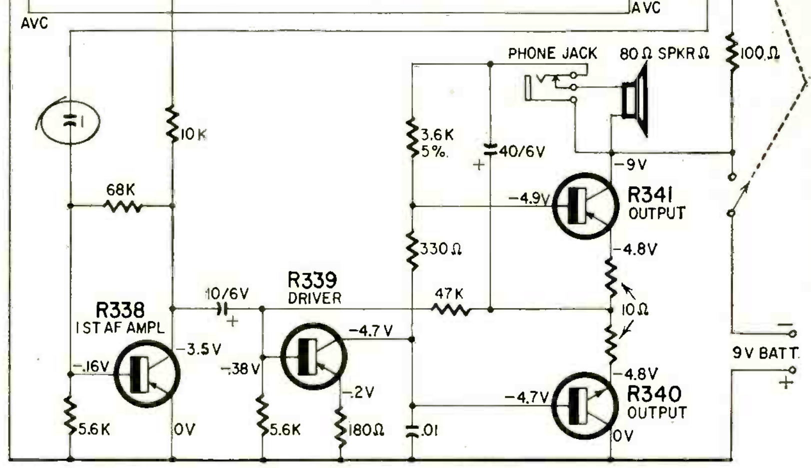
In servicing work, capacitors are usually tested for leakage resistance. However, these units have a relatively low leakage resistance which would mislead the service technician into thinking that a perfectly good unit is defective. So it is important for the technician to know how to identify these units and how to test them.

Identification

As was mentioned previously, Ultra-Kaps are used only in low-voltage circuits. While their main application is in transistorized equipment, they are frequently used in vacuum-tube devices as cathode bypass or interstage coupling capacitors. They are also used in preamplifiers and crossover networks. However, they will never be found in any circuit carrying more than 10 volts.

Physically, they have the same shape and general appearance as any other ceramic disc capacitor. However, the Durez protective coating is *gray-green in color*, and they are much smaller than might be expected for a ceramic disc of such a high capacitance. In fact, no other ceramic discs are made in this capacitance range—.05 μf to 2.2 μf. While it is theoretically possible to build high-capacitance conventional ceramic discs, they would be too large and expensive for any practical application. The table shows the relative size and

*The Electronics Division of Globe-Union Inc.
†Centralab trademark. Similar units are being made available by other manufacturers.

This transistor radio (Admiral chassis 7A2) shows where Ultra-Kaps may be encountered. Seven of them are used in its circuit.

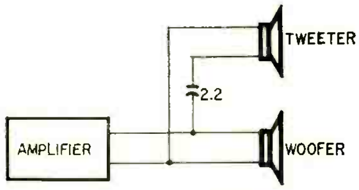


Fig. 1—A crossover network application.

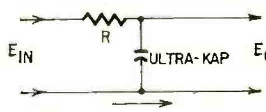


Fig. 2—Basic regulator circuit using an Ultra-Kap.

capacitance of 3- and 10-volt Ultra-Kaps and will help you to identify them.

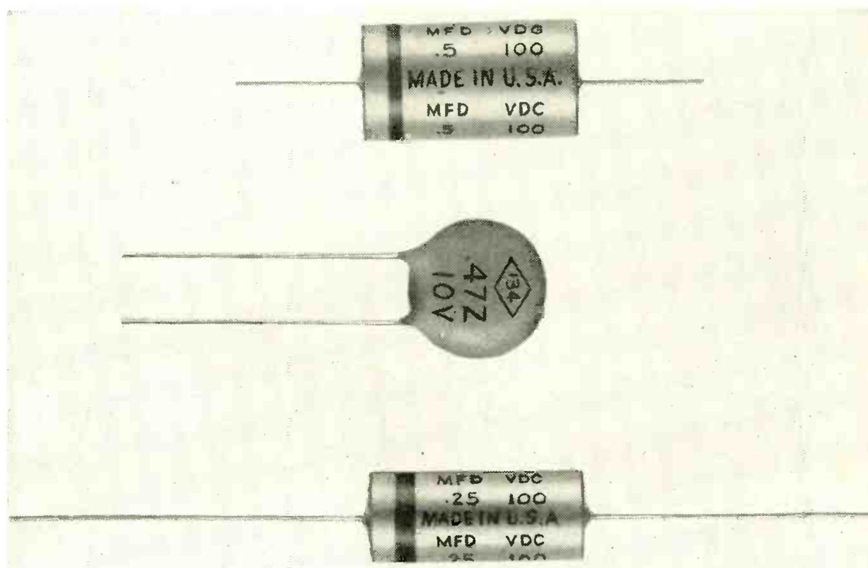
Testing

These low-voltage capacitors can be tested with an ohmmeter, by the same basic technique that is used in testing conventional capacitors except **the capacitor must be checked on the lowest resistance scale of the meter.** A technician usually uses the highest resistance scale or might even pay no attention to the scale being used, since most capacitors have an infinite leakage resistance. This is not true of Ultra-Kaps. As the table shows, leakage resistance is relatively low and decreases rapidly with increasing voltage.

It is apparent from the tables that the voltage applied by the ohmmeter can appreciably affect the leakage resistance reading. Most ohmmeters apply a test voltage of 1.5 or 3, so there would be no testing problems. However, some meters on the market use a higher applied voltage—they cannot be used to test these low-voltage units. If you don't know what voltage your ohmmeter applies, check the battery inside the meter before you use it.

To test a 3-volt unit, the applied voltage must be 3 volts or less. To test a 10-volt unit, the applied voltage must be 10 volts or less. Otherwise, the capacitor will appear shorted, even though it is in perfect operating condition.

While technicians generally try to replace any component with as exact an equivalent as possible, it is absolutely essential that only exact replacements be used when replacing these low-voltage high-capacitance ceramics because of the absence of series inductance in them. Equivalent paper or electrolytic capacitors have a series inductance and therefore may not operate properly in the original circuit.



Ultra-Kap (center) compared with ordinary units of equivalent capacitance.

A typical example of this is shown in Fig. 1. This is a simple conventional crossover network and uses a 2.2-μf Ultra-Kap. If an electrolytic capacitor were substituted for this unit, a 10-μf unit would be required. Depending upon the circuit function and its parameters, a paper or electrolytic replacement or even another ceramic capacitor, might require a capacitance from 2 to 10 times that of the Ultra-Kap. Since there is no simple correlation factor, it is not advisable to attempt any sort of substitution when replacing an Ultra-Kap.

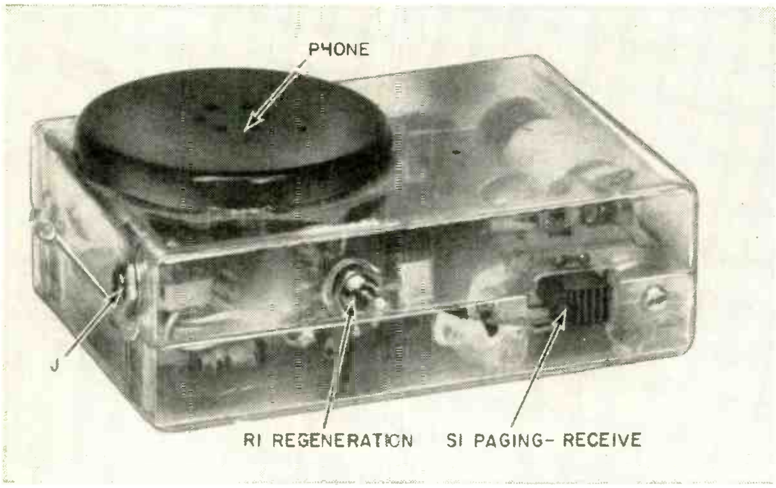
While this article has dealt with the testing and replacement of Ultra-Kaps, these units have a potentially wide range of new circuit applications. Although these applications have not been thoroughly investigated, it is conceivable, for example, the Ultra-Kap could be used for voltage regulation.

In Fig. 2 the Ultra-Kap in parallel with the output of the circuit would provide the basis for such a voltage-regulating device. Since the Ultra-Kap acts also as a voltage-sensitive resistor, decreasing in resistance with an increase of applied voltage, it provides voltage-equalizing characteristics at the output terminals. The Ultra-Kap could conceivably have many applications in a variety of control circuits because of this self-regulating characteristic. However, these characteristics have not been investigated to the point where their behavior in these circuits can be specifically stated. END

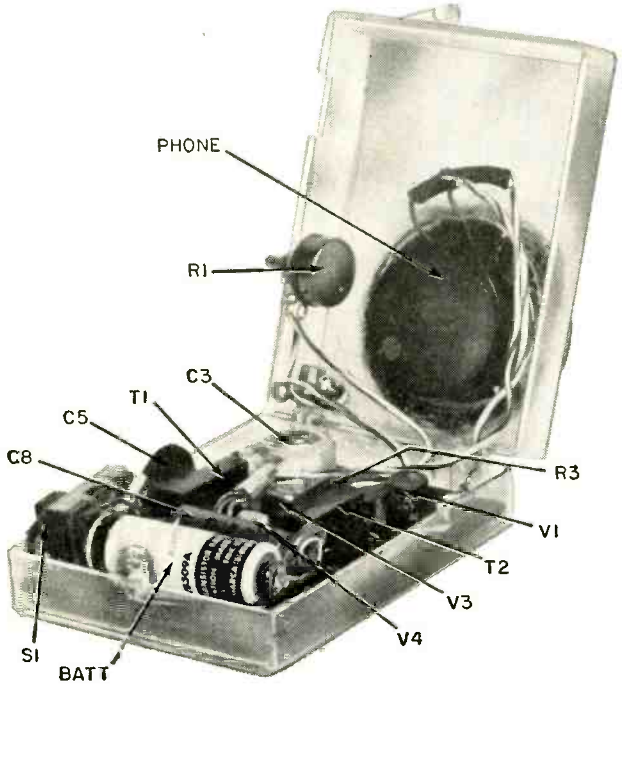
CITIZENS-BAND RADIO PAGES LISTENER

Distinct tone warns of message transmission so bearer can switch the unit to "receive" and get the message

By J. H. THOMAS



The completed receiver makes a neat shirt-pocket-size package.



With the lid open, it is easy to see how some of the components are fastened to the case.

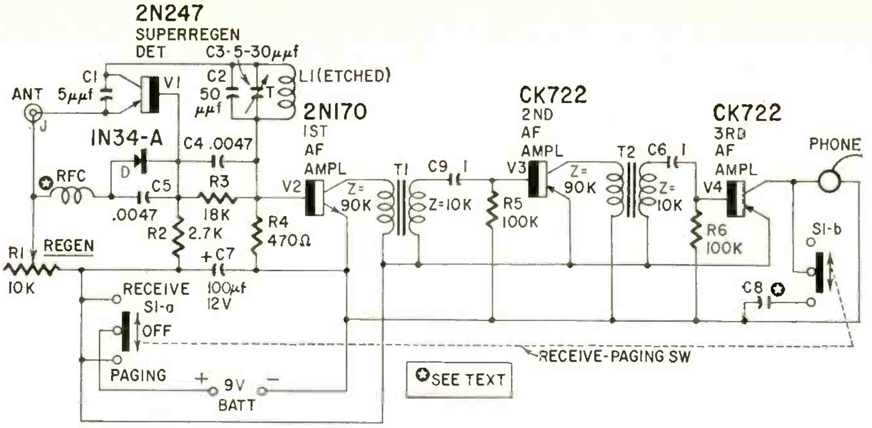
ARE you tired of calling yourself hoarse to get the kids home for dinner? Then equip them with a paging receiver, and call them with your 27-mc Citizens-band transmitter without ever leaving your kitchen. Although the sensitive receiver will pick up voice broadcasts from a 5-watt transmitter for many miles, it will also give a loud beep from a tone-modulated 5-watt signal for a radius of several blocks, usually enough to call the kids or communicate with someone in the vicinity. By using the 27.255-mc control frequency, you could, in fact, use 30 watts for the calling beeps to extend the paging range and then step down to 5 watts for voice communication.

Essentially, the receiver is not very different from the one shown by I. Queen in the March, 1958, issue of RADIO-ELECTRONICS, except that a lot of audio amplification and a special tone filter have been added to provide for the paging feature. Carried in a shirt pocket, with 2 feet of wire for an antenna, output from the single magnetic phone is loud enough to attract the wearer's attention.

Fig. 1 shows the complete schematic for the paging receiver. It consists of a superegenerative detector using an RCA 2N247 transistor and three stages of audio amplification.

Transformer coupling is used for efficiency, but resistance coupling would work too. Note how in the printed-circuit layout (Fig. 2) the transformers are mounted to avoid regenerative coupling. Similarly, it may be necessary to reverse phone connections if the magnetic type phone shows a tendency to link magnetically with the transformers. If this happens, reversing the connections provides an equivalent amount of decoupling. The single headphone used here is paralleled with a capacitor (C8) in the PAGING position of switch S1, providing a parallel-resonant circuit with the highest voltage swing for the network's resonant frequency.

The size of the capacitor must be determined for each phone and each frequency desired. But this is easy to do with an audio oscillator and a scope or ac vtvm. Simply set the oscillator for the frequency to be used, and vary the value of capacitance until maximum deflection is obtained. Or vice versa, use a capacitor you have on hand



R1—pot, 10,000 ohms, miniature
R2—2,700 ohms
R3—18,000 ohms
R4—470 ohms
R5, 6—100,000 ohms
All resistors ¼-watt 10% and are carried by most mail-order houses even if not listed in their catalog. For ¼-inch length, ask for Ohmite Little Devils.
C1—5 $\mu\mu$f, 15 volts, ceramic
C2—50 $\mu\mu$f, 15 volts, ceramic
C3—5-30 $\mu\mu$f, ceramic trimmer
C4, 5—.0047 μf, disc ceramic
C6, 9—1 μf, 15 volts, subminiature tantalum
C7—100 μf, 15 volts, subminiature tantalum
C8—approximately .02 μf, 15 volts (see text)
BATT—9 volts (RCA VS309A or equivalent)
D—1N34-A
J—phone jack, miniature
S1—2-pole 3-position slide switch
T1, 2—miniature audio transformers: primary, 10,000 ohms; secondary 90,000 ohms (UTC SO-2 or equivalent)
V1—2N247
V2—2N170
V3, 4—CK722
Earphone, 1,000 ohms
Etched-circuit board, single-sided, 2½ x 3½ inches
Transistor sockets (4)
Miscellaneous hardware

Fig. 1—Circuit of paging receiver calls for 4 transistors.

and vary the frequency. Use the one that gives maximum output in the circuit for calling. In the set shown, it is about 1,400 cycles, a clear penetrating tone. When the caller transmits a series of short notes, the tone becomes even more obvious. The receiver then flips switch S1 to the RECEIVE position and can listen to the transmitter.

Construction details

The entire unit is built into a 2½ x 3½ x 1⅛-inch plastic box. Actual component mounting is on the etched-circuit board, which is shown full size in Fig. 2. The antenna coil is etched right into the board. The coil, with the capacitors shown, tunes from about 25 to 30 mc, much more than is required. However, this is just as well, since in copying the etched-circuit coil there might be some differences in the coil inductance. The space allowed for resistors may seem small but nevertheless is correct, for these are ¼-watt resistors that are only ¼ inch long and 5/64 inch in diameter. There is probably room for larger resistors, but you will then have to allow for them in laying out the etched-circuit board.

The rf choke is made from a small resistor. On a standard ½-watt resistor, wind 36 turns of No. 34 enamel-covered wire. The resistor should have a high value. I used 10 megohms.

Operating instructions

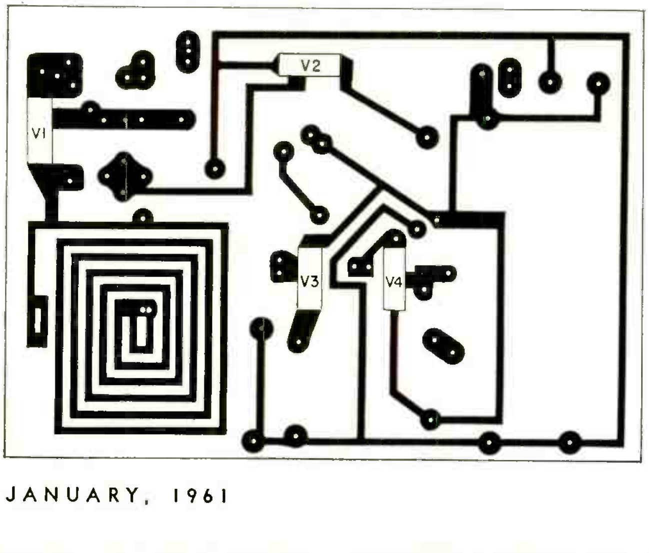
In use, there is nothing simpler. As with all superregenerative circuits, the regeneration control (R1) must be adjusted until a hiss is heard, and then with a small alignment screwdriver the trimmer (C3) can be adjusted for the proper frequency. Since frequency is affected materially only by the tuned circuit and not by the transistor, detuning because of temperature effects is no problem. The set should be aligned with the case closed. Make a small hole in the case for this purpose.

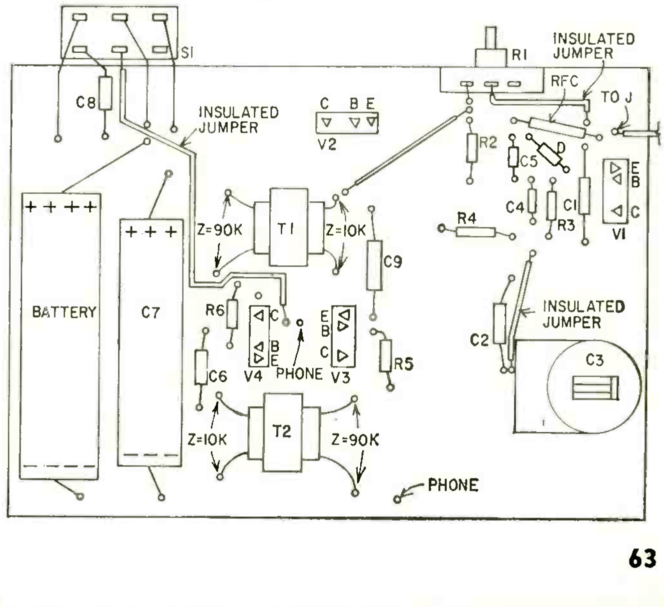
The receiver shown in the photos is slightly different from the one suggested by the etched-circuit boards. A more advantageous arrangement of some of the parts was included in the new board. Space requirements depend somewhat on the space needed by the phone. I used a Navy surplus single headpiece of 1,000 ohms impedance. This is about standard size. But a larger phone should be carefully fitted before holes are cut; it may require rearranging the parts. When in use, switch S1 is left in the PAGING position.

Calling the kiddies is just one of the less commercial uses of this receiver. It can also be used on a construction project where phones cannot be installed and some means must be available to call superintendents or inspectors to the phone or office. Or it can be used by firefighters who must be informed of where to go and where not to go. This receiver is a lot lighter and easier to pack than a regular walkie-talkie, and much less expensive. In disaster areas it could be worn by rescue workers, doctors or other personnel. It could be used in play rehearsals as a prompting receiver, or on movie sets (some of which are quite large) to instruct the actors (or the horses) on their next move. And there are many other uses for this 27-mc receiver which make it well worth building, particularly if you already have a 27-mc Citizens band transmitter.

Possible modifications include the use of UTC DO-TS transformers to reduce the size of the unit. No particular advantage is gained by using a 2N384, except slightly more sensitivity. Another approach would be to use R-C-coupled audio stages, but this does not save much space, since the additional resistors and capacitors will take up the room vacated by the transformers and more stages will be needed for the same result. The antenna can be a length of wire taped to a belt, and the receiver itself suspended from the belt, if shirt-pocket carrying is undesirable—but somewhat less efficiency must then be expected. Current consumption of the set when regenerating is approximately 2.5 ma from the 9-volt battery, so the unit can be used many, many hours on a single battery. The set will keep operating all the way down to 6 volts, allowing extra hours from weak batteries. Overall, the 4-transistor set is an economical little receiver that can be used in a thousand different ways. END

Fig. 2—Details of the printed-circuit board's layout.





STRAIN GAUGES what they can do

Some actual industrial applications

By ARTHUR S. KRAMER

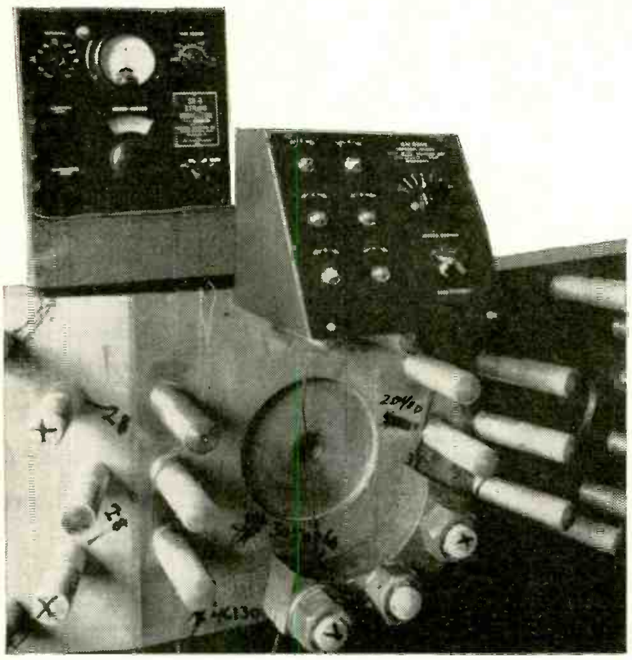


Figure 1

THE article "A Look at the Electronic Strain Gauge" (December, 1960) told rather completely how electronic strain gauges and load cells are made and how they work. For the benefit of the newcomer, a strain gauge is usually a piece of wire made of a material that changes in resistance considerably with slight stretching. It is cemented to a piece of paper or fabric which is in turn cemented to the object in which strains are to be measured. When the object is subjected to strain, its shape is distorted and the fine wire of the strain gauge stretched or compressed. The changes in resistance are usually sensed electrically by making the gauge one arm of a bridge and are amplified to give an indication on a meter or a trace on a recorder.

How strain gauges are used is the subject of this article. Only a few of the more interesting and important applications are pictured and described.

A setup for testing flanged hub bolts on a wind-tunnel fan is shown in Fig. 1. Baldwin SR-4 gauges are used.

Baldwin SR-4 load cells can be used to measure horizontal thrust of jet engines, as well as for weighing.

Fig. 2 is a head-on view of a large jet engine on the thrust stand in Ryan Aeronautical Co.'s test cell in San Diego. The load cells are located under the engine platform.

B-52G aircraft static testing is shown in Fig. 3. The forward end of the craft faces the camera and some 10 or 15 strain gauges are attached to the top surface of the fuselage. Leads from each of the gauges go to a frame above the fuselage and then down to indicating and recording equip-

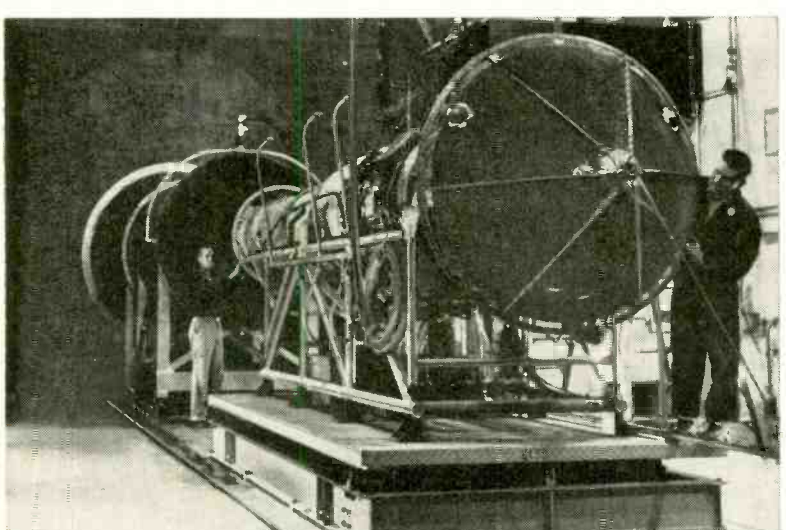


Figure 2

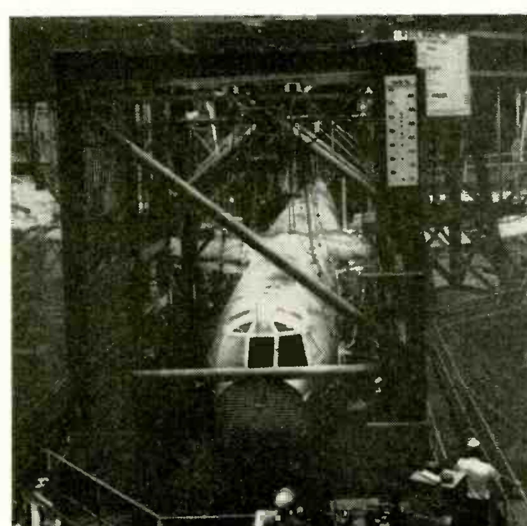


Figure 3

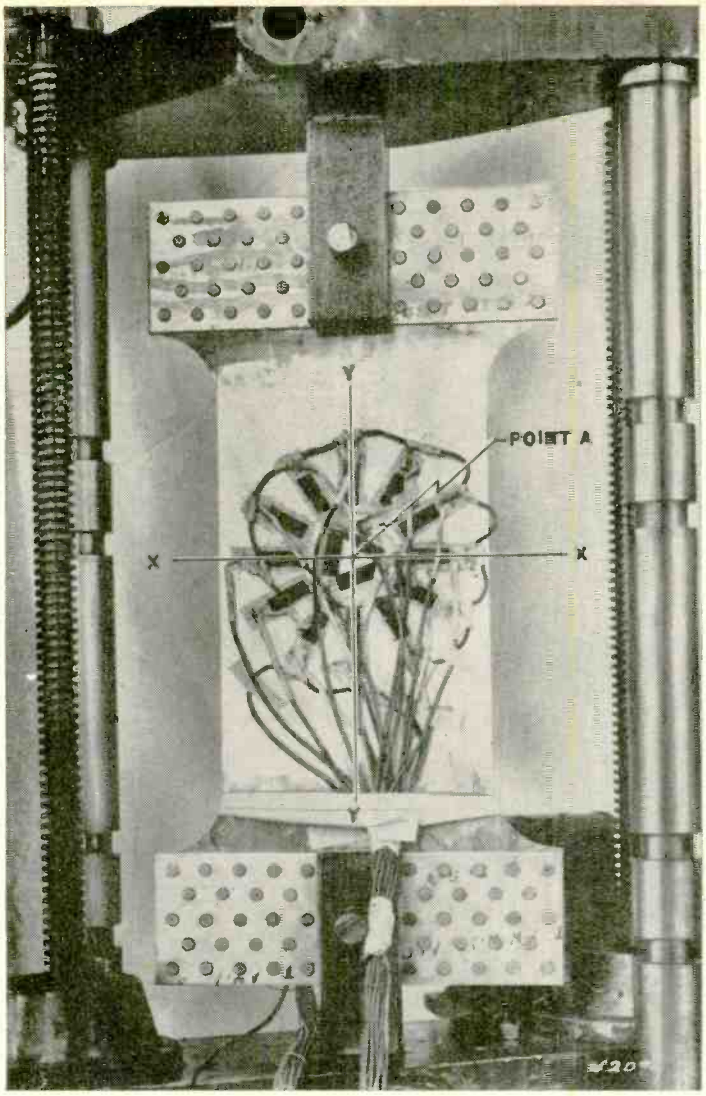


Figure 4

Figure 5

ment that appears in the foreground.

