ANNUAL TEST EQUIPMENT ISSUE

HUGO GERNSBACK, Editor-in-chief ■ NOV. 50c

Radio-Electronics

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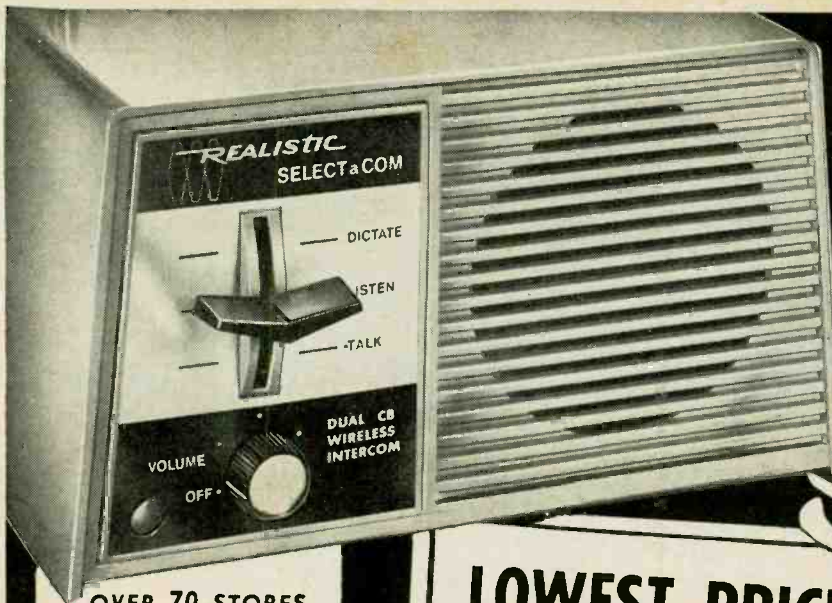

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- *Operates on 117 VAC*

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Same as above with 12 trans., battery **#21-906. $49.95**

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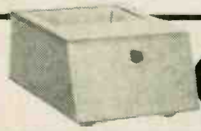
America's favorite wired hand radio. Ready to use; not a kit! Talk up to ¼ mile! **#60-3030.**



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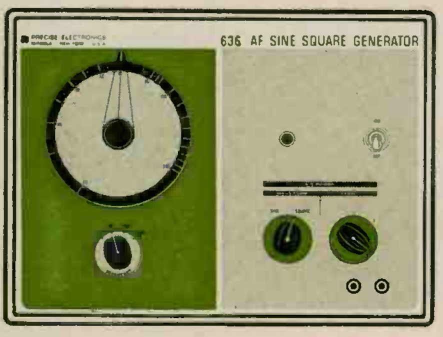

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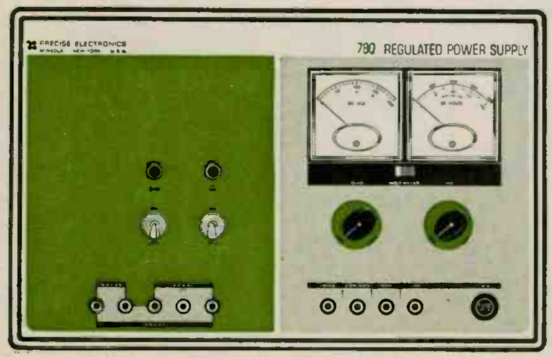

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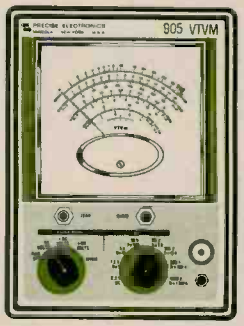

MODEL 905

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Radio-Electronics

NOVEMBER, 1965 VOL. XXXVI No. 11

Over 55 Years of Electronic Publishing

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THE DEPARTMENTS

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

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RADIO-ELECTRONICS, November 1965. Volume XXXVI, No. 11. Published Monthly by Gernsback Publications, Inc. at Ferry Street, Concord, N. H. 03302. Second-Class postage paid at Concord, N. H. Printed in U.S.A. One-year subscription rate: U. S. and possessions, Canada, $5. Pan-American countries, $6. Other countries $6.50. Single copies: 50¢.

POSTMASTERS: Send Form 3579 to 154 W. 14th St., New York 10011.

NEWS BRIEFS

ROBERT SARNOFF RCA PRESIDENT

Robert W. Sarnoff was elected president of the Radio Corporation of America at the last directors meeting.

President Elmer Engstrom was promoted to chief executive officer, chairman of the executive committee. General David Sarnoff, turning over to Engstrom the duties of chief executive officer, will continue to serve as executive chairman of the board, while Robert Sarnoff's former position of NBC chairman will be taken over by Robert E. Kintner.

COMPUTER ROUNDS UP SCOFFLAWS

Motorists who failed to answer traffic-violation summonses, and criminals of a graver kind, like car thieves, were rocked back on their heels recently as the New York City Police Department began experiments with a computerized method of picking up violators of the law. The technique worked so well that it caught a lady driver on a major traffic artery in New York, while police and reporters were on the way to a spot where a simulated demonstration for the press has been set up. About 200 members of the press witnessed the catch, which was an unexpected bonus in a demonstration of Operation Corral—*C*omputer *O*riented *R*etrieval of *A*uto *L*arcenists. The lady was arrested for having ignored for some months a summons for running through a red light.

The system, whose heart is a Univac 490 real-time computer at the US Pavilion at the World's Fair, has been under test since May. A patrolman in an observer car reads off license plates as the cars swish by. The numbers are fed by radio to the computer, which has a memory drum containing the license plate numbers of some 30,000 stolen cars and 80,000 scofflaws. The machine rings a bell when it recognizes a number. The number is printed out on a teletype machine and the operator radios a patrol car, which is spotted far enough ahead to be in a good position to pursue the flagged car.

Variations on electronic sleuthing are used in Detroit, Chicago, Alameda County, Calif., and St. Louis. Detroit's computer prepares lists of stolen goods, digests crime reports quickly and identifies criminals. Chicago's system, called Operation Crime Stop, has led to more than 3,800 arrests since April 1964.

FCC REQUESTS CONTROL OVER POTENTIAL INTERFERENCE PRODUCERS

The FCC has asked that the 1934 Federal Communications Act be amended to give the commission authority to regulate emission from any devices that can put out enough radio-frequency energy by radiation, conduction or other means to interfere harmfully with radio communication.

There is now no law giving the FCC authority to prevent potential interference-producing equipment from being manufactured and sold, though the FCC can immediately take action once it is in the hands of the user and interference has actually been produced.

Among the devices that the FCC has listed as possible interference producers are electronic garage-door openers, some electronic toys, high-powered electronic heaters, diathermy machines and welding equipment.

NATESA ELECTS OFFICERS AT NATIONAL CONVENTION

The National Alliance of Television & Electronics Service Associations held its annual convention at the end of August. This was the fifteenth NATESA convention. Officers elected were John Gibson, of Roanoke, Va., president; Andy Archie, Nashville, secretary-general; Tom Easum, Memphis, treasurer.

According to John Gibson, the new president, NATSEA will devote its main attention during the next year to CATV, licensing and extended warranties.

RCA OFFERS 15-INCH RECTANGULAR COLOR TUBE

RCA dramatized the announcement of a new color TV tube to be delivered in limited quantities in the first quarter of 1966 by demonstrating a "simulated" 15-inch tube. Showings were held in the East and the West. While the tube demonstrated was not

New York City police officers and patrolman stand by ready for action as Univac 490 computer reports by teletype that a stolen vehicle has been spotted. Policewoman is instructing radio patrol car in the field to apprehend suspect.

At Sea ⚓ On Land In the Air

Job Opportunities are G-R-O-W-I-N-G for DeVRY-TRAINED ELECTRONICS TECHNICIANS

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A CAPTAIN'S CAPTAIN

Remarkable developments in electronics have helped make possible such luxury liners as the S.S. France, of which Joseph Ropars is commandant. Ropars is known as a captain's captain, one of the most popular masters of the French Line's trans-atlantic fleet.

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the one RCA expects to put on the market, it was intended to demonstrate to color manufacturers the feasibility of the new size and to assist them in "consideration of design details and help promote color picture tube interchangeability within the industry," in other words to encourage compatability and all-around replaceability.

The tube actually demonstrated was in a 14-inch rather than a 15-inch glass bulb and the mask was cut from a piece intended for a 25-inch tube. The screen spacing of the mask for the 15-inch tube will be different, RCA spokesmen stated.

A second reason for the demonstration appeared to be a desire to establish the 15-inch tube as being a logical size in the family of color TV tubes, between that of G-E's 11-inch and the larger 19 inches.

COAXIAL CABLE HANDLES 32,400 CHANNELS

A new coaxial cable system, with nearly twice the capacity of any broadband system now in use, has been announced at Bell Telephone Laboratories. The new system, the L-4, covers a broader band than even microwave radio. The cable contains 28 coaxial conductors and operates at frequencies twice as high as those used in its predecessor, the L-3.

The L-4 marks the first use of transistor repeaters in a coaxial cable system. They are spaced every 2 miles. In addition, there are regulating networks about every 14 miles, equalizing networks every 50 miles and additional equalizing networks at main repeater

RADIO-ELECTRONICS is published by Gernsback Publications, Inc.
Chairman of the Board: Hugo Gernsback
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Editorial, Advertising, Subscription and Executive offices: 154 West 14th Street, New York 10011.
Subscribers: When requesting change of address please furnish an address label from a recent issue. Allow one month for change of address.

ADVERTISING REPRESENTATIVES: East: John J. Lamson, Eastern Sales Manager, RADIO-ELECTRONICS, 154 West 14th Street, New York 10011, 212 AL 5-7755; **Midwest:** P. H. Dempers Co., 740 North Rush Street, Chicago, Illinois 60611, 312 MI 2-4245; **Texas/Arkansas:** Media Representatives, Inc., 2600 Douglas Avenue, Irving, Texas 57060, 214 BL 5-6573; **West Coast/Oklahoma:** Husted-Coughlin, Inc., 1830 W. 8th Street, Los Angeles, Calif. 90057, 213 389-3132; Husted-Coughlin, Inc., 444 Market Street, San Francisco, Calif. 94111, 415 GA 1-0151; **United Kingdom:** Publishing & Distributing Co., Ltd., Mitre House, 177 Regent St., London W.1, England.

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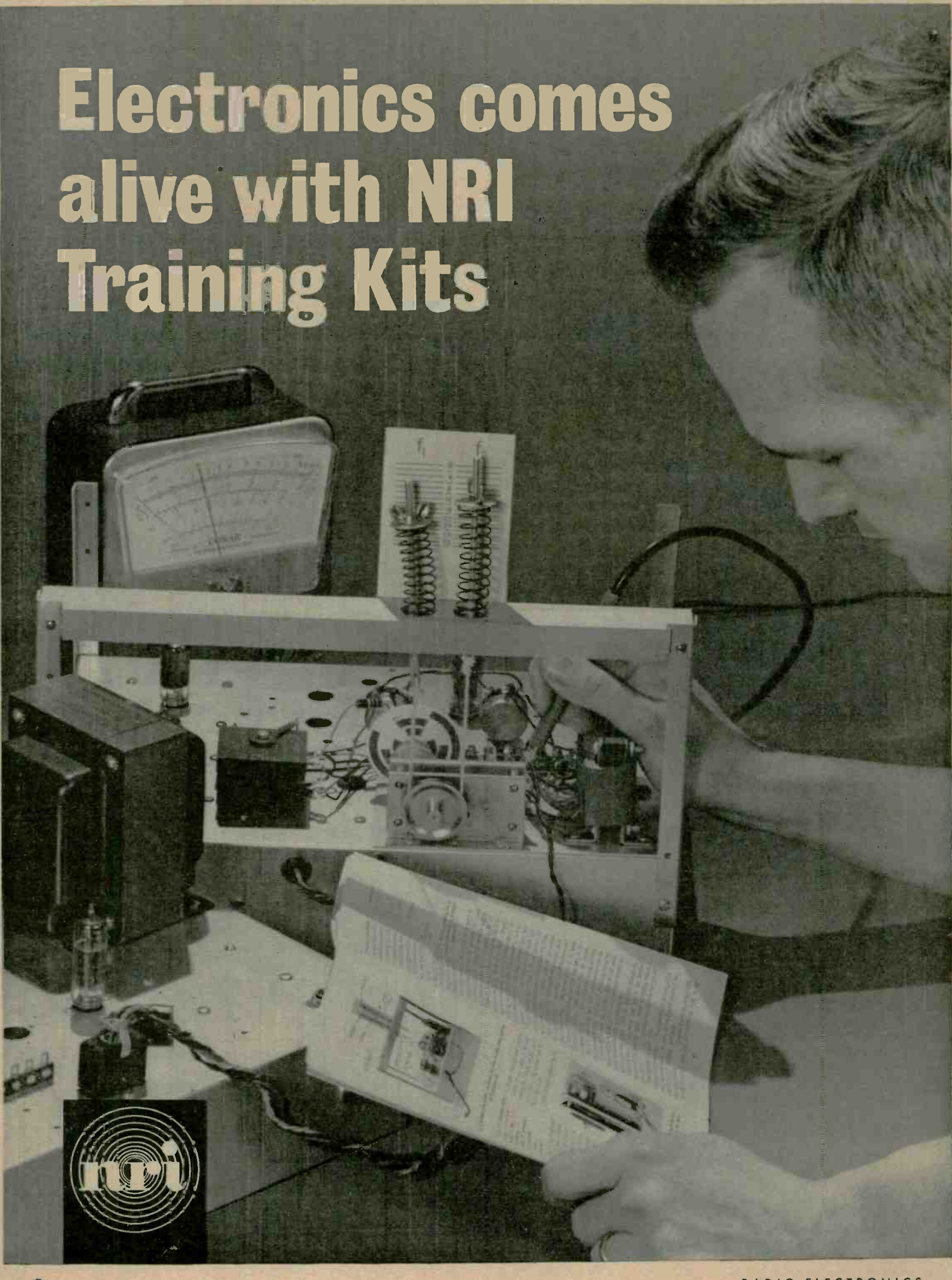
Circle 6 on reader's service card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stations as much 160 miles apart. Thus repeater gain is kept constant, though changes in temperature and other factors vary the cable losses. Voice channels can thus be maintained over routes of several thousand miles.

TV ON 30-KC BANDWIDTH USES VELOCITY SCANNING

A New York engineer, George J. Doundoulakis, has patented a velocity-scanning system that can transmit a high-definition picture in a bandwidth of only 30 kc. Mr. Doundoulakis and his associate, Ira Kamen, state that the narrow bandwidth will make it possible to use standard ¼-inch audio tape at 15 inches per second.

The new system, called Sonic Vee, will also make closed-circuit line charges much cheaper, and may have applications in FM. It may be possible to send television pictures over part of the subsidiary channel (SCA) that many stations now use in supplying paid radio music services to restaurants, supermarkets, offices, etc.

BRIEF BRIEF

That part of Jupiter's radio emissions that lies in the 10-meter region appears to be linked with the position of its satellite Io, according to G. A. Dulk and J. W. Warwick of the University of Colorado. Bursts of emission occur when the satellite is 90° and 240° from *superior conjunction* (when the satellite is behind Jupiter as seen from earth).

CALENDAR OF EVENTS

1965 National Electronics Conference, Oct. 25–27; McCormick Place, Chicago, Ill.

98th SMPTE Technical Conference, Oct. 31–Nov. 5; Queen Elizabeth Hotel, Montreal, Que.

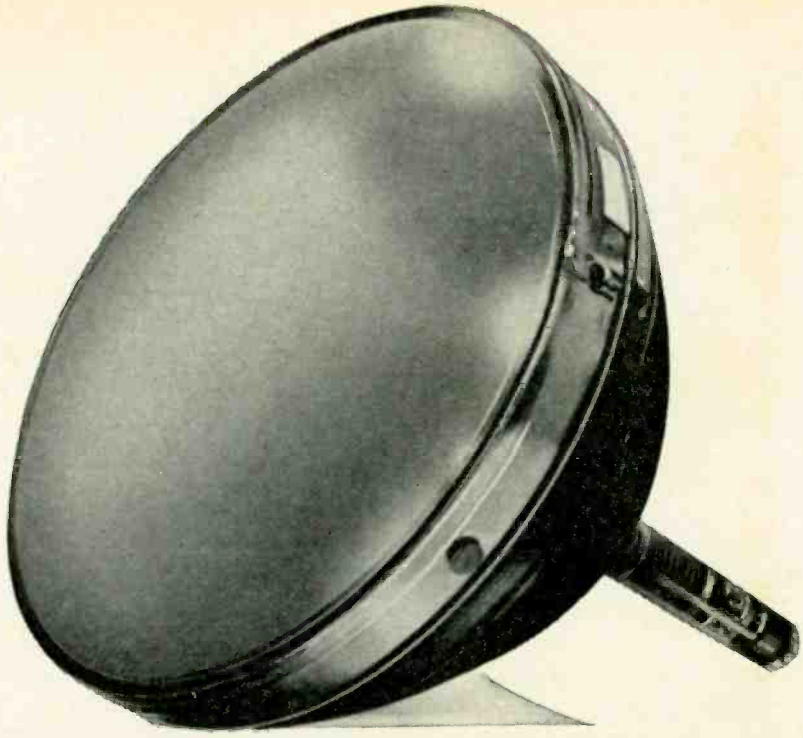
International Electron Devices Meeting (IEDM), Oct. 20–22; Sheraton Park Hotel, Washington, D. C.

18th Annual Conference on Engineering in Medicine & Biology, Nov. 10–12; Univ. of Pennsylvania & Sheraton Hotel, Philadelphia, Pa.

International Conference on UHF Television, Nov. 22–23; London, England

Fall Joint Computer Conference, Nov. 30–Dec. 2; Convention Center, Las Vegas, Nev.

Philco Service Training Meetings: Birmingham, Ala., Nov. 16, T. J. Hotel; Philco Distributors, Inc.; **Gadsden, Ala.,** Nov. 18, Holiday Inn; **Montgomery, Ala.,** Nov. 23, South Ala. Distrib. Co.; **Andalusia, Ala.,** Nov. 24, J. B. Restaurant; **Columbia, S. C.,** Nov. 29, Brown-Rogers-Dixon Co.; **Winston-Salem, N. C.,** Dec. 1, Brown-Rogers-Dixon Co.; **Raleigh, N. C.,** Dec. 2, Brown-Rogers-Dixon Co.; **Chattanooga, Tenn.,** Dec. 13, Philco Distributors, Inc.; **Knoxville, Tenn.,** Dec. 15, Philco Distributors, Inc. For more detailed information, exact times and places, contact the local Philco distributor.



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Yes! You read right!

From now through December 15, 1965—with every purchase of an RCA WR-64B Color Bar Generator—you get a FREE color-TV TEST picture tube for use in your color-TV test jig. This is a 21-inch 70° round color-TV TEST picture tube, electrically guaranteed six months from first installation date. These tubes will have minor mechanical (not electrical) defects... they're not quite good enough to go into a new TV set but perfectly adequate for testing purposes.

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Simply buy an RCA WR-64B Color Bar Generator—*THE* essential color-TV test instrument—between now and December 15, 1965. Fill out your warranty registration card and attach the red identification label on the WR-64B carton. Send them to RCA, Test Equipment Headquarters, Bldg. 17-2, Harrison, N.J. We send you the tube (either from Lancaster, Pa. or Marion, Ind.) freight charges collect. To allow for postal delay, we will honor cards received up until December 31st.

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Circle 8 on reader's service card

Correspondence

YOU CAN RECORD FIDELIPACS

Dear Editor:

About "Tape Players for Your Car": Fred Blechman states that the Fidelipac cartridge may not be recorded at home. He is half right. *One* pair of the stereo tracks may be recorded on any home four-track recorder with 3.75-ips speed.

You can thus record whatever music you like best on these tapes and change it when you get tired of it. But you get only half normal playing time.

Full details were given in *High Fidelity* magazine, June 1965, page 100. Newark Electronics sells the cartridges loaded with blank tape.

CHARLES D. HAUPT

Wichita, Kan.

DEGAUSSING DEGARBLED

Dear Editor:

I read with interest the article "Putting in an Automatic Degausser" in the October issue. The author wrote that it is necessary to remove the chassis to install the kit. Actually, it is usually necessary only to remove the tuner subchassis.

Though it does not pertain to our kit (which is added to sets without automatic degaussing), I thought your readers would like to know of a servicing problem in the RCA CTC16.

Considerable care must be taken when replacing the four degaussing coils installed as original equipment in the RCA set. It is very easy to get these hooked up backward. While the service information on the chassis shows one part number as correct for all four coils, actually two of the coils are different. On these, the red and black leads are crossed inside the white tape around the coils before they are connected to the windings. This reverses the polarity. Be sure to compare the internal connections on the replacement with the original before installation. Reverse, or cross, the leads if necessary. This will make sure that the coils are in the correct phase so that they will aid each other. Disregard the color code on the leads.

DICK PAVEK

Colman Electronic Products
Amarillo, Tex.

REVERSED ELECTROLYTICS?

Dear Editor:

In your September 1965 Technotes section is an article "Reversed-Polarity Electrolytics in Ford Radios" submitted by a Mr. James R. Giles. The conclusions drawn by Mr. Giles are incorrect.

First C2-a can and does see both polarities of dc voltage. With zero or small rf input signals the terminal labled "+" is actually about −0.3 vdc negative with respect to the common terminal. However, as the rf input is increased, a positive-going avc voltage is generated and applied across C2-a so that, with 5,000 microvolts input, the voltage across C2-a is zero. With 1 volt rf input (a not uncommon condition), the voltage across C2-a is approximately 1.2 volts positive.

C2-b does have a negative voltage of approximately 0.2 applied to its plus terminal at all times. Thus, under no-signal input conditions both capacitors are indeed "reversed-biased" as Mr. Giles states. The significant factor is that the reverse voltages are always well under a ½ volt dc.

As you well know, the anode of an electrolytic capacitor differs from the cathode only by the presence of aluminum oxide on its surface. Normally this oxide film is formed chemically on the anode foil to the desired thickness as determined by voltage-rating requirements. However, if no deliberate forming is

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done, the mere exposure of aluminum foil to air, or to the electrolyte solution, will produce an oxide layer which will block up to 1 volt dc. This 1-volt oxide film is unavoidable and it does not deteriorate with age regardless of the polarity of applied voltage. Thus the capacitor in question can honestly be rated at +3 to −1 vdc and as such will always have a 3 to 1 safety factor over maximum applied voltages.

We have produced well over one million radios using this particular capacitor and feel that we are justly proud of the reliability of this design.

J. M. MILLER

Bendix Corp.
Baltimore, Md.

DON'T TWIDDLE

Dear Editor:

On Mr. Mivec's "—CB service call" in the June issue, one of the pitfalls of transmitter servicing by inexperienced service technicians is demonstrated. I hope his customer did not receive an off-frequency citation!

He tuned the oscillator coil ". . . One more turn for maximum oscillator stability." Any adjustment of this circuit will change the frequency, yet here he was, in a truck on a cold day with no frequency meter, and certainly an improper environment for using one if it was on hand. The rule is: *Don't touch the oscillator tuning unless you are measuring the frequency.*

ROBERT W. SCHOENING

Bloomington, Minn.

HANDS OFF, MECHANICS!

Dear Editor:

On Mr. Babcock's experiences with electronic ignition and auto mechanics (Correspondence, Aug. 1965): it is true that mechanics do not trust something electronic installed in a car's wiring. One of my cars acquired an FM tuner a few years ago, and I naturally installed a few resistors in the lines to suppress noise. Several times since, when I have sent the car in to be overhauled or even just tuned up, unless I remembered to give express instructions to the contrary, when I got my car back, all my suppression equipment had been removed and thrown away. The mechanics were not trying to gouge me with new parts (I know them that well), but threw out my stuff because they did not understand it (especially the resistor between the coil and the distributor).

Moral of the story—if you want a mechanic to work on your car and you have a bunch of special stuff on it, *warn him about it,* and tell him what not to do, or you'll have to scrounge up parts again.

STEPHEN A. KALLIS, JR.

Huntsville, Ala.

END

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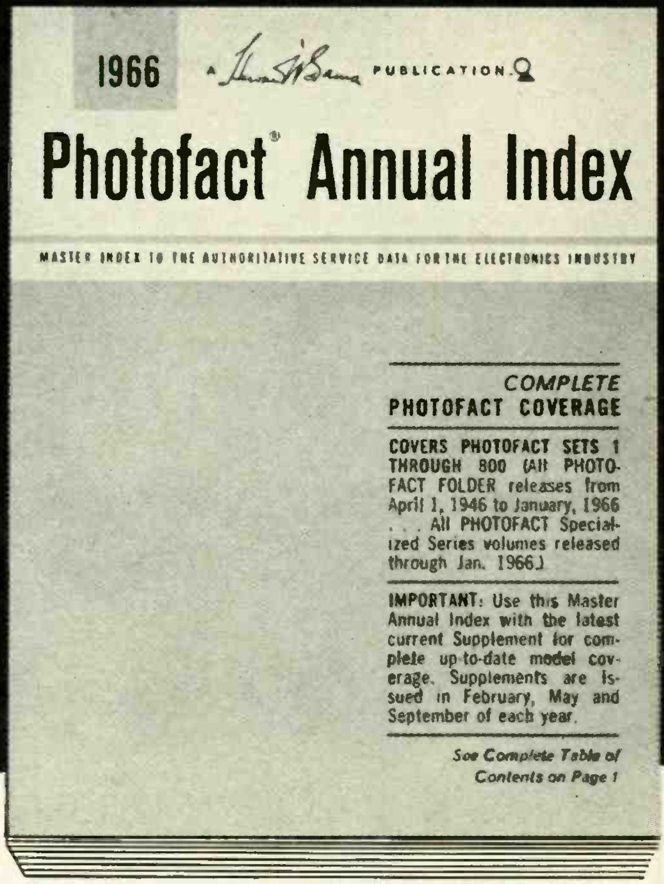

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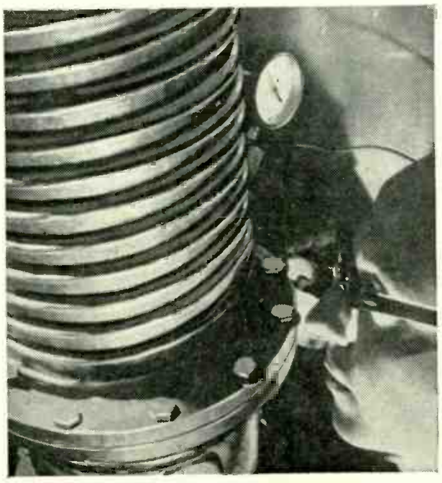
696,000 TECHNICIANS NEEDED BY 1970!

Government Report* Points Out Rapidly Growing Job Opportunities: Need for Trained Electronics Technicians An Important Factor

By Bill Gordon, RCA Institutes, Inc.

President Johnson Emphasizes Need. In his 1964 annual manpower report, President Johnson indicated that the demands for manpower are expanding most in, among other fields, service and technical (including technician) occupations. This expansion is the result of a handful of causes underlying today's big changes in the occupational picture: (1) increasing complexity of modern technology, (2) trend toward automation of industrial processes, (3) growth of new areas of work, such as in the field of atomic energy, earth satellites and other space programs, and (4) data systems analysis and data processing. Indicative also of the growing importance of the use of technicians is a recent revision of the "List of Critical Occupations" published by the U.S. Department of Labor in which technicians are listed for the first time by the U.S. Government.

Salary Levels for Trained Technicians Rising Fast. Beginning salaries for graduates of top level technician education programs have continued to go up during the past five years, at a faster rate than salaries of similar types of jobs. In fact, a U.S. Labor Department projection based on the figures shows that by 1970, technician salaries will average an all-time high.

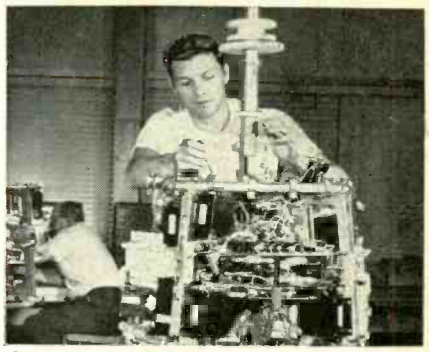


Nuclear Instrumentation

Technical Education is One of Today's Best Investments. Today, a person interested in becoming a technician can choose Home Training or Classroom Training to begin building his career. One of the nation's largest schools devoted to training electronics technicians, RCA Institutes, offers a wide variety of courses in both categories. In addition, the RCA "AUTOTEXT" Programmed Instruction Method is helping people learn faster and easier so they can get started on their careers in the shortest possible time. Dramatic proof comes from the success stories of countless graduates who find profitable positions in government, industry, or in their own businesses.

Of the total 696,000 technicians needed by 1970, it can be estimated that electronics technicians at all levels will form a vital core in today's major job picture.

*"Scientists, Engineers, and Technicians in the 1960's" U.S. Department of Labor, Bureau of Labor Statistics.



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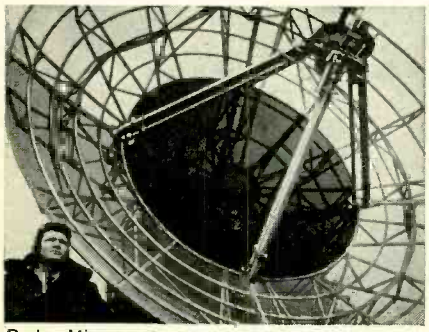

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SERVICE CLINIC

By **JACK DARR** Service Editor

The Misleading Reading

DOES YOUR METER MEAN WHAT IT SAYS? If it tells you, "10 volts here", is it right?

Well there are times, for example, a perfectly good ac voltmeter will give you a wildly inaccurate reading with no relation to the actual voltage! Now let's see why it does that.

Table I shows readings from four ac voltmeters. A is a 10,000-ohm-per-volt type, B a 5,000-ohm-per-volt, and C is a vtvm (using a vacuum-tube ac rectifier). D is a very cheap imported type, thrown in for comparison. A, B and C are made by well known US instrument firms, and are in perfect shape. The ac voltage of Table I comes from an oscilloscope calibrator; a scope was used to "monitor" all voltages for all tests.

On a 10-volt (rms) sine wave, we got 10 volts, except for meter D. Now look at Table II. Hmmm. The *voltage* is the same, on the scope, but look what's happened to our readings. The frequency is still the same, 60 cycles, but the source is now a *square wave*.

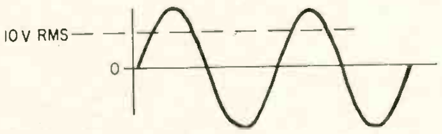


TABLE I
Voltage: 60-cycle sine wave, 10.0 volts rms.

Meter	Indicated
A	10.00
B	10.00
C	10.00
D	8.0

At the same frequency and voltage, look at Table III. Wow! Worse and more of it. Also, note the difference when the prods are reversed. (On an ac voltage? How come?) This is *not* an ac voltage; it's voltage spikes on the cathode of the vertical oscillator of a TV set—actually pulsating dc with a steady 12-volt dc component.

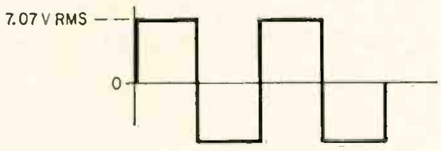


TABLE II
Voltage: square-wave, 7.07 volts "rms", 60 cycles

Meter	Indicated
A	15.0
B	9.8
C	9.0
D	5.2

Meter A has a full-wave bridge rectifier; B has a half-wave. Look at the drastic change when the prods are reversed: 8 volts for A and 28 volts for B. What would this do to you if you were trying to find trouble in a circuit?

In Table IV, we read the grid voltage on the horizontal output tube, at 15,750 cycles. Oddly, these are nearer

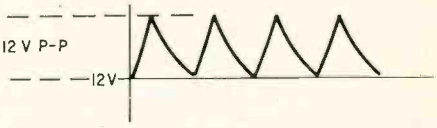
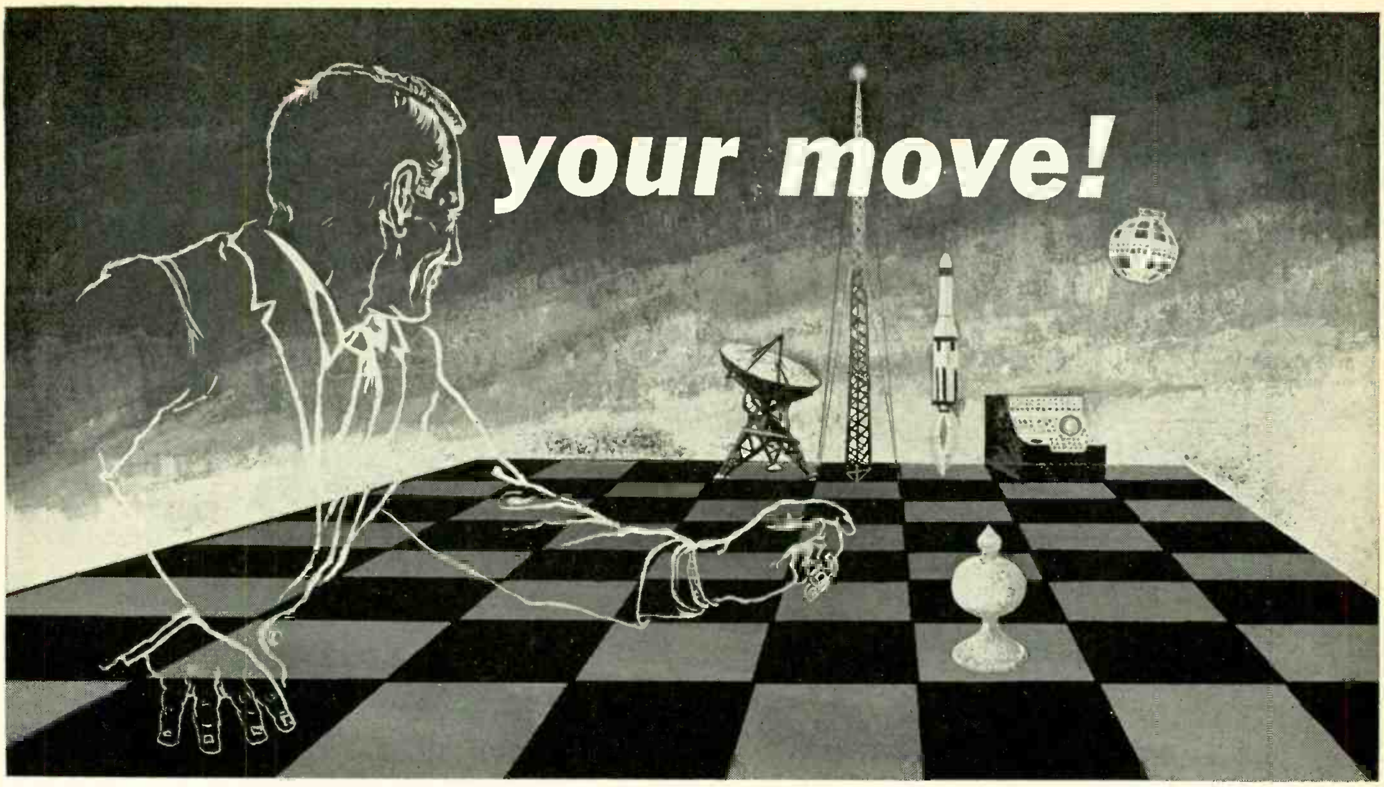


TABLE III
Voltage: 12.0 volts peak to peak, 60 cycles with 12 volts dc, from vertical osc. cathode

Meter	Indicated
A	18.0 (50-volt range)
A, prods reversed	10.0
B	28.0 (60-volt range)
B, rev.	Small off-scale reading
C	7.0 (12-volt range)
D	4.5
D, rev.	6.0



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the true value than the 60-cycle vertical waveforms! Perhaps because this is a trapezoidal waveform, not a spike. The actual voltage is 110 peak to peak, which, if you work it out with the sine-wave formula, comes out about 40 volts rms.

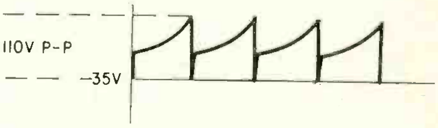


TABLE IV
Voltage: 110 peak to peak, horizontal output tube grid, 15,750 cycles. —35 volts dc to ground

Meter	Indicated
A	39.0
B	0.4
C	40.0
D	35.0

That's what happens. Now, *why?* The typical ac voltmeter is a dc microammeter with a rectifier; some use full-wave bridges, some half-wave, and some use tubes (6AL5, etc.). Any dc present when an ac reading is taken will find a conducting path through the rectifier, and upset the accuracy of the reading!

These meters are calibrated on the rms value of a perfect 60-cycle sine wave. If we change the *waveform* or the *frequency*, the reading changes drastically. So, square, pulse and spike waveforms simply aren't going to read anywhere near their true value.

What conclusions can we draw from this experiment? (Which, incidentally, you can repeat for yourself very easily.) One, if you want to measure only 60-cycle sine-wave ac, fine. Two, if there is any dc component, as there will be in tube plate circuits, transistor collectors and so on, you will have to use a series (blocking) *capacitor* if you want anything like the actual ac voltage. Any capacitor big enough to have negligible reactance at the test frequency is fine (2 to 4 μf for the lowest range of a 20,000-ohm/volt meter is adequate down to 30 cycles. The higher the frequency and the input resistance of the meter, the smaller the capacitor can be.)

That takes care of one problem, but what about the spikes and pulses? The answer is simple: Don't! *To read*

This column is for your service problems—TV, radio, audio or general and industrial electronics. We answer all questions individually by mail, free of charge, and the more interesting ones will be printed here.

If you're really stuck, write us. We'll do our best to help you. Don't forget to enclose a stamped, self-addressed envelope. Write: Service Editor, Radio-Electronics, 154 West 14th Street, New York 10011.

pulse and spike voltages, use the only instrument that'll give you an accurate indication: the oscilloscope with a voltage calibrator. If you don't have a calibrator, use the voltage from the heater supply of your tube tester, and work out peak, peak-to-peak, and rms from the formula. After all, in TV service work, what we need to know about any signal is "Is it there at all, and if so, is it *about* the correct value?" Accuracy down to .001% isn't necessary.

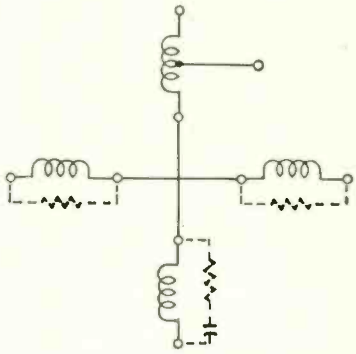
While running these tests, I wondered if there was any way to work out a formula so that we *could* use common ac voltmeters and then convert. Turns out there isn't—or at least I didn't find one. There are so many variables—dc voltage, actual waveshape, and so on—that I don't think it can be done with any usable accuracy.

So, remember this: make it a habit to know the *limitations* of any test equipment you use, so that you won't be led up the garden path by false indications! (We've got enough trouble as it is, without our test equipment telling us fairy tales!)

TEST YOKE/CRT FOR BENCH

I have a 17HP4 tube I'd like to rig up as a test CRT to mount over my bench, with a universal yoke for 90° and 110° sets. How can I do it?—C. A., Cap de la Madeleine, Que.

It'd be handy, but there are problems. Horizontal deflection coils aren't hooked up the same in all sets—some are in parallel, like G-E; some with center taps, and most of them in series. Vertical coils are mostly in series. A typical yoke is shown. Dashed lines show resistors and capacitors required in some sets. Your best bet would be to bring all connections out to individual pin jacks. Then you can make up adapter cables with sockets to fit the sets, or clips, for those without plug-in yokes.



You'll have to check the schematic carefully on each set to get the horizontal coils hooked up right. Even then, you'll get odd effects on a few of them from a slight mismatch. However, the scheme *might* be made to work fairly well. You'll find a difference in sweep between the 90° and 110° sets, for it takes quite a bit more power to sweep a 110° tube. However, if you remember and don't waste time trying to find the cause of a narrow raster, it could be OK.

A good average horizontal coil inductance for these sets would be somewhere around 18 mh, with the vertical around 25 to 30 mh. (Most 90° yokes seem to run about 40 mh, 110° yokes about 15.)

You can make up an adapter cable for the CRT base with different sockets on it, and bring these terminals out to pin jacks too. Be sure to *label* all pin jacks so that you'll know what you're hooking up! END

REPAIR RECORD CHANGERS

If you can fix a TV set, you can whip a record changer back in shape. This article tells how. The trick is knowing the unique functions of a variety of ports. Lots of photos, special pointers, secrets of the trade make learning easy. You'll see what to do, what not to do, to become an expert.

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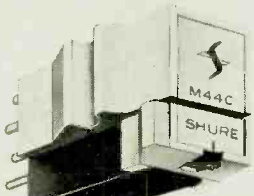

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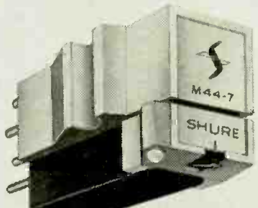

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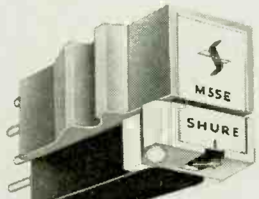

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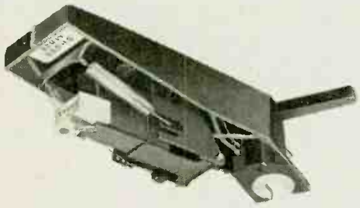

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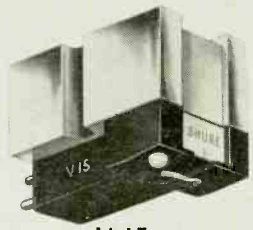

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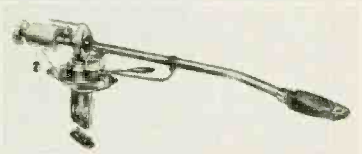

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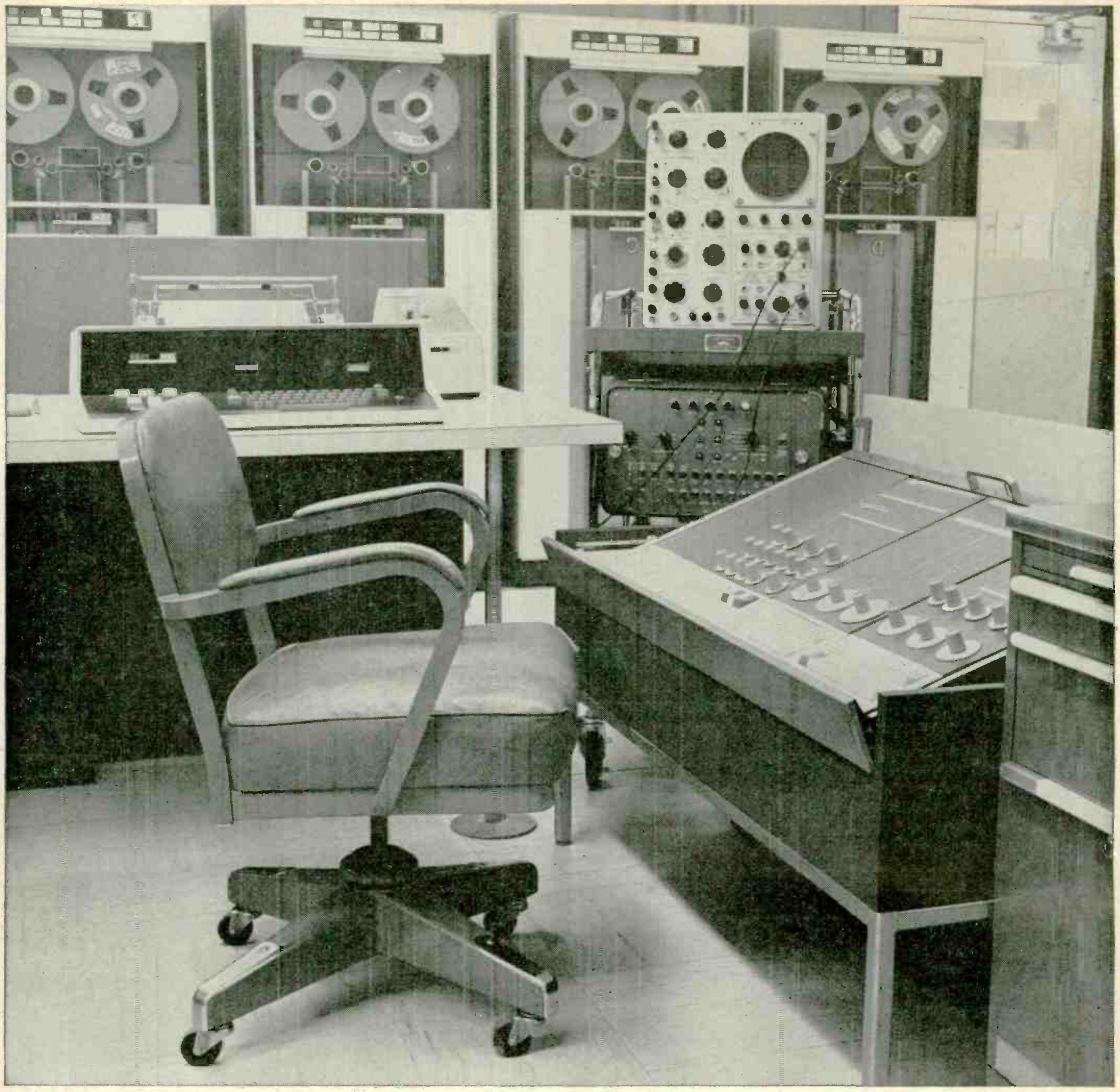

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RE-11

1945-1965: TWENTY YEARS OF LEADERSHIP IN CREATIVE ELECTRONICS

Circle 21 on reader's service card

Radio-Electronics
Hugo Gernsback, Editor-in-Chief

JOHN R. MEAGHER
Manager, ELECTRONIC
INSTRUMENTS OPERATIONS
RCA ELECTRONIC
COMPONENTS & DEVICES

The Past and Future of Test Equipment

GUEST EDITORIAL BY JOHN R. MEAGHER

IN 1919 I acquired my first piece of radio test equipment, a door buzzer. When connected in series with four No. 6 dry cells, this instrument created and radiated electrical interference that was picked up in the antenna circuit of my first crystal receiver. Using this more-or-less white-noise signal, I could find a sensitive spot on the galena crystal by patiently manipulating the cat's-whisker. My second piece of test equipment was a click type continuity checker—a pair of "2000-ohm" headphones connected in series with one or more dry cells.

My third piece of test equipment was a reflecting galvanometer. Its sensitivity was a few microamperes per division. With it, I could make comparative measurements of the effectiveness of different antennas, tuning arrangements and detectors.

Crystal sets were quickly superseded by tube sets, starting with regenerative receivers and progressing through tuned rf amplifiers to the superheterodyne. Ac power supplies, screen-grid and pentode tubes soon made their appearance, also short-wave sets and car radios.

As receivers became more complicated, the need for qualified radio repairmen and suitable service test equipment also grew. Radio repairmen evolved successfully from the ranks of hobbyists, amateurs, experimenters, electrical repairmen and students. Test equipment also evolved, but at a slower pace. In the early days of radio, the principal test equipment consisted of separate meters, one for dc voltage, one for ac voltage and one for direct current. Progress was made when manufacturers began incorporating several voltage or current ranges in each meter. This led eventually to the multimeter or volt-ohm-milliammeter, which combines many functions and ranges in a single compact instrument.

The first multimeters usually had 1-ma meter movements, with a sensitivity of 1,000 ohms per volt for dc.

