June 1965

We built a Home Video Tape Recorder

N/p 74 MASTER

HUGO GERNSBACK, Editor-in-chief ■ JUNE 50c

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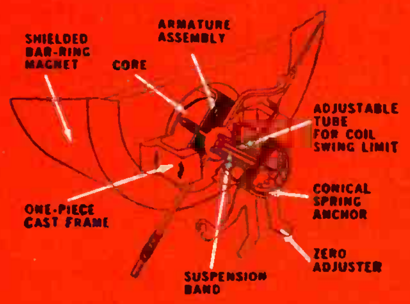

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D.C. MICRO-AMPERES	0-5 at 300 MV. 0-60-600 at 150 MV. 0-120 at 300 MV.
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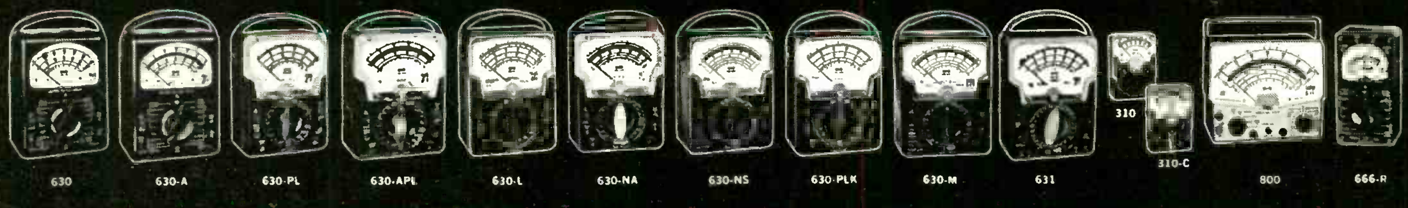

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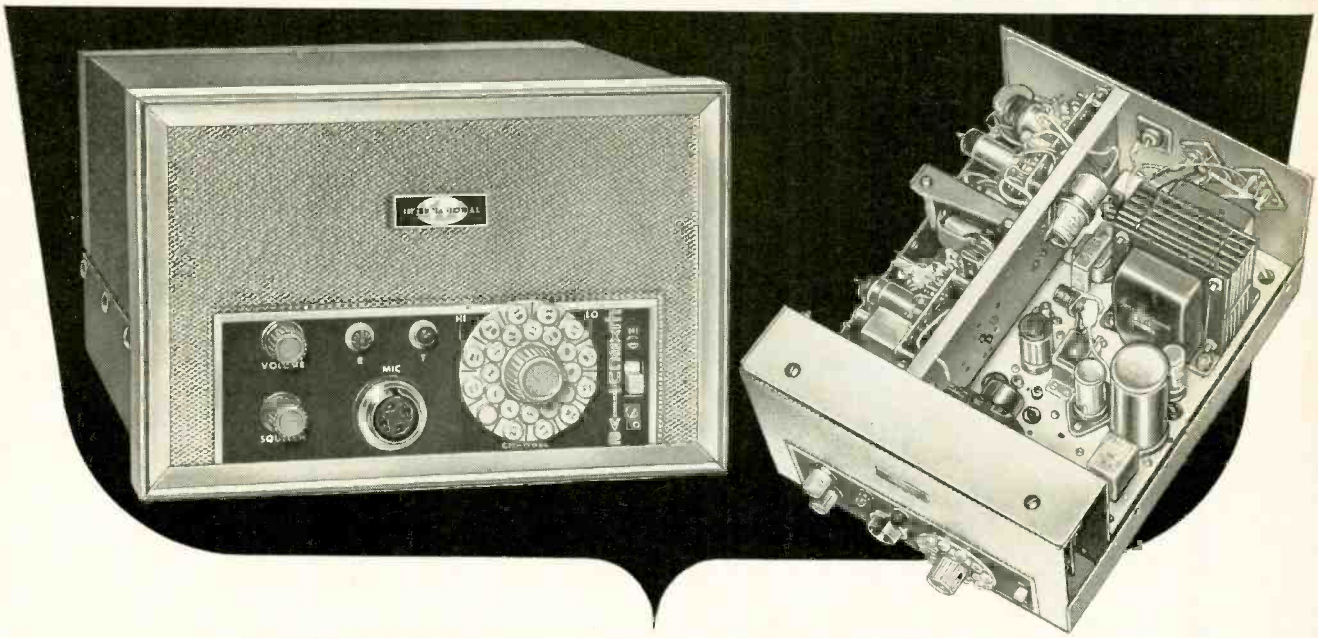

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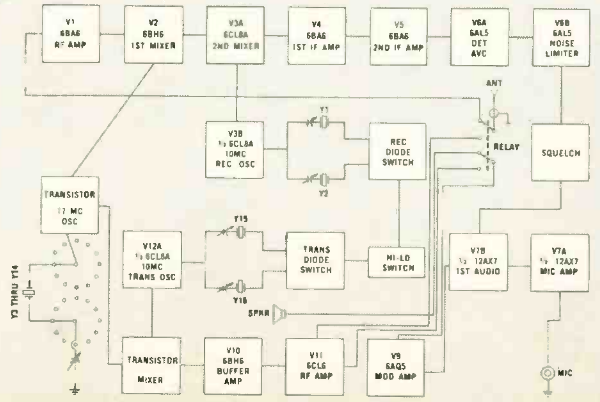

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Radio-Electronics

JUNE 1965 VOL. XXXVI No. 6

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NEWS BRIEFS

IEEE GOES TO FIVE DAYS

The annual convention and show of the Institute of Electrical and Electronics Engineers ran from March 22 through March 26 this year, one day longer than previous conventions. This was necessary to accommodate the 80 technical sessions with a total of more than 350 papers, the largest amount of material ever to be handled at one of these conventions.

The range of subjects was almost as wide as the number of sessions, papers being read on subjects from the development of artificial organs for the human body to industrial power rectifiers.

More than 1,000 exhibitors displayed $20 million worth of the latest electrical and electronic equipment. They filled the New York Coliseum completely, with a spill-over of 62 exhibits in the New York Hilton Hotel, in which most of the technical sessions were held.

The number of engineers attending dropped to 59,000, as compared with 64,000 last year. The main factor in the decreased attendance was considered to be the growing specialization of the profession, which has led to the development of new meetings and conventions dealing with small portions of the field. Another reason suggested was the increase in admission prices ($2 for a member and $5 for a nonmember, as compared with $1 and $3 last year).

DOCTOR URGES CAUTION IN LASER RESEARCH

"Potential hazards" may lurk in laser beams, Dr. Edmund Klein of Buffalo told the American Chemical Society. Laser beams, he said, can cause damage to the eyes, brain and other organs in a way that may not be immediately apparent.

Research on animals indicated that laser irradiation that caused only superficial external effects created much greater internal damage. Thus, researchers should "err on the side of safety in precautionary measures" in work with lasers.

Potentially, Dr. Klein said, the laser is a very valuable surgical tool, and that "very encouraging results have been obtained with lasers in the management of detachment of the retina, a very delicate eye operation." In cancer surgery, however, he said, a great deal of additional animal and basic study must be done before the laser's value can be assessed.

COLOR CONVERTER WITHDRAWN

The electromechanical color converter developed by Scope, Inc. (RADIO-ELECTRONICS, January 1965, p. 33), has been taken off the market, "at least temporarily," by Conar Division of the National Radio Institute, after a national mail-order test. Production and shipping problems were given as the reasons for abandoning the device. Conar is developing a nonmechanical three-color converter which it hopes to have ready within the year.

SINGLE-FREQUENCY LASER PRODUCES HIGH POWER

The use of FM techniques has produced a laser that puts out all its power on a single frequency. The ordinary laser oscillates at a number of equally spaced frequencies. To concentrate the output power of the laser, Stephen E. Harris and Russell Targ of the Optics Department of Sylvania Electronic Systems, Mountain View, Calif., developed the FM approach. The laser is phase-modulated at a frequency nearly equal to the difference between the frequencies put out by the free-running laser.

The output of the FM laser is then passed through a second phase modulator, 180° out of phase with the first one. After passing through the modulator, the output is a single optical frequency, bearing no trace of the original FM. This new super-mode laser, conceived by Gail Massey of Sylvania Electronic Systems, makes it possible for the first time to compress all the energy in the previously existing frequencies into a single, monochromatic signal, with nearly the full power of the laser concentrated in it.

SCHIZOID CHILDREN HELPED BY "TALKING TYPEWRITER"

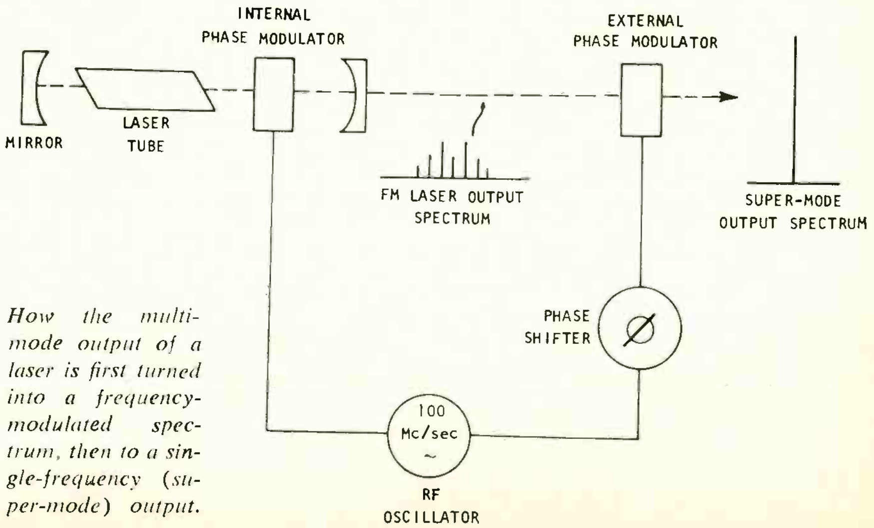
A computerized "talking typewriter," which can be programmed vocally or visually, has been credited with amazing success in experiments with schizophrenic children in a hospital in Cooperstown, N.Y. The children can make the machine "talk" through a loudspeaker by punching keys. The machine was conceived by Dr. Omar Khayyam Moore, a behavioral scientist at Rutgers University. The hospital staff tentatively attribute the progress to the fact that the machine has removed the human factor in communications.

RUSSIANS STUDY CYBERNETICS

"Inexhaustible opportunities" in the development of radio-electronics, cybernetic machines and computers were seen by Dr. Vladimir Siforov, president of Russia's Popov Society,

continued on page 6

Super-Mode Laser Showing FM Laser Plus External Phase Modulator



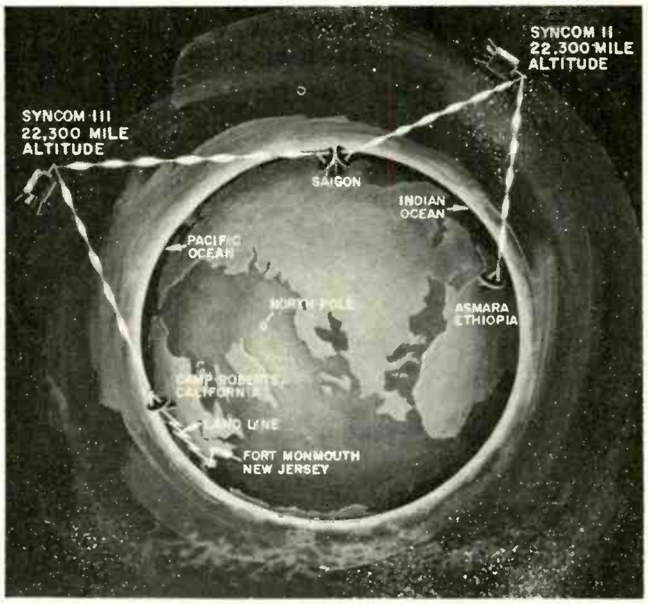
How the multi-mode output of a laser is first turned into a frequency-modulated spectrum, then to a single-frequency (super-mode) output.

NEWS BRIEFS continued

in a specially arranged address to members of the Institute of Electrical and Electronics Engineers at their recent convention. The Popov Society is an organization that resembles the IEEE.

Speaking on computers, Dr. Siforov suggested that cybernetic machines and control equipment were among the major strides in Soviet scientific research during the last 20 years, the others being transistors and quantum electronics (maser-laser devices).

Dr. Siforov pointed out the important development of self-programming machines, and looked to development in this type of equipment as being particularly important in the future, mentioning cybernetic machines that might be able to teach, and calling attention to the work being done in pattern-recognizing instruments. He quoted, though he did not suggest he agreed with, a Russian author who looked forward to "cybernetic machines with more cells than human brains," which might presumably, therefore, be more intelligent than the human being. Dr. Siforov did suggest, however, as his own opinion that research might make entirely new breakthroughs in the realm of fundamental science, and that "new Maxwells will find new forms of matter-motion . . . fantastic to us now."



LONG-DISTANCE PHONE CALL

Using two Syncom communications satellites (built by Hughes Aircraft), Brig. Gen. J. Wilson Johnson, Commander of the Army Satellite Communications Agency "telcommed" from Fort Monmouth, N. J., with a staff office stationed in Asmara, Ethiopia. The voice link spanned three continents and two oceans, traveling westward around the world in the longest telephone call ever made via satellites—17,000 miles.

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THIN-FILM TECHNIQUES MAY BRING SOLID-STATE TV SCREEN

According to Dr. Fred Chernow of MIT, thin-film techniques may make picture-on-the-wall TV practical. In 3 years, he said, thin-film electroluminescent units have been improved from a type with a 4-hour life to one with a half-life of 1,000 hours, with brightness increased from 10 to 100 times. Devices capable of TV resolution have been developed.

Dr. Chernow is carrying on research for Electro-Tec Corp. of Ormond Beach, Fla., whose president, George J. Pandapas, recently stated, "An acceptable TV screen can be developed, using this technique, within 3 to 5 years."

NEW HEARTS FOR HUMANS FORECAST BY SCIENTISTS

The artificial human heart is "definitely out of the realm of science fiction." This statement was made by

continued on page 8

NEWS BRIEFS continued

Dr. E. F. Murphy, chief of the Research and Development Division, Prosthetic and Sensory Aids Service of the Veterans Administration.

In opening a day-long symposium on artificial organs and prosthetic and sensory aids at the IEEE convention, he also discussed the problems facing researchers in the field of artificial limbs and kidneys as well as aids for the blind and deaf.

No less than three papers at the session discussed the possibility of artificial hearts, and one speaker, Dr. Yukihiko Nose of the Cleveland Clinic Foundations, described experiments with artificial hearts for animals. In one case, the subject, a calf, was kept alive with an artificial heart for 30 hours.

TV SERVICE COMPLAINTS DROP

The Better Business Bureau of Philadelphia reports a drop of coplaints from 597 in 1963 to 500 in 1964. The drop, according to the BBB, was not due to any major reform movement by unethical members of the TV service industry, but to less publicity on the activities of the organizations fighting unethical operations, and therefore to less public attention.

Philadelphia BBB appliance-sales-and-service complaint man William Henderson reported that one of the largest categories of complaints was unsatisfactory service and installation. Next, guarantee or contract not fulfilled, promised adjustment not made (very often failure of the technician to return as promised). A third and large category—unjustified complaints—amounted to 30% of the total.

CALENDAR OF EVENTS

International Federation for Information Processing (IFIP) Congress '65, May 24–29; New York Hilton Hotel, New York, N. Y.

Third Annual San Joaquin Valley CB Jamboree, June 5–6; Wildwood Beach Country Club, San Joaquin River at Highway 41.

First Annual IEEE Communication Convention (including Globecom VII), June 7–9; University of Colorado and National Bureau of Standards Laboratories, Boulder, Colo.

Chicago Spring Conference on Broadcast and TV Receivers, June 14–15; O'Hare Inn, Des Plaines, Ill.

73rd Annual Meeting, American Society for Engineering Education, June 21–24; Illinois Institute of Technology, Chicago, Ill.

San Diego Symposium for Biomedical Engineering, July 6–8; US Naval Hospital, San Diego, Calif.

FIRM SEEKS INJUNCTION AGAINST NEW CB RULES

Lafayette Radio Electronics Corp. has announced that it intends to seek an injunction to force the FCC to drop the new Citizens-band rules (RADIO ELECTRONICS, May 1965, page 4). Whether the company would be joined by others was not known at the time of writing. Lafayette's stand is based on the property rights of the many who bought CB equipment in good faith and were permitted to remain in peaceful possession and use of it for a considerable time before any crackdown, as well as on the public-interest features of the use of CB radio as a hobby.

Lafayette requests all Citizens-band clubs (and individual CBers where there are no clubs) to contact the company and supply information that could help in conducting the case. It would be particularly helpful to know:

The number of members in each club, and, if readily available, their names, addresses and (most important) the dollar value of their equipment. Also desired are letters from club members and individual CBers stating the

continued on page 10

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NEWS BRIEFS continued

amount of money they have invested in CB equipment. If this money is invested for hobby purposes, the CBer should state whether he has any substantial recreational pursuits other than CB communication with other CB licensees, and whether their communications naturally center around their equipment and its use, making it difficult to avoid reference to such equipment.

If the CBer is retired, that should be mentioned in the letter. And if he is disabled or has a health problem that may require contact with a hospital, a doctor or some other individual on whom he relies for help in an emergency, this should be mentioned specifically.

Address all letters to Robert Laub, Lafayette Radio Electronics Corp., 111 Jericho Turnpike, Syosset, N. Y. 11791.

TWO COLOR SYSTEMS FOR EUROPEAN TV?

The Vienna color conference, called to try to decide on a single color system for all Europe, broke up without agreement, but with most of the participants agreeing on one or the other of two systems. (The various systems were described and the background of the conference covered in RADIO-ELECTRONICS, January 1965, page 40, and March 1965, page 58.)

The system backed by a small majority of the delegates was the French-sponsored SECAM. Already approved by the Soviet Union before the conference started, it got the votes of most of the other East European countries, and Luxembourg, Spain, Greece and Morocco. A number of African countries formerly under French influence also voted for it. Since these have no immediate prospect of even black-and-white TV, it may well be that when TV comes to them, it will come in color, without going through a black-and-white phase.

The proponents of NTSC and PAL joined to support a new concept, QUAM, or *quadrature amplitude modulation*. The term describes both NTSC and PAL, and those who favor it believe that the two systems can be operated compatibly with each other by making slight modifications in equipment. Thus a country might use PAL for domestic TV, switching to NTSC to join an international network.

QUAM is supported by Britain, West Germany, the Netherlands, the Scandinavian countries, Italy, Ireland, Switzerland, Austria and Iceland.

Among the nations present from outside the European TV sphere, Brazil plumped for QUAM (NTSC version). There were also abstainers, including Belgium (sandwiched between

French SECAM and Netherlands QUAM) and Yugoslavia. Pakistan made a declaration of double independence by "refusing to abstain."

Color is expected first in Britain. The Soviet Union has set October 1967—the 50th anniversary of the Russian Revolution—as the starting date. In his article in the January issue of this magazine, Eugène Aisberg expected that France and Germany might also have color television by that year.

C. J. LeBEL DIES AT 59

Sound recording engineer C. J. LeBel died April 14, of a heart ailment. At the time of his death he was president of the Audio Instrument Co. and vice president of Audio Devices, Inc.

Mr. LeBel had been a leader in the audio field since the mid-30's, when he helped found Audio Devices. He was director of research on hearing aids for Maico from 1942 to 1945. In 1948 he became the first president of the newly founded Audio Engineering Society, and was its secretary from 1951. He was a member of the Acoustical Society of America, the SMPTE and the IEEE.

SIR EDWARD APPLETON DIES

The man who, perhaps more than any other, deserves the much-shared title of "inventor of radar," died in Edinburgh April 21, at the age of 72.

Sir Edward Victor Appleton was the discoverer of the ionospheric layers that reflect radio waves, and only his own modesty prevented the present "F" layer from being called the Appleton layer, as the lower layer is named after Heaviside, who first suggested the existence of the layers discovered by Appleton.

Sir Edward did much more work in the science of ionospheric research, which he may be said to have founded, and was awarded the Nobel Prize for his work in that field, as well as other high honors from Britain and the U.S.

During World War II, Sir Edward directed the British Department of Scientific and Industrial Research. In 1949, he became principal and vice chancellor of Edinburgh University.

END

Correspondence

COLOR TV CORRECTION

Dear Editor:

In my article "Color Television Throughout the World" (January 1965), I wrote that the SECAM color receiver would cost "only a few percent more than black-and-white." What I had intended to say was that a SECAM color receiver is a little more expensive than the NTSC type, rather than a black-and-white receiver.

I regret the inexactitude, and trust that you will draw it to the attention of your readers.

E. AISBERG

Paris, France

THE FET: SOME FURTHER NOTES

Dear Editor:

Since I wrote my article, "Tube Impedances with Transistors" (May, page 49), there have been several notable improvements in FET state-of-the-art.

1. FET's now have input impedances of the order of 10^{13} ohms. [Raytheon has just announced FET's with input impedances of 10^{15} ohms—100 times higher.—*Editor*]

2. Gain-bandwidth products of 400 mc have been attained.

3. Unit prices are now below $5 for experimental FET's.

DAVID L. PIPPEN

Las Cruces, N. M.

OPPOSES NATESA EXEC'S VIEW

Dear Editor:

This is in regard to a portion of the letter from Frank J. Moch, executive director of the National Alliance of Television & Electronic Service Associations, to President Johnson, protesting the intended inclusion by some TV manufacturers of 5-year warranties on their products. [*Technicians' News*, March, 1965].

I wonder if the last washer and automobile Mr. Moch purchased were chosen for their minimum warrantal coverage, so he would be able to patronize the local appliance repairman and auto mechanic to the fullest extent?

As an electrical engineer who has seen some friends subjected to terrific

CORRESPONDENCE continued

gouge jobs by members of the profession that Mr. Moch represents, I can hardly blame the consumer for seeking some protection.

It seems to me that Mr. Moch is another of an increasing number of persons who would oppose the achievement of higher quality levels because of possible financial repercussions to themselves.

KENNETH CONLEY
Albuquerque, N. M.

FURTHER COMMENT ON "ANONYMOUS" LOUDSPEAKERS

Dear Editor:

I found the article on anonymous speakers (February R-E) rather interesting. However, the point missed by all concerned is that hi-fi manufacturers who spend large sums in pursuing the ultimate in audio reproduction do not seem to care that their high-quality equipment is sold with some inferior merchandise, so long as they reap the profits.

The speaker is the weakest link in the whole chain and, unless manufacturers of hi-fi equipment are willing to specify the speakers to be sold with their amplifiers in a package deal, the nontechnical customer might just as well invest his money in some other "prestige product."

What the hi-fi industry needs is a conscientious willingness to satisfy the nontechnical customer. The technical customer is usually in a position to disregard the color brochures and evaluate the equipment before purchase.

T. S. SUNDERAM
New York, N. Y.

Agreed. But who will supply the conscientiousness? We won't lapse into cynicism, spouting *"Caveat emptor!"* all around, but it has always turned out to be the *consumer's* responsibility, not the maker's, to see that the merchandise he buys is what he wants. (There are a few brilliant examples of manufacturers

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safely, reliably, and inexpensively. Build this low-cost fence charger using an SCR pulse-generator. Pulses at high voltage, low current, once per second. Keeps cattle in, people out. And it's absolutely safe! Full build-it-yourself instructions.

COMING IN . . .
July RADIO-ELECTRONICS

CORRESPONDENCE continued

genuinely and publicly concerned about what their products are used with, but they are rare.)

Sales through the larger discount houses are a major part of several hi-fi manufacturers' total business, and they will think many times before taking a stand that will cut off those outlets for their products.

The purpose of the article was to dramatize the need for critical investigation *by the purchaser* before he commits himself to a several-hundred-dollar outlay with which he may be bitterly disappointed.—*Peter E. Sutheim*

MORE "IMPORTS" DATA

Dear Editor:

Many thanks for the "Japanese Transistor Radio and Tape Recorder Guide" in the April issue.

Brothers International Corp. has not imported or distributed the Sheraton and Sovereign radios since 1963. If these are still imported under the same name by another firm, we do not know.

A few Summit (Summit International) and Starlite (Starlite Electronics Corp.) recorders are identical right down to color. Parts for them may be ordered from either place. The only difference may be in part numbers, since each firm uses its own system for identifying parts.

It is true, as you stated, that some importers do not answer requests for information. And it is not uncommon to receive your letter back, marked "MOVED, LEFT NO FORWARDING ADDRESS."

GEORGE MISHLANIE
Utica, N. Y.

END

CORRECTION

If you hook up the FET amplifier as in Fig. 6 of "Tube Impedances with Transistors", May, page 51, you will get an ellipse or a straight line, depending on the phase of the signals. You won't get the superimposed traces unless you use a dual-trace scope. The author specified a dual-trace scope with the input signals applied to the two vertical input channels. Our artist used a standard scope drawing and the error was not noticed until called to our attention by Mr. Albert C. W. Saunders, electronics instructor of Belmont, Mass.

Incidentally, it appears that manufacturers have not standardized the base-wiring codes for FET's. For example, Texas Instruments and Atlantic Instruments & Electronics use the base-wiring code shown in Fig. 7. At least one manufacturer (Crystalonics, Inc.) connects the drain, source and gate to leads 1, 2, and 3, respectively, when reading clockwise from the index tab. Check the manufacturer's data sheet before hooking up an FET.

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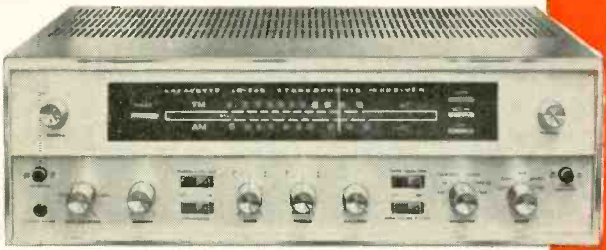

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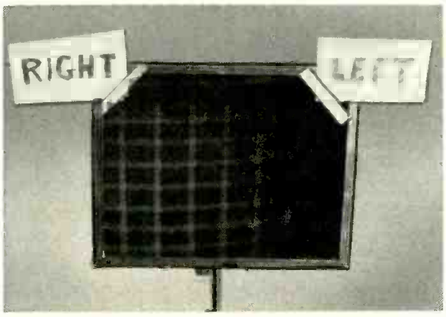
SERVICE CLINIC

By JACK DARR Service Editor

Time Shavers

I'm not drunk. I mean *shavers*. A lot of little gadgets will shave time off every service job. If you're not using them, you're not getting full value from your bench time.

Most of them are so simple that you don't think of them, unless you're as lazy as I am. All the world's labor-saving devices were invented by lazy men, so get in there and start figuring.



"Idiot cards" pasted on mirror can save you a lot of trouble while converging color sets from behind!

One of the first things is a set of extension cables: yoke, picture-tube, high-voltage, speaker, etc. For one thing, you can fix big consoles a lot faster if you can leave the tube and speaker in the cabinet and put only the chassis on the bench. Most of the cables are simple. A lot of yokes, for example, use the same fitting—a nice, standard octal plug and socket. If they use odd plugs, you can get a set of the plugs and sockets from the distributor for about 30–40 cents apiece and make up your own. You can buy any of these, too, ready-made, at radio parts houses.

Color sets? Ideal! You can get extension cables for yoke, HV, CRT and convergence yoke, plus speaker connections, and so on. So quit trying to find troubles in color chassis while squatting painfully on the floor, or sitting on a very sharp-cornered toolbox because it's the only thing in the shop that's low enough! Also, this ends working on big color chassis while they're cocked up at odd angles inside the cabinet so that the cables will reach!

The mirror on a stand is almost indispensable, especially on color sets. You can also get 'em with a spring clip so that they can be fastened to the back of a chair, the cabinet of another set and so on. Very handy. (Only one thing: I'd recommend that you add something to your mirror, as I had to! See the photo. Don't think you can't get confused while you're trying to get a set to converge!)

The little test picture tubes can save a lot of time in the crowded vertical chassis, portables and so on, where you can't get to the parts, PC boards, etc.

Cheap but handy: a 6-inch PM speaker in some kind of box, with about 4 feet of line cord on it. Put alligator clips on the ends and use it as a substitute speaker for any TV set, radio, PA system (with certain power limits, of course; it won't handle over 50 watts, say!). Saves letting the speaker flop around on the bench, and punching holes in the cone when you turn the chassis over.

The "clothespin" antenna clips come in handy on your shop antenna. For the sets with little pins on the antenna lead, get one of the terminal boards used on the set's back cover. Slip the pins into the clips, and hook your antenna to the screws. This alone can save you up to 10 minutes of lost time when the antenna keeps falling off!

My real favorite is nothing but a bunch of short test leads, with alligator clips on both ends. Make up about four pairs, from 18 inches to about 4 feet in length. Hang 'em on a hook on the front of the bench where you can get at them quickly. You'll be surprised how many times a day you'll use them!

Also get some of the little slip-on" test clips for your instruments. These slip onto prods or probes, and let you hang the probe on the terminal while taking measurements, instead of using up one perfectly good hand holding it in place! The ground lead should always be an alligator clip, of course, never a test prod.

You can make all kinds of handy hookups with these things, all the way from clipping in test electrolytic capacitors, resistors etc. to making up inter-

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.

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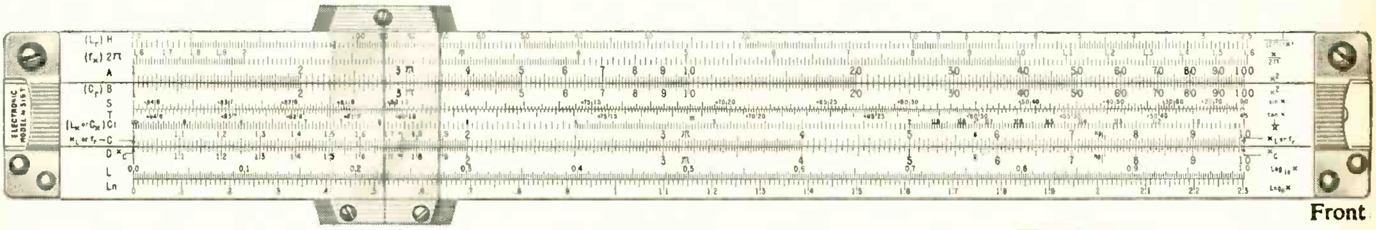

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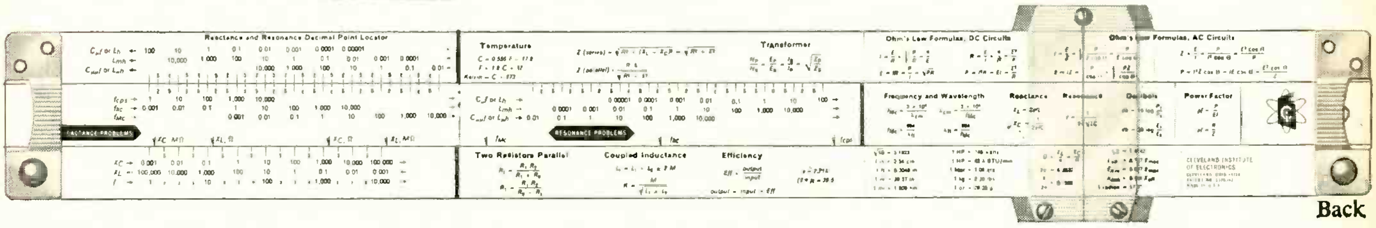

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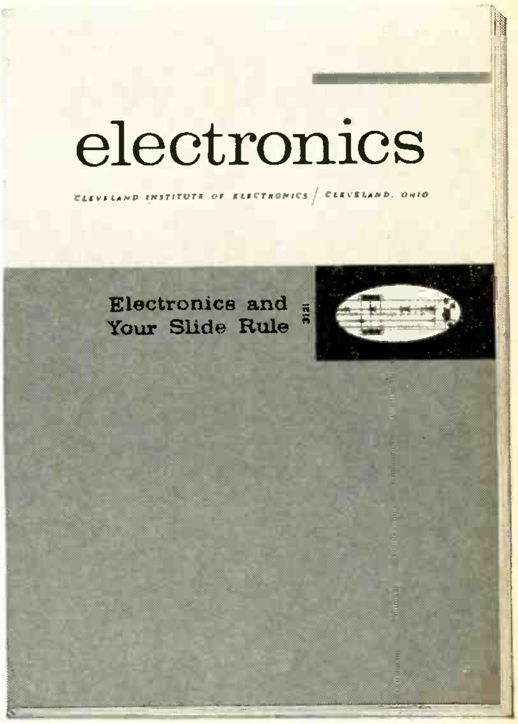

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A leader in Electronics Training . . . since 1934 connecting leads for sets with oddball plug and cable connections. In fact, I once took a very short one, wound it around the bench light, and then clipped the two ends to a schematic diagram, to hold it up so that I could trace out a certain tricky circuit.

The uses of these things are limited by nothing but your imagination and ingenuity, so have at it!

Warmup drift in Coronado TV

I have a problem to which I cannot seem to find a solution. On a Coronado 45TV2-43-9061B, the horizontal sync is off when the set is turned on. If it is locked in sync then, as it warms up it drifts out again. All components in the horizontal oscillator and afc circuits have been replaced and sync pulses to the afc are normal. In the sync separator stage, the screen of the 6BE6 is low, and the plate voltage of the 12AT7 is about twice that shown on the schematic.—M.Z., Lake View, Iowa

Your trouble seems to lie in the horizontal sync separator (Fig. 1) or in the afc, rather than in the oscillator itself, from the description. The incorrect voltages on the sync separator tubes should be the clue. These are fed from

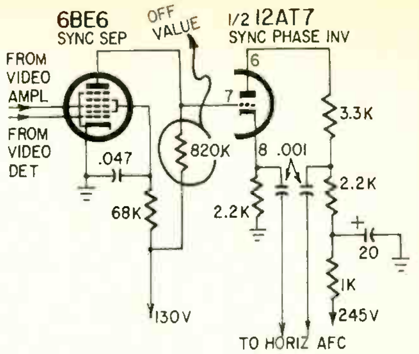

Fig. 1—Resistor values in sync circuits are often critical. When the 820,000-ohm resistor in the diagram here changes value, the circuit can go completely haywire.

the 130-volt line, through the 820,000-ohm resistor. If this has changed in value, it will upset the whole sync separator circuit. From the "time constant" of the trouble, it is almost certainly thermal in nature, and very likely due to a resistor. Check all the resistors associated with this stage after the set has been turned on long enough for them to warm up. You might encourage them a little by connecting an ohmmeter across them and heating them up with the tip of a soldering iron, one at a time.