Fig. 4 shows a setup for making a stress analysis of a special steel panel at Ford Motor Co. Some 15 gauges are arranged in a circle to measure strain in many directions. The panel is fastened to the base and the movable platform of the stress machine as shown. Stress can be applied to the panel by turning the jack screws. Wire leads come down to remote indicating equipment (not shown).

Strain gauges can also be used for vibration testing. Such an application is shown in Fig. 5, where Baldwin-Lima-Hamilton SR-4 gauges are being cemented to the blade of a Curtiss-Wright propeller.

An interesting application of strain gauges is found in observing and measuring strains in a shotgun barrel. As shown in Figs. 6 and 7, three gauges were placed at three points along the barrel. The oscillograms show that the greatest strain occurs at the breech, and that the strain drops progressively toward the muzzle.

In Fig. 8 we see one of four load cells used to weigh hot metal at Armco Steel Corp. in Houston, Tex. The load cell is the cylindrically shaped device with the electrical conduit projecting from its side.

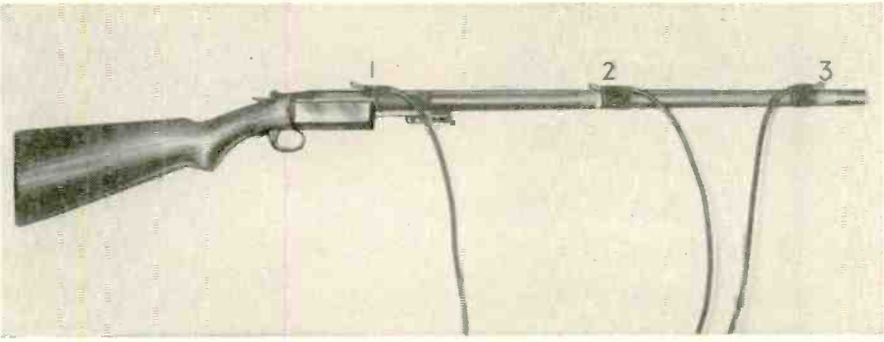


Figure 6

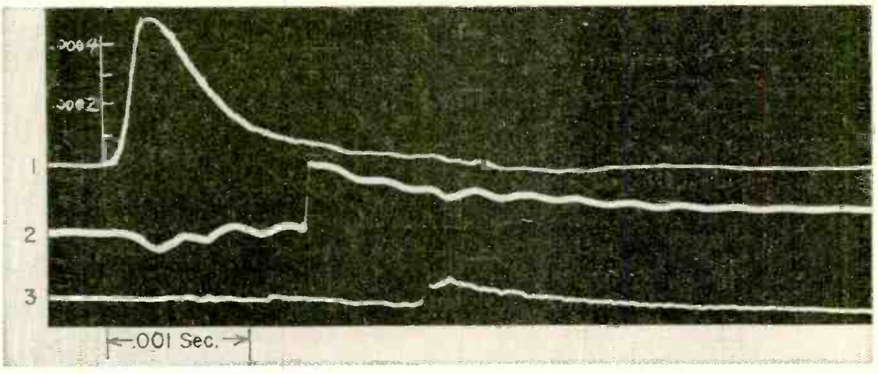


Figure 7

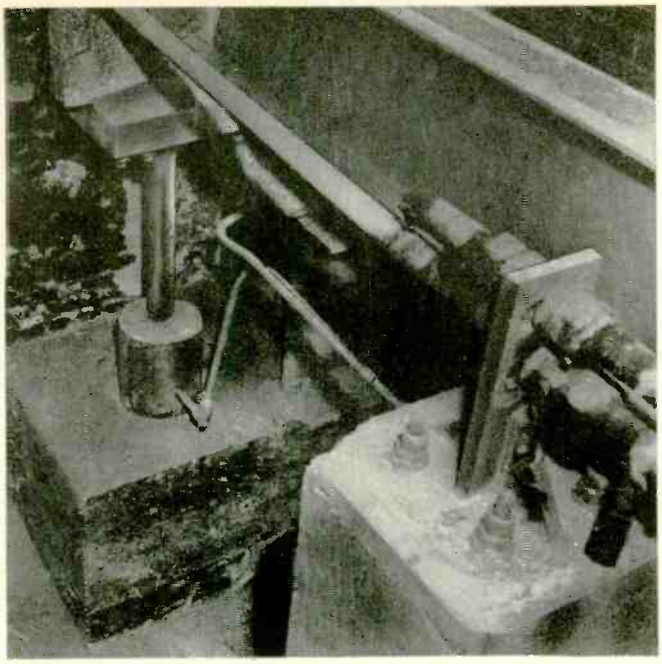


Figure 8

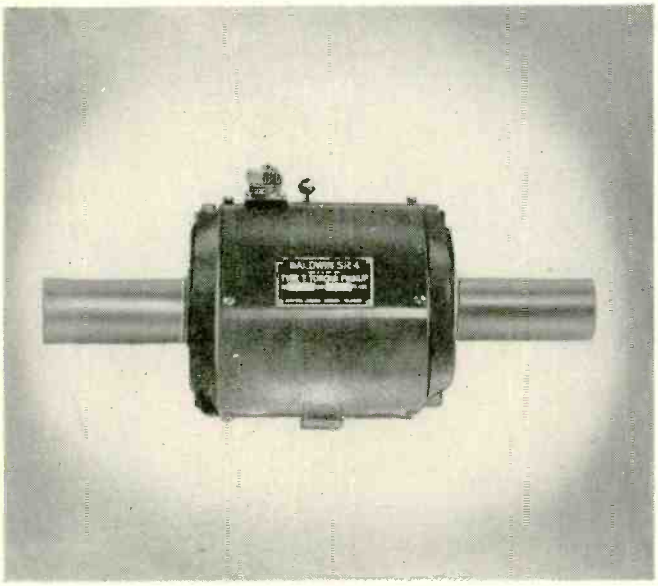


Figure 9-a

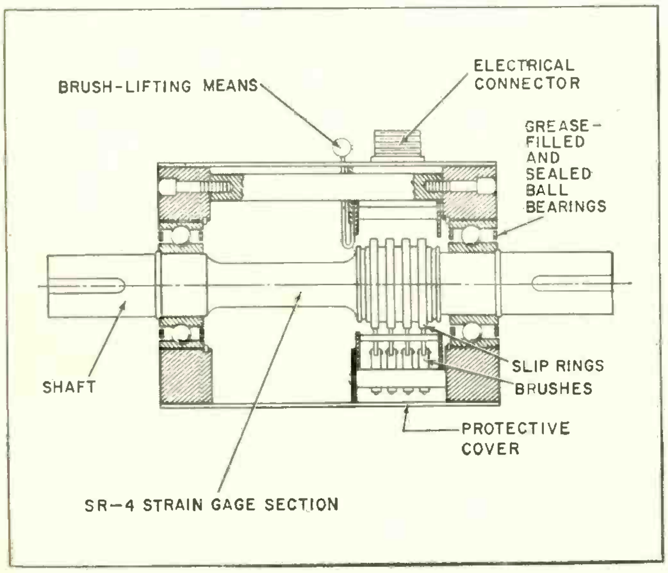


Figure 9-b

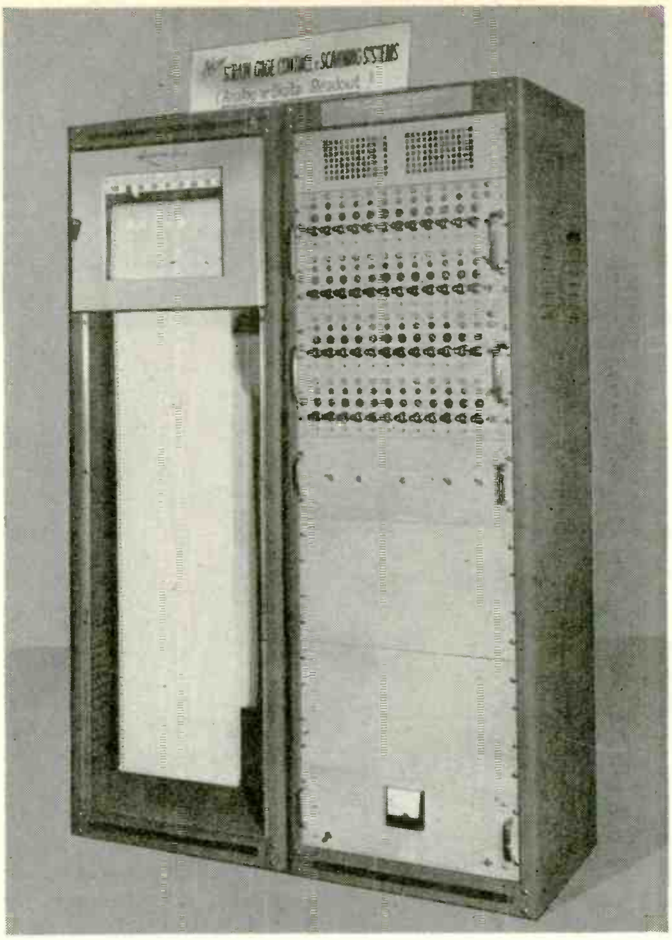


Figure 10

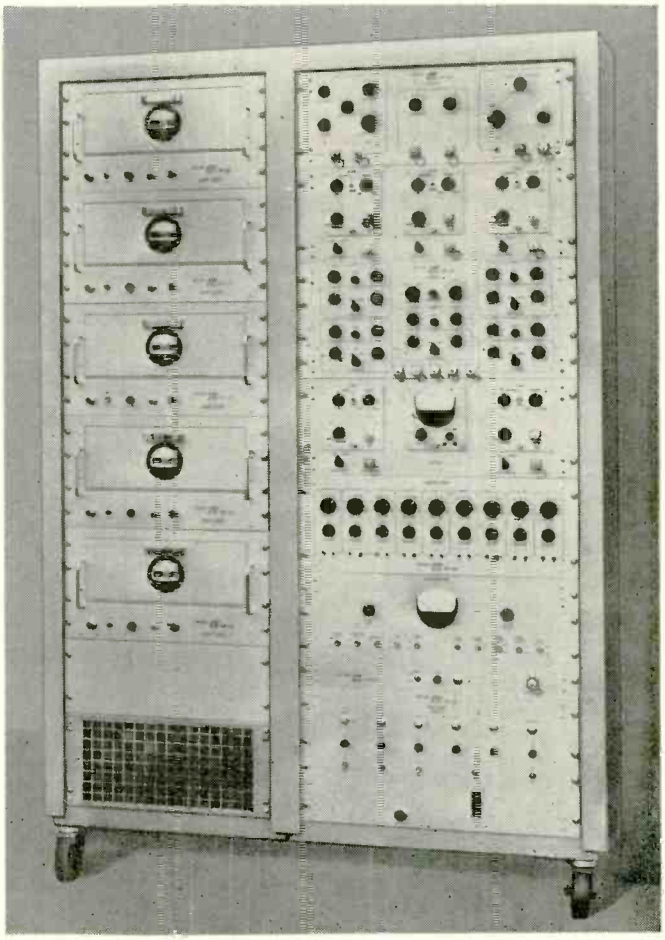


Figure 11

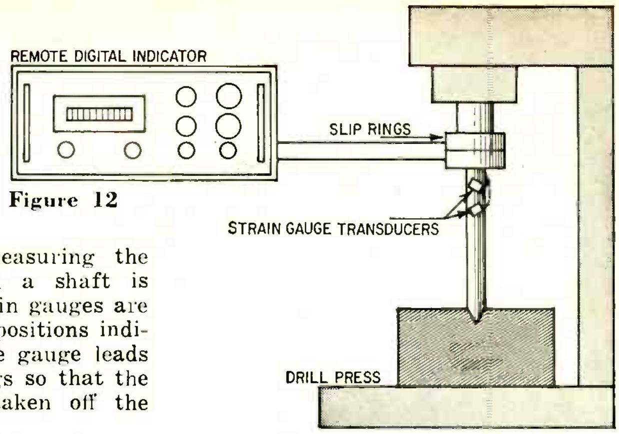


Figure 12

A device used for measuring the torque required to turn a shaft is shown in Fig. 9. The strain gauges are cemented to the shaft in positions indicated in Fig. 9-b and the gauge leads connected to the slip rings so that the output signals can be taken off the brushes.

In Fig. 10 we see a "multichannel data logger" designed and built by B. & F. Instruments, Inc., of Philadelphia. This device provides strain-gauge input conditioning for aircraft and missile flight testing. In such applications, scores of strain gauges are used, and each acts as a separate channel of information which must be recorded. This data logger provides 48 separate channels and plots strain vs load. Connections from the gauges are made via gold-plated AN connectors to maintain low contact resistance. Each remote gauge is connected to its own bridge circuit, and each bridge output is connected, in turn, to the recorder–plotter by the internal scanning switches.

In Fig. 11 we see the Electronic Tube Corp. (Philadelphia) model K-55 automatic five-channel recording system. Its purpose is to provide an automatically programmed system to record on film the output of several strain gauges used for static testing of rocket propellants, heavy artillery and dynamic stress–strain measurements. The indicator unit contains a five-gun cathode-ray tube, type 55PAP11, which is mounted through the side of the instrument. The unit operates very nearly the same as five conventional oscilloscopes but with the information displayed on only one cathode-ray tube. The unit can be used to control a complete program, including such actions as starting the cameras, recording the phenomena, calibrating, firing the unit under test and shutting the system down.

The Baldwin type N strain indicator is a small, transistorized, portable instrument that can be set up at any remote point to read strains directly in values of micro-inches per inch. The dial readability is 2 μin per inch and its accuracy is ± 3 μin per inch.

Performance Measurements Co. of Detroit manufactures a universal strain-gauge transducer indicator which produces a direct digital readout from any transducer using bonded or unbonded strain gauges. Fig. 12 shows how torque produced in rotating equipment such as a drill press may be measured with a pair of strain gauges bonded directly to the drill and read on the digital indicator directly.

Typical circuits

The simplest strain-gauge circuit is that in Fig. 13, in which a strain gauge (Rg) is connected in series with a battery and a fixed or "ballast" resistor R. The circuit is capacitively coupled to the electronic amplifier, the capacitor presenting infinite impedance to steady dc voltage but transmitting pulsating dc. It is coupled with an amplifier, and the output of the amplifier drives an oscilloscope, oscillograph, ac voltmeter or similar instrument.

To measure static strains or the static component of a varying strain, the most convenient circuit is the Wheatstone bridge. This is shown in its simplest form in Fig. 14. When this bridge is set up so that the only source of unbalance is change of resistance in the gauge, resulting from the application of strain to the gauge, the difference in potential across the output terminals becomes a measure of that strain. This potential can be measured by a sensitive voltmeter, but for most purposes a strain indicator or recorder calibrated in terms of micro-inches per inch is much more satisfactory.

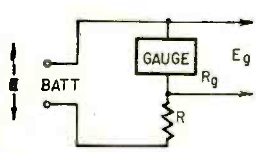


Figure 13

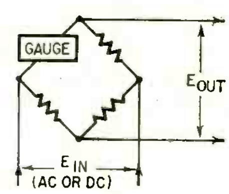


Figure 14

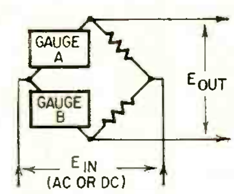


Figure 15

This simple form of Wheatstone bridge circuit has one serious defect. The filament wire used for SR-4 gauges is temperature-sensitive as well as strain-sensitive. The voltage measurements made from this circuit, therefore, are the combined result of strain and temperature.

To cancel any effect of temperature on the gauge wire, a circuit like that shown in Fig. 15 is used. Probably the most commonly used circuit in strain-gauge work, this circuit employs two SR-4 gauges as adjacent arms of the bridge. One of these, the "active" gauge, is mounted on the stressed metal; the other, the "dummy," is mounted on an unstressed piece of the same material. The two are located close together, so that both are subjected to substantially the same temperature.

Now, if the two gauges are identical, resistance changes due to temperature alone will be the same for both of the Wheatstone bridge arms in which these gauges are located. The effects of temperature on the gauges will have practically no influence on the measurement of the stress-induced strain at the active gauge.

The measurement will, however, include strain due to thermally induced stresses in the metal. It is thus a true measure of stress, whether the stress results from temperature or applied force or load, or both. The dummy gauge simply compensates for the undesired temperature effects.

Latest developments

As previously mentioned, gauge factors of most commonly used metal-wire strain gauges range between values of 2 and 4. Recent experimental work indicates that germanium, silicon and other semiconductors when used as strain gauges have factors ranging from 150 to 175. This makes any circuit employing them extremely sensitive. The sensitivity is high enough that hydrostatic forces can be measured merely by immersing the gauge in the fluid. Also, static and low-frequency stresses can be measured at frequencies up to resonance of the material. Applied stress forces can be large, since semiconductors are strong structurally. These gauges are stable under conditions of high temperatures and high humidity. They respond well to torsional and shearing forces. Semiconductors have nearly all the qualities needed for an ideal gauge.

Future outlook

It is very doubtful that our missile and space exploration effort would have made such tremendous progress without the various types of electronic strain gauges to telemeter back the happenings during flight tests. Smaller and more sensitive gauges will become available soon. Perhaps other materials will be found with gauge factors higher than those of semiconductors. It is possible that all industrial weighing will soon be done electronically, using load cells or their equivalent. Strain gauges will be useful in the field of deep-sea exploration, where pressures of thousands of pounds per square inch can set up severe strains in the submarine vessel.

Acknowledgment

The writer again acknowledges with gratitude the assistance of Mr. T. L. Gaffney of Baldwin-Lima-Hamilton Corp., Waltham, Mass., who contributed much helpful technical information and most of the photos used. END

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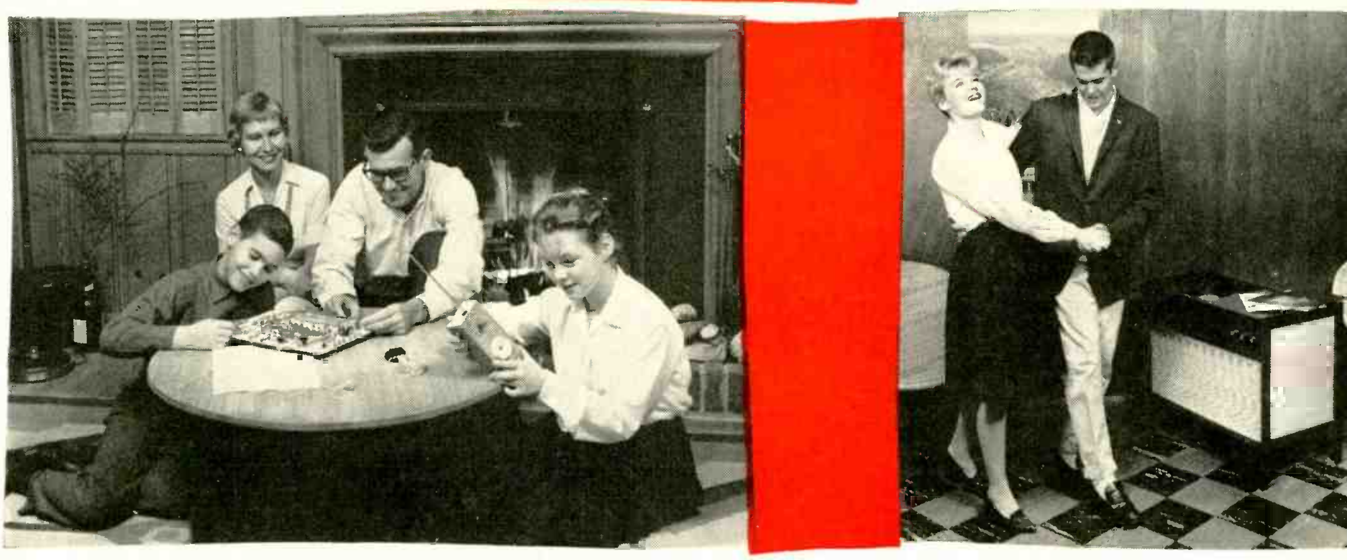

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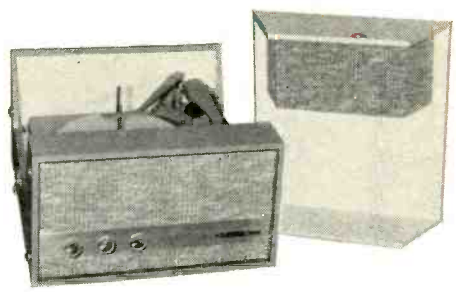

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From jazz to classics, the younger set will have stereo wherever they go! Plays either stereo or mono records on its top quality 4-speed automatic changer with diamond and sapphire styli. Has detachable stereo speaker wing and complete tone and stereo balance controls. Record changer and cabinet are factory-assembled, the kit is a "snap" to build. 15½" x 18" x 8⅝". 28 lbs.

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Model AS-10W (walnut)...$6.50 dn., $6 mo. **$64.95**

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The IP-10 presents a significant improvement in isolation transformers. Provides output voltage from 90-130v in 0.75v steps at 300 watts continuous duty, 500 watts intermittent duty, with 117v input—ample power for even color TV servicing. Built-in meter continuously monitors output voltage with ± 1 volt accuracy (linear scale is electronically expanded to cover 90-140v). Power line input voltage can also be measured by operating spring-return slide switch on front panel. Fused primary. Measures 6½" W x 9½" H x 5" D. 22 lbs.

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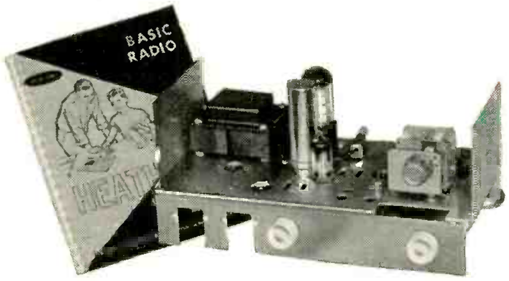
Checks ignition faults quickly and accurately. One simple hook-up to ignition wiring, and the IO-20 does the rest! No removing plugs, wiring or other engine parts. Checks engine in operation. Switch selection of primary, secondary, parade or superimposed patterns without changing leads to the engine. Detects shorted plugs, defective distributor points, defective wiring, coil and condenser problems, incorrect dwell time, worn distributor parts, etc. Features improved trigger circuit for locked-in patterns without trigger level adjustment; 2-1 vertical and 10-1 horizontal expansion. 8" H x 9½" W x 16" D. 22 lbs.

Model IO-20...$8.95 dn., $9.00 mo.................. **$89.95**



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INTERCOM...

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Super-duper model 1

By PETER J. VOGELGESANG*

An intercom system is usually made up of one master station and a group of remote speakers. The master can call any or all of the remotes and each remote can call the master, but communication from one remote to another is impossible. For a completely versatile system, you would need a master unit at every station, but then every station requires ac power and many amplifiers must operate simultaneously. Then, too, multiconductor cable connection between all master stations is required.

You can keep almost all the advantages of an all-master system and still have only one amplifier by using a comparatively simple relay exchange to route the amplifier's output to any preselected remote.

The unit's amplifier is conventional. Its input is matched to the remote speakers with a voice-coil-to-grid transformer. The amplifier's output is fed to the relay exchange.

Exchange circuits

As in the schematic, the audio output is routed through the normally closed contacts of all six exchange relays, where it is returned to ground through the normally closed contact of the last relay, muting the amplifier. If any of the relays is energized, the grounding circuit is opened and the amplifier's output is fed through the normally open contact of that relay to the respective remote station. By energizing the proper relays, the amplifier can be made to feed any one of the remote stations.

Each relay is energized by the plate current of a triode which is normally cut off because of a negative bias on the tube's grid. Bias voltage is obtained from the 117-volt winding of T4. The 90-volt rectified output is dropped through a series of resistors to produce voltages in increasing increments of −15 volts. Each discrete voltage is fed through a 4.7-megohm resistor to the grid of one of the triodes. When the negative supply is returned to ground by R26, all the triodes are cut off. However, by returning it to some positive voltage, the bias on any or all of the triodes can be effectively removed, thereby causing them to conduct. For example, if the junction of R24 and R26 is returned to positive 60 volts, the triodes that operate relays RY3 through RY6 have no bias and will close the relays. The triode operating relay RY2 still has a grid bias of −15 volts and the triode connected to relay RY1 has a bias of −30 volts so these two relays will not be actuated. At V6, there is a positive voltage on the grids, but 4.7-megohm grid resistors limit grid current and protect the tubes.

Although RY3 through RY6 are all actuated, only RY3 routes the amplifier output to a remote speaker because, when it closes, it opens the contacts that feed audio to RY4, RY5 and RY6. In this way, any of the six exchange relays can be closed by returning the negative supply to the correct positive voltage. Control of the exchange relays is simply a matter of providing a system that lets each remote station supply a variable reference voltage to the negative supply.

A conventional intercom usually requires a three-conductor cable between the master station and each remote station. One wire is a talk line, one is a listen line and the third is common to both and is usually at ground potential. By using a five-conductor cable between the amplifier and each remote station, a positive voltage equal to the full voltage of the negative supply can be carried to each remote station on the fourth line, and a referencing voltage can be carried back to the exchange system on the fifth line. Thus it is possible to control the exchange from each remote station. How this is done is shown in the diagram of a remote station.

The remote units

About 100 volts is tapped from the amplifier's power supply and is fed to each remote station. Normally it is not used. However, when the FUNCTION switch of any remote station is depressed, the voltage is fed to potentiometer R29. The wiper of the potentiometer taps part of this voltage and sends it through the FUNCTION switch to the exchange circuits over the control line. By rotating the potentiometer, it is possible to control every relay in the exchange. If linear potentiometers are used, as recommended, they can be calibrated in six equal divisions, each one representing one of the remotes.