An important advance was made when new magnet materials made it possible to use 50-μa movements in multimeters, giving a sensitivity of 20,000 ohms per volt for dc. This improvement reduced the resistive loading effect of the meter and gave truer indications of voltage in high-resistance circuits, but the capacitive loading effect of the test leads (50 to 100 pf) meant, and still means, that a 20,000-ohm-per-volt vom cannot be connected to a tuned circuit, such as an i.f. circuit, without detuning the stage, hence agc voltage cannot be read at the grids without seriously disturbing the circuit action. The same limitation applies to measurement of oscillator grid voltage.

The VoltOhmyst, first introduced by John Rider in the late 1930's, was, in my opinion, the most important advance in service test equipment. The VoltOhmyst was a special type of vtvm, with a 1-megohm isolating resistor in the probe tip, with a fixed input resistance of 10 or 11 megohms on all dc voltage ranges, and with a burnout-proof electronically protected meter. The isolating resistor effectively eliminates the capacitance effect of the input cable or test leads, thus making it possible to measure agc voltage at the grids of the tubes, or developed oscillator grid voltage, without appreciably affecting the action of the circuit.

Again in my opinion, this instrument is the most important and most useful item of test equipment in radio and TV service shops, just as the 20,000-ohm-per-volt vom remains the principal item for field use.

The tube tester is probably the next item of importance. There wasn't much need for such an instrument in the early 1920's. There were only a few kinds of tubes, all simple filament type triodes. If the filament lit, if there was no visible evidence of gas and if there was no obviously broken internal connection, the tube was probably OK.

Present-day TV technicians are offered a wide variety of service type tube testers. The drastic decline in the number of new tube types is giving test-equipment manufacturers a much-needed breathing spell to consolidate and improve existing designs.

Cathode-ray oscilloscopes made their appearance in the radio service field in the early 1930's, but very few service men bought them. It wasn't until the mushroom growth of TV after World War II that technicians began to appreciate the value of scopes for localizing troubles. I believe that the majority of TV technicians still do not take full advantage of the assistance that a good oscilloscope can give. It takes study, time and effort to become expert in interpreting abnormal CRO patterns. Schools, manufacturers and technical writers still have a job to do in making it easier for technicians to understand what they see on the scope.

Rf-i.f. alignment, which had never been a real problem in radio receivers, became very important in TV sets, and even more so in color TV. Experienced TV technicians know that it is very helpful to check the overall rf-i.f. response in "dogs", where the cause of trouble is obscure. Good sweep and marker generators are not cheap, but they are essential for progressive TV service shops.

continued on page 78

As a service authority who has lectured to radio and television servicing groups in virtually every state, John R. Meagher has become one of the nation's best known experts in these fields.

Starting with a high-school vacation stint on one of Gernsback's early publications, then as a technical editor of Wireless Age *in the early '20's, followed by research laboratory work and, since 1936, when he joined RCA as technical editor, field engineer, author and lecturer. John Meagher has devoted his years to technical radio and TV services.*

Closely associated with television servicing problems from the first black-and-white receivers, he developed the TV Dynamic Demonstrator, an outgrowth of the original Radio Demonstrator he devised in 1936. In 1946 he compiled the RCA Pict-O-Guides —illustrations showing the most common faults of TV sets as observed on the screens of picture tubes.

Mr. Meagher is now active in the development, design and promotion of RCA test equipment.

YOUR SHOP – A SERVICE TOOL

Your shop's layout and equipment can work for or against you.
Read about the simple steps you can take toward a more efficient work setup

By JACK DARR
SERVICE EDITOR

THE BIGGEST, COSTLIEST, MOST ELABORATE tool you work with is your shop. Like any tool, your shop can *help* you or *hinder* you, depending on how well you use it. While this article is aimed mainly at the men who try to make a living out of one, these principles will make home hobby shops more useful and enjoyable.

Here's the basic principle: we need a shop setup that will let us get a set in, tested, repaired and out again in the least possible time. The two keys are *convenience* and *traffic flow,* plus a goodly amount of self-discipline. (I'm not saying I *do* all these things myself all the time—just do as I say, not as I do!)

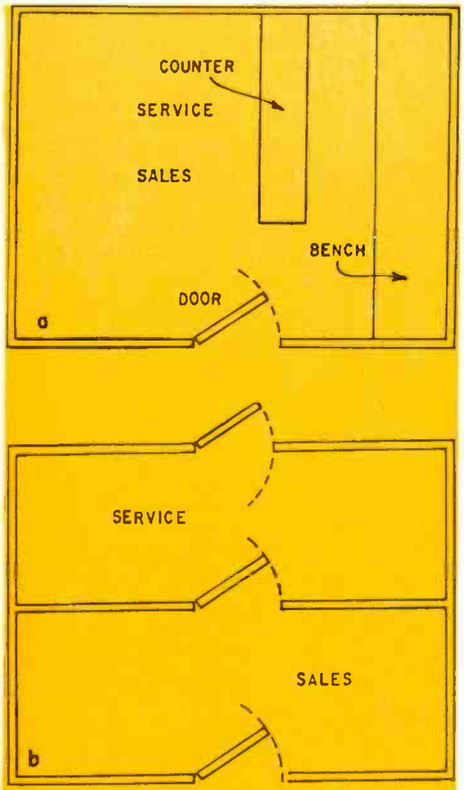


Fig. 1—Shop layout is important for smooth flow of sales and service traffic. At (a) is convenient one-room, one-door layout; (b), two-room layout, which should have back door direct to service area.

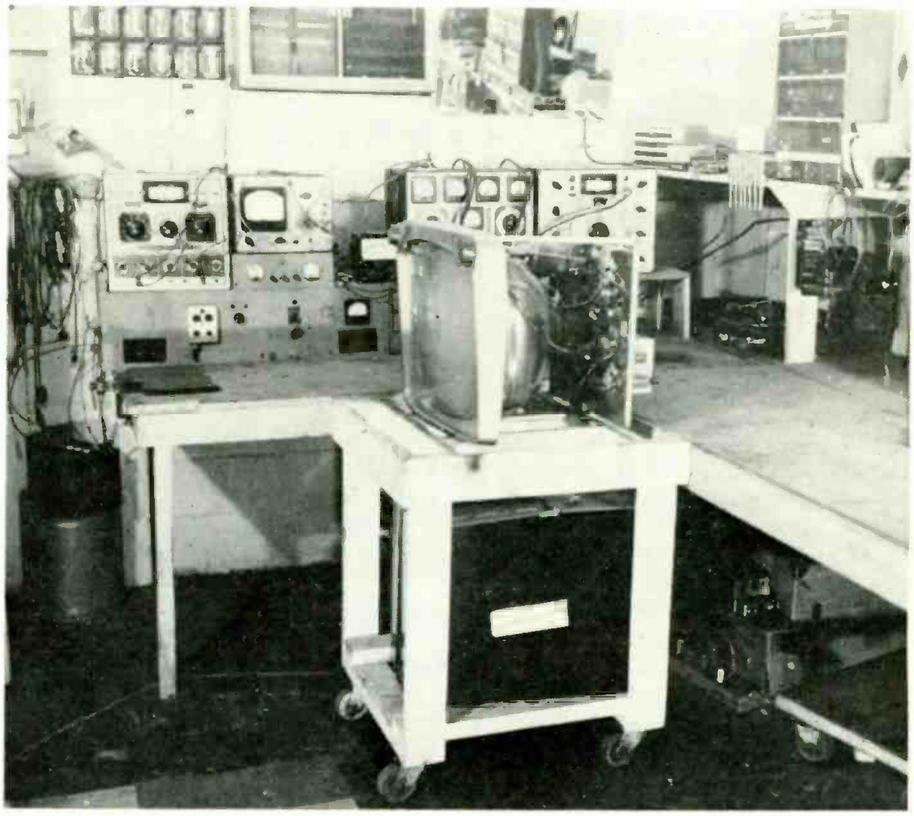


Fig. 2—L-shaped corner bench, with instruments conveniently arrayed in some order related to amount of use they get, is terrific help. Wheeled, slat-top cart, same height as bench, is practically a necessity.

The overall layout of the work area is first. There are two types of shops: service-and-sales, and service-only. If you sell, make sure that service jobs are never hauled in and out through the sales/display area. Load and unload service work directly into the service section. With only one entrance, the layout of Fig. 1-a is better than Fig. 1-b. With a back door, of course, 1-b is very handy. There are lots of possible variations, but remember the principles.

The working area

This is where you do the actual testing and repair work. The key here is *convenience*. The ideal setup is one that lets you concentrate on the work itself, without having to worry about inconvenient things around the bench.

Most jobs will be simple: tubes, resistors, capacitors, etc. So, set up your most-often-used test equipment within easy reach: vtvm, capacitor tester, scope, etc. Near, but not in the way, the secondary equipment: sweep generator, flyback tester and so on. Keep all test equipment where it can be seen and reached, but never where it will be in the way.

Keep the common hand tools on the bench where you can pick them up instantly: nut drivers, screwdrivers, long-nose and cutter pliers, soldering iron, etc. Keep the others nearby, but not in a place that takes too much time to reach.

Try out different setups for the test equipment. While you're working, look out for things that are inconvenient, then see if you can figure out a way to make improvements. It's easy.

Your parts stock

You need parts handy, yet out of the way. Keep them all arranged so that you know where they are: tubes on a shelf, by the numbers, resistors and capacitors on shelves or in small cabinets; flybacks, controls and less commonly used parts in a place where they can be found and reached, but nearby. A handy setup for a long, narrow shop is a bench along one long wall and the parts shelf on the other: then, all you have to do is turn around and reach!

The storage area

About the most common fault in shops is a lack of *storage space*. Far too many of us use the bench! Don't! We must have a place where sets can be kept out of the way while waiting to be worked on, or, once fixed, while waiting for delivery.

Shop discipline

The hardest part of the whole thing is *discipline!* I mean *us;* thee and me! My bad habits have cost me money. Force yourself to do things right, and in time it'll get to be a habit (a good habit this time).

Step 1 in this is *keep the bench clean.* This means *one job on the bench at a time.* When you bring a job into the shop, do you have to put it on the floor while you shovel off a place on the bench? Then you're the guy I'm talking to! The storage space should be all ready, so that this new job can be put away there to wait its turn. Be sure that all jobs are tagged *the minute they come in*, and that the tags are placed so that they can be seen immediately.

Never leave "awaiting-parts" sets on the bench; pick 'em up and get them into the storage area. Suggestion: divide your storage area into three sections—fixed sets, unfixed sets and awaiting-parts sets. Put the finished sets nearest the door for fastest loading. Another suggestion: if you find several sets that need parts, put 'em all together, make up a list, and make one trip to the distributor's do for them all. Sounds obvious—but do you do it?

Transport

Moving sets around the shop can be easy or hard. Save the poor old back by making up some carts on casters, like the one in Fig. 2. If you're a halfway good carpenter, as most of us are, you can make one of them in less than an hour. Make them so that the top comes out exactly level with the bench. Don't forget the height of the casters. Making the cart so that the top is very nearly the same width as the shop door is also handy: if a set hangs over the cart edges, you know right away that it's not going to make it through the door! Try

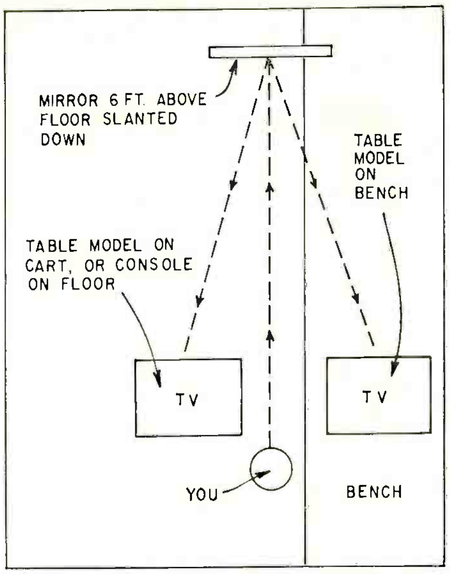


Fig. 3—How to set up a wall-hung mirror to serve sets on floor and bench.

a couple of these to begin with, and add more later.

When you bring in a set, roll a cart up to the back of the truck. Pick up the set, turn around, and there's the cart. Much less strain on the back! Table models of all kinds, even color sets, can be rolled into the work area, the back pulled off, and many service jobs done without moving it again. The open-slat construction of the cart top lets you take out the mounting bolts from below without lifting the chassis. If it must be pulled, the bolts can be taken out and the chassis slid off onto the bench.

If the tube stays in the cabinet, it can be hooked up with extension cables for the CRT, yoke, high voltage, etc. This is handy for heavy color sets.

For consoles, make up low platforms on casters, in the same way.

When the job is done, the set can be rolled into the storage area. If the set needs parts, the chassis can be put on top and the cabinet underneath, as in Fig 2. Put all loose parts and knobs inside the cabinet.

The little time-savers

Little things can save a heck of a lot of time. Here are a few that have worked out very well for me:

Save little cardboard boxes. When you take a set out of the cabinet, put all the bolts, knobs and loose parts in a box and keep the box with the set. Hunting for knobs and odd parts can waste a tremendous amount of time!

When you take out bad tubes or parts, just put them into another small box. When you finish, take them out and list them on the job ticket.

Get, or make up yourself, a full set of extension cables for yokes, CRT, high-voltage lead, etc. You can get these for color TV sets, too. This lets you leave the cabinet on the cart and put only the chassis on the bench.

Get a big mirror, about 2 x 4 feet if possible. Mount it on the wall at one end of the bench, about 6 to 8 feet above the floor. Tilt it down and set it so that you can see the whole bench and at least 3 feet of the floor, as in Fig. 3. This lets you see the bench and floor area, and saves a lot of the time you would waste trying to get a small stand mirror set just right. Also, if you have a shelf over the bench for test equipment, try putting a smaller mirror on the back wall, under the shelf, right in front of you. Very handy for portable TV's. You can often pick up discarded dresser mirrors behind furniture stores.

Put a "clothespin" quick-disconnect antenna clip on the bench antenna lead-in. If the TV has the two little pins for the antenna lead, use one of the little phenolic boards you find on the backs of those sets. Plug the pins into their sockets, and clip the clothespin to the screws.

Keep a cheater cord plugged in and ready on the bench at all times.

A 4- or 6-inch PM speaker, with about 4 feet of two-conductor cord and alligator clips, makes a handy test speaker. Mount it above the bench out of the way.

Keep a lookout for new "gadget" tools: nut-holding nut drivers, or screw-holding screwdrivers; forceps, clips or any kind of odd tool that will save time in doing some one particular job. They don't cost much, and most of them can be worth a lot in time saved.

There's just one idea behind all this. What we want to do is get our shop set up so that we can bring in a set, test it, repair it and get it home again in the least possible time. Anything that slows this process will cost you money. All you have to sell is time: *your* time! Figure this out: if you have a minimum service charge (and you'd better have!) and you can make minor changes so that you can get out only *one* more TV set per day, that's a clear gain of at least that much and perhaps more! From actual experiments, you ought to be able to get two more per day! END

CALIBRATE YOUR SCOPE

Even an inexpensive scope can measure voltage, time and frequency—if it's properly calibrated.

By ROBERT G. MIDDLETON

THE SINGLE MOST REWARDING THING you can do right now is to trot over to your bench and calibrate your oscilloscope. If it has calibration markings, check 'em: if it's never been calibrated, do so now. It's easy, it'll teach you things about your scope, and it will make that king of instruments even more useful.

The basic calibration is for vertical sensitivity, and takes advantage of the decade vertical attenuator on most modern scopes. (If yours doesn't have one, don't go away.) If you have a dc scope, it is very easy to make the initial calibration with a mercury cell or battery, as shown in Fig. 1. The vernier vertical-gain control is adjusted for a convenient reference deflection, such as 1 dc volt per inch. For ac, the sensitivity of the scope will be 1 peak-to-peak volt per inch.

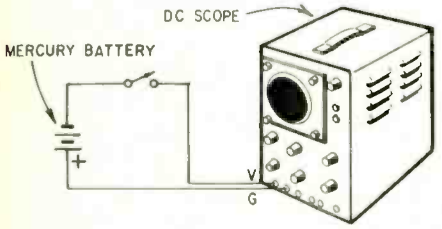


Fig. 1—Adjust the vernier vertical gain control for a reference deflection.

If the decade (step) attenuator is accurate, the scope can now be used to measure dc or peak-to-peak voltages over a wide range. Normally, when the decade attenuator is turned from its ×1 to its ×10 position, the reference sensitivity is reduced to 0.1. The vertical sensitivity in the ×10 position (assuming 1 volt for the ×1 position) would be 10 dc or peak-to-peak volts per inch. However, you cannot know that the decade attenuator is accurate unless you check its calibration. This can be done with a series of precision resistors, as in Fig. 2.

A 60-cycle source is used, so that only the resistive part of the scope's input impedance is signifiant. (At that low a frequency, the capacitance is negligible.) Voltage is chosen for convenience—let's say 100 volts rms. Its absolute value is not important. Precision (1%) resistors are connected in a divider chain to obtain decade relations on the successive steps. The values in Fig. 2 give a low source resistance which is not seriously loaded by the scope's input impedance. The 9,000-ohm resistor should be rated at 1 watt; the smaller resistors may be rated at ¼ watt.

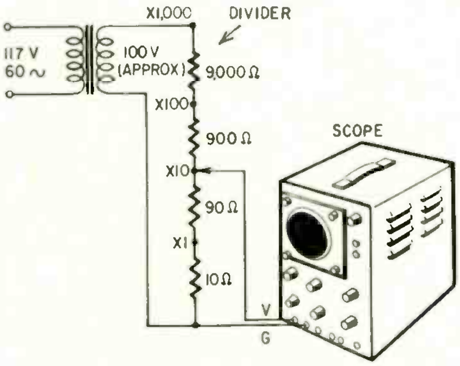


Fig. 2—Basic check of scope's attenuator. Actual voltage is not important. Calibrations are the inverse of those on the scope.

Observe the trace height at each step. It should be the same at all *corresponding settings* of both switches. That is, the height at the × 1 position of attenuator and divider should be the same as the height at the × 10 position of both switches. Likewise, the same deflection should be obtained with the step attenuator set to its × 100 position at the × 100 tap of the divider, etc.

Suppose you *don't* find the same deflection on various positions of the step attenuator? This means that the resistors in the scope's attenuator network are off value, and need replacement. But think for a moment about how high accuracy you need. One well-known service scope is manufactured with 2% decade resistors; another uses 5% resistors; still another is made with 10% resistors. You might choose to replace all the decade resistors with 1% values. That's up to you.

Fig. 3—This scope has a terminal that carries an 18-volt p–p calibrating voltage.

Initial calibration—ac scope

Now let's go back to the beginning and consider the initial calibration of an ac scope. A mercury cell or battery can be used, although it is not convenient. Before an ac scope will respond steadily to the dc battery voltage, the voltage would have to be chopped into a square wave. Furthermore, the chopper would need to operate at a frequency within the flat response range of the scope, such as 60 cycles. Hence, it is more convenient to use a calibrated ac source.

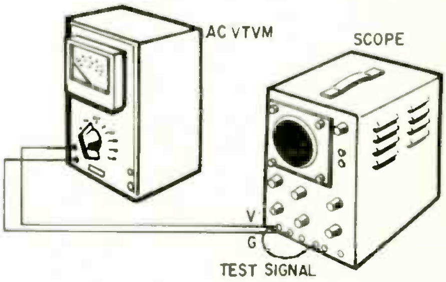


Fig. 4—Measure the calibrating voltage with an accurate vtvm.

Most modern scopes have a front-panel terminal for this. For example, the scope in Fig. 3 has an 18-volt peak-to-peak test signal, available at the terminal just left of the horizontal input post. This is a 60-cycle voltage. *Note carefully that this is a nominal value, which depends on the line voltage.* So, always use an accurate vtvm, as shown in Fig. 4, to check the calibrating voltage. The test signal has appreciable harmonic content, but this is of no concern as long as you are working with peak-to-peak voltages. Although you *could* use a vom, which indicates rms voltages, by converting to peak-to-peak values, your goal of accuracy becomes difficult to reach. Har-

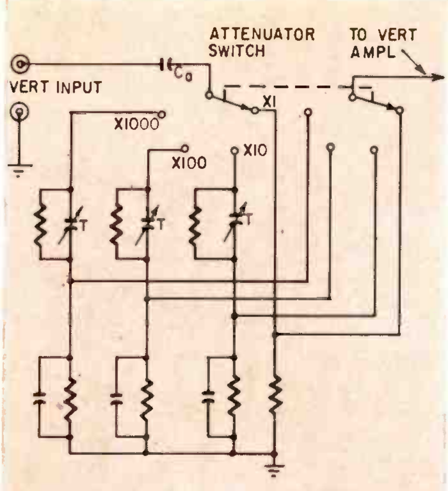


Fig. 5—Typical scope step attenuator.

monics in the test signal cause the rms voltmeter to read more or less incorrectly, even if the voltmeter is inherently quite accurate—for pure sine waves.

To check decade attenuation of an ac scope, use the same test setup as in Fig. 2. Test-instrument users often want to know why the decade resistors are sometimes widely off-value. The usual cause is accidental overload. Fig. 5 shows a typical step-attenuator configuration. If a high ac input voltage is acci-

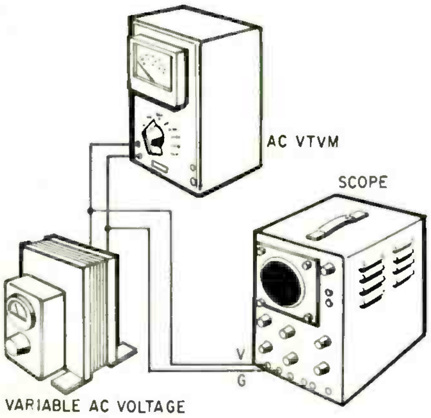


Fig. 6—Setup for calibrating a continuously variable vertical-gain control.

dentally applied, such as from a TV sweep circuit, abnormal current flow can overheat the resistors. Keep in mind, too, that capacitors occasionally become leaky or shorted, giving the *effect* of resistors too low in value. If C_a should open, there will be little or no deflection.

Calibration of vernier vertical-gain control

It is very convenient to have a calibrated vernier vertical-gain control. Then a pattern can be brought to a reference height, such as 3 inches on the scope screen, and its peak-to-peak voltage is indicated directly by the settings of the vertical gain controls. A small minority of service scopes are factory-calibrated this way. Most scopes have a vernier gain control merely marked zero to 10, or zero to 100, or not at all. You can relate these arbitrary divisions to peak-to-peak voltage with the calibrating setup of Fig. 6.

The variable ac voltage can be obtained from a variable autotransformer, or from a small transformer with a potentiometer. It is most convenient to use a peak-to-peak vtvm, because you can forget about waveform error. Calibration data can be plotted as shown for a typical scope in Fig. 7. It is advisable to use log-log graph paper, because the

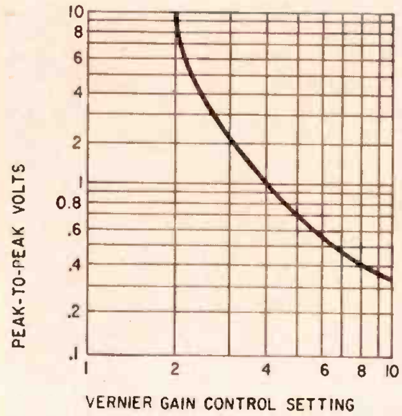


Fig. 7—Sample chart of p–p voltage versus gain-control setting.

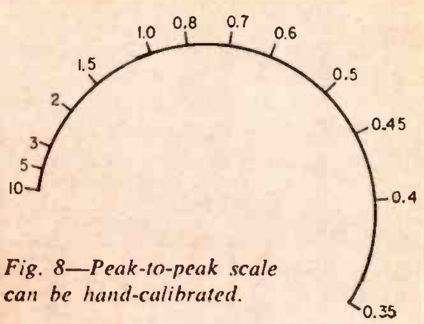


Fig. 8—Peak-to-peak scale can be hand-calibrated.

vernier gain control has a very nonlinear characteristic, and the curve is much easier to plot and read on log-log coordinates. The gain control may not be useful over the first 20% of its range; many scopes tend to overload at such low control settings. Thus, data were taken only over the range from 2 to 10 for Fig. 7.

Since a graph is less convenient than a direct-reading scale, you may prefer to hand-calibrate a scale for the vernier gain control. A scale for the useful operating range of a typical gain control is shown in Fig. 8. The calibrations indicate peak-to-peak voltage on the ×10 range. When the step attenuator is set to the ×1 position, the decimal point is shifted one place to the left. Or, when the step attenuator is turned to its ×100 position, the decimal point is shifted one position to the right. Thus, the peak-to-peak scale is as easy to read

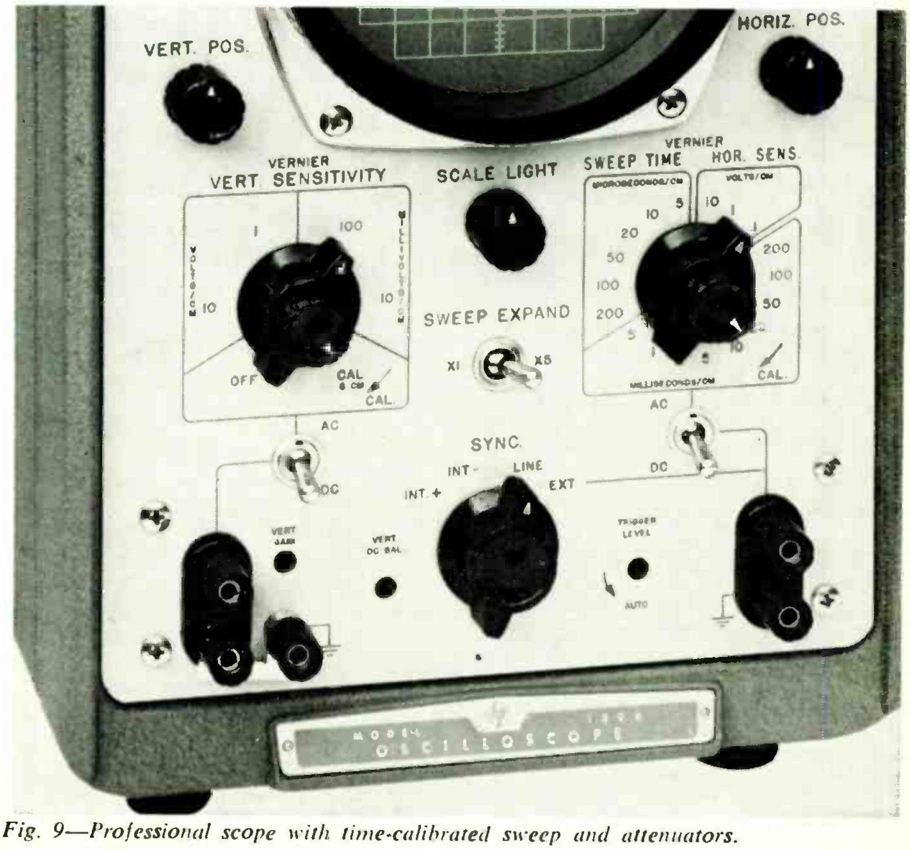


Fig. 9—Professional scope with time-calibrated sweep and attenuators.

as an ohmmeter scale.

It might occur to you that some kind of tapered potentiometer could be used as a vernier gain control to make the peak-to-peak calibration vs rotation more uniform. This is quite practical. Again—it's up to you.

As tubes in the vertical amplifier weaken, the calibrated gain control becomes inaccurate. So, check the calibration occasionally, and replace tubes that show a slump in mutual conductance. A calibration control can be added to the vertical amplifier to adjust the amplifier gain (analogous to a vtvm calibration control), but that's a subject for another article.

Horizontal frequency calibration

Nearly all more expensive scopes have calibrated sweeps. A typical professional scope is illustrated in Fg. 9. Calibrated sweep is a very useful feature, because it indicates the frequency of a displayed waveform, and measures the rise time of square waves or pulses. Service type scopes provide only a rough indication of the sawtooth rate (Fig. 10). If you wish, you can calibrate the vernier frequency control accurately, and get much of the usefulness of factory-calibrated sweeps.

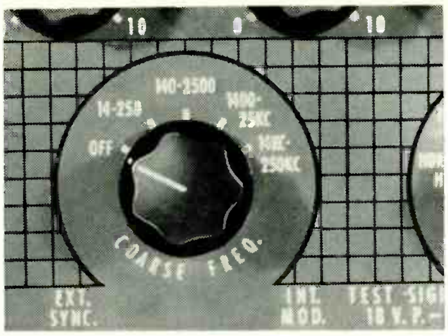


Fig. 10—Coarse-frequency switch is rough indicator of sweep rate.

A good audio oscillator is most convenient for this. Simply feed the output from the audio oscillator into the vertical input terminals of the scope. Do not advance the sync amplitude control farther than necessary to lock the sine-wave pattern; otherwise the frequency of the sawtooth oscillator will be disturbed objectionably. Adjust the sweep rate to display one cycle on the scope screen; the audio oscillator then indicates the sawtooth frequency. You can either plot a curve of frequency vs vernier sweep control indication, or draw up a hand-calibrated frequency scale.

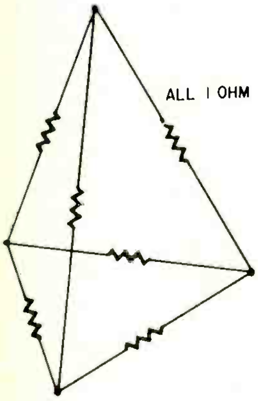
If the audio oscillator range is too limited, use a good AM generator to calibrate the scope at high sweep rates. Note that the vernier frequency control usually does *not* "repeat" its calibration from one step to the next of the coarse frequency switch. Therefore, you must calibrate the vernier control on each step of the coarse control. As the sawtooth-oscillator tube ages, the original calibrations change gradually, Hence, it is good practice to check calibration occasionally, and replace that tube if necessary.

Some scopes have regulated power supplies, and others do not. Unregulated power supplies make a scope pretty susceptible to line-voltage variations. Both sensitivity and sweep rate are affected by substantial changes in line voltage. However, it is very easy to provide the equivalent of a regulated power supply by using an automatic line-voltage regulating transformer. In addition to optimizing calibration accuracy, a regulating transformer also minimizes pattern bounce due to voltage fluctuation. If both the scope and the equipment under test are powered from a regulating transformer, you will have maximum stability. END

WHAT'S YOUR EQ?

Conducted by E. D. CLARK

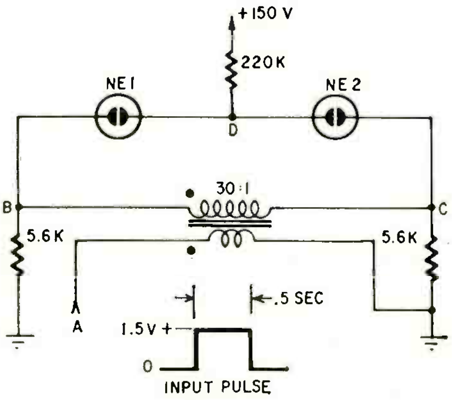
Corner to Corner



A tetrahedron (pyramid with a triangular base) is constructed, using 1-ohm resistors for the sides. What is the resistance between *any* two corners?—*Jack L. Shagena, Jr.*

Flip-Flop Circuit

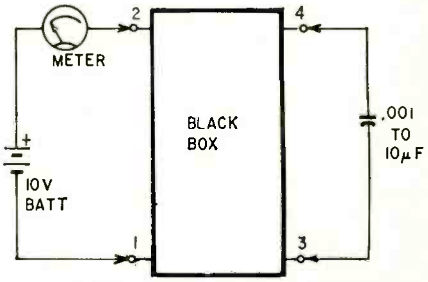
NE1 and NE2 are NE-23 neon glow lamps. Under stable conditions, one lamp is on and the other is off. NE1 has a firing voltage of 70 and a maintaining voltage of 55. NE2 has a firing voltage of 80 and a maintaining voltage of 65. A standard audio output transformer steps up the input voltage to a peak amplitude of 45 or more.



If a positive input pulse of 1.5-volt amplitude is applied to terminal A, which lamp will flop into steady conduction? Assume that, for each lamp, the extinguishing voltage equals the maintaining voltage.—*Kendall Collins*

Black Box No. 1,001

A black epoxy cube 1 inch on a side, with no internal power source, has four terminals. Terminals 1 and 2 are



connected to a 10-volt dc supply with an ammeter (or milliammeter) in series.

A dc voltmeter and scope show only about ½ volt dc when connected to terminals 3 and 4—*but no ac*.

Any capacitor between .001 and 10µf will reduce the input current (as read on the meter) by about 50% if placed across terminals 3 and 4. What's in the box?—*Dave Koller*

Three puzzlers for the students, theoretician and practical man. Simple? Double-check your answers before you say you've solved them. If you have an interesting or unusual puzzle (with an answer) send it to us. We will pay $10 for each one accepted. We're especially interested in service stinkers or engineering stumpers on actual electronic equipment. We get so many letters we can't answer individual ones, but we'll print the more interesting solutions—ones the original authors never thought of.

Write EQ Editor, Radio-Electronics, 154 West 14th Street, New York, N. Y. 10011.

Answers to this month's puzzles are on page 103.

50 Years Ago

In Gernsback Publications
In November, 1915
Electrical Experimenter

- New York to Honolulu by Radio Phone
- Photographing Sound Waves Electrically
- How to Build a Wave Meter
- High Frequency Currents and Apparatus
- Amateur Station that Aided Uncle Sam

Burnout-Proof Your VOM For Less than a Dollar

Two silicon diodes paralleled back to back prevent burned-out meter coils

By L. M. DEZETTEL

WHEN YOU CAN PROTECT AN EXPENSIVE meter movement from overvoltage burnout so cheaply, everyone should hurry to add this simple gimmick to his vom. It costs only 77¢, for a pair of silicon diodes, and that's all you need to buy. There are no wiring changes. You connect the two diodes in parallel (but with reversed polarity) across the meter movement.

You've seen this described briefly before, but here is the complete story. Silicon diodes have almost infinite resistance when reverse-biased. Silicon diodes also have the happy characteristics of having extremely high resistance when *forward*-biased—up to a certain point—somewhere around 500 mv. This is called the threshold voltage. Beyond that the curve of current vs voltage rises rapidly, and this characteristic is what protects the meter movement.

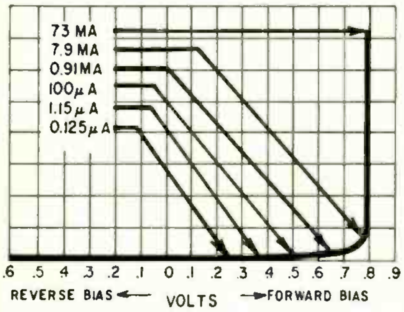


Fig. 1—Diode forward characteristic is the secret of this simple protection. Diode's resistance is extremely high even with forward bias until that bias reaches about 0.5 to 0.7 volt. Then conduction begins abruptly, shunting excess current around the meter.

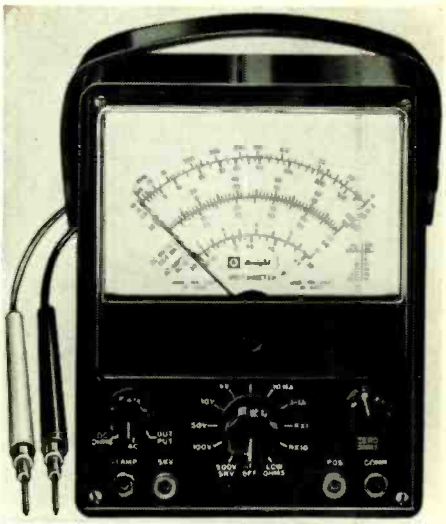
The 1,000-ohms-per-volt vom design is based on a 50-mv full-scale deflection. The coil of the meter movement can stand more than 10 times the voltage for maximum deflection before current through it will do any harm. By that time the diode takes over and carries most of the current from overload. On heavy overloads the needle will be pinned, but the coil is protected against burnout.

The graph shows actual measurements made on a pair of bargain silicon diodes (Allied Radio stock No. 39 U 669-M). Note the sudden rise in current when the threshold voltage is overcome. Below the knee of the curve, the current conducted by the diode is tiny compared to the current taken by the meter. Thus meter accuracy is hardly affected.

In the Knight-Kit 1,000-ohm/volt vom to which this protection was added, for instance, 50 mv across the meter movement gives full-scale deflection. Full-scale current through the meter movement (including a 100-ohm shunting resistor) is 1 ma. At 50 mv, the current through the forward-biased diode is less than 0.1 μa, which means less than .01% effect on accuracy. The reverse-biased diode draws no current.

(Note: In this particular vom, a 400-μa meter movement provides 1,000-ohm/volt sensitivity on ac, because of the shunting effect of the ac rectifier. The 150-ohm movement is shunted by a 100-ohm resistor on dc ranges to retain the same sensitivity.) The curve shows that you can't get 1 volt across the meter movement on any volt range; yet the movement will take 1 volt without burnout.

There are limitations in this method of protection which you must be aware of. Protection depends on some resistance being in series with the circuit so that the principal voltage drop during overload takes place there. This is provided in all the dc and ac ranges of any vom, in the multiplier resistors of these instruments. It is also part of all resistance ranges, *except the "backup" range*, sometimes identified as LO OHMS. Low-value resistances are measured by paralleling across the meter movement, and there is no protective series resistor.



Knight-Kit 1,000-ohm/volt vom on which this diode-protection trick is used.

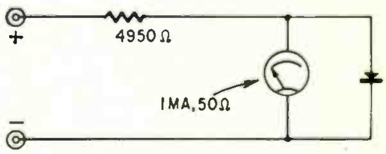
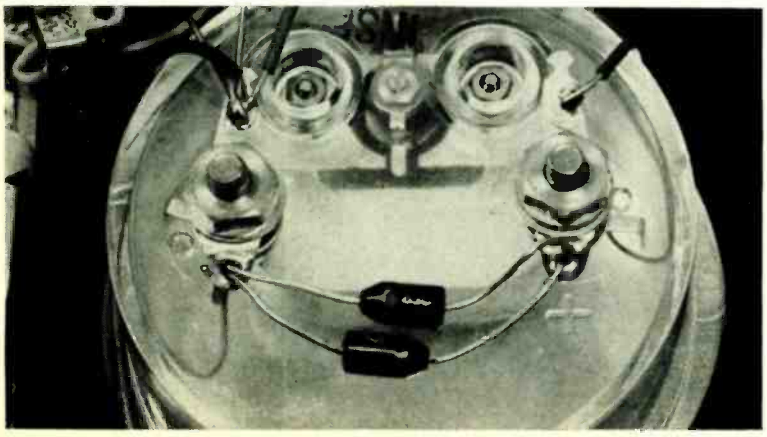


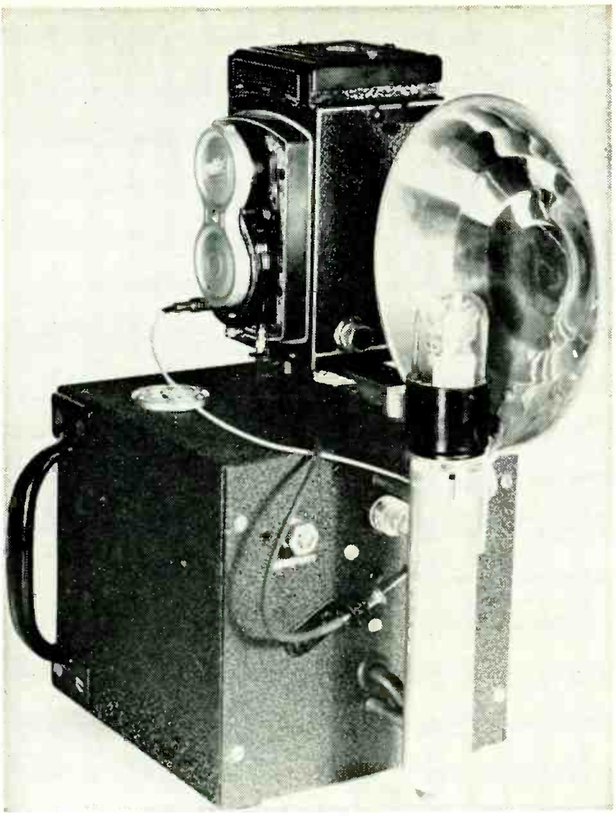
Fig. 2—Typical circuit of 5-volt range of a 1,000-ohm/volt vom. If, without the diode, 500 volts were suddenly applied to the terminals marked + and −, 100 ma would flow through the meter coil and probably burn it out. With the diode connected, the meter is protected.

One other thing to keep in mind: Even though the series resistance protects the meter movement, there is no protection against overheating the multiplier resistor. Leaving an overvoltage on for a while will heat up the series resistance and may change its value, if not actually burn it out. It is necessary only to know this, not to worry about it. If you are paying attention to what you are doing, you will catch the overload in time. Even if you don't, it is cheaper to replace a resistor than the meter movement.

That second diode, with its reversed polarity, protects against overvoltage in case you have connected your meter probes to excessive voltage backward. END



Connect diodes in parallel back-to-back right at the meter terminals.



Author's flash is built into rugged steel box. Meter is visible on top surfce of box, just under flash sync wire. Sensitivity control, with locking nut, is R7 in Fig. 2.

SCR TRIGGER FOR YOUR PHOTOFLASH

Prevent pitted shutter contacts and insure reliable pictures with your strobe light

By LYMAN E. GREENLEE

EXPERIMENTS WITH THE GENERAL Electric's Experimenter Line GE-X5 silicon controlled rectifier indicated that it would make an excellent triggering device for a photoflash unit. Rugged, dependable, small, the X5 will easily handle the current surge requirements, and can be triggered by an extremely small signal of 200 *micro*watts or less. it is also inexpensive. All the parts necessary to convert to the GE-X5 triggering circuit can be fitted into most photoflash units with room to spare. Parts values are noncritical. With the SCR, arcing shutter contacts are eliminated entirely, and shock hazard is reduced.

Fig. 1 is a typical speedlight wiring diagram. This circuit is for 117 volts ac. The circuit for battery operation is identical except for the primary of the power transformer (T1), which would then be wound for use with transistors or a vibrator. Most of the electronic flash equipment now on the market uses a firing or triggering circuit that discharges a capacitor through a small transformer (T2) similar to a model-airplane ignition coil. This transformer provides a single high-voltage pulse to ignite the flashtube. The pulse is generated when capacitor C4 is discharged through the primary winding. The capacitor may have a value from 0.1 to 0.5 μf. The charging voltage may vary from 75 to 200 volts dc.

This triggering circuit works, but has some very serious faults. The capacitor discharge soon burns up the shutter contacts, and the user can get a very unpleasant shock at the shutter connection. The shock itself is not hazardous, but it can cause the recipient to drop an expensive camera. To avoid burning up the shutter contacts in a hurry, C4 is kept as small as possible. This means that triggering will be erratic unless the shutter contacts are kept clean and free from pitting. It is next to impossible for the ordinary camera owner to disassemble the shutter on his camera to clean the flash contacts. The SCR firing circuit reduces the load on shutter contacts to less than a milliampere.

The modified flash with the SCR trigger circuit is shown in Fig. 2. Capacitor C4 of Fig. 1 is disconnected at point X and moved to X1 in Fig. 2. The shutter tripping connection is moved to the free end of R5. The rest of the circuit shown in Fig. 1 is left as is, and the components and wiring shown in Fig. 2 as heavy lines are added.

Since C4 must operate at reversed polarity to discharge through the SCR, a simple power supply is needed. Resistors R7, R8, R9 and the diode rectifier supply the negative voltage needed to maintain a charge across C4. This voltage can be varied by adjusting potentiometer R7. After the correct setting is found experimentally, R7 can be replaced by two fixed resistors if there is no space available to mount the pot in the speedlight case. The SCR can be wired into the circuit, using reasonable care in handling and soldering to prevent damage.

Since C4 will no longer be discharged through the shutter contacts, it can be made larger for more reliable triggering. The usual value for C4 is 0.25 μf or less. We can use up to 1.0 μf with the SCR, or the largest capacitor that will fit into the space. The working voltage of C4 should be at least 200, and the capacitor must be a good-quality, low-leakage component, preferably with a Mylar or oil-impregnatd paper dielectric. To check the voltage across C4, connect a vtvm from point X1 to ground. Set the voltage at 50 to 75 (not critical) by adjusting R7. The minimum triggering voltage across C4 will be about 40, and the maximum just below the value that produces self-triggering

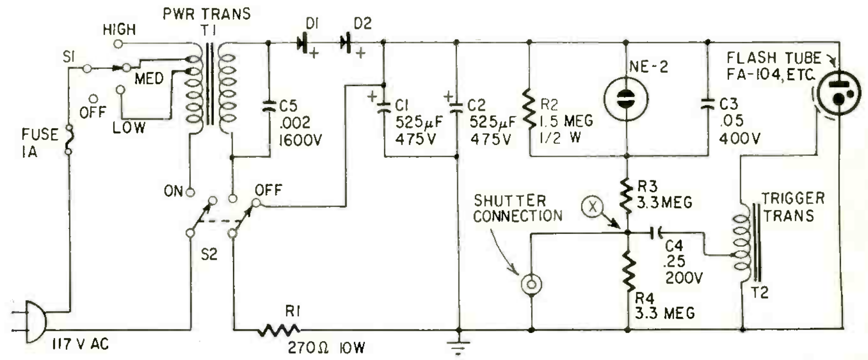


Fig. 1—Typical small electronic photoflash unit (from Sprague Electronic Flash Handbook*). Direct discharge of C4 through shutter contacts for triggering can damage contacts quickly.*

by operating the SCR too close to its breakdown level.

The shutter triggers the discharge through R5, which is 10,000 ohms. This resistance may vary from 5,000 to 15,000 ohms with negligible effect on triggering. R6 may vary from 75,000 ohms to 150,000 ohms. The purpose of R6 is to hold the SCR turned off by tying the gate to the cathode, and the value of R6 determines the sensitivity of the triggering. Triggering occurs at a definite point as the gate potential is moved toward the anode potential. For our purpose, a point is chosen that will give reliable trigger action with minimum load on the shutter contacts.

R5 is a limiting resistor to hold the discharge through the shutter contacts to a lower level. The potential of the gate is the same as that of the cathode, since the shutter connection is normally open. By using a vtvm we can measure the voltage across C4 by measuring the voltage across the shutter contacts and allowing for the drop across R5 and R6. This is a useful check point in case of trouble. The primary purpose of R5 is to protect the shutter contacts if the SCR should short between gate and cathode.

R5 and R6 were chosen arbitrarily to allow approximately 1 ma to flow through the shutter contacts. The absolute maximum sensitivity of the SCR is in the neighborhood of 200 μa, so this allows a good safety factor to insure positive triggering.

Most photoflash units are negative-ground. However, in case the positive side of storage capacitors C1 and C2 should be grounded, the triggering circuit remains the same except that we can now eliminate D3 and tie R9 directly to the minus side of the storage capacitors. It is necessary to maintain the correct polarity across C4, and this means that the positive side of C4 must be grounded through the primary of T2. In case of doubt, measure the voltage across C4 to check for proper polarity.