Grid capacitors in any of the sync circuits should be checked very carefully for leakage. All voltages are critical in sync circuits, and even the slightest leakage can upset bias voltages, causing sync troubles.

CBS 817: Snivets? No.

I've got vertical dark lines on the left side of the raster. Signal or no signal doesn't seem to make any difference. Pulling the rf amplifier or oscillator tubes doesn't make any difference; pulling the 1st i.f. amplifier tube kills them completely.—R. F., Flint, Mich.

This is pulse pickup from the horizontal sweep, sometimes (incorrectly) called "snivets". It does look like snivets at times. This is obviously getting into the circuits in the input of the first video i.f.

Shield the yoke leads by wrapping metal foil around them. Wrap a bare wire around the foil and ground both ends. Be sure that all shielding on the high-voltage cage is tight. Also replace any shields missing from i.f. tubes. You may have to add shielding on the video i.f.: plate on the bottom, etc.

Negative picture

The picture on a Zenith goes negative when the contrast control gets to halfway. Bad picture tube?—J. R., Easton, Pa.

Not always! Check the video amplifier tube, video detector and coupling capacitors.

Feed a 400-cycle audio signal into

the video amplifier grid: if the 400-cycle modulation makes good sharp bars on the screen, the CRT is OK. *Don't* replace the CRT until it's been tested on a good CRT checker.

"Permanent" magnetism in 21CYP22 color CRT

We've got an RCA CTC7A chassis that has us puzzled. There are colored areas on the screen, near the center, left side. Each area is only one color: red, green or blue. More intense at left, fading toward the center.

The colored areas disappear in any part of the picture that is black. Using a degaussing coil seems to make no permanent difference in the pattern! Help!—J.S., Kirksville, Mo.

We used to run into similar troubles in the metal-shell 21AXP22's, but they were more understandable. I remember one, a perfectly good tube, that would do this, and we eventually had to replace it. The colors kept coming back.

The CTC7 uses the glass 21CYP22 tube, so this can't be "bell-magnetism". The only halfway legitimate reason I can see would be something like a magnetized shadow mask, or some sort of external magnetic field close to the tube. Look around inside the cabinet very carefully, and try demagnetizing that side of the set. It can't be in the chassis, since this is on the right side (viewed from the front).

Also, check the positioning of the deflection yoke, the convergence yoke and the statics, plus the little hairpin magnets (if this set has them). If nothing helps, I'm afraid it means a tube replacement! (Incidentally, the speaker hasn't been replaced with a larger one, has it?)

Vertical Sync in Admiral 20G6

I have two Admiral 20G6 chassis in the shop with the same complaint! Slow vertical roll and general vertical instability after warmup. Voltages and waveforms look all right. Seems to be mostly on channel 12.—D.T., Racine, Wis.

This is a bit unusual but, come to think of it, nothing is really unusual in

WOW AND FLUTTER

and how to measure them without specialized or unusual equipment. Read how to make practical, repeatable, accurate, dependable tests for turntable speed variations—the easy way—with just a scope and a test record!

Coming in . . .

July RADIO-ELECTRONICS

TV work, is it? So let's see. To rule out "station trouble" check on another set: see if there is much difference between vertical sync on channel 12 and that on other channels. Check the sync-video ratio at the video output; should be 75% video, 25% sync.

There are a couple of factory modifications on this chassis. Fig. 2 shows one of them, and Fig. 3 the other. They're aimed at "eliminating the possibility of vertical roll under certain interference conditions." Apparently they hold the sync more stable. By the way, don't forget to check all those very large resistors around the 6BU8—just on general principles!

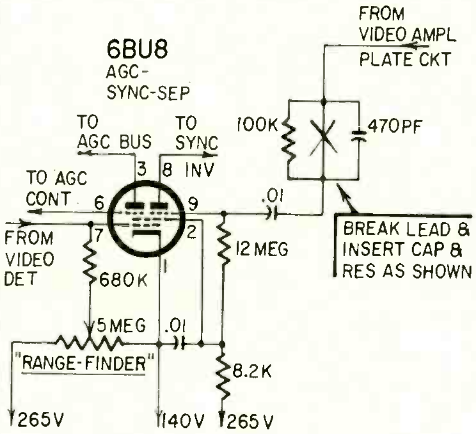

Fig. 2—First modification: add parallel 100,000-ohm resistor and 470-pf capacitor in pin-9-grid circuti of 6BU8.

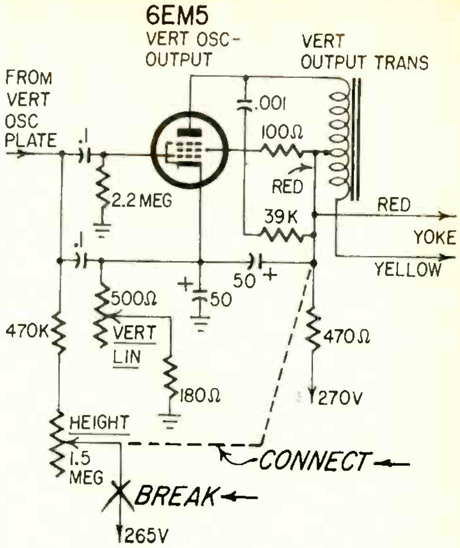

Fig. 3—Second modification: move B+ feedpoint for vertical oscillator triode to red wire on vertical output transformer (better filtering there).

Rf pickup on earphone extension

I have a set of stereo earphones with 5-ft leads. The phones work perfectly when plugged into the radio jack. I bought a 15-foot extension lead, so that I could sit in my easy chair. Now, on phonograph, tape, FM or AM radio, I can hear an AM radio station about 2 miles away from the house! It's always in the background, and the volume control has no effect on it.

Taking out the 15-ft. extension clears this up completely. It's got all the technicians around here baffled. What to do?—L. B., Oak Park, Mich.

This is a cute one! Don't think I've ever run into exactly this same thing before! However, it ought to be easy to cure. Let's see.

First, this is rf pickup—no doubt of that. So, we've got one of two things: The rf may be being detected by an oxidized joint in a plug or socket, or, more likely, it may be getting inside the radio chassis and running around the bottom on a long lead to a speaker selector switch, etc. (Fig. 4).

If this is the case, it is getting into an audio amplifier grid circuit, and being detected by grid-leak action. Then it's amplified and fed to the phones. Since the volume control has no effect on it, it must be getting in past that point.

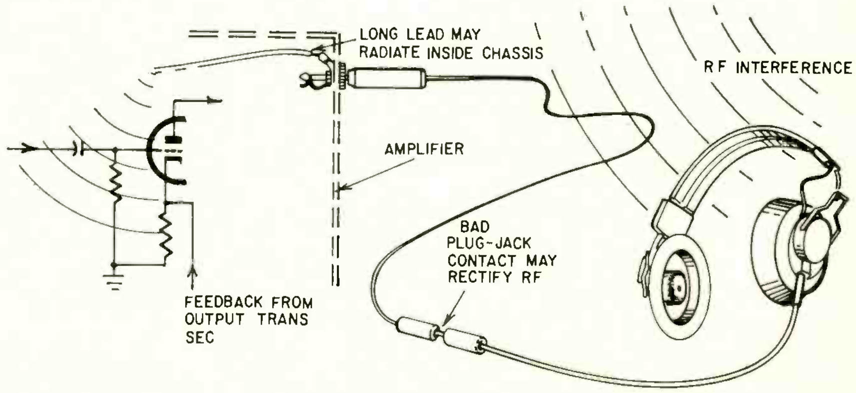

Fig. 4—Long earphone or speaker leads can pick up rf and radiate it under chassis to amplifier circuits. Sometimes oxidized connector contacts demodulate rf and feed modulation direct to phones.

Cure: bypass the speaker (earphone) leads at the point where they come into the chassis. Use a small capacitor, say about 250 pf. This will have no effect on the audio signals. If necessary, bypass at the audio grid (right at the grid pin of the socket), using about the same-size capacitor. You may have to add small low-resistance rf chokes in the earphone leads. As a last resort, you could shield the extension lead, grounding the shield at the chassis end.

High voltage, no raster: Hoffman Mk 10

I've got a Hoffman Mark 10 TV: No raster, due to missing high voltage. I get a good arc at the plate of the 1B3, and the boost voltage checks only 370 instead of the 550 on the schematic. Damper tube was replaced, and the horizontal oscillator seems to be working properly (waveforms OK, etc.) May be yoke trouble, but I can't get any data on it.—P. M., West Lafayette, Ind.

You may be right in suspecting the yoke. While we do have one symptom that says "Possible 1B3 filament trouble" ("rf" arc on plate, no dc output), we also have other symptoms, which could be more definite: low boost, for the main one.

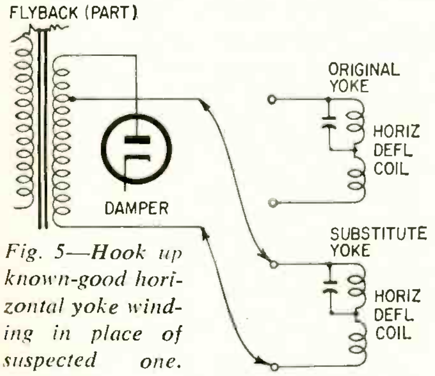

Fig. 5—Hook up known-good horizontal yoke winding in place of suspected one.

Try substituting another yoke for the original. You don't have to put it on the tube. Just set it on the bench alongside the set and hook the horizontal windings up in place of the originals (Fig. 5). If the yoke is bad, this substitution will bring the boost voltage back up, also the high voltage. Better turn down the brightness to keep from burning the CRT screen, or turn the set off quickly once you get that bright vertical line! Incidentally, this yoke is 20 mh vertical, 43 mh horizontal inductance, if you do have to replace it. Common values, and there are several standard yokes with them.

RCA transistor radio: too much current

An RCA 8-BT-7J radio is supposed to draw 8.5 ma, according to the service data in Sams 364-10. This one draws 18 ma from a well filtered 9-volt dc source. Filters all checked, and I can cut it to 3.0 ma by disconnecting the output transistor.—W. E., Cupertino Calif.

Check the service data again. I think you'll find they specify 8.5 ma with *no signal input*. On a strong signal, the drain will increase. Check the base voltage on the output transistor; this regulates collector current and is critical, down to 0.1 volt or even less. The base bias resistor may have shifted or something. I doubt if the transistor is defective; while it could happen, it's rare. Most output transistors go dead all over when they fail. END

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COMING IN . . .
July RADIO-ELECTRONICS

ELECTRONICS AND THE AGED

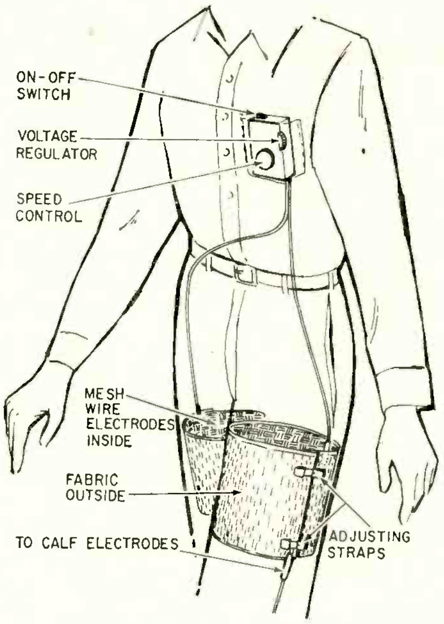
...Electronic Nerve Stimulation Can Be Very Helpful...

ELECTRONICS HAS NOT DONE too much for man as far as the problems of the aged are concerned. While it is true that nearly one hundred years ago faradization (a medical term derived from Michael Faraday, meaning to treat or stimulate with induced electricity) was tried out, nothing much came of it. The effects were not permanent and it was often necessary to apply the electric current over a long stretch of time. Earlier, Benjamin Franklin had been one of the first to experiment with electric shock for health purposes.

Not so long ago in Brooklyn, N.Y., a man fell down and was thought to be dead. He was quickly rushed to the hospital, where physicians tried cardioversion (electrically-timed heart stimulation) on the subject. They succeeded in getting his heart going again by electric shocks and the man, fortunately, is still alive today.

Although a few other ills besides heart failure are treated by electronics today, there are many others that could be treated electronically and a possible cure obtained.

Thus, for instance, the aged, particularly people over 80, 85 and 90, may have trouble walking. Often the legs give out entirely and the subject can no longer walk normally. Thus, ex-President Truman, in 1964, fell in the bathroom, broke four ribs and suffered a few facial injuries from his glasses. In 1960, the late Winston Churchill broke a bone in his back in an accidental fall in his London home. Two years later, he slipped and fell getting out of bed in Monte Carlo, fracturing his left femur. This is where electronics could be of great help.



There are two sets of muscles in the legs, the *flexor* muscles and the *extensor* muscles. Very often in the aged there has been nerve deterioration, and while the legs are perfectly able to support the subject, the nerves no longer function and the muscles need direct stimulation. Fortunately, each muscle has a "motor point" on the overlying skin.

The muscles could be stimulated by electrodes, one placed over the flexor muscles of the thigh, which bring it forward, and one on the extensor muscles on the back of the thigh. Another pair of electrodes would be placed on the lower leg. The electrodes could be held in place by a sleeve-like appliance around each thigh and around each calf. The electrodes would be placed on the inside of the sleeves and would be made of flexible mesh or gauze. Each electrode would be connected to the transistorized power supply. The alternation of impulses would be worked out in this power supply and would be subject to control by the user and by an on-and-off switch and a regulating rheostat. The transistorized power supply would raise the output of a 3-volt battery to 50 to 60 volts. This should be about the size of a portable transistor radio and could be carried in the pocket of trousers or jacket. A thin insulated conductor would connect the sleeves and the power source. The flexor and tensor muscles would be stimulated alternately, as in normal walking. All this does not present a problem.

The transistor device would have to be engineered in such a way that it would give a sinusoidal or some other appropriate current to stimulate the muscles. This stimulation would have to be periodic so the muscles would be stimulated when the subject was walking. A switch on the transistorized supply would be shut off when the subject was not walking. Actually what is needed here is a more complex supply that will send a series of pulses (approximately 40 per second) gradually increasing in intensity up to the point of full muscle contraction, then decreasing as the muscle relaxes. In other words, each step would call for the application and increase of power. A similar device is used for chest muscle stimulation to permit breathing in paralysis cases. It is felt that once the subject became used to the apparatus he would in time be able to walk again normally.

Many problems would have to be overcome as to proper dosage. What type of current should be used, how strong and how often would be problems for the physician and engineer.

Impotence in the aged is another problem for which electronics already has the solution. The U.S. Department of Agriculture is now using an apparatus with animals for insemination purposes.* There is no reason why a miniaturized apparatus of this type could not be used in a modified version of an "electronic male pessary." This would be inserted by the subject into the rectum. It could be very small, 1½" long and ½" in diameter. The pessary should be adjustable to regulate the intensity of the current to the patient. The pessary would induce a normal erection, the same as the device used by the Department of Agriculture in animal insemination. If properly engineered and worked out, a pessary of this type would be of great help to the aged. Since such apparatus has been used for many years with animals, there is no reason why apparatus of this kind for human use could not be worked out soon. It should not only work well with the aged, but also prove its value for younger men who for some reason have become impotent and require stimulation.

Electro-ejaculation on an experimental basis on human patients has already been reported by urologists (see the *Journal of Urology*, May 1962, and "Electrically Caused Ejaculation" by R. Stiller in *SEXOLOGY* Magazine, December 1962), but no practical application of this research has been made. According to these researchers, "electro-ejaculation may well be the answer to many of the urological problems in the field of sexual difficulty that are now unanswered."—*H.G.*

* See SEXOLOGY Magazine, November 1951, "Electrical Ejaculation in Animals," Frank; and July 1956, "Electrical Sex Stimulation," Frank.

WE BUILT A HOME VIDEO TAPE RECORDER

First low-cost factory kit shows great promise

By MELVIN H. SHADBOLT

HOME VIDEO RECORDING HAS BEEN ALmost here for several years . . . but until now only as promises. It all started in the summer of '63, when a British company announced plans to manufacture and distribute a revolutionary new $177 home video tape recorder—the *Telcan.*

First releases in the U.S. came as a filmed report shown on NBC's "Today" program. Taped portions of a horse race looked quite impressive. However, live demonstrations in London and later in New York City proved only slightly less than disastrous. One of Telcan's developers announced that it was necessary to demonstrate the recorder prematurely to create the public support needed to persuade some company to purchase Western Hemisphere manufacturing rights. Though Cinerama, Inc. did purchase the rights, apparently there were more problems than originally appeared, since nothing has been heard from either concern for over a year.

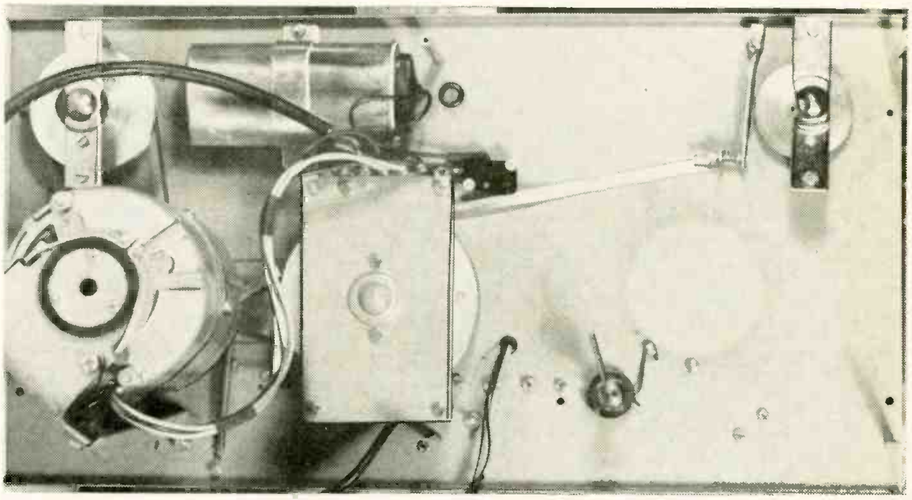
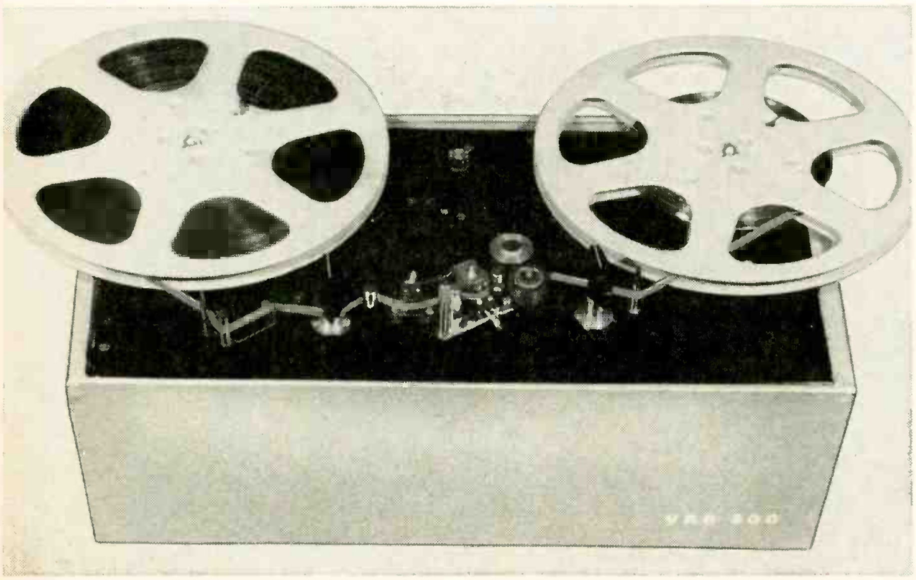


Fig. 1—Underside of VKR 500. At extreme left, motor and takeup reel slip-clutch. Nearer center, motor starting capacitor and capstan flywheel assembly. At extreme right, feedout reel spindle and brake.

At the time of the first releases there was much skepticism among engineers and technicians. The price seemed completely out of reason . . . perhaps $500 would have been more realistic. This at least would have allowed a little more margin for working out remaining bugs, and perhaps would even have made the recorder profitable to market. At any rate, the Telcan announcement did prod a number of companies into greatly accelerating their stagnant development programs—many of which were started over a decade ago!



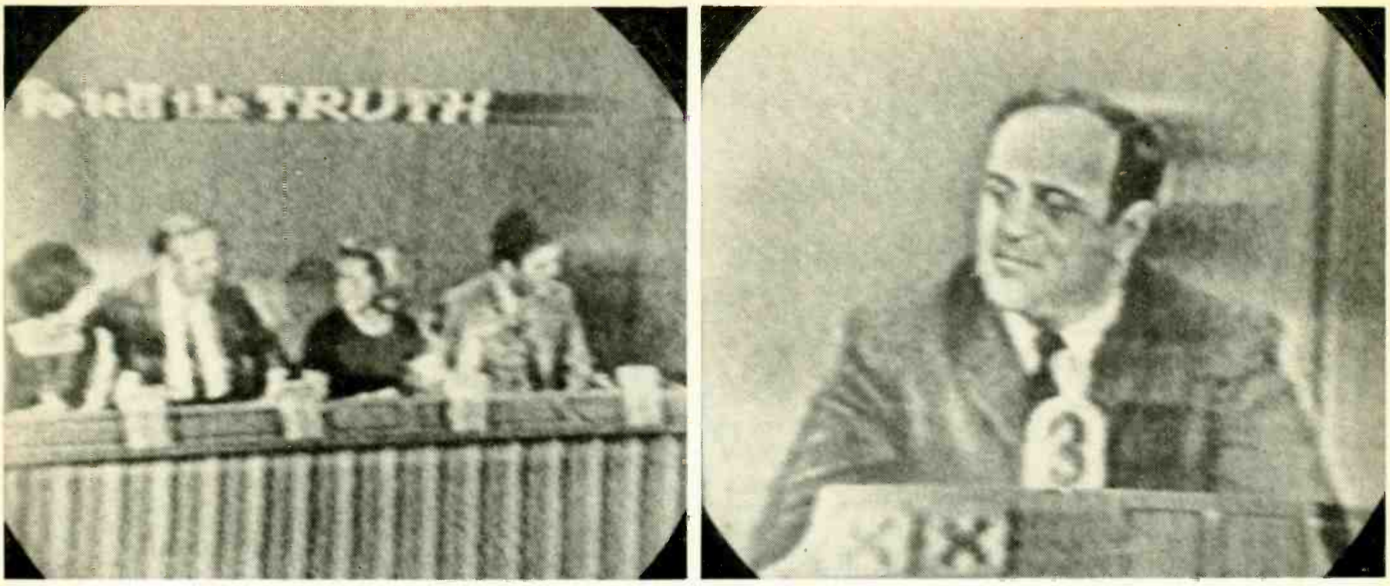
VKR 500 uses standard ¼-inch tape at 7.5, 10 or 12.5 feet per second.

Since mid '63, several companies have promised home video recorders in the *very* near future. The race has been won by Wesgrove Electrics Ltd., Nash House, New Street, Worcester, England. Their new VKR 500 is in kit form and being distributed in England and, very recently, in U.S. At least one importer is handling it: P.A.F. Enterprises, 32-34 E. 22 St., Bayonne, N.J. The price, in kit form, is $450; assembled, $650.

The VKR 500, with several pictures recorded off-the-air, is shown in the photos.

Although the new Wesgrove recorder is supposedly an outgrowth of the old Telcan (at least, one of its directors is one of the early developers of the Telcan recorder), comparison of photographs of the Telcan and the VKR 500 indicates that the Wesgrove machine has been completely revamped —at least mechanically.

We had been negotiating with Wesgrove Electrics before public news releases, and fortunately were able to get



Pictures of network TV program, recorded off the air on VKR 500.

one of their early kits flown over in time to conduct a series of tests and experiments prior to general U.S. distribution.

My first impression on opening the kit was that it was nothing more than a glorified audio recorder—stereo, perhaps, because of all the transistors (22). Stripped of all fanciness and housed in a very plain plastic-covered plywood case, the major portion of the recorder's cost is apparently in the mechanical and electrical components—both of high quality. Nothing has been spent to dress up the kit.

Many of the features you would like to see, such as rewind provisions, quick changeability of tape speeds and handy access to all adjustments, just aren't to be found. The VKR 500 was designed primarily to meet the requirements of the less critical lab or educational, industrial or home experimenter, who can get along without such conveniences, particularly when they could have delayed production for perhaps another year and increased cost considerably. The fact remains, the Wesgrove recorder is *actually here*—it *does work*—and best of all, it uses standard ¼-inch audio tape.

General features

Using the 10½-inch reels supplied and standard triple-play audio tape (0.5 mil), you have a choice of three speeds—7.5, 10 or 12.5 *feet* per second. Approximately 9,000 feet of 0.5-mil tape can be accommodated on the 10½-inch reels. Since the VKR 500 is a half-track recorder, a total of 40 minutes of recording time is possible when operating at 7.5 ft/sec (20 minutes per track). The maximum size reel the recorder will accept is 11½ inches, which increases recording time to 1 hour (30 minutes per track).

System frequency response is 1 kc to 2 mc for video and 50 cycles to 10 kc for audio. Input level for both video and audio is 1 volt p-p. The entire unit is only 19¾ x 9¼ x 10½ inches and weighs 28 lb. Total power consumption is 200 watts, the larger part being consumed by the $\frac{1}{10}$-hp motor.

The electronic portion is completely self-contained on a 8⅜ x 9⅞-inch printed-circuit board incorporating 22 transistors and 10 diodes.

Mechanically, the tape transport is as simple and straightforward as possible—no more complicated than that of an average audio recorder. Since there is no rewind, it is even simpler (underside shown in Fig. 1).

Only four operator controls are provided on the tape deck proper: record/playback, stop/start, video azimuth adjust and video playback gain control.

The recorder can be operated on any of three systems: the 405-line, 50-cycle British; the 625-line, 50-cycle European, or the 525-line, 60-cycle American standard. When ordering, you must state which system you are planning to use the recorder with.

Conversion to any system is simple. Primarily it involves changing the diameter of the dual pulley on the motor shaft. This pulley drives the capstan flywheel and the takeup-reel slip-clutch. Since motor speed depends on whether it is used on 50- or 60-cycle power, it is necessary to compensate by altering the pulley diameter. For any country using 120-volt lines, one other modification is necessary—an outboard stepup autotransformer for the British-made 240-volt motor and power transformer.

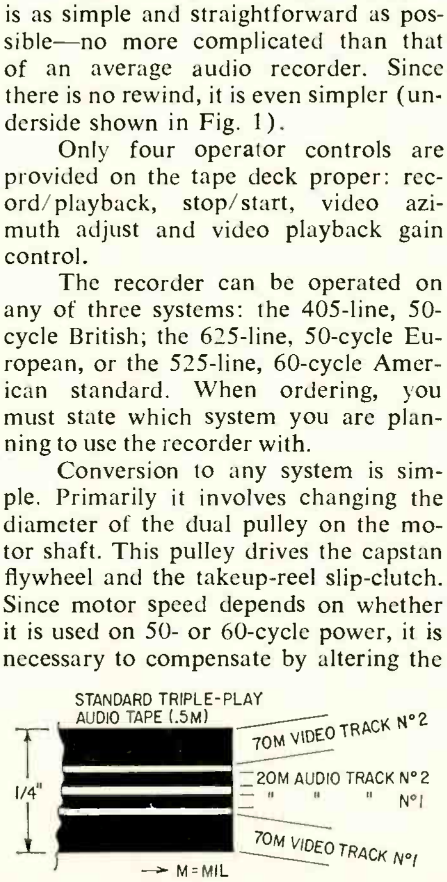


Fig. 2—Width and location of audio and video tracks. Half tape width is used in each direction.

Principles of operation

In the RECORD position, the tape is first erased by a permanent magnet which is rotated into position by the record/playback control. Erasing with dc eliminates possible interference with the wide-band video signal. The tape then passes the audio head, where an FM audio signal is recorded on a 20-mil-wide track just below the center of the tape (Fig. 2). Next it passes the video head, where the video signal is recorded near the bottom of the tape, 70 mils wide. After leaving the video head, the tape passes between the capstan and pinch roller and on to the takeup reel.

The video head is the only unusual item on the tape deck. It is made in two sections. On the oxide side of the tape is the gap. The section the tape passes over is in the form of a "V" (Fig. 3). Although no information is given on the nature of the head, it is probably similar to the design used by the Telcan recorder—probably using a gap on the order of 1 micron (approx. 40 microinches). This is a typical gap on wide-band instrumentation recorders.

The head is heated by feeding it dc through an 820-ohm 1-watt resistor attached to the back of the head by a heat sink. The purpose of this is conveniently overlooked in the manual. However, a few tests indicated at least one possible answer. As the tape passes over the head, more stretch seems to occur on the side opposite the oxide. This could cause a heat transfer away from the head to the opposite side of the tape. Short runs made with the head heater removed showed no deteriora-

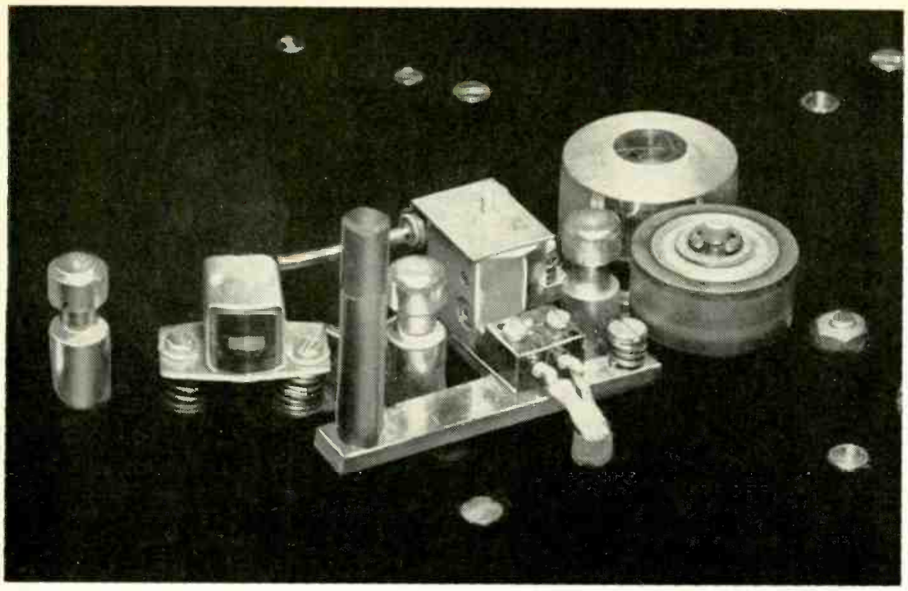


Fig. 3—Head and capstan assembly. Audio head is at left, just right of tape guide post. Video head is in two parts (see text); coil part is in front with its shielded-cable connection going through hole in deck. Gap portion is in back (V-wedge-shaped block). Note end of heater resistor behind gap block. Tall post with knurled end in foreground is video head azimuth adjustment.

tion in the recorded picture. I can only assume that the heater is an attempt to prevent excessive contraction or expansion due to large temperature variations.

The coil portion of the head is on the *opposite* side of the tape. (Again, see Fig. 3.) This coil (used for both recording and playback) measures about 100 μh and has a self-resonant frequency near 2.5 mc. The dc resistance is 2.65 ohms. Although potted and molded in a plastic holder, close investigation under magnification indicates it is wound on a horseshoe-shaped powdered-iron core. The open end of the core, when mounted, virtually touches the back side of the tape and is lined up perfectly with the gap portion of the head on the opposite side of the tape. The reactance of the coil appears to vary from a fraction of an ohm at the low frequencies to well over 1,000 ohms at the top recording frequency of 2 mc. This indicates the tremendous gain vs frequency compensation required in both record and playback amplifiers to record such a wide band of frequencies.

I tried replacing the coil portion of the head with a standard video peaking coil. Although I had some local rf pickup and the output was down, I was pleased to find I could reproduce a picture nearly as good as with the regular coil. This is just one more indication that it is well within possibility for the skilled experimenter to someday design and build his own video recorder—assuming, of course, that he first purchases or somehow makes the narrow gap portion of the head.

The video signal can be taken either from the detector output of any TV receiver or from the output of a CCTV camera. It is important to make certain the level falls between 0.7 and 1 volt p–p, otherwise proper video modulation cannot be obtained within the range of the record-level control. The video signal is first amplified by a conventional two-stage amplifier (Fig. 4). The collector output of the second stage drives the "video driver unit" and also provides a monitoring signal which is fed back to the video amplifier in the TV set. From the emitter of this same stage, a signal of the opposite polarity feeds a sync separator, the output of which drives a separate amplifier to furnish the differentiated sync pulses to the head. It is important that the sync be properly modified to offset the poor low-frequency response of the low-inductance head coil.

The video "head driver unit" is factory potted and sealed. No schematics are shown, nor is there any information about what it is other than that it contains a transistor and certain critical inductances used to predistort the video signal. Its purpose is supposedly to maintain constant gain and frequency response. My guess is that it shouldn't be too hard to duplicate. (Perhaps that's the reason no schematic is given.) Record level is adjusted by varying a 100-ohm pot in series with the dc supply feeding this unit. The dc bias needed to overcome the hysteresis loop of the tape is varied by adjusting a 2,000-ohm pot in series with the bottom end of the head coil.

The VKR 500 has no rewind mechanism. To rewind tape, you must swap reels and restart the recorder. During rewind, the tape does not pass the heads or between the capstan and pinch roller. (This would double the wear on heads and tape.) It rewinds at an average rate of about 2,500 feet per minute.

During playback, two changeover switches, mounted directly on the printed circuit board, are switched to the proper mode and both heads (audio and video) are switched to their appropriate playback amplifiers. For the time being we are concerned only with the video portion of the recorded signal. (See Fig. 5.) The video from the head again passes through one of those "little black boxes," and, as before, no schematic is given. This preamp probably contains one or two transistors and the necessary critical inductances to equalize the video response back to normal. At the output of this stage, the signal divides. No attempt is made to preserve the sync portion through the video amplifiers, since sync is amplified separately by a four-stage sync amplifier/clipper circuit. The horizontal-sync pulses are preserved much better in the recording process than the low-frequency vertical-sync pulses, and therefore require two stages fewer of ampli-

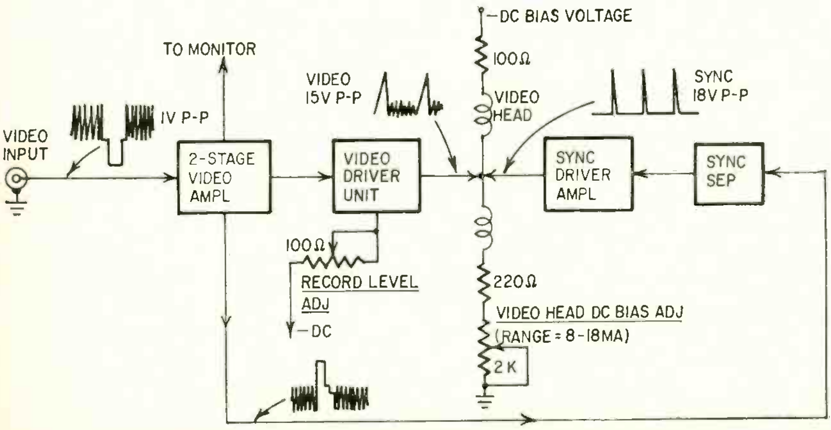


Fig. 4—Block diagram of video record section.