In operation, with none of the FUNCTION switches depressed, all remote speakers are connected to the listen line and the negative supply in the exchange is referenced to ground by R26. When a call is originated at any remote station, the potentiometer at that station is set to the station being called. Now, when the FUNCTION switch at the transmitting station is depressed, it not only switches that speaker to the talk line—it also sends a referencing voltage to the exchange that will route the audio output to the station being called. Before answering, the potentiometer at the station being called must be set to the station originating the call. As the two stations converse alternately, the

R1—1,800 ohms
R2—1 megohm
R3—470,000 ohms
R4—pot, 1 megohm, audio taper, with spst switch
R5—10,000 ohms
R6—270 ohms, 1 watt
R7, 8, 9, 10, 11, 12—27,000 ohms, 1 watt
R13, 14, 15, 16, 17, 18—4.7 megohms
R19, 20, 21, 22, 23, 24—2,700 ohms, 1 watt
R25—220 ohms
R26—2.2 megohms
R27—18,000 ohms, 2 watts
R28—10,000 ohms, 2 watts
R29—pot, 100,000 ohms, linear taper (1 per remote station)
All resistors ½-watt 10% unless noted
C1—250 μμf, ceramic
C2—10 μf, 25 volts, electrolytic
C3—.02 μf, paper
C4—.01 μf, paper
C5—10 μf, 450 volts, electrolytic
C6—25 μf, 25 volts, electrolytic
C7—20-20 μf, 450 volts, electrolytic
C8—40 μf, 200 volts, electrolytic
C9—0.1 μf, 200 volts, paper
Capacitors 600 volts unless noted
CH—Filter choke, 8 henrys, 100 ma, 375 ohms (Merit C-2995 or equivalent)
F—2 amps
RECT—75 ma, 130 volts, selenium
RY1, 2, 3, 4, 5, 6—relay, sealed miniature, spdt contacts, 10,000-ohm coil (Potter Brumfield SM5LS or equivalent)
S1—spst on R4
S2—4 poles, 2 positions, lever action, spring return (Mallory 7242L or equivalent) (1 per remote station)
T1—intercom transformer: primary, 4 ohms; secondary, 25,000 ohms (Stancor A-4744 or equivalent)
T2—universal output transformer; use 5,000-ohm primary; 4-ohm secondary (Merit A-2900 or equivalent)
T3—power transformer: primary, 117 volts; secondary, 560 volts ct, 90 ma; 6.3 volts, 5 amps; 5 volts, 2 amps (Merit P-3052 or equivalent)
T3—filament transformer: primary 117 volts; secondary, 6.3 volts, 1 amp (Merit P-2944 or equivalent)
T4—filament transformer: primary, 117 volts; secondary, 6.3 volts, 1 amp. (Merit P-2944 or equivalent)
TS—terminal strip, 10 lugs, barrier type
V1—6AU6
V2—6AQ5
V3—5Y3-GT
V4, 5, 6—12AT7
Chassis, 5 x 10 x 3 inches
Miscellaneous hardware

*Engineer, KSTP-TV.

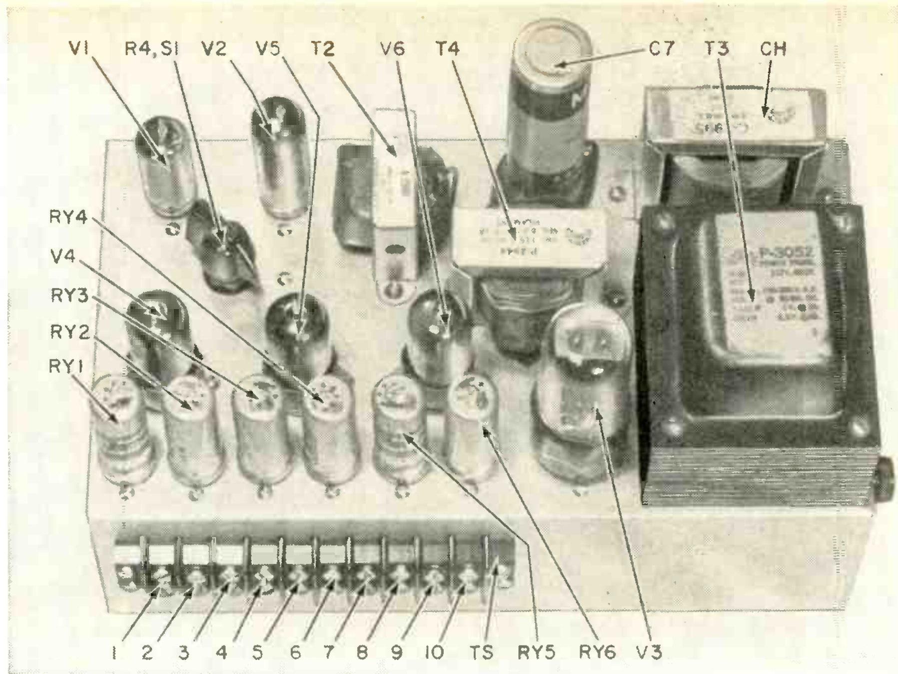
relay exchange will route the amplifier output alternately as the respective FUNCTION switches are depressed.

The system has limitations. Only one conversation can be held at a time, and only one station can be called at a time. A call to two stations simultaneously is impossible. In spite of these limitations, the overall system is nearly as versatile as an all-master conventional system but is simpler, more economical to build and operate, and easier to install.

The amplifier can be located at some point near the center of the system to eliminate long runs of interconnecting lines. It can be placed in a closet or any other out-of-the-way place because it is operated remotely. The remote stations can be made small and compact, and, because they do not require ac power, can be mounted in places where there are no power outlets.

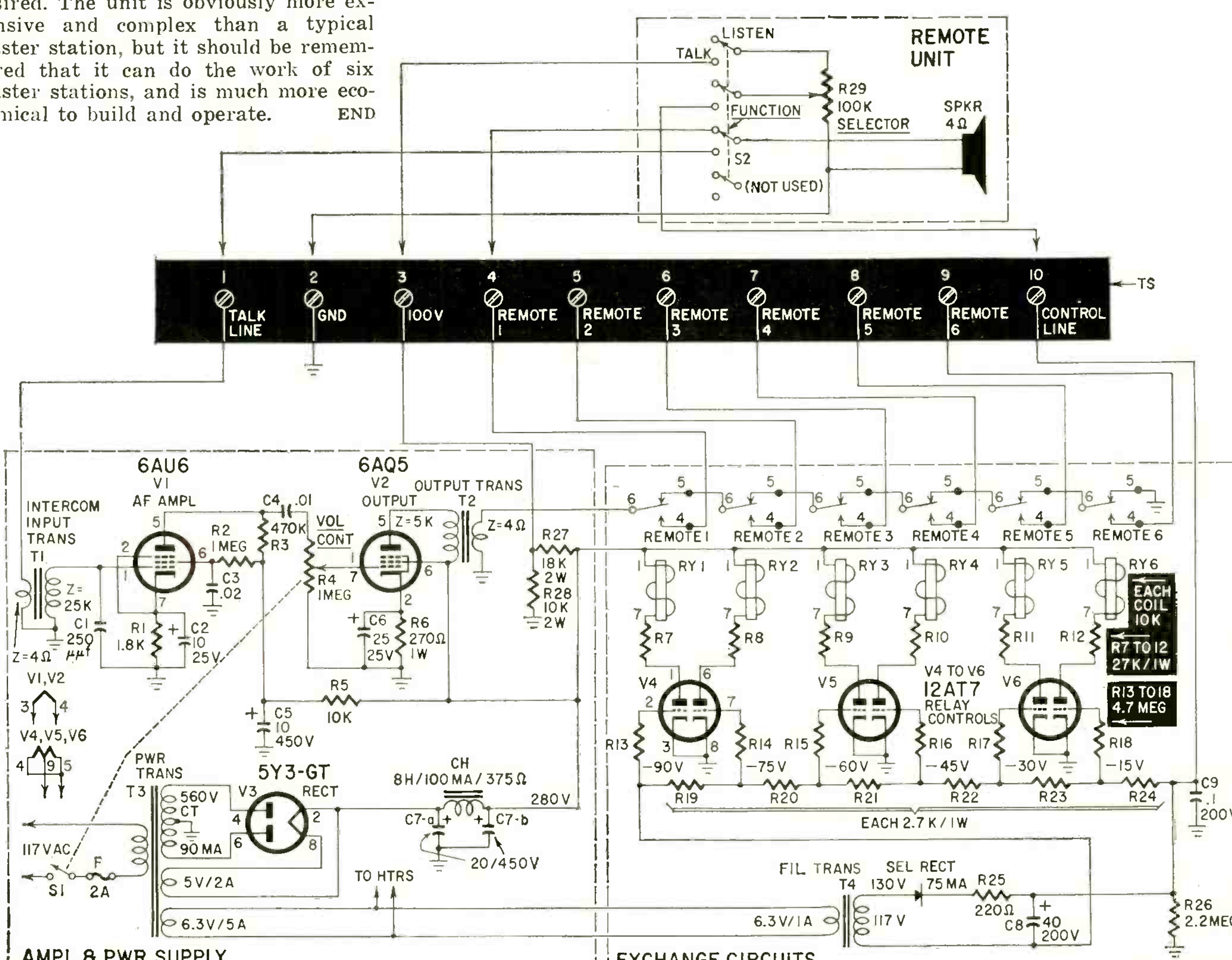
Construction hints

The unit is built into a 5 x 10 x 3-inch steel chassis. All transformers except the input transformer are mounted above the chassis to minimize inductive coupling to the input transformer. While six relays are used in the unit described, more or fewer can be used, depending upon the extent of the system. The small, hermetically sealed relays give long, unfailing service because of their sealed design, but can be replaced with a less expensive type if desired. The unit is obviously more expensive and complex than a typical master station, but it should be remembered that it can do the work of six master stations, and is much more economical to build and operate. END



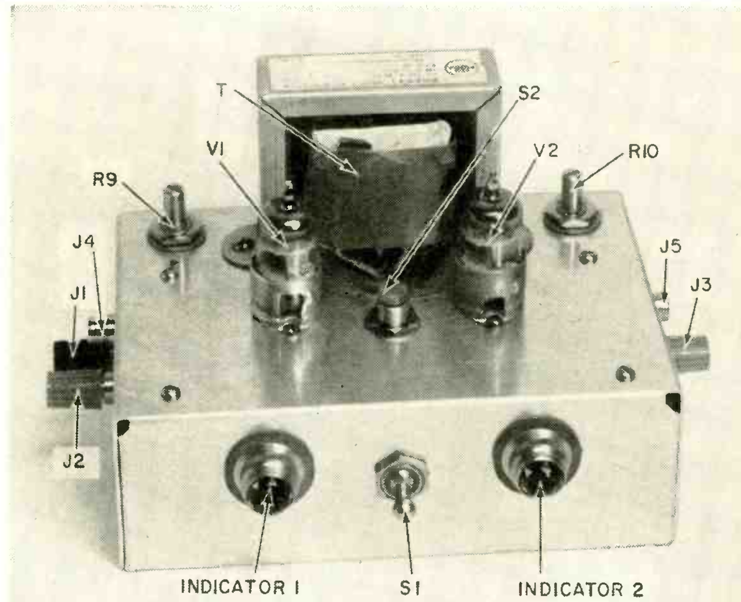
Finished unit fits on 5 x 10 x 3-inch chassis.

Circuit of the versatile unit, with connections for remote unit 1 shown. When other remote units are added, similar connections are made. The only exception is the talk line. It is connected to the respective remote unit terminal.



ELECTRONIC JUDGE SPOTS THE WINNER

Time-discriminating circuit picks out the first car across the finish line



The complete electronic judge. Just hook up to the photocells at the finish line and it is ready to use.

By SAM GARSON

INCREASING interest in drag racing and the high speeds of the contestants' autos require an accurate way to determine which of two autos crosses the finish line first. Consider the problem: At well managed drag strips there are two parallel lanes ¼ mile long and about 50 feet apart. Two autos start from a dead stop at the starting line and may cross the finish line at 120 mph or faster. This final speed is 176 feet per second, or 2.1 inches per millisecond. It is extremely difficult for a judge standing at the finish line to pick out the winner when the cars are moving that fast and yet are within inches of each other in the forward direction.

This is where the electronic judge comes in. Two pairs of spotlights and photocells are set up at the finish line (Fig. 1). The photocell circuit, which delivers a 20-volt positive-going pulse when the light beam shining on the cell is interrupted, is conventional. The judging (or, more literally, time-discriminating) circuit consists of two 5696 thyratrons in a cross-coupled grid-bias configuration. When either 5696 fires, the other is immediately biased so far negative that it cannot possibly be fired. At the same time a relay closes in the plate circuit of the tube that fires, supplying power to a large red lamp hanging over the lane of the winning auto. Laboratory tests show that the circuit will differentiate between signals arriving at the two tubes as close together in time as 10 μsec. Therefore, two autos traveling at 120 miles per hour can be as close as .02 inch, and the winner will still be correctly identified. Obviously, dead heats are few and far between!

The simple circuit of the electronic judge (Fig. 2) requires little power. So the power supply consists of only a small transformer and two selenium rectifiers in a full-wave voltage-doubler arrangement delivering 150 volts positive and negative. The control grids of the 5696's are held at −10 volts by the cross-coupled voltage dividers made up

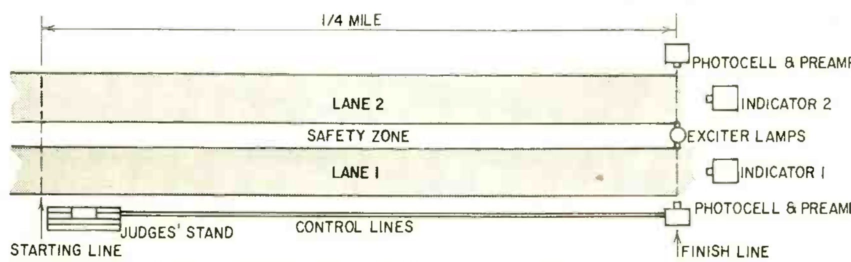


Fig. 1—Equipment layout at a typical drag strip.

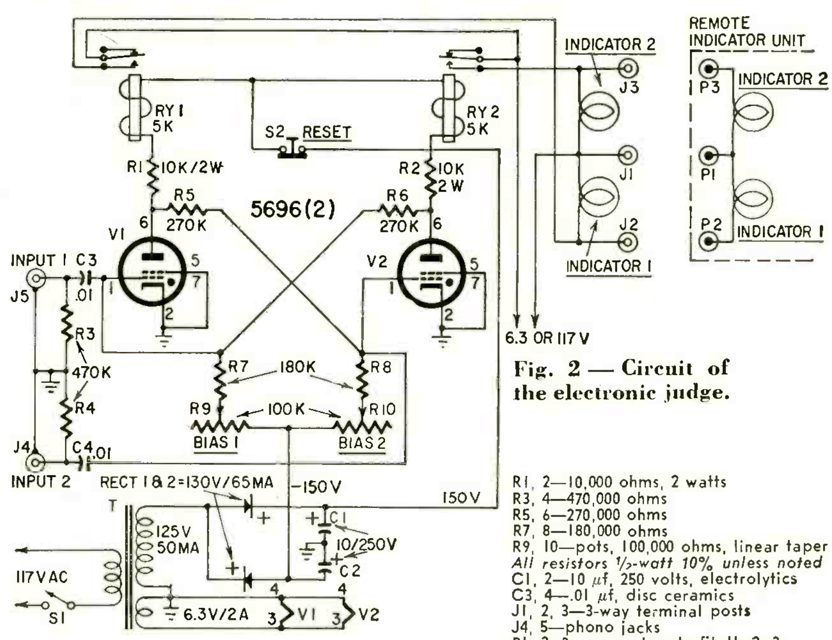


Fig. 2 — Circuit of the electronic judge.

R1, 2—10,000 ohms, 2 watts
R3, 4—470,000 ohms
R5, 6—270,000 ohms
R7, 8—180,000 ohms
R9, 10—pots, 100,000 ohms, linear taper
All resistors ½-watt 10% unless noted
C1, 2—10 μf, 250 volts, electrolytics
C3, 4—.01 μf, disc ceramics
J1, 2, 3—3-way terminal posts
J4, 5—phono jacks
P1, 2, 3—connectors to fit J1, 2, 3
RECT 1, 2—selenium rectifiers; 130 volts, 65 ma
RY 1, 2—spdt plate relay; 5,000-ohm 6.3-ma coil (Potter & Brumfield LB-5 or equivalent)
S1—spst toggle
S2—spst pushbutton, normally closed
T—power transformer: primary, 117 volts; secondary, 125 volts, 50 ma; 6.3 volts, 2 amps (Stancor PA-8421 or equivalent)
V1, 2—5696 thyratron
Chassis, 6 x 4 x 2 inches
Sockets, 7-pin miniature (2)
Miscellaneous hardware

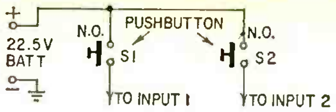


Fig. 3—Auxiliary triggering circuit to test reaction time.

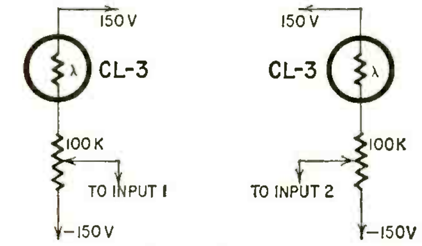


Fig. 4—Another alternative triggering circuit.

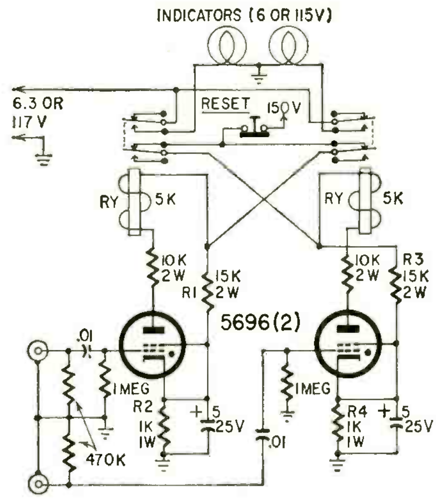
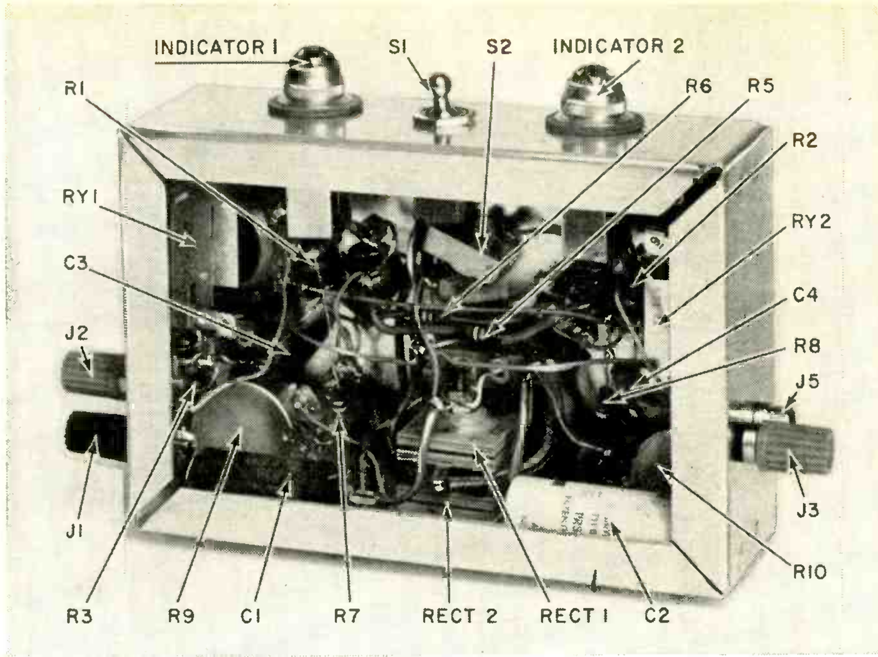


Fig. 5 — A simpler, but less accurate, time-discriminating circuit. R1, R2 and R3, R4 are voltage dividers designed to bias the cathodes. Use isolation transformer to supply indicator lamps.



Underchassis layout is less complex than it looks.

of R5, R8, R10 and R6, R7 and R9. R9 and R10 are adjusted for proper bias.

As soon as a pulse arrives at a control grid, say V1, the tube fires. Its plate voltage drops to about 10, and V2's grid drops to −75, rendering it completely insensitive to any signals below about 73 volts. Relay RY1, having closed, supplies 117 or 6.3 volts to J2, which powers the red lamp suspended above lane 1 at the finish line. (If more power is needed, use 117 volts ac for the lamps. Simply disconnect the 6.3 volts from the relay and connect to the ac line input through an isolation transformer. Use 115-volt lamps.)

Indicator 1 lights up on the panel of the instrument, for the information of those in the judges' stand. The circuit remains in this condition until reset button S2 is pressed. This removes B-plus from both tubes, extinguishes the indicator lamps and, when the button is released, both grids are again at −10 volts and ready for the next event.

In use, the instrument is located in the judges' stand at the starting line, the 20-volt pulses having been sent over telephone cable from the finish line. We found it necessary to put cathode followers between the photocell circuit and the telephone cable for impedance matching, to preserve the rise time of the output pulse from the photocell. We used 6.3-volt indicator lamps in the unit shown in the photos. If 115-volt lamps are needed for greater visibility at the finish line, you can control them with 6-volt ac relays tied in through J1, 2 and 3, or you can use 115-volt lamps throughout.

Aside from this very practical application to sporting events, the home electronics gadgeteer can adapt this circuit to all sorts of games. For example, one can compare the reaction times of two persons by having each one press his switch at a given signal (Fig. 3). Or you can construct two flashlight guns and let your young cowboys and cowgirls draw against each other. Let each one have his or her own target, consisting of a photocell (Fig. 4). At a given signal, each draws and shoots. As soon as a target is hit, a positive pulse fires the appropriate thyratron and the winner is immediately indicated. Adjust the pots for your own particular lighting conditions so that the voltage change at the 5696 control grid will be about 20 volts when the flashlight beam hits the photocell.

Note that the circuit of Fig. 5 is somewhat simpler, since no B-minus is necessary. When V1 fires, two of the normally closed contacts on the relay remove B-plus from V2's plate circuit, and thereby prevent it from firing. However, tests with sensitive relays show that the opening times of these contacts were nonreproducible and varied by as much as 2 or 3 milliseconds. The final circuit (Fig. 2) has an almost infinitesimal dependence on relay characteristics.

Undoubtedly, the home experimenter can devise many other interesting uses for this simple and reliable circuit. END

Reverberation Improved

Improvements in artificial reverberation promise to facilitate conversion of an ordinary auditorium into the acoustic equivalent of a full-sounding concert hall.

"Colorless" artificial reverberation is being developed jointly by Dr. M. R. Schroeder ("Stop Feedback in PA Systems," R-E, February 1960) and Mr. B. F. Logan of the Bell Laboratories.

Artificial reverberation has been used by recording companies, broadcasters and room acousticians for many years before its recent upsurge in packaged hi-fi equipment. A typical user might be a radio station wishing to broadcast a recording of an outdoor concert or open-air summer music festival. At the broadcast studio, an artificial reverberator would introduce reverberations, or echoes, to imitate the fullness of indoor performance.

Another application is acoustic conversion of public or private auditoriums lacking in reverberation because they are designed primarily for speech. When artificial reverberation is thus employed, no changes in architecture and interior decoration are required.

Bell Laboratories' colorless artificial reverberation, Messrs. Schroeder and Logan report, represents a significant advance over that produced by presently obtainable equipment because it does not alter the sound's tone color (timbre). It reproduces all sound, music or vocalization or both, with equally high quality similar to the effect of a real concert hall. Nor does colorless reverberation add unpleasant distortions of its own to the original sound.

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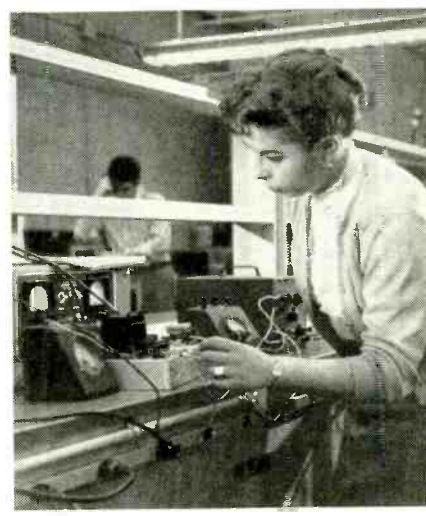

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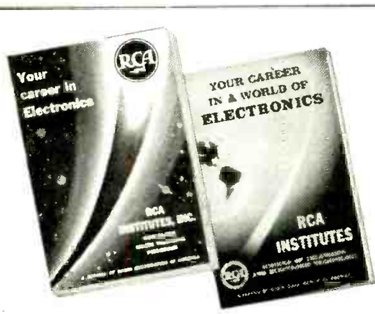

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COVER STORY

NEW short-range Communicator

All-transistor wireless microphone may offer substantial improvement in short-wave communication and control

The Vega-Mike wireless microphone.

The FM receiver.

By C. ARTHUR FOY

VEGA-MIKE* is essentially a small FM broadcasting station which transmits to a tuned receiver at a central location. The all-transistor microphone–transmitter is battery-powered and completely self-contained. The receiver is small and can be either portable or rack-mounted. Vega-Mike can be used for either relaying information, direct broadcasting over commercial radio, public address or actuating a variety of auxiliary systems including tape recorders. It offers broadcast-quality transmission of sound over distances ranging from as little as 25 feet to more than ½ mile, depending upon environmental conditions.

Under development for more than 3 years, Vega-Mike had its origin in the classrooms of San Jose State College in California. Here Mr. Ray Litke of the Audio-Visual Department was assigned by his department head, Dr. Richard Lewis, to develop some method of wireless transmission of the voice which would enable a teacher to lecture to his classes in a large auditorium or feed audio to a closed-circuit TV system for his teacher-observation program, and to be able to do it without the inconvenience of trailing wires.

Subsequent development by Vega Electronics resulted in a completely miniaturized broadcast station contained in a cylindrical unit only 1 inch in diameter by 5⅛ inches long, with the antenna external to the structure.

The Vega-Mike system is designed for the professional user who requires the dependability and quality of a standard microphone without the inconvenience of an interconnecting microphone cable. It operates at authorized FCC frequencies in the 25- to 45-mc band.

There are three models: a hand-held unit with a telescoping whip antenna attached to a swivel joint at the base; a modification of the hand-held model in which the antenna is attached to the top of a helmet—as shown on the cover—for better transmission in crowded situations or over longer distances, and a lavalier model worn around the neck, with the suspending cord acting as the antenna.