Some earlier speedlights used a type 0A5 gas-discharge trigger tube. To modify these circuits for use with the SCR, rewire the circuit as shown in Fig. 2. Where the flashtube operates at 2,500 volts, the total value of R7, R8 and R9 should be 12 megohms. Make R8 and R9 total 10 megohms, and use five resistors in series because of the high voltage. Each resistor may vary between 1.8 and 2.2 megohms. Choose a string of five that will make a total value close to 10 megohms. Use 1-watt carbon resistors, 10% tolerance. Increase the value of R7 to 2 megohms, or connect a 1-meg resistor between the lower end of R7 and ground to give the proper voltage across C4. You should be able to vary the voltage across C4 from 40 to about 150 by adjusting R7. Excessive

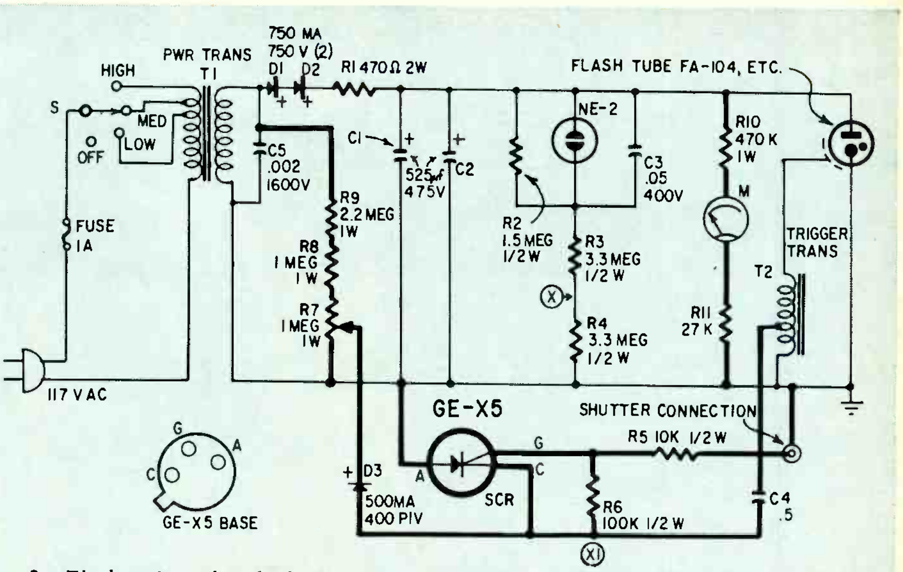


Fig. 2—Flash unit author built, based on circuit of Fig. 1 but with SCR triggering circuit and voltmeter added. Heavy lines indicate new wiring.

C1, C2—525 μf, 450 volts, electrolytic (special photoflash capacitors—Sprague FF-1 or equivalent)
C3—.05 μf, 400 volts, paper
C4—0.5 μf, (or existing capacitor), 200 volts or more
C5—.002 μf, 1600 volts, paper
D1, D2—silicon rectifiers, 750 peak inverse volts, 750 ma forward current
D3—silicon rectifier, 400 peak inverse volts, 500 ma forward current
F—fuse, 1 ampere
M—1-ma miniature meter, used as 500-volt meter (see text)
R1—470 ohms, 2 watts
R3, R4—3.3 megohms, ½ watt (or single 6.8-meg ½-watt resistor)
R2—1.5 megohms, ½ watt
R5—10,000 ohms, ½ watt
R6—100,000 ohms ½ watt
R7—pot, 1 megohm, linear, 1 watt
R8—1 megohm, 1 watt
R9—2.2 megohms, 1 watt
S—single-pole, 4-position rotary switch
SCR—GE-X5 silicon controlled rectifier, or 2N2324, 2N2325 or 2N2326
T1—photoflash power transformer, Stancor P-6425
T2—photoflash trigger transformer (G-E 86G41, Stancor P-6426 or model airplane ignition coil)
Flash tube—100 watt-second, 450 volts (Sprague FA-104, Kemlite U-5W or equivalent)
Miscellaneous hardware

voltage across C4 will cause the SCR to break down internally, so do not let the voltage exceed 175.

Fig. 2 shows the circuit I am now using. Note that the value of R1 has been changed to 470 ohms (from 270 ohms) to reduce the peak voltage across the photoflash storage capacitors, and its position changed. A 1-ma meter has been added with two series resistors to form a 0–500 voltmeter. Resistors R10 and R11 were selected to make the meter read full scale with 500 volts dc. This is fairly easy to do by picking 10% values from stock. The voltmeter indicates the actual voltage across the storage capacitors with far greater accuracy than a neon flasher. The neon bulb is at best only a rough indication of the charge in the capacitor bank. It will start to blink at about 350 volts and continue to do so until the unit recycles. With the voltmeter, pictures can be taken with far more accuracy since shots can be made at a specific voltage. I used a miniature milliammeter, only 1 inch in diameter, so it takes up very little space.

On my equipment, the minimum triggering voltage at point X1 is about 40 volts with a 0.5-μf capacitor (C4), and the GE-X5 is triggered successfully when the voltage is raised to 175, which is beyond the maximum setting of R7. (Voltages across C4 will creep higher than indicated by a vtvm connected from X1 to ground.) Even at the maximum of 175 volts, there is no tendency for the SCR to fire spontaneously before the shutter is tripped.

With consistent triggering at around 75 volts, and also at 175 volts, it would seem that the SCR could be safely run at around 100 volts indefinitely with little chance of breakdown. The SCR triggering circuit has been far more reliable than the original shown in Fig. 1. With the original firing circuit, I had to disassemble my Rollei to clean the shutter contacts after a few months of use. This is not an easy job. With the new circuit, there have been fewer missed shots, less spoiled film, and no cleaning of shutter contacts.

This triggering circuit represents a worth-while modification for any electronic flash equipment. Shutter contacts should last indefinitely with it. Cost of the job should not exceed $8, and this includes the cost of the GE-X5 SCR. END

Everybody who uses it loves it, but still it remains one of the least common low-priced test instruments!

THE VERSATILE DIP METER

By RUFUS P. TURNER

QUESTION: WHAT IS SMALL, INEXPENSIVE, eats little power, can be a tunable rf oscillator or a wavemeter, can measure capacitors, inductors and Q, can tune circuits and antennas and be held in one hand?

Our title is the answer. The dip meter can do all these things and more; yet, though it's been around in one form or another for over 35 years, it seems that hardly anyone uses it except hams —and not too many of them. Well, you're missing out on a good thing!

Pick up a dip meter. It's a small box (Fig. 1), usually small enough to fit in your palm. A plug-in coil sticks out one end, like a probe—which it is. There's a dc milli- or microammeter usually calibrated in arbitrary numbers, and a large tuning dial calibrated in frequency—often made to be turned by the thumb of the same hand you're holding the dipper with.

When the instrument is switched on, the meter shows a steady current. If the dipper probe coil is now brought near an external circuit tuned to the same frequency, the meter *dips* sharply. The frequency of the external circuit can be read directly from the dipper dial. *The external circuit need not be energized—it can be completely "cold."*

During most of its history, the dipper used a vacuum tube in a simple oscillator circuit, and its meter read grid current. Hence the name "grid-dip oscillator." But in late years, a transistor or tunnel diode (neither of which has a grid) is often used instead, so the new term *dip meter* is more appropriate.

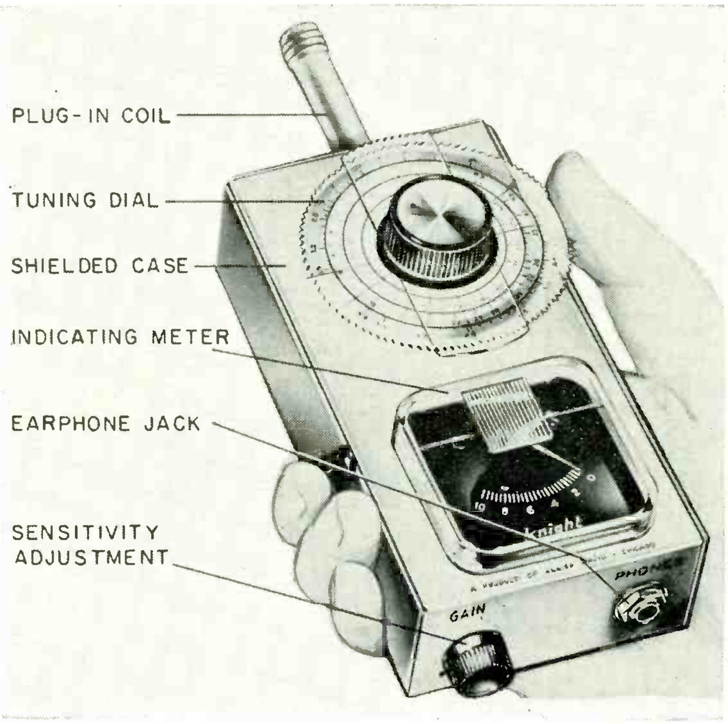


Fig. 1—Typical modern dip meter.

Basic theory

A dead (not energized) tuned circuit (tank) absorbs rf energy from a circuit if it is coupled to the circuit and tuned to its operating frequency. In Fig. 2-a, the external (cold) tank is L1-C1, and the live (hot) tank is L2-C2. (It may be the plate tank of an oscillator or amplifier.) When the cold tank is tuned to the frequency of the hot tank by adjusting C1, it absorbs energy from the hot tank. Since this robs the hot tank of some energy, the reading of meter M will rise. This much is simply the principle of the absorption wavemeter, or wavetrap; to make such a wavemeter useful for determining unknown radio frequencies, you need only calibrate the dial of variable capacitor C1. Plug-in coils extend the frequency coverage.

The wavemeter principle works fine as long as the circuit under test is hot and has a meter to read. But what about checking the frequency of a cold tank? Just reverse the two! Make the frequency-calibrated tank (L1-C1) part of a low-powered oscillator containing an indicating meter (Fig. 2-b). Then the cold circuit under test will rob the now hot test circuit, and the meter will dip. Now you have a dip meter.

Practical dippers

Dip meters come in tube, transistor and tunnel-diode versions, as kits or factory-built. With plug-in coils, they cover a frequency range of 100 kc to 300 mc in overlapping bands, the exact coverage varying among makes and models. Transistor and tunnel diode types are battery-operated and thus completely portable. Tube instruments contain miniature, usually ac power supplies.

Fig. 3 shows typical circuits. Fig. 3-a is a tube type ultraudion oscillator powered by an ac-operated supply. The predip deflection of microammeter M is set to some convenient spot as high on the scale as desired by R. This deflection varies from one end of the tuning range to the other. Dual variable capacitor C1 tunes the circuit. Switch S cuts the oscillator without cooling the tube heater.

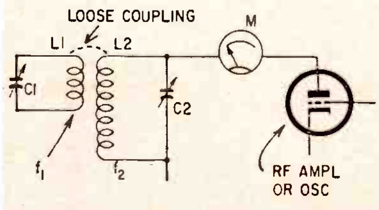
Fig. 3-b shows a transistor circuit. Here, Q is a high-frequency transistor. R1 has the same function as R in the tube circuit (setting the meter), and C1 is the tuning capacitor. Since none of the transistor's dc electrode currents is as sensitive as tube grid current, the microammeter is used as a radio-frequency millivoltmeter (with germanium diode D, coupling capacitor C2 and rheostat R2—the latter to prevent the meter from pinning).

Fig. 3-c shows a tunnel-diode circuit. Tunnel diode D1 oscillates when

its dc bias is set to the critical voltage with R. As in the transistor circuit, microammeter M is a radio-frequency millivoltmeter, with germanium diode D2 and coupling capacitor C2. In each of the three circuits, a plug-in coil L determines the tuning range. Frequencies within that range are read directly from the calibrated dial of the tuning capacitor.

In each of the circuits, opening operating switch S disables the oscillator and turns the instrument into an absorption wavemeter for testing hot circuits. Some commercial dip meters have a headphone jack for listening to the signal from a hot circuit, and some provide switch-selected amplitude modulation of the dip oscillator.

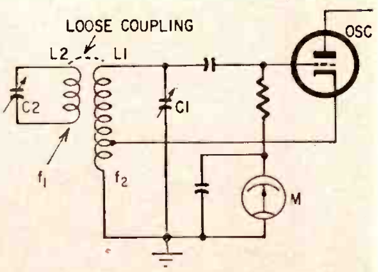
The tube type dip meter provides the sharpest response, in most situations. The semiconductor types are somewhat less sensitive, but they are completely free from the power line, cool, shock-free and free from undesirable coupling. They are also instant starters.



FREQUENCY RELATION	METER READING
$f_1 < f_2$	LOW
$f_1 = f_2$	HIGH
$f_1 > f_2$	LOW

a

Fig. 2—Basic dip-meter principle. Meter (b) will read high as long as circuit frequencies do not coincide; when they do, meter dips.



FREQUENCY RELATION	METER READING
$f_1 < f_2$	HIGH
$f_1 = f_2$	LOW
$f_1 > f_2$	HIGH

b

Dip-meter applications

The dip meter has many more applications in electronics than we can describe here. Here are some of the most common; they will suggest others. The "pointers" referred to in the instructions are in the following section, *Pointers on Operation*.

Resonant frequency, cold circuit. Couple the dip meter (dm) loosely to the cold tank under test. Switch the dm on and determine the resonant frequency of the cold tank by tuning the dm for dip and reading the frequency from the dm dial. *See Pointers 1 and 2.*

Resonant frequency, hot circuit. Switch the dm oscillator off (that is, open S in Fig. 3-a, 3-b and 3-c. Couple the dm loosely to the hot tank under test and determine the resonant frequency by tuning the dm for *peak deflection* (the opposite of dip) of the dm microammeter. Reading the unknown frequency from the dm dial. *See Pointers 1 and 2.*

Presetting a cold circuit. A cold grid or plate tank, wavetrap, filter or i.f. transformer can easily be pretuned with a dm. Switch on the dm and set its dial to the desired frequency. Couple the dm loosely to the cold circuit. Adjust the variable capacitor or slug in the cold circuit until the dm dips sharply. *See Pointer 3.*

Checking frequency by heterodyne. The method just described of checking the frequency of a hot circuit uses the dm as an absorption wavemeter with visual indicator. The heterodyne method is more accurate. If your dm has a headphone jack, plug in high-impedance headphones. Switch on the dm and couple it loosely to the signal source. Determine the unknown frequency by tuning the dm to zero beat—as heard in the headphones—and reading the frequency from the dm dial. This method works best with an unmodulated signal from the hot circuit. *See Pointers 1, 2 and 3.*

Monitoring a signal. If the dm is equipped with a headphone jack, it may be used as a monitor for either CW or AM signals. For CW, switch on the dm and couple it loosely to the signal source. Then tune in the signal, setting the dm dial for the most pleasing beat note. For AM, switch off the dm and couple it loosely to the signal source. Then, tune in the signal, setting the dm dial for loudest sound in the headphones. For either AM or CW, if the headphone signal is too loud, decrease the coupling.

Generating signals. The dm is not intended to be a precise rf signal generator. Still, it can be useful as a test oscillator. To use it as one, switch it on, couple it loosely to the device under

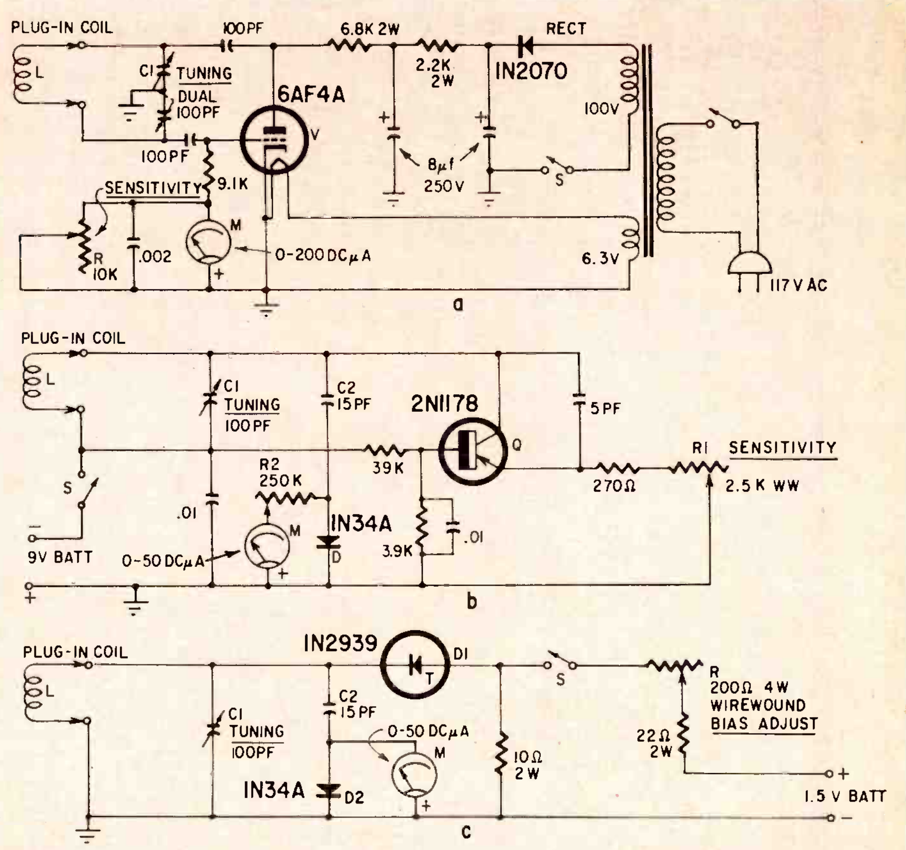


Fig. 3—Three basic dip meter circuits: a—Tube design with ac power supply; b—Transistor version, battery operated; c—Tunnel-diode type, battery operated. In all circuits, plug-in coils are wound to cover desired frequency range with capacitor used. See data in various radio handbooks.

test, and set the dm dial to the desired frequency. Most dm's deliver an unmodulated signal, but a few models have an internal modulator for producing AM. Signal strength may be varied by increasing or decreasing the coupling between dm and device under test. *See Pointers 1, 2 and 3.*

When you use the dm as a test oscillator, if no coil is accessible for magnetic coupling to the device under test, try capacitive coupling. An insulated wire with one turn looped around (but not touching) the dm coil, and the other end connected to the input terminal of the device often works well.

Checking capacitors. An unknown capacitor (*nonelectrolytic*) may be measured by using the dm to find the resonant frequency (f) of a cold tank made up with this unknown capacitance (C) and an accurately known inductance (L), and then calculating the capacitance from the known L and measured f values.

Fig. 4 shows the test setup. Here, the unknown capacitance C is connected to an accurately known inductance L (rf choke or other coil whose inductance has recently been checked—100 μh is a convenient value). Switch on the dm and couple it loosely to the coil. Tune the dm for dip (*see Pointers 1 and 2*), and read the frequency from the dm dial. Calculate the unknown capacitance:

$$(1) \qquad C = \frac{25{,}330}{f^2 L}$$

(C is in picofarads, f in megacycles and L in microhenrys.)

Example. With a 100-μh test coil, the resonant frequency with an unknown capacitance is 2,800 kc. What is the capacitance?

$$f = 2{,}800 \text{ kc} = 2.8 \text{ mc}$$

$$C = \frac{25{,}330}{2.8 \times 2.8 \times 100} = \frac{25{,}330}{7.84 \times 100} = \frac{253}{7.84} = \mathbf{32.3\ pf}$$

Checking inductance. An unknown inductance can be determined by using the dm to find the resonant frequency (f) of a cold tank in which this inductance is connected to a capacitor of accurately known capacitance (C), and calculating the inductance from the known capacitance (C) and measured frequency (f).

Fig. 5 shows the test setup. Here, unknown inductance L forms a cold tank with the known capacitor C, which can be a good-grade mica capacitor whose capacitance has recently been checked. 100 pf is a convenient value. To make the test, switch on the dm and couple it loosely to the unknown inductance. Tune the dm for dip (*see Pointers 1 and 2*), and read the frequency from the dial. Calculate

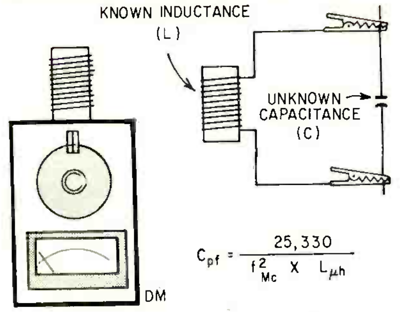


Fig. 4—Checking capacitance with the dip meter.

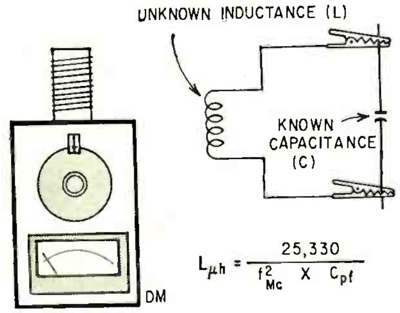


Fig. 5—Checking inductance with the dip meter.

the unknown inductance:

$$(2) \qquad L = \frac{25{,}330}{f^2 C}$$

where L is in microhenrys, f in megacycles and C in picofarads.

Example. With a 100-pf test capacitor, the resonant frequency with an unknown inductance is 7.5 mc. What is the inductance?

$$L = \frac{25{,}330}{7.5 \times 7.5 \times 100} = \frac{25{,}330}{56.25 \times 100} = \frac{25{,}330}{5{,}625} = 4.5\ \mu\text{h}$$

The dip meter can do a whole lot of jobs—fast—that ordinarily take several instruments. *Get in the habit of using it!* Pointers on operation.

1. Always use the loosest coupling (greatest separation between dm coil and circuit under test) that gives a discernible dip.

2. Always tune from the low-frequency end of the tuning dial to the high-frequency end. Stop at the first dip. When you have no clue to the unknown frequency, start with the lowest-frequency dm coil, and change coils successively upward until you find a dip.

3. How precise the dm will be when used as an emergency test oscillator depends on how—and how recently—it was calibrated, how sturdily it is built and how stable the power supply is. The accuracy of good low-cost instruments is ±10% to ±20% of indicated frequency. *Frequency error is increased considerably by pulling action when the dm is coupled too tightly to the circuit under test.*

4. Allow 30 minutes warmup before you use a tube dip meter.

5. Treat the dm with the same care you give any delicate electronic instrument: Protect it from vibration, shock, temperature and humidity extremes, and tampering. Avoid overloads from high-powered hot circuits. Calibrate it from time to time. END

This alphabetical list of dip meters contains all the makes and models available to experimenters (except Aerovox and Quement, for which information was not available as we went to press). Specifications given here are only enough to acquaint you with the instruments; the manufacturers will be delighted to send you more details on request. Mention this **Radio-Electronics** directory when you write.

B & W 600. 1.75 to 260 mc with 6 coils. Ac power. Sensitivity control, phone jack, on–off–diode switch. 3 x 3 x 7 in., 2 lb. $55. **Barker & Williamson, Inc.,** Bristol, Pa.

Eico 710. 400 kc to 250 mc with 8 coils. Ac power. Sensitivity control, phone jack, oscillator–diode switch, on–off switch. 1:7-ratio tuning drive. 2¼ x 2 9/16 x 6⅞ in., 3 lb. $29.95 kit, $49.95 wired. **EICO Electronic Instrument Co.,** Inc., 131-01 39th Ave., Flushing, N.Y. 11352

Heathkit HM-10A "Tunnel Dipper." 3 to 260 mc with 6 coils. 1.5-volt battery power supply. Sensitivity control, off–diode–oscillator switch. Tunnel diode oscillator, diode detector and voltage stabilizer, 3-transistor dc amplifier. 5⅞ x 2 13/16 x 4 3/16 in., 1½ lb. $34.95 kit (not available wired). **Heath Co.,** Benton Harbor, Mich. 49023

Knight-kit G-30. 1.5 to 300 mc with 6 coils. Ac power. Sensitivity control, phone jack. Can be used as crystal oscillator by inserting crystal instead of coil. 6⅜ x 3¼ x 1⅝ in., 1½ lb. $19.95 kit, $29.95 wired. **Allied Radio Corp.,** 100 No. Western Ave., Chicago, Ill. 60680

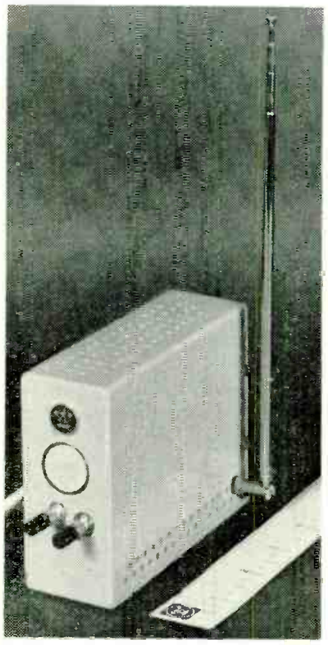
Lafayette 99 R 2503. 1.7 to 180 mc with 6 coils. Ac power. Nuvistor oscillator. Sensitivity control. 2¾ x 5½ x 1¾ in., 1½ lb. $22.95 wired. **Lafayette Radio Electronics Corp.,** 111 Jericho Tpke., Syosset, N.Y. 11791

Measurements Corp. Series 59. Three oscillator units, available separately, plus separate power supply containing meter and controls. 59-LF oscillator: 100 kc to 4.5 mc, with 4 coils. **59-STD** oscillator: 2.2 to 420 mc with 7 coils. **59-UHF** oscillator: 420 to 940 mc in one range. All units individually calibrated to ±2% accuracy: all have either CW, 120-cycle modulated or externally modulated output. Models 59-LF and 59-STD, $98.50; model 59-UHF, $128.50. All prices less power supply. Model 59 power supply, for 115 or 230 volts ac, contains regulated dc supply for any of the above oscillator units, oscillator grid-current meter, phone jack, modulation jack, sensitivity control, diode-oscillator switch. 5⅛ x 6⅛ x 7½ in. $75. **Measurements Corp.,** PO Box 180, Boonton, N.J. 07005

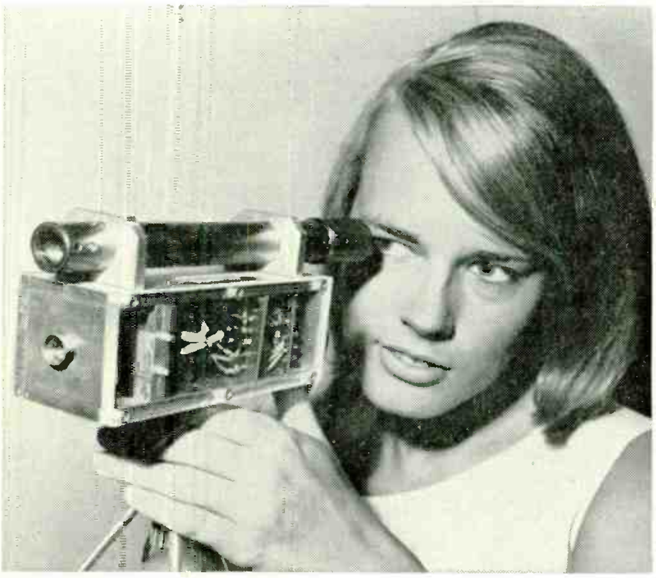
Millen 90651. 1.7 to 300 mc with 7 coils furnished; accessory coils to 225 kc. Calibrated to ±2% Ac power; provision for battery operation. Separate plate and heater power switches; phone jack. 7 x 3 3/16 x 3⅜ in., 3½ lb. $68.85. **90661** Industrial model, same as 90651 except hand-calibrated to ±0.5%. Has industrial power cord with 3-prong plug, metal carrying case. **90662-A** Industrial model covers 225 kc to 300 mc, hand calibrated to 0.5% Built-in transistor tone modulator and transistor dc amplifier. Switch selects off, diode, oscillator, modulated oscillator. Phone jack, sensitivity adjustment. Metal carrying case. Size and weight same as other models. $1.95. **James Millen Mfg. Co.,** 150 Exchange St., Malden 48, Mass.

Waters 331 "Little Dipper." 2 to 230 mc with 7 coils. Calibration accuracy ±3%; each coil carries separate frequency scale. Transistor oscillator, dc amplifier, 1-kc tone generator for modulation. Power supply: four 1½-volt penlite cells. Diode–oscillator–modulated oscillator switch; sensitivity control. 7 x 2¼ x 2½ in., 1 lb 6 oz. $129.75. **Waters Mfg., Inc.,** Boston Post Rd., Wayland, Mass.

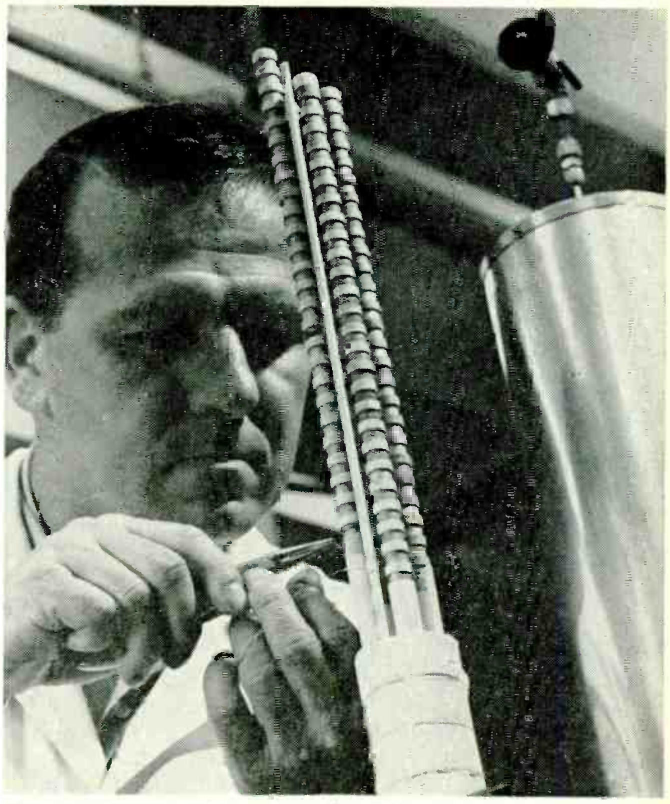
WHAT'S NEW



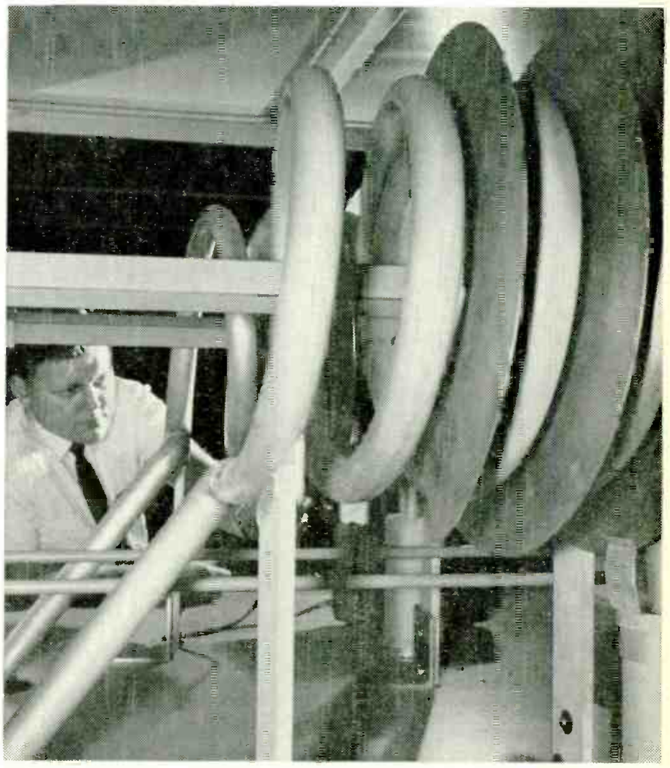
POCKET-SIZE TV — 3½ in. high, 1½ in. wide, 4½ in. deep! Picture appears on 1-in. electrostatic CRT. Design is conventional intercarrier, fixed-tuned to ch 11, but all circuits except video amplifier and sweep use integrated circuitry. SCR's are used for vertical and horizontal sweep. A 20-kc inverter develops high voltage. Set is powered by rechargeable batteries. Designed by Westinghouse Defense & Space Center, tiny TV is not for sale.



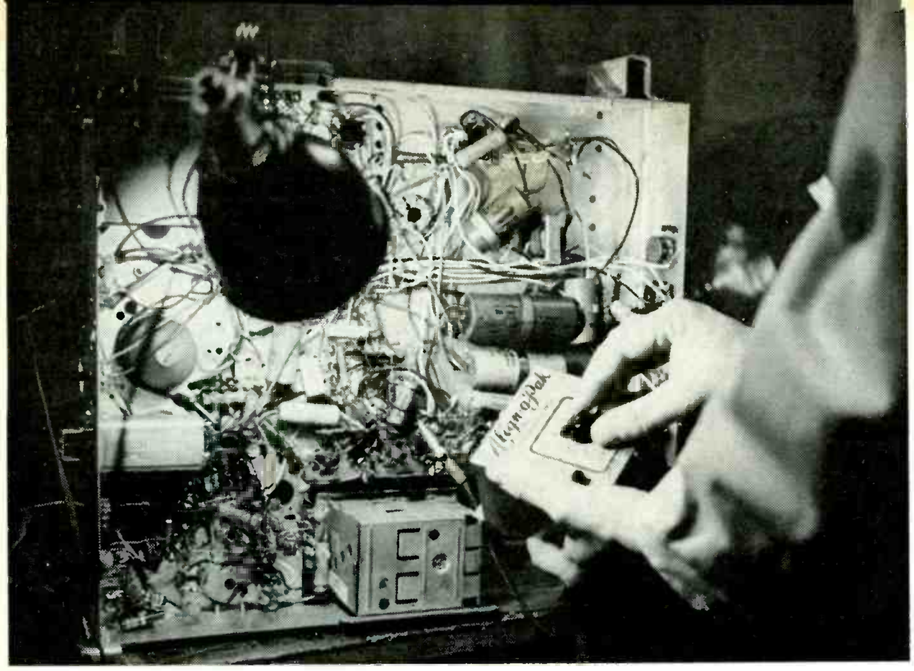
LOOK ME IN THE LASER! This is a public-demonstration model of a laser transmitter RCA will install on Gemini 7. Conversations by laser beam will be tried between Gemini 7 and ground stations. Heart of the actual (left) device is new room-temperature gallium arsenide laser diode. Four are used, located behind small lens openings. Large opening is for telescope used to aim transmitter at laser receiver beacon at White Sands Missile Range.



EXPERIMENTAL FUEL-CELL SYSTEM generates pure oxygen from two waste products of breathing—carbon dioxide and water. Normal cell uses oxygen in reaction with fuel—such as hydrogen—to generate electricity. Here, process is reversed: cell eats electricity, makes oxygen. Obvious application? Space-capsule oxygen generation. Westinghouse, developer of system, estimates four men could be supplied from equipment weighing 60 to 75 lb complete, occupying only 3 cu ft and taking about 1 kw power.



MASSIVE FINAL COILS are part of new Hughes-designed 250,000-watt AM short-wave transmitter for Voice of America service to Southeast Asia. To be located in Philippines, transmitter is tunable to any of 20 preset frequencies between 3.95 and 26.5 mc. Maximum tuning time is 20 seconds.



Even a real innocent like this bias box can mess up a dignosis.

Do You Understand What You Read on Your Meter?

Don't believe everything you read on its sweet face. The instrument may be doing everything its maker meant it to do, yet still lead you on a fool's chase **By ART MARGOLIS**

TEST INSTRUMENTS EXTEND MY EYES, ears and fingers so they can detect defective electronic components. But those same instruments do not always tell me the truth.

A bias box is a must during an agc seizure. A flyback tester pins the blame in a matter of minutes. A scope gives a valuable look-see at waveforms, and a tube tester saves the day when you don't have a substitute tube. But, **you must know the limitations of your test gear to use it properly.**

Unfortunately you learn those only by experience. Let me tell you about some of the times my favorite pieces led me astray.

The infallible bias box

Our regular bench man was on vacation so I brought Joe, one of the roadmen, into the shop to repair chassis. I worked with him (in an advisory sort of way) from my desk.

I hooked the bias box into the agc line. Sure enough, the trouble cleared. That proved it. It must be agc trouble. I unhooked the box.

Something didn't quite look right to me. The sequence wasn't quite true. Then I realized: When I disconnected the box, the trouble didn't reappear. The picture remained fine.

I turned off the TV, pulled out the schematic and examined the circuit for a few minutes. It was a conventional agc and i.f. strip.

I turned the TV on and watched it. It came on fine. Then as the minutes passed the picture gradually became more contrasty. It got darker and darker, developed tunable ghosts and then overloaded completely.

All went smoothly till the second day. "Art!" he called. "This Airline is driving me bugs."

I walked over. "What's it doing?"

He had it on. The chassis was half hanging out of the cabinet and there was a viewable picture in the mirror.

The picture was way overloaded, almost negative, and out of sync with a slight buzz in the sound. It was classic agc overload. I switched on a distant station. The trouble cleared. I switched back to a local station. The trouble came back.

I said, "Take the bias box and clamp the agc."

Joe smiled. "Way ahead of you. I attached the box here," and he pointed to the bottom of the first i.f. grid resistor at the agc junction point.

"What happened?"

"The trouble cleared up."

"That's it," I said. "I've never seen that test fail. If you hook the bias box into the agc line and the trouble disappears, you have agc trouble. If it stays, the trouble is in the rf, i.f., video or sync stage."

He snorted. "Oh yeah? I checked every part in the agc circuit by substitution and the trouble is still there."

I trusted Joe, but I figured I'd better check over his work. We can all make mistakes, especially when we aren't working on the bench day in, day out.

Even though the bias-box test had indicated agc, the condition looked like an i.f. circuit was oscillating. I took a .05-μf capacitor and began bridging in the i.f. amplifiers. When I bridged the first-i.f. screen bypass, the trouble cleared. I changed the .005-μf screen capacitor and the first i.f. tube, a 3BZ6. The trouble disappeared.

I explained the job to my man. "The first i.f. stage had an open screen bypass. That changed the circuit from an amplifier to a form of oscillator. But it didn't start oscillating right away. The oscillations took a little time to build up. When we installed the bias box, we damped the oscillation since it was unstable to start with."

Joe moaned. "What about that bias-box agc test that always works?"

I answered, "Change the always to *almost* always."

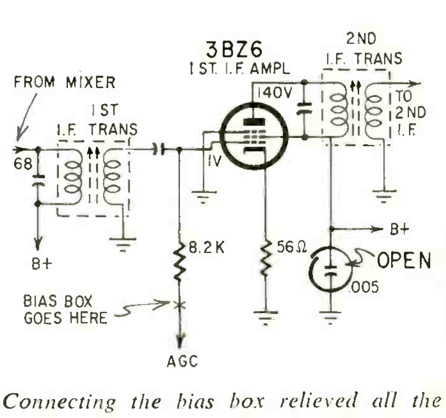
The safe-bet flyback tester

A distributor salesman, Bill, burst into the store one day and waved a box at me. "Art, I got a deal for you that's going to save you beaucoup time."

I said quietly, "Yes, what is it?"

He ripped open a box and pulled out a shiny new flyback tester. "You see this beaut? It's a flyback and yoke tester. We have a special deal. It's guaranteed to work on all flybacks. That means all you have to do is disconnect a few wires, use the tester and you know what's what right away."

I nodded. "But it doesn't always work."



Connecting the bias box relieved all the symptoms of agc trouble. But there was nothing wrong with the agc! An open screen bypass caused an i.f. stage to oscillate after a few minutes; biasing the tube with the box killed the oscillation.

"Ha!" he laughed confidently. "That's what you say."

I continued. "I never saw that one, but the ones we have do not test all flybacks."

I could see the challenge make his eyes light up. He was getting into one of his promise-him-anything-but-make-the-sale moods.

"This one is different. It's *got* to work; it *will* work. If it doesn't work on all flybacks, I'll *give* it to you."

He knew he was in hot water as soon as he said it. I snapped him up. "You're on," I said.

He swallowed audibly as we walked back into the shop. Up on a shelf was a Philco 1600-series TV from 1951. A few of the men in the shop had heard the confrontation and stopped to watch us.

I turned on the TV. It came on perfect with a good, bright, wide picture. I turned it off and turned to him. "Bill, do you agree that flyback must be good, or else the picture wouldn't be so good?

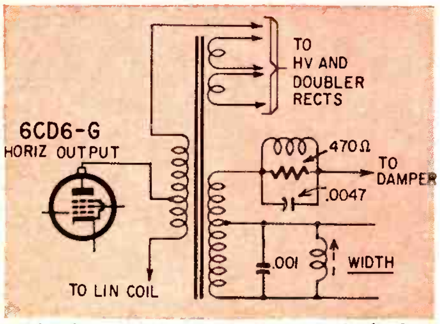
He nodded and gulped again. I pulled off the high-voltage cage, unsoldered the width coil, pulled out the high-voltage rectifiers and just for good measure unsoldered a few other connections, just to be sure there would be no circuits across the flyback windings.

I plugged in the tester, let it heat for about a minute and connected the leads to the horizontal output cap and the high-voltage rectifier cap according to the instructions.

I flipped the function switch to FLYBACK and the needle dipped into the SHORTED region. Bill's eyes widened.

He walked over, his head shaking slowly. He checked and double-checked my procedure. Then he picked up a new flyback from my stock and tested it. The needle this time rose into the GOOD part of the scale.

He checked the Philco again. There was no doubt in his mind. The tester was giving an incorrect reading. I executed the coup de grace by reconnecting the Philco flyback and turning the TV on again. The picture was beautiful.



Flyback of Philco 51-T2102 reads bad on dip-type testers even if it's good.

He turned to me with a sick smile on his face. "Art, you can have the tester, but could you let me sell it to you through the company? I'll pay you the price of the tester in cash in three or four weeks."

"Bill, I want the tester, but I'll pay for it. The bet wasn't really fair since I didn't put up anything, and I knew how this grid-dip type tester was going to work on that flyback. It's a good flyback checker, but, like all test equipment, it has limitations."

Bill was bewildered. "But why does it work that way?" he wanted to know.

'I don't know myself," I confessed. "Some day I'll put it on the bench and run a few tests. Maybe I'll find out."

The strange color syndrome

My roadmen carry a tube tester with them for one reason. With all the new tubes, they can't always test by direct substitution. When they run up against a tube they can't substitute, they test it on a tiny emission checker they carry with them.

One of them called me. He was on a house call at a friend of mine who is a computer technician and knows something about TV. My man Barry got on the phone and said, "Art, your friend Jonathan is giving me a hard time."

I said. "Put him on."

Jon blurted, "Art, you know I understand my color TV, right."

"Right."

"Well," he continued, "I checked the TV out. There is no color. The black-and-white is fine. In fact, I reconverged the set just to be sure it was OK."

I said, "Convergence has nothing to do with whether you're getting color or not."

"I found that out, but the convergence won't hurt the set, right?"

"Right," I agreed and thought, it's all according to the job you did.

"Now, Art, I took all the tubes into work and tested them on our big conductance checker. The engineer had to work out some of the settings for me, but I tested all the tubes. They are perfect."

"What did Barry do?"

"He doesn't have some of the tubes so he brought in that little emission tester of his. They all checked good on his tester too."

"So what's the problem?"

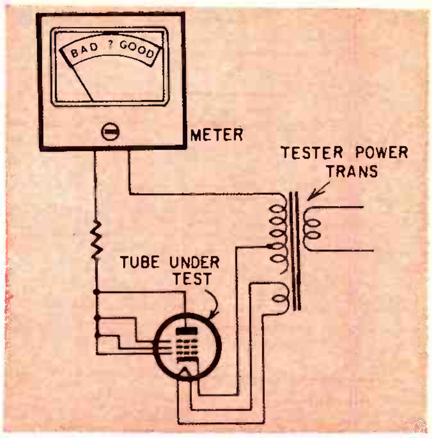
"I want him to pull the chassis and find the bad component. He won't do it."

"Let me talk to him."

Barry said calmly, "Art."

"What's the problem?"

"There's no color," said Barry. "This set uses a 6X9 triode-pentode for first and second bandpass amplifier. I don't have one. There's none in the shop. We'll have to get one out of the city."



An emission tester is a useful tool, but tubes that check good on it may still work erratically or not at all in their circuits. It tests emission of tubes by tying all elements except cathode to plate and indicating relative plate current on meter.

"Are you sure it's the tube?"

"Of course not. My checker says the tube is good. But I've had a lot of that in these color sets. I want a new 6X9 in the set before I go any further.

"Put Jon back on."

He was annoyed. "Oh, all right, but I——." Jon came back.

"Jon, we'll have to go along with Barry. After all, it would be silly to do a lot of troubleshooting looking for a bad component if it's just the 6X9 that's bad."

He grumbled, "But the testers all read good."

"Nevertheles, I'll have a 6X9 sent out immediately."

He hung up without saying goodbye. I called down to the distributor. They had 6X9's in stock and I ordered a few of them. They would send them out by special messenger for a small fee. If it worked, I was going to bill Jon for the messenger service.

Barry came in at the same time as the tubes arrived, grabbed them and left. About 20 minutes later the phone rang. It was Jon.

An aggravated Jon shouted, "It was that lousy 6X9!"

"So relax." We saved you bench labor fees."

He was not pleased. "You better throw those lousy little testers away."

I answered, "Not at all. They pull us out of a lot of tight situations. You just have to have a feel for when they are right or wrong."

I'm sure you have had similar situations. Every piece of test equipment has its own particular set of conditions where it will mislead you. When you know that no one piece is perfect, and when it won't perform, it becomes that much more valuable to you. END

New Designs in Complementary Amplifier/Loudspeakers

By GEORGE L. AUGSPURGER

FOR YEARS, ENGINEERS HAVE BEEN AWARE OF THE INTIMATE relationship between a speaker and its audio power source. Theoretically at least, an integrated system in which the amplifier and speaker are tailored to each other should be able to deliver results superior to those from a separate speaker system and an all-purpose amplifier.

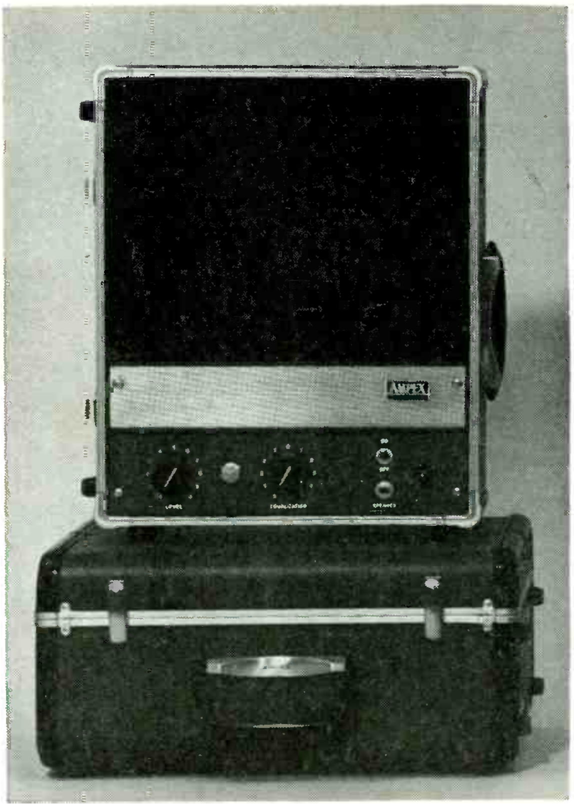
Yet, "powered speakers" have been rare, probably because most component manufacturers have traditionally specialized in only one restricted field. Within the last few years, this situation has changed. Companies previously known only for speakers, such as James B. Lansing and KLH, now make electronic equipment. Amplifier and tuner manufacturers such as Scott and Fisher now market speaker systems.

Also, a manufacturer does not like to limit his market potential by restricting a speaker to one specific amplifier. A third point is that the hi-fi purist has been led to believe that he can get best possible sound by assembling individual components, each as nearly perfect as possible. The notion of "compensating" one component to match another makes him wonder if the manufacturer is not trying to cover up deficiencies which shouldn't be there in the first place.

Four reputable and well established firms are now marketing complementary speaker/amplifier systems. Before discussing specific products however, it might be a good idea to consider the basic problems involved.

One big reason why a complementary speaker/amplifier is so attractive is that today's music enthusiast demands compact speaker systems. When you try to get full-range reproduction from a small box, you run into problems which may be solved better by designing a special amplifier than by juggling the factors in the speaker alone.