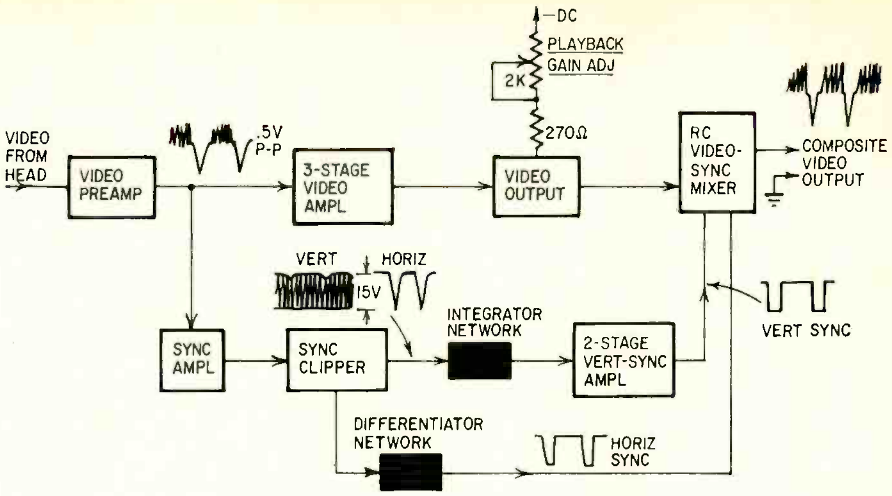


Fig. 5—Block diagram of video playback section.

fication. The playback gain control is in the emitter circuit of the video output stage. This adjustment is a "topside" control and can be set for proper contrast when monitoring the playback signal. The video output and vertical and horizontal sync pulses are all mixed, clipped and dc-restored in an R-C/diode video-sync mixer. Its output is then fed to the first video stage of a TV receiver.

If you want to feed conventional CCTV or amateur TV monitors, distribution amplifiers or modulators, you will have to amplify this output with an additional amplifier–cathode-follower combination to increase it to the standard level of 1 volt p–p across 72 ohms.

During the first few playbacks, one further adjustment is necessary; video head azimuth. This can be considered a "focus" control, if you like, since it affects the resolution of the playback picture. If it is misadjusted too far in either direction (causing the head gap to be not perfectly perpendicular to the tape), you will lose all fine detail—the picture will appear fuzzy. Once set, it will need only occasional touching up.

Recording the sound

So far I have neglected the audio portion, since primary concern is with the stranger, more difficult video portion of the VKR 500. The audio circuitry is really rather simple.

Audio is picked up at the speaker terminals of the TV receiver. Recording level is adjusted by the volume control on the receiver. This signal frequency-modulates a multivibrator circuit operating above the audio range. The output of the multivibrator is fed directly to an output amplifier stage, which is connected to a conventional audio head. On playback, the head is switched to a four-stage amplifier/limiter circuit, then demodulated and fed to a frequency-compensating output stage.This signal is then fed back into the TV receiver, preferably before the volume control, since no volume adjustment is provided. Since the audio is applied to the head on an FM carrier, it is not necessary to have a separate bias oscillator.

Modification to the receiver

Practically all receivers in this country use some form of automatic frequency control (afc) on the horizontal oscillator. Since that uses a slow-acting dc correction signal specifically designed to overcome many manmade disturbances, it will not provide satisfactory operation with the VKR 500. Due to the simple tape transport mechanism, the horizontal sync stability will not remain absolutely constant. Tape stretch, flutter and line-voltage variations all result in minor changes in tape speed and cause the sync to vary, sometimes faster than the afc circuit can react. This causes bending and jitter in the playback picture. Therefore, to insure a stable and jitter-free picture, you must modify the horizontal circuit for a certain amount of "direct" synchronization. This can generally be done by connecting a small capacitor (10 to 50 pf) between the plate of the sync separator and the grid of the horizontal oscillator. The value of the capacitor must be high enough to eliminate the bending, yet low enough to prevent horizontal sync tearing.

Weak points

The weak points of the VKR 500 are basically five: no rewind mechanism, critical signal/noise ratio tolerances, inadequate shielding, some negative smearing, and response and sync stability reduced noticeably at slow speed.

The signal-to-noise tolerances demand that the record level be held as high as possible without causing white compression, otherwise the noise level increases very rapidly. If a choice has to be made, the record level should be set so white compression occurs occasionally. Most viewers tolerate occasional white compression more than excessive snow.

If the recorder is to be operated near high-power radio or TV stations, additional shielding will be necessary around the head and the video playback amplifier.

Some low-frequency negative smear will be noted at all times following large contrasty objects. This is undoubtedly due to the excessive loss of low-frequency information and the inability to compensate for it fully, using simple frequency and phase correcting amplifiers.

At slower speeds, response and sync stability are an increasing problem. It's my feeling that the 10- and 12.5-ft/sec speeds will find more acceptance than 7.5 ft/sec, which will be left for less critical applications where added recording time is desired at the sacrifice of quality.

Conclusions

Life of the head and tape, although not mentioned in the instruction manual, can be estimated from what is known about other recorders operating at the same general speed, such as instrumentation recorders. Depending on whether low-friction lubricated tape is used, head life should be between 500 and 1,500 hours. Tape should be good for about 500 to 1,000 passes.

Splices can be made the same as on an audio recorder, and when properly made will have virutally no effect on the picture or the transport mechanism. At these speeds you're bound to have accidents occasionally, so you'd better have some splicing tape ready!

The VKR 500 definitely has limitations. But considering that this is the very *first* home video tape recorder to reach the market for less than $500, and when that price is compared with, say, $10,000 for an industrial recorder or $50,000 for a broadcast recorder, I think it has put us much closer to practical home video tape recording. Although perhaps not yet completely suited for the average consumer, it certainly meets the needs of many technical and experimental users. It offers the opportunity for unlimited experimentation even to the budget-minded lab and industrial organization. It furnishes amateur TV'ers with a heretofore impossible means of exchanging video signals with fellow hams all around the world. It offers educational and technical institutions a cheap and economical research tool. END

New Transistor Voltmeter Is Stable and Drift-Free

200,000-ohm-per-volt sensitivity, 1-volt range, zero-center meter make this unit ideal for measurements on transistor circuitry

By V. H. LAUGHTER

IN MAKING MEASUREMENTS AROUND transistor and tunnel diode circuits, I found I needed a low-reading, battery-operated voltmeter. The battery drain must be low, so this indicated a transistor device.

In the April 1962 issue of *Electronic Technology* (p. 147), published by Illife Co., London, an article by K. P. P. Nambiar describes a "Transistor Differential Amplifier" using high degenerative feedback and cross-coupled positive feedback to get stability and low drift.

HOW IT WORKS

Resistors R1 and R2, connected from the collector to base on each transistor, provide high negative feedback, reducing the circuit's dependence on transistor parameters. Stated in another way, this means you can insert another type of n-p-n transistor without greatly affecting operation. Likewise, temperature effects are reduced and overall stability is greatly improved over the usual differential circuit.

R3 and R4 are cross-connected between collectors and bases of Q1 and Q2. To explain the action, consider a voltage applied from the test probes with, say, positive on the base of Q1 and negative on the base of Q2. The transistors, being connected in an emitter-coupled arrangement, reverse phase; thus positive on base of Q1 will make Q1's collector go negative; likewise, minus at base of Q2 makes its collector go plus. Of course, the signal is amplified as well as reversed in phase. This amplified signal portion feeds from Q1's collector through R4 to the base of Q2, and, being negative, it adds to the negative input signal voltage already applied to this base. Q2 amplifies this already amplified signal, feeding its plus-going output to the base of Q1, where it is again amplified and feedback to Q2 again occurs.

This is positive feedback, but part values are such that the circuit does not oscillate. The positive feedback effectively counteracts the shunt negative feedback through R1 and R2 as far as the signal is concerned, while still allowing the negative feedback to check drift due to thermal or supply-voltage changes. This makes a stable, high-gain amplifier.

All indications were that this circuit could be modified for use as a voltmeter. Differential amplifiers are usually laboratory instruments, using selected transistors that cost $35 to $60 a pair. I made a few modifications and built a meter using a readily available low-cost transistor pair. It has proved thoroughly satisfactory in general shop use.

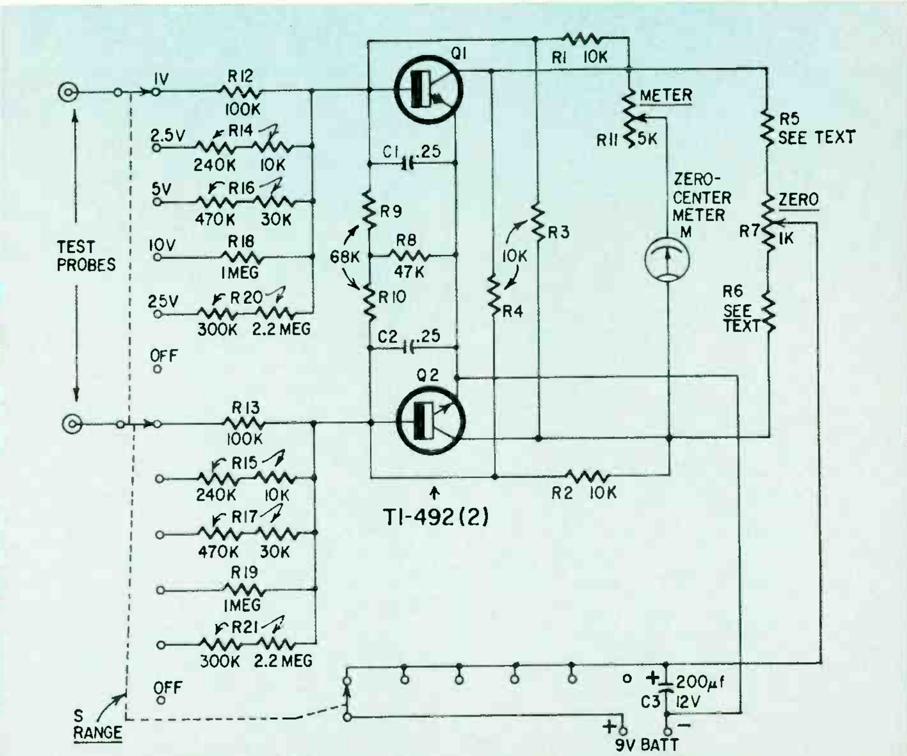
I used a galvanometer type zero-center meter, 50–0–50 μa. I preferred that to a left-hand zero type because it is more convenient to use and matches the symmetrical arrangement of the circuit. The scale that comes with the meter is not suitable and I had a special one made. It reads 1, 2.5, 5, 10, 25 volts. This scale cost $3, but I consider it well worth the cost as it included calibration of each major point under microamp load, and machine layout of divisions. However, if you have a 100-μa meter on hand, it can be used. In this case, bias the meter pointer to center scale with the ZERO knob. Likewise you can hand-print your scale as desired. It is not at all necessary to use the voltage ranges I did. Just hold to 200,000 ohms per volt.

The METER knob (R11) is used in initial calibration. (The cap over the slot in the control shaft is to discourage visiting knob twisters.) The ZERO pot (R7) is 1,000 ohms. This value works out nicely and gives a degree of vernier control when in circuit with R5 and R6.

The complete circuit is shown in Fig. 1. R12 through R21 are the multiplier resistors. The moving contacts of the switch are wired to the input binding posts. Thus we end up with 100,000 ohms in each leg of the input, or 200,000 ohms total, for the 1-volt position.

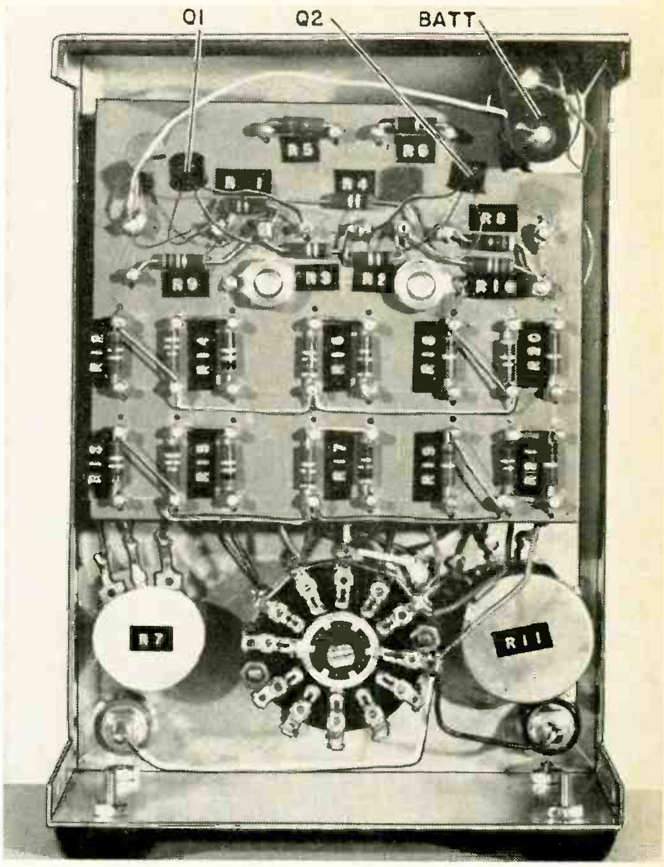
Circuit, assembly & calibration

An examination of the circuit shows that the transistors' bases receive equal but opposite potentials when the voltmeter leads are applied across a voltage. Thus the circuit, up to and including the galvanometer type meter, is completely symmetrical, and all parts are above ground. The phenolic terminal board is mounted on the rear of the meter and held by the meter nuts. All fixed resistors and the two TI-492 transistors are mounted on the board; the turret terminals are the tie points.



Circuit of the balanced, compensated transistor voltmeter.

Zero-center meter eliminates need for interchanging probes or switching polarity. Neither input terminal is grounded to case.



Phenolic board, on meter terminals, makes wiring easy. Multipliers R12 through R20 can be matched, selected 5-per-centers.

A cutout in the upper right corner allows space for the battery. A battery holder is riveted or screwed to the upper part of the metal case.

The locations of the multiplier resistors are shown in the photo.

An 11-point switch is installed, though only 6 points are used. This switch, as well as some other parts, came out of the junkbox. The values of R5 and R6 are determined later. Values of the capacitors are not at all critical. They are mounted behind the panel, and filter transients and other unwanted potentials in the circuit under test.

To adjust and calibrate you will need two variable 10,000-ohm resistors, a 5- or 10-ma meter, a new 1.4-volt mercury battery and an extra mercury battery of 8.4 volts. Be sure the single mercury cell is of the 1.4-volt type.

Wire the two 10,000-ohm pots in as R5, R6 and set them for full resistance in circuit. You will need to insert the milliammeter in series with R5, R6 or the arm of R7. Set R11 to 5,000 ohms.

It would be a miracle if your transistors matched and had exactly equal collector currents. The ZERO adjust, R7, compensates around the circuit to give a zero-center reading on the meter even though there may be considerable difference between the final values of R5 and R6. My present meter with final adjustment and calibration ends up with values of 5,100 ohms for R5 and 8,200 ohms for R6, and METER resistor R11 set to 3,000 ohms. The 5,100 and the 8,200 are fixed values that most nearly matched, and replaced the 10,000-ohm variables. The total drain in the arm of R7 measured 2.25 ma; in R6, 700 μa, and in R5, 1.8 ma.

If at first the 5- or 10-ma meter shows abnormal drain in the arm of R7, check the wiring and look for shorts.

For calibration and adjustment, juggle variable resistors R5 and R6 while taking readings (on the proper scales) of the 8.4- and 1.4-volt mercury batteries, reversing probes to get right and left deflection.

With the ZERO control all the way to the right, the meter pointer should be at about right full scale, and full left on full counterclockwise setting. If the meter does not indicate right on right movement of the ZERO control, reverse the meter leads. Keep adjusting R5, R6 and R11 until you get proper calibration with lowest possible total drain, consistent with the swing of the meter pointer full scale right and left.

The drift is about equal to that of the average vtvm. As with most transistor devices, it seems to improve with age. Average linearity is about one-half division off between right and left scales. You can improve the overall accuracy by using precision resistors. Should you be lucky enough to have access to a large number of TI-492 transistors, you can match pairs by using the method shown in the May 1963 RADIO-ELECTRONICS, page 32—"Check Transistors with Your Scope," by Daniel P. Smith. END

C1, C2—0.25 μf, paper, 100 volts or higher
C3—200 μf, 12 volts, electrolytic
M—50-0-50-μa zero-center microammeter (see text) (Herbach & Rademan, 1204 Arch St., Philadelphia, Pa.; catalog No. TM 11K977 or TM 6597)
Q1, Q2—TI-492 (Texas Instruments)
R1, R2, R3, R4—10,000 ohms
R5, R6—see text
R7—pot, 1,000 ohms
R8—47,000 ohms
R9, R10—68,000 ohms
R11—pot, 5,000 ohms
R12, R13—100,000 ohms
R14, R15—250,000 ohms (240,000 & 10,000 in series)
R16, R17—500,000 ohms (470,000 & 30,000 in series)
R18, R19—1 megohm
R20, R21—2.5 megohms (2.2 megohms & 300,000 ohms in series)
All resistors ½ watt, at least 10% tolerance. R12 through R21 should be 5% or better.
S—3-pole, 6-position rotary switch, nonshorting contacts (Mallory 1331L or equivalent)
BATT—9-volt "transistor radio" battery (Burgess 2U6 or equivalent) or 8.4-volt mercury battery (Mallory TR146 or equivalent)
Aluminum case, 7 x 5 x 3 in. (Bud CU-2108A or equivalent)
Phenolic panel, 4⅜ x 3⅞ x 1/16 in. thick
Binding posts, rubber feet, miscellaneous hardware
Calibration batteries and 10,000-ohm pots (see text)

COVER STORY

What Is Electronic Music?

How is it composed and produced? What will be its role in the world of music (and that of electronics)?

By JAMES SEAWRIGHT

JUST NOW THERE IS A TERRIFIC EXPLOSION of interest in electronic music—more and more people are pricking up their ears to electronic music as ways to produce it improve.

Preserving sound waves in recordings is by now an old trick—and it has been immensely useful to musicians. But now there are ways to create sounds electronically, directly, according to predetermined specifications. Some instruments that do this are designed only to imitate conventional (mechanical) musical instruments. Others try to improve on them; still others generate entirely new and unique sounds—like the Theremin. But all these instruments still have one thing in common: they all need performers—often more skillful than performers on conventional instruments.

An even more exciting prospect for composers is *synthesizing all parts of a composition directly*, without performance, putting it directly onto a recording medium. Perhaps the first successful effort at this was made in Russia by Sholpo in the 1930's. He synthesized a motion-picture sound track by drawing the optical modulation patterns by hand and photographing them onto film.

Tape recording gave tremendous impetus to electronic music, because individual recorded sounds could be so easily edited, mixed, reversed, slowed or speeded. Pierre Schaeffer and Pierre Henry in Paris began to work just this way in 1948, with tapes of every kind of sound—musical instruments, speech, even street noises. Shuffling these created an amazing variety of new sounds, which they treated as discrete units, like the musical notes of an ordinary composition, and assembled into compositions they called *Musique Concrète*.

Our cover shows Mr. Seawright at the RCA Sound Synthesizer, with which, as explained in the article, many of the musical effects described here can be produced directly.

Some composers and engineers in Germany believed that the methods of Schaeffer and Henry depended too much on chance. These composers began to deal with directly generated signals, substituting them for recorded natural sounds.

In the USA, Vladimir Ussachevsky had been experimenting with both recorded sounds and electronic signals since late 1951. He was joined by Otto Luening in 1952, and their work led to the establishment in 1959 of the Columbia-Princeton Electronic Music Center, with a grant from the Rockefeller Foundation. A large number of composers are now working in dozens of studios all over the world, and a considerable body of electronic music is being performed.

Considering just the mechanics, what is "composition"? Until recently, it has always meant specifying the characteristics of a sound in terms a performer could execute—and this usually means telling him to do a certain thing with his instrument. This is not the same as specifying the sound. As a result, performances of a composition vary from performer to performer. There is no practical way to specify every chracteristic of every sound a player must make. Furthermore, the sounds of his instrument are not all fully under his control.

But the electronic composer *can* and *must* make all these specifications. His music *is* completely under his control. So that we can see what he is up against—how this is a golden opportunity and a crushing burden at the same time—let's look at some of the basic quantities he has to deal with, and what he calls them.

Music can be defined as a systematic organization of individual sounds

Vladimir Ussachevsky, Chairman of the Committee of Direction of the Columbia-Princeton Electronic Music Center, in the older studio of the Center, which still contains some of the original equipment with which he and Otto Luening began to work in 1952. To Ussachevsky's right are tape recorders, electronic switches, and sine- and square-wave oscillators. To his left are mixing, patching and filtering facilities and other tape recorders and oscillators.

See Sept p16

in time. The physical characteristics of a single musical sound are its frequencies, their intensities and duration, and their rates of change. *Pitch* is the word we use to name the psychological sensation of frequency. (A system of discrete pitches is a *scale*—but electronic music can use all audible pitches.) *Timbre* is sound color—or, to the physicist, spectral distribution of components, or waveform. *Loudness* is perceived intensity of sound.

There are also periodic and aperiodic changes to be considered: *vibrato,* a recurrent pitch change; *tremolo,* a recurrent loudness change; *portamento* or *glissando,* one-time pitch changes that may cover wide ranges of frequency. And there are timbre variations like those produced by the "wow-wow" mute on jazz trumpets and trombones.

Most of these changes are under the player's control. But some are built right into the instrument, a part of its design, and they are what help us identify it as a violin or clarinet, pipe organ or tambourine. Much early electronic music lacked these clues, and simultaneously most of the interest that conventional instruments have, so it sounded intolerably dull and artificial. Its pitch and timbre were too regular and mechanical.

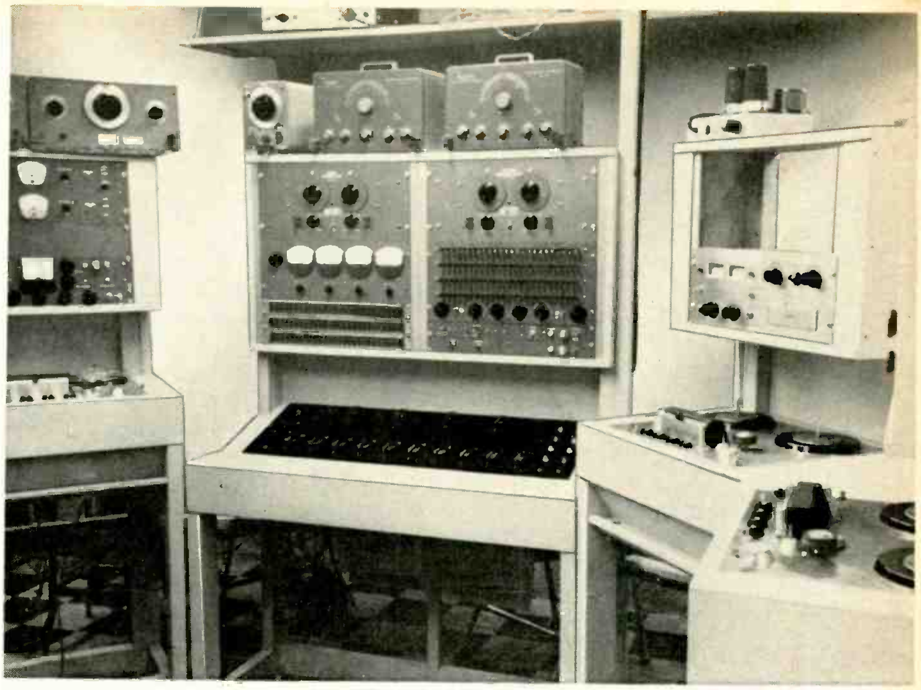
For in electronic music, *everything* is variable and must be specified—even noises. A good example is the "chiff" of a pipe organ—the initial transient made by the inrush of air into the pipe. Its lack on electronic organs made them easily distinguishable from pipe organs, until designers developed circuits to synthesize the chiff.

A few more terms: *steady-state* refers to all the characteristics of a sound including periodic variations like tremolo or vibrato if they're there—that exist from some moment after it starts to some moment before it ends. *Attack* includes characteristics of the beginning of a sound; *decay,* the end. These are *envelope* changes. *Crescendo* and *diminuendo* (or *decrescendo*) are "getting louder" and "getting softer"—which may extend over several sounds. They are superimposed on attack and decay loudness changes.

Now how are sounds produced electronically? What instruments are used?

Sounds which are electronic transformations of natural sounds, as in the *Musique Concrète* of Schaeffer and Henry, are highly complex varying events on which variations have been superimposed, or whose rate of existing variations has been changed. This method makes available a tremendous variety of effects, but the composer is stuck with his raw material—he must accept all of the characteristics of the original sound.

Direct electronic synthesis lets the composer control each characteristic of each sound, including any variations he may care to introduce. Let's spend the rest of our space on music produced by that kind of process.



Partial view of the newest of the three studios of the Columbia-Princeton Electronic Music Center. In the center is a 10-channel mixing panel with 10 line inputs switchable to any one of four outputs. A total of 10 playback channels is available from 5 Ampex tape transports. On the right of the mixing panel is a remote starting device for 4 tape recorders. Among the unique devices shown on the right center panel is an elaborate 4-channel pushbutton selector that makes it possible to hear a signal at any one of 25 points in the mixing system on one or more of the four loudspeakers. Thus a signal may be heard progressively through many stages of transformation by merely selecting the appropriate button. Also shown are two Krohn-Hite variable band-pass filters, (top instrument in each of the two center racks) a remote control for an EMT 140 reverberation unit, a panel controlling variable speed drive for tape recorders, some of the sine and square wave oscillators, and a patch panel.

There are two approaches: *additive* synthesis and *subtractive* synthesis. In the first, sine waves of desired frequencies and intensities are mixed with wideband or band-limited noise (if noise is wanted). Unlimited control of spectral distribution is possible, so any steady-state pitch-and-timbre combination may be built up. In subtractive synthesis, a single sawtooth wave of a frequency equal to the lowest-frequency component desired is passed through filters to accentuate or suppress harmonics at will. Because all the frequencies in a sawtooth wave are harmonically related, this method is limited to making harmonically structural sounds. But a combination of the two methods is often used, adding non-harmonic components to harmonic ones. Having enough oscillators to synthesize *anything* additively would be expensive, but the subtractive method simplifies the synthesis of the basic harmonic structure.

Other waveforms than sawtooth can be used in subtractive synthesis. Square and triangular waves, for example, lack all the even-numbered harmonics. A sine or complex-wave carrier may be modulated by another sine or complex wave with a balanced modulator. The result is an output containing sum and difference sidebands, and *they* can also be filtered in a subtractive-synthesis process.

A *tone shifter,* which is essentially a single-sideband generator for audio frequencies, has been developed by L. Heck of the Südwestfunk, Baden Baden, Germany. It allows a composer to transpose each component of an input waveform the *same number of cycles* up or down. (The number of cycles can be varied.) Note that here harmonics are not transposed proportionally, but by a constant numerical value. The transposed upper harmonics are no longer strictly harmonics (they are no longer harmonically related to the fundamental), and the tone sounds decidedly different. As you might expect, shifted tone structures with their new timbres are tremendously interesting to composers.

You can begin to see some of the immense practical problems an electronic composer has. So far we have been talking only about steady-state pitch and timbre combinations. If a composer needs a complex system of generators and filters for his music, he must make a forbidding number of adjustments to produce pitches in a musical scale or graduated and systematic changes of timbre. This obstacle has brought about much investigation of control methods.

Voltage control of oscillators and filters shows much promise if tracking errors can be reduced. Voltage control could be done through a keyboard, as on an organ, where a composer wants *real time* control over a large body of equipment. (Real time is a computer phrase which in electronic composition means that the music is composed in time with the composer's ideas, so to speak, so that his hearing the music he creates influences the composition.) But this is an instrumental approach—performing skills are required. Programming methods are the ultimate form of control, and much depends on how easily changes can be introduced into the program.

One major topic we haven't touched on yet is how steady-state pitch-timbre sounds are converted into discrete musical "notes". Gating and modulation techniques are often used. At one time, tape editing was used—bits of tape recorded with desired waveforms were spliced together, sometimes with bits of blank tape or leader between, to produce rapid bursts of sound when played back. A long diagonal splice would make a smooth transition between sounds. But these methods are often cumbersome—it is much nicer to be able to program these envelope changes at the same time as pitch and timbre are specified.

The electronic techniques used to do this are basically simple. Control signals to voltage-controlled oscillators produce vibrato and periodic timbre variations. Tremolo and envelope changes, as well as large volume changes, are usually made with variable-gain amplifiers. Some interesting results have come from gating a tone with a single, slow shaped pulse whose amplitude changes conform to the envelope changes desired in the tone.

Photoconductive cadmium sulfide and cadmimum selenide cells have been used as resistive elements in variable attenuators. Modulation patterns can then be drawn on a transparent substrate which is then moved between the cell and a light source.

All this need not be as laborious as it sounds. The effort decreases with increasing flexibility in the programming capabilities of the composer's equipment. Composer Milton Babbitt has produced compositions on the RCA Sound Synthesizer with hardly any tape editing except for splicing together successive recordings which had been programmed on two 40-channel paper charts. Programmed information was read by the Synthesizer at a maximum rate of 32 samples per second, and characteristics of sound were developed basically by subtractive synthesis.

But in the average studio, mixing, copying, editing are still necessary. Top audio quality is essential, for errors and distortions multiply through many generations of rerecording. Tape speed must be continuously variable (usually by varying the frequency of the ac power to the capstan motor). Most other recording techniques are just like those of any broadcast or recording installation, except that four or more simultaneous recorded channels are commonplace.

What of the future? The most enticing development—which may very well make present techniques obsolete—uses a high-speed digital computer to produce musical sounds and music directly. This method, pioneered by J. F. Pierce, M. V. Mathews and others of Bell Labs, consists of specifying mathematically the characteristics of desired waveforms, and, by suitable programming, rapidly calculating a result that is a digital approximation of the actual waveform. Digital-to-analog conversion filters out the sampling noise and produces a recording which can then be played as music. Real-time inefficiency and high computer time costs are drawbacks now, but they will be overcome. Then this most elegant of all approaches to electronic music bring a widening of musical horizons as great as that brought by electronic music itself. END

REFERENCES

Books

Harry F. Olson, *Musical Engineering*. McGraw-Hill Book Co., 1953.

Alan Douglas, *The Electrical Production of Music*. McDonald, 1957.

Articles

Harry F. Olson and Herbert Belar, "Electronic Music Synthesizer," *The Journal of the Acoustical Society of America*. May 1955, p. 595.

J. R. Pierce, "Computer as a Musical Instrument," *Audio Engineering Society Journal*. April 1960, p. 139.

James C. Tenney, "Sound generation by means of a digital computer," *Journal of Musical Theory*. Spring 1963, p. 24.

Vladimir Ussachevsky, "The Processes of Experimental Music," *Audio Engineering Society Journal*. July 1958, p. 202.

Modifying The Knight C-100 CB Transceiver

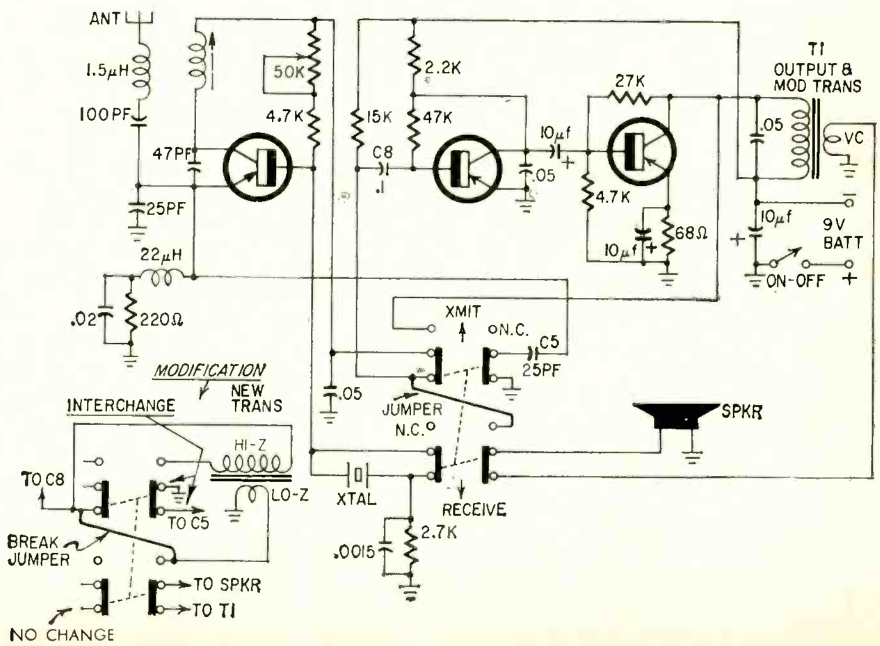
By W. G. ESLICK

If you want more modulation—which means a clearer signal and more range—follow these suggestions.

In the TRANSMIT position, the speaker is used as a mike and is coupled through C8 to the base of the first audio transistor, which is a terrific mismatch. Installing a common transistor-to-speaker transformer (salvaged from a junked portable) backward will give more modulation. Solder it to the speaker frame so it mounts between the speaker and the end of the case.

The diagram shows the switch as it is on my units. *Others may be different.* Anyway, on the diagram there is a (printed-circuit) jumper connected as shown. Cut this in two with a razor blade or sharp knife. Now rewire the circuit as shown in the modified schematic.

The change is very simple and the results are well worth the effort. END



Now—A 117-Volt Transistor Radio

IN THE FEBRUARY "NEW SEMICONDUCTORS and Tubes" department, we introduced a new line of RCA transistors—three small-signal p-n-p germanium types and an n-p-n silicon power type—designed as a complement for an ac–dc table radio to be operated directly off the power line. Also included in the family is a silicon rectifier.