Uses to which the system can be put are limited only by the range of the system and the imagination of the operators. Recently, Vega-Mike scored in the field of reporting when it was used by the news-gathering staff of the American Broadcasting Co. at the two major political conventions. It is also applicable to such diverse fields as sports broadcasting, security police, watchmen making their rounds, regular police work, fire department control and emergency direction, the entertainment field—freeing performers from the limitation of conventional microphone systems, baby-sitting, public-address broadcasting, and many more.

*Trademark Vega Electronics Corp., Cupertino, Calif.

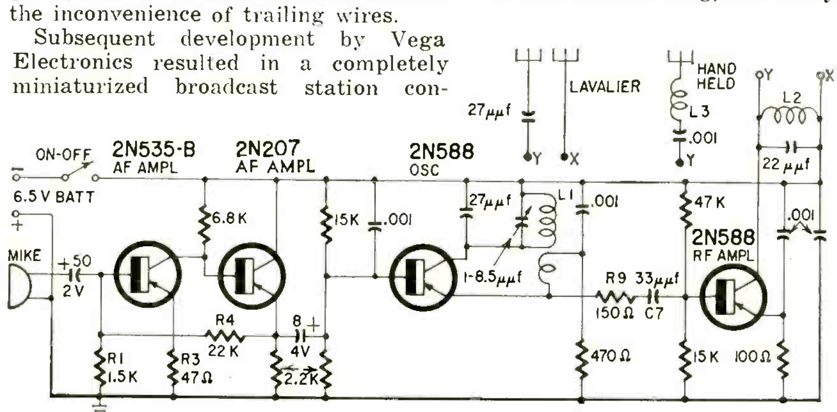


Fig. 1—Hand-held transmitter uses four transistors.

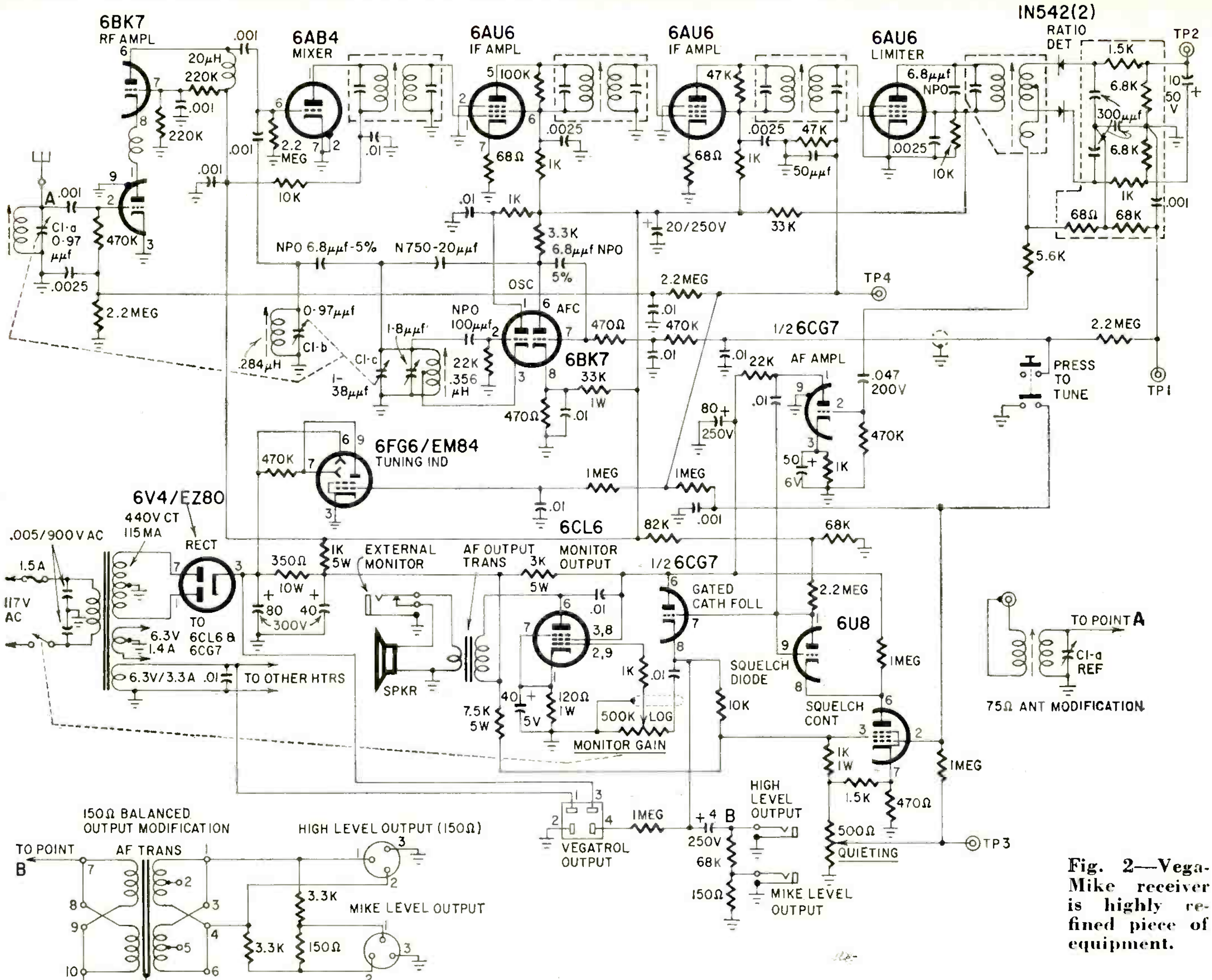


Fig. 2—Vega-Mike receiver is highly refined piece of equipment.

Vega-Mike is an all-transistor wireless microphone system with the entire transmitter circuitry microphone and power supply enclosed in a cylindrical case only 1 inch by 5⅛ inches and weighing only 7½ ounces (Fig. 1).

The transmitter consists basically of an audio amplifier, an FM-modulated oscillator and an rf amplifier. Four transistors are used. All components are mounted on both sides of a circuit board slightly less than 1 inch wide by about 2⅛ inches long. Normal voice levels modulate the transmitter over an FM swing of ±20 kc. The circuit has been designed to minimize drift due to ambient temperature change, battery voltage change, proximity to the body, and even holding the hand on the antenna. Final power input is of the order of 25 to 35 mw, depending on the frequency assignment. Radiated power is about half that value. The transmitter is the same for all three models; the lavalier, hand-held and helmet-adaptation versions.

The microphone is a high-quality, low-impedance dynamic type baffled front and back. Its acoustic response is from 80 to 14,000 cycles. The equipment is type-approved by the FCC for operation on FM frequencies of either 26.25, 33.14, 35.02 or 42.98 megacycles.

The on–off switch is located on the side of the transmitter housing. When the V imprinted on the switch is at a right angle to the long axis of the transmitter case, the power is off. The power is turned on by merely turning the switch 90° to bring the V parallel to the long axis of the case. Being transistorized, no warmup time is required and transmission can begin instantly.

Power is supplied by a Mallory mercury-cell battery, type TR-115R, 6.5 volts. It will deliver power for more than 20 hours and has been selected because of the stability of the power output and the very rapid deterioration at the end of its life. The battery is inserted in the base of the housing and retained by a screw plug. Another circuit design element is provided so that the transistors are protected if the battery is inserted wrong-end first, thus reversing the polarity of the applied voltage. The transmitter won't work unless the battery is inserted properly.

All moving contacts, such as battery power switch, battery contacts, and antenna swivels are plated with gold or other nonoxidizing metals.

A low-impedance dynamic microphone element drives a 2N535-B low-noise transistor connected as a common-emitter amplifier. This in turn feeds the 2N207 modulator connected as an emitter follower. R1, R3 and R4 provide bias and negative feedback to stabilize the gain of the modulator–amplifier stages. Modulation is then introduced directly into the base circuit of the oscillator from the 2N207 emitter follower. Another 2N588 transistor operates as a class-AB1 rf amplifier stage. This is fed from the emitter circuit of the oscillator through isolation components R9 and C7. The final tank or collector circuit of the rf amplifier then feeds the various types of antennas needed for all versions of the Vega-Mike. On the hand-held version the antenna is matched to the transistor circuit by loading coil L3.

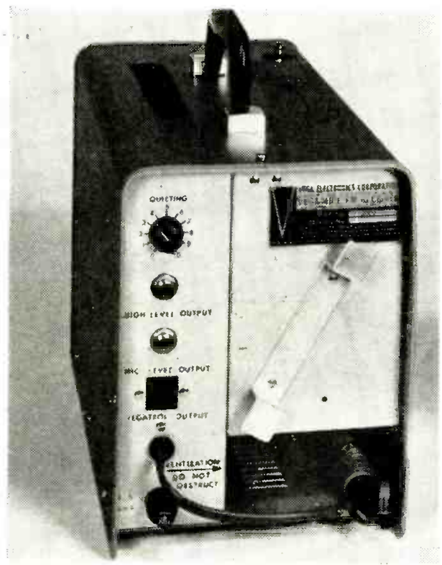
Receiving equipment

The receiver was designed specifically to operate with and as a companion to the transmitter. Its final form was dictated primarily by the necessary physical juxtaposition of its many circuit elements for greater sensitivity and best performance, plus simplicity of system operation.

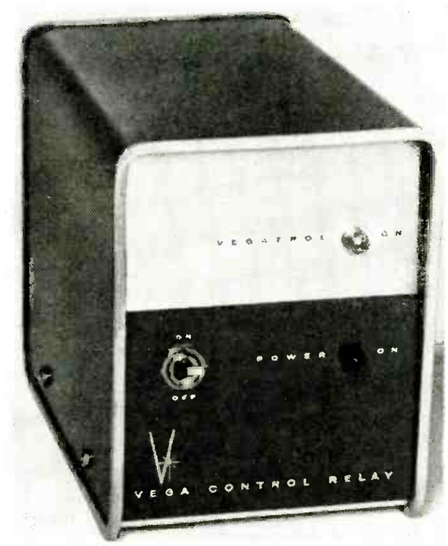
The Vega-Mike receiver (Fig. 2) can

be either portable or rack-mounted. The portable model is 6¾ x 9⅜ x 12⅝ inches in exterior dimensions; the rack-mounted receiver is 19 x 10½ x 11¾ inches. All controls except squelch sensitivity are on the front of the panel. The portable receiver has a carrying handle, a telescoping antenna mounted on a ball swivel and recessed in the case when not in use and a monitor speaker on the left side, or with a carrying handle and a 72-ohm antenna connector for an external antenna as well as the speaker on the left side. The rack-mounted receiver has a connection for a 72-ohm antenna and the monitor speaker mounted in the panel.

The power switch and MONITOR GAIN (volume) control are located on the lower right of the panel. The tuning dial, graduated in megacycles from 25 to 45, has a 3-to-1 reduction drive for precision tuning. At the lower left a spring-return afc and squelch-defeat switch allows fine tuning. The eye at the top of the panel gives visual indication of a correctly tuned carrier signal.



How receiver looks from rear.



The Vegatrol relay control unit.

Generally speaking, the circuit design is conventional. However, the elements of the input circuit are arranged with care, and the antenna loading is optimized. These are items contributing in large measure to the sensitivity.

The receiver utilizes a 25–45-mc continuous-tuning FM band with 10.7 if and afc.

It has a complement of 11 tubes and 2 diodes (two 6BK7, three 6AU6, one 6AB4, one 6FG6/EM84, one 6V4/EZ80, one 6CL6, one 6CG7, one 6U8 and two 1N542). The cascode input amplifier feeds a triode mixer. A small parasitic suppression coil is used to permit maximum gain in the input stage. Automatic gain control is supplied by a negative signal derived from the limiter grid and applied to the input grid through a filter and isolating resistor. The cascode plate is shunt fed through a coil to allow optimum placement of the tuned circuit elements. The Hartley oscillator, designed to have good inherent stability, operates at 10.7 mc above the signal frequency. The oscillator signal is injected into the grid of the mixer through a capacitor. The second half of the oscillator envelope is used as a reactance tube to provide automatic frequency control. The triode mixer provides the 10.7-mc signal to feed the if amplifiers, of which there are two. These stages are followed by a limiter, the grid return of which provides the avc voltage.

The ratio-detector transformer drives a pair of matched semiconductor diodes. All the small components of this ratio detector are encapsulated in a ceramic package. This provides greater uniformity and freedom from radiation and regeneration than individual component construction would provide. A small four-pin socket provides test points at four critical places in the circuit and simplifies alignment.

The afc signal is derived from the ceramic package of the ratio detector. It is filtered and applied to the grid of the reactance tube. The PRESS-TO-TUNE switch on the front panel allows the afc signal to be shorted to ground so that the center of the carrier may be more accurately tuned. This switch also defeats the squelch or quieting circuit so that the faintest signals can be sought. The audio output circuit is a gated amplifier and cathode follower.

Two separate audio circuits are incorporated with connections to the rear of the receiver. One branch, through its own power tube and output transformer, furnishes 1 watt to drive the small (4 x 6-inch) built-in monitor speaker. The monitor level in this circuit is controlled by the gain control on the front panel. A jack, also on the front panel, for headphones, cuts out the speaker when the phone plug is inserted. The main audio output branch features a fixed "line"-level, low-impedance cathode-follower output. This output is 2 volts from a signal deviated ±20 kc.

A fixed pad gives a second or "mike" level output at .004 volt from the same input signal level. Thus the output of the receiver may be used to feed a large variety of standard sound reinforcement amplifiers, tape recorders or radio-station input consoles.

Quieting control

The entire system is equipped with a quieting control (squelch) which eliminates any of the unusual rushing noises heard when the incoming signal is eliminated in an FM system.

The quieting signal (squelch) has an adjustable sensitivity with the control in the rear of the receiver.

Receiver audio response is flat from 20 cycles to 20 kc down 3 db at 14 cycles and 60 kc. The signal-to-noise ratio is better than 60 db for 20-kc deviation, unmodulated carrier.

Since this is an FM system, the strongest radio-frequency signal on the receiving antenna will override and tend to block out all other signals on the same frequency. Therefore, it is not possible to receive signals from two Vega-Mikes simultaneously if they are transmitting on the same frequency. The solution, under these circumstances, is to turn the power off on the one not being used. Thus, two or more transmitters *may* be used on the same frequency if only one is turned on at any one time.

Several transmitters may be used with one receiver if they are on different frequencies, each one being tuned in separately. Any number of receivers may, of course, be tuned to receive the signal of one transmitter at the same time without any problem.

The receiver can be set up in any convenient operating position by plugging it into any convenient power source of 117 volts, 50–60-cycle ac power. The receiver can also be connected to a suitable input of the associated power amplifier, tape recorder, mixer console, etc. Two outputs are available: (a) high level—output approximately 2 volts for feeds to line inputs (bridging), "phono inputs," etc. and (b) low level—similar to usual cabled microphone output (−40 db) to feed mike input on amplifier, mixer or tape recorder. (Unbalanced 150-ohm may be fed to either low- or high-impedance inputs.)

To operate the receiver, the operator merely extends the telescoping antenna whip to its fullest extent and turns the power on by rotating the gain-control knob to the right. This knob also controls the volume level of the built-in monitor speaker or head-phones, when used, but *does not* affect the volume level of the high-level or low-level outputs, which are fixed.

If the receiver is turned on a few minutes before the system is to be used, the operating stability will be somewhat improved.

Tuning the receiver is simple. The operator first notes the frequency allocation as stamped on the microphone nameplate. The Vega-Mike is then held or worn as it would normally be in use and turned on. The main tuning dial on the receiver is rotated to the approximate frequency of the microphone. The

operator then depresses the PRESS-TO-TUNE button and, while rotating the tuning dial, observes the tuning eye at the top of the panel, tuning to smallest closing of the eye pattern. The operator then releases the tuning button and the receiver is locked onto the transmitter FM output signal and the system is ready for use.

Many professional users require a 150-ohm balanced output from the receiver instead of the unbalanced output normally supplied. The system can easily be modified in the field by adding a few parts: one transformer (UTC A-24), two connectors (tip ring, sleeve phone jack or Cannon type XL), two resistors of 3,300 ohms, and one resistor of 150 ohms.

The antennas

The antenna for the hand-held models is a telescoping whip mounted on a swivel at the base of the housing. This antenna should be extended to its fullest length (22¾ inches) for the most efficient operation. Under certain conditions it may be used in a telescoped condition (5¾ inches).

The accessory helmet is designed to accommodate the hand-held antenna, which is removed from the hand-held model by unscrewing the antenna, attaching it to the helmet top and connecting the helmet cable to the hand-held mike where the antenna was removed. This accessory extends the range of the system as the antenna is farther away from the body.

The antenna for the lavalier model is a two-element system comprised of conducting cords attached at one end to the transmitter and having a hook on the other end to engage an eye on the case. One element is used to support the Vega-Mike about the neck, lavalier-fashion; the other may be coiled and placed in the pocket or in the shirt front for short-range transmission (25 to 50 feet). For greater ranges (up to several hundred feet), the longer element should be looped about the waist and hooked to itself with the hook on the cord end.

The human body absorbs some of the radiated energy from the antenna, and the two-element system yields the necessary increase in radiation efficiency to obtain the optimum transmission range.

The energy absorbed by the body is harmless, as it is only a few thousandths of a watt. Removal of either element from the lavalier model will result not only in lower efficiency but, more important, will shift the radiation from its assigned frequency, thus causing the device to be operated illegally.

Use in automobiles

The Vega-Mike can be used from automobiles both for communications radio, such as police radio, and for the actuation of auxiliary systems through the use of the Vegatrol*. It is interesting to note, that, since the rf emitted from the system is FM, the interference with the receiver from the ignition system is minimized, if even discernible.

Any mobile power source capable of delivering 65 watts at 117 volts, 50–60 cycles, may be used to power the receiver. The receiver may be placed on the seat with the antenna pulled out and rotated to project out of the window. Better results will be obtained if the receiver is placed on the hood or on top of the car outside the metal body.

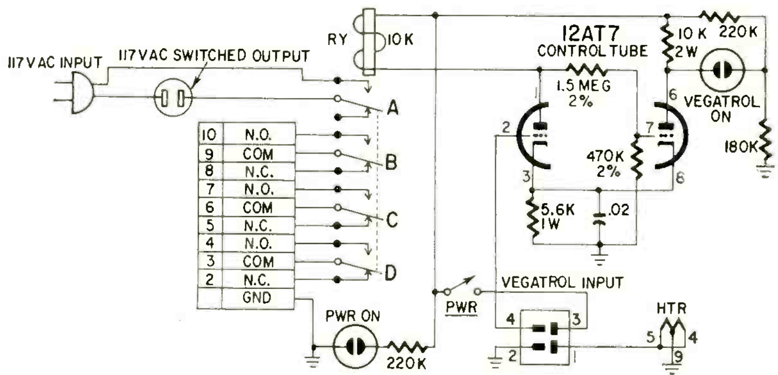


Fig. 3—The Vegatrol greatly extends the system's usefulness.

The Vegatrol

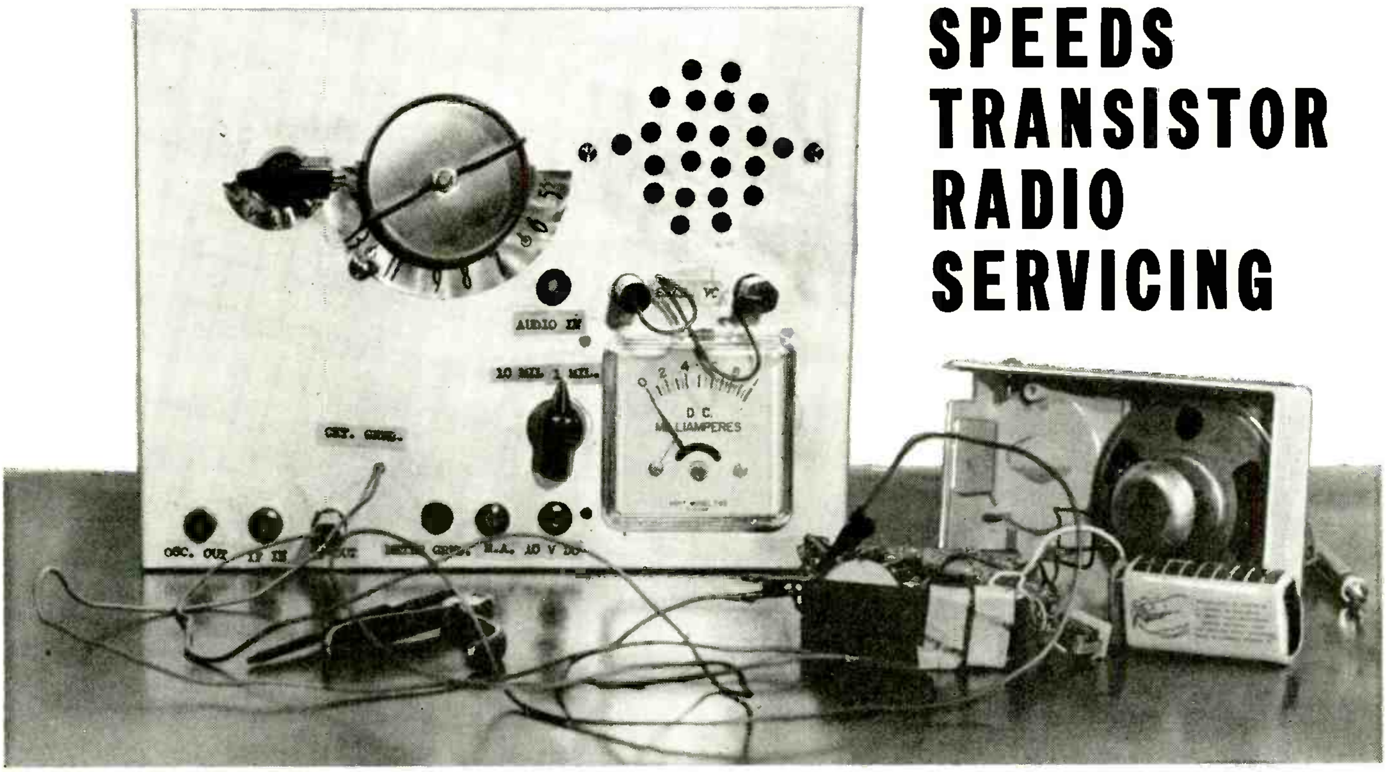
A unique accessory of the system is the Vegatrol, basically a carrier-operated, four-pole double-throw relay (Fig. 3). With this accessory it is possible for an operator to start and stop a variety of accessory instruments or related items by remote control. When the transmitter and receiver are properly tuned and the quieting control (squelch) is set properly, the relay in the Vegatrol accessory can be energized by turning the Vega-Mike control to on and de-energized by turning to off.

The Vega-Mike can thus control such external circuits as cuing lights (for example, "On the Air"), a variety of tape recorders (starting, placing in recording mode and stopping), and closing or opening other relay control circuits such as remote-controlled radio transmitters, floodlights and the like.

Vega-Mike's unique design and operating characteristics offer a wide variety of advantages to those desiring a high-quality wireless microphone with a range of up to ½ mile. It is a system that not only performs as a wireless mike but, with the addition of the Vegatrol relay, can function as a wireless remote control as well. END

Circuit substitution

The old reliable method, with a few new wrinkles, can solve your transistor service problems



SPEEDS TRANSISTOR RADIO SERVICING

By C. J. BORLAUG *

CIRCUIT substitution is by no means a revolutionary new way of servicing electronic equipment. It has been used with great success for years. The old Chanalyst and Analyst that have been on the shelf in the back room for many years prove that. Unused and gathering dust now, they were once standard pieces of equipment in the well equipped radio service shop.

We have since learned so much about the simple four- or five-tube AM radio circuit that we can service radios by tapping grids and arcing plates and screens (on the really tough radio problem we might even use a volt-meter!).

But we are not familiar with the transistor radio. Maybe we should dust off the old Chanalyst and put it back in service! Actually, it will do the job, but if we are to be completely successful with this method of servicing, we will have to substitute transistor circuitry for our circuit checker, then use some of the same old methods.

The reasons for *not* using vacuum-tube equipment for circuit substitution lie in the difference in voltages, circuit impedances and signal levels between tube and transistor circuits. Your investment in a transistor circuit-substitution checker would be a transistor radio chassis (Fig. 1). A suggested panel layout is shown in Fig. 2; the optional meter circuit is shown in Fig. 3. Any good operating transistor radio chassis will do the job. You will find a chassis with a separate oscillator transistor a definite advantage over one using an autodyne converter. The oscillator output can be used to better advantage in checking inoperative oscillator circuits.

Transistors are essentially current-operated devices and the best way to service a transistor circuit is to check current. An accurate 1-ma and 10-ma meter is very convenient. The meter circuit could easily be expanded to other ranges of voltage and current by adding shunt and series resistance and changing the switching arrangement. The meter is calibrated with batteries, a variable resistor and a known accurate meter for comparison.

To convert the transistor radio chassis to a circuit-substitution checker, it is necessary to couple in and out of the circuits with external jacks as shown in Fig. 1. Circuit ground would be the chassis ground of the radio.

Making a schematic work

If we are going to service an inoperative transistor radio, the diagram of the inoperative set would be roughly the same as that of the substitution checker. To eliminate an additional diagram we

(*Continued on page* 88)

*District service manager, Sylvania Home Electronics Corp.

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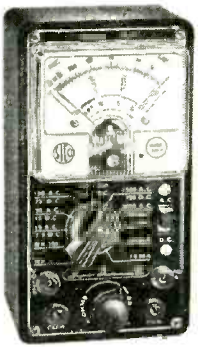

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- Housed in round-cornered, molded case.

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6 D.C. VOLTAGE RANGES: 0-7.5/15/75/150/750/1500 Volts.

2 RESISTANCE RANGES: 0-10,000 Ohms, 0-1 Megohm.

3 D.C. CURRENT RANGES: 0-15/150 Ma., 0-1.5 Amps.

3 DECIBEL RANGES: —6 db to + 18 db, + 14 db to + 38 db, + 34 db to + 58 db.

The Model 770-A comes complete with test leads and operating instructions. **Price is $15.85. Terms: $3.85 after 10 day trial then $4.00 monthly for 3 months.**

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SUPER-METER

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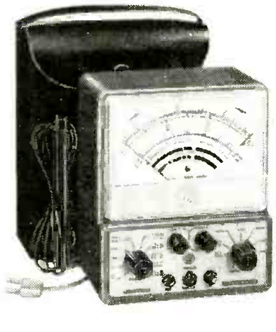

SPECIFICATIONS:

D.C. VOLTS: 0 to 7.5/15/75/150/750/1,500.
A.C. VOLTS: 0 to 15/30/150/300/1,500/3,000.
D.C. CURRENT: 0 to 1.5/15/150 Ma. 0 to 1.5/15 Amperes.
RESISTANCE: 0 to 1,000/100,000 Ohms. 0 to 10 Megohms.
CAPACITY: .001 to 1 Mfd. 1 to 50 Mfd.
REACTANCE: 50 to 2,500 Ohms, 2,500 Ohms to 2.5 Megohms.
INDUCTANCE: .15 to 7 Henries. 7 to 7,000 Henries.
DECIBELS: —6 to + 18, + 14 to + 38, + 34 to + 58.