For example, Fig. 1 shows what happens when a high-quality 8-inch speaker is mounted in a small box—say, about 1 cubic foot of internal volume. The low-frequency rolloff is a result of the restricting effect of the small enclosure. The high-frequency droop is a characteristic of the speaker itself (the curve is not meant to represent any particular unit—more or less typical of a good speaker in the $20 to $40 price class.)



Ampex model 622 Amplifier/Speaker

Equalizing the speaker

There is no point in going into what exactly is meant by "flat" response in a speaker, or whether we even *want* flat response once we agree on a definition. But there is no question, I think, that everyone would prefer a system which has more bass and treble than that indicated by Fig. 1. We can often make it sound better by applying corrective equalization.

There are two ways of going about it. One is to insert an equalizing network in the amplifier circuit. There are limits: building a $300 equalizer to make a $30 speaker sound better is obviously not the way to advance the state of the art. Apart from this, we cannot apply too much bass or treble boost without overloading the speaker or the amplifier under normal operating conditions. Nevertheless, a reasonably simple R-C network can smooth the response of the

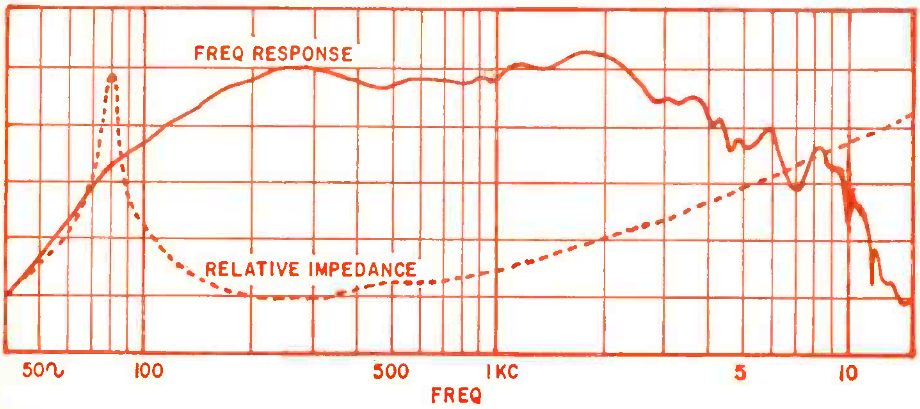


Fig. 1—Frequency response and relative impedance of typical 8-inch speaker in small cabinet. Damping will lower the impedance peak, and corrective equalization can extend response.

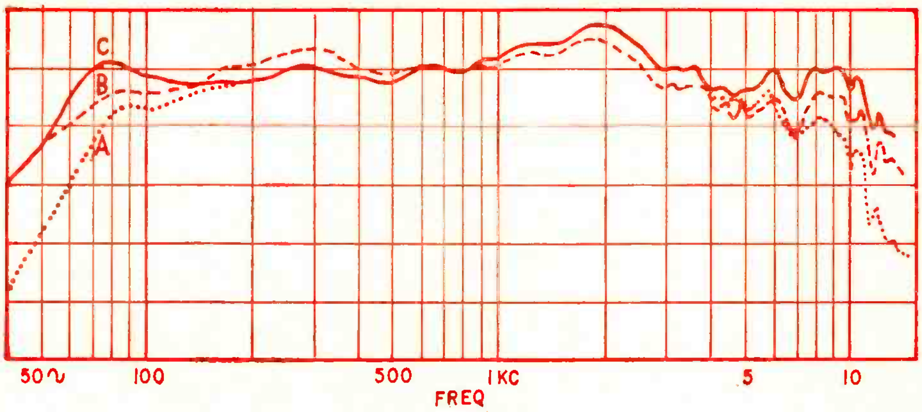


Fig. 2—Response of same speaker as in Fig. 1, but with equalization. Curve A: same as Fig. 1 but damping factor lowered. Curve B: Same as Fig. 1 but R-C equalization added. Curve C: both types of equalization added.

speaker and improve its performance noticeably.*

A second, and somewhat more unusual, approach is to use the impedance characteristics of the speaker to let it select its own equalization.

Let's take a second look at Fig. 1. The response curve is assumed to have been measured with constant voltage fed to the speaker. In other words, this is the curve you get if you drive the speaker from an amplifier with a relatively high damping factor—8 or more. But if we lower the damping factor, interesting things happen to the speaker's response curve. The amplifier no longer delivers constant-voltage signal. Instead, it feeds *more* drive to the speaker where the impedance is high, and *less* where it is low (Fig. 2).

If we are lucky enough to have the impedance curve correspond in some degree to the corrective equalization we need, we can get a definite improvement by adjusting the damping factor to best suit the particular speaker system. This is why some makers publish response curves with a notation that the internal impedance of the amplifier has been adjusted to give the smoothest response.

There is a certain damping factor which will give best results from any particular speaker system. And by using that with additional electronic equalization, the full potential of the speaker can be realized with a minimum of circuit complications.

*Although circuit values become a little awkward, there is no reason why such a corrective circuit cannot be inserted between the speaker and the amplifier output. This is exactly what KLH does in its Model 14. In this instance, the speaker does not require a special complementary amplifier.

Commercial systems—how designed?

One of the oldest manufacturers of high-quality complementary speaker/amplifier combinations is Ampex. A number of years ago when *all* good speaker systems were very large, Ampex began demonstrating its small integrated speaker/amplifiers to astounded audiophiles.

"But how does Ampex get such good sound from a little box?" hi-fi enthusiasts would ask. The answer is that they powered the speaker from an amplifier equalized to match the speaker's performance in that particular enclosure. Ampex has produced a number of these units over the years. They are engineered and styled to be used with Ampex tape recorders.

In a typical Ampex unit, an equalization network is in the feedback loop of the power amplifier. The circuit boosts treble response somewhat to compensate for the characteristics of the speaker, and also boosts bass to overcome the restrictions of the small cabinet volume. If an auxiliary speaker is plugged into the jack provided, the built-in speaker is silenced, and the equalization circuit is bypassed.

Small Ampex units generally use a highly efficient 8-inch

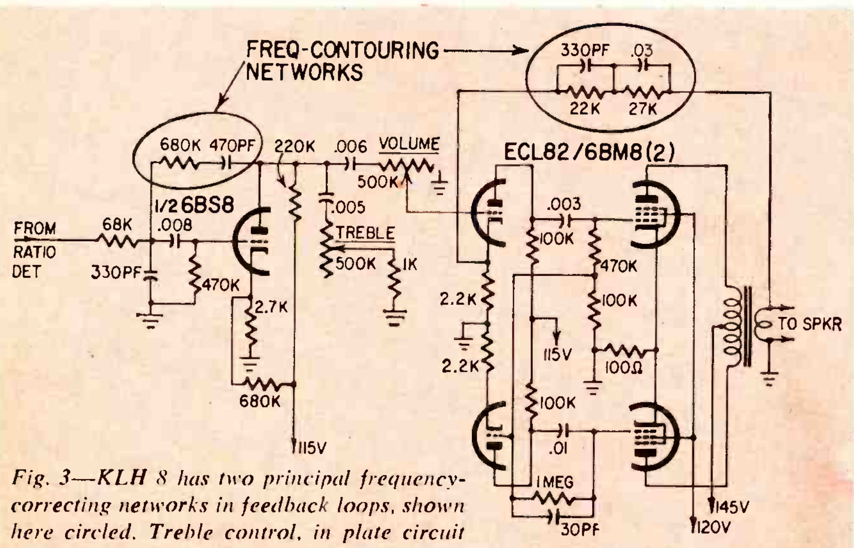
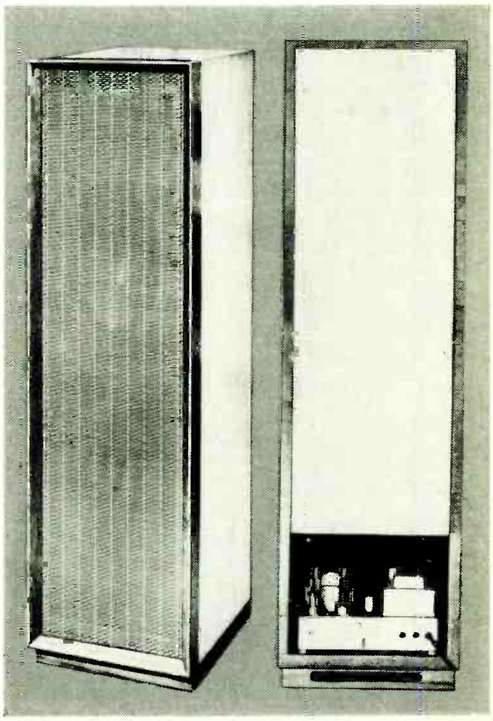
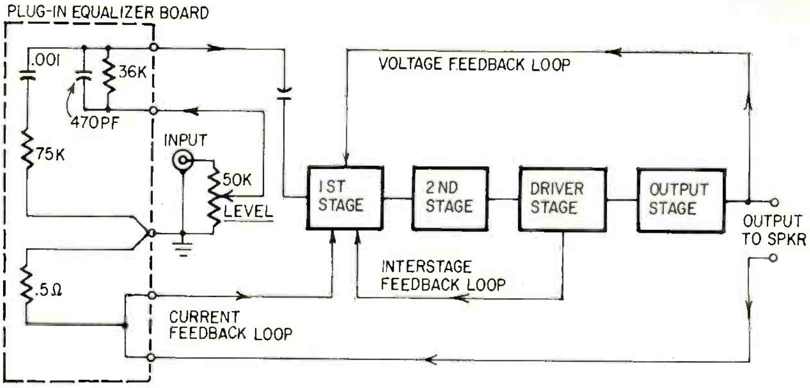


Fig. 3—KLH 8 has two principal frequency-correcting networks in feedback loops, shown here circled. Treble control, in plate circuit of 6BS8, looks like common "high-cut" type, but actually ranges from 10 db treble boost through flat to about 10 db cut (at 10kc). How? Ratio detector output is not fully de-emphasized, so receiver uses some of the treble boost built into FM signal at transmitter. Note, at input, the 68,000-ohm resistor, which is normally followed by .001 or .0012-µf capacitor. Here, the capacitor is only 330 pf, leaving high-end response up about 10–12 db at 10 kc.



EMI model DLS-1 amplifier/speaker. Rear view shows vacuum-tube amplifier in base of cabinet.

Fig. 4—Semi-schematic of JBL stereo Energizer (one channel). Plug-in equalizer board adjusts frequency response contour and damping factor. Response network is passive, at input to amplifier; damping is controlled by current feedback through (in this case) 0.5-ohm resistor.



loudspeaker with a 2-inch edge-wound copper-ribbon voice coil and an aluminum center dome (to handle the range above 5,000 cycles or thereabouts). The speaker is specifically designed for the system, and it is not recommended for general-purpose use even though it resembles certain commercial 8-inch units.

Another system in which a vacuum-tube amplifier and a matching speaker system are installed in the same cabinet is the EMI DLS-1. Unlike the Ampex, this is not a portable unit, although it is not particularly large as speaker systems go. It is designed primarily for use as a professional monitor, and this accounts for the tall thin shape. The speakers are positioned about 4 feet above floor level so that a listener will hear about the same sound, standing or seated.

Like some other EMI speaker systems, the DLS-1 uses an elliptical speaker for the woofer. Two small direct-radiator tweeters are mounted directly above the woofer to give a dispersion pattern with its greatest spread horizontally.

The 25-watt amplifier in the base of the column has four adjustable controls (factory-set) to balance the overall response and gain of the system to standard specifications. By making the equalization adjustable, EMI can compensate, not only for the inherent characteristics of the speakers and enclosure, but for small variations between individual units.

A third speaker/amplifier combination, quite familiar to US audiophiles, is the heart of the KLH Model 11 stereo phonograph. In this unit, KLH engineers decided to correct the inevitable limitations of a tiny speaker enclosure by providing complementary equalization in the amplifier.

Unlike the Ampex and EMI, however, the Model 11 has its speakers physically separated from the matching amplifier. This makes it possible to keep the size of the speaker systems at an absolute minimum. It also means that a pair of speakers can be driven from a single complementary stereo amplifier. In the previously described systems, each speaker cabinet has its own monophonic amplifier built in.

Again, equalization is provided by correcting the frequency response curve electronically. The tone-control network, a feedback system, is designed so that when the bass control is physically centered, there is a 4-db-per-octave boost from about 500 cycles down to about 75 cycles, below which the amplifier's response falls off rapidly to prevent driving the small speaker into distortion at frequencies below its resonant point. There is no special emphasis on controlling the damping factor of the amplifier. As mentioned previously, KLH makes the same speaker components available with a passive equalizing network so that they can be used with any standard power amplifier.

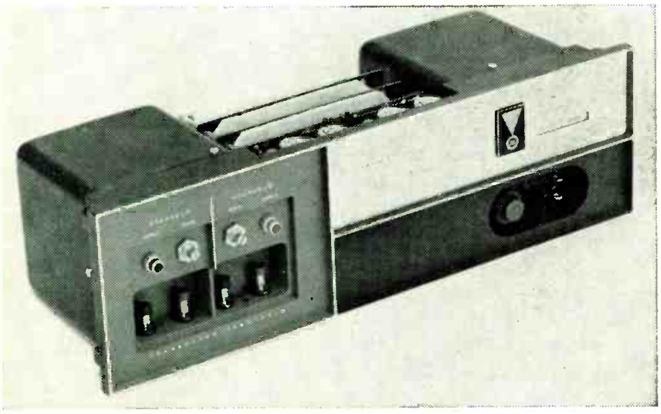
The equalizing components in the KLH Model 8, an FM receiver, are shown in Fig. 3.

James B. Lansing has combined the "built-in" concept of Ampex with the single stereo amplifier idea of KLH and the adjustable equalization feature of the EMI and added several entirely new developments of its own. The JBL Solid-State Energizer is basically a transistor stereo power amplifier, however, it installs directly in one speaker cabinet of a stereo pair.

Mounting the Energizer directly in the speaker enclosure is practical because the entire faceplate of the unit is really a cast aluminum heat sink for the output transistors. With the heat problem out of the way (transistors generate much less heat than vacuum tubes to begin with), JBL engineers were free to design an audio power source that would literally become a part of a specific speaker system.

The Energizer is flexible enough in its characteristics to match a variety of different speaker systems. A plug-in etched-circuit equalizer board (Fig. 4) controls the damping factor for the speaker system. Because no output transformer is used (a characteristic shared by other high-quality transistorized circuits), stable performance and uniform damping can be maintained into the 10-cycle region.

In addition to controlling the damping factor, the plug-in board can include electronic equalization as well. Because boards are available to match each speaker system JBL makes, any system can be supplied as a standard speaker, or as an integrated "Energizer/Transducer".



JBL Solid-State Energizer adjustable for variety of speakers.

A new hi-fi trend?

There is every reason to believe that increasing numbers of manufacturers will offer complementary speaker/amplifiers in the future. The freedom from tube replacement, overheating and microphonics that comes with transistors means that combining speaker and amplifier in the same package is now as practical as it is theoretically desirable. But there is no immediate rush to get rid of the conventional speaker or the all-purpose power amplifier. None of the four companies mentioned is committed *entirely* to the powered-speaker concept.

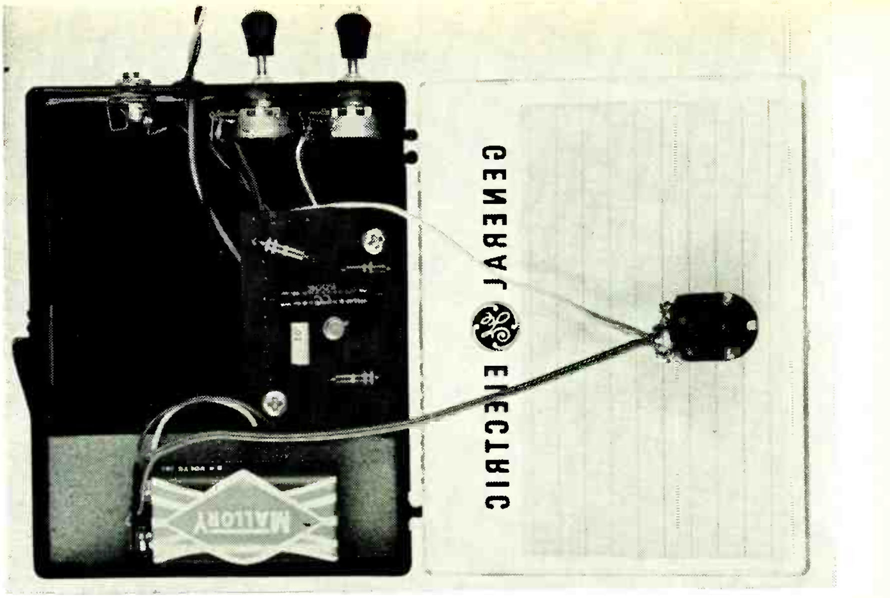
I believe that in the next 5 years, the hi-fi industry will see a definite de-emphasis of the separate power amplifier. Instead, the audiophile will have his choice of an all-in-one amplifier/control center *or* the separate control center driving an all-in-one amplifier/speaker. END

Meterless DC Voltmeter

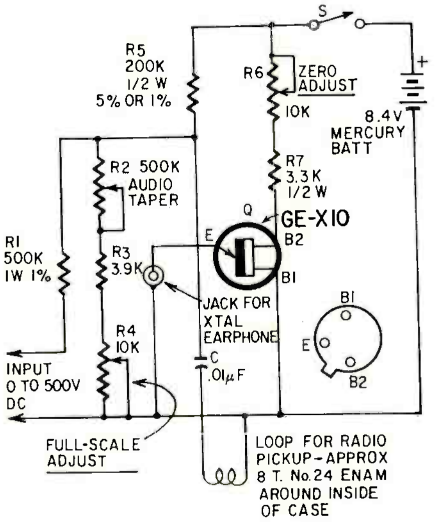
Light, tiny, accurate, simple and cheap—only a single unijunction transistor and no expensive movement!

By DR. R. A. STASIOR*

Rugged and small, this voltmeter can be dropped without being damaged or losing calibration. It has only one scale, 0 to 500 volts, but the low end (0 to 100 volts) is expanded, allowing flashlight batteries and transistor circuits to be tested accurately. The 0.5-megohm input impedance loads the circuit being tested very little. A Mallory TR-146 mercury battery with long shelf life and excellent voltage regulation gives accuracy at a low price.



The Meterless Meter with lid open. Knobs at left adjust miniature zero and full-scale pots; jack is for crystal earphone. Note wire loop running around inside of case.



Meterless Meter works on simplified potentiometer principle.

C—.01 μf paper
Q—Type GE-X10 unijunction transistor (G-E Electronics Experimenter line) or 2N2160
R1—500,000 ohms, 1 watt, 1%
R2—pot, 500,000 ohms audio taper
R3—3,900 ohms, ½ watt, 10%
R4—pot, 10,000 ohms linear
R5—200,000 ohms, ½ watt, 5% or 1%
R6—pot, 10,000 ohms, linear
R7—3,300 ohms, ½ watt, 10%
S—spst on-off switch (part of R2 in original unit)
BATT—8.4-volt mercury battery (Mallory TR-146)
Plastic box, knobs, miscellaneous hardware

The operating principle is to compare the voltage at the voltmeter input with a reference voltage. A potentiometer adjusts the input voltage until it is exactly equal to the reference. The potentiometer can be calibrated to indicate the input voltage.

A unijunction transistor GE-X10 generates the reference and detects when the input and reference voltages are equal. Whenever the input exceeds the reference voltage, the unijunction transistor generates an audio tone. The tone drops in frequency as the voltages approach each other, and stops when the voltages are equal.

The tone can be detected in either of two ways. A crystal earphone is suitable, or, instead, any radio can be placed close to the voltmeter to detect the high-frequency harmonics generated. For best results tune the radio to a quiet spot on the low-frequency end of the band and turn up the volume. The radio should be close to the capacitor leads for maximum volume. You'll hear an audio tone whenever the unijunction is oscillating.

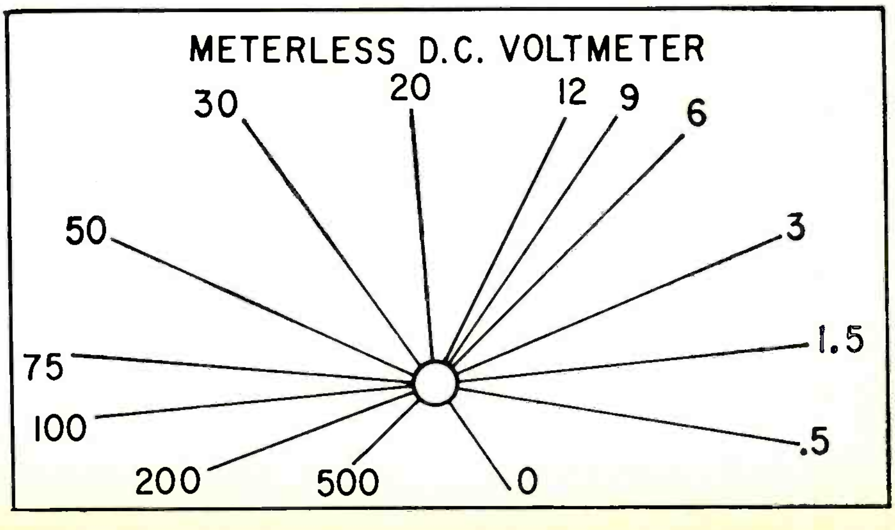
To use the voltmeter, connect the input leads to the voltage source you want to measure. Whilel you listen with the earphone or radio, turn on the voltmeter and rotate the potentiometer knob until you just hear an audio tone. The dial then indicates the input voltage.

Ripple or ac superimposed on the dc can be detected by a change in the tone character.

Two very nearly equal voltages can be recognized by setting the potentiometer to produce a low-frequency audio tone with one voltage and then noting the change in pitch as the other voltage is measured. The change in pitch is also useful in detecting lack of regulation in power supplies.

For calibrating the voltmeter, the easiest and most accurate approach is to mark its scale to agree with that of an accurate conventional voltmeter. The zero set and full-scale-set potentiometers can be replaced with fixed resistors of 3,900 and 3,300 ohms, respectively, if this calibration procedure is used. This reduces the circuits cost and size.

Another way is to use the scale below. Adjust the voltage-indicating potentiometer to its maximum value and short the input terminals. Adjust the zero-set potentiometer until oscillations just stop. Align the pointer on the voltage-indicating knob with the 0 mark on the scale. This gives reasonable accuracy at the low-voltage end of the scale. Now connect the input terminals to the highest known voltage available. Set the voltage-indicating pointer to this voltage. Adjust the full-scale-set potentiometer until the scale reading is correct. For better accuracy, adjust the zero-set and full-scale-set a second time. END



*Application engineer, Semiconductor Products Dept., General Electric Co.

COMPONENT CURVE TRACER

Quickly built box adapts your scope to check practically any common electronic part: diodes, resistors, capacitors, transistors, inductors, SCR's . . .

By FRED BLECHMAN K6UGT

IF YOU OWN A SCOPE, CHANCES ARE you don't use it as much as you could —possibly only for the more exotic operations, like TV or FM alignment, modulation checking, or waveform analysis. But wouldn't you get more use out of your scope if you could use it to check *all kinds of components*, especially the tricky-to-test semiconductors?

Well, with only four parts in its circuitry, the Component Curve Tracer will display a characteristic trace on your scope for regular and unijunction transistors, diodes, silicon controlled rectifiers and photoconductors. You'll be able to test and approximate the *value* of capacitors, resistors, potentiometers and inductors. And you can check the continuity of lights, switches, fuses, circuit breakers and relays or transformers having resistance up to 100,000 ohms! Not only that, but the necessary calibration is built into the unit!

The ultra-simple Component Curve Tracer schematic is shown in Fig. 1. Once the circuit operation is understood, you'll find it extremely simple and effective. Let's see how it works.

With the line cord plugged into an outlet, a 60-cycle sine wave at slightly over 6.3 volts rms appears at the output of T. With *no* component connected across them, T's full sine-wave voltage appears between J2 and J3 (since no current flows through R1, and hence no voltage is dropped across it). Now let's assume a dead short is placed across J2–J3. This effectively "grounds" J3, and the full sine-wave output of T now appears across J1–J2. If J2–J3 is left open, and calibration switch S is closed, equal voltages will appear across J1–J2 and J2–J3, since R1 and R2 are equal in value, with "ground" at their junction.

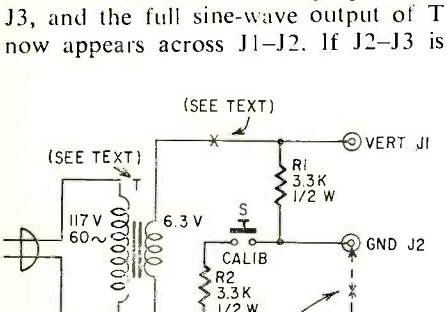


Fig. 1—Circuit of the Component Curve Tracer.

An oscilloscope connected to VERT, GND and HORIZ as shown in Fig. 2 (shielded leads are *not* necessary) will display characteristic patterns that depend on what is connected across the GND and HORIZ binding posts. A semiconductor diode, for example, is polarity-sensitive and conducts only when biased in the proper direction. During half the input cycle it acts as a short circuit across GND–HORIZ, tracing a vertical line on the scope screen; during the other half cycle, it "looks like" an open circuit and traces a horizontal line. The result is an L-shape for a good diode. Each type of component has characteristics that yield a distinctive trace on the scope. With very little practice, you'll learn to distinguish them.

Construction

A small two-piece aluminum box makes a convenient housing. The only precaution in wiring is to be sure that the transformer input is not connected to the case, to avoid a severe shock hazard. Use a two-terminal solder lug strip for wiring the line cord to the transformer primary leads, and run the line cord into the box through a rubber grommet, with a strain-relief knot on the inside of the box. The binding post and pushbutton switch terminals allow the remainder of the wiring to be point-to-point—no additional terminal strips are needed. External alligator-clip leads attached to the GND and HORIZ binding posts are handy.

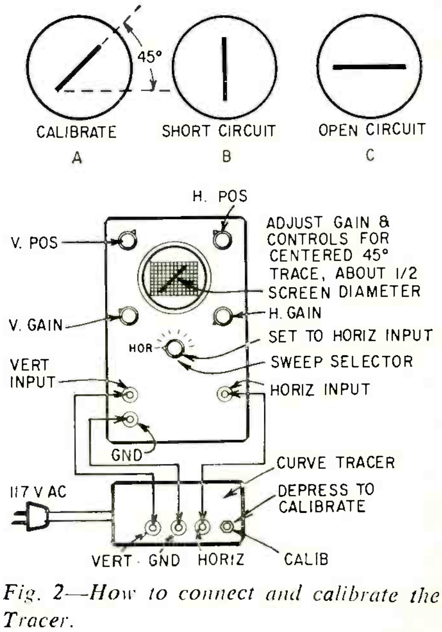


Fig. 2—How to connect and calibrate the Tracer.

Construction shouldn't take over

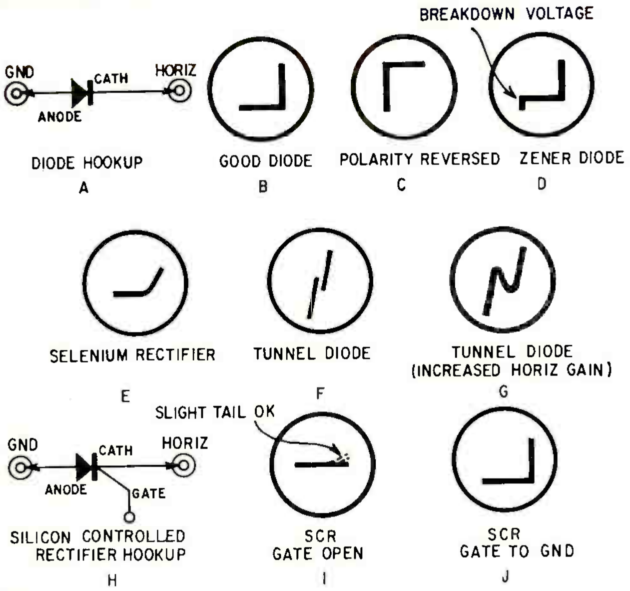


Fig. 3—Diode and rectifier tests with the Tracer.

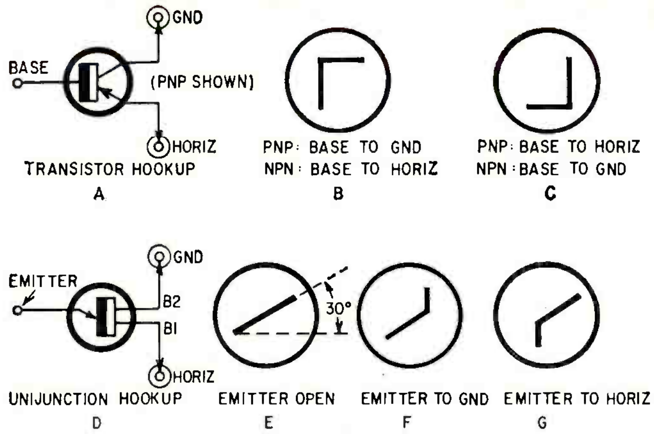


Fig. 4—Testing transistors with the Tracer. In checking unijunctions, right end of sloping line turns up when emitter is connected to base 2 and left end turns down when emitter is connected to base 1.

an hour. Marking with decals or dry-transfer labels completes the unit.

Current drain from the secondary of transformer T is only about 2 ma with GND–HORIZ shorted, so there's no worry about the power rating of T. Anything over 15 mw will do! The little 600-ma transformers, rated at nearly 4 *watts,* are the smallest and least expensive commonly available. Calibration switch S may be a slide, toggle, lever or rotary type instead of the pushbutton switch I used—but the small size and low price of the pushbutton are hard to beat.

Calibration

Connect the Curve Tracer to your scope as shown in Fig. 2. Be sure to put the sweep selector to the "Horizontal" or "External" position. When the Tracer's cord is plugged into an ac outlet, you should get a horizontal line on the scope screen (with nothing connected across GND–HORIZ). Now close the calibration switch; the line on the screen will tilt. Adjust the scope's vertical and horizontal gain and positioning controls until the display is a straight line tilted at a 45° angle, centered on the screen, and covering about half the screen diameter. This completes calibration, and the oscilloscope controls will not need to be adjusted again, except as indicated in specific tests that follow.

Don't be surprised, incidentally, if all your patterns seem to be the *reverse* of the patterns shown in the illustrations and photos. If your calibration line slants in the opposite direction from that shown in Fig. 2-a, all your patterns will be flipped left-for-right around the scope screen's vertical centerline. This is a result of the *direction* of horizontal deflection in your scope (left to right or right to left), which varies with different makes. Also, the slight double line shown on the photos is the result of slight phase shift between vertical and horizontal deflection voltages at 60 cycles, and is nothing to worry about.

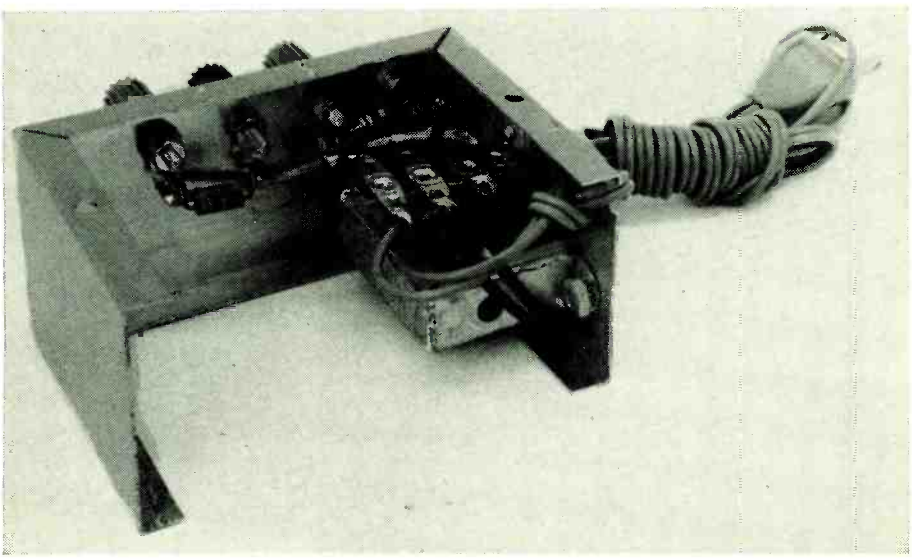
Testing components

About the only common electronic components the Curve Tracer *won't* test in some manner are quartz crystals and batteries. Just about everything else can be given a functional or continuity test as described in the following paragraphs. In all cases, the component under test is connected between the GND and HORIZ binding posts, with "polarity" as described. A short is shown by a vertical line (Fig. 2-b), an open by a horizontal line (Fig. 2-c).

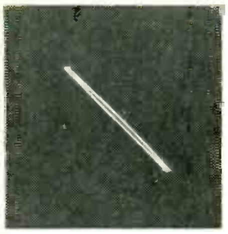
Semiconductor diodes. Connect the anode (arrowhead on symbol) to GND and the cathode (bar on symbol) to HORIZ, as shown in Fig. 3-a. A good diode will look like Fig. 3-b. If you've connected the diode with the anode and cathode inverted, the pattern will be inverted (Fig. 3-c); this allows you to identify the polarity of unmarked diodes. If the vertex of the L-shape is rounded, or if either leg is much shorter than the other, or slanted from the horizontal or vertical, the diode should be discarded.

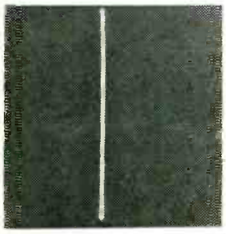
Zener diodes. Connect as for any other diode. If the Zener "breakdown" voltage is below about 10 volts, you'll get a pattern like Fig. 3-d. The distance of the breakdown ledge from the vertex is a measure of the Zener voltage, from zero at the vertex, to 10 volts at the end of the horizontal leg.

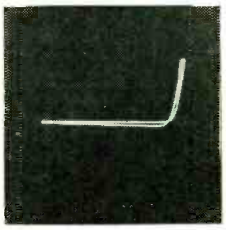
Selenium rectifiers. Connect as shown in Fig. 3-a. Typical pattern is Fig. 3-e. Note the rounded vertex and



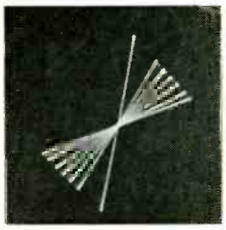
Inside the Curve Tracer.

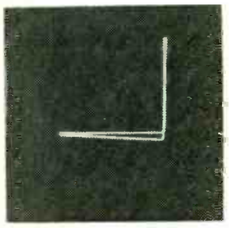

Calibration trace—45°, half screen diameter

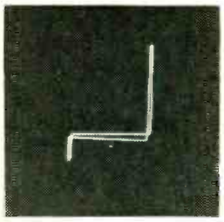

Short circuit between terminals GND-HORIZ

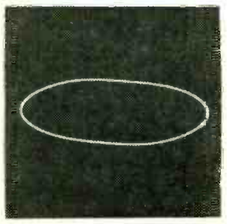

Selenium rectifier: rounded knee


Tunnel diode with trace expanded


Potentiometer: various shaft settings (multiple exposure)


Good semiconductor diode


Zener diode: 8.5-volt breakdown


Good 0.27-μf capacitor

the short vertical leg, slightly slanted, indicative of poor transfer characteristics, high forward voltage drop, and some forward resistance. These are characteristic of selenium rectifiers, and should not be cause for concern unless the vertical leg is *very* short or *very* slanted.

Tunnel diodes. Connect as shown in Fig. 3-a. The initial display will be as shown in Fig. 3-f—two vertical lines with a gap in the center. However, by increasing the scope's horizontal gain, you can get the pattern of Fig. 3-g, almost the classical tunnel-diode curve! Remember to recalibrate the scope (reduce horizontal gain) before testing other components.

Silicon controlled rectifiers (SCR's). Connect as shown in Fig. 3-h, with the gate *not* connected. The pattern should be as shown in Fig. 3-i, possibly with a slight slanted tail. Now, with a cliplead, connect the gate to GND, and you should get the pattern of Fig. 3-j, since the SCR will now conduct during the half-cycle when the anode and gate are positive with respect to the cathode.

Transistors. Since, basically, a transistor is two diodes joined at the base, we'll test it that way. First, connect the transistor as shown in Fig. 4-a. (Note: actually the emitter and collector connections could be interchanged with no effect.) The base is *not* connected. The pattern should be a straight or slightly kinked horizontal line—if the line is arc-shaped, the transistor is leaky. If the transistor is shorted, the line will be vertical.

Now touch the base lead to the GND terminal and you should get Fig. 4-b for a p-n-p transistor, Fig. 4-c for an n-p-n. This allows you to determine the polarity of an unmarked unit. Now swing the base lead to the HORIZ terminal and the pattern should invert (Fig. 4-c for p-n-p, Fig. 4-b for n-p-n).

If, in either of these last two tests, there is no L-pattern, the transistor junction is open. If the pattern is badly distorted, the transistor is leaky. If one leg of the L is slanted, the diode action is not good: vertical leg slanted means high forward resistance; horizontal leg slanted means low reverse resistance (leaky). *Power* transistors *normally* show symptoms of very high leakage since, relatively speaking, they *have* high leakage. Test a few known good power transistors to get a "feel" for how they should look with the Curve Tracer; you'll find the patterns variable, but opens and shorts will still show up instantly.

Unijunction transistors (UJT's). Fig. 4-d shows the connections. Initially, the emitter lead is not connected. The pattern should be a straight line,

BENCH TESTED

The Curve Tracer was checked by a member of RADIO - ELECTRONICS' staff and found to work just as described. It was extremely interesting to watch it check a large number of very different devices without any need for adjustment. It is especially useful as a comparator. The angle for a given resistor is noted, or the horizontal and vertical controls set so a capacitor produces a perfect circle. Then any deviation from the angle or the circle indicates a capacitor or resistor larger or smaller than the standard. The direction of deviation shows which way the difference lies. Power transistors can be compared to a standard (known-good) transistor as well.

slanted about 30° from the horizontal, Fig. 4-e. Now touch the emitter lead to the GND binding post. The upper end of the pattern should swing vertical, as shown in Fig. 4-f. When the emitter lead is touched to the HORIZ terminal (base 1 of the UJT), the lower end of the line should swing vertical (Fig. 4-g).

Resistors. Since an open circuit between GND and HORIZ shows as a horizontal line, and a short circuit shows as a vertical line, it stands to reason that a finite nonzero value of resistance will show as something in between—a slanted line. Fig. 5 is a plot of the angle of this line from the horizontal as a function of resistance. Of course, the Curve Tracer must be calibrated for the chart to be valid. Values from 100 to 100,000 ohms can be estimated. Less than 100 ohms is essentially vertical; more than 100,000 ohms is essentially horizontal. The unknown resistance is merely placed across GND–HORIZ, the angle estimated, and the resistance read from Fig. 5.

Potentiometers. Connect the center lug and either end of the pot between HORIZ and GND. As the shaft of the pot is rotated the display will be a straight line that swings between vertical and horizontal. A jumpy or fuzzy trace indicates a noisy unit, which should be squirted with contact cleaner or discarded. The resistance value can be estimated from Fig. 5 by judging or measuring the trace angle from the horizontal.

Photoconductors. Connect between HORIZ and GND. Keep the face of the cell covered with your hand. The trace should be horizontal, or at a slight angle, indicating the high dark resistance of the cell. Now expose the surface of the cell to light and the line will slant toward the vertical. By using Fig. 5 you can estimate the resistance

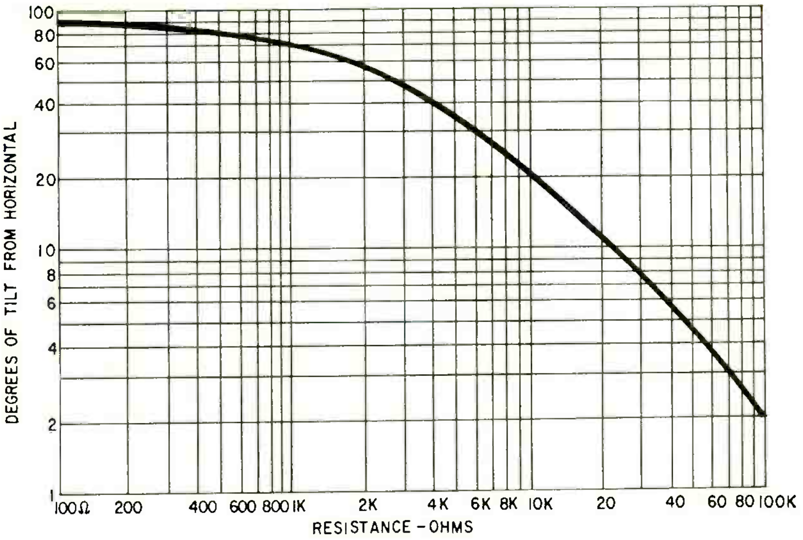


Fig. 5—Plot of tilt-angle of scope trace against resistance makes it possible to find approximate values of resistors and of pots in various positions.

for any particular light value—an exotic light meter! Also, this allows you to match photoconductors for similar characteristics, which may vary considerably even between units of the same part number.

Capacitors. Calibrate the scope as described previously. Connect the unknown or suspect capacitor between HORIZ and GND without regard for polarity, even for electrolytics. The pattern on the scope screen for a good unit will be an ellipse, with the long (major) axis horizontal for values up to 0.85 μf. At about 0.85 μf, the pattern is a circle, and above this value the major axis is oriented vertically. By measuring the ratio of the horizontal axis to the vertical axis and referring to Fig. 6, you can estimate the *value* of the capacitor. This is particularly useful for those difficult-to-test low-voltage, low-value electrolytic and disc capacitors so common in transistor circuits today. When testing capacitors, if the major axis of the ellipse is *tilted*, throw the capacitor away—its leakage is much too high.

Inductors, transformers, relays. Connected between HORIZ and GND, an inductor will show an elliptical pattern, with the major axis tilted. Generally speaking, values of less than about 5 h will show an ellipse with the major axis inclined toward the vertical, with around 5 h showing as a circle. Above 5 h the major axis tilts toward the horizontal. Unfortunately, this is only a very rough indication of inductance, since the capacitance of the windings combines with the inductance, and what the scope shows is the effect of the combination, including phase shift.

Since the method of winding an inductor, the number of turns and the wire size all contribute to the resistance and distributed capacitance, trying to specify the value of inductance indicated with the Curve Tracer is not much more than a "ballpark figure." However, this test is useful to show up units that are either open or shorted. Furthermore, you can spot a unit with *shorted turns* by comparing the suspect unit with a known good one just like it!

Continuity tests. Obviously, since a vertical display indicates a very low resistance between HORIZ and GND, the Curve Tracer can be used to check the continuity of switches, lights, fuses, circuit breakers, circuit wiring, etc. Admittedly, an ohmmeter, buzzer or light device can test continuity also, but this is just another application for the Curve Tracer, not its primary design goal.

Precautions

The very low power in the Component Curve Tracer avoids harm to even the most delicate components. Tunnel diodes, microwave diodes and vhf transistors, all notoriously easy to ruin, have been checked without damage. The transformer isolates the operator from the power line, and built-in resistor R1 limits the output current to a couple of milliamperes even when the output terminals (HORIZ and GND) are shorted.

Only two potential "danger" conditions exist: don't connect anything except the scope lead to the VERT terminal, since it is directly connected to the transformer output. Make sure, as previously mentioned, that the transformer primary leads are insulated from the box. If you want to use the Curve Tracer as a handy 6.3-volt 1-amp ac supply, and want to be certain of making it burnout proof, put a 1-amp fuse at the point marked "X" in Fig. 1. You can now connect between VERT and HORIZ for use as a substitute filament transformer.

The Component Curve Tracer is simplicity itself in construction, costs very little to build and, with a little practice, performs tests easily and quickly that would otherwise require an array of exotic test equipment. END

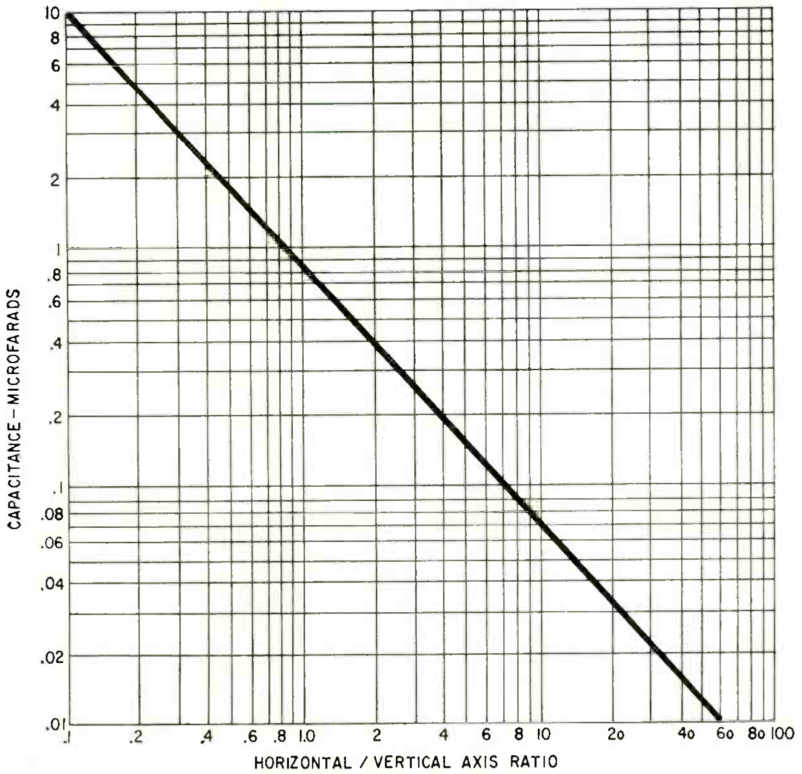


Fig. 6—Size of scope ellipse's horizontal axis, divided by size of vertical axis, is proportional to capacitance.

SCOPE x 100

Your low-cost 200-kc scope can be improved by a factor of 100 in gain and bandwidth with just an evening's work and very little expense

By TOM JASKI

ARE YOU UNHAPPY WITH YOUR economy oscilloscope? Did you underestimate your future needs when you bought it, or did you just run out of money? In either case, if your scope is now too limited for your needs, here is a way to make a silk purse out of the sow's ear. For it is relatively easy to extend the sensitivity of your small scope and not very expensive, and it is even feasible to increase the bandwidth. For a few pennies you can speed up the sweep generator or slow it down. I can't promise a truly "professional" scope without many other changes, but you will see some drastic changes in performance with simple changes in circuitry.

What are the limitations of scopes —and *why* are they? First of all is *sensitivity*. A certain voltage difference is needed to deflect the CRT beam a given distance, and to get this voltage the signal is amplified. Sensitivity then depends on the deflection sensitivity of the CRT and the gain of the vertical deflection amplifier. Improve either or both, and you gain sensitivity.

The other factor, *bandwidth*, is a little more complicated. The CRT is willing, up to about 30 mc at least. But

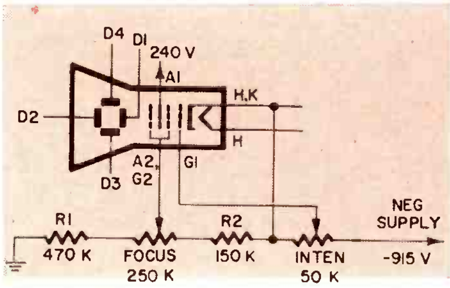


Fig. 1—How to lower focusing voltage when you change CRT type.

the signal is lost in the amplifier if the frequency gets too high. Economy scopes are generally limited to about 200 to 400 kc. This is a matter of time constants in the amplifier. Large plate-load resistors, used to get high gain with few stages, excessive capacitance in the wiring and tube elements, and deflection plate capacitance in the CRT, all conspire to lower the maximum frequency that can be displayed.