This month, we present the circuit of such a set, taken from RCA application note 1CE-313 9-64, revision 1, available from RCA Electronic Components & Devices, Harrison, N. J.

The circuit (Fig. 1) is relatively conventional up to the audio driver stage. The driver (Q3) is a high-gain germanium type, direct-coupled to an n-p-n silicon power transistor (Q4) as the audio output stage. The power transistor receives nearly the full peak rectified line voltage—about 160 volts minus about 20% drop through R14, the rectifier, T5's primary and R15. The driver is a common-emitter stage. Its collector gets a negative voltage through R13, the collector load, and the base-emitter junction of Q4 via chassis ground; the emitter is returned to the positive side of the supply via R12, a bias-stabilizing resistor, and R16, a dropping resistor for the driver and the earlier stages. Bias for the driver is taken through R11 from the output stage emitter resistor R15; R10 establishes a minimum bias current through R11.

The fact that the bias supply point for Q3 is the emitter of Q4 and not ground (the most negative point) establishes a dc negative feedback loop which stabilizes the operating points of both transistors. (There is no ac feedback, because of bypass capacitors C17 and C18.)

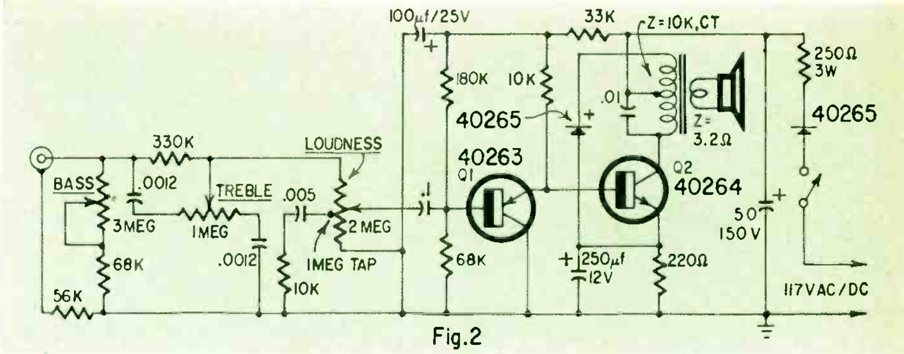


Fig.2

Half the output transformer winding is used as a normal output transformer to feed the speaker. The other half develops a voltage, at the end opposite the center tap, equal to the instantaneous peak collector voltage but opposite in polarity (phase). Normally, because the entire transformer winding is at a much higher positive potential than the emitter of Q4, the silicon diode (the same type as the rectifier) is reverse-biased and does not conduct. When a sudden high-amplitude transient (due to "hash" or lightning interference) passes through Q4, the diode breaks down momentarily, putting R15 and C18 across the lower half of the transformer winding. This damps the pulse before it has a chance to generate an inductive kick that might damage Q4.

C20 is the usual "tone control" capacitor, added to reduce hiss and harmonic distortion.

A different circuit that uses the same two audio transistors is the 1-watt phono amplifier shown in Fig. 2. There, Q1 is connected as an emitter-follower (common-collector) driver for Q2, the silicon output transistor. In this circuit there is no overall dc feedback; the emitter follower's high inherent feedback stabilizes the circuit enough.

Experimenters:

Data are given in the RCA application note for rf, oscillator and i.f. transformers T1 through T4 (Fig. 1), but they are for factories or prototype model shops with commercial coilwinding machines. The exception is T1, the antenna transformer, which is 150 turns wound 6 inches long on a ⅜-inch diameter ferrite rod. It should tune to 535 kc with 135 pf. The secondary (Q1 base) winding is 10 turns. Wire size is not given, but No. 30 to 34 should do nicely. You may be able to find suitable i.f. transformers and an oscillator coil from among the stock items made by J. W. Miller, Stancor, Merit or Lafayette.

A recent *Allied Semiconductor Directory* gives the prices of Q1, Q2 and Q3 as around 40 cents each; Q4 is $1.20 and the rectifier is 35 cents.

Radio sets of this general design can be expected to appear on the market very soon. Prices will be extremely low—one manufacturer expects to sell his set for about $6—and the radios are not intended to be serviced. END

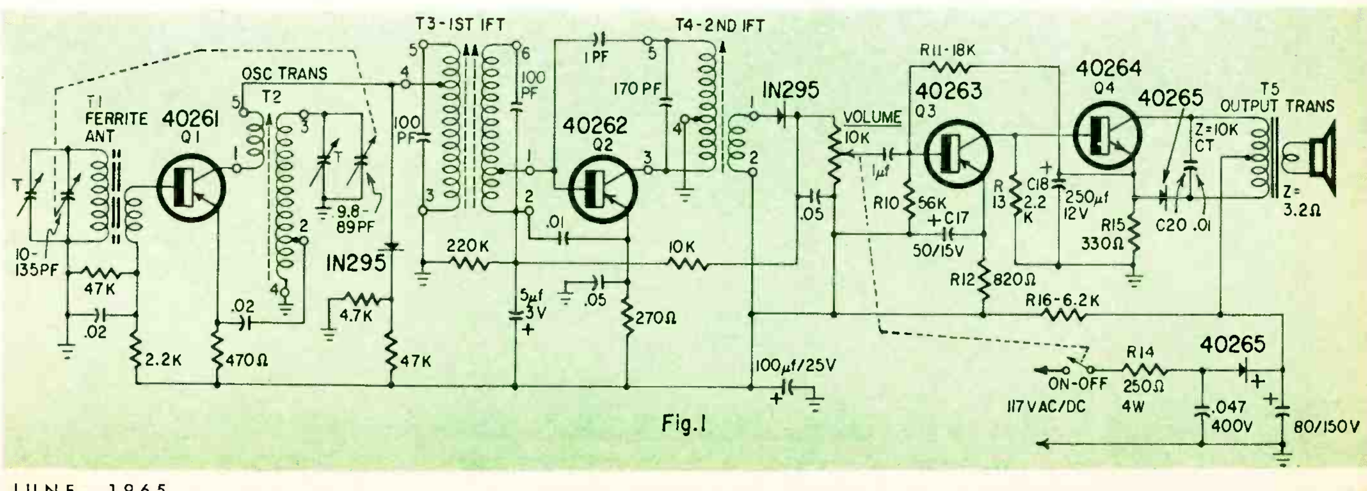
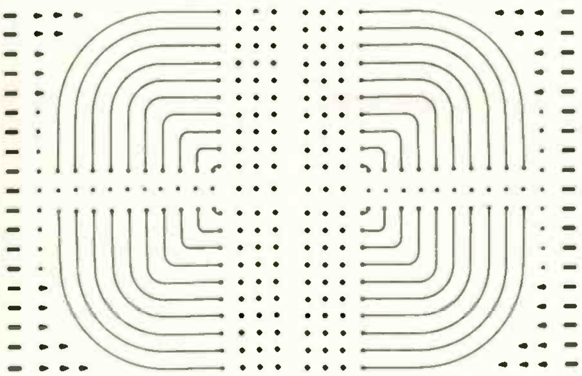


Fig.1

Professional Printed Circuits Without Photography

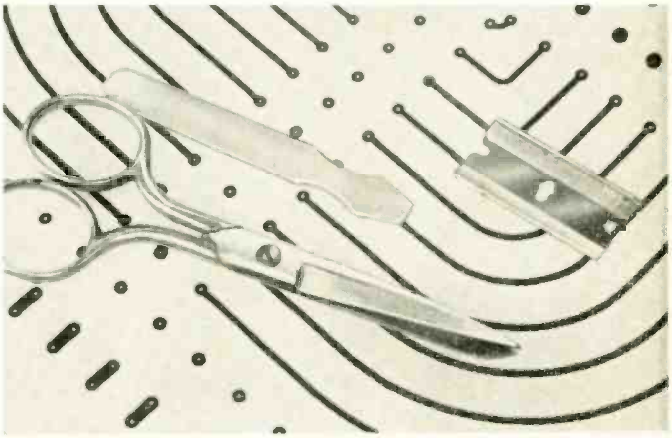
By ELMER C. CARLSON

One drawback to using ordinary tape or hand-drawn resist for making printed circuits is the ragged pattern you get when the etching is finished. Acid seeps under the edges of the resist material and eats into the edges of the copper because the resist material often doesn't adhere tightly enough.

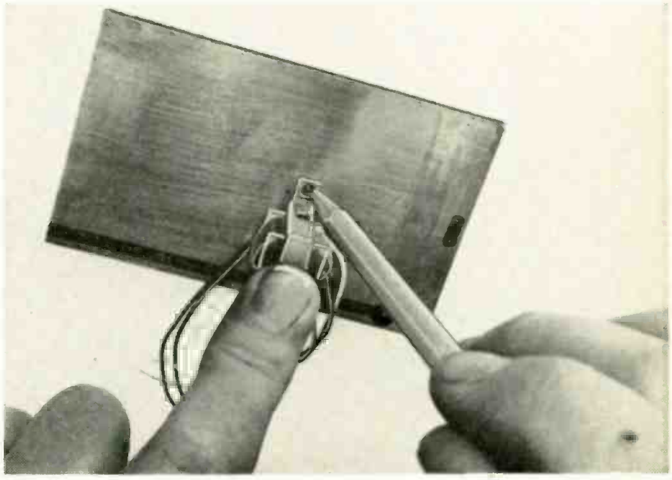


Using ready-made press-on resist patterns like the Etchtronics type above (from Prestype, 136 W. 21 St., New York 11, N.Y.) and Vectoresist (Vector Electronic Co., 1100 Flower St., Glendale, Calif.) will give you much neater printed (etched) circuits, and usually in less time, too. These pattern sheets are handled by art and drafting supply stores. For the name of a dealer in your area, write to the manufacturers.

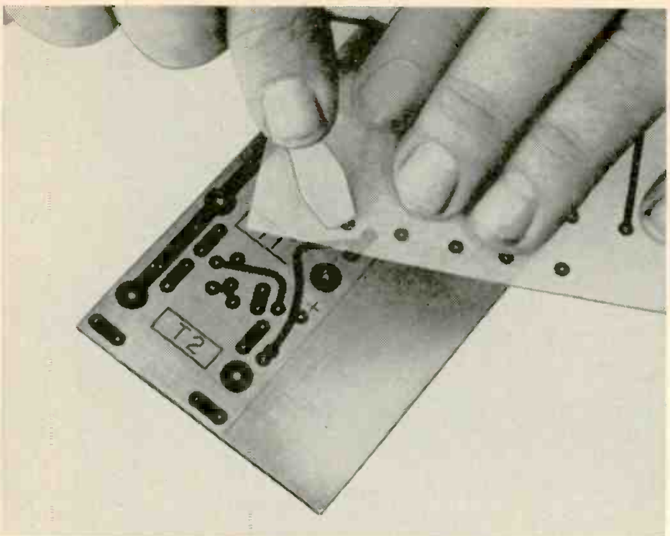
The only preparation the copper laminate needs is a cleaning with soap, water and fine (No. 000) steel wool. Tools needed



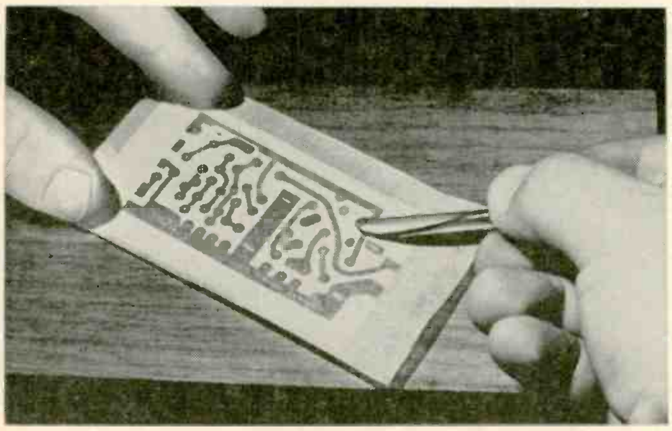
to lay out the resist pattern are few—a razor blade, a pair of small sharp scissors, an icecream stick as a burnishing tool (or a ballpoint pen) and a pencil. While scissors and razor blade are not a necessity, small snipped-out sections are easier to handle than a whole 12-by-16-inch sheet.



With one-sided copper laminate it is customary to mount the components on the plain side of the board. This requires the circuit to be laid out "upside down". Components with several connections, such as controls, transformers and transistors, must be laid out as viewed from the bottom. Mounting holes of symmetrical components can be marked right on the copper side with a pencil. Other components may require quite exact measurement if they are to fit the drilled mounting holes properly.



Once the basic parts layout is made (it can be done on a scrap of paper first), it's simple to apply the appropriate resist patterns by pressing them in place after they have been positioned. Even parts numbers, test points or other permanent identification can be added from other dry-transfer sheets, as were "T2" and the "+" sign.

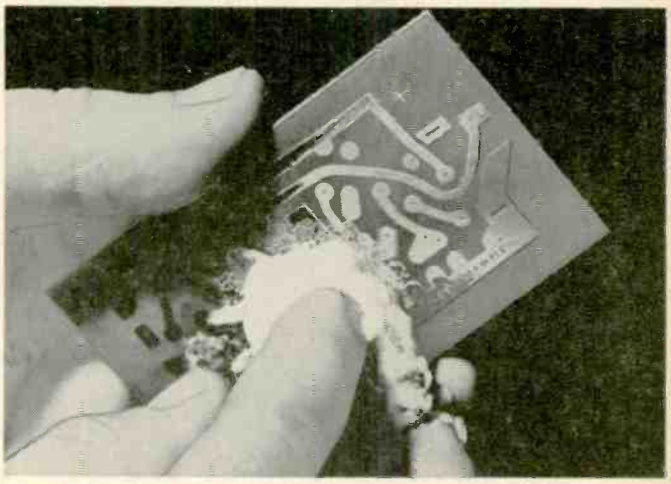


After all resist patterns are in place, burnish them again to insure positive, acid-proof contact with the copper laminate. A piece of the specially treated red protective paper must be used between burnisher and pattern to prevent the resist patterns from being lifted from the copper surface.

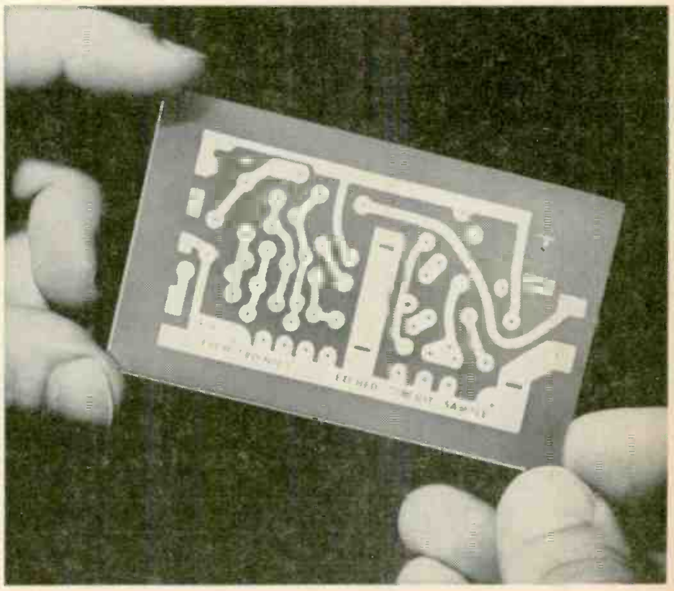
After all portions of the resist pattern have been burnished, follow the normal etching procedure.

An etchant, like ferric chloride, is put into a nonmetallic tray (those used for photo processing are suitable) and the copper laminate is submerged in the solution. Frequent agitation and a temperature of 90° to 120°F will make the etching more uniform and speed it up.

When etching is complete, the laminate is washed and rinsed to remove all traces of the etching chemicals. It is wise to let running water flow over the board for a few minutes.



Additional cleaning with soap, water and fine steel wool will remove the resist from the unetched copper underneath. Inspect the board to be sure that no thin copper bridges are left between close adjacent conductors.



The board is now ready for drilling and for mounting the components. **End**

Build a Solid State Muscle Stimulator

Single-transistor pulse generator does wonders for stiff, sore or long-unused muscles

By SAM BRESKEND

IT ALL STARTED DURING A TWO-WEEK stay in a hospital. The diagnosis: "disc syndrome." The treatment and therapy were probably no different from that received by hundreds of other people in hospitals for that affliction. (The place was just full of disc syndromes.)

What made my stay so fascinating was a piece of electronics used to exercise the muscles of the lower back. Imagine—effortless exercise! Just relax and let the electronic gadget do it all! With each successive treatment the old spine became more nearly normal. This machine had aroused my curiosity so much that I actually looked forward to the next treatment.

One by one, I asked doctors and nurses questions about this unit, and they in turn, one by one, began treating me as though I were some sort of a nut. I sent a note to the manufacturer. A prompt reply informed me that home units sold for no less than $149.50 and that some of the deluxe models, incorporating diathermy and ultrasonics, cost upward of $1,500.

All was not lost, however. In listing the various virtues of their particular equipment, manufacturers intimated that these units were proprietary items. A list of patent numbers confirmed their claims to these circuits. Immediately, I compiled a list of the numbers and sent it to the United States Patent Office, with 25 cents for each patent I wanted. (This sort of skulduggery is practiced every day by industry. It is probably the simplest method a manufacturer has to determine just what is new and interesting in his competitors' future lines. These documents are a storehouse of information and are worth every penny of their cost.)

All the patents had one thing in common. The circuits devoted to muscle-stimulating all used blocking oscillators to generate the output pulse. But nowhere in the disclosures were any figures given for frequency, pulse width or output amplitude. Without knowing any of these, an experimenter would probably get all shaken up before optimizing the circuit. I was discouraged.

Some time later, discussing this miracle-worker with friends, I learned that one of them had purchased a unit sold as a muscle toner. I borrowed it im-

The complete Stimulator with its sink-drain electrodes in the foreground.

See AUG - P 14, OCT P 12, DEC 10

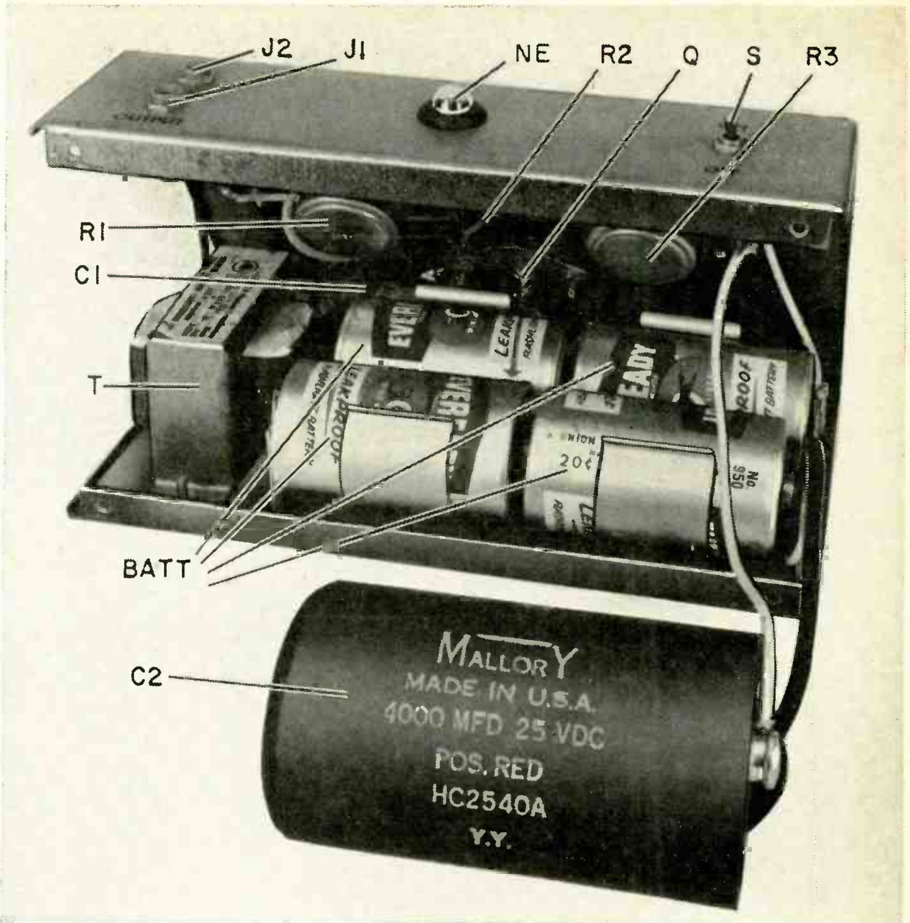
mediately, and found:

1. Raw ac on the oscillator plate
2. Width of output pulse, 1 millisecond
3. A double pulse every $\frac{1}{60}$ second
4. Pulse output amplitude 300 volts (into open circuit)
5. Internal impedance approximately 2,000 ohms
6. A 6-second on–off time, controlled by a small clock motor.

With such factual data on a commercial unit at hand, I felt a new surge of interest. Any unit I built, I decided, should be portable and transistorized. But I couldn't find any articles describing blocking oscillators that produce a 1-msec pulse. Another deterrent was the lack of pulse transformers for a circuit of this type. Transformers at electronic jobbers are all in the microsecond range.

I decided I would have to start from scratch. I knew what I was trying for, so I set about figuring out how to get there. I wanted to use a 6-volt supply—four inexpensive D-size flashlight cells.

The transistor had to switch the entire current in the primary of the transformer. That came to 2.34 peak amperes. The 2N301-A (or 2N2870) fits this specification very well with its 3-amp maximum collector rating. Actually, the maximum duty cycle, or *on* time, of the transistor is only 6%, so it is being used well within its maximum current rating.



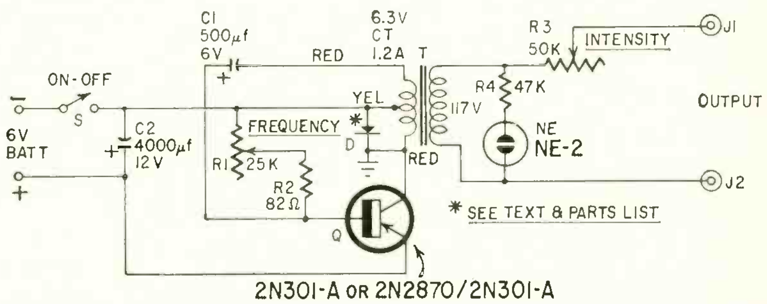
Bottom view shows most components. 4,000-µf capacitor fits in space over batteries.

Pulse width would be determined mainly by the inductance of the transformer. The feedback capacitor (C1) would have to be large, to insure that it would not narrow the pulse. The turns ratio of primary to secondary should be equal to the ratio of supply voltage to output voltage desired—in this case, 6 to 150, or 1 to 25.

The best transformer turned out to be a small 1.2-amp filament transformer. Output pulse width and amplitude when loaded with the required 2,000-ohm resistor vere 0.3 msec and 125 volts.

Some further experimenting with a different transistor proved interesting. When a 2N1100 transistor was inserted into the circuit, the pulse width in-

C1—500 µf, 6 volts, electrolytic
C2—4,000 µf, 12 volts, electrolytic
D—1N648 (G-E), 1N2070 (or 10D4—Int'l. Rect.) or other 400-piv silicon rectifier
J1, J2—banana or pin jacks
NE—NE-2 neon lamp
Q—2N301-A (RCA, Delco) or 2N2870/2N301-A (RCA)
R1—pot, 25,000 ohms, linear
R2—82 ohms, ½ watt, 10%
R3—pot, 50,000 ohms, linear
R4—47,000 ohms, ½ watt, 10%
S—spst switch
T—filament transformer: 6.3 volts, 1.2 amps, center-tapped (Stancor P-6134)
Battery—four size-D flashlight cells or equivalent
Case and hardware



Circuit of the Muscle Stimulator. With method of mounting shown in photographs, collector of transistor is electrically connected to the cabinet. This is harmless, but be sure that no other components are connected to the cabinet. Or, mount transistor with insulating mounting kit (mica insulator and extruded fiber washers).

Report on the Muscle Stimulator

I am the editorial staff's most accident-prone man-about-the-house so RADIO-ELECTRONICS' managing editor assumed I would be the logical one to test the muscle stimulator. He was so right!

The electrical performance was close to the author's specifications. The speed range is variable from 12 pulses per minute to around 60 per second. Maximum pulse amplitude was around 146 volts with the electrodes 8 inches apart on the lower calf.

Each pulse causes muscles in the vicinity of the electrodes to contract momentarily. It appears that it is this rhythmic contraction that brings relief to sore muscles. The intensity of the contraction depends on the amplitude and frequency of the pulses. Both can be adjusted by the patient. Muscle contractions are plainly visible before the intensity reaches an uncomfortable level.

The stimulator was first used in an effort to ease the pain of a "trick knee". Results were questionable—possibly because of the small area in which the pain was localized. My next mishap resulted in a sprained muscle in the lower back that prevented me from sitting or standing more than about an hour at a time. I believe that frequent use of the stimulator helped to relieve the stiffness and ease the pain.—**Robert F. Scott** creased by 0.1 msec because of the lower saturation resistance of the 2N1100. If that caused so marked an effect, why shouldn't the same be true of the internal impedance of the power supply? With this in mind, I connected a 4,000-μf capacitor across the power supply. The pulse width was now 0.5 msec and the output amplitude had risen to a full 150 volts.

I put the 2N301-A back to optimize the only remaining component that could possibly affect pulse width —the coupling capacitor. I had previously decided hastily that 100 μf would be sufficient to have a negligible effect on pulse width. I was way off. When I shunted a 4,000-μf capacitor across this coupling capacitor, the pulse width increased by a factor of at least 6. I had completely neglected the fact that the input resistance of the 2N301-A is only about 20 ohms!

My final choice was a 500-μf capacitor. The design was now complete.

Two potentiometers mounted on the front panel control frequency and amplitude. Frequency is variable from ¼ pulse per second to 60 pps. Amplitude can be varied from a point where no sensation is felt up to the point that causes involuntary movement of excited muscles. The diode across half the primary of the transformer limits the back swing of the pulse after the transistor has stopped conducting. Otherwise, the sharp spike could burn out the transistor.

The 6-second on–off feature was not incorporated in this model because of the added cost. You can turn down the amplitude control to suit your convenience—that does the same thing. The double-pulse feature of the commercial unit was not considered necessary for proper operation.

To use the stimulator, attach the disc probes (I used sink strainers) directly to the different parts of the body with wet sponges. The best method of determining just what the unit is capable of doing and what can be expected is to place the probes, with the sponges, under one forearm, and gradually increase both frequency and amplitude with the other hand.

Don't use this unit carelessly or indiscriminately. It is possible to pull tendons loose from their moorings or damage muscles from overfatigue. The stimulator should be used with discretion, preferably under a doctor's guidance. A safe rule to follow when using this instrument is to adjust the intensity control only up to a point that causes no discomfort.

The whole idea reminds me of the penny arcade with its shocking machine. This machine had two big brass handles with a voltage between them. The voltage on the handles (and across the contestant) increased as he brought them together. If he could make it all the way, a gong would strike to announce his triumph! END

THYRATRON WITH BLACK BOX

ANY GOOD ELECTRONICS MAN KNOWS that a thyratron acts like a switch. When the dc grid voltage is varied, the tube, at a certain critical point, passes suddenly from full to zero conduction. However, in this common motor control circuit, varying the dc grid voltage causes the thyratron conduction to change gradually, allowing motor speed to be adjusted smoothly from zero to full speed. A Black Box in series with the grid-cathode circuit contains the secret. The thyratron is a standard type. Sounds like a puzzle?

The Black Box contains a simple phase-shifter circuit (Fig. 1). This circuit consists of a center-tapped transformer, a resistor and a capacitor. The values of the resistor and capacitor are such that the output of the Black Box is ac that lags the anode (plate) supply for the tube by 90° (Fig. 2). As the dc grid voltage is changed, this ac grid signal is shifted "up" or "down" with respect to the critical grid voltage for the tube. (The dc grid voltage acts as the axis for the ac grid signal.)

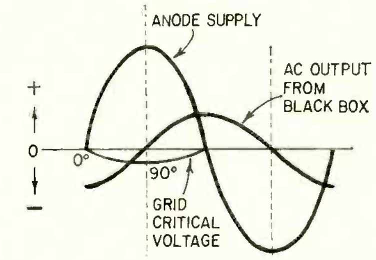


Fig. 2—Grid voltage, which reaches grid via "box", lags anode voltage by 90°.

When the ac voltage is moved up by a positive-to-grid dc voltage, it crosses the critical grid-voltage line sooner. (Fig. 3-a.) The thyratron is allowed to fire (conduct) earlier on each half cycle, and the average voltage applied to the motor armature is higher. This causes the motor to run fast. As the positive-to-grid voltage is reduced, or made negative, the ac moves down. Since it now crosses the critical grid line later in the half cycle, the tube fires over a smaller remaining part of each half cycle (Fig. 3-b), voltage to the armature is reduced, and the motor slows down.

Note that the Black Box output must be 90° lagging. Try drawing the waveforms with any other value and you will find that control cannot be had over the entire half cycle. This is a common industrial control principle, called "vertical" phase shift.—*Dellroye D. Darling*

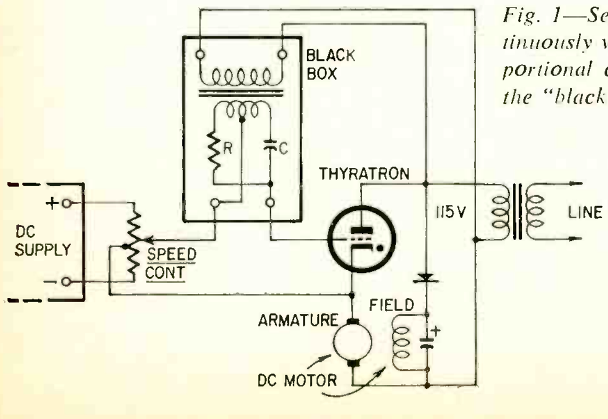


Fig. 1—Secret of continuously variable proportional control is in the "black box."

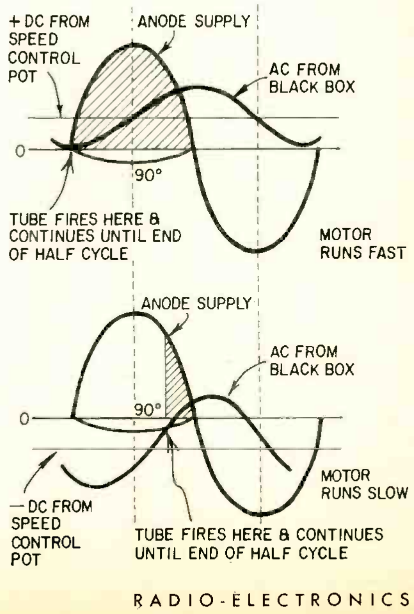


Fig. 3—Ac control voltage from black box "slides up and down" with dc.

Output Circuit Protection For Transistor Amplifiers

How manufacturers try to keep power transistors safe under overloads and output shorts. A new RCA circuit for ideal protection

By **PETER E. SUTHEIM**
Associate Editor

IF YOU TRY TO DO SOMETHING DRASTIC to high-power output tubes in an amplifier, like shorting the speaker terminals, you'll find them quite forgiving. A momentary short rarely does any harm, and sometimes you can short a tube output stage for many minutes or even indefinitely without trouble.

An *open* output can cause spectacular—and destructive—flashovers in tubes, sockets or output transformers. (But a hefty 50- or 100-ohm resistor across the output terminals is all you need to eliminate opens as a source of trouble.)

Transistors are more temperamental. By now almost everyone who works with power transistors has been cautioned *not* to short the speaker terminals —even for a moment.

Warnings, though, aren't always enough. For some people, a caution against is an invitation to (and there are always accidents). So sensible amplifier designers have tried all sorts of ways to idiot-proof transistor output stages.

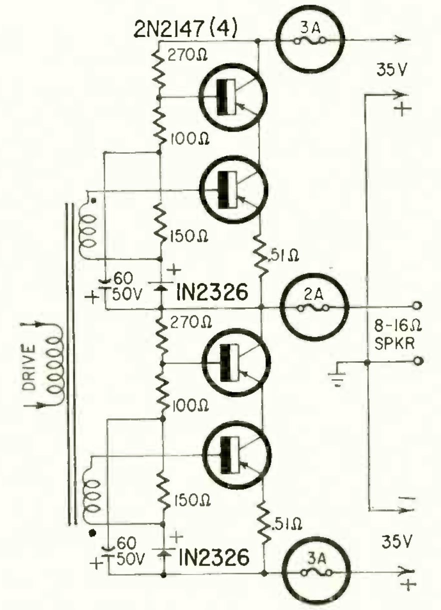
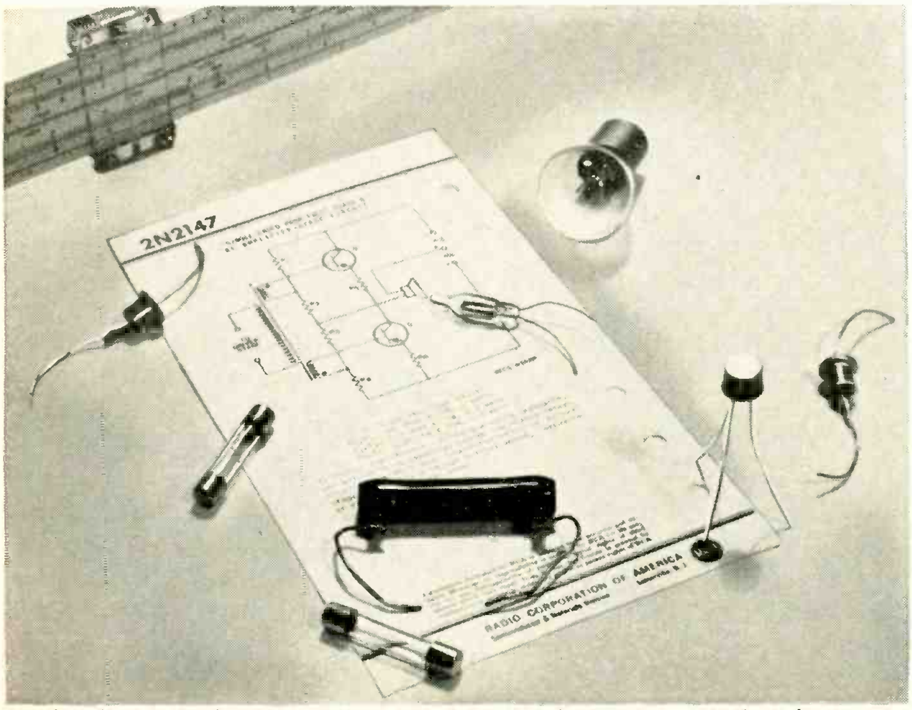


Fig. 1—Output of Bogen RT1000 is fused.