The following components are all tested for **QUALITY** at appropriate test potentials. Two separate **BAD-GOOD** scales on the meter are used for direct readings.
All Electrolytic Condensers from 1 MFD to 1000 MFD.
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- **AC VOLTS (RMS)**—0 to 3/15/75/150/300/750/1500 volts.
- **AC VOLTS (Peak to Peak)**—0 to 8/40/200/400/800/2000 volts.
- **ELECTRONIC OHMMETER**—0 to 1000 ohms/10,000 ohms/100,000 ohms/1 megohm/10 megohms/100 megohms/1,000 megohms.
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- **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.

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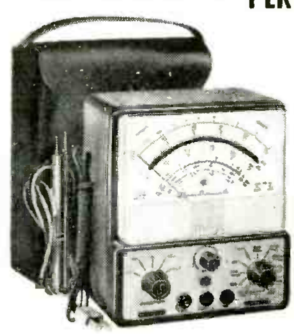

NOTE: The line cord is used only for capacity measurements. Resistance ranges operate on self-contained batteries.

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.

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. **Price is $42.50. Terms: $12.50 after 10 day trial then $6.00 monthly for 5 months.**

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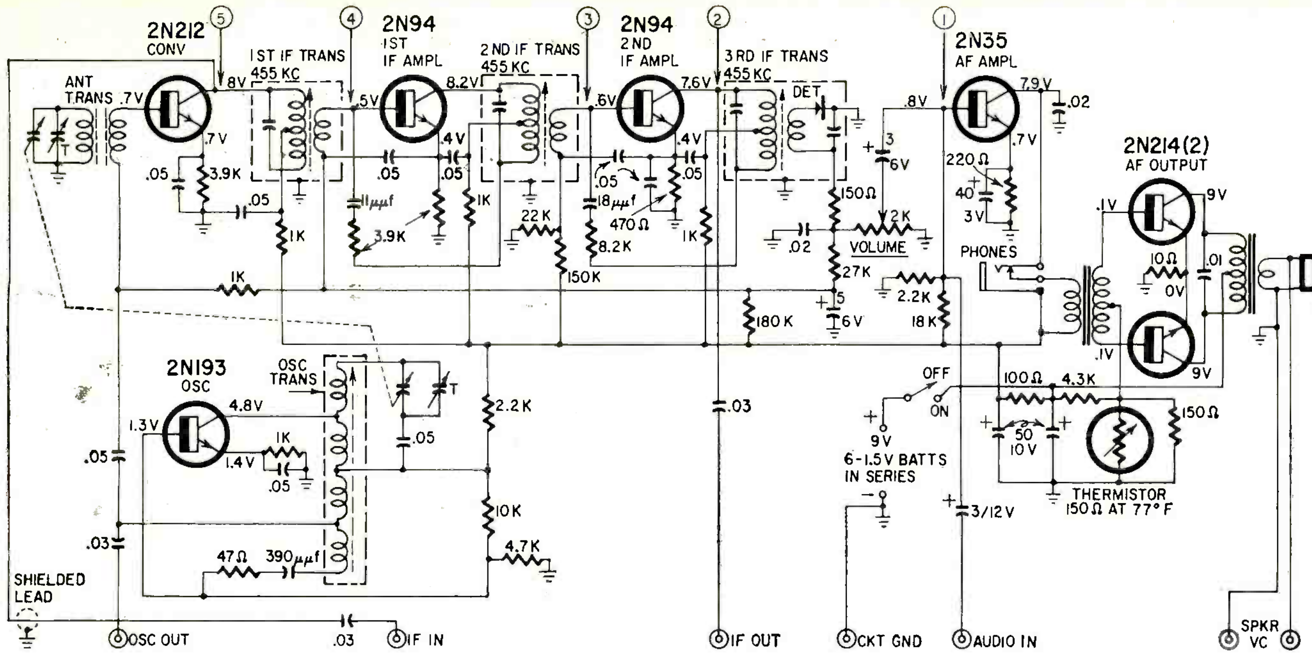


Fig. 1—The substitution checker is a good transistor receiver, with jacks brought out as indicated.

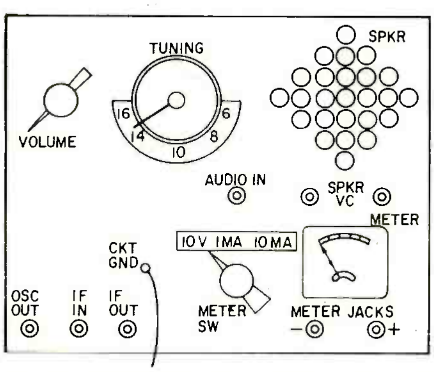


Fig. 2—Suggested front-panel layout for checker, including a meter.

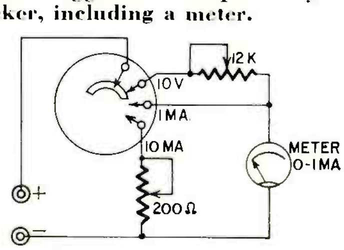


Fig. 3—Circuit for the meter, if used.

(*Continued from page* 85)

will use Fig. 1 again, this time to indicate the set being serviced. The test points indicated by circled numbers 1 through 5 along the top of the schematic will indicate connections made into the inoperative set.

Starting with the output section of our receiver, we can check the speaker voice coil by taking the output from SPKR VC and feed it directly to the speaker terminals. The SPKR VC jacks have another good use. If we wish to use the audio section of our substitution checker to service the audio section in the radio, we can short across the voice coil jacks and eliminate the sound from the checker. *Do not open the voice-coil circuit of a transistor radio.* The output transistors and circuit components can be damaged if the load is removed from the output transformer and the radio operated.

A two-way check can be made in any one of the circuits. We can feed audio from the AUDIO IN jack to test point 1 of the inoperative set and listen to the results from either speaker by turning either set on and off station.

We can perform the same check by connecting test point 2 of the set we are repairing to the IF OUT jack. It provides an amplified 455-kc output that can be coupled to test points 3 and 4 to determine the operation of the if's in the set. A definite increase in the sound should be noted when feeding 455-kc to test points 2, 3 and 4.

At test point 4 we can make a sensitivity as well as circuit operating check on the converter circuit in the inoperative set. Connecting point 4 to the IF IN jack, we can feed the output of the converter circuit into our circuit analyzer and listen to the output. As we tune across the dial on the set we are checking, the output should be normal.

If only the oscillator section of the radio we are checking is defective, we can bring the set back to life by tuning both sets to the same station and feeding the OSC OUT to test point 5.

Transistor fundamentals

For a brief review on transistor theory refer to Fig. 4. An n-p-n transistor is used for the example instead of the more common p-n-p, because the technician is more at home with the electron than with the "hole" (the little electron that isn't there). Substitute holes for electrons, and the discussion applies to p-n-p transistors.

In the transistor, the left section of the circuit is biased for maximum current (low resistance); the right side is connected for minimum current (high resistance).

Resistance in the emitter-to-base circuit could be about 500 ohms and in the collector-to-base about 500,000 ohms. The n-type germanium in the emitter section of the transistor contains a surplus of electrons. These surplus electrons are accelerated toward the base when the negative voltage is

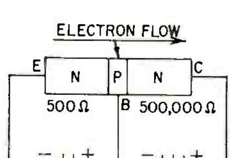
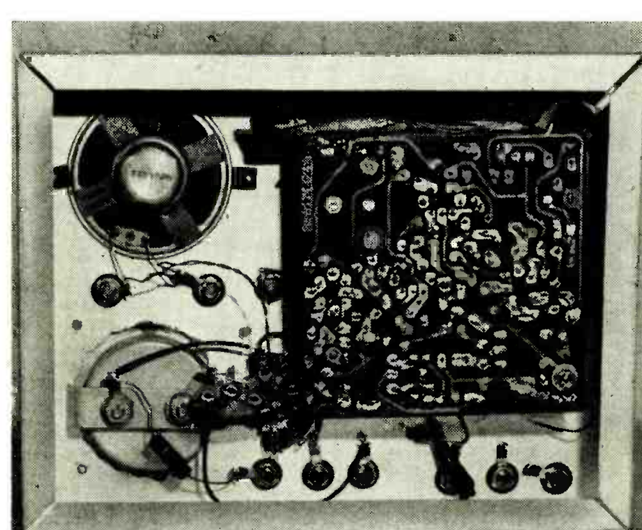


Fig. 4 — Basic diagram, n-p-n transistor.



Inside view of the substitutor.

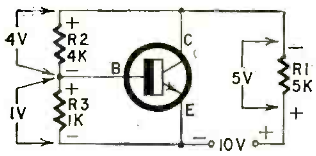


Fig. 5—A circuit using one battery.

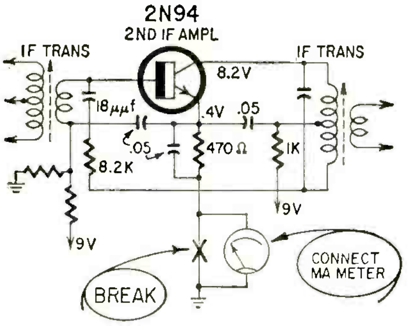


Fig. 6—How bias-current check is made.

applied to the emitter. The normal path for this current would be back to the positive terminal of the battery through the base connection. For several reasons —one that the base section is physically very thin, another that as soon as the electrons approach the base region they are attracted toward the collector because of the positive voltage applied to it—most of these electrons cross the base section and continue on to the collector.

If 100 electrons left the emitter area, approximately 95 of them would reach the collector, with only 5 returning through the base connection. Referring again to the resistance of the emitter and collector, we see that we have only a 5% current loss but a resistance gain of 500,000/500 which gives us a voltage gain of 0.95 × 500,000/500, or 950. Before we can get this voltage gain, it is necessary to have bias current flowing in the emitter-to-base portion of the transistor.

Refer again to the bias applied in Fig. 4 and a common method of obtaining bias for a common-emitter amplifier shown in Fig. 5.

The highest positive potential is applied to the collector as in Fig. 5. Let us assume that we have 10 volts available from the battery and the bias bleeder is made up of: R1—5,000 ohms, R2—4,000 ohms, R3—1,000 ohms. Voltage drops across these resistors, without considering the internal resistance of the transistor, would be R1—5 volts, R2—4 volts and R3—1 volt. This places the collector 4 volts positive with respect to base, and the base 1 volt positive with respect to the emitter, and we have satisfied the bias needs with only one voltage source.

A typical example

To apply this current-check method of servicing, let us assume that we have injected a 455-kc signal from the IF OUT jack of our circuit checker into the collector and base of the if stage in Fig. 6. The results were the same with

(*Continued on page* 94)

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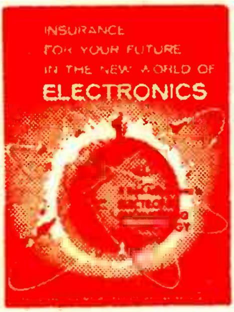

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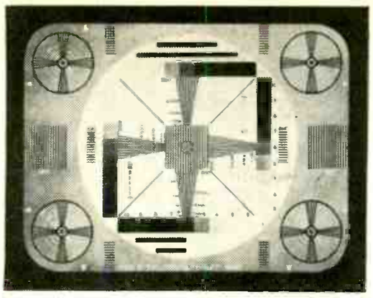


TV TIPS FROM TRIAD

"What gives with the schnorkel?", asked Bill as he examined the receiver on the bench. A four inch line of vent tubing angled up crazily and appeared to originate in the lower portion of the cabinet. A slight whirring sound suggested some kind of motor operating in the nether recesses.

"You are looking at the second power transformer I've installed in that set," answered Joe. "With everything normal it still smells after running for a couple of hours with the cabinet buttoned up. I thought the little fan on the phono motor might move enough air if I had the vent to direct it out of the cabinet. Well, it seems to help, but I can't put the back on, and you can hear the motor when the room is quiet. Looks like I need a power transformer that will give more watts without being one iota larger."

Neither Bill nor Joe had noticed Al, the parts salesman, enter, which was unusual, because Al was usually very noticeable, and today he was still exhibiting effects of the weekly sales meeting brainwashing.

"Just happen to have exactly what you want," said Al, "I looked over the shipment of new Triad power transformers with Triple X Steel,"—he shifted smoothly into high gear—" and these transformers use the same size iron, so they fit, but because they're made of fine grade audio steel, we can design them to operate at a higher flux density and in many cases do not need heat dissipating fins to maintain safe temperatures—"

"Send me one," said Joe.

"—and since the efficiency of the steel is higher we do not require as large a stack, so our copper losses are lower—"

"I'm sold," said Joe.

"—and by utilizing a simple type of mounting bracket you can adapt the new series, even where the original had an unusual configuration—Oh, you'll take one? So soon? What's the matter? Don't want to learn anything?"

* * *

MORAL: Sometimes a little "extra" in a replacement part will help make up for the effects of ageing in the receivers you service. If you would like to see for yourself how "Triple X" differs from the old "one grade better than stovepipe iron" drop us a line and we will be pleased to send you a sample. We will also include information on the new "Triple X" units. Write to **Triad Transformer Corporation**, 4055 Redwood Ave., Venice, California.

(*Continued from page* 89)

the signal applied to the base or collector, indicating no gain through the transistor. The first check would be to measure the voltage on the collector.

The next step would be to determine the correct bias on the transistor. The schematic indicates 0.4-volt bias at the emitter. This voltage is developed across the bias resistor (470 ohms) so that the bias current must be 0.4/470, almost 1 ma. A bias current check is always more accurate than a voltage check.

With the meter still connected, we can also check for leakage in the transistor by shorting the unit's emitter to its base. If the current does not drop to almost zero, we can be sure the transistor has internal leakage. This check is important in miniature radios where current must be kept at a minimum to insure long battery life.

Bias current is also important in checking the push-pull output circuit. We can easily determine if the output transistors are matched by breaking the emitter connection on each transistor and checking to see if the current in each emitter is approximately equal.

To match transistors in a push-pull circuit, note the emitter bias current in one transistor and substitute transistors in the opposite socket until equal bias current is obtained.

If the radio has solder-in transistors, solder a socket in place temporarily when trying new transistors. Your stock of new transistors will remain in good condition if you avoid soldering them in for testing. END

"Take this tranquilizer and lie down and relax. I'll try to get your set fixed in time for you to see 'Gunsmoke'."

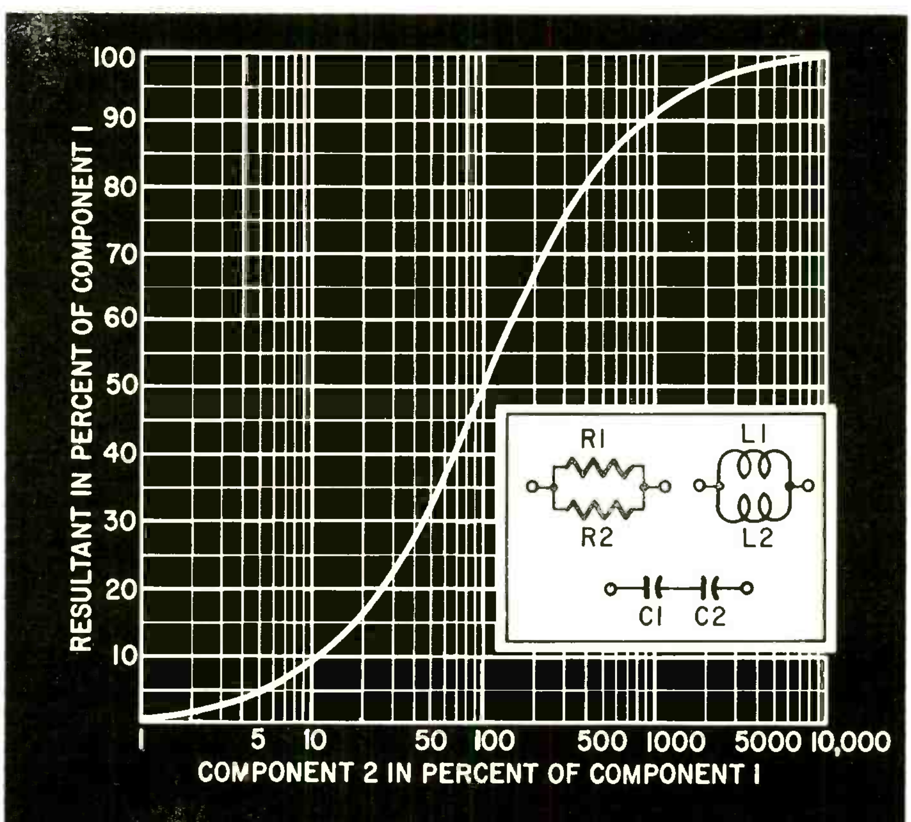
SINGLE-CURVE CHART

By E. T. THIERSCH

THIS chart solves parallel resistor or inductor, (provided their magnetic fields do not interact) and series capacitor problems. Both scales are in percentages of component one (R1, C1 or L1, see chart). The horizontal scale gives component 2's percentage of component 1; the vertical scale gives resultant or total R, C or L.

Example: Determine total R of a 200-ohm resistor (R1) and an 800-ohm resistor (R2) in parallel. Since 800 is 400% of 200, follow the 400 line from the bottom of the chart until it hits the curve. From there go to the left and read the answer as 80% of R1, or 160 ohms.

Another example: What capacitance (C2) is needed in series with a 500-$\mu\mu$f capacitor (C1) to make a total of 300 $\mu\mu$f. Since 300 is 60% of 500, go to the right from 60, down from the intersection and read the answer as 150. C2 should be 150% of C1, or 750 $\mu\mu$f. END



new PRODUCTS

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TRANSISTORIZED DEPTH FINDER, *model DF-90,* kit or factory wired. Operates from boat's power source or batteries. Oversize reading scale cali-

brated in 1-foot intervals with 0–120-foot range. Barium titanite hermetically sealed transducer. Gymbal mount can be used as carrying handle. All-aluminum. 9 pounds. 7 x 5¾ x 6 inches.—**PACO Electronics Co. Inc.,** 70-31 84 St., Glendale 27, N.Y.

TRANSCEIVER (120 watts CW), *G-76.* Covers 6 amateur bands, 3.5, 7, 14, 21 and 28 and 50 mc. 1 foot wide, 6 inches high. Fits under dash of vehicle

in mobile applications. 117-volt ac power supply including loudspeaker; transistor 12-volt dc supply for mobile applications.—**Gonset Div.,** Young Spring & Wire Corp., 801 S. Main St., Burbank, Calif.

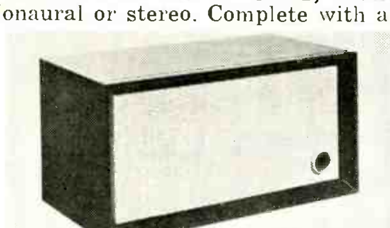
CW TRANSMITTER, model 723. Kit or factory wired and tested. 60 watts. 1-knob bandswitch covering 80, 40, 20, 15 and 10 meters. 1-knob off–standby–tune, transmit switch. Panel meter switches into grid or plate circuit of final. Modulator accessory socket for

modulator and emergency power input, antenna relay, vfo power takeoff. Copper-plated chassis. 6 x 8½ x 9 inches.—**EICO (Electronic Instrument Co. Inc.),** 33-00 Northern Blvd., Long Island City 1, N. Y.

CALIBRATION STANDARD, *model 381,* professional. For recording channel

calibration, radio stations and record evaluation. High-impedance model, 47,-000-100,000 ohms. Low-impedance, 250 or 500/600 ohms. Response flat within 1 db from 20 to 10,000 cycles; within 2 db from 10 kc to 17 kc. 5-mv output per channel. 35-db channel separation.—**Pickering & Co. Inc.,** Sunnyside Blvd., Plainview, New York.

ADD-ON REVERB UNIT, *RVB-1.* Monaural or stereo. Complete with am-



plifier and speaker. Connects to speaker line. Interconnecting cables. Acousti-control knob. 20 x 10 x 10¼ inches.—**Utah Radio & Electronic Corp.,** 1124 E. Franklin St., Huntington, Ind.

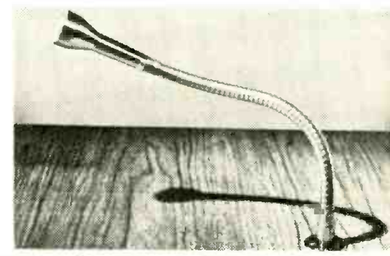
REVERBERATION UNIT, *KN-701.* Short time delay in audio signal simu-

lates cathedral or stadium acoustics. Plugs into hi-fi system using separate preamp and amplifier.—**Allied Radio Corp.,** 100 N. Western Ave., Chicago 80, Ill.

FM TUNER KIT, *KT-650.* Variable afc control. Electronic bar tuning indi-

cator tube. Flywheel weighted tuning. Front-panel tuner level control. Factory prealigned. Printed-circuit boards. Sensitivity; 2-μv for 30-db quieting. Frequency response: ±½ db from 15 to 35,000 cycles. 14 x 5⅛ x 11 inches.—**Lafayette Radio Electronics Corp.,** 165-08 Liberty Ave., Jamaica 33, N. Y.

MICROPHONE, *model CM-17 Flex-Mike.* Ceramic transducer cushion-mounted in rubber. Feeds from 50 to over 11,000 cycles at —56-db sensitivity. Controlled presence peak in mid-range. One-piece, die-cast metal mike case on



13-inch flexible stand terminating in removable mounting plate. Shielded electrical cable.—**Sonotone Corp.,** Elmsford, N. Y.

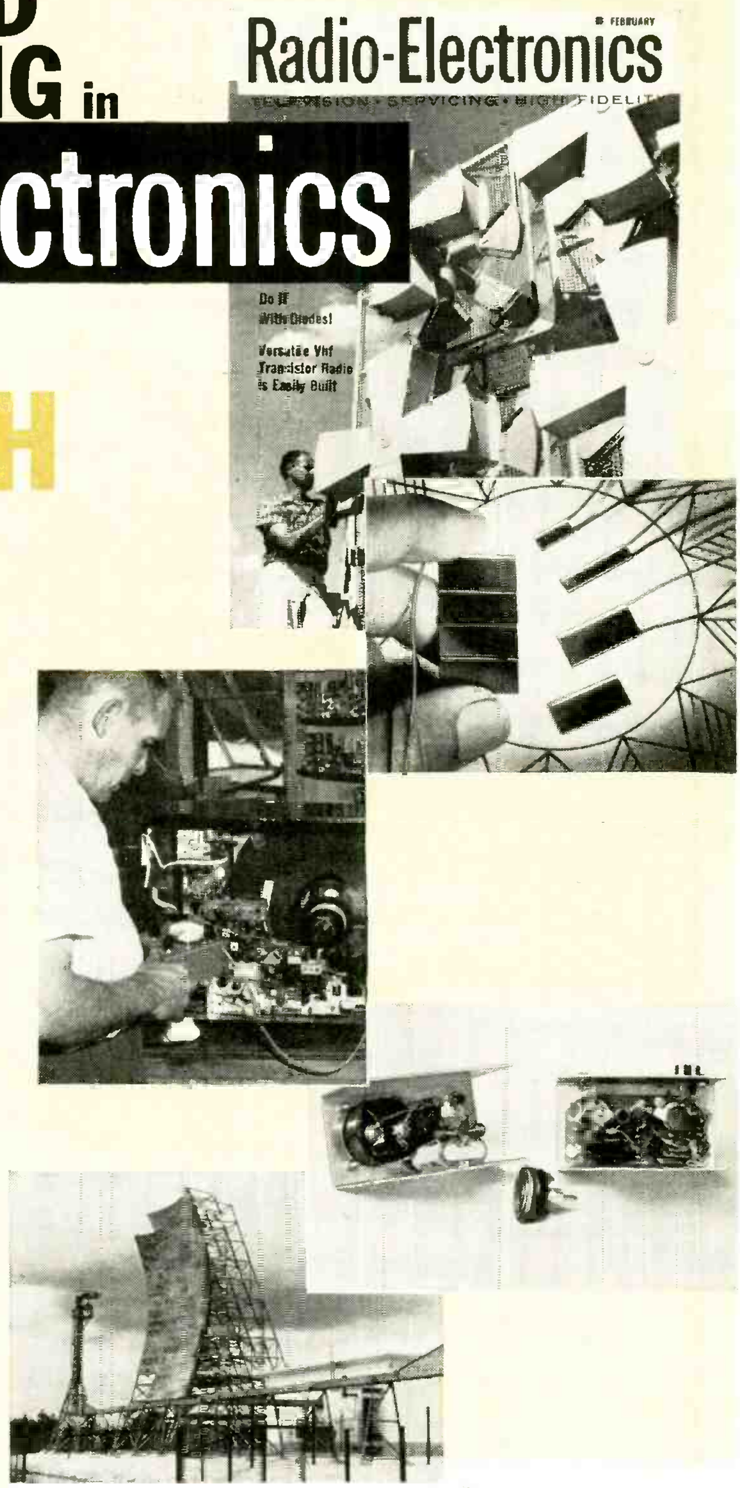
PATIO SPEAKER, *CA-60-P.* Two 6-inch woofers. Cone type tweeter with built-in crossover. Frequency response: 70 to 17,000 cycles. Built-in carrying handle and 25-foot cable. Independent volume-control knob. Detachable legs. 9 x 10 x 18 inches.—**Rek-O-Kut Co. Inc.,** 38-19 108th St., Corona 68, N. Y.

AMPLIFIER KIT, 72 watts, *LK-72.* IHFM power band extending down to 20

cycles. Less than 0.4% total harmonic distortion. Amplifier hum level better than 70-db below full power output. Four 7951 output tubes, two 7199's, four 12AX7's and a 5AR4. 12-pound transformers. 15½ x 5¼ x 13¼ inches.—**H. H. Scott Inc.,** Dept. P, 111 Powdermill Rd., Maynard, Mass.

80-WATT AMPLIFIER, *Citation V.* Kit and factory wired. 40 watts rms per channel with 95-watt peaks at less than 0.5% distortion. Rated power at extreme ends of frequency range. Two 7581's per channel, bias meter, 4 silicon diodes,

RECOMMENDED READING in Radio-Electronics NEXT MONTH



Do It With Diodes!

Never underestimate the power of the diode. You're missing plenty if you think this versatile and inexpensive little giant is nothing more than a rectifier or detector. Have you ever used it as a bi-lateral conductor, a switch, amplifier, voltage regulator? You can increase its applications immeasurably if you do. This article tells you how.