We can compensate for much of the excessive capacitance by introducing inductance at well chosen places in the circuit. In doing so we also lower the plate load resistances, sacrificing gain in the amplifier. Gain and bandwidth are inevitably related inversely for a given amplifier. To obtain more bandwidth for the same sensitivity we

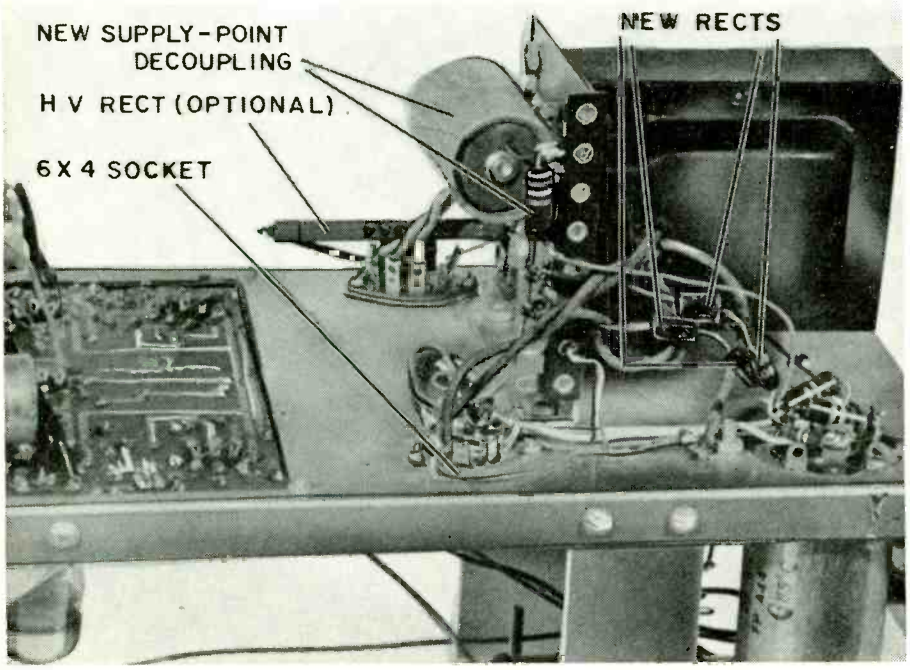
Author's 12-year-old Heathkit OL-1 was the patient in the surgery described here. Small black knob at bottom of pannel is of now new sync control; vertical attenuator occupies former sync control's hole.

must improve both the time constants and the gain of the amplifier.

How to go about it

Some sensitivity can be gained simply by changing CRT's. Table I shows the deflection sensitivities of the most likely CRT's to be used. Note that if you change from a 3GP1 to one of the other types, you may have to change the socket or focus voltage. The focus voltage for many CRT's of the same screen size falls within the same general range. However, actual focus voltages available vary with the make and model of the oscilloscope and may not cover nearly the range listed in the table. The optimum focus voltage for the tube you select as a replacement may be outside the range of the focus control in your scope. You can change the range of available focus voltage by selecting new values for R1 and R2 (Fig. 1), while keeping the total value of the voltage divider relatively constant. Note well that if you change from a 3GP1 to a 3WP1 you can nearly double the scope's sensitivity.

A second way to increase sensitivity is to install a series resistor in the high-voltage supply to lower the total voltage applied to the CRT. However, this reduces the brightness and produces a larger, less-accurate spot. In general, a decrease in high voltage will increase sensitivity in about the same proportion.



Silicon rectifiers and new decoupling, as shown in Fig. 2.

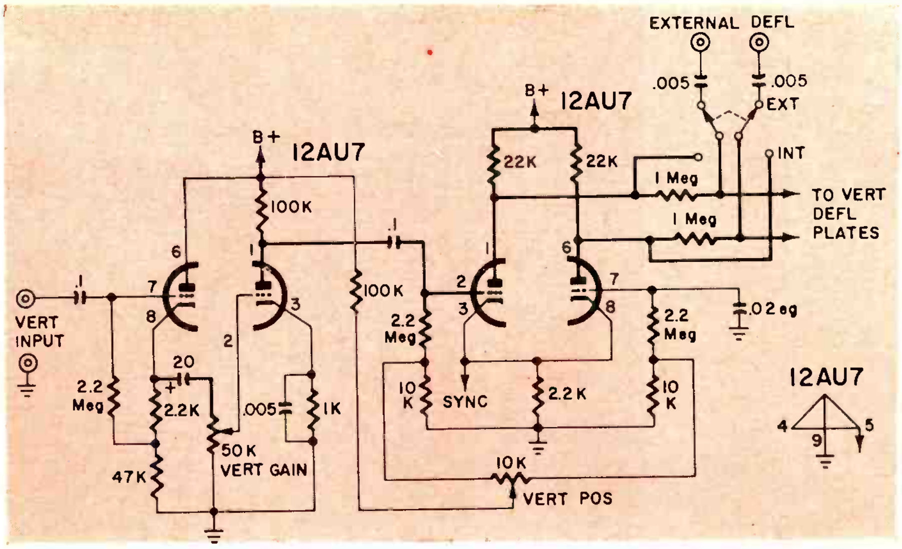


Fig. 2—Original vertical deflection amplifier in 3-inch Heath OL-1 (newer IO-21 is very similar). Wiring and parts shown as heavy lines affect bandwidth seriously.

Pitfalls in CRT substitution

If you plan carefully and know what to watch out for, you should not have any difficulty in making a successful CRT substitution.

Deflection electrodes (plates) D3 and D4 are nearer to the gun than D1 and D2 and are more sensitive. D3-D4 are normally used for vertical deflection. But, you should check your scope before replacing the CRT. In a few of the older scopes and some economy models, D1-D2 are used for vertical deflection and a simple low-output sweep oscillator drives D3-D4.

Also, some CRT's, such as the 3AP1 and 5MP1, have one horizontal and one vertical deflection plate connected to a common terminal and are not designed for push-pull deflection.

Another point to watch is the length of the replacement CRT. It might be a tough job squeezing a longer tube into the scope. Too, if the original CRT has a tight-fitting contoured shield, you may have to purchase one to fit a new tube.

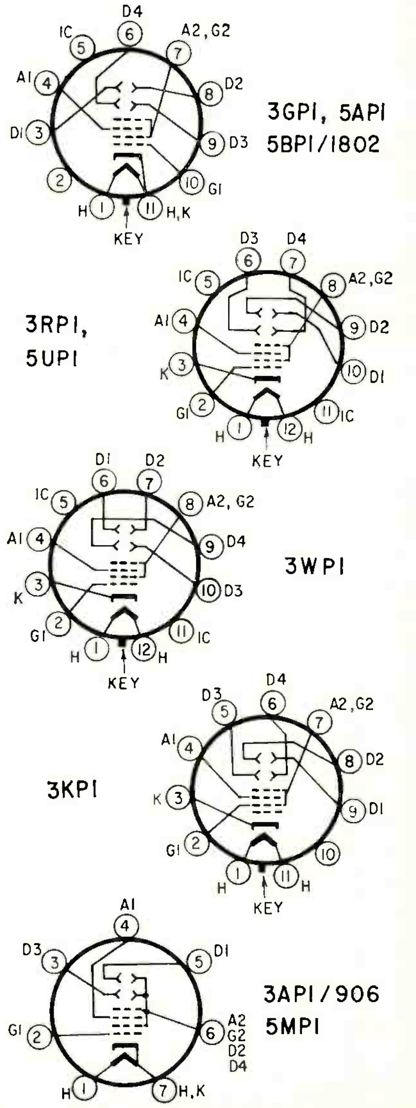
Increasing amplifier gain

The best, and most complicated, way to increase a scope's sensitivity is to modify the amplifier. Since this involves changes in the scope's circuitry, you might as well do the whole job and improve the bandwidth, too.

The scope I worked over was an old Heath OL-1, forerunner of the IO-21. While the IO-21 uses a 3RP1 and the OL-1 uses a 3GP1, their deflection and sweep circuits are quite similar. The same considerations, with possibly slight variation in values, should hold for economy 5-inch oscilloscopes. Where the original vertical sensitivity is listed as ±2 db from 2 cycles to 200 kc, the final product has approximately +0.5 db to −5 db variation from 2 cycles to 5 mc. The 2-db point now lies well over 2 mc (hence a 10:1 improvement in bandwidth). The sensitivity at 1,000 cycles, originally 0.25 volt rms per inch, is now approximately .025 volt per inch with a 3WP1 and .05 volt rms per inch with the original 3GP1. (A possible improvement of more than 10:1 in sensitivity; therefore a gain–bandwidth improvement of 100 times!)

As shown in the photos, the original printed circuit can be used in the OL-1 (the IO-21 does not use a printed circuit). Fig. 2 shows the original schematic of the vertical deflection amplifier. Fig. 3 shows the modified amplifier. The parts and wiring shown as heavier lines are new or replaced. Notice the low plate-load-resistor values, with peaking coils in series. On the OL-1 it is best to modify the vertical position circuit as shown. The extra wiring to external terminals for the plates should also be removed, since it seriously affects performance at the upper end of the frequency range. Rise time of the new circuit is about 0.1 μsec or less.

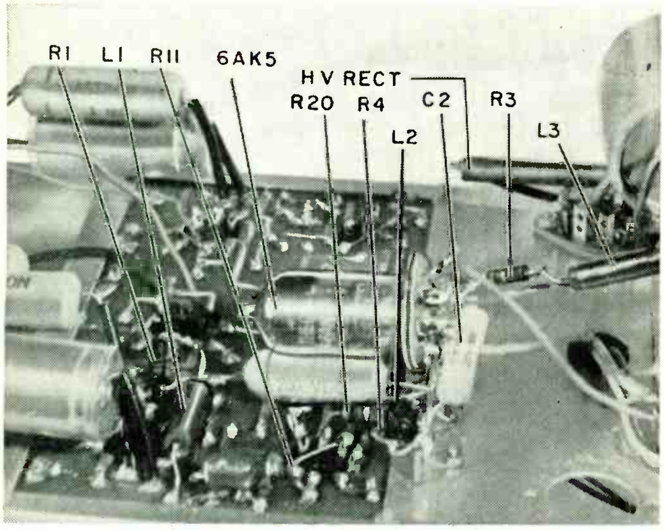
Note that the ECC81 (replacing the cathode follower and amplifier 12AU7) and the ECC82 (replacing the final amplifier 12AU7) are installed in the original sockets. Parts for these tubes can be mounted on or under the



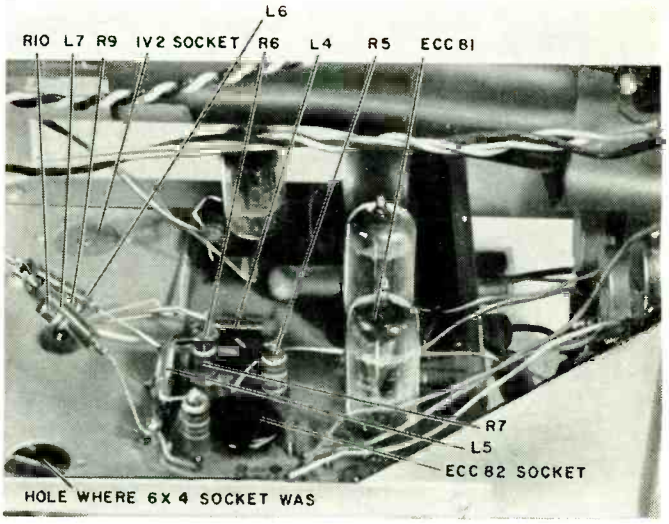
CRT's YOU CAN USE

Type	Vert. defl. sensitivity (dcv/in. when A2 is 1,000 v)	Focusing voltage	Overall length (in.)	Socket
3AP1/906[3]	73	285	11½	Medium 7-pin
3GP1[3]	56–84	163–291 (16–29% A2)	11⅞	11-pin medium-shell Magnal
3KP1	38–52	160–300	11¾	11-pin medium-shell Magnal
3RP1	52–70	165–310 (16–31% A2)	9⅜	12-pin small-shell Duodecal
3WP1	28.5–35	165–310	11⅝	10- or 12-pin small-shell Duodecal
5AP1[3]	90[1,2]	430[1,2]	13	11-pin large-wafer Magnal
5BP1/1802	47–67[1]	253–422[1]	17⅛	11-pin large-wafer Magnal
5MP1[3]	60[2]	250[2]	15⅞	Large 7-pin
5UP1	23–31	170–320 (17–32% A2)	15⅛	12-pin small-shell Duodecal

¹ A2 is 1,500 volts
² Average value
³ Obsolete. May be available only from military surplus sources.



How 6AK5 socket is mounted under chassis on terminal strip right next to pc board. This keeps leads short.



Above chassis: new plate loads and inductances. Holes for original plate load resistors now take one lead each of new resistors; inductors span remaining leads. L6 and L7 (left) are suspended in leads to CRT.

printed-circuit board, as shown in the photos.

As a first step, I removed the 6X4 and replaced it with silicon diodes. This lowered the heater load on the transformer and thus provided for the extra tube, the 6AK5 amplifier. I also replaced the high-voltage rectifier, but that is optional. Not much is gained.

Because silicon rectifiers have a much smaller voltage drop than tubes, supply voltage will rise by about 10%. This higher voltage may exceed the ratings of some components, so either replace them with higher-rated ones or increase the value of the first filter resistor to bring the voltage back down.

A new filtered and decoupled supply point is desirable. The photos show it installed on the transformer bracket under the chassis. The 6AK5 socket is soldered to the lugs of a terminal strip under the chassis. This is not mandatory, but it reduces chances of hum pickup in this tube. It can also be installed in the 6X4 socket (rewired, of course).

Note in the photos that I removed the sync control to accommodate in its place a new attenuator switch, also shown in Fig. 3. This is optional, but with the additional sensitivity you will find it much more comfortable to have

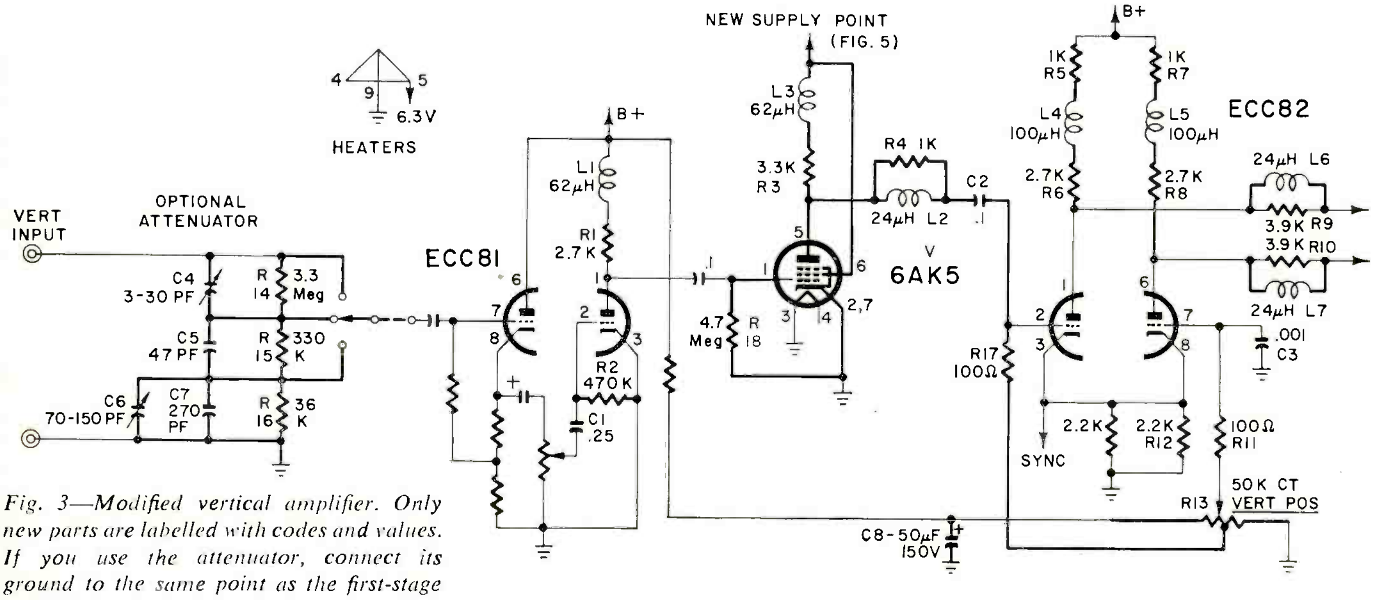


Fig. 3—Modified vertical amplifier. Only new parts are labelled with codes and values. If you use the attenuator, connect its ground to the same point as the first-stage grounded cathode resistor.

C1—0.25 μf, 25 volts, ceramic (mount on back pc board)
C2—0.1 μf 600 volts, paper or ceramic (mount on 6AK5 socket)
C3—.001 μf, 600 volts, paper (replace existing .02-μf on pc board)
C4—3–30-pf trimmer (mount on atten. switch)
C5—47 pf, Mylar (mount on atten. switch)
C6—70–150-pf trimmer (mount on atten. switch)
C7—270 pf ceramic (mount on atten. switch)
C8—50 μf, 150 volts, electrolytic (mount on chassis)
L1, L3—62 μh (J. W. Miller 4630)
L2, L6, L7—24 μh (J. W. Miller 4626)
L4, L5—100 μh (J. W. Miller 4632) (Mount on ends of upright resistors R5–R6 and R7–R8.)
R1—2,700 ohms (mount on pc board bottom)
R2—470,000 ohms (mount on socket bottom)
R3—3,300 ohms (mount on 6AK5 socket lug)
R4—1,000 ohms (mount on terminal strip)
R5, R7—1,000 ohms, 2 watts (mount one end on pc board—remove 22,000-ohm res)
R6, R8—2,700 ohms, 2 watts (mount like R5, R7)
R9, R10—3,900 ohms (suspend on wire to defl. plates)
R11—100 ohms (mount on back of socket)
R12—2,200 ohms (mount on pc board, parallel to existing 2,200-ohm res)
R13—pot, 50,000 ohms, center-tapped (mount on front panel)
R14—3.3 megohms (mount on atten. switch)
R15—330,000 ohms (mount on atten. switch)
R16—36,000 ohms (mount on atten. switch)
R17—100 ohms (mount like R11)
R18—4.7 megohms (mount on terminal strip)

All resistors ½ watt carbon, 10% except as noted

V—6AK5
See text for hardware, sockets and other parts for the modifications. Parts for modifications to sweep and CRT circuits, etc. are given in Figs. 2, 5 and 6

the attenuator. The trimmers are adjusted by displaying a 1,000-cycle square wave, removing overshoot and rounding, starting with the ×100 step. You will probably have to go back and forth through the attenuator steps several times before both trimmers are adjusted satisfactorily. Use an insulated screwdriver for the job.

Wiring must be carefully considered. At several megacycles, even a few inches of wire become meaningful, and may decrease amplifier performance considerably. If wires must be run some distance, run them out in the open and

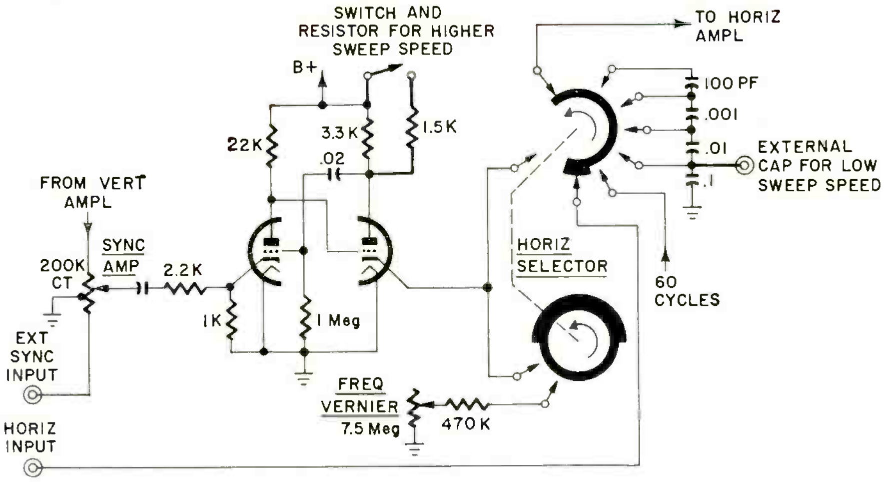


Fig. 4—How to speed up sweep by lowering plate resistor in multivibrator; how to bring out terminal for increasing sweep time (slow sweep) by adding external capacitor. One end of the external timing capacitor goes into the added jack; the other connects to ground.

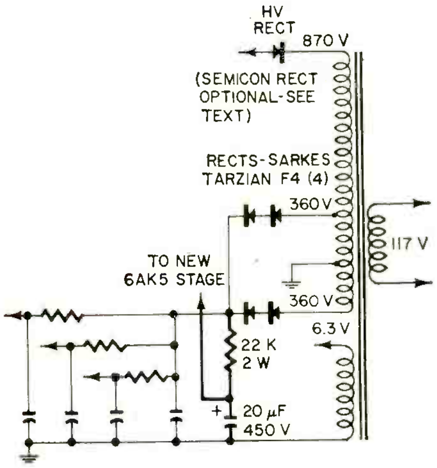


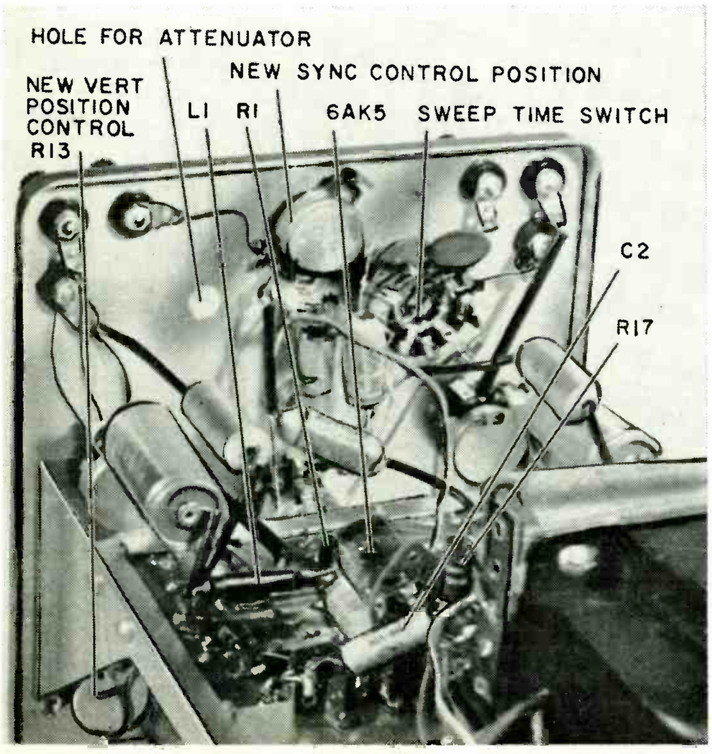
Fig. 5—Changing to silicon rectifiers reduces load on power transformer. New resistor and electrolytic decouple new amplifier stage. Each rectifier must be rated at 600 volts minimum—such as Sarkes Tarzian F-6 (1N2484) or RCA 1N3195. The HV rectifier should be two 800-volt diodes in series—such as RCA 1N3196.

as direct as possible—no dressing in neat loops against the chassis. Remember, too, when testing the scope that now at the higher frequencies any long coax test cable will have its own effect on the input. Use short shielded connections with as little capacitance as you can get. Shorter connections were my main reason for mounting the 6AK5 where it is.

Sweep circuit

Now that you have a scope that will respond in the megacycle range, the old 100-kc sweep circuit may not satisfy you. Fig. 4 shows how you can speed up the sweep circuit by about 2:1 without any further changes. By replacing the capacitors with smaller ones, you may gain some speed, depending on how neatly the sweep circuit is wired. Fig. 4 also shows how to bring out a terminal for an external capacitor to slow down the sweep rate. This has a limit; if you slow down the sweep below 2 cycles per second it will start losing linearity due to the ac-coupled horizontal-deflection amplifier. It is in most cases not worth while to alter that circuit unless you anticipate much work with slow sweeps. That is another story.

Fig. 5 shows changes in the power supply to accommodate the extra stage.



Rear view of front panel shows new location of sync control. Control was moved without disconnecting any wires. Plenty of space if you use a miniature switch for the attenuator.

Z-axis, too!

A final touch in improving the scope's versatility is to add a Z-axis terminal, allowing the scope to be used for checking TV circuitry, and for time measurements with Z-axis (intensity) mod-

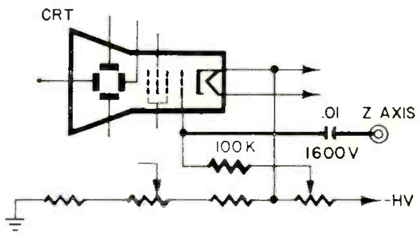


Fig. 6—How to add a Z-axis-modulation terminal to your scope.

ulation. Fig. 6 shows how it can be done. This does not degrade scope performance in any way. By providing timed pulses on the Z-axis, either blanking part of the trace or creating thicker places on it, you can inject a timing signal without interfering with the vertical amplifier at all.

Total cost of the entire modification (not including a new CRT, if used) comes to about $15 for all new parts—hardly a fortune. END

SIGNAL-MAKERS

An up-to-the-minute directory of every kind of signal-generator likely to be useful in the hobby or service shop!

Units are listed in alphabetical order under their classification: RF, Audio, Sweep, etc. All specifications were supplied by the manufacturers.

AM RF GENERATORS

Clemens—Model SG-83A. Precision all-transistor instrument covers 50 kc to 54 mc in 6 bands with 1% calibration accuracy. Output voltage across 50-ohm load adjustable in 1-db steps from 0.6 µv to 160 mv and twice these values open-circuit. Leakage field measured 3 ft away equivalent to less than 0.3 µv at output terminals.

Rf signal may be modulated by 400-cycle internal oscillator or external source. Input of 1.5 v rms required for 50% modulation. Modulation level, variable from 0% to 50%, indicated on panel meter. Modulation flat within 1 db from 100 to 5,000 cycles and within 3 db from 50 cycles to 10 kc. Incidental FM negligible below 10 mc and less than .05% at 50 mc.

On 7th band, rf oscillator is controlled by 1-mc .02% crystal with harmonics usable to at least 20 mc.

Operates from 9-volt transistor battery or built-in ac supply. 10½ x 12½ x 7½ in. 19 lb (shpg wt). $275.—**Clemens Manufacturing Co.,** 630 S. Berry Rd., St. Louis, Mo. 63122.

Conar—Model 280 covers 170 kc to 60 mc on fundamentals and from 60 to 120 mc on harmonics. Has 400-cycle oscillator for modulation and audio tests. Output level at least 1 volt p-p 170 kc to 5 mc and at least 20 mv up to 60 mc. Af output at least 5 volts p-p. Accuracy better than 3%. CW and AM outputs variable with coarse and vernier attenuators.

Nine-inch dial with 6:1 planetary drive. Single gle cable for 400-cycle audio and modulated and unmodulated rf outputs. Solid-state 117-volt 60-cycle supply.

Two tubes and selenium rectifier. 9⅞ x 7½ x 6½ in. 8 lb. $24.95 kit, $35.95 wired.—**Conar Instruments, Div. National Radio Institute,** 3939 Wisconsin Ave., Washington, D.C.

EICO—Model 315. The manufacturer's deluxe rf signal generator. Calibrated coverage 75 kc to 50 mc in 5 fundamental ranges and 13–150 mc on harmonics in 2 bands. Has 400-cycle internal modulation and provision for external modulation. Bandspread tuning for good resetability. Dial accuracy better than 1% all bands. Regulated power supply, fully shielded chassis and attenuators and line filters for minimum leakage radiation.

Has 4 tubes including rectifier. 117 vac. 13 x 12 x 7 in. 18 lb. $49.95 kit, $69.95 wired.

Model 320. Five fundamental ranges cover 150 kc to 34 mc. Two calibrated harmonic ranges cover 22–102 mc. Has Hartley rf oscillator with 6:1 vernier tuning for more accurate and easier setting. Rf output over 100,000 µv. Colpitts oscillator for internal modulation and 400-cycle output at 1.5–2 volts.

Two tubes, 117 vac. 8 x 10 x 4¾ in. 8 lb. $24.95 kit only.

Model 324. Range 150 kc to 145 mc on fundamentals in 6 bands, 111–435 mc on calibrated harmonics. Dial calibration accuracy 1.5%. Colpitts rf oscillator plate-modulated by cathode follower. A 400-cycle Colpitts oscillator provides modulation level adjustable to 50%. Rf output to 100,000 µv, af output to 10 volts.

Etched aluminum tuning dial viewed through two heavy plastic windows with illuminated hairlines. Coarse rf attenuator has two 20-db steps; fine attenuator provides continuous control. Copper-plated chassis, line filters and shielded output cables.

Two tubes and selenium rectifier. 117 vac, 8 watts. 8 x 10 x 4¾ in. 8 lb. $28.95 kit, $39.95 wired.—**EICO Electronic Instrument Co.,** 131-01 39th Ave., Flushing, N.Y. 11352.

EMC—Model 502 has 6 bands covering 115 kc to 110 mc on fundamentals and to 220 mc on second harmonics. Colpitts rf oscillator with 400-cycle internal modulation available. Rf accurracy within 1.5%. Cathode-follower output with attenuator. Has jack for external modulation and shielded output lead.

117 vac. 6⅝ x 6⅝ x 4 in. 4 lb. $17.95 kit, $24.95 wired.

Model 700 (Rf–AF–Crystal Marker–TV Bar Generator) covers from 18 cycles to 108 mc on fundamentals and to 216 mc on harmonics. Basically a Colpitts rf oscillator and Wien-bridge audio oscillator providing sine- and square-wave outputs from 18 cycles through 300 kc. Rf signal modulated by any signal developed by af oscillator or external source.

External crystal can be plugged in to produce markers on a scope trace or to check 700's accuracy by listening for zero beat in a receiver or phones plugged into AF-RF OUTPUT jack. Modulated oscillator, when tuned to a TV channel frequency, can produce vertical and horizontal bars for TV linearity adjustments.

Two tubes plus selenium rectifier. 117 vac. 14 x 10 x 6 in. 10 lb. $55.90.—**Electronic Measurements Corp.,** 625 Broadway, New York, N.Y. 10012

Heathkit—Model IG-102. Tunes from 100 kc to 110 mc in 6 bands and from 100–220 mc on harmonics. Frequency accuracy ±2%. Output 0.1 volt across 50 ohms. Internal modulation 30% at 400 cycles. External 3-volt af source provides 30% modulation. Af output (400 cycles) 10 volts open-circuit. Output impedance 50 ohms.

Features 2 Hartley rf oscillators. One uses bandswitched coils for 100 kc through 32 mc. The second has coil permanently connected to minimize calibration errors on frequencies above 30 mc. Preassembled and aligned coil and bandswitch assembly.

Two tubes, silicon rectifier. 6½ x 9½ x 5 in. 4½ lb. $27.95 kit, $54.95 wired.

Model IG-42, a laboratory-type instrument for testing and aligning radio receivers and making sensitivity, selectivity and signal-to-noise measurements. Has 5 bands covering from 100 kc to 31 mc. Output impedance 50 ohms, continuously variable from approximately 5 to 100,000 µv.

Fine attenuator is continuously variable and feeds coarse attenuator consisting of four 20-db and one 26-db step. Panel meter can be switched to indicate rf level at output of fine attenuator, or modulation level. Rf signal may be modulated from 0% to 50% by built-in 400-cycle oscillator or signal from external source.

Features triple shielding, shielded attenuators and line filters to minimize leakage, and voltage regulation and grid-modulated buffer amplifier for stability.

Four tubes, 3 crystal diodes and selenium rectifier. 13 x 8½ x 7 in. 15 lb. $56.95 (kit).—**Heath Co.,** Benton Harbor, Mich.

Hickok—Model 288AX Universal Crystal-Controlled Signal Generator produces CW, AM and FM (narrow-band) signals for overall and stage-by-stage alignment of AM and FM receivers. CW and AM coverage: 35 kc to 110 mc in 8 bands. 400-cycle internal modulation or external source. FM coverage: 35 kc to 110 mc (0–30-kc sweep); 1–160 mc (0–150- and 0–450-kc sweeps); 1 mc fixed (0–30-kc sweep); 50 mc fixed (0–150- and 0–450-kc sweeps).

Crystal output: Choice of 100-kc or 1-mc CW or 400-cycle AM. 100 kc provides harmonics to 15 mc. 1 mc has harmonics to 125 mc. Af output: 20–15,000 cycles or 400 cycles.

Output: Vernier control and 3-stage 40-db step attenuator. Output meter calibrated —10 to +6, +6 to +22 and +22 to +38 db.

Six tubes including rectifier. 115 vac, 30 watts. 16 x 13 x 7 in. 30 lb. $315.

Model 295X Microvolt and Crystal-Controlled Signal Generator produces wide range of highly stable variable and crystal-controlled frequencies at accurately metered output levels as low as 0.1 µv. Used for receiver gain tests, rf and i.f. alignment, sensitivity and selectivity measurements and for adjusting afc and agc.

Variable rf oscillator tunable 125 kc to 175 mc in 8 fundamental ranges. (Separate oscillator is used on 120–175-mc range.) Calibration accuracy 1%. Output level variable from 0.1 to over 100,000 µv in 6 attenuator steps. Output impedance 50 ohms. May be modulated approximately 30% by 400-cycle oscillator.

The crystal oscillator—supplied with 1-mc .05% crystal—can be used with fundamental type crystals from 400 kc to 20 mc and harmonic types from 20 to 175 mc. Maximum output about 2 volts. Output impedance variable from 0 to 5,000 ohms. Can be modulated by 400-cycle source.

The 400-cycle oscillator delivers signal variable from 1-volt maximum. Output impedance varies from 0 to 50,000 ohms.

Constructed for minimum spurious radiation. All leads to shielded vfo chassis pass through 2-section low-pass filters.

Eleven tubes including rectifier, ballast and 2 voltage regulators. 105–125 volts, 50–400 cycles. 90 watts at 60 cycles. 19 x 12½ x 9 in. 47 lb (shpg wt). $655.—**Hickok Electrical Instrument Co.,** 10514 Dupont Ave., Cleveland, Ohio 44108

Knight-Kit—Model KG-650 rf signal generator kit. Five bands cover 160 kc to 112 mc on fundamentals. Usable second harmonics to 224 mc. Colpitts rf and af oscillators. The 400-cycle oscillator can modulate rf oscillator or serve as signal source for audio troubleshooting. Rf output more than 0.4 volt, controlled by 3-position switched attenuator and continuously variable control. Af output more than 10 volts.

Two tubes, selenium rectifier. 110-130 vac. 7¼ x 10⅛ x 5¼ in. 8½ lb. $23.95 kit, $32.95 factory assembled.—**Allied Radio Corp.,** 100 No. Western Ave., Chicago, Ill. 60680.

Lafayette—Model 99R5015 tunes 120 kc to 130 mc in 6 fundamental ranges and 120–260 mc on harmonics. Two-step coarse attenuator delivers 100,000 and 100 µv maximum rf to vernier control. Can be modulated by 400-cycle internal oscillator or external source. Audio (400 cycles) adjustable from maximum of about 8 volts. 4¼-in. etched aluminum vernier dial.

Two tubes, silicon rectifier. 105-125 vac. 7 x 10½ x 5⅜ in. 9 lb (shpg wt). $29.95.—**Lafayette Radio Electronics Corp.,** 111 Jericho Turnpike, Syosset, N. Y. 11791

Mercury—The **model 1500** uses 7 overlapping bands to cover from 115 kc to 110 mc. A 400-cycle internal source can be used to modulate rf signal or for af troubleshooting. Permanently attached coaxial output cable. Etched dial with vernier drive.

One tube, selenium rectifier. 110-120 vac. 10 x 6 x 4½ in. 5 lb. $37.50.—**Mercury Electronics Corp.,** Mineola, N. Y. 11501

Precision—Model E-200C Multi-band signal–Marking Generator for circuit alignment and troubleshooting and as a variable marker source for a sweep generator. Coverage 88 kc to 440 mc (to 110 mc on fundamentals). Hand-calibrated 6½-in. aluminum dial direct-reading in 10 bands to 440 mc; accuracy 1% all bands. Has 0–1,000 vernier scale for hand-calibration and frequency spotting. The 400-cycle oscillator delivers over 50 volts of adjustable sine-wave output. Direct-reading control varies modulation from 0% to 100%.

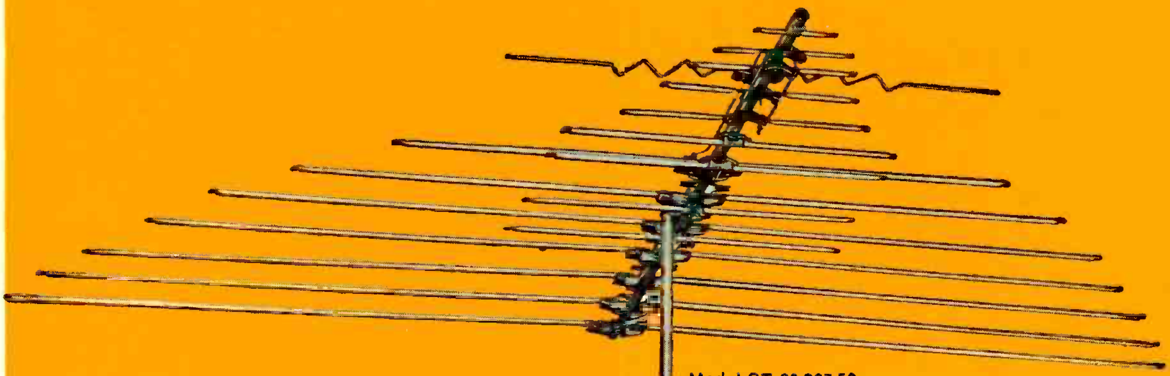
Features double-shielded stepless rf attenuators, compartment shielding, electrostatically shielded power transformer and ac line filters for minimum radiation. Built-in agc–avc substitution source.

Three tubes including rectifier. 13 x 11½ x 6⅝ in. 16 lb (shpg wt). $109.95

Model G-30 designed for full coverage of all AM, FM and TV applications. TV i.f., FM and other often-used frequencies especially marked on dial for rapid selection. Covers 160 kc to 240 mc in 8 direct-reading bands (to 120 mc on fundamentals). Modulation percentage continuously variable. The 15–30.5- and 20–60-mc

continued on page 66

New Winegard Chroma-Tel gives you full size power in a half-size All-Band (UHF-VHF-FM) color antenna



Model CT-80 $27.50

Why are most all-band antennas larger, heavier, more difficult to install and less effective than Winegard's Chroma-Tel? Simply because they're nothing more than VHF antennas with UHF antennas added on.

The Chroma-Tel is *much* more!

It's the first integrated antenna created *especially* for all-band UHF-VHF color operation. And it's super-compact. In fact, it's half the size of other all-band color antennas.

Here's how we did it. Our new Chroma-Lens Director System intermixes both VHF and UHF directors on the same linear plane without sacrificing performance.

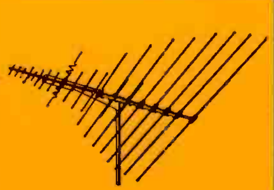
That's a first! And our Impedance Correlators (special phasing wires that automatically increase the impedance of Chroma-Tel's elements to 300 ohms) are placed only 5¾" apart instead of the usual 10" to 14".

The result? Half the bulk; half the wind loading; half the storage space; half the truck space; and half the weight of other all-band antennas—and at a much lower price!

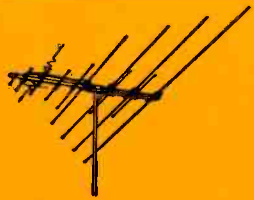
That's Chroma-Tel . . . the most efficient, easiest-to-install (UHF-VHF-FM) high gain antenna ever developed. For complete information, ask your distributor or write for Fact-Finder #242 today.

Winegard Impedance Correlators insure 300 ohm impedance on each element.

All Chroma-Tels include Winegard's model CS-283 UHF-VHF signal splitter. Hangs behind set and separates UHF and VHF signal coming from antenna to the 2 sets of terminals on set. It's FREE

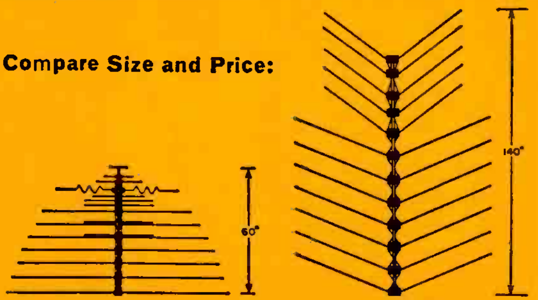


Model CT-90 $37.50



Model CT-40 $17.50

Compare Size and Price:



	Winegard Chroma-Tel	V type (Approximate Figures)
Boom Length:	60"	140"
Total Weight:	5 lbs., 1 oz.	10 lbs., 3 oz.
Carton Size:	.97 cu. ft. (less than 1)	5.8 cu. ft.
Elements:	17	12
List Price:	$27.50	$50.00

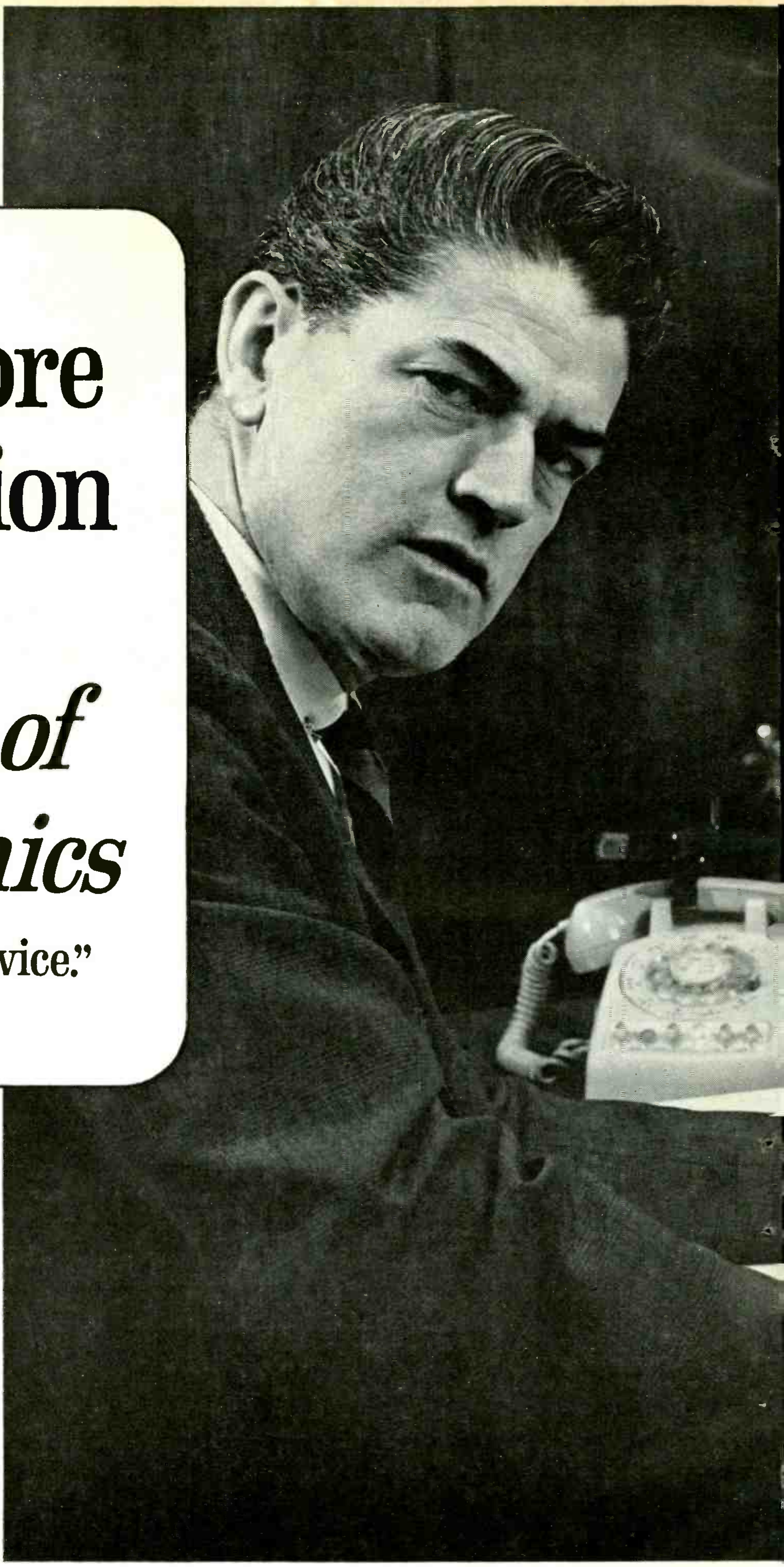
Winegard Co.

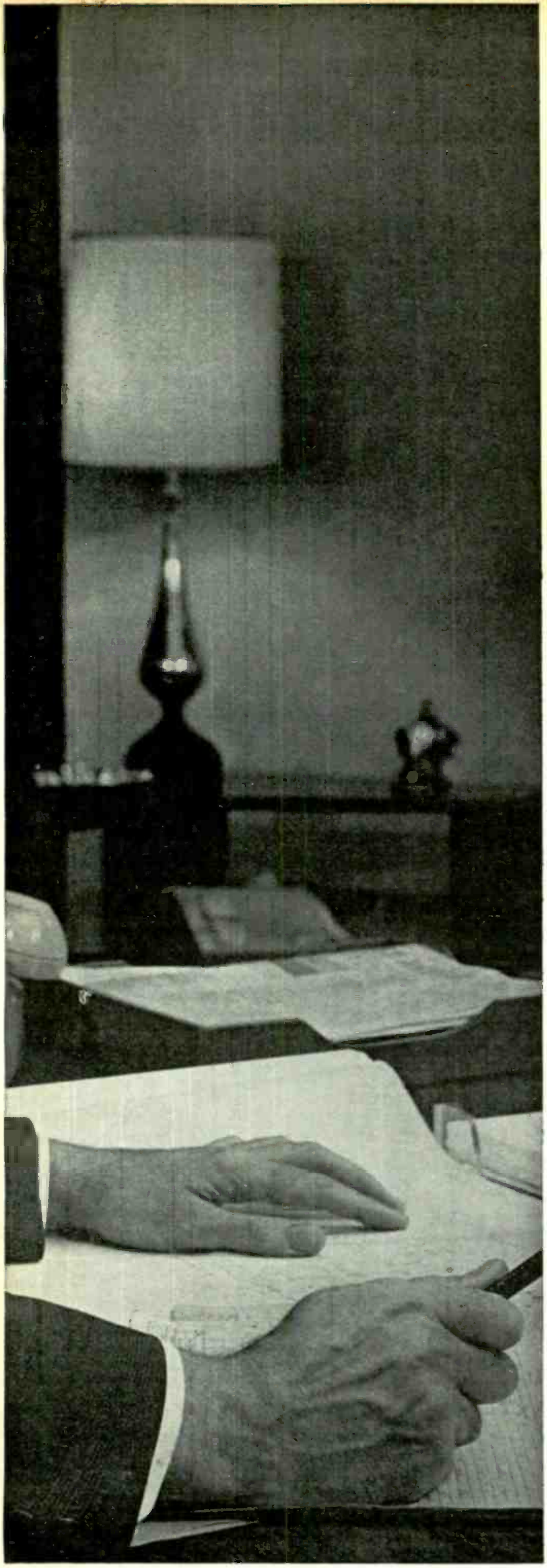
ANTENNA SYSTEMS
3000 Kirkwood • Burlington, Iowa

Circle 22 on reader's service card

"Get more education or *get out of electronics*

...that's my advice."





bands are "bandspread" for accurate markers on i.f. alignment curves. Rf output over 100,000 μv; 400-cycle output up to 15 volts.