First and most obvious is to fuse the stage at some strategic point—say, in the power supply line or directly in series with the speaker. Fig. 1 shows such an approach. It is used by Fisher, Eico, Bogen and by manufacturers of low-priced package systems. Fast-acting fuses are best here, because it is no great trick to turn an expensive transistor into a useless glob of germanium during a fraction of an audio cycle. Fusing is certainly the simplest, least expensive approach from the manufacturer's standpoint, but a bit inconvenient from the user's; a momentary short across the speaker terinals means the fuse has to be replaced. And often a fuse can't blow fast enough.

Some engineers tried thermal circuit breakers, used exactly like fuses—in the supply line or in series with the speakers. Again, the difficulty was that breakers often don't act fast enough. The transistor became the fuse, saving the circuit breaker from overload! Sometimes temperature-compensating diodes in the output transistor bias networks would blow—but they, too, are more expensive than fuses.

Some relatively quick-draw breakers are being used in the Heath AA-21. They do not eliminate *all* danger from shorts, though.



Diodes, fuses, transistors, resistors, tiny circuit breakers—all are used to keep power transistors from destroying themselves.

Electronic methods

The Lafayette LA-200 uses an interesting approach that calls for a few extra electronic parts, rather than circuit breakers. The method is shown in Fig. 2. It amounts to an electronic circuit "shorter" rather than a "breaker". The audio signal current in each output stage flows through the 1-ohm emitter resistor of the bottom transistor of each output stage. (Only one channel is shown here—both channels share the same circuit.) This produces an ac voltage drop proportional to the voice-coil current. The voltage is rectified into a negative dc voltage, which is applied, after filtering, to the base of a p-n-p transistor. The emitter of that transistor

See Sept p 16

is grounded through a silicon diode, and its collector goes to the power supply point for intermediate amplifier stages.

If one or both of the amplifier's output stages are working harder than they should (as they would if driven to severe overload, or if the speaker lines were shorted), the current through the 1-ohm resistor is greater than it would be during normal operation, and the signal drop across it is higher. Hence the rectified negative dc is also higher—high enough to bias the protective transistor into conduction as it overcomes the threshold voltage of the diode in its emitter.

As soon as the protective transistor conducts, it practically shorts the intermediate-amplifier supply voltage to ground. This kills the drive to all later stages and rescues the sweating output transistors. The time constant built into the R-C network between the rectifying diodes and the protective transistor makes the whole operation cycle on and off about twice per second until the short or overload is removed. This can go on indefinitely, according to the manufacturer, without harm to any part of the amplifier.

The system used in the recent KLH model Sixteen stereo power amplifier seems to work every bit as well as the Lafayette approach, and has one overwhelming advantage: simplicity.

In Fig. 3, notice the 0.33-ohm resistor in series with the speaker and ground. (Again, only one channel is shown.) So far, the scheme is the same as Lafayette's: the resistor "samples" the signal output current and produces a voltage drop. From the "hot" end of that resistor there is a negative feedback loop back to the emitter of the driver stage, through two parallel back-to-back silicon diodes. These, like all semiconductor diodes, have a small threshold voltage (usually about 0.7 volt) that must be overcome before they can conduct in the forward direction. Until then, they are effectively open circuits.

This means that the loop is just not there at all until the ac "sample" is great enough to exceed the threshold voltage of the diodes. When the amplifier's output current rises above the expected normal maximum, the diodes conduct and throw heavy negative feedback around the last two stages, removing almost all the audio drive to the output transistors, which just sit there and wait until the user takes out that strand of wire from between the speaker terminals.

Some engineers feel that this circuit can cause increased distortion at high signal levels, as one or both of the diodes begin to conduct on peaks.

One of the simplest, most foolproof approaches of all is used by Harman-Kardon in some of its recent amplifiers. The fuses in the circuit of the A1000T are there only in case of direct power supply shorts; they are not expected to blow with amplifier overloads. The amplifier output stages use silicon transistors whose ratings are not exceeded even when the amplifier is driven to overload, with a dead short across the output terminals. (In the opinion of Robert E. Furst, chief engineer of Harman-Kardon, fuses cannot be made to act fast enough to protect power transistors reliably.)

In another approach, Harman-Kardon has designed the driver to overload before it can put out enough power to push the output transistors into their danger zone.

The light-bulb trick

A simple and fairly effective method used in a Knight (Allied Radio) transistor amplifier combines overload protection with thermal stabilization. The output circuit of the Knight KG-870, for example (Fig. 4), is a balanced, single-ended-push-pull class-B "half-bridge" circuit. The usual emitter resistors (usually about 0.27 to 0.68 ohm) have been replaced by selected 6-volt tungsten-filament lamps. They have a positive temperature coefficient (their resistance increases with temperature), so that, as current through each output

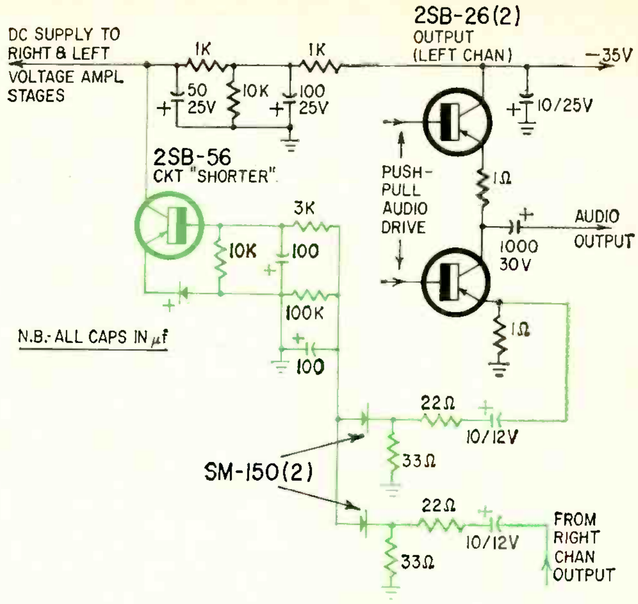


Fig. 2—Lafayette LA-200 uses electronic "shorter" to kill drive to output transistors in case of shorted or too-low load.

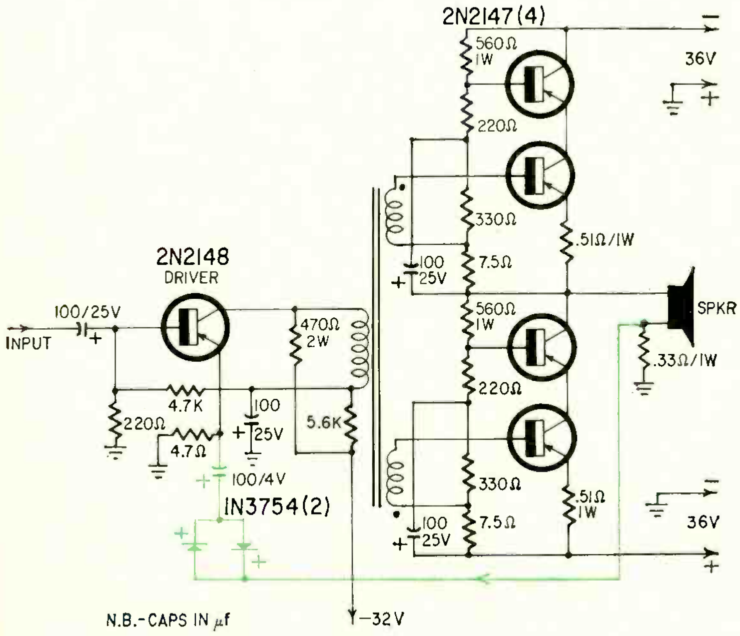
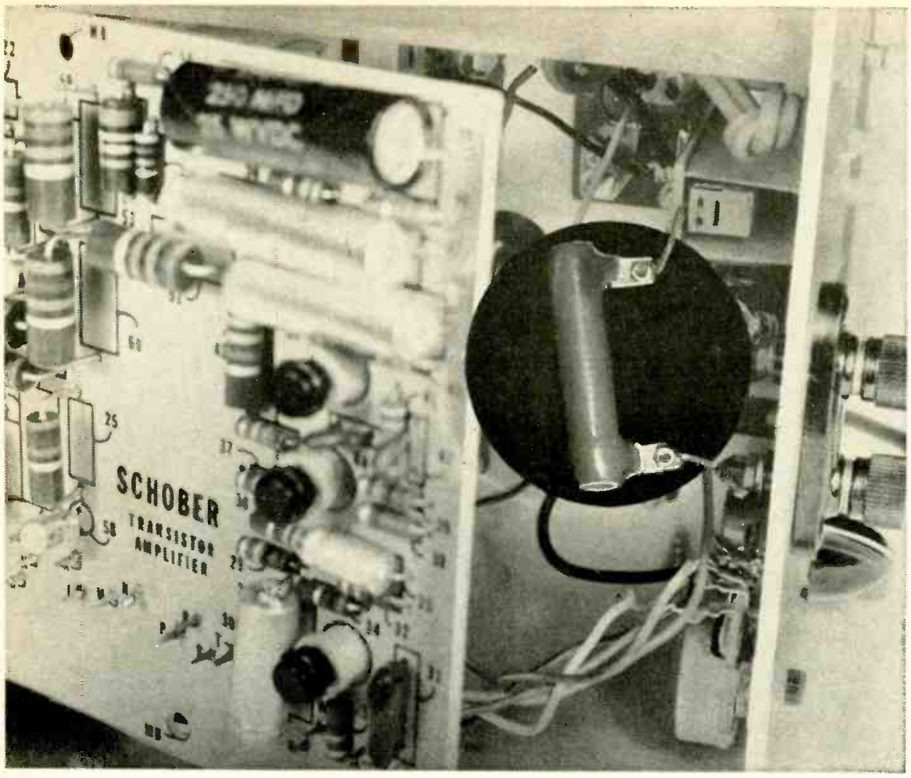


Fig. 3—KLH uses diode "safety valve", which remains nonconducting until signal current in output circuit exceeds safe level.



One secret of protection in Schober TR-2: this ordinary wirewound resistor. (See text and Fig. 5.)

transistor increases and the lamp filament gets hotter, circuit resistance increases and tends to oppose the rising current. At the same time, increased drop across the filament cancels some of the base-emitter forward bias, helping to hold down collector current. This amounts to degenerative dc feedback and helps keep the output stage stable with changes in ambient temperature, sustained high signal levels and changes in power supply voltage.

The lamps' thermal characteristic protects the output transistors against mild overloads. In case of a serious overload, the lamps will burn out, just like fuses, only faster—in about 70 milliseconds, which is claimed to be fast enough to protect the alloy-junction output transistors used in that amplifier. (Certain transistor designs, like the RCA drift-field 2N2147 and 2N2148, are more vulnerable.)

A particularly straightforward and successful approach is used in the Schober TR-2, a monophonic 40-watt transistor amplifier designed for reliability in electronic organ installations, where sudden transistor failure could be highly embarrassing. It's diagrammed in Fig. 5. A 0.3-ohm 10-watt wirewound resistor is in series with the speaker. Also in series, in the other speaker lead, is a 0.24-ohm resistor, the pickoff point for a current-feedback loop to the driver transistor's emitter. These resistances, with the 0.51-ohm emitter resistors in the lower transistor of each series pair, help to hold down the maximum current that can flow through the transistors in case of a short across the output with a high signal current to the output stage.

Furthermore, as signal current increases, so does the negative current feedback to the driver, which tends to keep the drive (signal) current down to safe levels.

The system is foolproof except when the output transistor junctions are already near their maximum temperatures. Then a slight overload may be enough to push them over the brink into destruction.

At least one manufacturer—Eico—feels that any truly reliable protection would raise the price of transistor amplifiers to a point where they couldn't compete with tube amplifiers—or non-

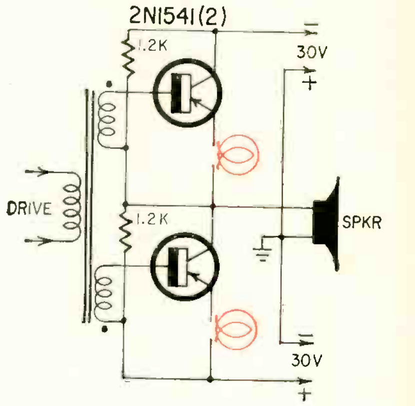


Fig. 4—Some Knight amplifiers use tungsten lamps for temperature compensation and short-protection.

protected transistor models. A conservative estimate is that complete protection for even a relatively low-power stereo amplifier which uses split-power-supply output circuitry (like that of the KLH or others diagrammed in this article) would raise the retail price by some $20. That's a lot of extra money to shell out for protection against possibilities that just may never occur.

Why so much? Eico's refusal to go

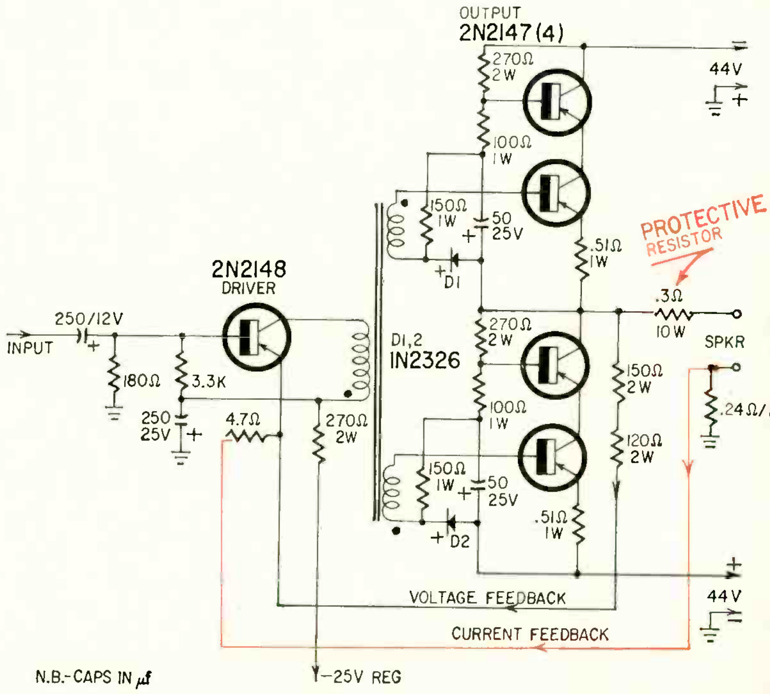


Fig. 5—Schober TR-2 has combination of resistive protection and current feedback.

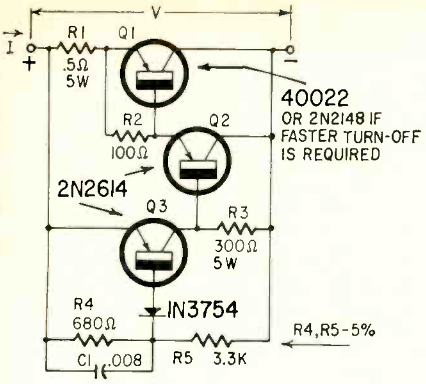


Fig. 6—Recently developed RCA current-limiting breaker turns off in about 100 μsec.

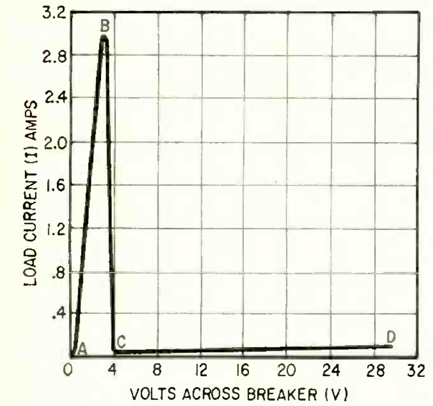


Fig. 7—Voltage vs. current characteristic of RCA breaker—see text for explanation.

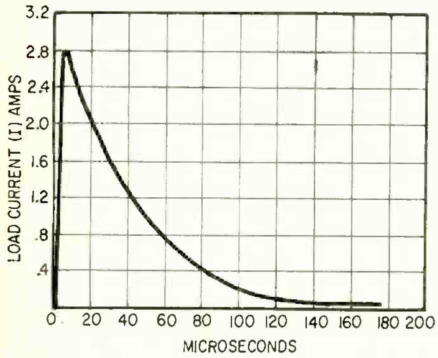


Fig. 8—Limiting and turn-off characteristics of RCA circuit in Fig. 6.

along with the protection racket is based heavily on a paper by an RCA engineer[1]. This paper points out that the immediate cause of all transistor failure in this kind of circuit is too much current, whatever may have initiated the trouble (shorted ouput, high transients, etc.) Then: "Destruction of the transistor may occur *in a few microseconds or less* after the failure mode is initiated." (Italics ours)

The writer goes on to say that simple circuits can limit the drive signal or sense a too-low load impedance, but that is not enough. "The ideal protection circuit should limit maximum transistor current. . . . To be reliable, the circuit should react more quickly than the fastest rise time of current expected. Current limiting should begin within a few microseconds after a failure mode is initiated, and the power supply should be disconnected within 100 microseconds after limiting occurs."

No fuse at a price within reason can do that. The only answer so far has been an ingenious—but comparatively costly—"electronic circuit breaker" described in the same paper (see Fig. 6). It uses three transistors, one of which is a power transistor and requires some heat-sinking, a diode, five resistors and a capacitor. Its action is ideal, though, as shown by the curve in Fig. 7.

Normally, when total current through R1 and Q1 is less than 3 amperes, the circuit behaves like a low resistance in series with the supply line to the output stage. Q1 and Q2 are held in saturation by the bias developed across R3. Q3 is off because the voltage across R4 is not high enough to overcome the offset (threshold) voltage of Q3 and the 1N3754 diode in the base circuit.

When the current draw from the power supply through R1 and Q1 reaches a predetermined level (about 3 amps in this case—point B on the curve), the resulting voltage drop V produces enough voltage across R4 to turn on Q3. The drop across R3 then increases, reducing the bias on Q1 and Q2 so that they start to cut off. As the voltage V increases to the value shown at point C in Fig. 7, Q3 becomes saturated and Q1 and Q2 are cut off completely. When the voltage drop across the breaker is between points C and D, the breaker acts as a high resistance in series between power supply and amplifier. All this happens in approximately 100 microseconds (Fig. 8).

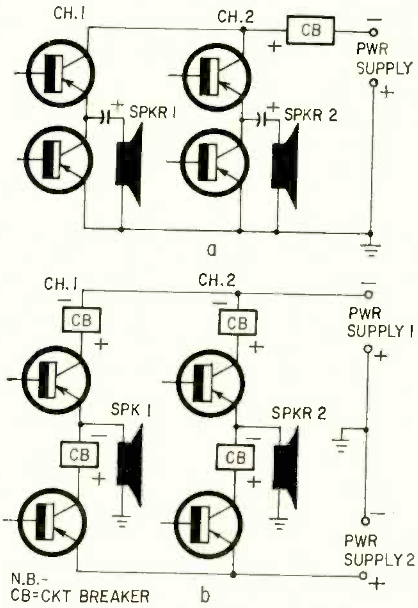


Fig. 9a—In capacitor-coupled speaker circuits, with their single-ended power supplies, one breaker can do, except that it must limit only above the peak current for both channels. This means that for safety, all four transistors must be rated at twice normal peak current, because if overload occurs in one channel, breaker will not trigger until current through it exceeds that normally drawn by two channels operating at maximum signal level. b—Popular class-B output circuit with split power supply requires four breakers.

It will stay that way as long as the drop across R1 and Q1 remains at point C (Fig. 7) or higher. A bleeder must be used to keep pulling current through the breaker, otherwise it will continually reset itself and destroy the output transistors anyway. The proper approach is to make reset impossible until the power supply has been turned off.

For the most popular output circuit, *four separate breakers* of the kind just described are necessary for complete protection! (Fig. 9.)

Until transistors become immune to maltreatment, engineers will spend almost as much time designing protective systems as they spend on output circuits themselves. We'll keep reporting on new circuits and devices. END

[1] M. S. Fisher: "Protection of Transistors in Class B Audio Output Stages". IEEE Transactions on Broadcast & Television Receivers, Vol. BTR-10, No. 3, Nov. 1964. Material used by permission.

NEUTRON RADIOGRAPHY COMPLEMENTS X-RAYS

A new method of taking television pictures enables scientists to look through a lead wall and detect a stream of water flowing on the other side. The new neutron radiography system has been developed by the Rauland Corp. (a subsidiary of Zenith) and Argonne National Laboratory.

Neutron radiography was introduced at Argonne about 2 years ago by physicist Harold Berger, and has become a valuable research tool. It is essentially the opposite of X-rays. Thermal (slowed-down) neutrons go through heavy elements like lead, bismuth and uranium that stop X-rays, but are themselves stopped by hydrogen, lithium, boron, and other light elements which are quite transparent to the X-rays. A combination of neutron radiography with an image-intensifier tube makes this system practical for a wide range of uses, including observation of motion. The output of the image intensifier is picked up by a television camera and displayed on the screen of a closed-circuit TV monitor. Previously, the neutrons bombarded a screen, which was made radioactive by the impact of the neutrons. The radiation pattern on the screen was then transferred to a piece of photographic film by contact printing. END

Scientists are working to develop an efficient semiconductor lamp that may one day be used for home and street lighting

By CYRIL HILSUM*

Two gallium arsenide lamps (rear) and two small semiconductor lasers. In the background, a British threepenny piece (slightly larger than a US cent) for size comparison.

Semiconductors for Illumination?

LAMPS ARE PROBABLY THE MOST WIDELY used electrical devices today. While their chief use is illumination, great numbers act as indicators or optical sensors in control systems. A successful semiconductor lamp could replace tungsten lamps for some of these purposes, and might be more effective in such operations as high-speed computing.

The ideal source of light for a lens or mirror system is a monochromatic point. The tungsten lamp is far from that. In fact, it's a most inconvenient source. Gas discharge lamps and spark sources may meet particular needs, but are also deficient on several points, particularly ease of operation.

Semiconductor lamp

The simplest form of semiconductor lamp would convert electric current directly into radiation. It would work by electroluminescence. At least two effects might be used—the Destriau effect and the Lossev effect. Destriau found (in 1936) that light was emitted when he applied ac to a capacitor structure which contained zinc sulfide particles embedded in a dielectric. Lossev produced light by applying direct current to a crystal of silicon carbide.

Up to a year ago, nearly all work in this field was on the Destriau effect. This led to the development of electroluminescent panels. Such panels are inefficient, not very bright and have a short life. The Destriau effect does not seem likely to give us a general-purpose lamp. The Lossev effect (discovered in 1923), is easier to understand and to use.

How junctions make light

Two processes of electrical conduction may occur in a semiconductor. The current may be carried by the negatively charged electrons. In that case, the semiconductor is n-type. It may be carried by the positively charged electron vacancies, or "holes". The material is then p-type. A crystal may be prepared with a sharp gradient of impurity concentration, and an abrupt change from p-type conductivity to n-type at the p-n junction.

When a negative bias is applied to the n-region, electrons flow across the junction into the p-region, and "holes" in the opposite direction. The injected carriers recombine rapidly with the "majority carriers" (the ones that carry most of the current) and give up their excess energy. The recombination energy is equal to the energy required to free an electron from its parent atom, and is a characteristic of the particular semiconductor. It is known as the activation energy, or "energy gap".

In most semiconductors, electrons and holes can recombine only if the carriers interact with the atoms of the crystal. In these semiconductors, the recombination energy takes the form of heat.

But a more direct recombination process occurs in some semiconductors. The carriers recombine directly with each other. Most of the recombination energy is then emitted as light. We must choose materials in which the recombination process is direct to obtain a pronounced Lossev effect.

There are several simple ways of distinguishing between the two types of

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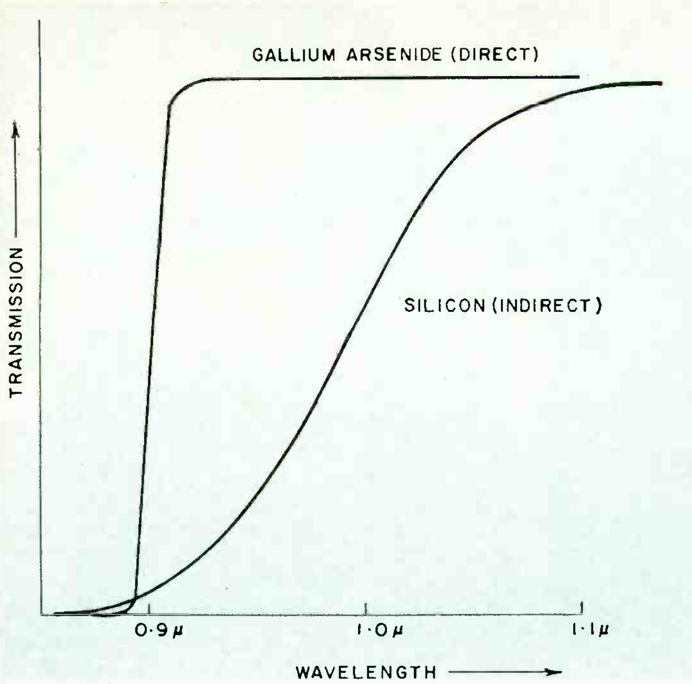


Fig. 1—Direct recombination materials and indirect ones are distinguished by the sharp knee in the light-transmission curve as the wavelength of the light is increased.

semiconductors. At wavelengths where the photon energy corresponds to the energy gap, all semiconductors show a change in the transmission-wavelength curve. In direct-recombination materials, the change is particularly sharp (Fig. 1).

Some materials which are thought to recombine directly are listed in the table, together with their energy gaps and the wavelength of the radiation they might be expected to emit.

Only materials with an energy gap less than 1.5 electron-volts can be prepared as both p- and n-type. There is therefore at present no direct-recombination binary compound that would give a lamp emitting visible radiation. But we can alloy direct-recombination materials such as gallium arsenide with indirect-recombination materials of larger energy gaps such as gallium phosphide. In this combination the direct-recombination property persists until 50% of the phosphide is present, and the energy gap is t[illegible]2 electron-volts. Our present technology should, therefore, allow us to make infrared lamps at wavelengths as low as 7 microns, and visible lamps emitting in the red.

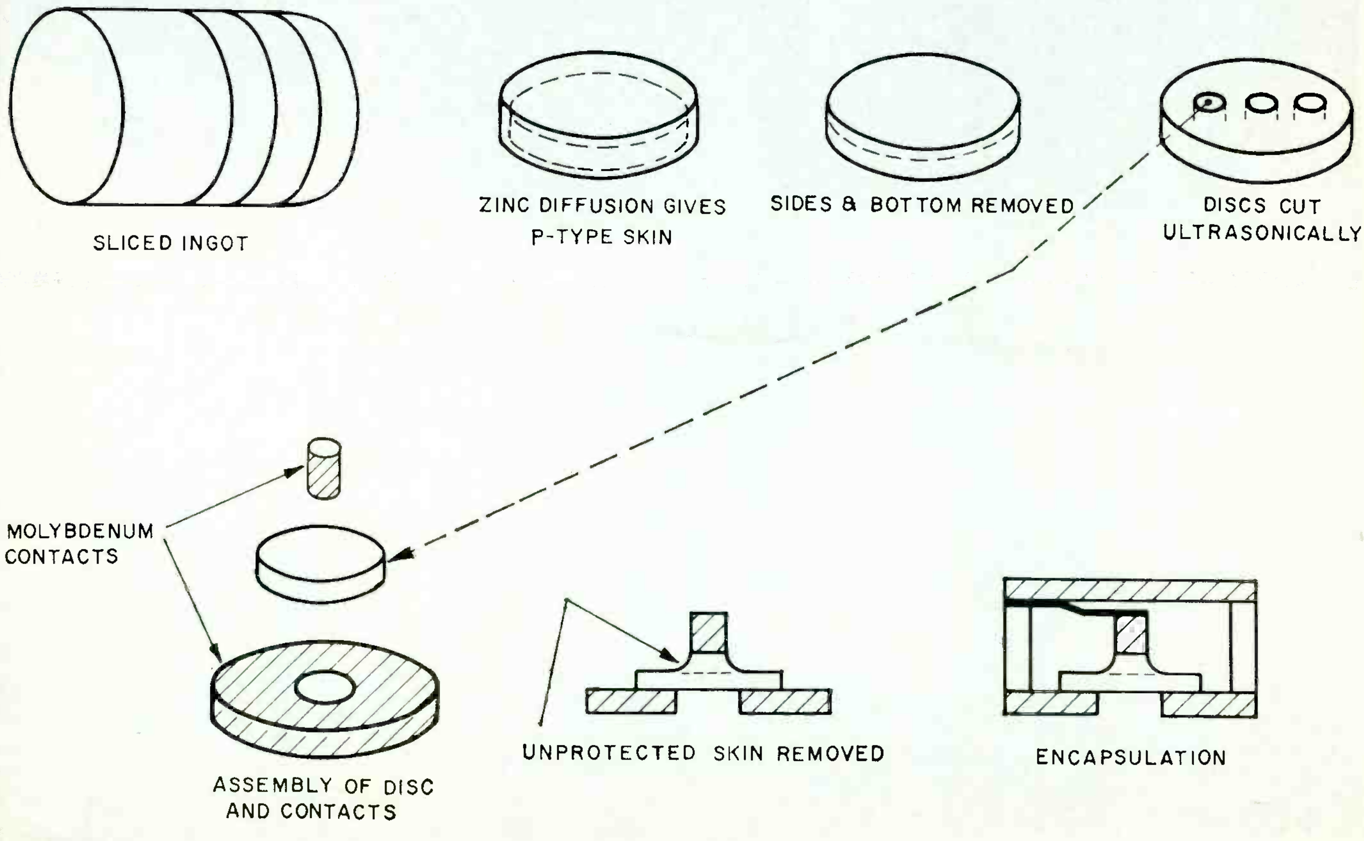
Experimental lamps

Most of the work in making semiconductor lamps has been concentrated on gallium arsenide, because that is the direct-recombination material with the most advanced technology. A lamp is generally made by diffusing zinc into heavily doped n-type gallium arsenide (Fig. 2). Some lamps are shown in the photograph.

The maximum reported efficiency is only 2%, and the brightness is not high. The mean brightness is about 1 watt per square centimeter, but, since the lamp can respond to very short current pulses, peak brightnesses 100 times greater are possible.

Lamps comparable in performance to the gallium arsenide devices have

Fig. 2—Steps in making one kind of semiconductor lamp.



been made from indium phosphide, gallium antimonide, indium arsenide and indium antimonide. Alloys of gallium arsenide with indium arsenide have given radiation in the near infrared, at wavelengths between 0.9 and 3 microns.

Progress on lamps emitting visible radiation has been less striking. Gallium phosphide red or yellow lamps have been available for some time, but their efficiency is only .01%. Since gallium phosphide is not a direct-recombination material, this low value is not entirely unexpected. Lamps from zinc selenide have been shown to emit visible light, but are still in a very early stage of development.

The laser approach

If we have already converted most of the electrical input into radiation, we can increase the brightness of the device only by persuading all of this radiation to be emitted from a small area of the diode. If most of the light were emitted in the plane of the junction, there would be a large geometrical gain. This becomes feasible if we can selectively amplify light traveling in the junction plane.

We can think of light amplification as the inverse of absorption. In absorption, a photon impinges on an electron population and creates a free electron and a hole, while giving up its own energy. Light is amplified if the photon persuades a free electron to recombine with a hole and give up the recombination energy as an additional photon, which is then identical in all respects with the original photon.

In thermal equilibrium the conditions in the semiconductor favor absorption. But when high densities of electrons and holes are injected into the semiconductor, absorption is no longer probable and amplification becomes quite likely in the recombination region near a p-n junction. At these current densities, any photon emitted spontaneously when an electron and a hole recombine will be amplified, provided it travels in the plane of the junction. The extra photon is identical with the first, so that it too travels in the same plane and can also be amplified.

If reflectors are added at the two ends of the junction, a portion of the amplified light is reflected into the active region. It travels to and fro as a growing wave until saturation occurs. Hence we have a laser; the light output is coherent, polarized and spread over a small wavelength. But its main interest, as far as we are concerned, is that it is extremely bright and quite efficient.

Materials in which the recombination of electrons and holes is believed to be direct (Values are appropriate for room temperature)

MATERIAL	ENERGY GAP (ELECTRON-VOLTS)	EMITTED WAVELENGTH (THEORETICAL) (MICRONS)	
Indium antimonide	0.18	7.0	infrared
Tellurium	0.33	3.8	infrared
Indium arsenide	0.36	3.4	infrared
Gallium antimonide	0.67	1.8	infrared
Indium phosphide	1.3	0.95	infrared
Gallium arsenide	1.4	0.90	infrared
Zinc telluride	2.2	0.56	yellow
Aluminum arsenide	2.3	0.54	green
Cadmium sulfide	2.4	0.52	green
Zinc selenide	2.6	0.48	blue
Zinc sulfide	3.7	0.34	ultra violet

The first semiconductor lasers were made of gallium arsenide, but indium phosphide, indium arsenide and indium antimonide lasers have been fabricated, too. Alloys of gallium arsenide with either indium arsenide or gallium phosphide have also operated. Some gallium arsenide lasers are shown in the photo.

At liquid air temperature the peak brightness of a gallium arsenide laser is commonly well over a megawatt per square centimeter, and the mean brightness is over 10,000 w/sq cm. These figures are much higher than any given in the table. The efficiency of a laser at 77°K (−196°C) is about 40%, so it is certainly a bright and efficient source.

Semiconductor lasers can operate at room temperature, but their efficiency is lower, and they will work only at very high current densities, between 100,000 and 1,000,000 amperes per square centimeter. The peak brightness is about a megawatt per square centimeter. High mean brightness has not yet been achieved.

This survey of progress in making lamps from semiconductors shows that we can make infrared sources that are efficient, bright and convenient, though possibly not all at the same time. We have not advanced far along the path toward visible semiconductor lamps. Let's look at progress in that direction, and the prospects for the future.

Visible light

Scientists at the Joffe Institute in Leningrad are studying ternary compounds such as zinc silicon arsenide and zinc germanium phosphide. It has been established that the energy gap is the right value for a yellow lamp, but the nature of the recombination process is not yet known.