Build This In-Cabinet Horizontal Sweep Analyzer

How much time have you wasted and what pains have you gone to to get at the horizontal sweep circuit? Say goodbye to all that. This plug-in unit has many of the troubleshooting capabilities of specialized horizontal sweep test instruments. And it's fun to build.

Versatile SW Transistor Radio

Uses only 3 transistors—and it's a cinch to build. But look what it can do. Pulls in Citizens Band, 11-meter broadcast, and the 10-meter ham band. Add on a relay unit and it becomes a radio control or paging receiver.

Klystrons For Outer Space

New uses for a not so new type tube! This article tells how klystrons work and what they can do. Very worthwhile reading since klystrons are becoming more and more familiar as communications and industry move more and more towards microwaves—whether for satellite communications or short-range systems.

Plus many, many other top-flight features.

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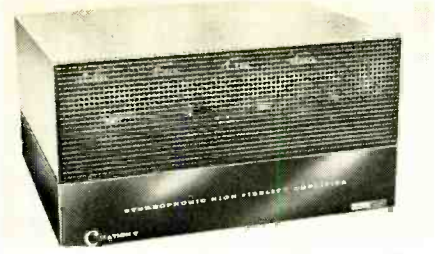
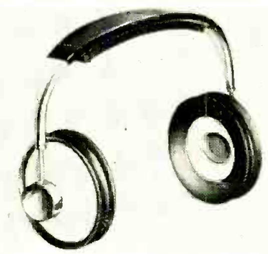
Radio-Electronics 154 West 14th Street, New York 11, N. Y.



heavy-duty electrolytics.—**Harman-Kardon, Inc.,** Ames Court, Plainview, N. Y.

STEREO HEADSET, *KN-840.* Electrodynamic driver and hyperbolic baffle with 20–16,000-cycle frequency response



in each earphone. Designed to match low-impedance outputs. — **Allied Radio Corp.**—100 N. Western Ave., Chicago.

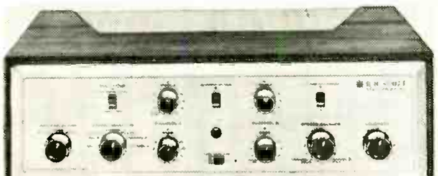
STEREO AMPLIFIER, *AA-100* kit, *WAA-100* wired. 25 watts per channel.

6 pairs of inputs, including provision for monophonic magnetic record cartridge. Mixed-channel speaker output.—**Heath Co.,** Benton Harbor, Mich.

STEREO FM–AM TUNER, *202-R.* 6 if stages. 0.5-μv sensitivity for 20-db quieting with a 72-ohm antenna. Electronic switch muting functions during

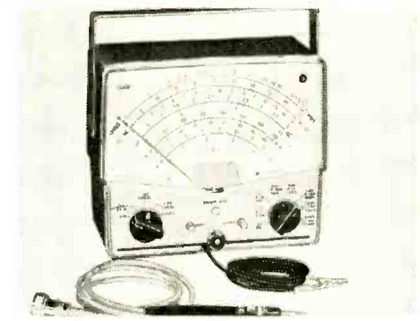
multiplex operation. Wide-band design. 5 limiters for capture ratio of 1.5 db. 16 tubes, 4 diodes, rectifier. 90-watt power consumption. 15⅛ x 4 13/16 x 12¾ inches.—**Fisher Radio Corp.,** 21-21 44th Drive, Long Island City 1, N. Y.

STEREO AMPLIFIER *222B.* 15 watts per channel. Tape monitoring facilities. Separate tone controls each



channel. Tape-head and electronic-organ inputs. Oversize 20-watt transformers. Aluminum chassis.—**H. H. Scott, Inc.,** Dept. P, 111 Powdermill Rd., Maynard, Mass.

VACUUM TUBE VOLTMETER, *model 850.* Resistance ranges to 1,000 megohms. 0.5-volt low range on dc. 1,500-volt high range. Frequency range 15 cycles to 3 mc. Minimum ac imped-

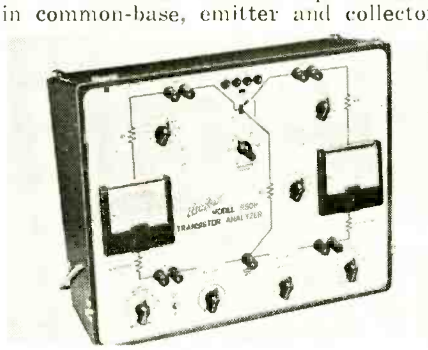


ance 0.83 megohm. 7 ac ranges cover 0 to 1,500 volts. Peak-to-peak ac to 4,000 volts.—**Triplett Electrical Instrument Co.,** Harmon Road, Bluffton, Ohio.

IN-CIRCUIT RECTIFIER TESTER, *model 600.* Checks power rectifiers in

circuit for quality, shorts, fading, opens, arcing and life expectancy.—**Mercury Electronics Corp.,** 77 Searing Ave., Mineola, N. Y.

TRANSISTOR ANALYZER, *model 850-P.* Measures transistor parameters in common-base, emitter and collector

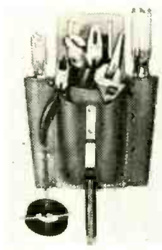


configurations. For n-p-n and p-n-p transistors. Circuit configuration in use shown on front panel.—**Hickok Electrical Instrument Co.,** 10531 Dupont Ave., Cleveland 8, Ohio.

TELEVISION ANALYST, *model 1076,* pinpoints TV circuit troubles. Rf and if, video test pattern, composite sync, frequency-modulated audio, color patterns, horizontal and vertical plate drive, B-boost indicator and high-voltage transformer test signals on front panel. Includes switch type tuner, nega-

tive bias supply, agc keying pulse and picture tube modulation.—**B&K Manufacturing Co.,** 1801 W. Belle Plaine, Chicago 13, Ill.

TOOL HIP HOLSTER. Electric tape holder, knife clip and 5 tool pockets.

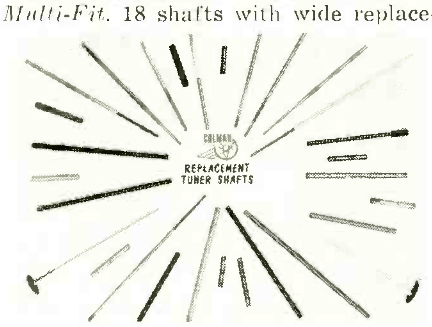


Natural cowhide.—**Xcelite Inc.,** Orchard Park, N. Y.

ULTRA-MINIATURE JACK, *TR-2A.* 1/10th standard jack size. Accepts phone plugs for use on transistor radios and other miniaturized applications. 2-

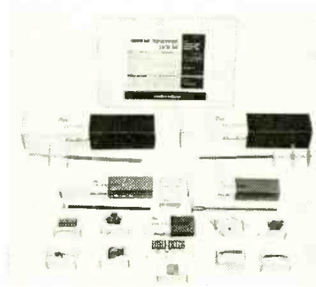
conductor single-closed-circuit design but usable as open-circuit jack.—**Switchcraft Inc.,** 5555 N. Elston Ave., Chicago 30, Ill.

TUNER-SHAFT ASSORTMENT, *Multi-Fit.* 18 shafts with wide replace-



ment application. Fit most popular tuners. — **Colman Electronic Products Inc.,** P.O. Box 2965, Amarillo, Tex.

REPLACEMENT TUNER PARTS. *Kit model 31T3890* contains popular Standard Coil mechanical and electrical



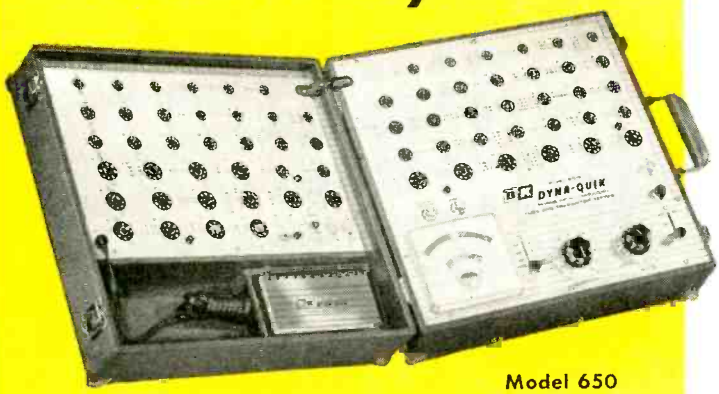
parts that include springs, detent and roller assemblies, if alignment tool and other parts for tuners manufactured between 1947 and 1957.—**Standard Kollsman Industries Inc.,** Melrose Park, Ill.

PACKAGED ELECTRONIC CIRCUITS, *PC-371* through *PC-404.* 3 vertical-integrator, 2 tone-control, 1 video- and 3 audio-coupling, phase-comparator, flip-flop, 2 yoke-balancing networks included.—**Centralab,** 900 E. Keefe Ave., Milwaukee 1, Wis. END

All specifications from manufacturers' data.

MAKE COMPLETE TUBE TEST

FASTER, MORE ACCURATELY



Model 650
DYNA-QUIK

Simply by checking all the tubes in the set, and testing each tube completely the Dynamic Mutual Conductance way, you can

SELL MORE TUBES PER CALL
INCREASE YOUR INCOME*
SATISFY MORE CUSTOMERS
SAVE COSTLY CALL-BACKS
INSURE YOUR REPUTATION

*Actual experience shows TV servicemen average 2 extra tube sales per call. 5 calls per day in 5 days means as much as $50.00 more income per week.

Widely Used and Preferred by Thousands of Professional Servicemen Everywhere

B&K

Model 650 *Dynamic Mutual Conductance* PROFESSIONAL TUBE & TRANSISTOR TESTER

With multi-sockets and other B&K features, you can accurately quick-check most of the tubes widely used in television receivers, plus popular home and portable radio tubes. Includes spare sockets for new popular types. Tests each section of multiple tubes separately. Checks for Gm and all shorts. Makes highly sensitive grid emission and gas test. Checks for leakage and life. Shows true tube condition on "Good-Bad" scale and in micromhos. B&K patented bridge circuit. Also tests transistors.

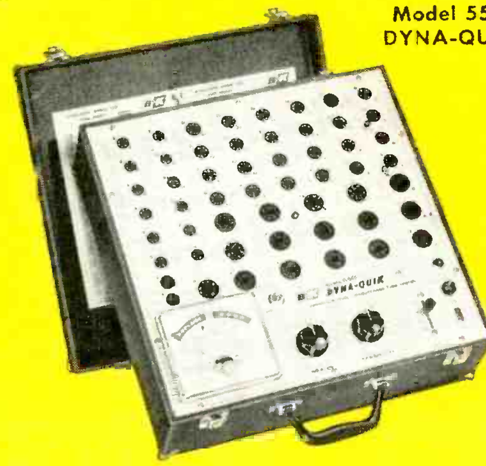
Net, **$179.95**

Model 550 *Dynamic Mutual Conductance* PROFESSIONAL TUBE TESTER

Real professional instrument for the limited budget. Provides 52 sockets to quick-check most of the TV and radio tubes usually encountered in everyday service work. Tests each section of dual-section tubes separately. Checks for Gm and all shorts. Makes highly sensitive grid emission, gas, and leakage test. Shows tube condition on "Good-Bad" scale and in micromhos. B&K patented bridge circuit.

Net, **$119.95**

Model 550
DYNA-QUIK

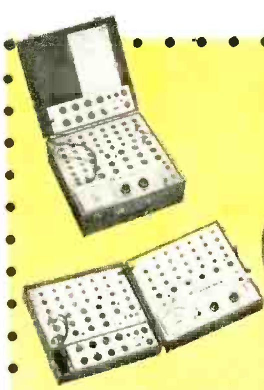


NEW Model 610 ACCESSORY TEST PANEL

Increases Capacity of Model 500, 550, or 650 Dyna-Quik

TO TEST BOTH OLD AND NEW TUBE TYPES

including New TV Types, Thyratrons, Voltage Regulators, Auto Radio Hybrid Tubes, Battery Radio Tubes, European Hi-Fi Tubes, and most Industrial Types



Shows how easily the new "610" fits into Models 550 and 650

Comes in 3 types:

Model 610-500 for use with Model 500 Tube Tester
Model 610-550 for use with Model 550 Tube Tester
Model 610-650 for use with Model 650 Tube Tester

Simply by adding Model 610 to the Dyna-Quik, you have all the advantages of fast multi-socket testing, plus freedom from obsolescence. Enables you to test all present plus future TV, radio, and other tube types. Measures genuine dynamic mutual conductance.

Net, **$49.95**

NEW TUBE INFORMATION SERVICE

Get test data on new tubes even before you encounter them in the field. Subscribe now to *New Tube Information Service* for owners of B&K tube testers. Issued every 3 months, at $2.50 per year.

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Canada: Atlas Radio Corp., 50 Wingold, Toronto 19, Ont.
Export: Empire Exporters, 277 Broadway, New York 7, U.S.A.

TECHNICIANS' ASSOCIATIONS

of the United States and Canada

THE following master list of electronic service technician's associations includes all such US and Canadian groups about which we have obtained information. Each listing has been checked and each group listed has been contacted to verify its address. We have attempted to list every association, but may have missed one or two along the way. Please let us know if your group has been left out.

Each state's listing is headed by Federations of service associations active in that state. The groups listed below do not necessarily belong to the federations listed above them, of course.

ARIZONA

Better Electronic Service Technicians
P. O. Box 1284
Phoenix
David Gordon, Executive Secretary

Better Electronic Service Technicians of Tucson
4215 E. 22 St.
Tucson
Don Wallace, Secretary

ARKANSAS

Television Service Association of America
P. O. Box 542
North Little Rock
W. D. Todd, Secretary

CALIFORNIA

California State Electronics Association
1111 Weldon Ave.
Fresno 4
James F. Wakefield, Executive Director

Radio Technicians Association of California, Inc.
4729 E. Gage Ave.
Bell
Victor L. Bangle, Executive Director

Bakersfield Chapter, RTA
P. O. Box 3245
Bakersfield
John L. Blackwood

Los Cerritos CSEA-RTA
P. O. Box 129
Bellflower
H. J. Mackey, Secretary

Glendale Burbank Chapter, CSEA
1617 W. Verdugo Ave.
Burbank
Ralph H. Johonnot, President

San Francisco TVSA
36 Park Plaza
Daly City
J. Jerrold Strauss

Central Valley Chapter, RTA
4510 E. Balmont
Fresno
Louis E. Edises

Glendale-Burbank Chapter, RTA
P. O. Box 4012
Glendale
Ralph H. Johonnot

South Bay RTA
2002 Springfield Ave.
Hermosa Beach
Loyd Brown, President

San Gabriel Valley Chapter, CSEA
P. O. Box 524
La Puente
Eddie McCoy, Secretary

Long Beach RTA
1401 E. 55th St.
Long Beach
Fred S. Abrams, Jr.

San Fernando Valley Chapter, CSEA
7001 Reseda Blvd.
Reseda
E. A. Stevens, Secretary

Riverside Chapter, CSEA, Inc.
P. O. Box 7074
Riverside
Ken Jenkins, Secretary

Sacramento Chapter, CSEA
3093 Fair Oaks Blvd.
Sacramento
Keith Kirstein, Secretary

Salinas RTDA
830 Park Row
Salinas
William Packwood, Secretary

San Bernardino Chapter, CSEA
P. O. Box 3398
San Bernardino
Victoria Garrison, Secretary

San Diego CSEA
3331 El Cajon Blvd.
San Diego 4
Earl K. Robbins, Board of Directors and Treasurer

Santa Clara Valley and Santa Cruz Chapter, CSEA
Rm. 467A, Porter Bldg.
San Jose 13
Chet Spink, Secretary

Television and Electronic Association of Marin
1535 4th St.
San Rafael
Oakley Dexter, Secretary

Santa Monica CSEA
1642 Ocean Pk. Blvd.
Santa Monica
Harry Bernstein, Secretary

Mother Lode Chapter, CSEA
169 Shepherd St.
Sonora
Howard W. Nott, Secretary

Independent TV Service Dealers Association of Los Angeles County, Inc.
213 S. Coronado St.
Los Angeles 57
Abe Bowers, Secretary

Alameda County TV and Radio Association
5585 Thomas Ave.
Oakland 18
Fred W. Rock, Secretary

Pasadena Chapter, RTA
Main P. O. Box 1143
Pasadena
Bob Kealey, Secretary

Pomona Valley Chapter, RTA
P. O. Box 567
Pomona

San Antonio Chapter, RTTA
P. O. Box 626
South Gate
Andrew Goodwin, Secretary

San Joaquin Chapter, CSEA
P. O. Box 1306
Stockton
Dave Young, Secretary

San Joaquin RTA
2310 N. El Dorado
Stockton
Kenneth Preston

San Gabriel RTA
1200 Sylvan Ave.
West Covina
Jack F. Brown

CONNECTICUT

TELSA of Connecticut
P. O. Box 444
Meriden
Peter Lucus, President

Danbury Chapter, TELSA of Connecticut
Main Radio & TV, Inc.,
272 Main St.
Danbury
Max Parcell, Secretary

TELSA of Meriden
7 Yale St.
Meriden
Bud Lackipo, President

New Britain Chapter, TELSA of Connecticut
c/o Ted's TV
Orange St.
New Britain
Ted Gryguk, Secretary

Norwalk Chapter, TELSA of Connecticut
Twin City Radio
N. Main St.
Norwalk
Peter Huntington, President

Stratford Chapter, TELSA of Connecticut
91 Huntington Rd.
Stratford
Robert Steer

Waterbury Chapter, TELSA of Connecticut
P. O. Box 683
Waterbury
Bernard Fisherman, Secretary

DELAWARE

TV Service Dealers Association of Delaware
808 W. 4th St.
Wilmington 1
James A. Mayhart, President

DISTRICT OF COLUMBIA

Television Service Association of Metropolitan Washington
Washington Bldg.
15th and York Ave. N. W.
Room 852
Washington, D. C.
Hyman Nussbaum, Executive Secretary

FLORIDA

Electronic Service Association of Broward County
901 N. W. 4th Ave.
Ft. Lauderdale
Hamilton Boyd, Secretary

Television Service Dealers Association of Greater St. Petersburg Area
121 108th Ave.
St. Petersburg
Arthur Oesterling, Secretary

Television and Service Association of St. Lucie County
P. O. Box 381
Ft. Pierce
John Forget, Secretary

Jacksonville Electronics Technician Society
906 San Marco Blvd.
Jacksonville
Dale Andrews, President

TESA of Miami
6001 S. W. 20 St.
Miami
James J. Ross, Corresponding Secretary

Tallahassee Television and Electronics Association
213 College Ave.
Tallahassee
Don Birch, Secretary

Television Service Dealers Association of Palm Beach
407 Flamingo
W. Palm Beach
Roy Batton, President

GEORGIA

Television Electronic Association of Macon, Inc.
P. O. Box 2033
Macon
James Moore, Secretary and Treasurer

ILLINOIS

National Alliance of TV Service Association (NATESA)
5908 S. Troy St.
Chicago
Frank J. Moch, Executive Director

Professional TV Servicemen's Association
7002 W. Cermak
Berwyn
Charles Doose, Secretary

Associated Radio and Television Servicemen
433 S. Wabash Ave.
Chicago 5
Howard J. Wolfson, Chairman

TESA of Quint Cities
532 Brady St.
Davenport, Iowa
Len Gregson, Secretary

DuPage County TV Association
138 W. Park St.
Elmhurst
Howard Hitzmann, Secretary

Tri-City Service Dealers Association
2011 Delmar
Granite City
Myron Convers, Secretary

TESA of Will County
2?0 E. Washington St.
Joliet
L. R. McAllister

ETA of Illinois
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Rockford
Ed Tanrath, Secretary

TESA of Lake County
918 Glen Florda
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1515 18th St.
Bedford
Bill Frump, President

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304 S. Walnut St.
Bloomington
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TVSMA of Jackson County
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RTVSDA of Columbus
1621 California
Columbus
Dean Horn, Secretary-Treasurer

Indiana Electronic Service Association
1017 S. Main St.
Elkhart
Lamar Zimmerman, Jr., Secretary

TVE of Elkhart
1136 E. Mishawaka Rd.
Elkhart
Wayne Clem, Secretary

RTSA of Evansville
2009 Polleck Ave.
Evansville
Ted Fink, President

Ft. Wayne Electronics Service Association
P. O. Box 691
Ft. Wayne
John Crocker, Corresponding Secretary

RTTA of Grant County
600 W. Kickapoo St.
Hartford
Charles R. Schwark

Indianapolis TV Technicians Association, Inc.
P. O. Box 23125
Indianapolis 23
Delbert Williams, Secretary

SIETA of Jasper
Jasper
Charles Lamberson, President

RTSEA of Kokomo
1136 North McCann
Kokomo
Charles Conwell, Secretary

RTSEA of Logansport
530 N. Cicott St.
Logansport
Donald Hyman, Secretary

RTSA of Muncie
R. R. 4
Muncie
Charles Irelan

ESTA of Henry County
417 N. 10 St.
New Castle
Brent Hay, Secretary

ARTS of South Bend
Kordona TV
830 Portage Ave.
South Bend
Bill Rapport, President

WVETA of Terre Haute
1443 S. 17 St.
Terre Haute
William Durham, President

IOWA

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Waterloo
Don Price

Boone TSA
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Boone
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118 6th St. S. E.
Cedar Rapids
Tom Cours, Secretary

Des Moines TESA
1300 55th St.
Des Moines 11
W. L. Grommon, Secretary

Linn TSA
118 6th St. S. B.
Linn
Dick Reeder, President

Marshall County TESA
1022 S. 9th Ave.
Marshalltown
Ray Navara, Secretary

North Central TSA
10 2nd St. N. W.
Mason City
Otto Schwartz, Secretary

TESA of Ottumwa
311 S. Madison
Ottumwa
Carl Jennings, Secretary

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Dyersville
Clarence V. Benke, Secretary

Hamilton TSA
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Hamilton
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P. O. Box 33
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George Argyros, Secretary

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KANSAS

TV Electronic Service Association of Kansas, Inc.
P. O. Box 81
Chanute
Paul Metzinger, Secretary

Ark City Chapter, TESA of Kansas
426 N. A St.
Arkansas City
Roger Thompson, President

Southeast Chapter, TESA of Kansas
8th and Lewis Sts.
Coffeyville
W. E. Breshear, Secretary

Dodge City Chapter, TESA of Kansas
712 W. Wyatt Earp
Dodge City
Jim Carlyle, Secretary

Midwest Chapter, TESA of Kansas
2324 N. Main St.
Great Bend
Carlos Taylor, President

Hutchinson Chapter, TESA of Kansas
110 E. Sherman
Hutchinson
Lloyd Murphy, President

Junction City Chapter, TESA of Kansas
115 W. 11 St.
Junction City
James Dodd, President

Pittsburg Chapter, TESA of Kansas
1121 S. Broadway
Pittsburg
David W. Ernsbarger, Secretary

Pratt Chapter, TESA of Kansas
605 E. 1 St.
Pratt
Stanley Gersham, Secretary

Salina Chapter, TESA of Kansas
P. O. Box 1057
Salina
Marian Wallis, Secretary

Wichita Chapter, TESA of Kansas
841 S. Poplar St.
Wichita
Homer Miller, President

KENTUCKY

Kentuckiana Television and Radio Technicians Association, Inc.
2206 Wingfield Court
Louisville 16
Charles Simmons, Secretary

MASSACHUSETTS

ETG of Massachusetts
895 Washington
Newton 60
Gilbert Clark

Fall River Chapter, ETG
The Lane
Assonet
Henry Nadeau, President

North Shore Chapter, ETG
132 High St.
Danvers
Arthur Drolet, Secretary

Brockton Chapter, ETG
12 W. Union St.
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E. Weymouth
Dominic Taglieru, Secretary

Lawrence Chapter, ETG
118 Essex St.
Lawrence
Donald Baron, President

Radio and TV Technicians Guild of Greater New Bedford
110 Topham St.
New Bedford
Ted Kurgan, Chairman, Membership Committee

Lowell Chapter, ETG
38 Ledge Rd.
N. Chelmsford
Al Nickerson

Greater Boston Chapter, ETG
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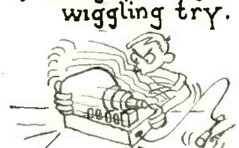
Otto Allemann, Membership Committee

SORRY, BUT . . .

Technicians News will not appear this month. In its place, this month only, is a complete comprehensive list of electronic service technicians associations in the United States and Canada. It is as complete and as up to date as we could possibly make it. We have tried not to miss a single group, anywhere. However, if in some way your association has not been included, please let us know so we can add you to our list.

I think that I shall never see,
a thing more ornery than tv.
It sets upon my bench and plays,
as it has done for many days.

I gently tap,
and gently pry
pushing, pulling,
wiggling try.



At last! At last! the set is dead,
its light before my blows has fled!

When towards the set
with probes I go,
returns the raster's
brilliant glow.

I raise my voice and loudly scream
No, nowhere in my wildest dream
Is there or can there ever be
a thing more ornery than T.V.

Technotes

RCA 21CD7000 SERIES

Color shading in this set is usually traced to a sawtooth voltage appearing at the red or blue pix-tube grids. This can be caused by R713, 470,000 ohms, in the killer plate circuit

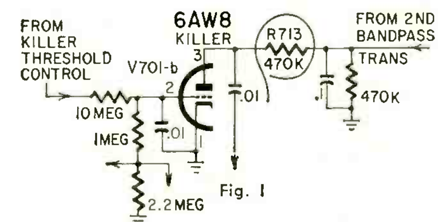


Fig. 1

changing in value (Fig. 1) or C733, C734 or C738 (.047 μf) in the R — Y, B — Y and G — Y amplifier plate circuits changing more than 20% in value (Fig. 2). Color shading

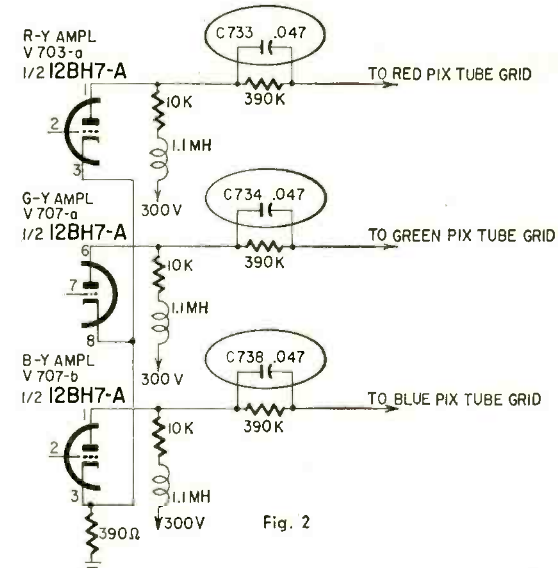


Fig. 2

caused by R713 changing in value appears on color programs and shows up as a color change in an object as the camera pans across the scene.—*Warren Roy*

HOFFMAN 331

On several of these models, no sound or intermittent sound has been caused by a shorted capacitor inside the ratio-detector transformer can. This capacitor, marked C101 on some of the manufacturer's schematics, is across the primary winding of the transformer and is composed of two small plates separated by a thin coated sheet of mica. If the mica shorts, the sound may vary intermittently or go out entirely. Our solution is to bend the top plate of the capacitor upward so it does not touch the bottom plate, and remove the mica sheet. A 100-$\mu\mu$f button type ceramic capacitor is then installed (either inside the can or across its terminals externally). A slight readjustment of the transformer slugs is necessary for peak output and minimum hum level.—*John B. Ledbetter*

SHORTCUT MAKES HUM

Recently, I replaced the volume control in an Espey model 511-B AM-FM radio. One end of the control was connected to the chassis near the grounded cathode of the 6SQ7 through a 4-inch length of wire. Installing the new control, I went ahead and removed the ground wire and used the ground strap supplied with the new control.