117 vac, 11½ x 7 x 5½ in. 9 lb (shpg wt). G-30W (wired) $44.95, G-30PCK (semi-kit) $39.95, G-30K (kit) $32.95.—**Precision Apparatus, Inc.,** 80-00 Cooper Ave., Glendale, N. Y. 11227

Triplett—Model 3432-A covers 160 kc to 110 mc in 7 fundamental ranges and to 220 mc on harmonics. Easily read 6¾-in. etched aluminum dial. Double-shielded rf circuits and cathode-follower buffer and output stage for good stability. Variable and 3-position rf output attenuators. 400-cycle modulation variable up to 100%.

Three tubes including rectifier. 115 vac. 15 11/32 x 11 1/32 x 6¼ in. 30 lb (shpg wt). $119.50.—**Triplett Electrical Instrument Co.,** Bluffton, Ohio

RCA—Type WR-50A, a versatile portable signal generator for shop or field applications requiring a CW or AM signal between 85 kc and 40 mc. Six overlapping ranges. Built-in crystal calibrator with front-panel crystal socket. Internal 400-cycle audio oscillator. Permanently attached output cables with blocking capacitors. Continuous and 2-step rf attenuators and af output/modulation control.

Maximum open-circuit output voltage (all ranges): .05. Audio output at least 8 volts rms across 15,000-ohm load. Af/input–output impedance 16,000 ohms (maximum, 400 cycles).

Two tubes. 105-125 vac. 15 watts. 7¾ x 5⅜ x 4¾ in. 5 lb. $39.95 (kit), $59.95 wired.—**RCA Electronic Components & Devices,** Harrison, N. J.

AUDIO GENERATORS

B & W—Model 210 audio oscillator covers 10 cycles to 100 kc in 4 ranges. Output up to 10 v into 600 ohms, ±1 db (referenced to 5 kc). Calibration accuracy ±2% over entire range. Distortion less than 0.2% at 5 v out from 50 to 20,000 cycles, slightly higher at higher outputs and frequency extremes. Hum and noise 70 db below 5 v output. Output impedance 600 ohms (balanced, center-tapped), 600 ohms (unbalanced) or 150 ohms unbalanced. 115 volts ac, 50 watts; 3-prong power plug (adapter for two-hole receptacles supplied). 6 x 9 x 12 in., 11 lb. $186.50. **Barker & Williamson, Inc.,** Bristol, Pa.

Clough-Brengle—Model 179-A beat-frequency oscillator covers 25 to 15,000 cycles in one continuous band. Beats 250-kc fixed oscillator against 250–235-kc variable oscillator. Calibration accuracy within 5 cycles from 25 to 300 cycles; within 10 from 300 to 1,000; within 2% above 1,000. Output 100 mw into 600 ohm load, controlled by constant-impedance continuously variable attenuator; also 100 mw into 20,000-ohm load from high-impedance output terminals, controlled by potentiometer. Distortion less than 5% above 100 cycles at any output level; not more than 10% below 100 cycles to 25 cycles. Hum more than 54 db down for any setting of level controls. Output on 600-ohm connection flat 100 to 8,000 cycles, falls less than 1½ db at 25 cycles and 1 db at 15 kc. Output to load much greater than 50,000 ohms equally flat. 6 tubes. 115 volts ac, 30 watts (models available for 230 volts and 115 volts 25–40 cycles). 7½ x 8½ x 14 in. 17 lb. $105.

Model 182-A Audiomatic (audio sweep) generator basically identical to 179-A (above) in specs and circuitry, except sawtooth-swept reactance tube circuit permits repetitive sweeping across audio range to allow direct observation of audio frequency response on oscilloscope. Logarithmic sweep; rate 5–6 per second; can be switched to 1 sweep every 5 to 8 seconds for judging speaker response, listening for peaks, etc. Cathode-follower sawtooth output feeds horizontal input of scope with same sawtooth used to sweep frequency; this assures perfect synchronization. 11 tubes. 115 volts, ac (230-volt and 25-cycle models available). 7½ x 16½ x 10 in., 21 lb. $185.

Model 610-A Audiomatic (audio sweep) generator is manual or electronically swept beat-frequency generator. Manual range 25 to 46,000 cycles in continuous sweep (no band-switching). Automatic-sweep range determined by setting of manual dial (lower limit) and sweep width control; maximum 20 kc. Calibration accuracy ±(1% + 5 cycles) after zero-beat setting. Automatic sweep is linear with time; can be internally generated or applied externally. Outputs: 4,000 ohms, 100 mw, unbalanced; 600 ohms, 19 dbm, balanced or unbalanced; 600-ohm center-tap accessible for connection to external circuit. Both outputs continuously variable over 40 db; 600-ohm output has additional switchable balanced pads to cut by 10, 20 or 30 db. Output flat from 50 cycles to 10 kc, rises 0.3 db at 20 cycles, drops less than 1 db at 46 kc (1.5 db at extreme ends of range on 600-ohm output). Distortion less than 0.5% over most of range, rises slightly at extremes. Hum less than 0.1% (60 db down). Sweep rate variable 2 to 10 per second. 14 tubes. 105-125 vac (others available), 50 watts. 19½ x 11 x 15 in., 48 lb. $485. **Clough-Brengle Co.,** 6014 Broadway, Chicago, Ill. 60626

EICO—Model 377 sine & square wave generator produces 20-cycle to 200-kc sine waves in 4 bands; square waves from 60 cycles to 50 kc (5% tilt at 60 cycles, 5% rounding at 50 kc). Calibration accuracy 3% or 1 cycle, whichever greater. Output flat ±1.5 db from 60 cycles to 150 kc. Output 10 v across 1,000 ohms (100 mw); 8 v across 500 ohms, 14 across 10,000 ohms or higher. Distortion less than 1%; hum less than 0.4% of rated output. 117 vac, 50 watts. 5 tubes. 7⅛ x 11⅛ x 7⅝ in., 13 lb. $37.95 kit, $54.95 wired.—**EICO Electronic Instrument Co.,** 131-01 39th Ave., Flushing, N.Y. 11352

Heathkit—Model IG-72 audio generator features switch-selected frequencies—two significant figures and multiplier (× 1, 10, 100 or 1,000) with 3 switches. Frequency range 10 cycles to 100 kc. Output switch-attenuated in 8 ranges, also continuously variable control, .003 v (full-scale reading on meter) to 1 v with 600-ohm load; to 10 v into 10,000-ohm or higher load. Output metered continuously on 4-in. rectifier type voltmeter with 2 voltage and 1 db scales; meter accuracy ±5% of full scale with correct termination. Frequency accuracy 5%. Distortion less than 0.1% from 20 cycles to 20 kc. Internal 600-ohm load available on all but 2 highest output ranges. 3 tubes. 105-125 vac,

Circle 24 on reader's service card

40 watts. 9½ x 6½ x 5 in., 6 lb. $41.95 kit, $64.95 wired.

Model IG-82 sine-square-wave generator produces sine waves from 20 cycles to 1 megacycle in 5 ranges; less than 0.25% distortion from 20 cycles to 20 kc. Output voltage level switchable in 4 ranges: 0 to .01, 0.1, 1 or 10 v; also continuously variable. Source impedance is high on 10-v range, 600 ohms ±10% on others. Output is flat ±1.5 db from 20 cycles to 1 mc. Unit generates square waves from 20 cycles to 1 mc with rise time less than 0.15 µsec. Output voltage switchable 0 to 0.1, 1 or 10 v peak to peak; also continuously variable. Source impedance 52 ohms on 0.1- and 1-v ranges; up to 220 ohms on 10-v range. Schmitt-trigger square-wave shaper. Frequency accuracy 5%. Sine and square outputs usable simultaneously. 5 tubes. 105-125 vac, 55 watts. 13 x 8½ x 7 in., 10 lb. $51.95 kit; available wired as EUW-27 for $94. **Heath Co.,** Benton Harbor, Mich. 49023

Knight—Model KG-653 covers 20 cycles to 1 megacycle in 5 bands, flat ±1 db over entire range. Output is continuously variable and step-attenuated from 0 to 10 v into 600 ohms. Distortion less than 0.25% from 100 cycles to 20 kc; less than 0.3% over entire range; less than 0.5% at 2 volts into 600 ohms. 4 tubes. 105-125 vac. 7¼ x 10⅛ x 8½ in., 14 lb. $39.95 kit (not available wired). **Allied Radio Corp.,** 100 No. Western Ave., Chicago, Ill. 60680

Lafayette—Model 99R5014 sine-square audio generator covers 20 cycles to 200 kc in 4 bands; it makes square waves from 60 cycles to 30 kc (5% tilt and 5% rounding, respectively). Switch selects either sine or square waves at common pair of output terminals. Calibration accuracy ±3%. Distortion less than 2%. Response ±1.5 db from 60 to 150,000 cycles. Output voltage 7 max into 1 megohm; 5 max into 10,000 ohms. 3 tubes. 117 vac. 7 x 10½ x 5⅜ in., 8.6 lb. $35.95. **Lafayette Radio Electronics Corp.,** 111 Jericho Turnpike, Syosset, N.Y. 11791

Paco—Model G-34 sine/square generator covers 7 to 750,000 cycles on both waveforms. Max output approx 160 mw into 600 ohms (approx 10 v); flat within 0.5 db 120 cycles to 120 kc; within 1 db 7 cycles to 750 kc. Distortion 0.5% or less 20 cycles to 20 kc. Square-wave output 20 v peak to peak, no load; rise time less than 0.15 µsec. Output amplitude control: 3-step, 20-db/step attenuator plus continuously variable control. Frequency accuracy ±5%. Meter jacks for ordinary voltmeter to monitor output level. 117 vac. 13 x 8½ x 7 in., 12 lb. G-34K (kit) $65.95; G-34W (wired) $99.95.—**Precision Apparatus Co., Inc.,** 80-00 Cooper Ave., Glendale, N.Y. 11227

Precision—Model E-310 wide-range sine and square wave generator covers 5 to 600,000 cycles in 5 bands with 2% or 1-cycle accuracy (whichever greater) and 1-db or less variation band-to-band. Distortion less than 1% over entire range. Sine-wave output 10 v into 600 ohms. Square-wave output 10 v peak to peak, 0.2-µsec rise time. 4-position step attenuator plus continuous control regulate output. Terminals for output-monitoring meter. 12:1-ratio dial. 117 vac. 11½ x 9 x 11¼ in., 24 lb. Wired only, $199.95.—**Precision Apparatus Co., Inc.,** 80-00 Cooper Ave., Glendale, N.Y. 11227.

RCA—Model WA-44C sine/square-wave generator has 4 overlapping bands covering sine-wave frequencies from 20 cycles to 200 kc. Calibration accuracy ±5%. Output 8 v rms into 100,000 ohms and 75 pf essentially flat ±1.5 db from 30 to 100,000 cycles. Distortion 0.25% or less over audio range. Hum less than 0.1%. 4-position decade attenuator also selects sine or square waves. Continuously variable output control. Single-scale brushed-aluminum dial with etched lettering. Separate 60-cycle output terminals for intermodulation measurements have separate level control. 105-125 vac, 40 watts. 4 tubes. 7 x 10 11/16 x 6⅛ in., 10½ lb. $98.50.—**RCA Electronic Components & Devices,** Harrison, N.J.

Waveforms—Model 510B extended-range oscillator is "briefcase portable" size, covers 18 cycles to 1.1 mc in 5 ranges. Distortion less than 0.2% over most of range at 2 v output into 10,000-ohm or higher load; some increase at higher outputs and very low frequencies. Output 10 volts open circuit, constant ±0.5 db from 18 cycles to 200 kc for any output-control setting above 0.1 v. Output control logarithmic, continuously variable, calibrated approximately in volts. Internal impedance 400 ohms. Calibration accuracy ±2% from 18 cycles to 210 kc (±1% on special order); ±10% to 1.1 mc. Stability ±0.2% for line-voltage variation from 105 to 130 volts; 0.5% for temperature range 0 to 50°C, 18 cycles to 100 kc. Hum and noise 0.5 mv or 60 db below signal, whichever greater. 3 tubes. 117 vac, 40 va. Accessory bolt-on matching transformer T-10 available to feed 150-ohm or balanced or unbalanced 600-ohm loads. 6 x 4½ x 6 in., 6 lb. $180.

Model 511A solid-state sine-and-square generator cover 10 cycles to 12 mc with calibration accuracy of ±(3% + 0.1 cycle). Output impedance is 50 ohms, making it suitable for video as well as audio work. Output level is 3 v into 50 ohms, 6 v open-circuit (sine: 3 v rms; square: 3 v peak to peak). Response flat ±1 db. Attenuator steps: 3 v, 300 mv, 30 mv, 3 mv. Sine-wave distortion 0.25% at 1 kc, 1% at 1 mc, 2% at 10 mc. Square-wave rise time 0.5 µsec. 115/230 vac. 6 x 4¼ x 6 in., 5 lb. $700. **Waveforms, Inc.,** 333 Sixth Ave., New York, N.Y.

NOTE: Waveforms, Inc. produces more than a dozen generators between the price extremes of $180 and $700. Write the manufacturer for literature.

FM STEREO MULTIPLEX GENERATORS

All generators have a crystal-controlled 19-kc pilot tone accurate within 2 cycles, as required by the FCC, and a 38-kc subcarrier accurate within 4 cycles.

EICO—Model 342 provides composite and FM rf outputs. Separation 40 db minimum from 200 cycles to 10 kc; 30 db minimum from 50 cycles to 15 kc. Composite output 0 to 8 v p-p continuously variable; output impedance 1.5K. Internal modulation oscillator frequency approx 1 kc; distortion 0.3%. External modulation requirements: 1 v rms each channel for max composite output; input impedance 10K. Stereo source modulation requirements: 1 v rms each channel for max composite output; input impedance 1 meg. Input amplifiers provide 75-µsec pre-emphasis. FM mpx rf output 200 mv at 50 ohms. Deviation control to 75 kc (= 100% modulation). 19-kc pilot phase adjustable ±45° to carrier; amplitude adjustable 0–15% of max composite signal. Pilot may be switched off. Signals available: L + R, L − R, L only, R only, 19-kc pilot only, stereo source. Frequency response 40 cycles to 15 kc ±1 db. Total harmonic distortion $<$1%. Scope can be synced from internal 1-kc oscillator, external modulating source or 19-kc pilot. 117 v ac. 8½ x 5¾ x 12½ in., 10 lb. $149.95, wired only.—**Eico Electronic Instrument Co.,** 131-01 39th Ave., Flushing, N.Y. 11352

Fisher—Model 300 includes FM signal generator, nominally 100 mc, but tunable 97 to 103 mc. Composite stereo output variable 0 to 6 v p-p; output impedance 300 ohms. Choice of flat (20 cycles to 20 kc, ±½ db) response or standard 75-µsec pre-emphasis (±1 db). Harmonic distortion below 0.25% at max output; hum and noise, more than 55 db below max output. 19-kc pilot variable 0—250 mv or fixed 1.5 v; output impedance 300 ohms. Audio oscillator signals used internally; available externally from back-panel jack: output voltage 2.5 rms; output impedance 5K; frequencies: 1 kc or 8 kc ±5% (switched by panel selector); harmonic distortion below 0.3%. Panel selector offers choice of: 19 kc out only, 1 kc left, 8 kc left, 1 kc right, 8 kc right, 1 kc left/60 cycles right, or external modulation. Output meter is true peak-to-peak indicator with separate scales for composite output, 19-kc pilot level and modulation (deviation) of FM generator. Outputs: composite mpx; 100-mc FM mpx; 19-kc pilot; audio oscillator (rear). Inputs: external modulation (left, right); SCA (0.5 v for FCC-required 10% modulation). FM generator frequency response 20 cycles to 150 kc ±0.5 db; harmonic distortion $<$ 0.25% for 75-kc deviation; hum and noise $>$ 50 db below 75-kc deviation; carrier stability .02%. Output 300 mv. Power 117 v, 50 watts. 8 x 10 x 12 in., 17 lb. $495.—**Fisher Radio Corp.,** 21-21 44th Drive, Long Island City, N.Y. 11001

Heathkit—Model IG-112 has 100-mc FM rf oscillator adjustable ±2 mc. Oscillator can be modulated with left channel, right channel, left-plus-right in phase or monophonic signal. Deviation adjustable to 75 kc. FM oscillator also functions as 60-cycle swept oscillator (sweep width adjustable to 750 kc) for aligning

FM tuner i.f. strips and detectors. Rf attenuator: three 20-db pads switched in by 3 slide switches; total 60 db. Crystal-controlled markers at 10.7, 90.95, 96.30, 101.65 and 107 mc. Composite signal available without rf (see outputs listed above under "oscillator can be . . ."). Audio outputs available: 400 cycles, 1 kc, 5 kc, 19 kc; 38 kc; 65 or 67 kc (SCA); max distortion at 400 cycles, 1 and 5 kc, 5%. 6 tubes. 105–125 v ac, 35 watts (230v model available). 10¼ x 8 x 13 in., 8 lb. $99 kit.—**Heath Co.,** Benton Harbor, Mich. 49023

Hickok—Model 725 is self-contained, generating its own audio and rf. Rf output tunable 92 to 104 mc, amplitude variable 50 to 1,000 μv, frequency-modulated with audio or composite stereo signal. Internal audio oscillators produce stable, low-distortion signals of 400 and 1,200 cycles. Composite output variable 0–4 v p-p; output impedance 250 ohms. Unit accepts external modulation from audio oscillator or stereo program source for listening tests and demonstrations. Standard 75-μsec pre-emphasis provided optionally via panel switch. Internal 67-kc SCA subcarrier generator for adjusting 67-kc receiver traps. Regulated B+. 12 tubes, 1 transistor. 117 v ac, 60 watts. 14½ x 18 x 7 in., 23 lb. $495.

Model 727 all-transistor FM stereo generator with an rf output, intended especially for in-home service. Audio composite output contains left or right 1-kc signal generated internally. Composite signal continuously variable 0–4 v p-p. Mono output 1-kc signal 1.8 v p-p. 19-kc pilot, 0.5 v p-p. 38-kc subcarrier 2–4 v p-p; 67-kc SCA 2 v p-p. Rf output 100 mc, 500 μv. Separation 35 db or better. Unit operates from 22.5-v battery; accessory plug-in power supply available for 117-volt service. 12 transistors. 11 x 8½ x 5 in., 6 lb. $199.95.—**Hickok Electrical Instrument Co.,** 10514 Dupont Ave., Cleveland 8, Ohio

Karg—Model MX-1G features 40-db minimum separation; no internal FM generator. Composite output level variable 0–15 v p-p; output impedance 600 ohms. Internal modulating oscillator 1 kc; voltage from external modulating source for maximum composite-signal level 15 v p-p. 19-kc pilot adjustable 0% to 15% of composite. Frequency response 40 cycles to 15 kc ±1 db; distortion <1%. Unit accepts SCA input from external oscillator, 20 to 75 kc, 3 v rms for 10% modulation. Scope-sync signals available: pilot, audio, from internal or external sources. Accepts stereo program material from tape or disc. Channels modulated separately, together in stereo or together in mono. 4 tubes. 105–125 v ac, 50 watts. Rack model 19 x 5¼ x 5½ in.; cabinet model 15⅜ x 5 x 5½ in. Rack model $255, cabinet model $250; kit $150 (cabinet model).—**Karg Laboratories, Inc.,** 162 Ely Ave., So. Norwalk, Conn.

Precision—Model E-490 appears to be identical to Karg MX-1G (see Karg) except for minor panel details. $249.95, wired only. —**Precision Apparatus Co., Inc.,** 80-00 Cooper Ave., Glendale, N. Y. 11227

RCA—Model WR-52A stereo FM signal simulator offers choice of left stereo, right stereo or mono at composite output; same on FM rf carrier (100 mc tunable); rf carrier can be swept at 60-cycle rate, from 0 to 750-kc swing for FM i.f. and detector alignment. FM stereo rf deviation adjustable 0 to 75 kc; output up to 0.1 v rms. Meter indicates deviation and 19-kc pilot level. Internal sine-wave frequencies 400 cycles, 1 kc, 5 kc (distortion < 2%); 19 and 38 kc available externally. Also 67 and 72 kc for trap alignment. External modulation terminals permit modulating either right or left channel with external audio. Composite output level adjustable 0–9 v p-p open circuit; source impedance 5K. 6 tubes. 115–125 v ac, 40 watts. 13½ x 10 x 8 in., 12¾ lb. $250.—**RCA Electronic Components & Devices,** Harrison, N.J.

Scott—Model 830 is intended for design and production-testing of multiplex adapters and tuners. No FM rf output (can be used with any professional FM generator). Inputs for: audio oscillator (600 ohms balanced), 7 v rms push-pull for max output, 50 cycles to 15 kc, insertion loss 3 db; modulator input L and R—>100K input impedance per channel, approx 10 db gain at 400 cycles, 75-μsec pre-emphasis. Level continuously variable. Input approximately 0.7 v rms for full output. Also monitoring inputs (high-impedance) for demodulated L and R signals. Composite signal output 14 v p-p into 10K min load resistance, total distortion <1%. Output impedance 500 ohms; residual subcarrier unbalance, hum and noise 60 db below max output. Pilot signal (alone) amplitude 0 to 0.5 v rms. Terminals for connecting scope or vtvm switchable to 6 critical points such as pilot signal at point of insertion to filter, composite signal at output, etc. Terminals for scope horizontal deflection or sync switchable to 4 points. Frequency response. audio oscillator input amplifier: 1 cycle to 150 kc (—3-db points); modulator input amplifier flat to 1 cycle at low end, standard 75-μsec pre-emphasis at high end; composite output amplifier If response down to 1 cycle, sharp cutoff at approx 55 kc, constant delay over passband by adjustable phase-corrector network. Trap at 76 kc (—35 db); >20 db down above 76 kc. Pilot 19-kc crystal-controlled ±2 cycles, stability 20 ppm; output to 0.5 v rms, phase adjustable +60° to —60°. Dc-powered heaters in critical stages, regulated B+. 17 tubes. 115 v ±10%, 125 watts. Mounted on standard 19-in. rack panel 7 in. high. $600.—**H. H. Scott Instrument Div.,** 111 Powdermill Rd., Maynard, Mass. 01754

Sencore—Model MX129 FM multiplex generator and analyzer produces composite multiplex, pilot, subcarrier and FM rf signals. Composite output 0-7 v p-p; impedance 2,000 ohms; frequency response 20 cycles to 20 kc; modulates FM rf oscillator to 50%. 19-kc pilot voltage 0 to 1 v p-p; modulates oscillator to 10%. SCA frequency 67 kc ±100 cycles, 8 v p-p fixed; modulates rf oscillator 10%, fixed. L & R external inputs, 5K impedance, 10 v p-p max input. Panel meter reads p-p composite volts or composite modulation (deviation). Can be switched for external use in 2 ranges: 3 and 30 v p-p. 19 transistors. 105–125 vac, 4 watts. 10 x 9¼ x 4 in., 7¼ lb. $166.11.—**Sencore, Inc.,** 426 So. Westgate Dr., Addison, Ill.

TV-FM SWEEP GENERATORS

Blonder-Tongue—Model 4122 solid-state vhf-uhf sweep generator. Vhf: frequency range 10–240 mc, sweep width 5–220 mc continuously adjustable; output 0.5 volt rms into 75-ohm load. Uhf: frequency range 470–890 mc, sweep width 5–420 mc continuously adjustable; output 0.1 volt rms into 75 ohms. Output level constant ±0.5 db over both ranges. SWR 1.5:1 max. Sweep rate 60 cycles, retrace blanked. Temperature range —20° to +140°F. One 10-db and two 20-db slide attenuators.

Includes 75-ohm output connector for post-detector marker injection, phase-reversing switch, test point for regulated power supply, BTF-type connectors and 117-volt 6-amp utility outlet.

105–130 vac, 10 watts. 11½ x 8½ x 7¼ in. 13 lb. $595.—**Blonder-Tongue,** 9 Alling St., Newark 2, N.J.

EICO—Model 369 TV-FM sweep and marker generator uses saturable reactor type sweep. Includes variable and crystal marker oscillators and built-in marker adder. Sweep oscillator ranges: 3–7.5, 6–16, 16–42, 36–95 and 75–220 mc. Maximum output level (controlled by 4-step decade and continuous attenuators): 0.3 volt on first 3 ranges, 0.2 on the next range and 0.1 volt on the highest. Regulation ±0.5 db on first 4 ranges, ± 1 db on the last.

Sweep width continuously variable up to 20 mc, depending on range. Marker oscillator fundamental ranges are 2–6, 6–20 and 20–75 mc. Calibrated harmonic range 60–225 mc. Supplied with 4.5-mc marker crystal. Other crystals can be plugged into front panel. Crystal and variable markers mixed internally. Marker and rf oscillator dials have 6:1 vernier drives. All necessary cables supplied.

117 vac, 50 watts. 8½ x 12½ x 7 in. 17 lb. $89.95 kit, $139.95 wired.

Model 360 TV–FM sweep generator covers 500 kc to 228 mc on fundamentals with sweep width continuously variable from 0 to max of 30 mc. Uses electromechanical sweep. Built-in crystal marker oscillator.

117 vac, 8 x 10 x 6¾ in. 11 lb. $39.95 kit only.—**EICO Electronic Instrument Co.,** 131-01 39th Ave., Flushing, N.Y. 11352.

Heathkit—Model FMO-1 FM test oscillator generates all signals necessary for aligning FM broadcast receivers. Supplies 90-, 100- and 107-mc signals for front-end alignment and 10.7-mc with sweep variable from 200 kc to over 1 mc for i.f. and detector alignment. Modulation 400 cycles. Markers 10.7 mc (crystal) and 100 kc.

105–125 vac, 12 watts. 7⅜ x 4¾ x 4⅜ in. 5 lb. $34.95 kit.

Model IG-52 TV alignment generator. Supplies sweep and marker signals for TV and FM receiver alignment. Saturable-inductor sweep circuit covers 3.6 to 220 mc in 4 bands. Sweep width adjustable from 0 to 42 mc, depending on range. Crystal marker 4.5 mc and harmonics. Variable marker 19–60 mc on fundamentals, 57–180 mc on harmonics. External rf marker signal can be mixed with crystal and variable markers to provide 3 markers on one trace. Step and fine attenuators for sweep output; separate attenuator for markers. Blanking and phase control. Output impedance 50 ohms.

105–125 vac, 50 watts. 13 x 8½ x 7 in. 14 lb. $67.95 kit.—**Health Co.,** Benton Harbor, Mich. 49023

Hickok—Model 615 TV sweep and marker alignment generator. Sweep ranges 0–50, 50–100, and 175–225 mc with deviation adjustable 0–15 mc. Rms output .07 volt on the first 2 ranges and 0.12 volt on the highest. Amplitude variation over swept range less than 0.1 db per mc. Output impedance 90 ohms; 300 ohms with accessory adapter.

Marker frequency ranges 2.5–5.5, 19–50 and 54–108 mc on fundamentals and 108–216 on harmonics. Variable marker and 4.5-mc crystal can be amplitude-modulated to 30%.

105–125 vac, 25 watts. 13¼ x 16¼ x 8 in 30 lb. $359.50.—**Hickok Electrical Instrument Co.,** 10514 Dupont Ave., Cleveland 8, Ohio

Knight-Kit—Model KG-652 rf sweep generator uses electromechanical frequency modulator and heterodyning to cover 300 kc to 250 mc in 4 fundamental ranges. Rf output over 0.15 volt and constant within 1 db over all ranges. Sweep frequency 60 cycles; sweep width 0 to 13 mc. Undesirable frequencies above 50 mc attenuated 20 db on 0.3–50-mc band. Crystal marker oscillator with dual crystal socket on panel. Crystal and external marker signals can be mixed. Blanking phase variable through 180°.

110–130 vac, 45 watts. 8⅝ x 12⅛ x 7 in. 14 lb. (shpg wt.). $44.95 kit.—**Allied Radio Corp.,** 100 No. Western Ave., Chicago, Ill. 60680

PACO—Model G-32 sweep generator and marker adder. Frequency coverage 3–213 mc in 5 fundamental ranges and 400–1080 mc on harmonics. Adjustable sweep width varies from 0 to 3 mc on lowest range (3–7 mc) to a maximum of 30 mc on highest range. Output impedance 50 ohms terminated.

Includes internal blanking and agc that holds amplitude constant over any one band. Marker adder permits control of marker width and amplitude independent of trace size on scope. Continuous control over sweep width and pattern height. Supplied with 5 cables.

17 vac. 13 x 8½ x 7 in. 15 lb (shpg wt). $85.95 kit, $159.95 wired.—**Precision Apparatus, Inc.,** 80-00 Cooper Ave., Glendale, N.Y. 11227

RCA—Model WR-69A TV/FM sweep generator uses preset switch positions for 12 vhf TV channels and FM broadcast band. Separate i.f./video output frequencies continuously variable from 50 kc to 50 mc. Sweep bandwidth variable from 50 kc to 20 mc on i.f./video and FM bands and at least 12 mc on TV channels. Output essentially flat and free from spurious responses.

Features dual piston-type attenuators with smooth output control from 5 μv to 0.1 volt; adjustable blanking, shielding for minimum stray radiation, two 0–12-volt negative supplies for agc biasing. Rf output impedance 300 ohms balanced. I.f./video output impedance 100 ohms.

105–125 vac. 45 watts. 13⅝ x 10 x 7 in. 16 lb. $295.—**RCA Electronic Components & Devices,** Harrison, N.J.

TV PATTERN GENERATORS

Amphenol—Model 860 Color Commander offers standard color bar, dot and crossshatch patterns, plus single vertical and single horizontal line for centering, 15 horizontal bars, 20 vertical bars, single dot for convergence, and 3-bar color pattern (R — Y, B — Y, —R — Y) for fast adjustments. All silicon transistors, crystal-controlled patterns. Rf output is ch. 3 or 4—slide switch on panel. Battery operated (12.6–13.5 v), 0.3 watt. Optional ac power supply. $19.95, fits battery compartment. 5 x 9 x 4 in., 4 lb. $149.95.—**Amphenol Distributor Div., Amphenol-Borg Electronics Corp.,** 2875 So. 25 St. Broadview, Ill. 60155

B&K—1076 Television Analyst is complete signal-generating source for point-by-point troubleshooting in black-and-white or color sets. Supplies audio and video rf and i.f. signals. Switch selection of ch. 2–13. Flying-spot scanner transmits in black-and-white any positive transparency approximately 3 x 4 in. (test patterns, pictures, written messages, etc.). Generates 4.5-mc FM sound carrier modulated to 25-kc deviation (100%) with 400-cycle audio. 400-cycle audio available separately. Vertical and horizontal driving pulses for checking sweep circuits; sync signals of reversible polarity and variable amplitude; vertical-output plate-drive signal, vertical yoke-test signal; B-boost and high-voltage indicators. Leakage, continuity tests for horizontal output transformer and yoke; shorted-turn test. Agc keying pulse and bias substitution. Dot, crosshatch, color bar and burst signals for color convergence and circuit adjustment. Horizontal oscillator crystal controlled. Unit can be used as display or video paging system in stores, hospitals, conventions, etc. High-level viedo output can modulate picture tube directly. 110-120 vac. 10¼ x 17 x 10 in., 25 lb. $329.95.

Model 1245 is all-transistor, provides crystal-controlled 10-bar keyed rainbow color bar display, dot, crosshatch, horizontal and vertical line patterns. Gun-killer switches. Color amplitude control varies output level between 0% and 200%. Rf output 5,000 μv on ch. 3, 4 or 5. Regulated power supply, 117 volts ac. 8⅞ x 2⅞ x 8⅜ in., 3 lb. $134.95.—**B & K Mfg. Co.,** 1801 W. Belle Plaine Ave., Chicago, Ill. 60613

EICO—Model 380 solid-state NTSC color generator delivers dots, horizontal and vertical lines and crosshatch signals at both rf and video outputs. Rf output on ch. 3. Output level, 0–50,000 μv into 300 ohms, is high enough to prevent interference from local ch. 3 broadcast.

Video output, positive and negative polarity, 0–10 v p-p into 4,700 ohms. NTSC colors: yellow, I, red, R – Y, magenta, Q, B – Y, blue, cyan, green, white. Bars and crosshatch: 13 vertical and 10 horizontal (variable-thickness) bars. Dots: 130 variable size.

117 vac, 8½ x 5¾ x 6⅜ in. 8 lb. $109.95 kit, $159.95 wired.—**EICO Electronic Instrument Co.,** 131-01 39th Ave., Flushing, N. Y. 11352.

Heathkit—Model IG-62 color bar and dot generator provides the usual color bars, and dot, crosshatch and vertical- and horizontal-bar patterns. In addition, it produces a unique crosshatch pattern of unusually wide bars called shading bars. This pattern has 4 levels of brightness and is used for gray-scale tracking adjustments.

Rf signal is tunable ch. 2–6 at a level variable from approximately 100 to 100,000 μv. The crystal-controlled sound carrier is not modulated. Video output, positive or negative, is variable from 0 to 10 v p-p, open circuit. All modulation signals are crystal-controlled. Dot pattern consists of 180 dots (less those lost in blanking) approximately 2 lines in diameter. Bar and crosshatch patterns are composed of 15 horizontal and 12 vertical lines. The 10 crystal-controlled vertical color bars are developed by the offset carrier method. Each bar has a white leading edge and black trailing edge for checking color registration.

117 vac, 70 watts. 13 x 8½ x 7 in. 10 lb. $64.95—**Heath Co.,** Benton Harbor, Mich. 49023

Hickok—Model 656XC color bar, white dot–bar generator features NTSC standard color and brightness. Generates 3 primaries, 3 complementaries, plus black and white and all standard alignment signals. Dot, bar and crosshatch patterns and sync pulses controlled by 315-kc crystal.

Dot pattern consists of 300 dots per frame (minus those lost in blanking). Minimum size is 2 lines. Choice of 20 vertical or 15 horizontal bars. (Count includes those generated during blanking interval.) Video output 0–2 v p-p with positive or negative polarity. Rf output on ch. 2–6, modulated with choice of patterns or color signals. Separate output from 3.58-mc burst oscillator. Sound carrier provided for fine-tuning adjustments.

105–125 vac, 40 watts. 16¾ x 18⅜ x 7½ in. 34 lb. $549.

Model 660 generator is designed for fast service in the field. Dot and crosshatch patterns same as model 656XC. All signals and patterns crystal-controlled. Color display consists of orange, red, magenta, blue, cyan and green bars. Video output 0–4 volts p-p, positive or negative polarity. Rf output .05 v max, .001 v minimum, modulated 60% by desired signal. Ratio of sync to video variable from 10 to 90%.

105–125 vac, 40 watts. 10½ x 10½ x 5¼ in. 15 lb. $245.

Model 661 Chrom-Aligner has many of the design features of the 656XC. Produces correct NTSC standard colors with sync, blanking and burst in correct pedestal position. In addition to the 6 NTSC standard colors, it produces the standard demodulator signals and dot, crosshatch and bar patterns. Separate video output. Rf output on channels 3 and 4.

115 vac, 20 watts. 20 lb (shpg wt). $349.50.

Model 662, called the **Installer's Color TV Generator,** supplies complete convergence signals—dots, crosshatch and vertical and horizontal bars. Dot pattern has 500 dots less than 2 lines wide and one line thick. Features a new alignment signal that provides a single horizontal bar at the exact burst frequency, allowing an instant check of hue control range, chroma and demodulator alignment.

105–125 vac, 25 watts. 11 x 8½ x 5⅜ in. 8 lb. $159.95.

Model 760 Video Scanner is a flying-spot type generator. Crosshatch and dot slides are used for convergence and linearity adjustments. Does not produce color bars.

Video output 2 v p-p across 75 ohms. Rf output on ch. 2–6. Output variable down from 50,000 μv. Scanning frequencies interlaced and crystal controlled. Resolution in excess of 450 lines—5.5 mc.

105–125 vac, 145 watts. 11⅛ x 17 x 19 in. 43 lb. $455.—**Hickok Electrical Instrument Co.,** 10514 Dupont Ave., Cleveland 8, Ohio.

Jackson—Model 800 color-bar/dot generator is crystal-controlled. Features pushbutton function and pattern selection for simpler and faster operation. Function buttons are ON–OFF, SOUND, PATTERN and STANDBY. The 12 buttons select crosshatch, horizontal lines, vertical lines and dot patterns; yellow, red, R – Y, magenta, B – Y, blue, cyan and green bars. Positive or negative video polarity selected by switch. A gun-killer switch cuts off any one or combination of any 2 of the 3 color guns.

117 vac. 13⅞ x 9 x 5 in. 12⅝ lb. $239.95. —**Jackson Electrical Instrument Co.,** 124 McDonough St., Dayton, Ohio

Lectrotech—Model V6 is all-transistor; 189-kc crystal oscillator drives divider chain. Pattern selector offers choice of crosshatch, dots, vertical lines only, horizontal lines only or color bars. Voltage-regulated supply. Gun-killer switches. Rf output on ch. 3, 4 or 5, more than 10,000 μv. Color level control for color sync checks, marked MINIMUM, NORMAL, MAXIMUM (normal = 100% modulation). Horizontal line adjust control sets lines 1 to 4 lines wide. Cables permanently attached, housed in test-lead compartment. 117 vac. 4½ x 7⅝ x 10⅜ in., 7½ lb. $99.50.

Lectrotech—Model V7 generator includes vectorscope. Keyed rainbow color signal produces 10 color bars spaced 30°. Scope presents visual display of phase angles and amplitudes of each bar signal. Self-calibrating circuitry uses built-in CRT to adjust timing (divider) circuits. Crystal-controlled divider chain is all-transistor (only 2 tubes used in unit). Gun-killer switches, adjustable horizontal line width. Voltage-regulated. Pattern selector gives cross-hatch, dots, vertical or horizontal lines only and color bars. Color level control for checking color sync. Video level control varies video output between 0 and 2 v p-p. Video polarity switch. Intensity, focus, horizontal and vertical position controls for built-in CRT. Cables permanently attached, stored in compartment. 117 vac. 8¼ x 7½ x 12⅞ in., 13 lb. $189.50—**Lectrotech Inc.,** 1737 W. Devon Ave., Chicago, Ill. 60626

Paco—Model G-36. Specifications essentially same as E-450 below. 13 x 18½ x 7¼ in. 14 lb (shpg wt). $119.95 kit, $179.95 wired.

Precision—Model E-450 generates color bars, dots, horizontal bars, vertical bars and crosshatch pattern. Rf output on ch. 3 or 4, 50 mv max. Sound-carrier amplitude 10% of pix carrier. 300 ohms output impedance. A single cable connection to set's antenna terminals, and 3 controls simplify operation. Voltage regulation and crystal control insure maximum stability.

115 vac, 13 x 12 x 8 in. 14 lb (shpg wt). $189.95.—**Precision Apparatus, Inc.,** 80-00 Cooper Ave., Glendale, N.Y. 11227

RCA—Model WR-64B color-bar/dot/crosshatch generator uses crystal-controlled circuits for maximum accuracy and stability. Crosshatch

continued on page 72

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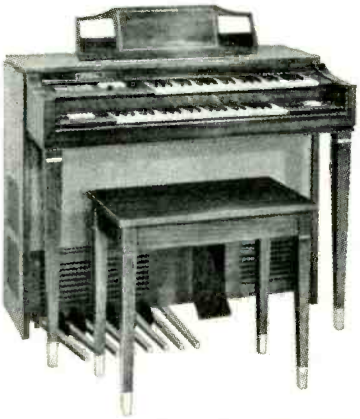
New Heathkit 10-Band Transistor Portable!

10 bands tune Longwave, Standard Broadcast, FM and 2-22.5 mc Shortwave. 16 transistors, 6 diodes, and 44 factory assembled and pretuned circuits. Two separate AM & FM tuners and IF strips. FM tuner & IF strip are same components used in deluxe Heathkit FM stereo gear. 2 built-in antennas. Battery saver switch cuts current drain up to 35%. Rotating tuning dial. Dial light. 4 simple controls for tuning, volume, tone, AFC and band switching. 4" x 6" PM speaker. Earphone & built-in jack. Optional 117 v. AC converter/battery charger available @ $6.95. Time zone map & "listener's guide." Man size: 13½" W x 5⅛" D x 10 9/16" H. 17 lbs.



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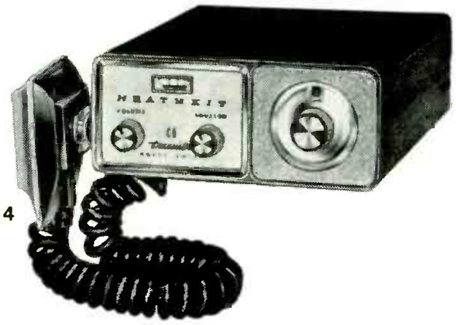

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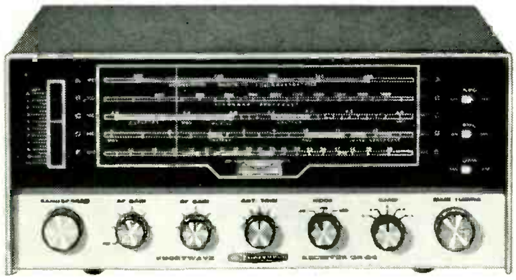

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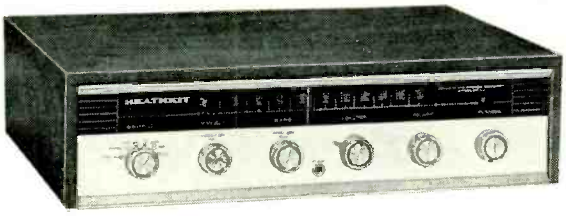

New 30-Watt Transistor FM Stereo Receiver . . . Less Than $100!

Features 31 transistors, 11 diodes for cool, natural transistor sound; 20 watts RMS, 30 watts IHF music power @ ±1 db, 15 to 60,000 cps; wideband FM/FM stereo tuner plus two preamplifiers & two power amplifiers; front panel stereo headphone jack; compact 3⅞" H x 15¼" W x 12" D size. Assembles in 20 hours or less. Custom mount it in a wall, or optional Heath cabinets (walnut $9.95, beige metal $3.95) 16 lbs.

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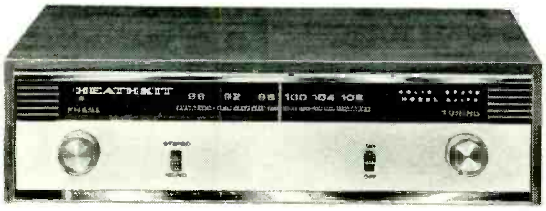

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Heath's easiest to build stereo/hi-fi kit . . . takes only 4 to 6 hours! 14 transistor, 5 diode circuit for cool instant operation, transparent transistor sound. Phase control assures best stereo performance. 3 transistor "front-end" plus 4-stage IF section. Filtered outputs for direct stereo recording. Automatic stereo indicator light. Preassembled & aligned "front-end." Install in a wall or either Heath cabinet (walnut $7.95, beige metal $3.50). 6 lbs.

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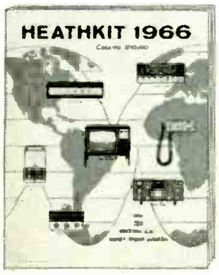

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and dot patterns provide fixed number of lines and dots for easy convergence, size, and linearity adjustments. Color pattern has 10 bars spaced at 30° phase angles for color phasing, demodulator, and matrix adjustments. Has chroma control to check receiver sync-lock action. Gun-killer switches on panel. Crystal-controlled picture and sound output on ch. 3. Ch. 4 crystals available. Sound carrier can be modulated for accurate setting of set's fine tuning control.

105–125 vac, 40 watts, 13½ x 10 x 8 in. 13½ lb. $189.50.—**RCA Electronic Components & Devices**, Harrison, N.J.

Seco—Model 900 generates keyed-offset-carrier RCA-type color bars, dots, crosshatch, vertical and horizontal bars. Dot size adjustable. Rf output on ch. 2, 3 or 4, modulated with color bars, convergence signals or sync only. Output 100 mv into 300 ohms. Gun-killer switches. Pattern selector has "clear raster" position for purity checks and gray-scale tracking. Color output control, color quality control (stops drift due to slow beat between burst and scanning frequencies). All-transistor; Zener-regulated power supply. 105–125 vac, 6 watts. 8½ x 10½ x 3½ in., 6 lb. $129.95.—**Seco Electronics Corp.**, 1201 So. Clover Dr., Minneapolis, Minn. 55420

Sencore—Model CA122A color circuit analyzer produces 6 basic patterns: color bars (crystal-controlled), white dots, vertical, horizontal and shading bars, crosshatch. Color bars are RCA type (10). Crystal-controlled divider chain. Color-gun interrupters. Sync and video polarity-reversible, both variable ±30 v p-p. Crystal-controlled 4.5-mc sound carrier, 900-cycle audio signal provided. 11 tubes. 117 vac. 10 x 14 x 8 in., 10 lb. $183.75.

Model CG126 generates 10 crystal-controlled 30°-spaced color bars, adjustable white dots, crosshatch pattern, vertical and horizontal bars. Rf output factory set to ch. 4, can be moved to ch. 3 or 5. Color output adjustable 0% to 200%. Standby switch. 9 tubes. 117 vac, 35 watts. 11 x 8 x 6 in., 9½ lb. $107.75.

Model CG135 offers 10 standard color bars, crystal-controlled, 30° between each. White dots of adjustable size, crosshatch, vertical and horizontal bars. Color-gun killers. Composite video and sync available to permit injection after i.f. strip and detector. 4.5-mc audio carrier can be inserted in rf output to aid in tuning. Rf output on ch. 3, 4 or 5. Composite video output polarity reversible, ±2 v p-p; composite sync output —2 v p-p. All-transistor. Attached cables store in compartment. 117 vac, 3.5 watts. 9½ x 10¼ x 4 in., 8 lb. $146.95—**Sencore, Inc.**, 426 So. Westgate Dr., Addison, Ill.

Simpson—Model 430 generates 8-bar pattern compatible with all color demodulation systems. Rf output (10,000 μv) covers ch. 2–6 (7–13 on harmonics); rf attenuator has 15-db range. Video output 0 to 3.5 v p-p. Chroma attenuator switch: 0, —6, —15 db; variable attenuator —15 to 5 db. Video polarity reversible. 4.5-mc signal available to aid tuning. Other outputs: 15,750-cycle sync pulse, 3.58-mc sine wave. 117 volts, 100 watts. 11 x 14½ x 16¼ in., 30½ lb. $395.—**Simpson Electric Co., Inc.**, 5200 W. Kinzie St., Chicago, Ill. 60644

RF MARKER GENERATORS

RCA—WR99A crystal-calibrated marker combines functions of multiple-marker generator, crystal calibrator and heterodyne frequency meter. Continuous coverage from 19 to 260 mc in 8 ranges. For servicing and aligning TV, communications and other receivers within its range. Checks TV rf and i.f. bandpass and vertical and horizontal linearity. Checks frequency of unknown signals fed into it by zero-beat method. Calibration can be checked at 242 1-mc intervals or at 250- and 500-kc check points throughout the range. The 1- and 10-mc calibrator crystals have 0.01% accuracy.

Internal modulation: 1 mc, 10 mc, 4.5 mc 600 cycles or a combination of 4.5 mc and 600 kc. Sound and picture carrier markers available simultaneously. External modulation from any source up to 10 mc, fundamental crystal from 1 to 30 mc or plug-in L-C circuit from 100 kc to 10 mc. Output impedance 90 ohms. Attenuator: 0–60 db in twelve 5-db steps.

105-125 vac, 45 watts. 10 x 13½ x 7 in. 17 lb. $256.50.—**RCA Electronic Components & Devices**, Harrison, N.J.