The two main American laboratories working in this field, those of General Electric and the Radio Corporation of America, are both concentrating on zinc selenide. It is not possible to make a p-n junction in zinc selenide, so attempts are being made to grow layers of p-type zinc telluride on n-type zinc selenide, and also to make a junction between copper selenide and zinc selenide. Lamps have been made by these processes, but the efficiencies are low.

The most promising alternative to zinc selenide for yellow lamps involves aluminum arsenide and alloys of this compound with gallium arsenide; some work along these lines is under way at the Standard Telephone Laboratories, Harlow (Britain).

The prospects for blue-green and blue lamps are not good, because we know of few direct-recombination materials with a large enough energy gap. Silicon carbide, the semiconductor Lossev used in 1923, can emit blue light, and might be useful as a lamp if its efficiency were higher.

What of the future?

Today, we can already see applications for semiconductor lamps and lasers. Gallium arsenide lamps will be used for tapes and card readers, and for more than one type of automatic control equipment. (See page 70, this issue.) "Optoelectronic" computers that use light pulses as signals may be expected in the near future. The filament lamp is an anomaly in transistor circuits, and will start to disappear in the next few years.

Development of visible lamps for illumination will depend on further progress, but we may anticipate red lamps becoming available as indicators. An efficient red semiconductor lamp would be useful as a rear lamp for motorcars—though we can hardly expect it within the next few years. Workers in electroluminescence would like to see houses completely equipped with semiconductor lighting panels, but this may not come about for a long time, if ever.

We have already seen the transistor taking over from the vacuum tube. It is not unreasonable to expect semiconductors to replace the closely related tungsten-filament lamps, and the next few years should show some very interesting steps in that direction. END

A veteran service technician invites you to witness a few things that make life worth living!

Come Along on a CB Service Call

By F. J. MIVEC

I HEARD THE PHONE RINGING MADLY—like maybe someone had blown a gasket. I checked the clock: 2 minutes till 8.

"Whoever it is certainly wants service in a hurry," I thought. I threw the door closed, rushed for the phone and knocked over the service file, which in turn knocked the phone off the cradle. But I managed to come across with a cheery, "Good morning, Radio Communications Company." I heard a grunt: "This is the dispatcher at Sam's Trucking. We're having trouble with truck No. 12. Can you come right down and take care of him before he goes back out on deliveries?"

"What seems to be the trouble? Can't he transmit?"

"Nope, he sure can't," said the dispatcher. "I call him, and when he goes to talk, all I hear is a voice way far away—like he was over a hill and down in a well."

"Does this happen all the time, or just once in a while?" I asked. I was hoping it was a constant condition, not one of those intermittents. I had had more than my share of that particular kind of "dog" lately.

"It seems to get worse the farther he gets from the terminal. When he's sitting here at the dock, his radio acts OK," said the dispatcher, "but let him get about 2 or 3 miles off, and down she goes. Just like he was sitting inside the cab, holding the mike out the window and talking very softly."

"What time does the truck pull out?"

"Nine o'clock."

I told him I would be right down.

When I pulled into the docks, I headed straight for truck No. 12 and trouble. "This is a simple case of low power output," I told myself. Setting up the field-strength meter in the window of my service truck I could see it conveniently, I jumped into No. 12 and turned the set on. Absolutely nothing happened.

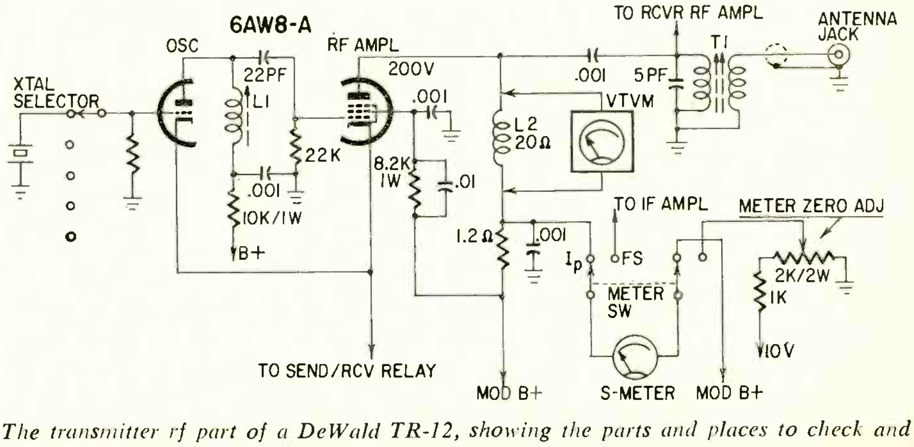
I'd forgotten to turn on the ignition; the radio wouldn't work without it. I started the engine and watched the set warm up. Switching the crystal over to channel 5 (Class D service), I keyed the transmitter on and gave a long, high whistle into the mike. The FSM in my truck hit midscale, but the one on the panel of the radio almost pegged. "Well," I thought, "something's rotten." I released the mike button, switched over to channel 4, keyed the mike and got the same thing. Just to be sure, I went to channel 10 and tried once more. Still the same.

Killing the engine, but turning the ignition back on, I hopped out of the truck and jumped into my own to get my throughline wattmeter. I got back in No. 12 and disconnected the antenna lead-in at the radio. Connecting the wattmeter in series with the radio and the antenna, I keyed the set on and again whistled loud and long into the mike and observed the forward power output of the transmitter. The meter needle swung up to 3.5 watts—only to fall off rapidly but consistently. Holding the mike button down for a while longer, I noticed that the power gradually fell to nil. Rekeying it quickly only caused the meter needle to jump slightly and settle on the needle rest.

Since not only the wattmeter but both field-strength meters read nothing, I was fairly certain the transmitter was as dead as the proverbial doornail. So, pulling the set out of the truck, I slipped it on the workbench in my own truck. I hooked up 12 volts to it and again waited for it to warm up. I then connected the dummy load to the antenna terminal, keyed the set on and again whistled. Wow! The power output was at least 4 watts now. I kept whistling into the mike for about 5 or 6 seconds and the power held. Both field-strength meters were registering a high output, and were holding steady.

I released the mike button and thought a while. "What could cause this power to hold so well in my truck—and at 4 watts output yet—and not do so in truck No. 12 with the engine off?" Well, for one thing, I knew that if either of the transmitter rf tubes were voltage-sensitive, their output would fall off. Or it could be a bad vibrator. It might even be a component breaking down under load. (I remembered a similar case where a cathode resistor in the rf amplifier of a high-power FM rig slowly increased in value as the transmitter was held on. This caused the output power to drop as the resistor heated up and allowed less and less plate current to flow.)

I checked the A voltage (12-volt supply) in my truck and then in truck No. 12. Truck No. 12 had only 11.5 volts and mine had 12.1 volts. Well, that could make all the difference in the world. Then I lowered the voltage in my truck by turning the battery eliminator and disconnecting the truck's battery from the bench. When I keyed the set, whistled into the mike, and adjusted the eliminator for anything up to 11.8 volts,



The transmitter rf part of a DeWald TR-12, showing the parts and places to check and adjust.

the power dropped off just as it did in the customer's truck. Leaving the eliminator set where it was, I substituted a new 6AW8-A (see the diagram) in the transmitter for the old one. Once more, I tried the transmitter (at 11.8 volts), and it worked fine. So! It was a voltage-sensitive tube after all.

I tuned the transmitter up to the dummy load and rf power output meter by switching from receive to transmit several times and slowly turning L1 counterclockwise a half turn each time for maximum output. After reaching maximum, I carefully turned L1 about one turn more counterclockwise for maximum oscillator stability. I knew that if L1 were left at the point of maximum power output, the oscillator might not take off when the transmitter was keyed on. I then touched up T1 to read maximum on the power meter. I had a good 3.75 watts with a healthy whistle in the mike. Whistling more softly, I got about 3.5 watts—which was good.

I checked the power input to the final by measuring the voltage drop across L2 (which read 20 ohms) with a vtvm. The IR drop was right at 0.5 volt. According to Ohm's law, I figured the plate current to be in the neighborhood of 25 ma. And this figured out to be a power input of about 5 watts. Since this was within tolerances, I let the tuning go at that. After all, the rf output portion of the tube was about 70% efficient. What more could you ask?

So, I put the unit back in Truck No. 12, and checked it out once more with the field-strength meters. And, again the FSM in my own truck registered low, but the one in the radio itself registered high. What could be wrong? Maybe my FSM was bad. Once again I put the wattmeter on the unit and checked out the transmitter. The power was still good. But now I did one thing I didn't have the available power to do before.

Now I was able to check the reflected power (SWR) of the antenna system. Doing this by reversing the element in the wattmeter, I found I had as much reflected as forward power. Well, at last, now I had it whipped. Getting out my trusty Simpson, I found the antenna ground open. And it just happened to be open at the connector where it plugged into the radio. A simple matter of clipping off the connector, heating it up good with my soldering iron to get all the old wiring out, and stripping and properly dressing the coaxial cable.

After I soldered the job, I rechecked with the Simpson to be sure I had a good dc ground to the frame of the truck. Then I put the wattmeter back in the line and tried the transmitter. Power was good forward and absolutely flat reflected. "Wonderful," thought I, "got a good rf as well as a good dc ground." (Sometimes if the solder doesn't get hot enough to flow into the wire mesh on the coax, a bad or intermittent rf ground can develop. And, boy, that can *really* cause more than a few headaches.)

Well, I wrapped the job up, went into the dispatcher's office and had him sign my job ticket. He naturally asked me what the trouble was, and I told him. Actually the biggest trouble was the bad antenna. When the truck was running, the generator was able to deliver a little more juice to the radio—just enough to prevent the tube from failing. And as far as the radio being able to receive—well, the center lead of the coaxial was still acting as an antenna for receiving purposes (as well as the antenna itself).

I told the dispatcher to get a new battery into the truck, or get that one recharged, and everything would be OK with truck No. 12. He said he would take care of it right away before the truck went out. And then he asked me how I would like a cup of coffee. Well, being rather cool from working out in the 20° weather, I readily accepted.

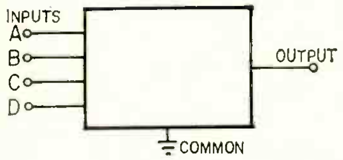
As I sipped the hot coffee, the dispatcher made a remark that all technicians flinch at—just a little. "*Say*, while you're here . . . maybe you could check No. 97. He seems to have trouble hearing me when he gets out aways. And No. 31 says I sound scratchy later on in the afternoon. Could you look into that too?"

Wincing at the prospect of another few hours in the cold, I gulped down the dregs of the coffee and set the cup down on the dispatcher's desk. "Sure," I said, and managed a wintry smile. END

WHAT'S YOUR EQ?

Conducted by E. D. CLARK

Selective Circuit



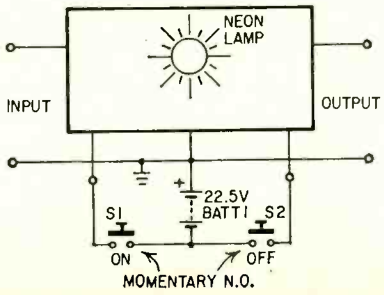
This box has four input terminals and one output terminal. If all of the inputs are made negative with respect to the box, the output is negative. If inputs A and B only or C and D only are negative, the output is zero. If inputs A and C, A and D, B and C, or B and D are made negative, the output is negative.

The box contains no relays, tubes or transistors. What's in the box? (Components are considered perfect.)—*Robert P. Brickey*

Audio Switch

A black box with five terminals is used to switch an af signal ON by momentarily pressing S1, and OFF by momentarily pressing S2. The af signal must not exceed a few volts and a neon-lamp indicator is used to show whether switch is ON or OFF.

The box contains no tubes, transistors, or relays. Also, input and output terminals are interchangeable. Can you draw the diagram of the black box?—*Qutaiba El-Dhwaib*



Two 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 puzzle are on page 79.

50 Years Ago

In Gernsback Publications

In June 1915

Electrical Experimenter

Talking Motion Pictures and Selenium

An Interview with Nikola Tesla

How to Build a Telegraphone Wire Recorder

The Fessenden Radio Station at Brooklyn, N. Y.

The D.C. Arc for Wireless

Things to do when your screen goes green.
Setting up a color set without equipment.

COLOR TV CHECKS WITH NO INSTRUMENTS

By JACK DARR SERVICE EDITOR

IN OUR JANUARY COLOR-TV ISSUE, WE ran an article called "No-Instrument Checks for Color TV", which covered complete diagnosis without test equipment. Now let's find out about *setup adjustments.* The most important of these is *color temperature,* which is another one of those long terms like "chrominance" (color) that I've been trying to avoid. All it means is "Is the screen *black* and *white,* or is it tinted greenish, reddish?" This means an all-over tint, and not random blobs of color (which is a matter of *purity*).

A color picture tube makes a black-and-white picture by making *three* separate ones: red, green and blue. These must be present in the right ratio to get white. (To get black is easy: we turn 'em all off!) That ratio is what we adjust. The controls are on the back apron of the set. Fig. 1 shows them on a typical RCA color chassis, a CTC 11. There are three "screen" controls (meaning the three screen grids of the picture tube), two "drive" controls, green and blue, in the cathode circuits, and a "kine-bias" control, in the control grid(s). There is also a slide switch, marked NORMAL-SERVICE. It is used in color-temperature adjustment; it collapses the vertical sweep. In older sets, this switch will be missing, and you'll find the drive controls marked BACKGROUND. Same thing, at least in the way they're adjusted. Now, let's run a full setup adjustment.

First, turn the three screen controls full off (counterclockwise). Turn the kine-bias control off. Contrast control full off, brightness control about half to three-fourths way up. Turn the switch to SERVICE. You'll need a mirror for this job unless you've got an unusually long left arm.

The screen will be dark. Turn one of the screen controls up until you can barely see a thin horizontal line. Now turn the other two up in the same way. The three lines may overlap or they may not. This is normal. By killing the vertical oscillator, we've changed the convergence waveforms. They'll go back OK.

If one of the screen controls won't make a line on the screen, turn the kine-bias control up just a little bit and try again. Now you'll have to reset the other two. Leave the kine-bias control set as low as possible. Now, turn the switch back to NORMAL, and the raster will come back. Look at the picture. It should be a pretty fair black-and-white.

Turn the brightness control down until you can barely see the picture. It should stay black and white. If you see some color, adjust the corresponding drive control. For example, if the "normal" picture is black and white but the picture turns bluish when the brightness is reduced, turn the blue drive down slightly, or the green up, whichever makes the picture look best. (If it looks reddish, turn blue *and* green drives up, and so on.)

Now the fun starts: we're getting into subjective reaction! Show five people a color TV screen, ask them "How's that for black-and-white?" and you'll get five different answers! (I tried it once, getting them to write it down on cards!) So, the best way, if you're doing a job for someone else, is to sit him (or her) down across the room, and say, "Tell me when I get it black and white!" Webster defines a subjective reaction as "belonging to one's own mind." So, since they're the ones who use the set, make it look black and white to *them.* If it's your own, set it so that it looks black-and-white to *you!* Seriously, the new tubes are capable of duplicating the "color" of a standard black-and-white picture tube screen, which is faintly bluish. Set a black-and-white TV near the color set and try it.

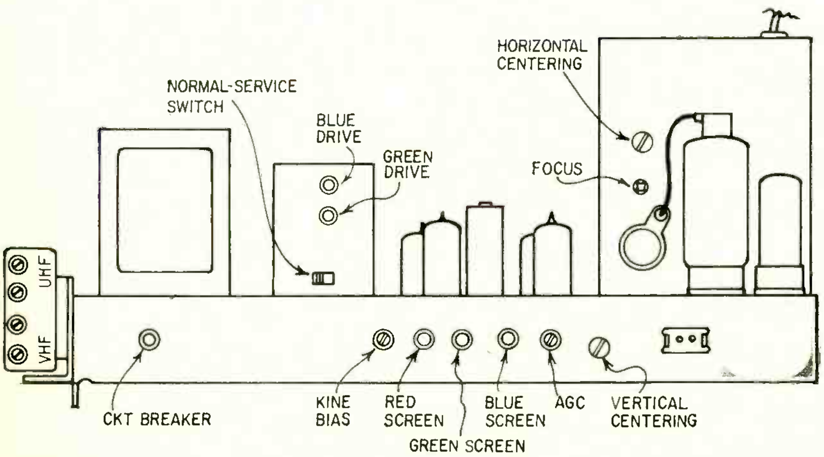


Fig. 1—Color-temperature adjustments, and others, accessible from the back of the chassis. (This is an RCA CTC 11).

The middle-aged set

Color sets now are divided into two main classes: those bought during the boomlet of the last year or two, and those bought several years ago. Up until now, we've been talking about "new-set" problems: things that could be the result of improper installation or setup. Now let's see what kind of troubles we'll run into in the middle-aged group—in a set old enough for some of the parts to have run down a little.

First, and by far the most common, weak tubes. Just like black-and-white: snow, poor sync and so on. Check by replacement, one tube at a time. Odd troubles in the color sections can often be located by checking all the color tubes for grid emission. Because of the

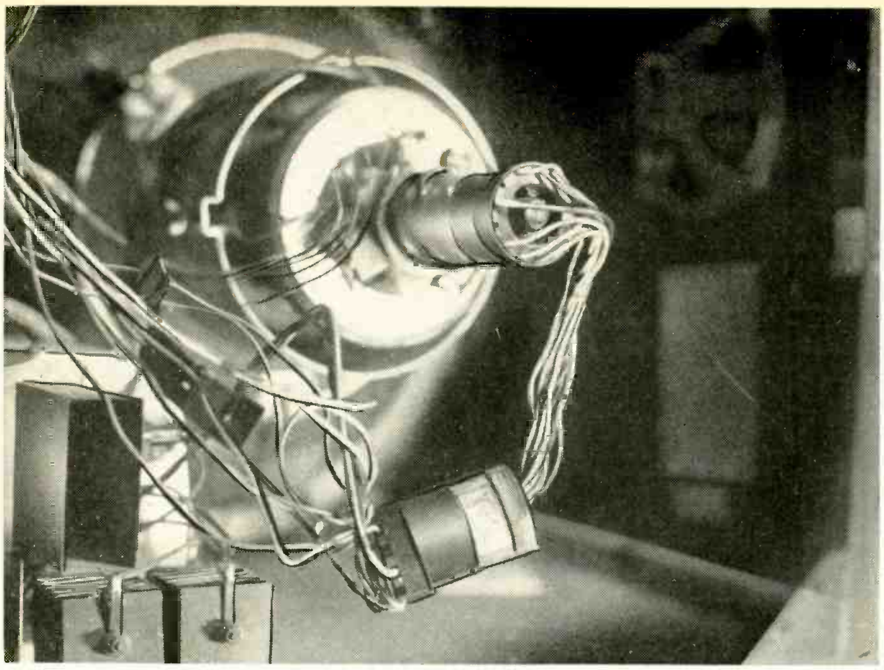


Fig. 2—Ordinary brightener will bring an old color tube back to work for a few more months.

universal dc coupling in video amplifiers and color demodulators, etc., a weak tube can cause a color drift on the CRT. In some cases, it can be corrected by resetting the screen control for that color. If the picture has turned greenish, reduce the green screen control, and so on.

If the CRT screen suddenly goes "all one color," check the tubes associated with that color: amplifiers, demodulators, etc. If a tube goes bad, it can cause one of two things: a complete loss of that color or a "too-bright" condition. This is due to some defect that runs one gun of the color tube full open; so you get a bright green (or red or blue) screen. So, look for what color is there, or for what color isn't there, or is there in too great a quantity!

One important point: keep your sweeps right up to snuff! Both horizontal and vertical sweep circuits affect not only the height and width of the picture, but the convergence (because they make the various dynamic-convergence waveforms). So, if you lose height or width, replace tubes first without touching any adjustments; this will often bring the picture back into correct adjustment.

Watch the damper tube. A weak damper can make the set "slow-heating", or cause a drop in boost: that in turn can affect the focus, brightness and even, in extreme cases, the color. In all cases of a mysterious loss of raster or some such drastic fault, replace the damper tube first. Check the fuse, too, for it usually goes, also.

The color picture tube

Despite their complexity, color CRT's are just like ordinary black-and-white tubes. If no adjustment will bring back a weak or missing color, check the tube on a good CRT tester; this will show up a weak gun. In the older tubes, the red gun usually went first, making the picture bluish or greenish all the time.

This can be helped by "shooting" the weak gun (rejuvenating it). A brightener will also extend the life of the tube for an indefinite time. (Mine lasted 7 months longer with a brightener!)

Even heater-cathode shorts in a single gun can be cleared, just as in black-and-white tubes. Use an isolating type brightener, like the one in Fig. 2. If the tube is still good, use a small black-and-white type isolating brightener, set to isolate but not boost. Put it into the heater wires on the tube base. It can be removed when the tube is replaced.

If the worst happens and the tube is beyond repair, the older 21AXP22's can be replaced by the glass-bulb 21CYP22A's. These are electrically identical to the 21AXP22, and seem to make better pictures. RCA has a kit for this under the number "12B101 conversion kit" (mostly mounting parts to hold the glass tube). As far as I can tell, it is not practical now to replace the old 21AXP22's with the sulfide-phosphor 21FBP22's, and similar types used in the very latest sets. The circuit modifications needed make it impractical.

With this article is a checklist of the color troubles we've been talking about, and what to do about them. Memorize it, and you'll be right up there with the experts. **END**

COLOR-TV TROUBLE CHECKLIST

1. Gradual drift to one color on screen (green, for example).

Color temperature: possible weak tube. Turn green screen control down very slightly; see if black-and-white picture comes back.

2. Colored snow ("confetti").

Check color-killer setting. Turn it until confetti just clears up on strong black-and-white picture.

3. Screen suddenly goes all one color (red, for instance).

Check tubes in "red" circuits: demodulator, color amplifier. Check CRT for short in red gun.

4. No color at all, on program known to be in color.

Check another TV station, if possible. Check tubes that handle "all colors": burst amplifier, bandpass amplifier, etc. Check color-killer setting and tube. Check fine-tuning setting.

5. Colors, but no color sync. Colors run in bars and stripes.

Burst oscillator or bandpass amplifier tube, color afpc tube, or crystal.

6. Color hard to tune: very narrow tuning range on color, although black-and-white pictures OK.

Rf, i.f. tubes weak. Try replacement. May be station trouble; often is. Try a different station. May be trap misalignment, or bad i.f. or rf alignment (not too common, though). Try all tubes, agc settings, etc. first, before taking to shop for full realignment. (Check with neighbor to see if he had same trouble, in all these cases!)

INTERCOM FROM TABLE RADIO

A handful of inexpensive or even junk parts is all it takes to convert any radio to a useful intercom

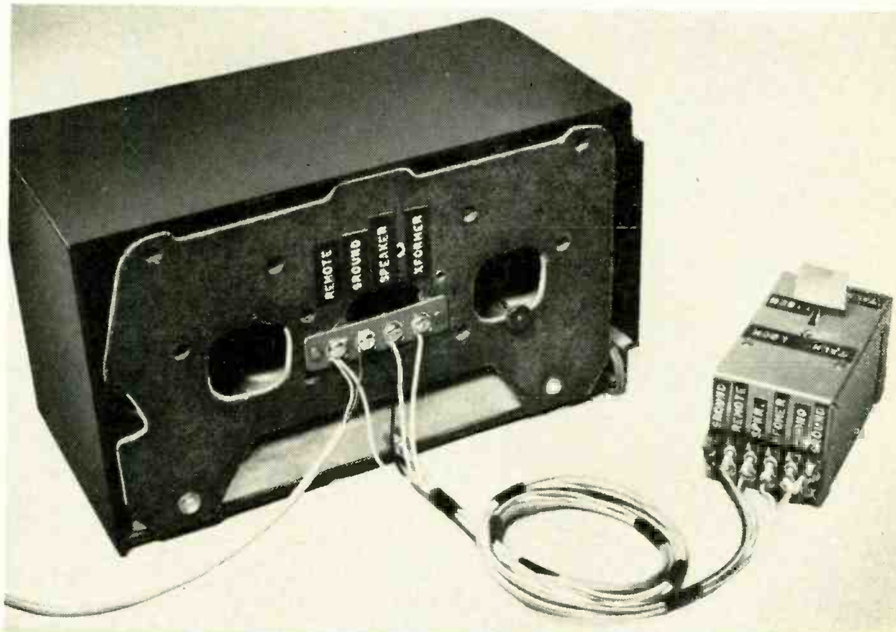
By JOSEPH L. BARRY

YOUR AC–DC TABLE RADIO CONTAINS the same basic audio circuitry used in most of the more inexpensive home intercom systems. An evening's work and less than $7 for parts will make you a radio intercom.

Only three main parts are required for the conversion: an input transformer, a talk–listen switch and a remote speaker. Expense can be cut by catalog shopping and using parts from an old radio.

The original version of this circuit was built from a speaker and output transformer from an old radio. The talk–listen switch was a dpdt toggle type. My total cost was zero. The "preferred" components in the parts list will make a more versatile, sensitive unit.

The radio to be converted *must* have a permanent-magnet speaker and should have a phono input jack.



Nice thing about this approach is that the radio can still be just a radio.

If you use a separate chassis as a control box you can avoid extensive modifications to the radio cabinet and chassis. This also reduces hum pickup and makes a convenient place for the talk–listen switch.

The input transformer (T) and the talk–listen switch are mounted in the control box, as shown in Fig. 1 and the photo. A cable approximately 2 feet long runs from the control box to a terminal strip on the radio's back cover. All the speaker wiring from the radio and the wiring to the remote station tie to that strip.

If the radio is no longer required as an intercom, it is necessary only to remove the external wiring and jump the speaker leads on the back cover.

Radios without a phono input jack may be modified as shown in Fig. 2.

To use a radio without a PHONO-RADIO switch as an intercom, tune it to some quiet spot on the dial. Adjust the volume control for the desired sensitivity. If you wish, you can install a switch (Fig. 2) to cut all radio sound.

The master station (radio) always monitors the remote station (nonprivate operation). To call the remote station, depress the talk–listen switch and talk toward the radio speaker, which now acts as a microphone. Release the switch to hear the remote station.

I use the clock feature on my converted radio as a wake-up alarm in the morning by placing the talk–listen switch in the lock position every evening. During the day the intercom is used to monitor the upstairs nursery when necessary, or used as a radio.

Remote stations

Several remote stations may be used with this intercom, but remember to maintain at least a rough impedance match between the radio output transformer and the remote station or stations. Wiring between the master and remote station or stations is a two-wire

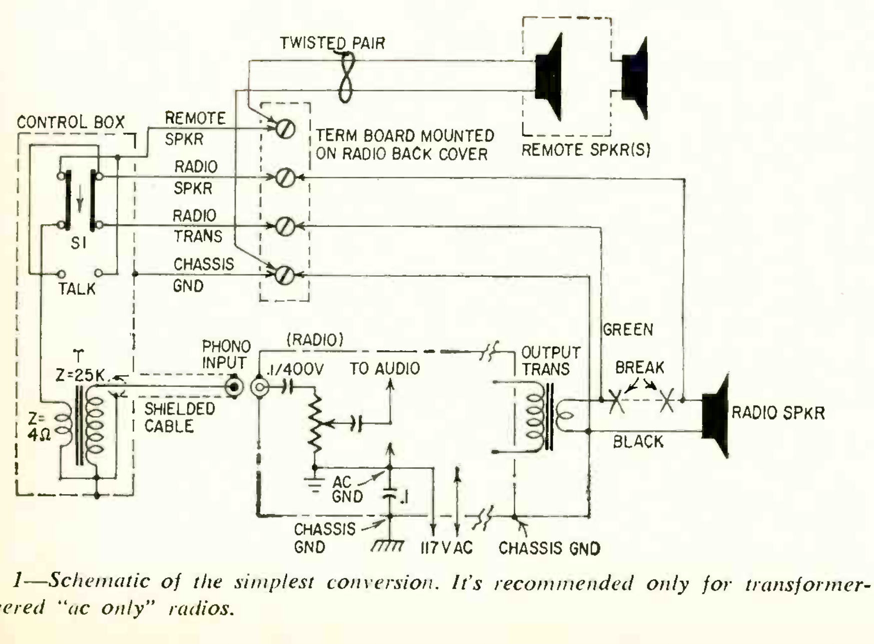


Fig. 1—Schematic of the simplest conversion. It's recommended only for transformer-powered "ac only" radios.

S—switch, dpdt or 4pdt (see text). Centralab 1457 (dpdt—has "lock" position) or 1450 (4pdt, positive) or 1451 (4pdt spring-return).
T—intercom input transformer, 4-ohm primary to 25,000-ohm secondary (Stancor A4744 or similar). High-ratio output transformer (such as Stancor A3857) may also be used, connected in reverse. Ordinary ac–dc radio output transformer (2,000 ohms to 4 ohms) will sometimes work, but sensitivity will be low.
Phono jack and plug (see text)
Control box chassis
Remote speaker (3–4 ohms) and housing
Connecting wire and cable
Miscellaneous hardware.

hookup, the simplest possible, requiring that all remote stations be tied in parallel.

The output impedance of most output transformers in small radios is 3.2 ohms. One remote station using a 3.2-ohm speaker will match properly. If two stations are required, then two 8-ohm speakers should be used, tied in parallel.

I am using three 12-ohm speakers in parallel, one located in each upstairs bedroom. Sensitivity is quite satisfactory.

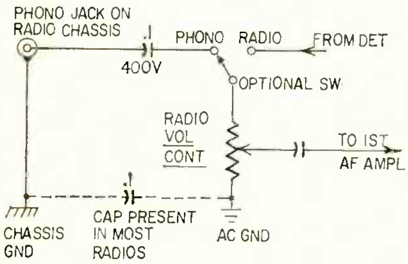


Fig. 2—If the radio you use doesn't already have a phono input, add a jack as shown here. Jack can be wired directly to high side of volume control. Switch is optional—use it if radio noise proves troublesome.

Using the control box as recommended might create a shock hazard in some of the older ac-dc radios. Before wiring your radio, check to see if there is an ac voltage between the radio chassis and a water-pipe ground. Check with the radio's ac plug inserted both ways into the wall socket. Mark plug and wall socket so that the plug will always be inserted the safe way—with the radio's chassis grounded. Better still, use a polarized plug or a clamp to hold the plug in the receptacle so no one can remove it accidentally.

Don't omit the coupling capacitor between the phono jack input and the high side of the volume control. Use a 400-volt capacitor at least.

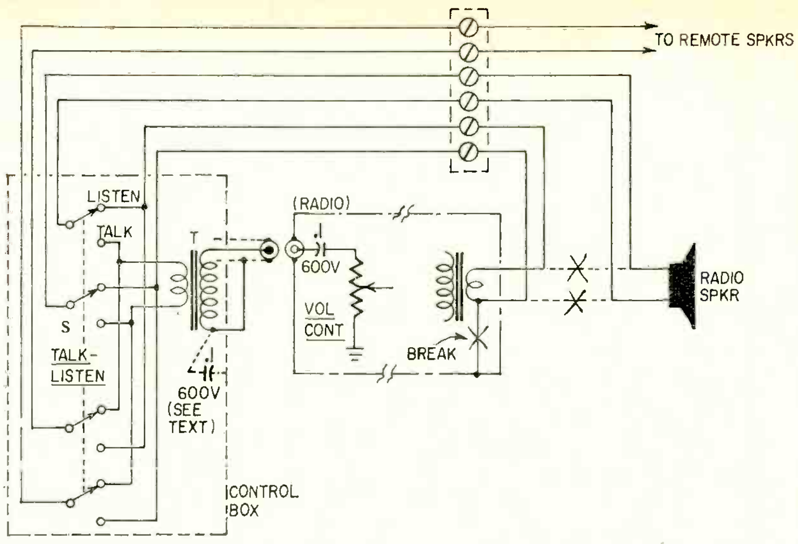


Fig. 3—This version of hookup is safe for transformerless (ac–dc) sets. You'll need a four-pole switch and six connections to the set instead of four.

[For best protection against shocks, we suggest that you use the circuit of Fig. 3 and avoid grounding the control-box chassis or the input transformer frame to the radio's chassis. Note that a *four*-pole double-throw switch is required. Use insulated single-conductor mike cable for the run between box and radio. If the transformer frame and the box must be grounded to reduce hum, connect them either to an outside (water-pipe) ground or through a 0.1-μf 600-volt paper capacitor to the cable shield.

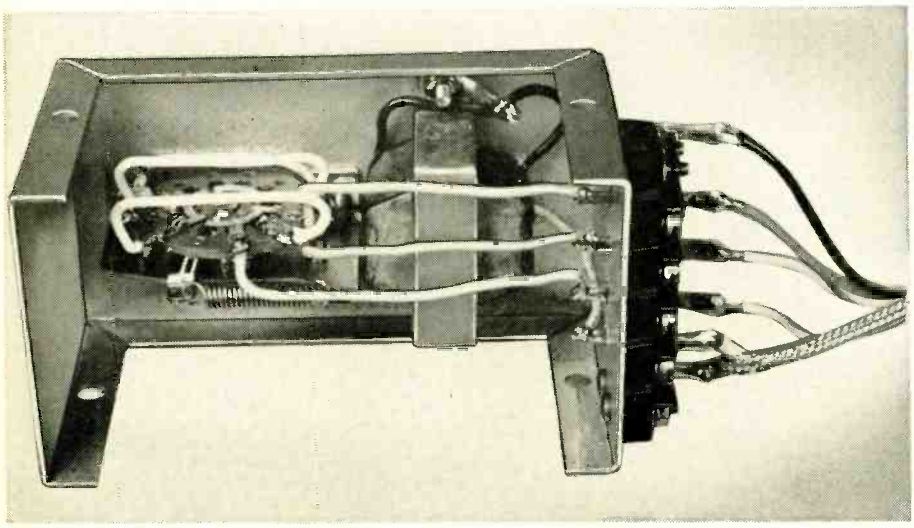
To protect remote-station users, the secondary of the radio's output transformer and the primary of T or one side of the speaker itself, are not grounded to chassis. If any are, or if one side of the secondary-to-voice-coil path is through the chassis, rewire the circuit so that it is not in any way connected to the chassis. *Remember—house current can kill!—Editor*]

Wiring

Other than adding the phono jack if necessary, the only changes are to break the output transformer leads to the speaker and bring them out to the terminal board as indicated. Additional wires go from the speaker and are also terminated at the board.

Use shielded wire from the control box to the phono jack because of the high input impedance. All other wiring can be regular hookup wire. The low-impedance circuits involved do not normally pick up hum.

The terminal block on the control box shown in the photos is not necessary. You can run the wires direct. END



Inside the control box: nothing but the switch and a transformer.