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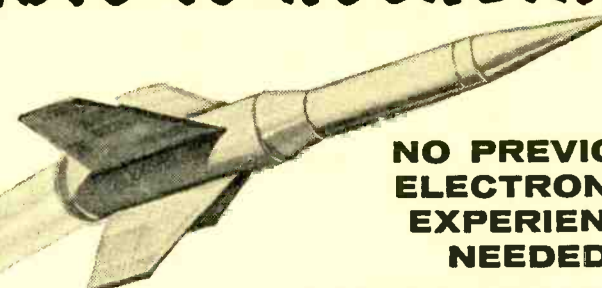

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When the job was finished, there was pronounced hum that was not present originally. At first I couldn't understand where it came from. Later on I figured out the reason and eliminated the hum.

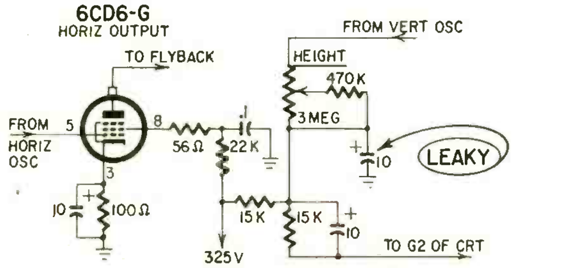
The triple-section filter capacitor, whose can is common negative and grounded, is mounted near the volume control. The center tap of the high-voltage winding of the power transformer is grounded at a point rather distant from the filter capacitor ground. This results in a strong, pulsating dc flowing through the chassis which now became the common return for the ac signal from the volume control back to the grounded cathode of the 6SQ7. Removing the ground strap from the control and reconnecting the original ground wire cured the trouble.

A hard-hitting reminder that shortening leads in audio circuits isn't always best.—*Carl C. Seidler*

BENDIX FM 27C

The set was pulled after a new yoke failed to cure a keystone pattern. Ordinarily most such symptoms arise from a partly shorted yoke but this one didn't.

The waveforms at the screen grid and cathode of the horizontal output tube gave the first clue to the trouble—the screen grid and cathode waveforms were fuzzy. Resetting



the scope sweep to half the vertical rate showed a rather heavy vertical signal synchronized with the low sweep rate. The vertical decoupling capacitor (height control circuit) was replaced after shunting it failed to eliminate the symptom completely. The new capacitor was a single-section replacement soldered in by its pigtails as the original unit seemed to be leaking to the remaining sections.—*Lawrence Shaw*

MARK II REALIST PHONO

Complaint: Picks up 96-mc FM broadcast station, amplifier cannot be controlled by volume control.

Solution: Replace the 0.1-μf paper capacitor in the grid circuit of the 12AX7 input stage with a metallized type and ground the shell to chassis.—*Lester J. Barthelmess*

OLDSMOBILE TRANSPORTABLE

Works as portable, dead in car. All voltages check out OK.

This common trouble calls for inspecting the slide contactors on the power unit with a magnifying glass. You will probably find a fine break in one or more of the contacts. Replace the slide, don't try to repair the old one.—*Wm. Porter*

PHILCO AUTO RADIOS

When one of these sets has a low, distorted output, check to see if it uses an AR5 output transistor. If it does, look for a charred 0.47-ohm bias resistor. If you find one, replace the AR5 with a later run of the same transistor or with a 2N256. Also replace the bias resistor.—*Wm. Porter* END

Readers of our December issue were no doubt surprised to see on page 50 immediately following the R-E printed-circuit preamplifier article, an announcement that such a story would also appear in January. We have not become as preamp-minded as all that; the story announced was indeed the one that you had just finished reading! Originally planned for January, we found it possible to put it in the December issue, but forgot to kill the announcement. Our apologies if we have misled any would would-be constructors into waiting to compare the two preamps.

NEW TUBES and SEMI-CONDUCTORS

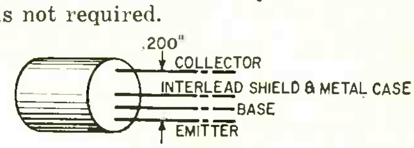
We have a wide range of entertainment and industrial types this month. There's a high-mu triode twin for audio pre-preamps and a p-n-p transistor for 450-kc and 10.7-mc circuits. On the industrial side are a group of 90-watt power transistors and a twin power-pentode for use at frequencies up to 500 mc.

Entertainment types

A short but interesting listing starts with an audio twin-triode and closes with a twin-diode high-mu triode.

2N1515

A p-n-p post alloy diffusion transistor especially designed for use in 450-kc and 10.7-mc if stages. Output impedance is such that usually neutralization is not required.



2N1515

Maximum ratings of this Amperex transistor at (25° C) are:

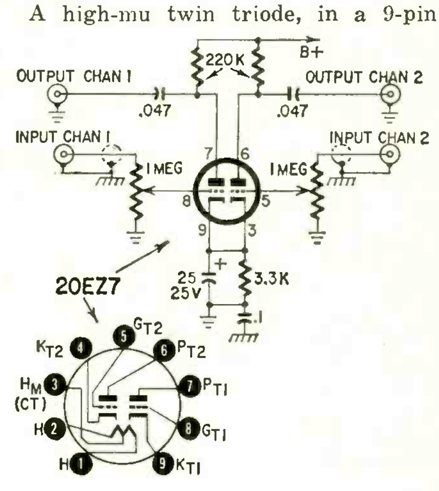
V_{CB}	20
I_C (ma)	10
I_E (ma)	10
P_C (mw)	83

Characteristics of the 2N1515 when $V_{CE} = 6, I_E = 1$ ma are:

f_T (cutoff frequency) (mc)		70
G_e (power gain)	(db at 10.7 mc)	28
	(db at 455 kc)	61
NF (noise figure)	(db at 10.7 mc)	8
	(db at 455 kc)	8

20EZ7

A high-mu twin triode, in a 9-pin



miniature envelope, especially designed for use in high-gain resistance-coupled low-level audio amplifiers such as pre-amps for low-cost stereo phonographs. The diagram shows the RCA 20EZ7 in just such a circuit.

Maximum ratings of the tube (each triode) in class-A1 amplifier service are:

V_H (series)	20
I_H (series) (ma)	100
V_H (parallel)	10
I_H (parallel) (ma)	200
V_P	330
V_G (neg bias value)	55
(pos bias value)	0
P_P (watts)	1.2

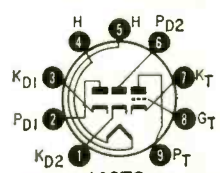
Characteristics at 100 volts plate voltage and −1 volt on the grid are:

μ	100
gm (μmhos)	1,250
R_P (ohms)	80,000

14GT8

A twin-diode, hi-mu triode of the 9-pin miniature type intended for use in FM receivers. The two diodes serve in ratio-detector or discriminator circuits—the triode as an audio-frequency amplifier. Each unit has its own cathode.

Characteristics of the triode section of the RCA 14GT8 when it is used in



14GT8

class-A1 amplifier service are:

V_P	250
V_G	−3
μ	72
R_P (ohms)	72,000
g_m (μmhos)	1,000
I_P (ma)	0.7

Maximum ratings of the diodes are:

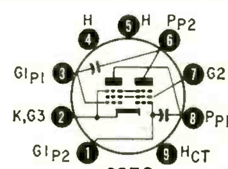
I_P (ma)	5
Peak heater-cathode voltage with heater either positive or negative with respect to cathode	200

Industrial types

Two groups of power transistors, a twin power pentode and a description of a new type of mesa transistor.

6939

A twin power pentode in a 9-pin miniature envelope with two built-in neutralizing capacitors. The tube, which has a common cathode and screen and suppressor grids, is designed for push-



6939

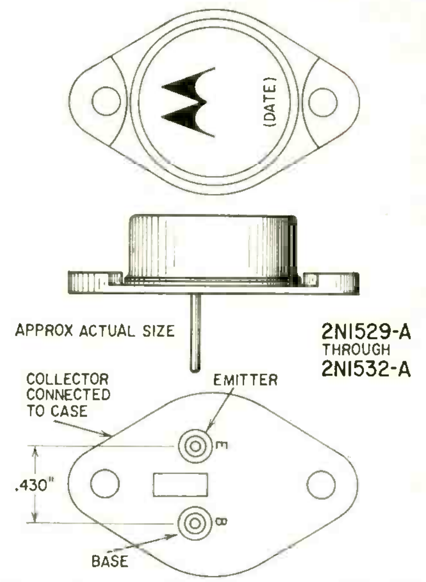
pull power-amplifier service or frequency-multiplier use in communications equipment at frequencies up to 500 mc. It can deliver 5 watts in continuous commercial service (CCS) or 6 watts in intermittent commercial and amateur service (ICAS).

Maximum ratings of this RCA tube:

	CCS	ICAS
V_P	250	250
V_{G2} (dc)	200	200
V_{G1} (dc)	−100	−100
I_P (dc) (ma)	90	100
I_{G1} (dc) (ma)	6	8
I_K (ma)	100	120
Plate input (watts)	12	14
G2 input (watts)	3	3.5
G1 input (watt)	0.2	0.24
P_P (watts)	6	7.5

2N1529-A, 30-A, 31-A, 32-A

A group of p-n-p germanium power transistors for industrial applications. These Motorola units can handle up to 90 watts at voltages up to 100 with ease.



Absolute maximum ratings at 25° C are:

	2N1529-A	30-A	31-A	32-A
V_{CE}	20	30	40	50
V_{CB}	40	60	80	100
V_{EB}	20	30	40	50
I_C (continuous) (amp)	5	5	5	5
(peak) (amp)	10	10	10	10
P_C (watts)	90	90	90	90
h_{FE} (current gain)	40	40	40	40
g_{FE} (transconductance) (mhos) (minimum)	1.2	1.2	1.2	1.2

Epitaxial mesa transistors

A new family of germanium mesa transistors which take maximum advantage of the characteristics and potential of semiconductor materials. Epitaxial transistors consist of thin semiconductor layers epitaxially (derived from the Greek "setting on") deposited on low-resistivity substrates of germanium. The performance of epitaxial units, including saturation voltage, switching speed and collector capacitance, is far superior to conventional germanium mesa transistors.

This process is being used by Sylvania to produce two new transistors, types SYL2300 and SYL2301 (available in production quantities soon). As an example of the advantages of these new devices, the following statement was released by Sylvania: For equivalent transistor dimensions, saturation voltage at a 50-ma collector current is reduced by a factor of 3.5 and typical switching storage times are reduced by a factor of four. END

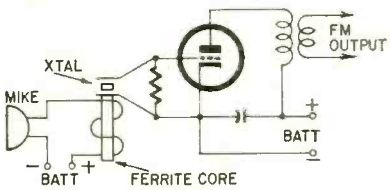
new PATENTS

CRYSTAL-CONTROLLED FM

Patent No. 2,945,192

Antoni Szymanski, Los Angeles, Calif. (Assigned to Standard Coil Products Co., Inc., Melrose Park, Ill.)

The control element is a ferrite bar whose length is varied by magnetism. A coil around the bar carries audio from a microphone. Thus the bar applies pressure against a quartz crystal in



accordance with the strength of the audio signal.

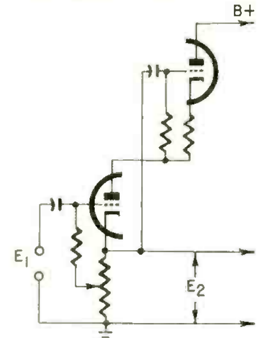
The crystal controls the frequency of an oscillator. When no audio is present, the crystal dimension is such that the oscillator is on the desired center frequency. The signal changes the effective thickness of the crystal and thus modulates the frequency above and below the average value.

UNITY-GAIN AMPLIFIER

Patent No. 2,950,443

Gareth M. Davidson, New York, N. Y., and Robert F. Brady, Ridgefield, N. J. (Assigned to American Bosch Arma Corp.)

Among important advantages of a cathode follower, are its isolation characteristics, low output impedance and low input capacitance. As is known, the output voltage of a follower is generally a few percent below its input.



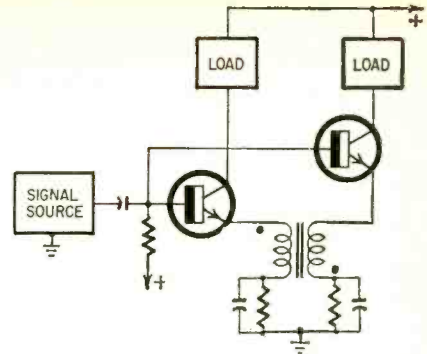
Sometimes it is desired that the output follow more closely the input voltage. Here two followers are used in cascade. Mathematical analysis shows that under this condition the expected output voltage (E_2) is only a *few tenths of a percent* below the input (E_1).

COMPENSATION OF PARALLEL TRANSISTORS

Patent No. 2,941,154

Samuel C. Rogers, Morristown, N. J. (Assigned to Bell Telephone Labs. Inc., New York)

It is unlikely that two transistors, even of the same type, will have similar characteristics.



When connected in parallel, one usually takes more than its share of power, leading to early breakdown. The circuit shows a distribution amplifier with equal loads in the collector circuits and a 1:1 ratio transformer (T) to compensate for transistor inequality. If one transistor passes more current through its winding than the other does, power is transferred to the other winding. This drives the weaker transistor to a greater extent and equalizes the load.

Here is an example of two dissimilar transistors, A and B, which were tested as follows:

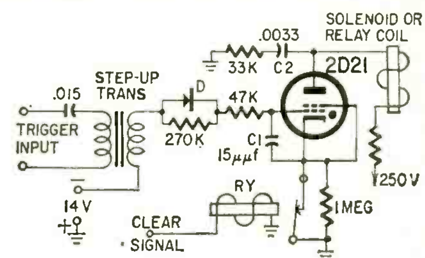
Transistor	Alpha	Coll. volts without T	Coll. volts with T
A	.994	2.25	1.49
B	.957	1.25	1.42

TRIGGERED THYRATRON

Patent No. 2,942,160

James B. Ricketts, Jr., Bryn Mawr, and Robt. H. Schafer, Upper Darby, Pa. (Assigned to Burroughs Corp., Detroit, Mich.)

Pulses can fire a thyratron if they last long enough. This circuit can be triggered by pulses as short as 1.5 μsec. The pulses are stepped up



and polarized so that positive pulses of about 50 volts are applied to the grid.

The short pulses pass through D and charge C1. This maintains the positive potential at the grid for a longer time than pulse duration.

Normally, the tube is cold and C2 is charged to the full 250 volts. After ignition, C2 discharges through the tube and "keeps it alive" until tube current through the inductive load (relay coil) rises enough to sustain conduction.

To reset the circuit, relay RY is energized. This connects the 1-megohm resistor in the cathode return and de-ionizes the tube. END

50 Years Ago

In Gernsback Publications

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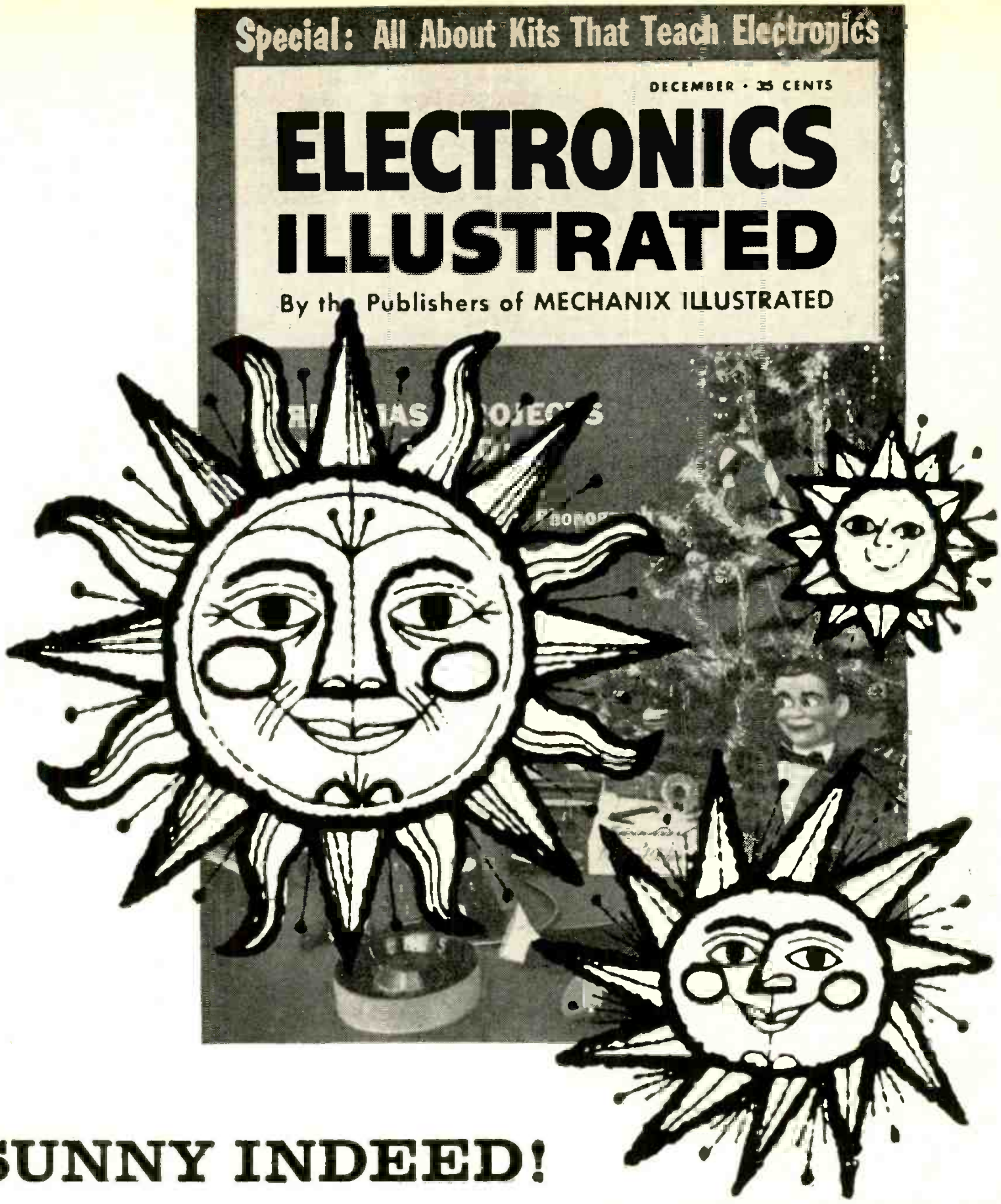
Modern Electrics	1908
Wireless Association of America	1908
Electrical Experimenter	1913
Radio News	1919
Science & Invention	1920
Television	1927
Radio-Craft	1929
Short-Wave Craft	1930
Television News	1931

Some larger libraries still have copies of Modern Electrics on file for interested readers.

In January, 1911, *Modern Electrics*

Demonstration of Wireless Telephony, by Dr. Erich F. Huth (Berlin).
Unique Wireless Submarine Installation, by Frank C. Perkins.
Unique Radiphone Arc.
New Loose Coupler.
Wireless on Department Store (Wanamaker's).
Construction of a 50-Watt Laboratory Transformer, by Charles F. Frassa, Jr.
An Audible Detector, by C. A. Pettingill.
Unique Variable Condenser.
Simple Detector, by Edward De Mello.
Improved Photometer, by A. C. Marlowe.
Effect of Winter Upon Wireless Wave Propagation, by George F. Worts.



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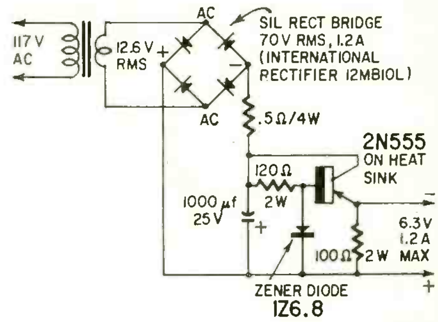
NOTEWORTHY CIRCUITS

REGULATED DC HEATER SUPPLY

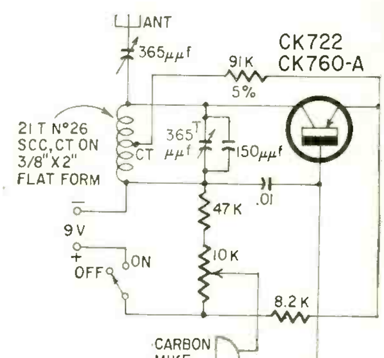
By combining Zener diodes and a standard power transistor we can get a low-ripple regulated dc heater supply. The circuit is very stable and provides good regulation despite line and load



variations. Combining the Zeners with the power transistor gives us a degree of regulation and filtering that is often difficult to get at low voltages and high currents.—*International Rectifier News*

1-TRANSISTOR SNITCHER

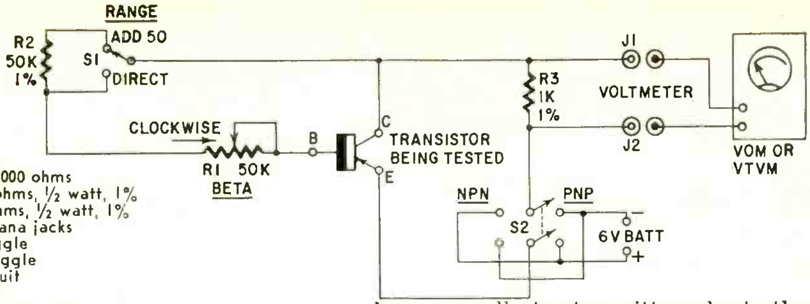
I have been experimenting with a one-transistor transmitter that meets the same qualifications as the Snitcher described by Irvin Chapel in the November, 1959, issue. I use a 3-foot car



antenna, Eveready 216 battery and a single-button carbon mike. By using a ⅜ x 2-inch flat coil form and trimmers for tuning, all the parts fit on a small chassis.—*Steve Greenbaum*

TRANSISTOR GAIN CHECKER

The schematic shows a simple but accurate transistor gain checker set for low-power transistors. It is used with any vom or vtvm and provides a direct-reading dial calibrated in beta gain from 5 to 100. In addition, it will determine



R1—pot, 50,000 ohms
R2—50,000 ohms, 1/2 watt, 1%
R3—1,000 ohms, 1/2 watt, 1%
J1, J2—banana jacks
S1—spst toggle
S2—dpdt toggle
Chassis to suit
Case to suit
Miscellaneous hardware

whether the transistor is shorted or open.

Mount R1 and its knob on the panel. Connect a good ohmmeter to the center and left-hand terminal (the end not tied to the slider) and scribe a mark on the panel opposite the knob setting every 5,000 ohms as the shaft is rotated clockwise. Label the first 5,000-ohm setting as 5, the next as 10, the next as 15 and so on until the 50,000-ohm value is reached and labeled 50. The rest of the wiring is straightforward.

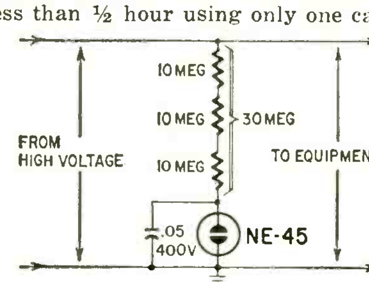
To test a transistor for beta between 5 and 50, throw S1 to DIRECT and S2 to the proper transistor polarity. Increase or decrease R1's resistance until a voltmeter attached to J1 and J2 reads exactly 3 volts. Then read beta directly from R1's calibrated scale. For betas between 50 and 100, throw S1 to ADD 50, adjust R1 for exactly 3 volts on the voltmeter and the beta will be the dial reading plus 50.

If the transistor has a collector-to-base or collector-to-emitter short, the voltmeter will read close to 6 volts and varying R1 will not produce any change in the meter reading. If the base is shorted to the emitter, little or no reading will be present on the meter. An open emitter or base results in no reading, and an open collector will result in little or no reading. If the transistor produces a reading above 3 volts on the DIRECT setting and cannot be reduced to 3 volts with R1, its beta is higher than 50 and S1 must be thrown to the ADD 50 setting.

The beta range can be extended by adding more 50,000-ohm resistors in series with R2 with appropriate switching. One 50,000-ohm resistor in addition to R2 will extend the range to 150 and two added will measure beta gain to 200. The basic direct dial reading is 50, and 50 more must be added for each added resistor. The 6-volt battery will last for some time but check it occasionally for aging. The accuracy of the tester will be affected if less than 6 volts is available.—*Dave Stone* END

DANGER—HIGH-VOLTAGE

While high-voltage indicator lamps are useful, one is apt to get used to seeing them lit and make the wrong move anyway. A blinker lamp will do a much better job of keeping one's subconscious informed that lethal high voltage is on. A very simple neon-lamp blinker can be made and installed in less than ½ hour using only one capacitor, three resistors and a ¼-watt neon lamp.



The value of resistance shown is about right for a 1,250-volt supply and produces about one blink per second. This resistance must be adjusted according to the voltage of the power supply being used and the desired blink rate.

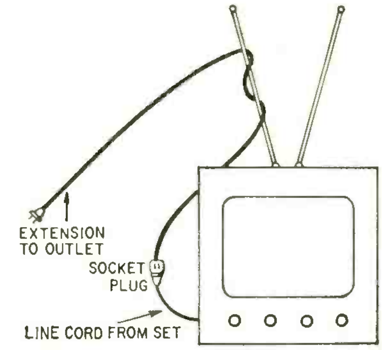
If the neon light glows steadily, the resistance is too low. Use a clear-glass jewel.—*Arnaldo Coro, Jr.*

NEW "MAGIC ANTENNA"

Some owners of portable television sets, or any larger sets with rabbit-ear antennas, will find a greatly increased signal by doing the following:

Plug your set into a heavy-duty extension cord rather than directly into a wall outlet and loop the extension cord around one of the antenna poles as illustrated. Be sure to use a heavy-duty extension cord. Ordinary household cords do not give a boost to reception.