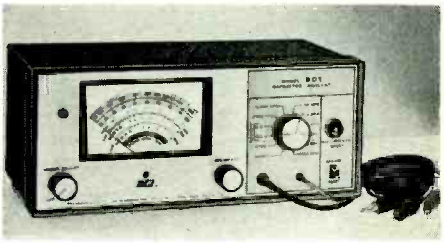
Precision—E200-C. See AM generators.

EQUIPMENT REPORT

B & K Model 801 Capacitor Analyst

Circle 30 on reader's service card

THE CAPACITOR TESTER IS ONE INSTRUMENT that never gets cold in *my* shop; along with the vtvm and scope, it goes on when the doors open. So I was happy to get the chance to work out with the new B & K model 801 Capacitor Analyst. It checks capacitors from 25 pf to 2,000 μf, reads leakage of all types and has *in-circuit* tests for all except electrolytics and very tiny capacitors, below 25 pf.



The 801 has an excellent combination test for electrolytics. Most testers measure capacitance and leakage separately. With a bridge circuit, the 801 puts the capacitor into the exact equivalent of the circuit in the set: a half-wave rectifier puts a voltage across it. The meter reads the "effective capacitance." Several things must be measured: capacitance, leakage resistance (parallel) and internal resistance (series). All these affect the quality of an electrolytic—its ability to do the job. A neon short-check bulb on the panel shows up the 100%-leakage ones that need no further testing.

We always know the *nominal* value of an electrolytic, from the schematic or the label on the case. The average capacitor reads about 20% high. I checked some new ones to see. So, if you check an 80-μf unit and read 50-μf, throw it out! Any defect in the capacitor will cause the effective capacitance on the meter to be below the nominal value.

Paper and ceramic capacitors are different. Here, we aren't too much interested in capacitance: a paper capacitor can't change—much! *But,* it can open, leak or short, and that's what we need to find out. The 801 has in-circuit tests for shorts and opens.

A 20-mc oscillator circuit is used. The capacitor under test is hooked across its tank coil through a quarter-wave line so that it reflects an opposite-sign impedance; the resulting tank-coil voltage is rectified and read on a vtvm. I gave this a very severe test. On opening the circuit and measuring the capacitors in the usual way, I got agreement in all cases! As for all other test instruments, results depend on interpreting meter readings under the conditions of the moment.

A leakage test is provided, with 3-volt and 100-volt ranges, so that all types of electrolytics and paper capacitors can be checked and the leakage read directly in megohms on the meter. Capacitors must be disconnected for this test. Full scale is 100 megohms.

The capacitance meter is calibrated directly on the 100- and 2,000-μf scales. Two more scales show values of smaller capacitors. Five multipliers are used: $\times 1$, $\times 0.1$, $\times .01$, $\times .001$-μf, and $\times 100$ pf. A reading of 3, for instance, on the $\times .001$-μf scale means $3 \times .001$ or .003 μf.

Two 12AU7 tubes are used. All wiring is printed-circuit, and very neat. This is an extremely rugged instrument. It had a *very* rough trip here, judging from the condition of the box, but it worked perfectly as soon as it was turned on.

READ the instruction book; it'll tell you exactly how to use the Capacitor Analyst and get best results. When I set it up for leakage tests, I adjusted the meter to full scale and hooked up one of my stock of bad capacitors (kept around for such occasions). Then I wondered why I didn't get the right reading. A bit later, I saw, in embarrassingly plain language on page 7, "Adjust METER ADJUST control until pointer is at INFINITY (*left* side of scale)." *Full scale,* as usual, is on the *right* side. (I'm thinking seriously of having L and R tattooed on the backs of my hands.) So don't just look at the words—*read* the book!—*Jack Darr*

EICO 435 DC/Wideband Oscilloscope

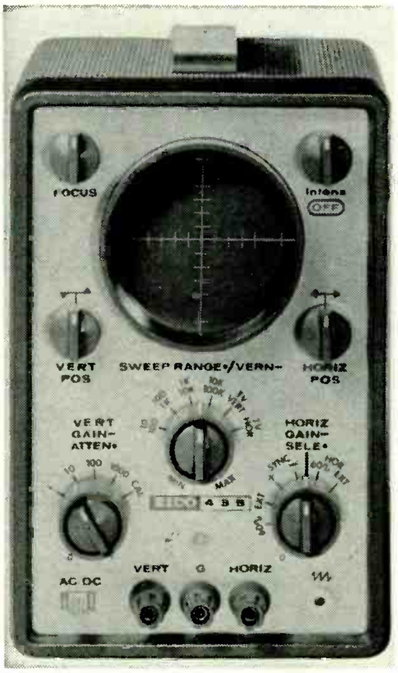
Circle 31 on reader's service card

EICO'S LATEST OSCILLOSCOPE IS A REAL compact, but it has all the features of many larger scopes. No bigger than a shoebox, it has nine tubes plus the flat-faced 3-inch CRT. The three-stage vertical amplifier, push-pull all the way, is dc-coupled with a flat response to 4.5 mc (+1, −3 db). The sensitivity, 50 mv/cm peak to peak, is ample for TV servicing. A frequency-compensated four-step attenuator lets you measure voltages up to 200 v/cm, or a maximum of 800 volts p-p. The screen is calibrated in four 1-cm divisions, and edge-lighted. Input impedance is 1 megohm shunted by 35 pf.

An AC/DC switch adds a series capacitor to the input, making an ac scope

Circle 32 on reader's service card

out of the 435. This is the position you'd use for TV servicing, mostly. The dc coupling is very useful for industrial electronics service, lab work, transistor design, etc (see Tom Jaski's "Scopes: dc or ac?" RADIO-ELECTRONICS, February 1965).



A built-in 200-mv p-p calibration voltage is provided; this is set by a Zener diode, and can be recalibrated by an internal adjustment if necessary.

The horizontal sweep covers 10 cycles to 100 kc in four overlapping ranges. The TV-VERT (30-cycle) and TV-HOR (7,875-cycle) positions will display two cycles of TV-sweep waveform. This can be very useful, especially for checking TV sweep and sync. The sweep-vernier control is the inner knob, concentric with the sweep selector switch.

A six-position horizontal-sync–input selector has four internally synced positions: ac line (60-cycle sync), external, + sync and — sync. The last two positions are EXT (external input to the horizontal amplifier) and 60 CYCLES (sinusoidal sweep from the ac line via the power transformer). Neither of these last two positions has internal sync. The horizontal gain control is the inner knob.

A sawtooth voltage from the sweep oscillator is brought out at a jack on the panel. This can be used for checking the frequency-compensated attenuator for phase shift, by feeding it into the vertical input. The compensating trimmers are then adjusted to give a straight diagonal line. Any trace of a hook at one end of the line means undesirable phase shift.

The calibration grid is edge-lighted; brightness can be controlled by a knob on the back panel. Z-axis or intensity-modulation input is also provided, and this useful but seldom-used feature is on the back panel, too.

The astigmatism, dc balance and vertical-bias controls are inside, but adjustable through holes in the side of the cabinet.

Although there is a lot of stuff in this instrument, all tubes and parts are easily accessible. A "split-level" chassis, one horizontal and the other vertical, gives free access to all parts, tubes and controls.

A portable scope has to be rugged, and this one is. The unit I got for this test had had a very rough trip through the mail! The box was in bad shape, but there was no trouble when I fired up the scope. I used it on several TV sets, making the usual tests: sync, video, sync pulses and so on. The patterns are clear and sharp, with very good stability. Visibility of the pattern is good; probably due to the deep bezel ring around the CRT face. Focus is sharp: color bursts, color bar signals and such show up clearly.

One thing I like is the positive action of the positioning controls. On my old scope, the spot "floats" after the controls are moved. After you move the control, you wait while the pattern saunters over and finally stops. On this one, when you move a control you get action immediately! The spot stops moving instantly and stays there.

A very detailed instruction book is included, with complete service data plus a troubleshooting guide, voltage and resistance charts, and a schematic. Recalibration and vertical-attenuator compensation tests are built in. The 435 uses standard tube types.—*Jack Darr*

MANUFACTURER'S SPECIFICATIONS

Vertical amplifier: frequency response from dc to 4.5 mc, +1, —3 db; sensitivity 18 mv/cm rms (50 mv/cm p-p); input impedance 1 megohm shunted by 35 pf; square-wave calibration voltage of 200 mv p-p ±1%; input decade attenuation 1/0.1/.01/.001 providing corresponding calibrated sensitivities of .05/.5/5/50 vcm at the 1/10/100/1,000 positions, respectively.

Horizontal amplifier: Frequency response from 1 cycle to 500 kc, +1, —3 db; sensitivity 0.7 v/cm rms; input impedance 4 megohms shunted by 40 pf

Sweep ranges: 10–100, 100–1,000, 1,000–10,000, 10,000–100,000 cycles; TV-VERT position (30 cycles) and TV-HOR position (7,875 cycles)

Intensity-modulation input: 3 volts blanking; input impedance 2.2 megohms

Sawtooth output: 10 volts p-p from 10 cycles to 100 kc, variable by H gain control; output impedance 300 ohms

Tube complement: two 6AU8, two 12BY7, two 12AZ7, one 6BL8, one EZ81, one 1V2, one silicon diode, one Zener diode, one WX-5013P1 CRT.

Power supply: 117 volts ac, 60 cycles, approximately 110 watts

Size (HWD): 8½ x 5¾ x 12⅝ inches

Weight: 15 lb

Price: $99.95 kit, $149.95 wired.

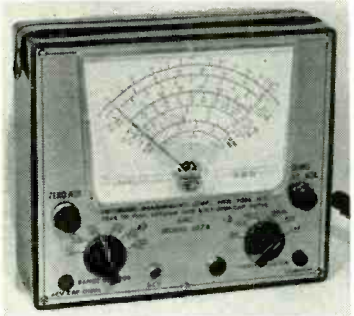
EMC Model 107A VTVM

Circle 34 on reader's service card

THIS EMC VTVM IS HOUSED IN A 7¼ × 8½-inch hard plastic case with carrying handle, and sports a 6 × 4-inch plastic-face meter. It reads dc voltages, plus or minus, and ac voltages either peak-to-peak or rms. It has standard resistance ranges for vtvms—R × 1 through R × 1 meg.

A feature of the EMC not found on many vtvms is capacitance-measuring scales. These are calibrated from C ÷ 1,000 through C × 1,000 on a .05- to 5-μf meter scale.

The input resistance of the 107A on the dc ranges is a bit unusual. The 1.5-volt range has 2.5 megohms but all others have 16.5 megohms. The 1.5 volt range is presumably designed with transistor circuits in mind. The 10-, 30-, 100-, 300- and 1,000-volt scales would give somewhat more accurate readings and less loading on the circuit under test than the standard 11-megohm input circuit.



The 107A uses three test leads. DC readings are taken with a separate, shielded cable with a 1-megohm isolation resistor at the tip to minimize capacitance loading in high-frequency circuits.

The 107A uses two 12AU7 twin-triode tubes and a silicon diode half-wave power supply. It has a neon pilot lamp.

This vtvm should make a good service type meter. On the unit we tested, the calibration on the dc scales was within 5% of full scale on all ranges.

As with all meters with capacitance ranges of this sort that I have tested, capacitance readings tend to be a little skittish for low values unless the test leads are removed and the capacitor is inserted directly into the test jacks. Capacitors from about .01μf up, however, can be checked with no problems.

The 107A seems to be well built and should give long service on the service bench.—*Wayne Lemons*

VIKING DATA CORRECTED

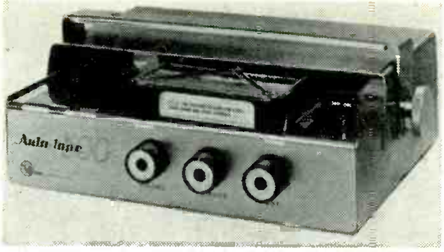
There were several errors in the information supplied for the Viking model 500 stereo cartridge tape player in the article "Tape Players for Your Car" in the September RADIO-ELECTRONICS. The correct information follows:

1. Positive-ground information *is* available; the instruction manual supplied with the 500 describes the minor internal wiring changes required to adapt the unit to 12-volt positive-ground electrical systems.

2. The price of the metal-finish (stainless steel) version is $159.95, not $169.95 as printed.

3. The player as purchased includes two speakers, not four. Additional speakers are available as a kit.

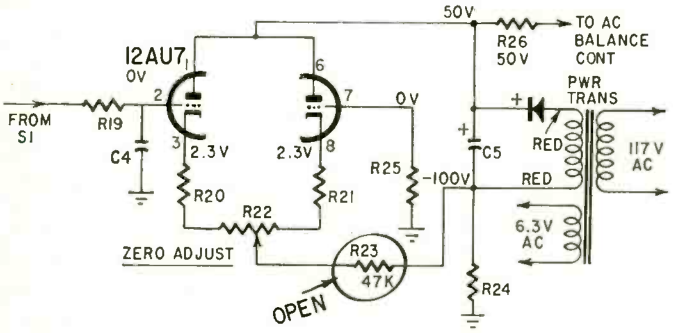
4. Price does not include installation.



Incidentally, the Muntz unit introduced in 1962 was made by Viking, who developed their first auto stereo tape players in 1958 and marketed them in 1960. END

TECHNOTES

ZERO-ADJUST FAILS ON EICO 232 VTVM



On an Eico 232 vtvm in our shop, the zero-adjust pot stopped working. We checked all tube-element and power-supply voltages, and eventually found that the 12AU7 cathode voltages were wrong. Checking resistors, we found R23, a 47,000-ohm resistor, was open. Replacing it cured the trouble.—*Pierre Cappaert*

BROADENED SCOPE TRACE

A little reminder—born of embarrassing experience: If, while you work with a scope, the trace suddenly broadens, check the focus control. You may have moved the knob accidentally. Try that before you start servicing the scope!—*Paul W. Conner*

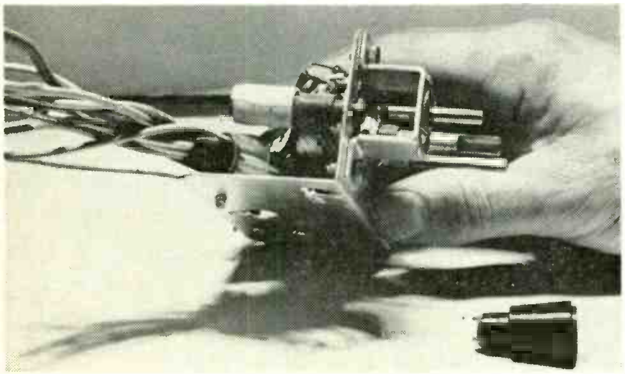
ERRATIC READINGS ON PACO V-70 VTVM

My Paco model V-70 vtvm would not measure voltages on any unisolated chassis. Connecting the ground lead would send the pointer off scale on the low side; connecting the "hot" lead to a voltage source would send the pointer off scale on the high side, even when the voltage was well within the range being used. Resistance readings and readings on isolated (transformer-operated) chassis were reasonably normal.

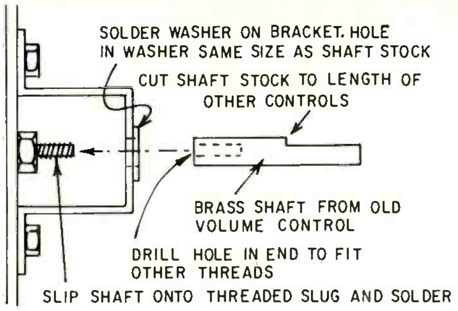
The trouble was finally traced to a 15,000-ohm leak between the primary and high-voltage secondary windings of the power transformer. Leakage was high enough to upset the sensitive balanced-bridge circuit under some conditions, but not high enough to prevent the meter from working normally on some tests. A new transformer and recalibration restored the meter to perfect operation.—*Klaus Halm*

EMERGENCY FIX FOR BROKEN KNOB

An RCA color-TV table model CTC9-B was brought into the shop. The only trouble was that the knob on the horizontal control had been broken. This knob is a large plastic type. We did not have one in stock, and our wholesale supplier did not have one like it either. Instead of tying the set up for several weeks, we made a new shaft of used stock.



Drill a small hole down the center of a ¼-inch brass shaft from an old volume or tone control. If there is no slot for the knob to fit on, file and grind down on the other end of the shaft. Slip the shaft over the horizonal threaded adjustment



screw and solder it in place. A small bracket was used to hold the large knob in place. Use this bracket but solder a metal washer over the larger hole; choose one that the shaft will twist snugly into. Push a new brown knob over the shaft to match.—*Homer L. Davidson*

UHER SR111 STEREO RECORDER FROM SERIAL NO. 89000

Symptom: Recordings in stereo at tape speed of 3¾ & 1⅞ ips play back with loss of highs on left channel. Mono recordings on left channel similarly affected. Prerecorded tapes at these speeds in stereo or mono, OK.

Fault: Lead from left-channel preamp (printed-circuit board closest to front) to equalization switch open. Switch is located below speed-change mechanism and operates from same shaft.

Cure: Check all leads from the yellow cables that run to the switch for breakage. To repair this fault it is necessary to remove the entire unit from case. It comes out easily if you first remove the plastic input/output panel through the side port.—*Steve P. Dow* END

The Past and Future of Test Equipment

continued from page 33

A new type of signal generator was introduced to meet the special requirements of color television. Dot or crosshatch patterns are needed for checking and adjusting convergence, and a dependable and accurate color bar signal is needed for checking, troubleshooting and adjusting color circuits. The "offset subcarrier" method of generating color bar signals, introduced in 1952, enjoys a commanding lead in this field. Color television also required oscilloscopes with a 4-mc bandwidth to permit viewing and tracing the color burst and color bar signals.

Transistorization has not required significant changes in basic troubleshooting methods or test equipment. The basic method of troubleshooting in transistor sets, as in tube receivers, is to localize the trouble to a particular section and then check the voltages and components in that section. The trouble can be localized by analyzing the visible and audible symptoms, by using signal-injection or signal-tracing methods, by using an oscilloscope or a combination of these methods.

Because some transistor circuit voltages are relatively low, it is desirable to have a low dc voltage range in the vtvm. Several available models provide a 0.5-volt full-scale dc range, which is just right for this purpose.

The big difference in troubleshooting transistor circuits is that, unlike tubes, the small-signal transistors are often soldered in and cannot be pulled for checking. Off-hand, it would seem logical to use an in-circuit transistor tester, but these devices have definite limitations.

In my opinion, the best way to localize trouble in transistor circuits is by using the signal-tracing method pioneered in the RCA Rider Chanalyst in the late 1930's. This method makes it possible to measure the approximate voltage gain or loss from input to output of each transistor, from primary to secondary of each transformer, or from stage to stage.

What of the future? Even in this brief editorial I must mention integrated circuits (IC's) and their possible impact on troubleshooting methods and test equipment.

Each IC, although only about the size of a pinhead, may contain several dozen transistors, diodes, resistors and capacitors, all connected in a single or multiple circuit. The IC might be a complete radio receiver, less the tuning elements and speaker. In time, even some tuning elements may be worked into IC's. With large production quantities and good yield, the IC can be made at relatively low cost.

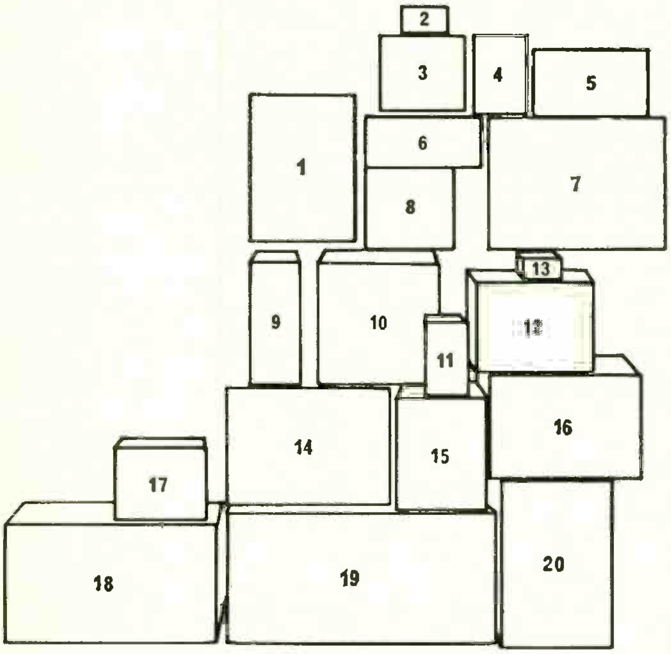
You need a microscope to see the individual items on an IC, so you can be pretty certain that you won't be involved in repairing one, but you will have to determine if the circuit is good or bad, and replace it if necessary. The IC is mounted on a holder with leads, so making a replacement is no problem. To determine if an IC is good or bad, you will need a vom or vtvm to measure the supply voltage, you will need a signal source for the input, and a meter or scope to measure the output, and you will need signal generators to check the alignment. Sounds familiar, doesn't it? END

WHAT'S ON THE COVER?

(Try guessing, first!)

The numbers in the outlines below correspond to the list at the bottom of the page.

Be sure to see the **directory of signal generators** on **page 60,** and the one of **dip meters** on **page 44.**



1. Tektronix 561A automatic oscilloscope
2. "Quick Henry" inductance-checker (R-E build-it-yourself project)
3. International Crystal C-12B Citizens Band frequency meter
4. Heath IM-11 vacuum-tube voltmeter
5. Mercury 1400 in-circuit capacitor checker
6. Seco 900 color-bar-dot-crosshatch generator
7. Triplett 3414 tube tester
8. Lectrotech V-7 color generator and vectorscope
9. Amphenol Signal Commander field-strength meter
10. Sencore MX129 FM multiplex generator and analyzer
11. EMC transistor tester
12. Conar 280 rf signal generator
13. Component curve-tracer (R-E build-it-yourself project—see p. 52)
14. RCA WR-69A television/FM sweep generator
15. Lafayette signal generator/tracer
16. EICO 902 harmonic & intermodulation distortion meter
17. Knight Ten-2 CB checker
18. B & K 1076 deluxe TV analyst
19. Amplifier Corp. of America wow and flutter meter
20. Precise 3151 5-inch oscilloscope

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Booklet entitled "The Open Door to TV Profits".
WINEGARD CO. (Pg. 61) Circle 22
Information on Chroma-Tel.

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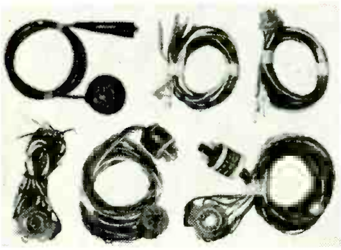
NEW PRODUCTS

More information on these new products is available free from the manufacturers. Each item is identified by a Reader's Service number. Turn to the Reader's Service Card facing page 80 and circle the numbers of the new products on which you would like further information. Detach and mail the postage-paid card.



COLOR SERVICE HARNESSES AND ADAPTORS. Line consists of CRT extensions, anode extensions, convergence deflection-magnet extensions and adaptors. With the *CR-506*, a 48-in. socket extension cable for all 21-, 23- and 25-in. color tubes, the chassis can be removed from set, leaving CRT connected. —**I. E. H. Mfg. Co.**

Circle 46 on reader's service card

SCREW-HOLDING SCREWDRIVER for Phillips-head screws, has steel fingers that grip screw for direct application of screw to hole. Two sizes:

608-3, No. 1 point with 3-in. blade; *608-4*, No. 2 point with 4-in. blade.—**Mathias Klein & Sons, Inc.**

Circle 47 on reader's service card

4-SPEED AUTOMATIC RECORD CHANGER, *model AC-33*, has heavy-duty 4-pole motor, heavy 11-in. balanced turntable. Intermixes up to twelve 10- and 12-in. records of same speed, stacks fourteen 7-in. discs. Ribbed rubber turntable mat. Aluminum tone arm with Euphonics turnover stereo cartridge with 0.7-mil diamond stylus and 3-mil synthetic sapphire. 13½ x 12 x 7½ in.—**Lafayette Radio Electronics Corp.**

Circle 48 on reader's service card

RECORD PROTECTING DEVICE, *Platter Pusses*, are felt-flocked leatherette discs which fold into the hand and keep fingerprints off records. **Robins Industries Corp.**

Circle 49 on reader's service card

AUTO RADIO ANTENNA, the A-85 CB/AM combination, uses encapsulated top-loading coil to get one-quarter-wavelength resonance. VSWR 1.1 to 1. No degradation when used for entertainment radio. Signal divider prevents 27-mc signals from entering AM radio. 47 in. extended, telescopes to 30 in.—**Webster Mfg.**

SWISS TAPE RECORDERS, the *ReVox* line, will be marketed in the US, Canada and Puerto Rico. Major product in ReVox line is *model G-36*, featuring 3

Pabst motors, solenoid-operated brakes, built-in mixing facilities, separate stereo record and play amplifiers, 2 VU meters, 3 ring-core heads, automatic end-of-tape

Circle 106 on reader's service card

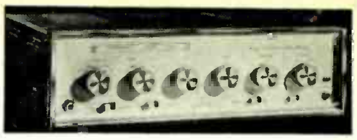
stop, 70-kc push-pull bias oscillator. Accommodates 10½ in. reels.—Elpa Marketing Industries.

Circle 51 on reader's service card

TRUE FLAT-SCALE EDGEWISE PANEL METER, *model 1201 PMP* (projected moving pointer) uses projection optics to eliminate the parallax problem inherent in bowed scale surface of edgewise meters. Self-illuminated; accuracy 1%; ranges 50 ma dc to 50 amps dc, 50 mvdc to 500 volts dc. Color can be added to define scale sections. 5⅝ x 2 x 5⅝ in.—**Weston Instruments, Inc.**

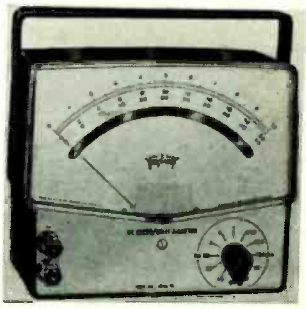
Circle 52 on reader's service card

SOLID-STATE STEREO AMPLIFIER, the *S-9900*. Power output: 90 watts IHF music power; 72 watts continuous sine-wave. Bandwidth at 1% harmonic distortion: 12–35,000 cycles. Harmonic distortion: ⅛% at rated output. Damping factor: 40. Maximum hum and noise: phono — 70 db; tuner — 80 db. Sensitivity: tape head 1 mv; phono 1.8



mv; tuner 0.25 v. 3 pairs high, 2 pairs low inputs. Power consumption 10–150 watts. 23 silicon transistors, 2 silicon rectifiers. 14 x 10½ x 4 in., 22 lb. Has audio power output to drive mono center channel.—**Sherwood Electronic Labs**

Circle 53 on reader's service card



DC PORTABLE INSTRUMENTS *model 825*, feature Bar-Ring suspension movement, 6.84-in. mirror scale, knife-edge pointer, open meter front with top and side natural lighting. Accuracy ± 0.5% in horizontal position. 3 units available: dc voltmeter, dc milliamp-ammeter, dc micromilliammeter. 7½ x 6⅝ x 3⅞ in., with carrying handle.—**Triplett Electrical Instrument Co.**

Circle 54 on reader's service card

ROCK 'N ROLL ORGAN. Portable, transistor dual-manual electronic organ has 7 voice stop tabs: bass, surf, latin,

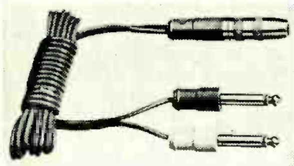
jazz, rhythm and blues, folk and blues. 49 treble notes upper keyboard, 25 bass notes lower keyboard. 35 lb.—**Magnatone Div., Estey Musical Instrument Corp.**

Circle 55 on reader's service card

AUDIO GENERATOR, *model 378*. Near-distortionless sine-wave generator (less than 0.1% between 20 and 20,000 cycles). Switch-selection of frequencies from a cycle to 100,000 cycles. 8-position 10-db/step output attenuator and fine attenuator. Output meter (4½-in., 200 μa) with voltage ranges and db scale.—EICO

Circle 56 on reader's service card

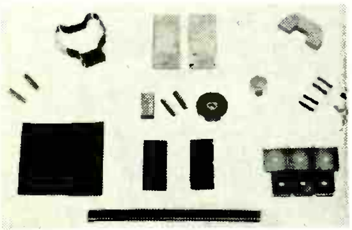
TWO NEW ADAPTER CABLES. *Part No. 82AB86*, 12 in., shielded, has two standard alligator clips wired to molded phono extension jack. *Part No.*



05FH81, illustrated, stereo headphone adapter cable designed to adapt 3-circuit phone plugs. Phone plugs color coded. **Switchcraft, Inc.**

Circle 57 on reader's service card

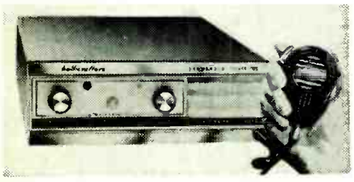
MAGNET VARIETY KIT contains 16 magnets, including Alnico magnets (baby bars, an Alnico U-shape), rectangular ceramics, two disc types, 4 magnet



pole pieces. These come in several compositions, including a rubber strip and flexible material, impregnated with thousands of tiny individual magnets.—**Edmund Scientific Co.**

Circle 58 on readers service card

FM 2-WAY RADIO, the *Commander Thirty-Two*, designed for mobile serv-



ice in 148–174-mc band. Operates from 12-volt dc source. Rated at minimum 30 watts output. 3½ x 10¼ x 15¼ in.—**The Hallicrafters Co.**

Circle 59 on reader's service card

HIGH-VOLTAGE CAPACITOR, *type B161Y* or *B161YT*, 3,000 to 15,000 volts for bypass, filter or coupling applications; uses combination of Mylar and paper dielectric impregnated with oil. No derating required up to 85°C; power factor will not exceed 1%; high insuration

resistance.—**Aerovox**

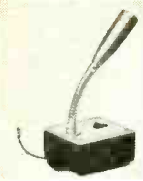
Circle 60 on reader's service card

TRI-BAND SSB/AM/CW TRANSCEIVER, the EICO 753, for 20-, 40- and 80-meter amateur bands. Input: 200 watts PEP on SSB or AM, 180 watts for CW. Output: 110 watts PEP for SSB and AM, 110 watts carrier power for CW. Receiver sensitivity better than 1

μv for 10 db signal-to-noise ratio. Selectivity from crystal lattice bandpass filter is 2.7 kc at 6 db. Receiver has offset tuning over 10-kc range. Frequency range: 3,490–4,010 kc, 6,990–7,310 kc and 13,890–14,410 kc. Flat-topping prevented by automatic level control. Available wired.—**EICO Electronic Instrument Co.**

Circle 61 on reader's service card

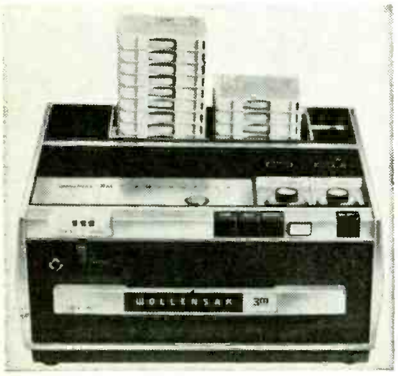
Circle 108 on reader's service card



PAGING MICROPHONE, the *MK-3DBS*, controls as many as 4 separate circuits for paging, dispatch, PA, audio–visual work, ham operation. Dynamic, low impedance (200 ohms), response 80–10,000 cycles. Weighted base, momentary action dpdt switch, adjustable gooseneck. 12-ft shielded multiconductor cable. *MK-3BS-1* is high-impedance ceramic mike with same features as listed above. Response 80–8,000 cycles. Output level −52 db at 1 kc.—**Audiophonics Corp.**

Circle 62 on reader's service card

STEREO AUTOMATIC TAPE RECORDER, *Wollensak model 7100*, with



built-in speakers and amplifiers, will play up to 15 hours of music. Response: 40–15,000 cycles. Wow and flutter less than 0.3%. Signal-to-noise ratio greater than 48 db. Power output 9 watts per channel, 5 watts continuous at 5% harmonic distortion. Power consumption 110 watts. 7 x 14½ x 14¼ in., 32 lb.—**3M Co.**

Circle 63 on reader's service card

SOLID-STATE OSCILLOSCOPE, *KN-5005*. Vertical system: .05 v/division sensitivity; 10-step frequency-compensated attenuator; Resp. dc–6mc, ±3 db, useful to 12 mc; rise time .075 μsec. Horizontal: sweep speeds 1 μsec/division to 100 msec/division in 6 steps; X1, X2 and X5 multipliers; continuously variable uncalibrated sweep speeds over above range. Trigger modes: free run, plus positive and negative internal and adjustable-trigger-level external slope. Aluminum case 8¾ x 6 x 14 in., 16 lb. 25 transistors, 18 diodes, nuvistor, CRT. For 110–120 volts, 50–60 cycles ac. Shpg. wt. 20 lb.—**Allied Electronics Corp.**

Circle 64 on reader's service card

CARTRIDGE HEAD ASSEMBLY steps up cartridge machine performance

to equal Ampex recorder specifications. Directly interchangeable on all ATC cartridge machines; azimuth and height adjustments are made with standard Allen wrench, just as on tape machine.—**Lang Electronics, Inc.**

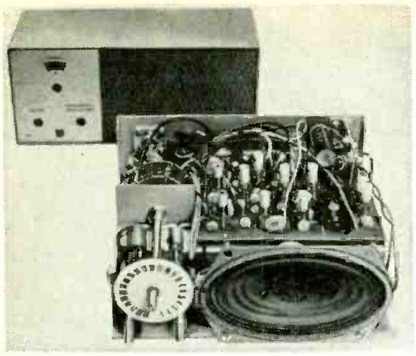
Circle 65 on reader's service card

TRANSISTOR TEST SOCKET, (*Part No. 5501*), accommodates 7/16 through ⅝-in. devices. Over 150°C operation; spring-temper beryllium copper contacts which can carry 15 amps. Lead wires No. 14 stranded with Teflon insu-

lation. Color-coded wires have solderless terminals.—**Azimuth Electronics**

Circle 66 on reader's service card

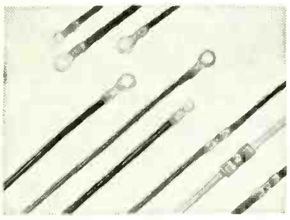
Circle 109 on reader's service card



23-CHANNEL CB TRANSCEIVER, the *23'er*, 25 silicon transistors, 6 diodes, 1 Zener diode. Ignition-noise silencer; crystal bandpass filter; 3 x 5 in. speaker; 4 watts maximum audio; PA service; power 12 volts dc, negative ground; separate 115-volt ac power supply; full 5 watts input to transmitter. 8 x 3½ x 7 in., 4 lb.—**Squires-Sanders, Inc.**

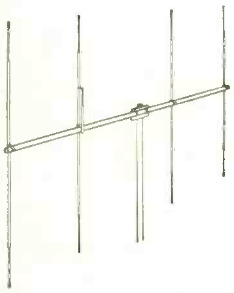
Circle 67 on reader's service card

SOLDERLESS TERMINALS AND CONNECTORS, the *Hi-Temp 20,000 Series*, feature nickel plating for use in



temperature ranges up to 650°F. Terminals come in 6 designs; connectors in 3 sizes.—**Vaco Products Co.**

Circle 68 on reader's service card



BASE-STATION ANTENNA FOR CB, the *A-411-S* from Mosley Electronics. Gain 8.7 db over ½-wave dipole or 11.2 db compared to isotropic source. Front-to-back ratio 20 db. Wind load 80 mph EIA standard. VSWR of 1.5/1 or better over 27-mc Citizens band.—**Mosley Electronics Co.**

Circle 69 on reader's service card

IN-CIRCUIT SEMICONDUCTOR TESTER, model *TT-22*. Tests include V_{SAT} in 2 ranges, 0–0.3 and 0–3 volts. Also tests voltage drop of diodes and SCR's at forward currents of 5, 50, 500 ma. Power is four 1.5-volt flashlight batteries (D-cells). Two test cables and

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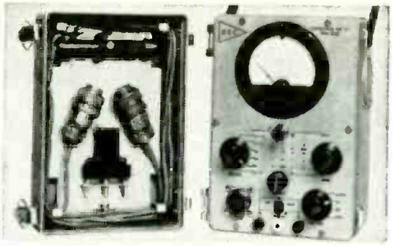
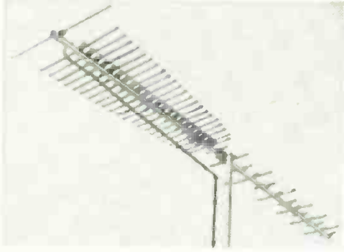
Circle 113 on reader's service card



adapter socket stored in hinged cover.—**Abbey Electronics Corp.**

Circle 70 on reader's service card



UHF ANTENNAS FOR COLOR TV. Called *Planar-Grid* Yagis, they feature broad bandwidth, can be peaked for ultimate in uhf translator band reception. Shown model *U-990*.—**Winegard Co.**

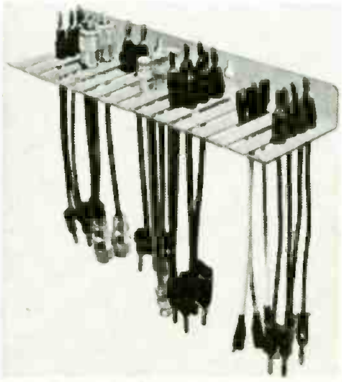
Circle 71 on reader's service card

MARINE RADIO DIRECTION FINDER, model *DF-765*. Transistorized, 3-band, operates from 6 self-contained flashlight-type batteries, with high-Q fer-

rite core loop antenna. 4 x 6 in. front-mounted speaker. Null meter, beat-frequency oscillator for coded signals. 10½ x 12½ x 4½ in., 10½ lb.—**Pearce-Simpson, Inc.**

Circle 72 on reader's service card

TEST-LEAD HOLDER is designed to store patch cords and cable assemblies.



Enameled steel finish, mounting holes; will accept cables up to 0.210 in. in diameter.—**Pomona Electronics Corp.** END

Circle 73 on reader's service card

NEW LITERATURE

All booklets, catalogs, charts, data sheets and other literature listed here are free for the asking (except where a price is given). Each item is identified by a Reader's Service number. Turn to the Reader's Service Card facing page 80 and circle the number of items you want. Then detach and mail the card. No postage required!

REFERENCE GUIDE No. 91-000, to integrated circuits—digital and linear. 8 punched pages, with diagrams and design features.—**Westinghouse Electric Corp.,** Molecular Electronics Div.

Circle 74 on reader's service card

DESIGN CHART AND CATALOG for specifiying Vaco solderless terminals and connectors. Information grouped in five steps: (1) barrel style, (2) tongue style, (3) wire range, (4) stud size and (5) special plating.—**Vaco Products Co.**

Circle 75 on reader's service card

BROCHURE describes *model RM-515* mobile carbon microphone, and gives explanation of principles used to cancel radom ambient noise.—**Roanwell Corp.**

Circle 76 on reader's service card

SPRAGUE UNICIRCUIT MONOLITHIC NETWORKS, COMPATIBLE COMPONENTS & TRANSISTORS *Catalog IND-800A*. 20 pages, looseleaf-punched. Diagrams, ratings, characteristics of line of integrated circuits such as clock driver, gates, differential amps, multivibrators; low-noise and high-speed silicon epitaxial transistors, etc., with some package outline drawings and integrated-circuit outlines.—**Sprague Electric Co.**

Circle 77 on reader's service card

SELECTION GUIDE FOR MOTOROLA SILICON ANNULAR TRANSISTORS, 14 punched pages, categorizes devices for high-speed saturated logic, small-signal amplifiers, current-mode switches, core drivers, pulse amplifiers, micro-power devices, choppers, field-effect transistor applications, high-voltage and general-purpose amplifiers. More than 100 transistor types.—**Motorola Semiconductor Products, Inc.**

Circle 78 on reader's service card

WESTON INSTRUMENTS CATALOG Z-100 *Stock Panel Meter Selector*. 20 pages, looseleaf-punched, with size-index tab guide on right-hand margin. Sizes: 2½, 3½, 4½, 5½ and 7½ in. Volume-level meters, projected-moving-scale meter, load meters and null indicators, etc., plus accessories, glossary of terms, conversion factors.—**Weston Instruments, Inc.**

Circle 79 on reader's service card

CATALOG SUPPLEMENT, 92 pages, supplements *Cambion General Catalog No. 700*, details advances in company's line of more than 15,000 electronic components: terminals, coil forms, rf chokes, capacitors, connectors, plugs and jacks, thermoelectric modules, etc.—W. G. Nowlin, General Sales Manager, **Cambridge Thermionic Corp.**

Circle 80 on reader's service card

KIT CATALOG, No. 810/60A, 108 pages with photographs of over 250 kits: TV sets, electronic organs, stereo and mono tuners and amplifiers, CB, marine electronics, educational products, ham, test and lab instuments, and many other categories.—**Heath Company**

Circle 81 on reader's service card

BROCHURE, *Directory of Accredited Private Home Study Schools,* lists 72 home-study schools, with the kinds of courses they offer, as having met the educational standards of the **National Home Study Council's Accrediting Commission.**

Circle 82 on reader's service card

MULTIPLIER PHOTOTUBE CATALOG, 92 pages, available on request for $1 per copy. Complete specs on standard photomultipliers, theory of spectral emission, response curves, operational theory, dark current and signal-to-noise ratio, selection guides.—**Du Mont Electron Tubes** Division of Fairchild Camera & Instrument Corp.

Circle 83 on reader's service card

SPEAKER-SYSTEM BROCHURE on the new *Empire Grenadier.* Full-color, 8 pages of photos and specs of the *Grenadier* line of wide-angle stereo speakers. Also featuring the *Empire 888P* cartridge and *Troubadour* turntables.—**Empire Scientific Corp.**

Circle 84 on reader's service card

RESISTOR SELECTION GUIDE to carbon-film and metal-film resistors. 3½ x 5½ in., adhesive-backed for wall or breadboard reference.—**Texas Instruments.**

Circle 85 on reader's service card

SHORT-FORM CATALOG of heat-dissipating tube shields, 8 pages with photos.—**International Electronic Research Corp.**

Circle 86 on reader's service card

BROCHURE, well illustrated, on customized power-engineering testing facilities and procedures. 8 pages of test equipment with photos of their applications.—**Kato Engineering Co.**

Circle 87 on reader's service card

PANORAMIC/MANUAL RECEIVING SYSTEM, *Bulletin PR-10,* describes in photos and specs and block diagram 30-mc to 18-gc electronically swept superhet reconnaissance receiver.—**Applied Technology Inc.**

Circle 88 on reader's service card

CATALOG NO. S-308, *Stack Switches.* 8 universal-punched pages of specs, diagrams of general-purpose stack switches and their components. Supersedes Catalog S-304.—**Switchcraft Inc.**

Circle 89 on reader's service card

RESISTOR CATALOG. 4 pages of tables of sizes and physical dimensions of fixed carbon composition resistors.—**Speer Carbon Co.**

Circle 90 on reader's service card

DATA SHEET ON INSTRUMENT KNOBS, 4 pages, photos, dimensions, of human-engineered designs.—**North Atlantic Industries.**

Circle 91 on reader's service card

CATALOG of EECoSWITCH sealed and lighted series 300/400 thumb-wheel switches. 4 pages, photos, tables.—**Engineered Electronics Co.**

Circle 92 on reader's service card

TECHNICAL BULLETIN 110, *How to Measure Phase-Sensitive Null in Ratio Bridges.*—**North Atlantic Industries.**

Circle 93 on reader's service card

CATALOG. 40 punched pages of TV installation accessories, indoor and outdoor vhf/uhf antennas and rotators.—**Parker Metal Goods.**

Circle 94 on reader's service card

BULLETIN E-507, *Four-Layer Diode Memory Circuits,* describes engineering applications of miniature glass 4-layer diodes. Also describes high-speed switching phenomenon known as "rate effect."—**ITT Semiconductors**

Circle 95 on reader's service card

DESOLDERING IRON, *Bulletin 100.* Single data sheet with photo and list of features of the *EDECO 300* pencil iron.—**Enterprise Development Corp.**

Circle 96 on reader's service card

CATALOG. Looseleaf notebook, index-tabbed, divided into General, Cooling Cabinets, Axial Fans, Centrifugal Blowers, Motors & Gear Motors, Servo Motors and Sangamo line of precision motors.—**Rotating Components, Inc.**

Circle 97 on reader's service card

FOUR REVISED CATALOG SHEETS on *Trimpot* potentiometers, models 215, 235, 3011 and 3051. Looseleaf-punched, with new extended resistance ranges from 5,000 ohms to 5 megohms.—**Bourns, Inc., Trimpot Div.**

Circle 98 on reader's service card

SCHOOL SOUND SYSTEMS BROCHURE, *Folder No. 1265,* 4 pages, photos of solid-state systems for intercom and program distribution for schools.—**Rauland-Borg Corp.** END.

Circle 99 on reader's service card

TRAPS AND PITFALLS IN SERVICING COLOR TV

An important feature on color circuitry tells about the sections that aren't *quite* the same as in black-and-white. Pinpoints the trouble-spots that can mislead you expensively. Gives special advice to cut shop time, reduce repair-trial-and-error, curtail excessive costs.

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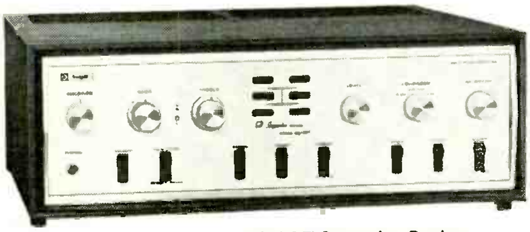
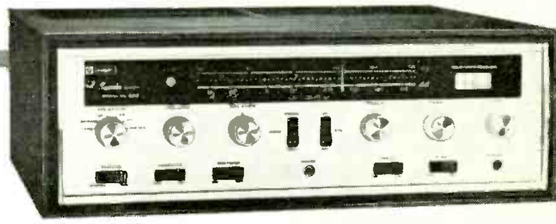
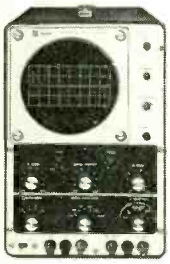


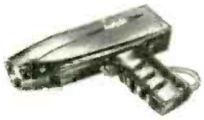
KG-895 Superba Series 120-Watt Solid-State Stereo Amplifier Kit. $149.95 (less case)



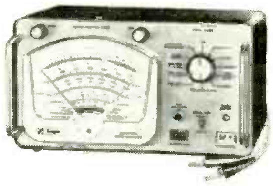
KG-964 Superba Series 64-Watt Solid-State FM-AM Stereo Receiver Kit. $189.95 (less case)



KG-635 5-Inch DC to 5.2 Mc Wide-band Oscilloscope Kit. $99.95



KG-371 Solid-State Auto DC Power Timing Light Kit. $19.95



KG-375 Solid-State Universal Auto Analyzer Kit. $49.95

Safari-I Deluxe 23-Channel Citizens Band Transceiver Kit. $129.95

C-540 Low-Cost 5-Watt Citizens Band Transceiver Kit. $49.95

KG-221 FM Monitor Receiver Kit (police, fire, marine, weather bands, etc.) $39.95

KG-201 Solid-State Motor-Speed/Light Control Kit. $9.95

KG-415 Superba Series Professional Solid-State Stereo Tape Deck Kit. $249.95 (less case)

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Circle 115 on reader's service card

HOW TO SET UP A COLOR-BAR GENERATOR WRONG

By JACK DARR

SERVICE EDITOR

OUR TECHNICIAN-READERS SEEMED TO APPRECIATE AN ARticle we ran recently showing how to make all of the *wrong* scope patterns for sweep alignment! So here's another one. This will show you how to make several absolutely useless patterns on a color TV screen, using a brand-new color-bar generator and a color receiver, both in perfect shape! What other technical magazine makes all the mistakes for you in advance?