TV SPY IN THE SKY

A new TV rating method is taking to the air in Orlando, Fla. A twin-engine Beechcraft flying at 2,000 feet at 150 mph collects and records electronically signals given off by TV sets. The Airborne Television Audit's instruments can record 1,250,000 actually operating sets in an hour.

No cooperation from the set owners is required. "It works by being able to detect to what channel a set is tuned," explained Steve Mixsell, one of its developers. "This is possible because each tuning oscillator gives off a specific signal for a specific channel."

David L. Nicholson, president of Television Audit Corp., which owns the ATA, says the devices can tell if two or more sets are tuned to the same channel in the same house—"because" he said, "there are no two exactly identical sets. Our instruments can tell them apart if they are as little as 2,000 cycles apart. Most sets have a difference of between 200 and 300 kc." END

EQUIPMENT REPORT

Low-Cost Strip-Chart Recorders

Recent designs put automatic voltage, temperature, pH recorders within reach of almost any lab or shop **By ERIC LESLIE**

SMALL LABS, SMALL MANUFACTURERS, schools, individual researchers and experimenters have long wished for a moderately priced recording device on which events, condition of processes or other information could be mapped automatically and continuously. Such equipment has been available at prices in the thousands of dollars, well out of reach of the average experimenter and even the small educational institution. Now a semi-laboratory piece of equipment is available in kit form from Heath, at less than $200. For certain types of work that fit within its limitations, an even cheaper type of recorder is also available, made by Amprobe Instrument Corp.

The Heathkit EUW-20A strip recorder does not claim to be a direct competitor of the laboratory recorders costing 10 times as much. Yet it can perform many operations for which they are used.

Applications are numerous. The EUW-20A can be used, according to the instruction booklet, to record pressure, speed, temperature, strain, pH, radiation and other phenomena when connected to suitable signal sources.

It uses a regular cartridge-type fountain pen, the position of which is controlled by servomotors, and which moves full scale (10 inches) in 1 second.

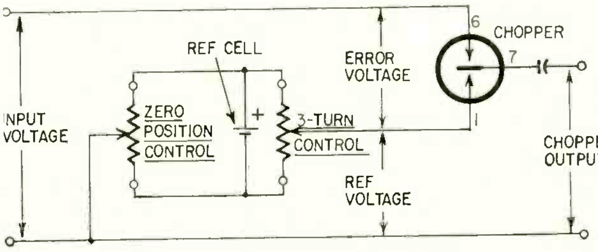


Fig. 1—How the EUW-20A works. Input voltage is balanced against reference voltage, and difference is made into an ac signal by the chopper.

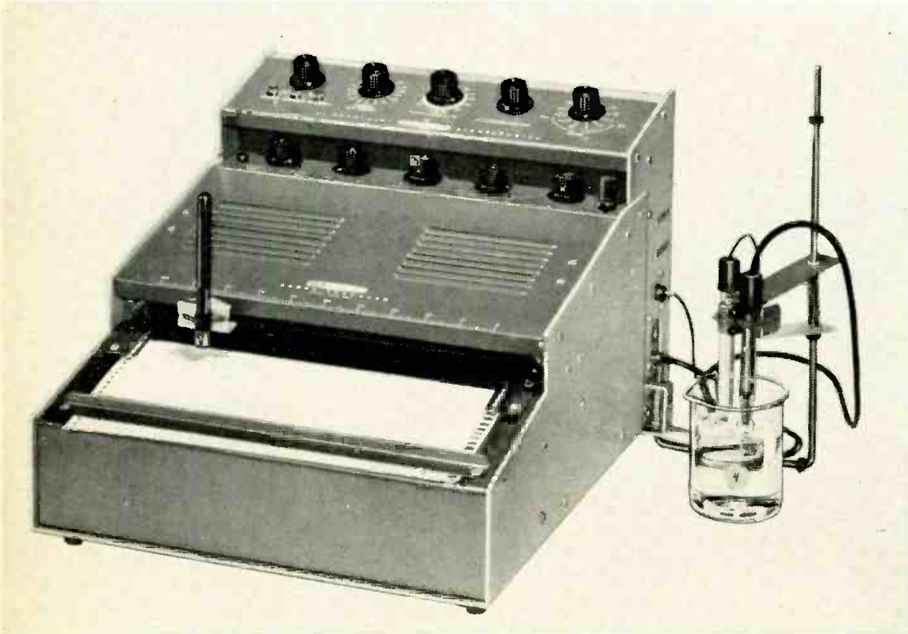
The EUW-20A has a special self-balancing potentiometric input circuit which feeds into a chopper, making ac out of the dc input signals. This is followed by an amplifier which actuates the servomotor.

The principle of the potentiometric metering system is simple (Fig. 1). The input voltage is continuously compared with a reference voltage from a mercury cell with a slide-wire potentiometer (3-turn control) across it. The hot input lead is attached to one contact of a chopper, the arm of which switches between the two contacts at a 60-cycle rate. If there is any difference between the input and the reference voltage, it appears as dc voltage at the input of the chopper, and is fed from the chopper's output as an ac voltage to the amplifier. A second potentiometer across the reference cell, with its movable arm connected to the cold input and reference voltage leads, sets the zero position so that the marking pen can be set at any desired point on the chart paper for zero input voltage.

The actual input circuitry (Fig. 2) is only slightly more complex, because the equipment is made particularly versatile with a number of special plugs which can be inserted in sockets at the back, making function switches unnecessary. There are three sockets, A, B and C. The numbers A1, A5, etc., refer to the socket connections. (The circled numbers are pin numbers on tube and chopper.)

Besides the three-turn slide-wire precision control and the zero-position control, there is a calibration sensitivity adjustment, and a switch and resistor bank across the reference voltage which makes it possible to adjust sensitivity from 10 to 250 μv.

When a signal is supplied to the input with the reference control at zero,



The Heath servo recorder EUW-20A, fitted with accessory units to make it into a pH recorder. (A pH meter measures relative acidity or alkalinity of a solution.)

SPECIFICATIONS

Chart paper: Grid width, 10 in.; length of roll, 120 ft.; markings, 0–100 right to left.
Chart speed: 2 in. per minute.
Chart span: 5 fixed ranges—10, 25, 50, 100, 250 mv.
Pen: cartridge type standard fountain pen.
Balancing time: 0.1 sec. per in., 1 sec. full scale (10 in.) (50 cycles 1.5 seconds full scale.)
Input circuit: self-balancing potentiometric on all ranges.
Input resistance: essentially infinite at null, approximately 500,000 ohms off null.
Overall error: less than 1% of full scale from 10 to 250 mv.
Dead zone: less than 0.5% of full scale from 10 to 250 mv.
Linearity: less than 0.5% full scale.
Maximum recommended source resistance: 50,000 ohms.
Reference source: mercury cell, 300-hour life.
Accessory sockets: 10 watts may be drawn from each socket at 120 volts ac; 10 watts total may be drawn at 240 volts ac; 6.3 volts ac at 50 ma may be drawn from the accessory 11-pin socket.
Power requirements: 120/240 volts, 60 cycles, 45 watts.
Fuse: 1 ampere slow-blow.
Dimensions: 13¾ x 8¾ x 13⅜ in.; **Weight,** 17 lbs.
Heath Co., Benton Harbor, Mich. **Price, $199.**

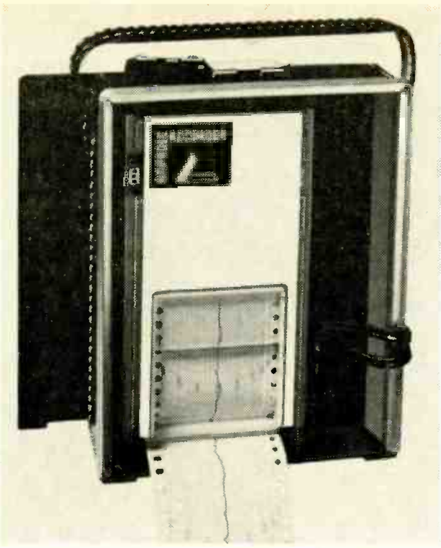
a square wave depending on the difference between the reference voltage and that of the input signal appears across the chopper output. It is passed on to the amplifier, a five-stage unit using two 12AX7's and a 6BQ5. The output of the 6BQ5 is applied to the control winding of a servo-motor, and the motor moves the pen along the chart paper to the point corresponding to the input voltage. At the same time, it moves the tap on the slide-wire potentiometer to make the reference voltage equal to the input voltage (the pen and the slide-wire potentiometer are attached to the same drive cord).

When the reference and input voltages are equal, there is no output from the chopper, and the pen comes to rest.

Should the input voltage now decrease, a signal will again go through the amplifier, this time in the opposite phase, and the signal from the output tube turns the motor in the opposite direction, moving the pen to a new and lower position, and bringing the slide-wire potentiometer also to a new point.

The square wave supplied by the chopper is not ideal for application to the servomotor. The corners of the square wave are therefore rounded by wave-shaping circuits in the grid circuits of the last four stages of amplification. Thus the signal becomes practically a sine wave.

The output of the 6BQ5 power amplifier is fed into a 60-cycle resonant circuit, and applied to the control winding of the servomotor. The resonant circuit also helps to improve the waveshape of the signal. Adjustable negative feedback from the 6BQ5 output tube to the preceding amplifier lowers the impedance of the output stage, to damp the pen and prevent overshoot.



The Amprobe ac expanded-scale voltmeter recorder.

The recorder has several features of much more expensive recorders. It can be operated remotely to control equipment or to record. It can be used to record the voltage or resistance indications of an external instrument such as a vacuum-tube voltmeter. And, while it has only one speed range, it can be adapted to various chart speeds by substituting other motors.

Another interesting strip recording device has been announced by Amprobe Instrument. Not pretending to the same wide range of applications as the one just described, it can nevertheless be extremely useful in a number of jobs. It consists of a paper feed that moves a strip chart 2½ inches wide and 30 feet long at 1, 6, or 12 inches per hour, depending on the motor supplied with the equipment.

The recording system is extremely simple. The pointer of an ordinary d'Arsonval type meter moves under the paper strip, which is pressure-sensitive. A stylus at the tip of the pointer just touches the strip. A lift plate rises and presses the pointer against the paper 60 times per inch of strip travel, making a series of dots. These dots form a roughly continuous line, giving a continuous record of the voltage or other quantity measured.

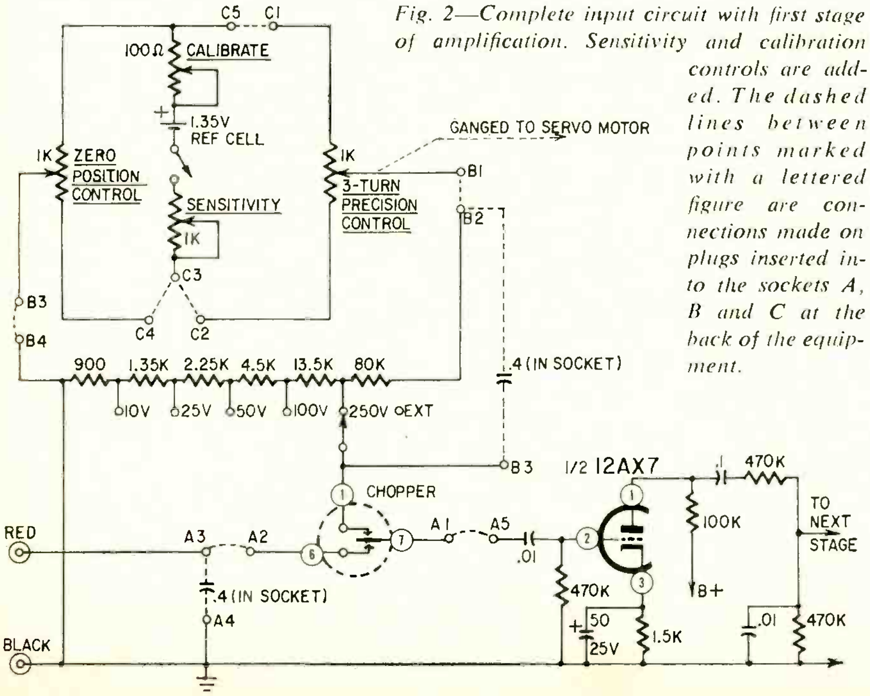


Fig. 2—Complete input circuit with first stage of amplification. Sensitivity and calibration controls are added. The dashed lines between points marked with a lettered figure are connections made on plugs inserted into the sockets A, B and C at the back of the equipment.

A number of standard instruments are available, from 0–50-microampere meters through milliammeters, ac voltmeters and even thermometers and pyrometers. Scales in many of the instruments are expanded. Thus an ordinary line-voltage recorder would operate from 95 to 130 volts.

An attractive application for the Amprobe 95–to–130-volt strip recorder is monitoring ac line voltage over periods of several hours—say overnight. TV technicians have used them to prove to unhappy customers with recurring complaints that their troubles are due to low or high or fluctuating line voltage rather than to sloppy service or a defective set. Another use is to check how much the line voltage drops when a particular heavy appliance (like a stove, air conditioner or power tool) is running.

SPECIFICATIONS

Paper: 2½ in. wide x 30 ft. long.

Standard chart speeds: 1 in., 6 in. or 12 in. per hour.

Impression rate: every 5 sec. at 12 in. per hour; every 10 sec at 6 in. per hour; every minute at 1 in. per hour.

Drive power requirements: 115 volts ac, 60 cycles, 2.5 watts.

Accuracy: dc instruments, ±2% of full scale; ac instruments, ±3% of full scale; ac expanded-scale instruments, ±1% of full scale.

Model LT/FT 8100: high range, ±50°F to +250°F; low range, ±4°F, −50°F to 20°F; ±3°F, 20°F to 100°F.

The various models retail at prices from $79.85 to $134.85, in some cases requiring special transducers at extra cost.—**Amprobe Instrument Corp.**, 630 Merrick Rd., Lynbrook, N.Y.

Note: Two even more recent small recorders have appeared since the above was written. Both use pressure-sensitive strip-chart paper and both record by clamping a pointer momentarily on the chart to produce a series of closely spaced dots. The *api* miniature recorder, made by Assembly Products, Inc. of Chesterland, Ohio, has a standard chart speed of 1 inch per hour, with other speeds optional, and can be supplied as a microammeter, milliammeter, ammeter, millivoltmeter or voltmeter, at prices ranging from $165 to $190. The new Simpson *model 604* Volt-Amp-Milliamp-Microamp Multicorder has chart speeds of 1, 3, and 12 inches per hour with impressions (dots) every 2 seconds. It is a true multimeter, with several ranges in both voltage and current functions, and contains a marking system that indicates the range used as the value is recorded. The model 604 sells for $199.95. END

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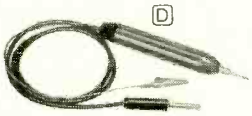

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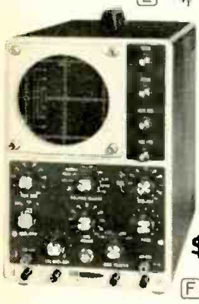

Kit $76.95
Assembled $126.95

F

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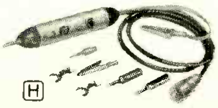

H

VACUUM TUBE VOLTMETERS!

A Low-Cost VTVM, Kit IM-11...$24.95, Assembled IMW-11...$39.95 Single AC/Ohms/DC probe; 7 AC/DC/Ohms ranges; 1% precision resistors for high accuracy; frequency response ±1 db from 25 cps to 1 mc; voltage doubler rectifier; 4½" 200 UA meter. 5 lbs.

B Deluxe "Service Bench" VTVM, Kit IM-13...$32.95, Assembled IMW-13... $49.95 7 AC/DC/Ohms ranges; measures AC volts (RMS), DC volts, resistance & db; separate 1.5 & 5 volt AC scales; gimbal mount for bench, shelf or wall; 6" 200 UA meter; single AC/Ohms/DC probe. 7 lbs.

C Laboratory AC VTVM, Kit IM-21 . . . $33.95, Assembled IMW-21 . . . $52.95 10 voltage ranges—0.01 to 300 volts RMS full scale; frequency response ±1 db from 10 cps to 500 kc; 10 megohm input impedance; calibrated db scale for audio measurements. 5 lbs.

METER TEST PROBES!

D Etched Circuit RF Probe, Kit 309-C...$3.50, Assembled 309W-C...$4.50 Use with any 11 megohm VTVM for RF measure up to 250 mc. 1 lb.

E 30,000 V. DC High Voltage Probe, Kit 336...$4.50, Assembled 336W... $5.50 Provides multiplication factor of 100 on DC ranges of any 11 megohm VTVM. 1 lb.

WIDE-BAND 5" OSCILLOSCOPE!

F Extra-Duty Wide-Band 5" Oscilloscope, Kit IO-12...$76.95, Assembled IOW-12...$126.95 Full 5 mc bandwidth for color TV servicing; Heath patented sweep circuit 10 cps to 500 kc; push-pull vertical & horizontal amplifiers; positive trace position controls. 24 lbs.

SCOPE TEST PROBES!

G Scope Demodulator Probe, Kit 337-C...$3.50, Assembled 337W-C...$4.50 Use in radio & TV servicing to check distortion & presence of modulation. Voltage limits, 30 v. RMS, 500 v. DC. 1 lb.

H Low-Capacitance Oscilloscope Probe, Kit PK-1...$4.95 Minimizes loss of gain, circuit loading or distortion due to overloading of scope input. Includes assortment of connectors to match most scope terminals. 1 lb.

Norelco Carry-Corder 150

THE NORELCO CARRY-CORDER 150 IS A cartridge-loading portable tape recorder of light weight and good quality. Its suitability for specific needs you may have in mind stands or falls on the use of the cartridge.

Where easy operation by inexpert personnel is the chief concern, or where tapes must be changed quickly, as in news coverage, the system is ideal. But the cartridges are not as widely available as reels are and are more expensive ($3.50–$4 for a 300-foot cartridge, vs about $1 for a 300-foot reel). They can't be played on any machine not designed for them.

Because of that, the machine is best suited for recording material which will not be stored indefinitely. The machine comes with a patch cord for recording from and dubbing to other machines. The sound on playback through a wide-range system is good, though by no means a match for the larger Norelcos.

A pedal start/stop control and an earphone are available for stenographic use. Since both pedal and headphones use the same socket of the Carry-Corder, the pedal assembly provides its own connection for the headphone.

The ac adapter, which uses the same socket as the pedal and headphones, provides no extra connections for the other accessories. Battery life with normal use of 2 hours or so per day is about 20 hours.

The cartridge looks like a miniature version of the RCA cartridge, but is different. The tape, about ⅛ inch wide, is spooled oxide out; during record and playback, the heads are pushed against it, and tape tension is maintained by a stationary pressure pad built into the cartridge. Since there are no reel flanges to accommodate, the two hubs are separated by little more than the radius of one full reel of tape. As the tape grows on one reel, it shrinks on the other and fills the growing empty space left by the shrinkage of the other, until it overlaps its original position. The dust-proof, plastic-covered tape observation window on the cartridge is graduated in arbitrary numbers to indicate tape position; as both tape speed and thickness are fixed, graduation in minutes of playing time would seem more reasonable. The graduations—dark gray on a dark gray field—are too dark to be seen under most conditions anyway. There is also an automatic stop mechanism which squeaks a signal when rewinding or fast forward are finished, but no signal indicates when the end of the tape is reached during recording.

The tape is driven by an exceptionally thin capstan, which must therefore rotate quite rapidly, even at the fixed tape speed of 1⅞ ips. This high speed takes maximum advantage of the 2-inch fly-wheel's mass. As a result of this and of the flutter-filter belt drive, wow and flutter are seldom noticeable, and never objectionable until the battery is nearly dead.

Electronically, the seven-transistor Carry-Corder features ac bias and erase, separate record and playback level controls, and a 250-mw audio output. Noise is reasonably low (due in part to the ac bias), and distortion unnoticeable at normal record and playback levels. As level controls are separate, there is no need for readjustment when switching from record to playback. Unfortunately, you cannot monitor the recording while it is being made, even through headphones. A record-level meter is provided; the instruction book makes it appear that this works backward, but this is only if the machine is operated with the controls farthest from the user. Normally, you'd work from the control end, and the meter reads normally.

The microphone is an omnidirectional moving-coil unit, with a detachable start/stop switch. An accessory microphone of higher quality is also available, an AKG cardioid unit with integral windscreen and start/stop switch.

No stand is provided for the omnidirectional mike, although its detachable leather pouch may be used as one; the unit also clips to a pocket. A stand adapter is provided with the AKG cardioid unit, however. The brass insert of this adapter is reversible to fit US and European microphone-stand threads.

The 150 struck me as a well engineered and well built machine, simple and easy to use and very light to carry (3 lb with batteries).—*Ivan B. Berger*

SPECIFICATIONS

(All specifications are the manufacturer's)

Supply voltage: 7.5 (five 1.5-volt C-cells)
Power consumption: approx. 100 ma at 7.5 volts
Battery life (2 hr/day avg. use): 20 hours
Tape: 300 ft. 0.5-mil tape 0.15 in. wide, in cartridge
Tape speed: 1⅞ ips
Tracks: two
Playing time per cartridge: 30 min. each track
Output power: 250 mw
Frequency response: 100 to 7,000 cycles, ±3 db
Signal-to-noise ratio: better than 45 db
Wow and flutter, rms: 0.35%
Fast wind and rewind time: 70 sec max
Bias & erase frequency: 35 kc
Ambient temperature range: 41 to 113°F
Housing: two-tone gray polystyrene
Dimensions: 7¾ x 4½ x 2¼
Weight with batteries: 3 lb
Price: $119.50
North American Philips Co., Inc., High Fidelity Products Dept., 100 E. 42 St., New York, N.Y. 10017

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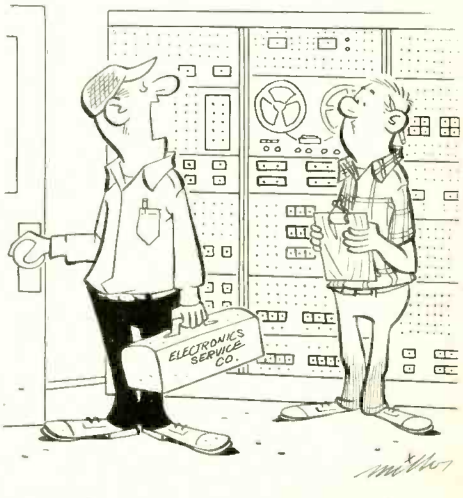
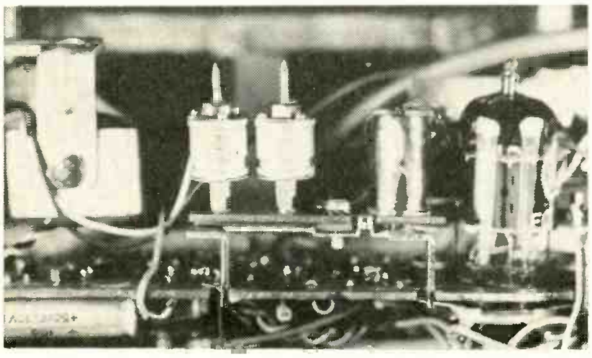
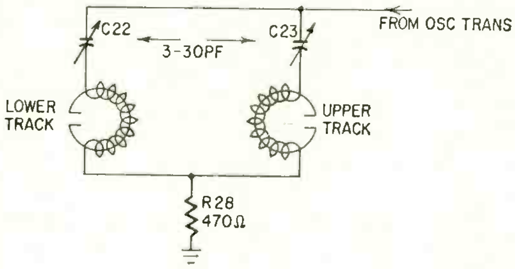


"As long as it goes gleepty-glup, gleepty-glup, it's OK. But if it starts going flipty-glep, flipty-glep, call me."

TECHNOTES

PHILIPS EL3515-D: BIAS ADJUSTMENT





When parts in the bias oscillator of this recorder are replaced or when new heads are installed, the bias adjustment should be reset. The four-track head has a resistor, R28, 470 ohms, in series at the low end, common to both tracks. Bias is fed via C22, C23, 30-pf trimmers (photo). The bias voltage across R28 should measure 70 mv on each track.—*Steve P. Dow*

AIR-FLOW INTERLOCKS

High-power rf induction heaters use air-flow interlocks to prevent the application of plate voltage when the cooling blower is not running. These interlocks are vane- (paddle-) operated switches in the intake or discharge side of the blowers. Those on the intake side frequently give trouble from sticky pivots or slight misadjustment.

Short-circuit the cubicle door interlocks and make sure the blower is running. Next ascertain that the pivots (vane bearings) are free; if so, bend the vane a trifle closer to the suction opening of the blower and the trouble will be corrected.—*R. C. Roetger*

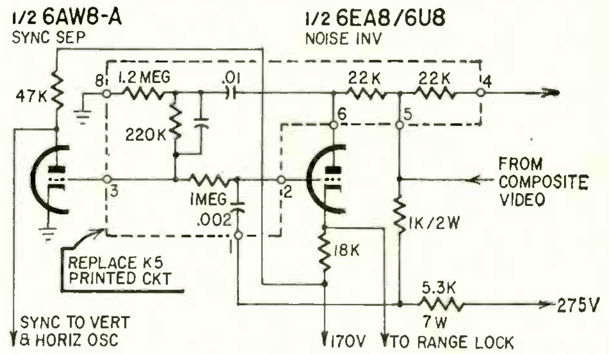
HUM BAR AND MULTIPLE TROUBLES: MOTOROLA 24K18-B

I got a 24K18-B Motorola in the other week that had been to five or six shops for the same trouble. The customer indicated that the set would lose vertical sync with the contrast turned halfway down.

I left the set playing. When I checked it about an hour later, this difficulty had disappeared. About two hours later a large, dark hum bar covered the top half of the screen, and operating the brightness control blanked out the screen just like a shade being drawn. I thought one of the tuner or i.f. tubes had gone gassy, but when I checked and substituted them, and every other tube in the set, I still had the hum bar and hum in the audio. Turning the set off and letting it cool did not help.

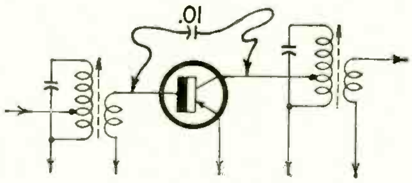
The keyed agc had gone positive. Checking the agc proved nothing. I opened the coax from the tuner to the first i.f. The hum disappeared. This did not show me much because naturally the video disappeared too. About the only thing left was the tuner. Everything pointed to the tuner. Checking the tuner the first time I found nothing wrong, but on second time I was a little more thorough. I found only about 10 volts on the screen of the 5U8 oscillator–mixer. Decoupling capacitor was OK. Then with one vtvm lead on the screen and the other on the chassis, I pulled the 5U8 out of the socket. Still 10 volts. Turned out a 270,000-ohm resistor buried deep in the tuner was about 2 megohms. In about 2 hours of surgery I had extracted the old resistor and tacked in a new one. I turned the set on and I was home free. —*Sid Elliot*

PHILCO 11N51A—BAD SYNC



After 5 minutes the set overloaded (much like agc trouble) and sync was touchy. After 10 minutes there wasn't any sync. Usual agc tests showed nothing. When K5 (see diagram) was sprayed with freeze mist, trouble cleared up till the part heated again. Replace K5—part No. 30-6536-1.—*W. G. Eslick*

QUICK STAGE CHECK FOR TRANSISTOR RADIOS



When troubleshooting for low gain in transistor radios, I bridge each transistor in turn by touching a .01-μf capacitor from base to collector. Bridging a good stage will cause the volume to drop noticeably. In a defective stage, there will be either no change or often increase in gain. At that point, voltage and resistance checks will indicate which component is bad.—*Charles B. Randall*

WRONG-WAY BATTERY CHARGE

A 1959 Ford radio worked perfectly on the bench but refused to play in the car. Substituting a new speaker and antenna didn't help. Checking and rechecking everything, I finally noticed that the car ground was positive. The battery was installed correctly, but its polarity read opposite to its markings.

Questioning the owner revealed that the radio had stopped playing after a new generator and voltage regulator were installed. Evidently they were connected wrong, and the battery was discharged to zero and then recharged with the opposite polarity. Everything in the car worked perfectly in this seemingly impossible situation, except the radio. Incidentally, the transistor in the set was not damaged.

P.S.—another argument for gages versus idiot lights.—*Andrew Glubshinsky*

LOCATING SHORTS WITH AN OHMMETER

When components overheat, ohmmeter tests are necessary.

First, turn the receiver off and discharge the electrolytics.

Set your ohmmeter to a medium range and touch one probe to the receiver B− point and the other probe to the cathode of the rectifier tube.

Suppose your reading at this point is 3,000 ohms. Transfer your probe to the top of the output filter capacitor and take another reading. Let's assume the reading is 2,000 ohms there.

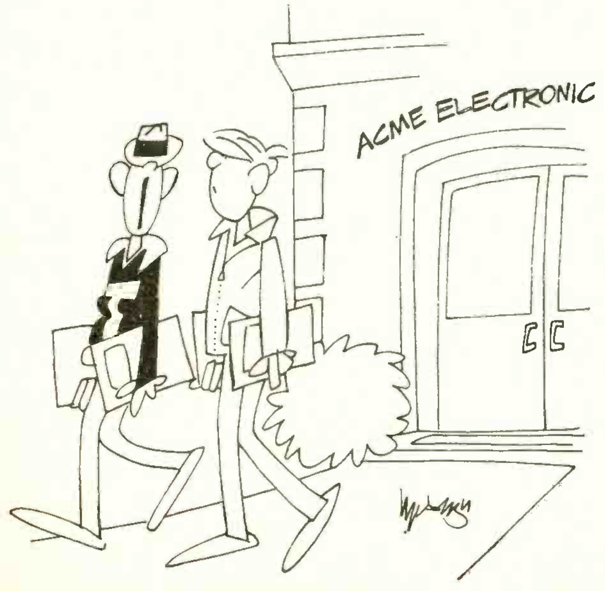
This definitely proves that the short is on the *set* side. The next point to check is the plate of the audio amplifier tube. Suppose that reading is 1,800 ohms. Now with all three of these readings in mind, remember that the short is where the lowest reading appears. Therefore, look for the trouble in the sector with the lowest reading, and you'll localize the defective component at once.—*E. L. Deschambault*

SHORTED WHIP ANTENNA: RADIO STILL WORKS ON SOME BANDS

An 11-transistor all-wave set I serviced recently was dead on all bands except marine and broadcast. The bandswitch proved OK and the oscillator was working on all bands.

Then I noticed that the insulated bushing for the whip antenna was split, and the antenna was solidly grounded. I would have thought of that—if the set hadn't worked on the broadcast and marine bands. It turned out that a ferrite-core antenna coil acted as antenna for the two lowest bands, even though the whip was coupled to a tap on the coil through a 10-pf capacitor on all bands. Even with the whip shorted, the extra 10 pf of shunt capacitance did not harm reception on the low bands. But the short-wave reception depended entirely on the whip antenna, so there was no sound on those bands.—*Steve P. Dow*

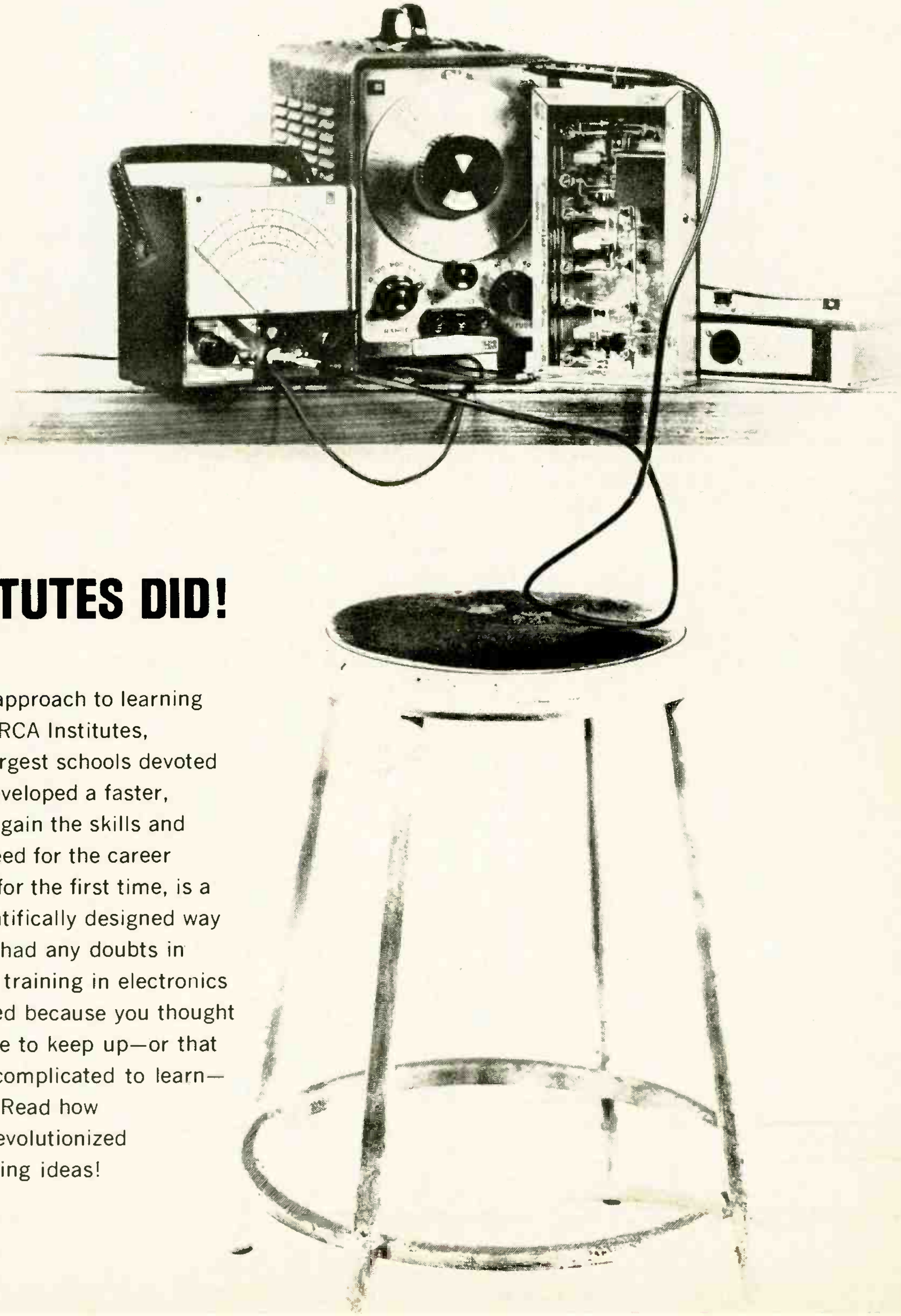
continued on page 70



"I'm getting a D− in B+."