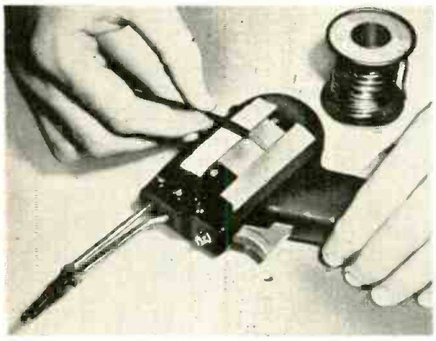
Before doing this, I could only pick up two channels, but now I pull in five,



including a very clear and highly satisfactory image from one channel which, in the past, didn't even show up faintly.—*Lawrence Bunker*

GUN CARRIES OWN SANDER

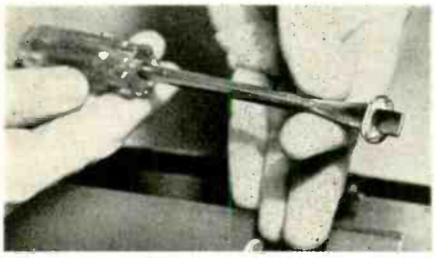
When soldering, a little sandpaper or other form of abrasive is often needed for cleaning wire tips, lugs, etc. A small square of sandpaper taped to



the side of your soldering gun can save you much wasted time and needless steps hunting up sandpaper when in the midst of a soldering job. Tape a piece to your gun now, before you forget!—*John A. Comstock*

SCREWDRIVER MODIFICATION

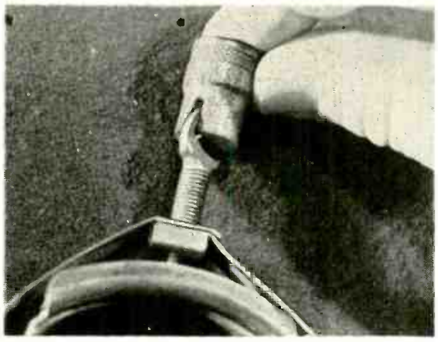
When working on electronics gear, you sometimes encounter screws in out-of-reach places accessible only to an



offset screwdriver. You will always have an offset driver handy if you convert a regular screwdriver by soldering a metal washer to the blade near the tip as shown. File two edges of the washer flat like the tip of a screwdriver.—*Scott Mock*

THUMB SCREW WRENCH

An effective tool to tighten or loosen thumbscrews quickly can be made from a discarded socket wrench. For this purpose a cheap socket is preferred



since it is made of soft steel which can be readily cut. Saw a rather deep, wide slot in the socket and it can be used with a socket-wrench speed handle. It will save a lot of time and turning effort.—*Glen F. Stillwell* END

Results?—You will get them with classified ads in Radio-Electronics only 50c a word.

See R-E classified ads page 119

BUSINESS and PEOPLE

B&K Manufacturing Co., Chicago, announced a new tube information service covering data on new tube types as they are produced by manufacturers. The service, which includes complete tube charts twice a year, will be issued every 3 months to owners of B&K tube testers on an annual subscription or individual copy basis.

Astatic Corp., Conneaut, Ohio, developed a simplified system for stocking its needle line. The new Asta-Stock system includes custom-designed cabinets, individual packages for each needle and complete cross-reference information as part of each needle package and on index tabs of the stock cabinet.

Shure Bros., Inc., Evanston, Ill., designed a new hang-tag for phonographs equipped with its Standard Stereo Dynetic phono cartridges to help hi-fi and radio appliance dealers promote phonograph sales.

National Technical Schools, Los Angeles, has 14 Afro-Asian students enrolled under the US Government's Non-Quota Student Act. William Inkumsah, son of the Minister of State for Interior of the Republic of Ghana, was recently graduated from the school after completing an 18-month course in electronics. He is shown (left) with Dr. L. J. Rosenkranz, president of National Schools.

RCA Electron Tube Div., Harrison, N. J., marked the 25th anniversary of its tube handbook. To commemorate the event, E. C. Hughes Jr., manager, commercial engineering (right), presented the initial five-binder set of the new

handbook *HB-3* to D. Y. Smith, vice president and general manager of the division. R. S. Burnap, consultant to the Electron Tube Div., who introduced the first handbook in 1935, holds the first single-binder edition.

Krylon, Inc., Norristown, Pa., presented its 1960 Award for Outstanding Sales Achievement to the Newhope Corp., New York City. Lee Rocke, Newhope president, is shown holding the

award as Richard C. Newbold, Krylon vice president, sales; Elmore E. Kayser, Krylon vice president, advertising and promotion; James W. Bampton, Krylon president; Tom Marchiano, Newhope vice president; Bernie Tonn and Bob Fitterman of the Newhope sales staff look on (left to right).

Clarence H. Hopper was appointed president of CBS Electronics, Danvers, Mass. He had been vice president - facilities, CBS, for the past 5 years. He succeeds **Arthur L. Chapman** who joined the headquarters staff of CBS in New York.

Glenn E. Ronk (left) was promoted to general sales director of Cornell-Dubilier Electronics Div., Federal Pacific Electric Co., South Plainfield, N. J. He was formerly industrial and military sales manager. He joined the company in 1959 after 7 years with American Electronics, Inc. Rear **Admiral Carl F. Stillman**, USN (Ret), was appointed

administrative assistant to the vice president, marketing. Since his return from the Navy in 1957, he has been engaged in various capacities in the military electronics industry for such

R-E Classified ADS

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DON'T BUY HI-FI COMPONENTS, Kits, Tape, Tape Recorders until you get our low, low return mail quotes. "We Guarantee Not To Be Undersold." Wholesale Catalog Free. HI-FIDELITY CENTER, 1797RC First Avenue, New York 28, N.Y.

companies as Radiation Research Corp., General Instrument Corp. and Stavid Engineering, Inc.

J. B. Holtz was appointed marketing manager, new products, for Centralab, the electronics division of Globe-Union. He has been with the company for 18 years in various executive and administrative capacities.

Leroy E. Tice joined Simpson Electric Co., Chicago, as chief field engineer. He comes from Cook Electric Co., where he was staff engineer and section director.

Thornton S. Adams joined Allied Radio Corp., Chicago, as director of marketing. He had been a marketing consultant to Allied since June, 1959. He was formerly vice president in charge of sales for Spiegel Inc. and consultant to Sears Roebuck & Co. and Aldens, Inc.

Harry Turkington (left) was named director of engineering and **Hal Moore** chief meter engineer of the Meter and

Controls Div. of Hickok Electrical Instrument Co., Cleveland. Turkington was formerly chief engineer, product application, for Simpson Electric Co. and Moore a member of Hickok's meter engineering department since 1957.

John Hauser was promoted to general manager, distributor sales, of CBS Electronics, Danvers, Mass. He had been distributor sales manager, electron tubes. **Roy Juusola**, manager of marketing administration, was promoted to manager of marketing services. **Lee Ballengee**, manager of equipment sales, electron-tube operations, is now responsible for all government and military marketing in addition to his former duties. **Ross Yeiter**, assistant semiconductor sales manager, has been elevated to sales manager, semiconductors.

C. P. (Bill) Oliphant was promoted to managing editor of the Technical Book Div. of Howard W. Sams & Co., Inc., Indianapolis, Ind. He has been with the company for 8 years as assistant editor of *PF Reporter*. 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.

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TV TUBE BRIGHTENERS, their specifications and prices are subject of *Guide to Proper Britener Selection.* Proper units for brightening, isolation and tube rejuvenation are matched to picture tubes of various types and heater ratings in booklet's *Quick Selector Chart.*—**Perma-Power Company**, 3100 N. Elston Ave., Chicago 18, Ill.

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KIT AND WIRED STEREO and mono high-fidelity, test and ham equipment and radios are featured in manufacturer's 27-page indexed catalog. Detailed descriptions and abundant photos. Prices.—**Electronic Instrument Co. Inc.,** 33-00 Northern Boulevard, Long Island City 1, N. Y.

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ELECTRONIC COMPONENTS *Catalog 60A* gives general and special-purpose use, specifications and prices of microphones and accessories, high-fidelity components, magnetic recording heads and replacement phono cartridges. 28 illustrated pages.—**Shure Brothers Inc.,** 222 Hartrey Ave., Evanston, Ill.

SILICON AND SELENIUM RECTIFIER *Catalog 116H* presents replacement and cross-reference guide with numbers of rectifiers interchangeable with most popular selenium rectifiers in addition to general information and prices.—**Technical Apparatus Builders,** 6 Church St., New York 6, N. Y.

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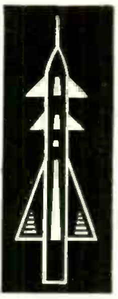

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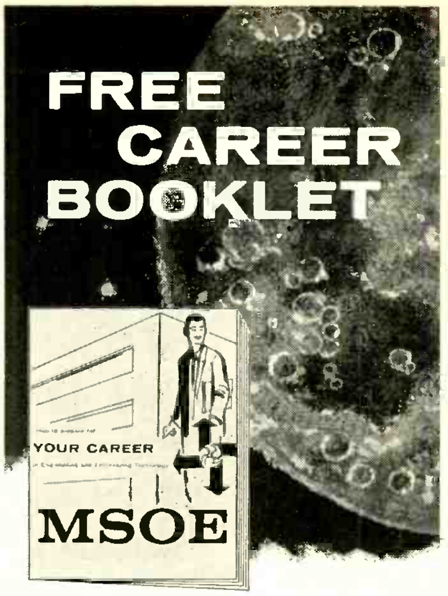

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101 WAYS TO USE YOUR VOM AND VTVM, by Robert G. Middleton. Howard W. Sams & Co. Inc., 1720 E. 38 St., Indianapolis 6, Ind. 5½ x 8½ in. 116 pp. $2.

Another in the 101 series by this well known author, the text covers two of the most used test instruments. It shows how to use them to make equipment checks, dc voltage tests; ohmmeter, signal-tracing, ac voltage, and dc current tests. Radio and TV alignment applications are also covered.—*LS*

INTRODUCTORY ELECTRIC CIRCUITS, by John B. Walsh and Kenneth S. Miller. McGraw-Hill Book Co., 330 W. 42 St., New York 36, N. Y. 6 x 9 in., 353 pp. $8.50.

An excellent book on basic dc and ac circuits, it analyzes two- and four-terminal networks, filters and transformers. Polyphase circuits are also treated. Toward the end, several chapters are devoted to mathematical subjects: Fourier series, Laplace transforms, matrix algebra, etc. The reader should know differential and integral calculus and basic physics. Many problems and numerical examples are included.

ALTERNATING-CURRENT CIRCUITS, Fourth Edition, by Russell M. Kerchner and George F. Corcoran. John Wiley & Sons, Inc., 440 Park Ave., New York 16, N. Y. 6 x 9 in., 602 pp. $8.75.

This is a detailed text limited to ac only. The level is that of the junior year, and math preparation to calculus is sufficient. Basic networks, phasor algebra, sinusoidal and nonsinusoidal waves are among the topics, with many problems and numerical examples worked out in the text. The authors go deeply into power generation and distribution with chapters on transmission lines, polyphase circuits and filters.

PRACTICAL RADIO AND ELECTRONICS COURSE FOR HOME STUDY (Revised 1960 Edition). 216 PP. $3.95.
TELEVISION SERVICING COURSE. 192 pp. $3.
Both books prepared under direction of M. N. Beitman. Supreme Publications, 1760 Balsam Road, Highland Park, Ill. 8½ x 10½ inches.

Earlier editions of these two books are known to many readers and are popular with experimenters and others interested in learning the fundamentals of radio, TV and electronics. The 35-lesson radio-electronics course begins with the basic radio receiver, its components and diagramic symbols and progresses through af and rf amplifiers, power supplies and test instruments to such subjects as strain gauges, high-frequency heating, transistors and servicing printed circuits. Excellent supplementary reading for students who may be having trouble with more

(*Continued on page* 128)

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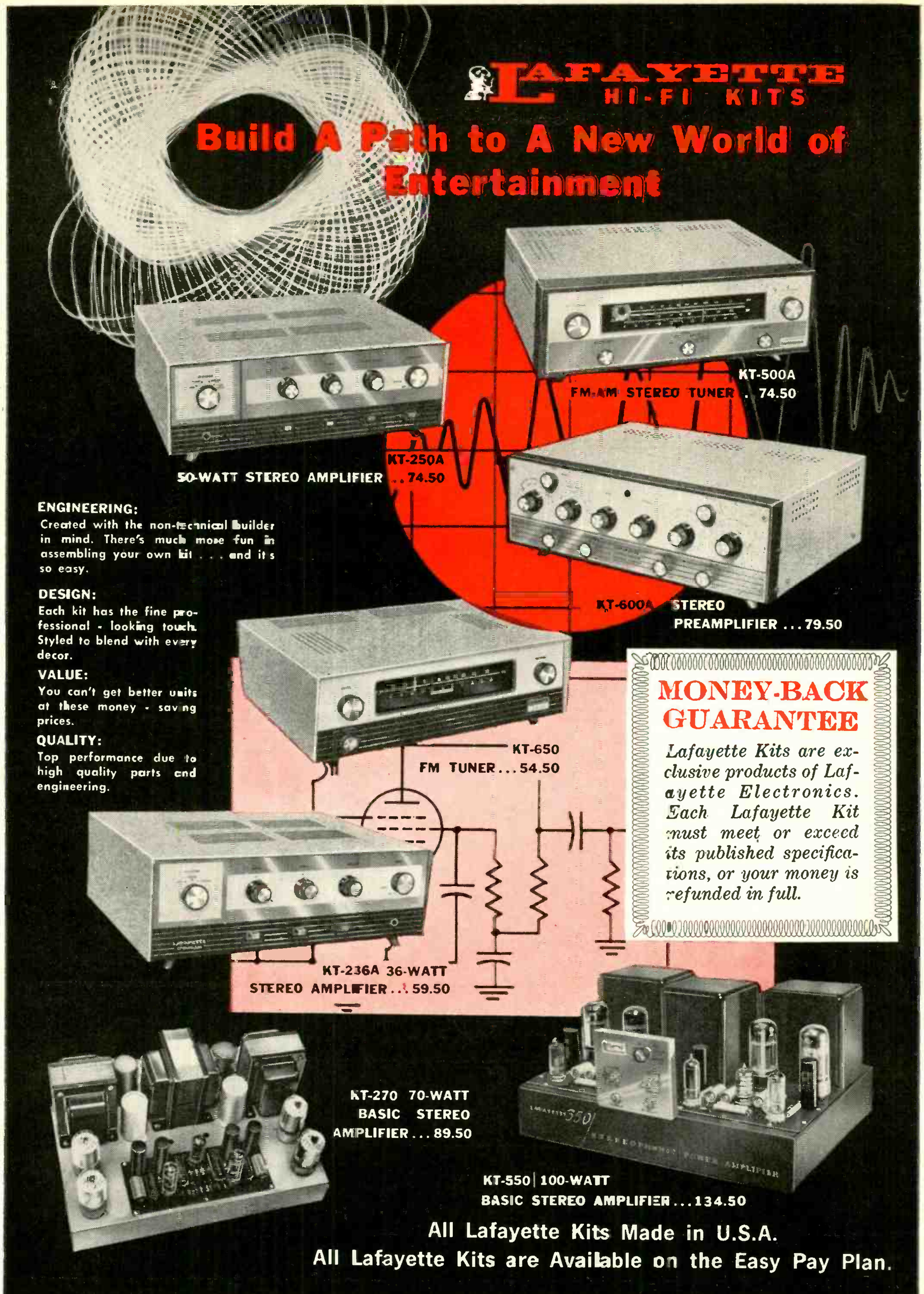
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(*Continued from page* 124)

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MODERN NETWORK SYNTHESIS, by M. E. Van Valkenburg. John Wiley & Sons Inc., 440 Park Ave. So., New York, N. Y. 6 x 9 in., 498 pp. $11.75.

This book is written for students at graduate level. It begins with a review of circuit analysis and mathematical methods. Approximations are treated in two chapters. One- and two-terminal-pair networks are discussed. Each chapter contains many problems and numerical examples.—*FS*

SERVICING TV VIDEO SYSTEMS, by Jesse E. Dines. Howard W. Sams & Co. Inc., 1720 E. 38 St., Indianapolis 6, Ind. 5½ x 8½ in. 222 pp. $3.95.

Written for the service technician, this book covers the video chain in the TV receiver—video if amplifiers, video detector, video amplifier and picture tube. It starts by reviewing the fundamentals of video systems and follows up with chapters on characteristics, circuits, alignment and circuit variations. Then the author goes into construction, replacement, repair, troubleshooting and service hints.—*LS*

THE ARITHMETIC OF COMPUTERS, by Norman A. Crowder. Doubleday & Company Inc., Garden City, New York. 5½ x 8½ in. 472 pages. $3.95.

An excellent text with a built-in teacher. Only a minimum of basic mathematics is required—addition, subtraction, division, multiplication—everything else necessary is detailed in the text. The unique approach used in this text comes close to packaging a live instructor with each book. First you study a small section of new material, then you are questioned about what you have just read and, if you make a mistake, the text explains your error in detail. Then, you are told to go on and try to answer the question again.

A student cannot get to the end of the book without understanding it, as there is no way to skim through without knowing the correct answers, which in turn require a knowledge of the subject material.—*LS*

TECHNICIAN'S HANDBOOK (1960 revision, 3rd edition). CBS Electronics, Danvers, Mass. 4¼ x 8¾ in.

Electronic technicians depend greatly on their tube-transistor manual. This handbook presents full data on all common types, with clear basing diagrams on the same page as the data. The information given has been selected for maximum usefulness.

Seldom-used types are described in shorter form. Separate tables list diodes, converters and tuning eyes. Other tables include pix tubes, foreign types and special-purpose tubes. An appendix contains further useful information: rectifier charts, tube testing, pix-tube installation, and color codes.—*IQ*

JUNCTION TRANSISTORS IN PULSE CIRCUITS, by P. A. Neeteson. Macmillan Co., 60 Fifth Ave., New York 11, N.Y. 6 x 9 in. 139 pp. $5.50.

This is a specialized text for engineers and designers who are concerned with computers, switch circuits, frequency dividers and logic circuits. It develops the mathematical analysis, and follows with an experimental circuit to prove the theory. Pulse shaping, feedback, transients, multivibrators are discussed in detail.—*IQ* END

CORRECTION

The base diagram of the 2N256 power transistor was drawn incorrectly in Fig. 3 of the article on the Rally-Pal Computer and in Fig. 1 of the article on the automobile FM tuner on pages 48 and 57, respectively, of the November, 1960 issue. In both cases, the base and emitter terminals were transposed. Looking at the bottom of the transistor with the pins in a vertical row to the left of center, the emitter is at the top and the base at the bottom.

Our thanks to Mr. Wm. F. Alexander, W3GFZ, of Newtown, Pa., for spotting and reporting these errors.

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Radio-Electronics does not assume responsibility for any errors appearing in the index below.

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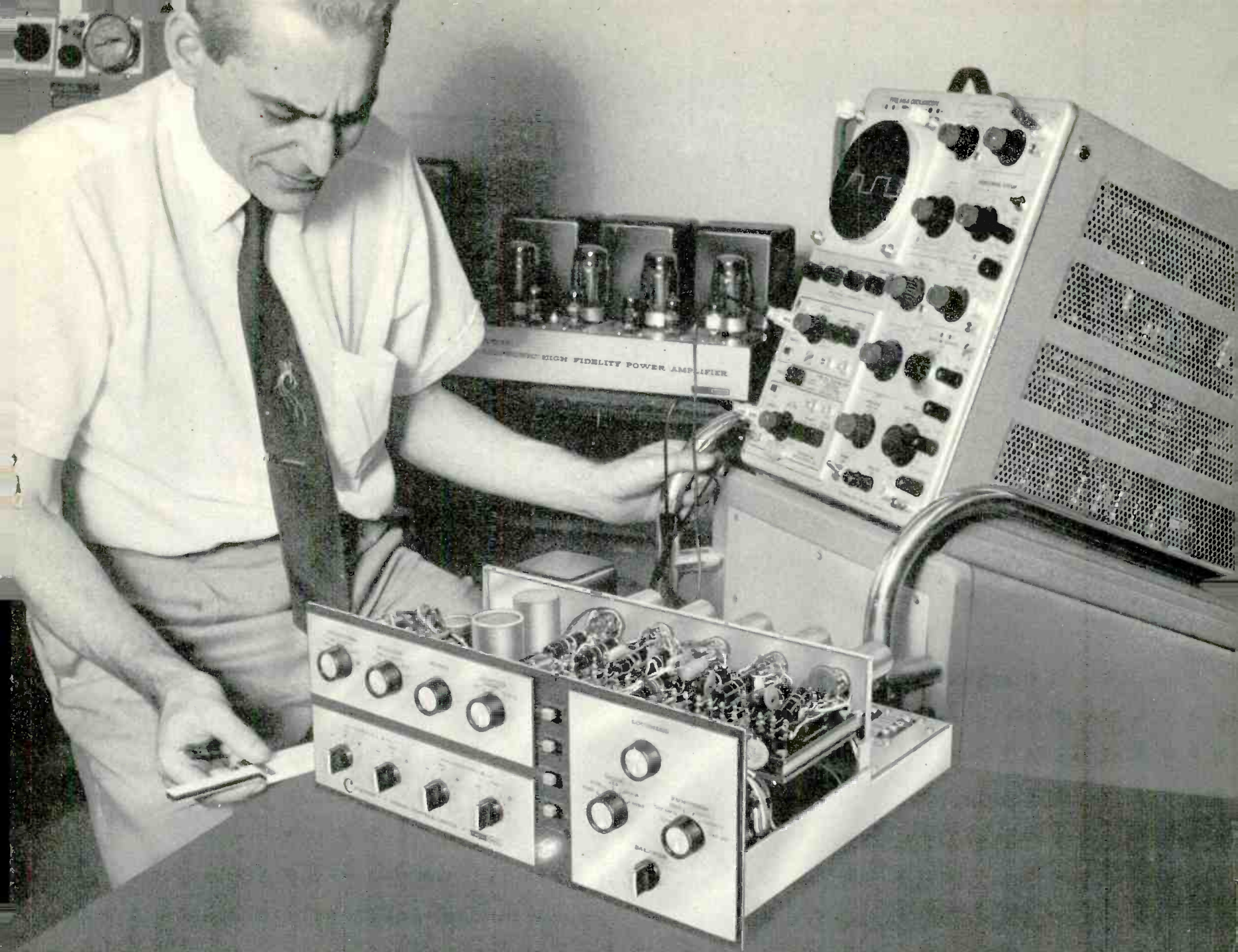

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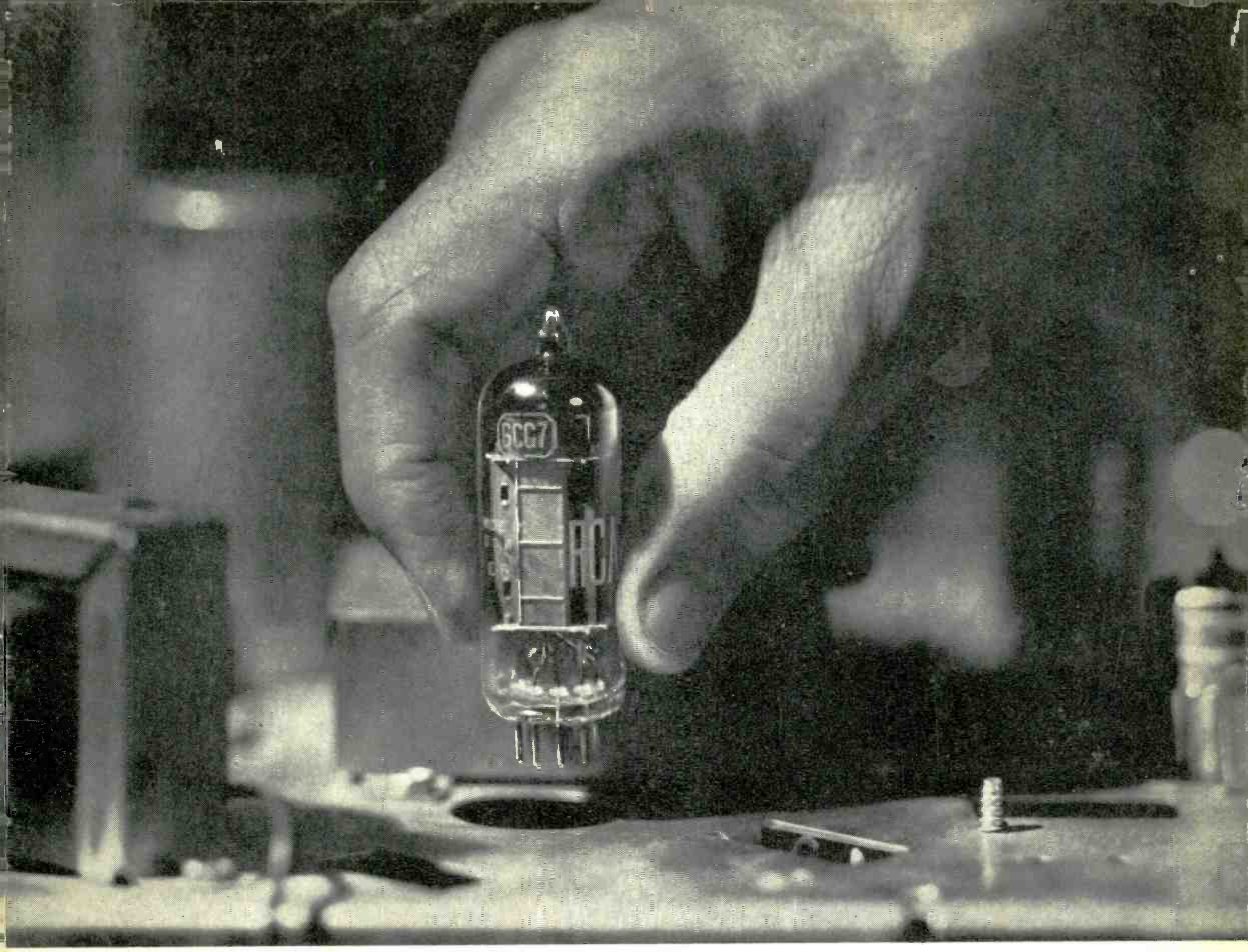

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