Seriously speaking, I did note all these patterns while running tests on a new bar generator. I have also had several letters from puzzled Clinic readers who appear to have had trouble along the same lines. So, I made up this set of photographs to illustrate some of the wrong patterns that you can get if your setup adjustments are just a wee bit off.

Two controls affect the pattern more than the rest (not counting the immediately obvious, such as being out of horizontal sync, etc.). The ones we'll show you are those which could lead you astray by pointing to "defects" that don't exist! (And, of all the things in color servicing, what we need least are *false* clues!)

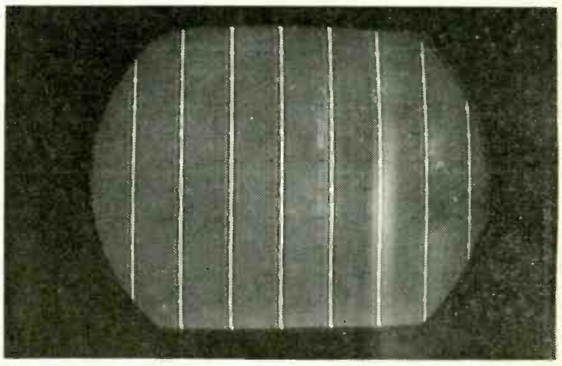


Fig. 1—These are dot patterns? (Nothing wrong with the set.)

Figs. 1 and 2 are dot patterns. (These are *dot* patterns?) Yes, sir. Dot patterns, with only one thing out of adjustment: the fine tuning. In Fig. 1 you can see the dots, but they're connected by vertical lines until the pattern looks like the vertical bar pattern. Fig. 2 shows the same thing but with the fine tuner a little farther off. The brightness is turned a great deal too high, partly for photographing this pattern and partly to show what it looks like when the brightness *is* too high! By the way, the faint "ringing lines" visible to the sides of the vertical lines are a good clue to a mistuned set. As you move the fine-tunning knob, you'll see them change. When the set is correctly tuned, they'll go away, and you'll have a sharp, clean dot (or vertical line, if you happen to be using that pattern).

The bar-dot generator used for this is a well known make, capable of making dots only one horizontal scanning line high and just as narrow, for a very fine dot structure. (We don't show a perfect dot pattern—you all know what that ought to look like!) To get it, from the condition of Fig. 1 or Fig. 2, all we did was turn the fine tuning very

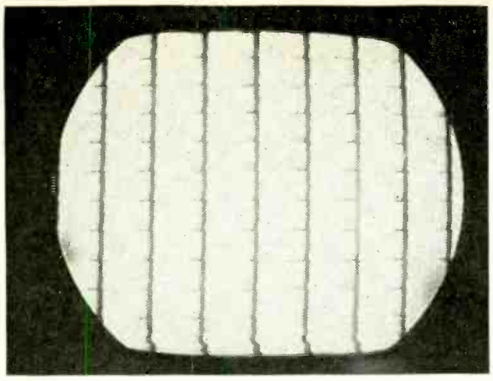


Fig. 2—Same thing as Fig. 1, a little more out of tune.

slightly and reset the brightness correctly.

Fig. 3 shows patterns capable of causing even more trouble than the first ones. This is a crosshatch pattern, but look at the very bad vertical convergence. What causes this? The *vertical hold* control! It's set all the way to one end of its range!

But, says somebody, how can this cause vertical misconvergence? Easy. The dynamic convergence waveforms, those famous parabolas, are taken from the vertical and horizontal sweep stages. When you run the hold control this far off its normal position (with the picture locked in sync), you change the *waveform* of the parabolic dynamic-convergence voltage. So, out of convergence we go, as you can see. Actually, the photograph doesn't show this as bad as it really is; try it on a set known to be working and see.

Even a comparatively small error in the vertical sweep frequency can cause serious misconvergence. I found this out myself while trying to set up a color set. At the time, my own bar generator was slightly off frequency, due to a few Experimental Adjustments on my part. The TV set would lock on a picture but, when the generator was connected, horizontal lines rolled. So I had to adjust the vertical hold control to stop the pattern.

After getting very good convergence on a crosshatch pattern, I put the TV picture back, and was astonished to see a very obvious color fringing on vertical lines! A cautious movement of the vertical dynamic-convergence controls took this out; so, it *was* obviously *misconvergence*. Repeating the tests showed the true cause of this trouble. Even the fraction of a turn that I'd moved the vertical hold was enough to throw the vertical dynamic convergence off badly!

To avoid this, make sure that the TV set is locked on a picture. Then, when the bar generator is connected, make sure that it locks in without *any* adjustment of the set's hold controls! Rolling horizontal lines in a pattern mean that the multivibrator in the generator that makes the vertical sync is just a little bit off frequency. Check your instruction

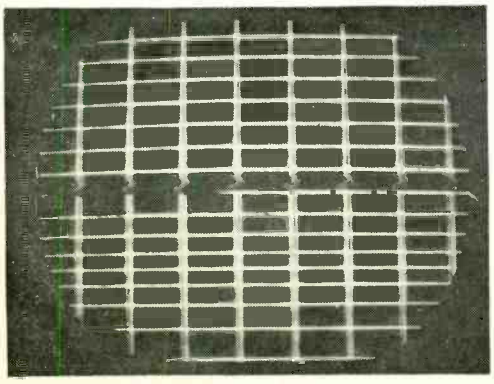


Fig. 3—Oh, look! It's out of vertical convergence! (Or is it? Be sure!)

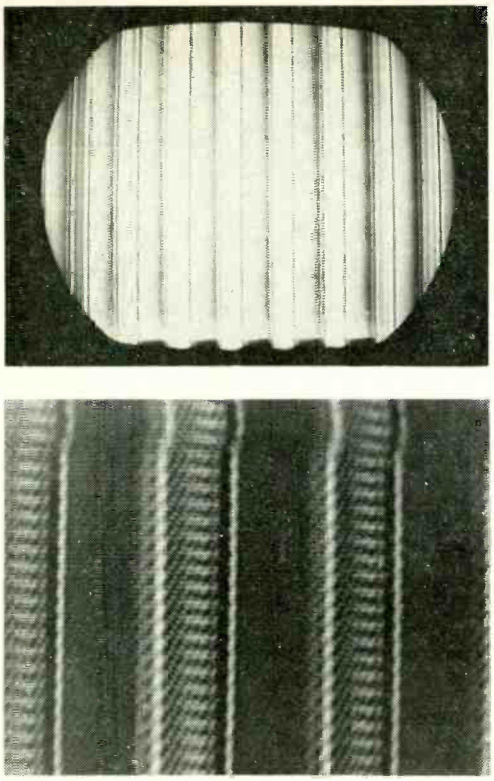


Fig. 4—These mistuned patterns (too bad you can't see the colors) look more like something you'd see after too much time with an entirely different "bar"! The lower photo is a closeup.

book to see which adjustment should be reset.

Unless a technician is on his toes, he could possibly try to converge a set that showed a pattern like that. This, of course, would result in a very bad misconvergence when the set was returned to an actual TV picture! Just to make sure, before making any convergence adjustments, check the TV's control settings. If any adjustments are needed to stabilize the pattern, make them very slight indeed.

Fig. 4 shows a mistuned color bar pattern, and a closeup view of the same thing. Bars aren't distinct, and the colors are strange and wonderful. Note the sound beats in the closeup. These are your best clue to mistuning. On all the generators I've tested so far, the color bars, when properly tuned, were smooth and even, without beats or colored ghosts following the bars.

The typical crystal-controlled "countdown" bar-dot generator (most of them are today) will give you very stable patterns, since all of them are derived from the same crystal-controlled oscillator. The only thing that could get out of adjustment would be the rf oscillator. You can check that quite easily. Tune in a TV station on the channel the generator is tuned to; then hook up the generator and see if it's on the nose. Real check: tune in a color picture, then set the generator on "color bars" and see if the colors are in the right places, as specified in the instruction manual. If they aren't, move the rf oscillator slug very slightly, and put it back exactly on frequency. A slight movement of the receiver's fine-tuning is OK, as long as the generator is within its range.

Caution: do *not* touch any of the bar-dot generator's "countdown" adjustments! That is, unless you're absolutely *certain* that they are off. (*Clue*: horizontal lines but no vertical, or vice-versa.) Believe a man who has had painful experience! They aren't usually off, unless you "adjust" them!

END

New Trick Squeezes Telephone Bandwidth

A new method for cutting telephone bandwidth has been invented by James L. Flanagan, Warren Township, N. J. It is disclosed in patent No. 3,158,693, assigned to Bell Telephone Labs.

When we talk, we emit acoustic energy in concentrated bursts, alternating with moments of silence. The lower frequencies are most important. A total bandwidth of 200 to 3,200 cycles is sufficient to cover normal speech.

The new method, called *speech interpolation communication,* divides the voice frequencies into two bands: 200–1,700 and 1,700–3,200 cycles. The lower band (L) can be amplified and transmitted by simple narrow-band and low-frequency equipment. The upper band (H) is converted *down* to 200–1,700 cycles, so it also can be handled by simple equipment. L is transmitted when it actually occurs (burst period) and H is sent a little later, during the quiet period. The components are synchronized by timing pulses generated by the bursts. These pulses are absent during silent periods.

First, L and H are separated by audio filters. Then H is converted to 200–1,700 cycles and delayed slightly. This delay, controlled by the timing pulses, means that H occurs after L is completed, and the silent intervals are not wasted. The delay is variable. If the burst happens to be short, so is the timing pulse, and the H signal can start sooner.

At the receiving end, L goes through a delay network (so H can catch up). This delay is also controlled by the timing pulses to assure synchronism between L and H. H is converted *up* to 1,700–3,200 cycles, and combined with L to reproduce the original speech.

Sometimes the silent period is so much shorter than the burst that H cannot be accommodated. Then H is neglected entirely. The speech is not distorted to any great extent when the higher frequencies are omitted occasionally.—*I. Queen*

NEW SEMI-CONDUCTORS AND TUBES

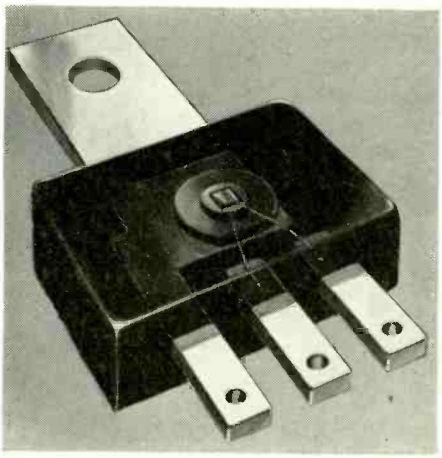
PLASTIC-ENCAPSULATED TRANSISTORS: ONE POWER, ONE FIELD-EFFECT

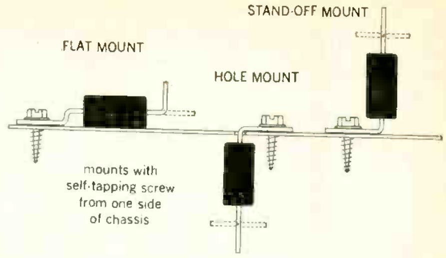
Molding transistors in plastic is all the rage these days, to judge from manufacturers' releases. Good reason, too—it's cheaper and simpler to do that than to stamp, fit and weld a two- (or more) piece metal package. And the transistor ends up being fully insulated, which is a definite virtue in today's crowded circuits.

While G-E, Motorola, Fairchild, Texas Instruments and others have been encapsulating transistors and rectifiers in plastic for some time now, two new products from Texas Instruments rate particular attention this month.

TI announced the first plastic-cased power transistor, an n-p-n silicon planar device, at the recent WESCON show in San Francisco. Dubbed the TIP14, the transistor has a flat plastic package that can be mounted by a single protruding tab with only a sheet-metal screw. The tab is electrically and thermally common to the collector of the transistor, and so provides a heat-sink path to the chassis.

Electrically, the TIP14 features extremely low saturation voltage (typically 0.1 volt at 200 ma), meaning comparatively small internal power loss and





heating, and very linear beta (35 typical at 50 ma, and 30 at 1 ampere).

TI points out that the device is "particularly well suited for audio amplifier applications requiring linearity over broad current fluctuations."

From the same source comes word of the industry's first plastic-encapsulated economy field-effect transistors. One is an n-channel type (2N3819), the other a p-channel type (2N3820). Both are silicon junction devices. They are priced under $1 each in high-volume quantities—presumably upward of 100; but even at double that price for small quantities, these are the lowest-priced field-effect transistors around.

They feature low leakage, superior cross-modulation (an important factor in AM and FM front-end design), high transconductance, low capacitance. END

NOTEWORTHY CIRCUITS

BATTERY SAVER FOR TRANSISTOR SETS

The portable transistor radio—particularly the AM–FM variety—is very popular and is often used in a fixed location within the home. Mine stays in the kitchen. A 9-transistor AM–FM model, it operates from six size-C flashlight cells connected in series and delivering 10 to 50 ma, depending on how loudly the set is played. Its only drawback is the high cost of battery replacement.

I solved this problem with the miniature battery eliminator shown in the diagrams. It is in a 2¼ x 2¼ x 5-inch box which, when plugged into the transistor radio, automatically disconnects the internal battery and powers the set from the power line. Cost of operating the eliminator is about 3¢ per 1,000 hours.

The power supply is in Fig. 1-a. Fig. 1-b shows how it is connected to the radio. Zener diode D1 regulates the power supply output at 0.5 to 1 volt above the maximum voltage supplied by the batteries. This voltage back-biases D2 and insures that no charging current is fed to the batteries.

R and D1 can be selected so the supply can be used with sets requiring less than 9 volts. Select a Zener diode (D1) that regulates at 0.5 to 1 volt *above* the normal battery voltage. Its wattage rating is the product of Zener voltage V_Z and maximum Zener current (I_{Zmax}).

Series resistor R equals

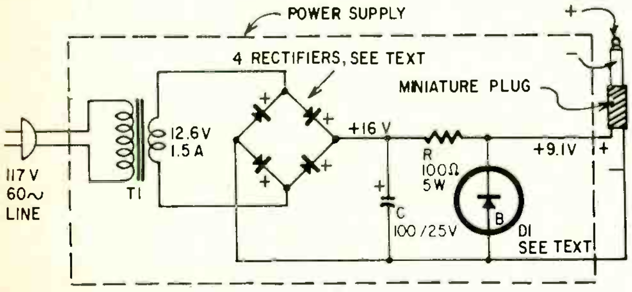
$$\frac{(V_{in} - V_z)\ 1{,}000}{I_L + I_Z}$$

where V_{in} is the voltage across the filter capacitor (C), V_z is the Zener voltage, I_L is the *maximum* load current and I_Z is the *minimum* Zener current. This can be taken as 10% of I_L or 20% I_{Zmax}.

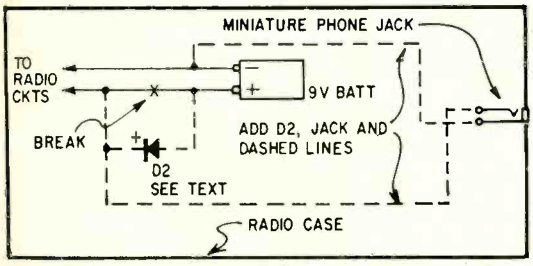
In the power supply shown, D1's maximum dissipation is 0.54 watt. A 1-watt diode will be perfectly safe and a 2-watt or larger unit may be used for cool operation and extremely long life.

The diodes in the bridge rectifier are not critical. Their piv rating should be at least equal to the transformer's secondary voltage (rms) multiplied by 1.41. With a 14-volt transformer, 40-volt diodes provide a safety factor of 2. The minimum current rating is the sum of the Zener and load currents. Almost any "top-hat" or similar silicon diode—usually rated at several hundred volts and 100 ma or more—will work.

D2's requirements are low forward voltage drop and current rating equal or exceeding the 50–60 ma maximum drawn by the receiver at full volume. Forward voltage drop is about 0.5. Reverse voltage is negligible—a few tenths of a volt—just enough to cause it to cut off when the external power supply is plugged in.—*Sidney Wald* END



a



b

Fig. 1—This simple battery eliminator will pay for itself in less than a year, if you use your transistor portable around the house as often as most people do. With suitable changes in voltages, it'll work with any battery radio.

TRY THIS ONE

EASY-TO-MAKE GRID FOR YOUR SCOPE

You can easily make handy grids to extend the usefulness of your scope. Use clear acetate sheets of the type found in stationery stores as sleeves for protecting loose papers. Art-supply and hobby stores often carry heavier plastics, clear and colored.

To make the grid, draw the desired pattern on a sheet of paper. Then center your plastic on the pattern and scribe over lightly with a compass point or similar sharp object. Do not use a sharp knife or razor blade; a scratch rather than a slit is required. Make about three passes over each line, shifting your guide slightly on each pass to give additional width. Patterns will be quite visible on the scope, though excessive back lighting may produce visible shadows. For added contrast, scrub the inscribed pattern vigorously with a pencil, then wipe off the excess lead.

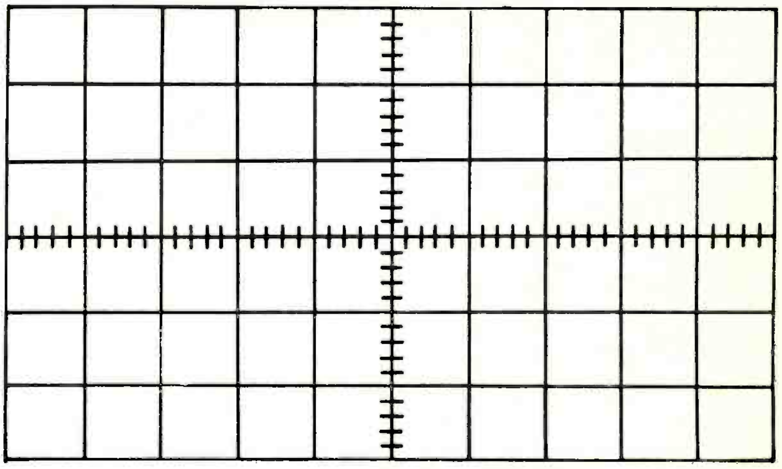


Fig. 1—Layout of a typical graduated grid for your scope. Use tape or escutcheon to hold it in place. Divisions can be 10 to the inch for convenience.

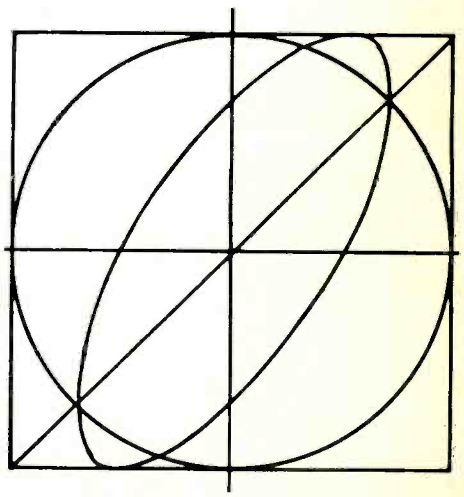


Fig. 2—Handy grid for phase measurements.

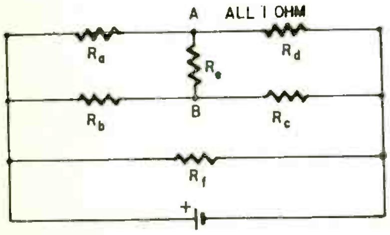
The patterns shown are useful for voltage and frequency measurements (Fig. 1) and phase measurements (Fig. 2). Perhaps you use your scope to measure transistor and diode characteristics. These are easily traced and are excellent for matching pairs or selecting components with specific characteristics.—*Clement S. Pepper*

WHAT'S YOUR EQ?

These are the answers. Puzzles are on page 38.

Corner to Corner

The circuit has been redrawn for clarity. Consider a voltage applied across R_f. Because of the balanced bridge formed by R_a, R_b, R_c and R_d ($R_aR_c = R_bR_d$), the voltage at point A equals that at point B. As no current flows through R_e, it may be removed from the circuit or replaced with a short without affecting the resistance across R_f.

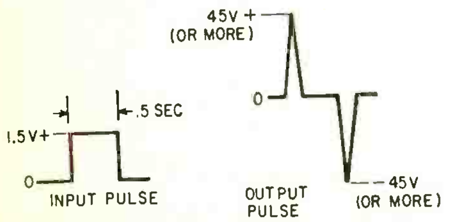


Removing R_e and solving for R_a plus R_d in parallel with R_b plus R_c, we get 1 ohm. This in turn is paralleled with R_f, yielding a result of ½ ohm across R_f. This ½ ohm is the value measured across *any* one of the resistors in the network.

This is but one of several methods of solving the problem.

Flip-Flop Circuit

Assume NE1 is conducting and neglect drop across the 5,600-ohm resistors. The leading edge of the positive input pulse induces a stepped-up peak voltage in the transformer secondary. This voltage raises the potential of point B and passes through NE1, raising the potential of point D. Simultaneously, point C is dropping in potential. When the potential difference between D and C equals 80 volts, NE2 fires, dropping the potential of point D to 65 volts. As the trailing edge of the output pulse falls to zero, NE1 is extinguished and NE2 remains conducting.

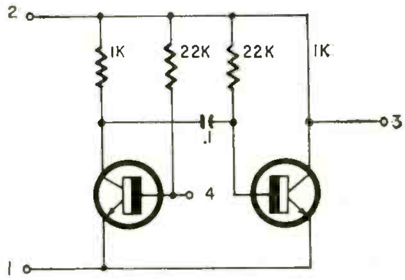


The trailing edge of the input pulse also induces a stepped-up peak voltage in the transformer secondary. This voltage raises the potential of point C and passes through NE2, raising the potential of point D. Simultaneously, point B drops in potential. When the potential difference between points D and B equals 70, NE1 fires and the potential of point D drops to 55 volts. As the trailing edge of the output pulse falls to zero, NE2 is extinguished and NE1 remains conducting.

If NE2 is initially conducting, the second output pulse, which is produced by the trailing edge of the input pulse, makes NE2 flop back into conduction.

Black Box No. 1,001

Any elementary astable multivibrator with one capacitor removed will have both transistors in saturation.



When it is oscillating, only one transistor is conducting at a time. Therefore, input current is reduced by about 50%.

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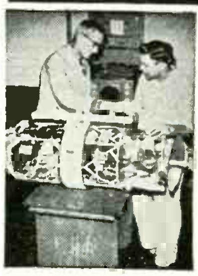

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Circle 125 on reader's service card

NEW BOOKS

THE HANDBOOK OF ELECTRONIC TABLES, by Martin Clifford. *Gernsback Library, 154 W. 14 St., New York, N.Y. 10011. 5½ x 8½ in., 160 pp. Paper, $2.95*

A collection of electronic data selected to assist the student, technician, experimenter and engineer and save him time. Full of information in tabular form not generally found in texts and handbooks: like resistances-in-parallel, transistor alpha-to-beta conversion, LC product for resonance, diode color code, TV channel frequencies, and more. Useful to everyone in electronics, from the beginning student or casual experimenter to advanced technicians and engineers.

BASIC ELECTRONICS, Prepared by Bureau of Naval Personnel. *Dover Publications, Inc., 180 Varick St., New York 14, N.Y. 6½ x 9 in., 459 pp. Paper, $2.75*

A study course that requires only knowledge of basic electricity. Covers a wide range: tubes and transistors, circuits, radio and radar, test equipment, etc.

DIGITAL COMPUTERS IN ACTION, by A. D. Booth. *Pergamon Press, Inc., 44-01 21 St., Long Island City, N.Y. 11101. 5 x 7¾ in., 146 pp. Paper, $1.95*

An introduction to computers, showing how they are used in science, engineering, language translation, even medicine, law and art.

TWO-DIMENSIONAL FIELDS IN ELECTRICAL ENGINEERING, by L. V. Bewley. *Dover Publications, Inc., 180 Varick St., New York 14, N.Y. 5½ x 8½ in., 204 pp. Paper, $1.50*

Based on a senior course given at Lehigh University. The author shows how to treat engineering problems as though they were based on plane fields, and discusses several methods for mapping.

INTRODUCTION TO ELECTRON TUBES AND SEMICONDUCTORS, by Charles Alvarez and David E. Fleckles. *McGraw-Hill Book Co., 330 W. 42 St., New York, N.Y., 10036. 6 x 9 in., 294 pp. Cloth $6.95*

For students at the technical-institute level. Contains many illustrations and numerous examples. Includes special devices like gas tubes and silicon switches.

TRANSMISSION-LINE THEORY, by Ronold W. P. King. *Dover Publications, Inc., 180 Varick St., New York 14, N.Y. 5½ x 8½ in., 513 pp. $2.75.*

A mathematical text on the graduate level. It prepares the engineer for further work on wave guides, cavities and antennas.

TRANSISTOR SPECIFICATIONS MANUAL. *Howard W. Sams & Co., Inc., 4300 W. 62 St., Indianapolis 6, Ind. 5½ x 8½ in., 159 pp. Paper, $2.95*

Lists more than 3,500 transistors. Gives ratings, physical data, frequency response, manufacturer, and terminals. END

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12	.30	.50	.70	.85
18**	.20	.30	.75	1.10
35	.65	.85	1.35	1.85
100	1.80	2.25	2.90	3.50
240	3.75	4.75	7.75	10.45

D. C. Amps	400Piv 280Rms	500Piv 350Rms	600PIV 420RMS	750PIV 525RMS
3	.29	.35	.43	.57
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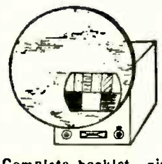
CONVERT TO COLOR TV



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0A3	.90
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0B2	.80
0B3	1.20
0C3	.75
0D3	.75
0G3	2.20
0Y4	1.20
0Z4	.90
1A3	1.49
1A5	2.00
1A6	2.00
1A7	1.05
1AB5	.95
1AX2	.75
1AY2	.98
1B3	.92
1B4P	2.00
1C5	2.00
1C6	1.50
1D5GP	.98
1D7	1.25
1DN5	.75
1E5GP	.98
1E7	.99
1F4	.95
1F5	.95
1F6	1.20
1G3	.92
1G4	1.75
1G6	1.50
1H4	1.25
1H5	2.59
1H6	.98
1J3	.92
1J5	.98
1J6	.98
1K3	.92
1L4	.66
1L6	2.60
1LA4	1.30
1LA6	1.49
1LB4	1.80
1LC5	1.05
1LC6	1.80
1LD5	1.95
1LE3	1.25
1LG5	1.98
1LH4	2.69
1LN5	2.25
1N5	1.85
1P5	2.00
1Q5	1.95
1R4	.80
1R5	.99
1S2A	1.90
1S4	1.49
1S5	.99
1T4	.99
1T5	.80
1U4	.99
1U5	.97
1V	1.85
1V2	.79
1X2B	.95
2A3	3.50
2A5	2.50
2A6	4.50
2A7	1.50
2AF4A	1.31
2AH2	1.10
2AS2	1.10
2AV2	.95
2B3	3.25
2B7	1.95
2BN4	.94
2CY5	1.08
2D21	.75
2DZ4	1.40
2EA5	1.35
2EN5	.81
2ER5	1.21
2FH5	1.30
2FQ5	1.85
2FS5	2.45
2FY5	1.39
2GK5	1.40
2GU5	1.50
2GW5	2.20
2HK5	.98
2X2	.60
2X2A	1.95
3A2	1.20
3A3	1.18
3A4	.74
3A5	1.10
3A8GT	1.25
3AF4	1.40
3AL5	.70
3AT2	1.10
3AU6	.57
3AV6	.66
3AW3	1.18
3B2	2.49
3B7	2.39
3BA6	.86
3BC5	.84
3BE6	.75
3BN4	1.05
3BU8	1.15
3BN6	1.29
3BY6	.99
3BZ6	.79
3CB6	.79
3CE5	.79
3CF6	.90
3CS6	.65
3CY5	1.15
3D6	1.48
3DG4	1.25
3DK6	.82
3DT6	.74
3DZ4	1.40
3EH7	1.30
3EJ7	1.25
3ER5	1.20
3FH5	.95
3FS5	1.08
3GK5	1.40
3GS8	1.15
3GW5	.98
3HA5	1.49
3HK5	1.23
3HM5	1.53
3HS8	1.29
3LF4	2.45
3Q4	1.25
3Q5	2.00
3S4	1.00
3V4	.85
4AU6	.85
4AV6	.70
4BA6	.85
4BC5	.80
4BC8	1.25
4BL8	.87
4BN6	1.30
4BQ7	1.30
4BS8	1.39
4BU8	1.19
4BZ6	.77
4BZ7	1.40
4CB6	.79
4CE5/4CB5	.89
4CS6	.75
4CY5	.98
4DE6	.95
4DK6	.85
4DT6	.77
4EH7	1.29
4EJ7	1.29
4EM6	1.19
4ES8	1.55
4EW6	.91
4GK5	1.42
4GM6	1.25
4GS8	1.15
4GZ5	.86
4GZ6	1.19
4HA5	1.85
4HA7	1.19
4HC7	1.39
4HM6	.91
4HS8	1.18
4HT6	.82
4JC6	1.20
4JD6	1.20
5AM8	1.30
5AN8	1.35
5AQ5	.76
5AR4	1.49
5AS8	1.50
5AT8	1.27
5AU4	1.17
5AV8	1.37
5AW4	1.00
5AZ4	1.85
5B8	1.99
5BC3	.89
5BE8	1.10
5BK7	1.19
5BQ7	1.35
5BR8	1.29
5BT8	1.12
5BW8	1.13
5CG8	1.12
5CL8	1.25
5CM8	1.25
5CQ8	1.35
5CZ5	1.49
5DE8	1.15
5DH8	1.95
5DJ4	1.12
5EA8	1.21
5ES8	2.21
5EU8	1.23
5EW6	.98
5FG7	.92
5FV8	1.05
5GH8	
5GJ7	1.62
5GM6	.90
5GX6	.90
5HC7	1.49
5HG8	1.69
5J6	.96
5KD8	1.35
5KE8	1.70
5T4	3.75
5T8	1.25
5U4	.70
5U8	1.14
5V3	1.30
5V4	1.29
5V6	.75
5W4	1.75
5X4	1.05
5X8	1.20
5Y3	.59
5Y4	1.45
5Z3	1.30
5Z4	2.75
6A3	2.75
6A4	2.20
6A6	1.75
6A7	2.90
6A8GT	2.50
6A8M	2.39
6AB4	.76
6AB7	2.10
6AC5	2.12
6AC7	1.75
6AD7	3.25
6AE5	2.50
6AF3	.99
6AF4	1.35
6AF6G	2.10
6AF11	1.70
6AG5	.89
6AG7	1.95
6AG11	1.34
6AH4	1.19
6AH6	1.49
6AJ5	2.25
6AJ8	1.95
6AK5	1.49
6AK6	.94
6AL3	.99
6AL5	.53
6AL7	1.95
6AL11	1.50
6AM4	1.19
6AM8	1.25
6AN4	2.27
6AN5	1.95
6AN6	2.45
6AN8	1.35
6AQ5	.69
6AQ6	.89
6AQ7	1.37
6AQ8	1.08
6AR5	.91
6AR6	1.50
6AR8	2.00
6AR11	1.48
6AS5	.92
6AS6	1.00
6AS7	2.85
6AS8	1.43
6AS11	1.90
6AT6	.58
6AT8	1.39
6AU4	1.19
6AU5	1.55
6AU6	.62
6AU7	.54
6AU8	1.38
6AV5	1.45
6AV6	.47
6AV11	1.52
6AW8	1.25
6AX3	.94
6AX4	.89
6AX5	1.05
6AX7	1.25
6AX8	1.28
6AY3	.93
6AY11	1.34
6AZ8	1.98
6B4	5.95
6B5	4.00
6B6	1.00
6B7	2.75
6B8	2.46
6B10	1.19
6BA3	1.05
6BA6	.60
6BA7	1.85
6BA8	1.27
6BA11	1.25
6BC4	1.98
6BC5	.72
6BC7	1.27
6BC8	1.35
6BD4	7.00
6BD5	1.20
6BD6	.83
6BD11	1.72
6BE3	.99
6BE6	.74
6BF5	1.19
6BF6	.64
6BF8	1.65
6BF11	1.64
6BG6	2.19
6BH3	1.15
6BH6	.89
6BH8	1.24
6BH11	1.60
6BJ3	.91
6BJ6	.83
6BJ7	1.05
6BJ8	1.19
6BK4	2.69
6BK5	1.25
6BK7	1.14
6BL7	1.26
6BL8	1.34
6BM8	1.03
6BN4	1.05
6BN6	1.03
6BN8	1.03
6BQ5	.79
6BQ6/6CU6	1.45
6BQ7	1.33
6BR8	1.29
6BS8	1.28
6BU8	.94
6BV8	1.05
6BW4	.98
6BW8	1.18
6BX7	1.75
6BY5	1.65
6BY6	.89
6BY8	.89
6BZ6	.70
6BZ7	1.35
6BZ8	1.49
6C4	.54
6C5M	1.63
6C6	2.00
6C8G	2.95
6C9	2.00
6C10	1.93
6CA4	.70
6CA5	1.05
6CA7	1.95
6CB5	3.25
6CB6	.54
6CD6	1.93
6CE5/6CB5	.79
6CF6	.84
6CG7	.75
6CG8	.95
6CH8	1.95
6CK4	1.00
6CL5	3.75
6CL6	1.15
6CL8	1.10
6CM6	1.10
6CM7	.94
6CM8	1.43
6CN7	1.25
6CQ4	1.07
6CQ7	1.80
6CQ8	1.15
6CR6	.81
6CS6	.85
6CS7	.98
6CU5	.84
6CU6	1.45
6CU8	1.49
6CW4	1.59
6CW5	1.20
6CX8	1.42
6CY5	1.03
6CY7	1.05
6CZ5	1.48
6CZ7	1.95
6D4	1.75
6D6	2.50
6D10	1.59
6DA4	.98
6DA5	1.08
6DB5	1.99
6DB6	1.01
6DC6	1.28
6DC8	1.07
6DC6	1.28
6DE4	.98
6DE6	.85
6DE7	1.14
6DG6	.92
6DJ8	1.65
6DK6	.79
6DM4	.96
6DN6	2.54
6DN7	1.21
6DQ4	.91
6DQ5	2.75
6DQ6	1.39
6DR7	1.32
6DS4	1.59
6DS5	1.19
6DT5	1.05
6DT6	.72
6DT8	1.29
6DV4	2.24
6DW4	1.27
6DW5	1.36
6DX8	1.05
6DZ4	1.34
6DZ7	2.89
6E5	1.74
6EA5	1.29
6EA7	1.52
6EA8	1.06
6EB5	1.75
6EB8	1.42
6EH5	1.03
6EH7	1.25
6EH8	1.06
6EJ7	1.28
6EM5	1.15
6EM7	1.73
6EQ5	1.10
6EQ7	1.00
6ER5	1.29
6ES5	1.03
6ES8	1.97
6ET7	1.60
6EU7	.93
6EU8	1.12
6EV5	1.02
6EV7	.99
6EW6	.85
6EW7	1.84
6EX6	2.74
6EY6	1.15
6EZ5	1.21
6EZ8	1.29
6F4	4.75
6F5GT	1.72
6F6G	1.95
6F7	3.95
6F8	3.08
6FA7	.99
6F8	3.08
6FD6	1.45
6FD7	1.70
6FE5	1.25
6FG5	1.99
6FG6	1.12
6FG7	1.10
6FG8	1.75
6FH5	.95
6FH8	1.24
6FJ5	2.25
6FJ7	1.24
6FM7	1.18
6FM8	1.01
6FQ5A	1.35
6FQ7	.79
6FS5	1.35
6FV6	1.33
6FV8	1.06
6FW5	1.39
6FW8	3.49
6FY5	1.11
6FY7	1.14
6G5	2.50
6G6G	2.25
6G11	1.48
6GB5	1.35
6GC5	1.34
6GE5	1.39
6GE7	1.19
6GF5	1.27
6GF7	1.69
6GH8	1.06
6GJ5	1.75
6GJ7	1.22
6GK5	1.39
6GK6	.98
6GL7	1.73
6GM5	1.09
6GM6	.94
6GM8	1.81
6GN8	1.33
6GQ7	1.89
6GR7	1.42
6GT5	1.54
6GU5	1.47
6GU7	1.15
6GV5	1.65
6GV6	1.85
6GV8	1.12
6GW6	1.39
6GW8	1.08
6GX6	.86
6GX7	1.70
6GX8	1.31
6GY5	1.49
6GY6	.88
6GY8	1.29
6GZ5	.98
6HA5	1.39
6HA6	1.88
6HB5	1.52
6HB6	1.59
6HB7	1.08
6HD5	2.19
6HE5	1.34
6HF5	2.69
6HF8	1.42
6HG5	.73
6HG8	1.48
6HJ5	2.10
6HJ8	1.12
6HK5	1.19
6HL8	1.11
6HM5	1.37
6HQ5	1.72
6HR6	.98
6HS6	.98
6HS8	1.08
6HT6	1.19
6HZ6	.98
6HZ8	1.85
6H6	.94
6J4	2.95
6J5G	1.10
6J5M	1.25
6J6A	.67
6J7	1.69
6J7GT	1.49
6J7G	1.50
6J8	2.50
6J10	2.02
6J11	1.82
6JB6	2.25
6JC6	1.36
6JC8	1.04
6JD6	1.19
6JE6	3.05
6JE8	1.35
6JG6	2.08
6JH6	.89
6JH8	1.48
6JK8	1.35
6JM6	1.67
6JN6	1.59
6JN8	1.30
6JS6	2.95
6JT6	1.72
6JT8	1.45
6JU8	1.09
6JV8	1.33
6JZ8	1.28
6K6GT	.90
6K7	1.69
6K7G/GT	1.49
6K8M	2.59
6K11	1.29
6KA8	1.38
6KD8	1.01
6KE8	1.72
6KL8	.93
6KM8	1.16
6KT8	1.25
6KU8	1.63
6KV8	2.12
6KY8	2.65
6KZ8	.94
6L5G	1.50
6L6G	.98
6L6GA	1.48
6L6GB	1.50
6L6GC	1.61
6L6M	3.00
6L7M	2.48
6L7G	1.75
6LB8	1.49
6LC8	1.40
6LF8	1.28
6LM8	1.52
6M11	1.81
6N7M	1.75
6P5	2.50
6Q7	1.95
6Q11	1.29
6R7	2.10
6S4	.76
6S7	1.95
6S8GT	1.50
6SA7GT	1.39
6SA7M	1.49
6SB7Y	2.19
6SC7	1.52
6SD7	1.49
6SF5	1.08
6SF7	2.19
6SG7	1.55
6SH7	1.05
6SJ7GT	1.49
6SJ7M	1.72
6SK7GT	1.30
6SK7M	1.38
6SL7GT	1.19
6SN7GT	.89
6SQ7GT	1.25
6SR7	1.42
6SS7M	1.88
6ST7	1.75
6SU7	2.00
6SV7	1.25
6SZ7	1.25
6T4	1.75
6T8	1.15
6T10	1.54
6U5/6G5	2.35
6U8	1.12
6U10	1.32
6V3	1.67
6V4	.59
6V6GT	.74
6W4	.83
6W6GT	.98
6X4	.56
6X5GT	.72
6X8A	1.05
6Y6GA	1.45
6Z4/84	1.22
7A4	2.25
7A5	1.95
7A6	2.25
7A7	2.35
7A8	2.75
7AD7	1.25
7AF7	2.10
7AG7	2.85
7AH7	1.95
7AU7	.83
7B4	2.35
7B5	2.75
7B6	1.25
7B7	2.50
7B8	2.00
7C4	1.15
7C5	1.19
7C6	2.69
7C7	1.23
7E5	2.00
7E6	1.25
7E7	1.95
7EY6	1.06
7F7	2.59
7F8	3.00
7G7	1.99
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17AX4	.92
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17C9	2.40
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23Z9	2.69
24A	1.35
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25W6	.95
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25Z6	.94
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33	1.15
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35B5	1.07
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35Z5	.58
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43	2.85
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45Z3	.55
46	.95
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48	4.00
49	3.50
50	1.75
50A1	2.60
50A5	2.10
50B5	.86
50C5	.65
50DC4	.63
50EH5	.72
50FE5	1.44
50FK5	.79
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50HC6	.86
50HC8	.89
50HK6	.77
50L6	.81
50X6	1.96
50Y6	1.49
50Y7	1.42
53	3.50
55	2.75
56	1.25
57	1.50
58	1.50
59	3.00
60FX5	.87
70L7	.89
71A	1.25
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76	1.50
77	1.50
78	1.65
80	1.25
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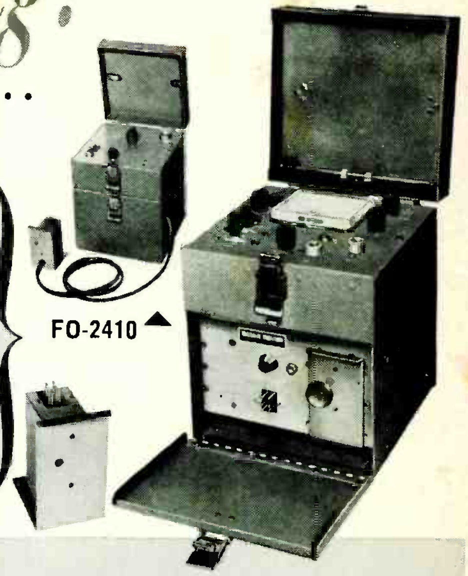

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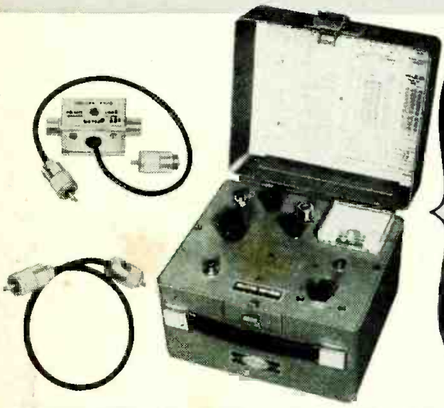

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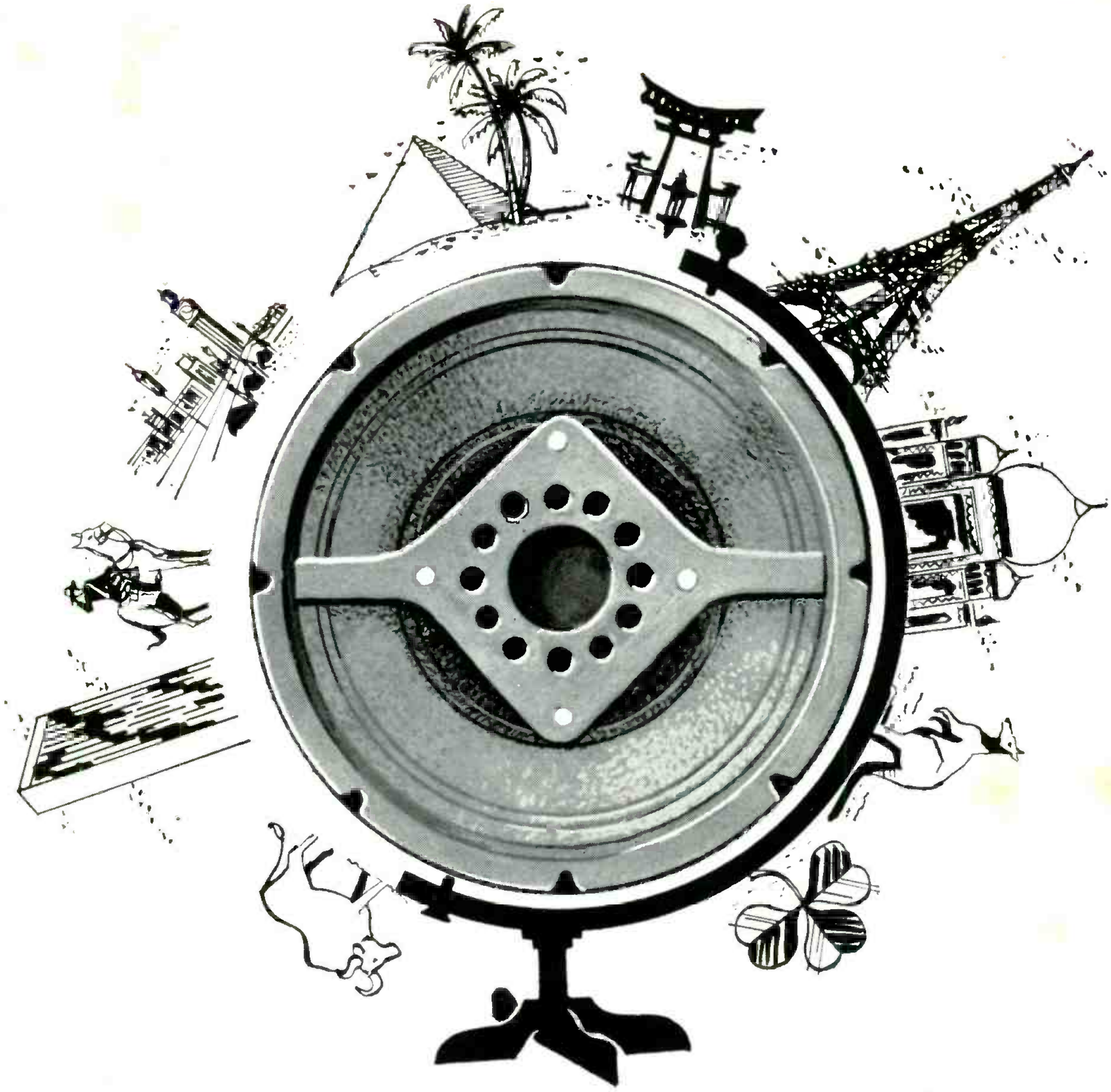
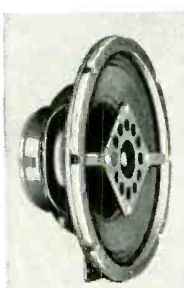


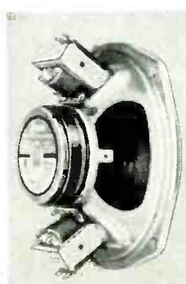
JENSEN Loudspeakers Around the World

Jensen 8-inch Professional Series loudspeakers are especially designed to meet the exacting rigorous demands of commercial sound service throughout the world. The Professional Series is *complete* with over 40 different models ready to meet any situation, any demand. These speakers are value engineered for lowest installed cost with such outstanding features as the handy 10-pack, preattached transformers, exclusive KWIKON™ solderless connectors and weather and corrosion resistant designs.

Jensen 8-inch Professional Series loudspeakers have been installed in such prominent structures as Washington's Dulles International Airport, New York's Lincoln Center, Chicago's O'Hare International Airport, The Tel-Aviv Hilton in Israel, the Hotel Flamboyan in San Juan, Puerto Rico and many others.



Model K-950 8-inch coaxial loudspeakers feature 110° coverage angle with exceptional frequency range and smoothness. This wide angle provides approximately twice the normal coverage area, so fewer loudspeakers are required for a given installation.



Dual Channel Access loudspeakers (DCA Series) have two separate voice coil windings that provide "independent access". Makes emergency overcall warning, alarm signals or voice communications possible under any conditions.

Basic models are all available with pre-attached 25-volt or 70.7-volt "constant voltage," transformers. Exclusive KWIKON™ instant connectors provide simple, fast, solderless and economical installation. You save up to 50 cents per unit on installation.

JENSEN

LOUDSPEAKERS

JENSEN MANUFACTURING DIVISION / THE MUTER COMPANY / 6601 SOUTH LARAMIE AVENUE, CHICAGO, ILLINOIS 60638

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