SOMEONE SHOULD DEVELOP AN EASY WAY

TO LEARN ELECTRONICS AT HOME

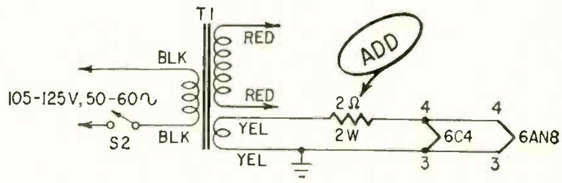


RCA INSTITUTES DID!

Here is a whole new approach to learning electronics at home! RCA Institutes, one of the nations' largest schools devoted to electronics, has developed a faster, easier way for you to gain the skills and the knowledge you need for the career of your choice. Here for the first time, is a student-proved, scientifically designed way to learn. If you have had any doubts in the past about home training in electronics —if you have hesitated because you thought you might not be able to keep up—or that electronics was too complicated to learn— here is your answer! Read how RCA Institutes has revolutionized its entire home training ideas!

HEATH TONE-SQUELCH FAILURE

Three separate Heath GD-162A tone-squelch units would fail to receive and send properly after a few hours of operation. Replacing the 6AN8 tube would cure the trouble temporarily. The heater supply was found to be more than 7.5 volts on all units (with a line voltage of 117). The 6AN8 tube was shorting, heater to cathode.



The problem was cured by adding a 2-ohm resistor in series with the heater line (see diagram).—*James R. Giles*

AC-DC PILOT LIGHT BURNS OUT IMMEDIATELY

In practically all cases the trouble is due to an open part in the tapped rectifier heater. When this occurs, all the current drawn by the other tube heaters flows through the pilot light, and it burns out.

The tube may have tested OK in a tube tester, since the heater supply in the tube tester may be connected across the tube heater without regard to the tap.

The easiest way to check a 35W4 is to substitute a new tube. Very often taps burn out for no apparent reason but, before inserting a new tube, check the filter capacitors.—*E. L. Deschambault*

END

1965 SEMI-ANNUAL INDEX

RADIO-ELECTRONICS January-June, 1965 of Vol. XXXVI

KEY TO SYMBOLS AND ABBREVIATIONS

* Construction Articles
† Section of full-length article
§ Transistorized
CI .... Service Clinic
Corr .... Correction
Corres .... Correspondence
NB .... News Briefs
NC .... Noteworthy Circuits
Pat .... New Patents
Tech .... Technotes
TTO .... Try This One
WN .... What's New

Regular departments not itemized are New Books, New Literature, New Products, Technicians' News, What's Your EQ?

FEEDBACK WITH A DIFFERENT VOICE-COIL IMPEDANCE

THERE ARE TIMES WHEN YOU WOULD like to change the feedback takeoff point in an audio amplifier from, say, the 16-ohm output tap to the 8-ohm tap. Or perhaps you want to replace a 4-, 8-, or 16-ohm output transformer with one that has only a 600-ohm winding, or only a 70-volt winding. Since, for a given power, the voltage across the voice coil (and hence the feedback voltage) varies with the impedance, you will have to change the feedback resistor. How?

Here is a simple formula you can use:

$$R2 = R1\sqrt{\frac{Z2}{Z1}}.$$

R1 is the given series feedback resistor, R2 the required new value, Z1 the present voice-coil impedance and Z2 the new impedance.

This formula gives an acceptably close value only when the series feedback resistor is much larger than the resistor (or other ac impedance) across which the feedback is applied—usually the cathode resistor (or part of it) of an earlier stage. Generally, the series resistor is about 20 times the value of the cathode resistor, and since you will generally be using 10% resistors, the computation isn't too critical anyway (10% voltage equals approximately 1 db).

If there is a phase-shifting capacitor across the series feedback resistor, it must be changed also. Its value is found by the inverse relationship

$$C2 = C1\sqrt{\frac{Z1}{Z2}}.$$

(Note that Z1 and Z2 are interchanged.) —*Radiotronics* (*Australia*)

CORRECTION p48

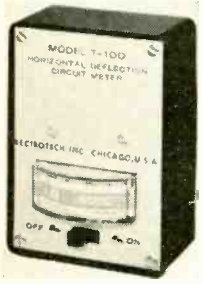
It looks like our EQ (editorial quality??) slipped when editing this column in the May issue. The polarity of diode D1 was inadvertently reversed in the diagram for the first question. This error was noticed by quite a few sharp-eyed readers. The first to report it was E. Nowak, Jr. of Saginaw, Mich. We are sorry if this error made the problem harder to solve.

NEW PRODUCTS

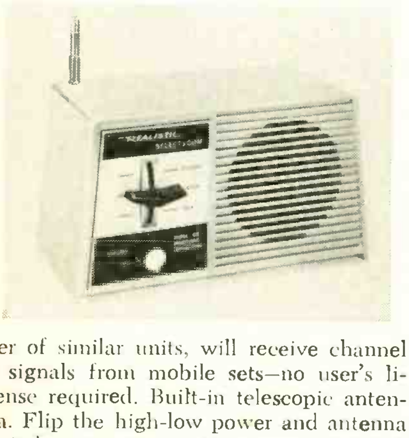
70-WATT STEREO AMPLIFIER, *LA-350,* has 11 front-panel controls and 6 pairs of stereo inputs; friction-locked bass and treble controls; tape monitoring facilities. Frequency response: 15 to 30,000 cycles ±1 db at normal listening level.

Distortion less than 1%; hum and noise 55 db down on phono inputs and 76 db down on high-level inputs. Channel separation 50 db at 1 kc. 14⅜ x 5¼ x 10 in. —**Lafayette Radio Electronics Corp.,** 111 Jericho Turnpike, Syosset, N.Y.

HORIZONTAL DEFLECTION CIRCUIT METER, *T-100,* is aimed at front of TV set. "Good" reading indicates normal operation of deflection circuits, including horizontal oscillator, high-voltage rectifier, damper, yoke and flyback transformer. "Bad" reading indicates abnormal operation in these circuits; fluctuating reading shows intermittent trouble in horizontal section. 2⅞ x 3⅜ x 1½ in.—**Lectrotech, Inc.,** 1737 Devon Ave., Chicago, Ill. 60627

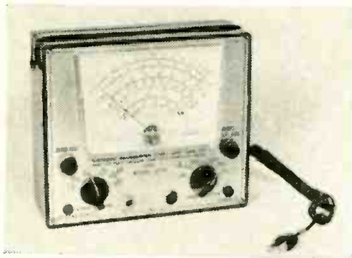


WIRELESS INTERCOM/2-WAY CB RADIO, the *SELECTaCOM,* 100 milliwatts and 3 watts, transmits and receives on CB channel 5, can be incorporated in intercom "net" with any num-



ber of similar units, will receive channel 5 signals from mobile sets—no user's license required. Built-in telescopic antenna. Flip the high-low power and antenna switches, connect an external ground-plane antenna for 3 watts input and increased-range licensed CB operation. Built-in speaker/mike.—**Radio Shack Corp.,** 730 Commonwealth Ave., Boston 17, Mass.

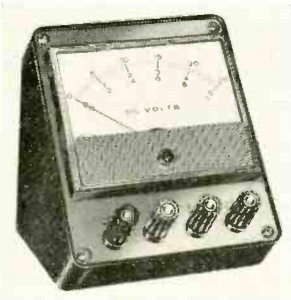
VTVM, *model 107A,* has 6-in. meter with 10 separately calibrated scales. Peak-to-peak voltage is measured in 6



ranges: 0 to 4, 28, 84, 280, 840 and 2,800. Ac/dc in 6 ranges: 0 to 1.5, 10, 30, 100, 300, 1,000 volts (up to 30,000 dc volts with accessory probe). 6 resistance ranges: 0 to 1,000 ohms (10 ohms center scale) up to 0 to 1,000 megohms. Capacitance measured in 6 ranges from 50pf to 5,000 μf. Db measured from −24 to +55. Accuracy 3% on dc, 4% on ac. Input resistance 16.5 megohms on dc, 1.5 megohms on ac. With instruction manual. —**Electronic Measurements Corp.,** 625 Broadway, New York, N. Y. 10012

THREE-CHANNEL PHONO CARTRIDGE *X3D* has 4 terminals: left and right output, 3rd "hot" terminal which carries a summed signal for a center-channel amplifier and speaker, and, of course, ground. Fits most tone arms with plug-in heads, 7/16- or ½-inch mounting centers. Easily installed in existing systems; mono amplifier can serve as center channel, new stereo amplifier and speakers can carry left and right.—**Jensen Industries,** Addison, Ill.

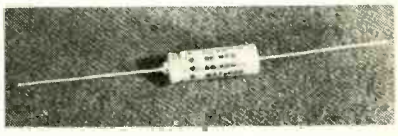
SCHOOL AND LAB METERS, *G/P Series.* 51 standard ranges available in 22 portable units to measure: ac, dc,



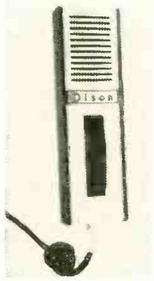
ohms, rf volts, watts. Accuracy: ±2% on dc and ac iron-vane types; ±3% on ac rectifier type and ohms. 5-way binding posts adapt to most test-lead configurations. 4 3/16 x 3⅞ x 4 3/16 in.—**Triplett Electrical Instrument Co.,** Bluffton, Ohio 45817

12-CHANNEL CB TRANSCEIVER, the *CB-12.* Receiver is dual-conversion superhet; sensitivity less than 1.0 μv for 10-db signal-to-noise ratio. External paging speaker can be used. Audio output 3.5 watts. Solid-state noise limiter and internal filtering, adjustable squelch circuit, adjacent-channel and image re-

jection circuits. Dual Zener regulates squelch. Battery drain 0.2 amp on receive, 1.0 on transmit. Push-to-talk mike, one set of crystals, mobile mounting kit. 2⅝ x 6 x 9½ n.—**Hallicrafters Co.,** 4401 W. 5th Ave., Chicago, Ill. 60624



MINIATURE ELECTROLYTIC CAPACITORS, *Arcolytic type ME,* aluminum-encased, designed for low-voltage transistorized circuitry. Corrosion and electrolyte leakage eliminated. Operating temperature range −30°C to +85°C. Capacitance value, working voltage and case size printed on each unit.—**Arco Electronics, Inc.,** Community Dr., Great Neck, N.Y.

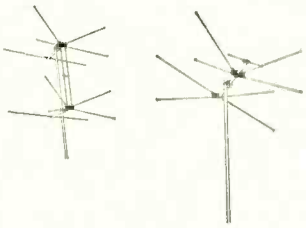


CRYSTAL MIKE, *model M-203,* hand-held, with push-to-talk switch and 4-conductor cable. Two extra wires start and stop battery-operated tape recorders. Push switch has lock position. Output level −50 db. Response: 40 to 6,000 cycles. 5⅝ x 1½ x 1 in.—**Olsen Electronics, Inc.,** 260 S. Forge St., Akron, Ohio 44308

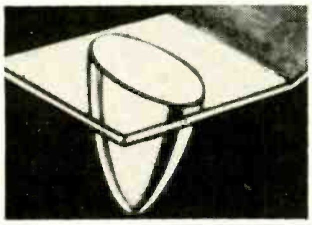
SPEECH-CLIPPING MICROPHONE, the *D-501K.* Two-transistor built-in amplifier provides variable amount of speech clipping for maximum intelligibility and high output level, and gain in excess of insertion loss in clipping circuit. Push-to-talk switch, hand-held

cast aluminum case, protective grille design. Power supplied by internal long-life cell. Output level adjustable through internal potentiometer which sets degree of clipping. Frequency response 100 to 5,000 cycles.—**American Microphone, Div. of Electro-Voice, Inc.**, Buchanan, Mich. 49107

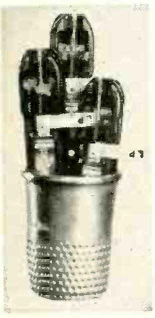
GOLD CONICAL ANTENNAS, 42 models, 6 head designs, and kits (both chimney and roof types). Wraparound mast clamp; factory pre-assembly; gold-vinylized finish on all models; all-alu-



minum conical tubing; snap-lock hardware; polystyrene insulator; 3-color box for consumer display.—**Winegard Co.**, 3000 Kirkwood, Burlington, Iowa



ELLIPTICAL DIAMOND STYLUS, the *Elipticon*, said to eliminate the major sources of sound distortion because the stylus tracks the record groove in exact same path through which original cutting stylus traveled. Replacements available for most cartridges.—**Duotone Co., Inc.**, Keyport, N.J.



FOUR NEW CERAMIC CARTRIDGES. Stereo *Micro-Ceramic T Series* for low-mass applications. *Model 25T*: output voltage 0.2; compliance 15.0 x 10^{-6} cm/dyne; tracking force 1 to 3 grams; separation 27 db at 1 kc. *Model 26T*: output 0.5; compliance 5 x 10^{-6} cm/dyne; tracking force 3 to 6 grams; separation 22 db. *27T*: output 0.25; compliance 5 x 10^{-6} cm/dyne; tracking force 2–6 grams; separation 22 db. *28T*: output 0.35; compliance 9 x 10^{-6} cm/dyne; tracking force 2–4 grams; separation 22 db. Each is 1 inch long and weighs 1 gram.—**Sonotone Corp.**, Elmsford, N. Y.

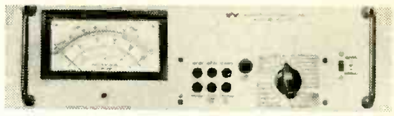
VHF CONVERTER comes in two models: fixed-frequency unit adapts auto or home radio for tuning through any 1-mc segment of 108–170 mc range, and tunable unit (shown) for continuous tuning across the entire band of frequencies. Built-in audio squelch circuit may be connected to receiver. Tuned rf stage and tuned mixer. Fixed-frequency model has

crystal oscillator; stable variable oscillator in tunable unit. 5 x 3 x 2½ in.—**Scientific Associates Corp.**, P. O. Box 1027, Manchester, Conn.

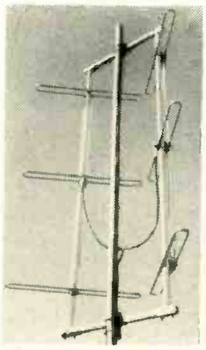
METER SENTRY. Solid-state *model MS-10* protects meter movements against overload damage by by-passing overload currents around instrument. Connects across meter movement terminals. Special Semitron silicon diode take surges up to 25 amps, protects basic meters ranging from 20 μa to 5 ma.—**Semitronics Corp.**, 265 Canal St., New York, N. Y. 10013

RACK-MOUNTED 1% VOM, *model 80-R Analyzer*, for standard 19 x 5¼-in. rack mounting, has refractive anti-parallax meter scale. Dc ranges (at 20,000 ohms per volt): 0.25, 1, 2, 5, 10, 25, 50, 100, 250 and 1,000 volts. Ac ranges (at 5,000 ohms per volt): 2, 5, 10, 50, 250,

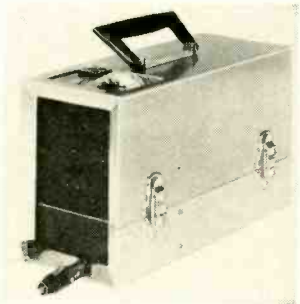
NEW PRODUCTS continued



500 and 1,000 volts. Dc currents: 50 μa, 1, 10, 100 ma, 1 and 10 amps. Banana-jack lead connections at center of panel; single selector switch on right and meter face on left; reversing switch at far right for switching polarity under load.—**Weston Instruments, Inc.**, 614 Frelinghuysen Ave., Newark, N.J. 07114



OMNIDIRECTIONAL ANTENNAS, *series Y-03*, designed for transmitting use of TV channels 2–13, other low-power applications such as translators in the 54–210-mc spectrum, have bandwidth of 6 mc, are cut to coincide with 11 vhf TV channels. Low- and high-power ratings range from 1.8 or 5 kw for the 54–60-mc model to 0.34 or 2.3 for the 210–216-mc model. Nominal gain is 4. 5db over isotropic source; VSWR is 1.5:1 for all models. Y-03's have two 3-element broadside arrays, each with 3 driven folded dipoles, center element being driven from stacking line and adjoining elements by parallel transmission lines. Made of aluminum alloy with terminal boxes for direct coaxial input.—**Defense & Industrial Products Div., TACO**, Sherburne, N.Y.



PORTABLE POWER SUPPLY, *model No. 50-160*. Output: 117 volts, 60 cycles ac. Frequency stable within ½ cycle with load change. Inverter capacity: 125 watts continuous, 175 watts intermittent. Rechargeable 12-volt 25-ampere storage battery. Built-in charger operates from ac receptacle or car lighter—capacity tapers automatically from 6 to 0 amps. Copper-clad steel case, 12 x 5½ x 8 in., 30 lb including battery.—**Terado Corp.**, 1068 Raymond Ave., St. Paul, Minn. 55108

All specifications from manufacturers data

NEW LITERATURE

TECHNICAL REPORT, *Varactors in Voltage Tuning Applications,* by Robert Fekete of Sylvania's Semiconductor Div. 10 pages with curves, diagrams, formulae and bibliography.—**Sylvania Electric Products, Inc.,** Semiconductor Div., Woburn, Mass.

CAPACITOR HANDBOOK, *Specification and Design Handbook—Elmenco Fixed Mica Capacitors.* revised 1965 edition. 28 pages covering such subjects as construction, nomenclature, coding and marking systems, physical, electrical and environmental specifications, reliability, silver migration. Tables and charts.—Write on company letterhead to **Arco Electronics**, Community Dr., Great Neck, N.Y. 11022

PRODUCT INFORMATION BULLETIN, No. C-105, describing models DVC-8H4 and DVC-8J4 dual-voice-coil speakers.—**Oxford Transducer Corp.,** 2331 N. Washtenaw Ave., Chicago, Ill. 60647

SHORT-FORM CATALOG for 1965, pocket-size, features most popular units in line of hi-fi/stereo components, test instruments, CB and ham gear, with new line of solid-state and vacuum-tube products.—**EICO Electronic Instrument Co., Inc.,** 131-01 39th Ave., Flushing, N.Y. 11352

1965 GUIDE TO STEREO HIGH FIDELITY, 164 pages, photos and specs on large selection of audio products, ranging from solid-state amplifiers to tape recording and phonograph accessories, plus ham and CB gear, representing more than 80 companies.—**Airex Radio Corp., 85 Cortlandt St., New York, N.Y. 10007**

INDICATOR LIGHTS CATALOG, *L-178.* 12 pages, contains subminiature incandescent and neon indicator-light data, illustrations, drawings, catalog number charts.—**Dialight Corp.,** 60 Stewart Ave., Brooklyn, N.Y. 11237

OPTICAL FLAT-GLASS BULLETIN lists optical, mechanical, electrical, chemical and thermal properties of 96% silica glass. 6 pages of charts and tables.—**Corning Glass Works, Optical Marketing Dept.,** Corning, N.Y.

POTENTIOMETER CATALOG, *High Precision Potentiometers.* 24 pages, illustrates line of ½- to 5-in. units; resistance range from 50 through 1,000,000 ohms. Dimensions and specs.—**Samarius, Inc.,** 300 Seymour Ave., Derby, Conn. 06418

"THIS IS GLASS", a 56-page illustrated booklet, reviews the history of glass and outlines basic glass composition, describes the many types of glass, including electrically-conducting types, the glasses in micro-electronic circuits and liquid amplifiers, and special types used in transistor and relay enclosures to absorb moisture.—**Corning Glass Works,** Public Relations Dept., Corning, N.Y.

MONTHLY BULLETIN, *Playback,* January 1965. 8 pages, features a roundup of the latest video tape recording equipment, aimed at broadcast engineers and technicians.—**3M Co.,** Dept. N5-109, 2501 Hudson Rd., St. Paul, Minn. 55119

DATA SHEETS. *Form 7079D* on record/play, record and erase heads. *Form 7082C,* consumer prices on tape heads. *Form 7076,* general information on bias and erase oscillator transformers T60-T2, T60-E, T60-F.—**Nortronics Co., Inc.,** 8101 10th Ave. S., Minneapolis, Minn. 55427

BOOK CATALOG, 16 pages of books of interest to engineers on mathematics/statistics, aeronautics, space technology, electronics, control, data processing, mechanical engineering.—**John Wiley & Sons, Inc.,** 605 3d Ave., New York, N.Y. 10016

SOLID-STATE MICROWAVE PACKAGED DEVICES, *MWD-105.* Well illustrated 16-page looseleaf booklet describing performances of varactor frequency multipliers, tunnel-diode devices and transistor devices, with bibliography.—**RCA Commercial Engineering, Electronic Components & Devices,** Harrison, N.J.

PAMPHLET, *Varactors for Harmonic Generator Applications.* 6-page, looseleaf foldout has 3 selection charts showing appropriate varactor for use in doubler, tripler and quadrupler circuits for given input frequency range and power level, plus performance chart of typical harmonic multipliers and empirical design equations.—**Sylvania Electric Products, Inc.,** 1100 Main St., Buffalo, N.Y. 14209

CATV PRIMER, *So You Want to Be a CATV Operator* covers in 32 pocket-size pages: what CATV is, what it is not; the public service nature of CATV; how to get started in CATV; how to avoid "pie-in-the-sky" pitfalls; CATV and related industries.—**National Community Television Assn.,** 535 Transportation Bldg., Washington, D.C. 20006

NICKEL-CADMIUM BATTERY BROCHURE, *No. BA-162.* Picture story from battery product application to battery design to development, raw materials to finished goods, battery capability and packaging. Lists addresses of key national distribution.—**Battery Div., Sonotone Corp.,** Elmsford, N.Y. 10523

TV PICTURE-TUBE REPLACEMENT-GUIDE WALL CHART, ETR-702J, 3 x 3 ft, illustrates pin configurations, deflection angle (glass or metal), shape of faceplate, type of implosion protection, faceplate treatment, external coatings, focus data, ion-trap information, overall and neck length, basing, heater and anode information, operating conditions for more than 650 picture tubes.—Available only through **authorized G-E electronics components distributors**

SEMICONDUCTOR REPLACEMENT CATALOG, 5th Edition, 10 pages plus foldout of transistor, rectifier, diode replacements conforming to JEDEC specifications.—**General Electric Co.,** 316 E. 9 St., Owensboro, Ky.

TRANSISTOR CATALOG, TUCO, 16 pages of transistors, rectifier diodes, tunnel diodes, electrolytic capacitors, Zener diodes, tantalytic capacitors, transformers, used test equipment, resistors, etc.—**Transistors Unlimited Co.,** 462 Jericho Tpke., Mineola, N.Y.

TRANSISTORIZED PHOTOELECTRIC CONTROLS LITERATURE, GEA-6822C, 10 pages, describes G-E's newly designed photoelectric line. Gives features, specs, ordering instructions and pricing for indoor or outdoor applications with self-contained devices or custom systems built up with single or multiple sets of sensing heads.—**General Electric Co.,** Schenectedy 5, N.Y.

END

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

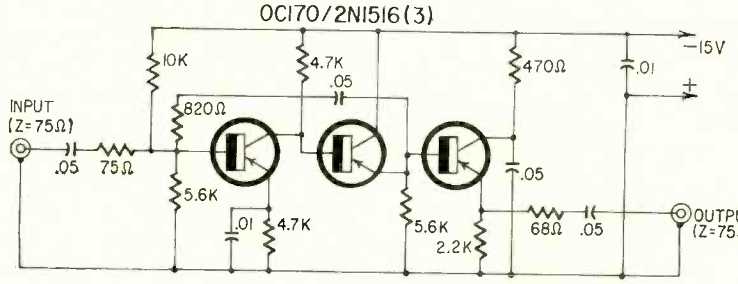
PRICE CHANGE

At the manufacturer's request, the price of the Schober TR-2 reviewed in the May RADIO-ELECTRONICS was carefully altered to include the expected Federal excise tax. A day or two after the issue was irrevocably on press, the starting date of the new tax was pushed ahead to July 1, making the original price the correct one.

So: unless and until the tax goes into effect, the price of the Schober TR-2 in kit form is $69.95, not $75.90.

NOTEWORTHY CIRCUITS

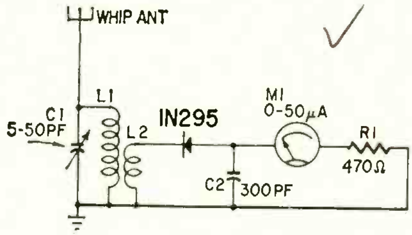
HIGH-GAIN BROAD-BAND BOOSTER



Hams and short-wave listeners are often handicapped by poor antenna systems or receivers with low sensitivity. Here is a broad-band booster that has substantial gain up to 40 mc. It was described by G3CEU in *The Short Wave Magazine* (London, England).

The input stage is a common-emitter amplifier with about 20 db gain. Two cascaded emitter followers reduce the output impedance to 75 ohms. Feedback from the second stage to the base of the first reduces the overall gain about 6 db. Gain is relatively flat at 10 db up to 10 mc and then rises to around 20 db at 28 mc. It then drops to about 10 db at 40 mc. Current drain is around 7 ma at 15 volts.

SIMPLE CB FIELD-STRENGTH METER



Manufacturers often recommend using a field-strength meter when tuning or aligning a CB transmitter. Here is the schematic of a field-strength-meter that Westinghouse suggests you use when aligning the transmitter circuits of their CB walkie-talkies.

L1 consists of 12 turns of No. 14 enameled wire closewound on a form approximately 7/16 in. in diameter. L2 is three turns of No. 14 insulated stranded wire wound around the ground end of L1.

When using, place the meter within a few feet of the transceiver. Press the push-to-talk switch and tune the field-strength meter for maximum deflection. Now, move the meter far enough away from the transmitter so the meter only reads about half scale. Follow the manufacturers' alignment instructions and tune the transmitter's circuits for a maximum reading on the meter.

Got An Ancient Phono? Swap It For A New One

Benjamin Electronic Sound Corp. has called for old phonographs for a collection which eventually will be made available to banks, schools and libraries as an educational service.

G. Thalberg, national sales manager, said the company will give one of its Miracord record players in exchange for every ancient phonograph that is accepted.

The company has not developed any list of wanted phonographs, but a spokesman said that all interesting and unusual record players of ancient vintage will receive consideration.

No one should send an actual phonograph to the company, the spokesman said. The first step should be to mail a snapshot or rough sketch of the phonograph, with a description. If the phonograph is accepted, Benjamin will offer in exchange its Miracord record player.

All correspondence should be sent to old Phonograph Collection, Benjamin Electronic Sound Corp., 80 Swalm St., Westbury, N.Y. END

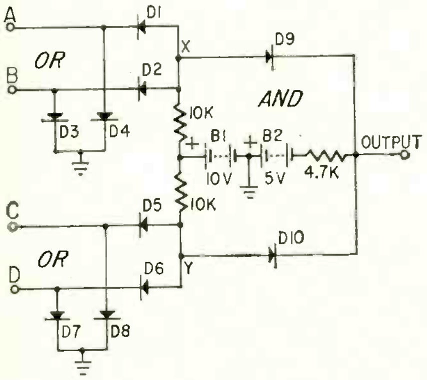
Radio-Electronics Is Your Magazine! Tell us what you want to see in it. Your suggestions may make it a better magazine for the rest of the readers as well as yourself. Write to the Editor, RADIO-ELECTRONICS, 154 West 14 St., New York, N. Y. 10011.

WHAT'S YOUR EQ?

These are the answers. Puzzles are on page 53.

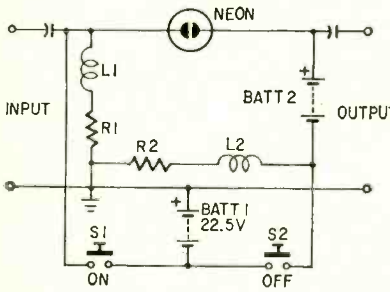
Selective Circuit

The box contains a two-level diode logic circuit. Inputs A and B connect to an OR logic circuit that produces an output if either A or B has an input. C and D connect to an identical OR circuit with same operation. Each of these OR circuits connects to one input of an AND logic circuit which requires signal at both inputs to produce an output.



In operation, with no input, all diodes are forward-biased and have zero voltage drop (perfect diodes). This places all inputs, points X and Y, and output at ground potential. A negative signal applied to A or B will reverse-bias D9, but D10 is still forward-biased, causing output to remain zero. If a negative signal is now applied to C or D, D10 will also be reverse-biased, allowing battery (B2) to produce a negative output.

Audio Switch



The box contains a battery (BATT2) having a voltage too low to fire the glow tube, but high enough to maintain it in the fired condition. When S1 is pressed, battery BATT1 is applied across L1–R1 and is effectively in series with BATT2, causing the neon lamp to fire. This provides a relatively low-impedance path for the af signal. When S2 is pressed, BATT1 is applied across L2–R2 in opposition to BATT2. This extinguishes glow tube and af signal is cut.

That Bad Resistor

We have received several comments on the answer to the "Which Resistor" puzzler (February 1965, p. 91) in which different solutions are offered.

Readers James H. Beggs, Charles A. Metzner and Alexius Hebra came up with similar solutions. The resistors are arranged in a triangle, or "like pins on a bowling alley" (Fig. 1), and marked in some manner. The open resistor will cause a rise in the total resistance and an ohmmeter will read one of the following values: infinity, 93, 81 or 78 ohms. The resistors are rearranged as in Fig. 2, and the second reading again indicates one of these four values. The chart shows the open resistor for any two readings.

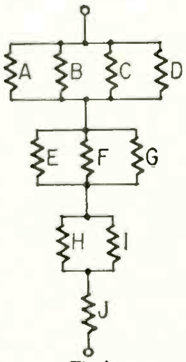


Fig.1

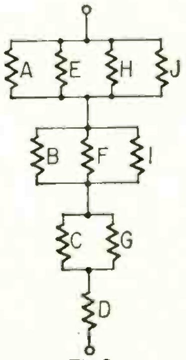


Fig.2

By using a "triangular" number (1 + 2 + 3 and so on) the number of resistors among which the bad one can be located is limited only by the accuracy of the measuring instrument.

SECOND READING \ FIRST READING	∞	93	81	78
∞				D
93			G	C
81		I	F	B
78	J	H	E	A

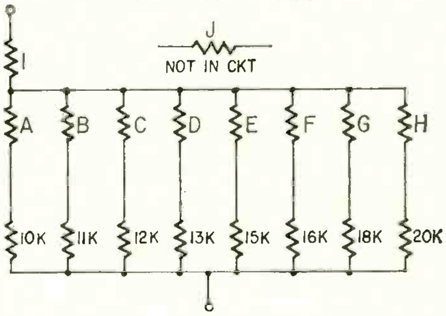


Fig.3

Reader Colin Campbell suggests that by arranging the 36-ohm resistors in series with additional precision resistors (different values) and connecting the group in parallel, the bad one can be located with *one* measurement (Fig. 3).

The drawback here is the need for additional resistors and a *very* accurate measuring instrument. END

TECHNICIANS' NEWS

RENT OUT TV SETS? TAKE HEED

You'd think a rented TV set belongs to the person who rented it out, no? And that if the person who paid his deposit and took the set away with him never came back with it, he'd be legally considered a thief, no?

No. Not, at least, in the State of Washington. The *Northwest Electronic World*, a Seattle-based technicians' publication, points out that in Washington all the owner can do is—at his own expense—locate the missing property, institute legal action to repossess it and sue the culprit for its depreciated value.

This unhappy situation has led the Washington State Electronics Council to join with the Washington State Rental Equipment Protection Committee to promote the passage of a "conversion law" similar to ones in force in neighboring states. The law would make it a misdemeanor to "conceal, convert, destroy or abscond with any personal property or part thereof on which there is a rental agreement, mortgage, lien, lease or sales contract."

Washington State residents who have an interest in such a law are being urged to write State Senators Peterson, Kupka and Riley in support of the bill, SB-328.

Why not check the law in *your* state?

INDIANA AGAIN SEEKS LICENSING

The Indiana Electronic Service Association, with what their *Hoosier Test Probe* describes as "a sudden, last-minute burst of enthusiasm," has decided to press again for a licensing law this year.

A hearing, which included testimony from manufacturers, service people and the public, took place on Feb. 9 at Indianapolis.

LICENSED FOR WHAT?

The March issue of the *BBB Spotlight*, publication of the Metropolitan Better Business Bureau of New York and Long Island, comments:

"When a home appliance company's advertising proclaims that its technicians are 'fully licensed,' the public has a right to assume that its repairmen have a government license.

"However, there is no licensing requirement in New York State for home appliance repairmen. The Bureau, therefore, asked the company [Associated Factory Service, 55 Anchor Ave., Oceanside, N. Y.] what this advertised claim referred to.

"The BBB was informed that it meant the firm's technicians were licensed to drive—as are 6,500,000 people in the state."

TEN COMMANDMENTS OF ELECTRONIC SAFETY

A recent issue of the Iowa TSA *Beacon* carried this admonitory decalogue, reprinted from another publication, which may have reprinted it from yet another, in an unbroken line back to the technicians of Elizabethan, or perhaps even Mosaic times. The work is attributed to a man named Author Unknown. With a few squeezes and tugs in the direction of a more highly polished Biblical style, here it is.

1. Beware of the lightning that lurks in an undischarged capacitor lest it cause thee to be bounded upon thy backside in a most ungentlemanly manner.

2. Cause thou the switch that supplies large quantities of juice to be opened and thus tagged, so that thy days may be long on earth.

3. Prove to thyself that all circuits that radiate and upon which thou workest are grounded, lest they lift thee to a high-frequency potential and cause thee to radiate also.

4. Take care that thou use the proper method when thou takest the measure of high voltage, that it not incinerate both thee and the meter; for verily, though thou hast no account number and canst be easily replaced, the meter doth have such and shall bring great woe upon the supply department.

5. Tarry not amongst those who engage in intentional shocks, for they are surely nonbelievers and not long for this world.

6. Take care thou tamper not with interlocks and safety devices, for this shall incur the wrath of thy seniors, and unleash the fury of the safety officer down upon thy head and shoulders.

7. Work not with energized equipment; for if thou dost, thy buddies will surely be buying beers without thee, and thy space at the bar will be filled by another.

8. Verily, verily, I say unto thee: never service high-voltage equipment alone; for electric cooking is a slothful process, and thou mightest sizzle in thine own fat for hours before thy Maker seeth fit to end thy misery, and draw thee into His fold.

9. Trifle not with radioactive

tubes and substance, lest thou commence to glow in the darkness like unto a lightning bug.

10. Commit thou to memory the work of the prophets, which are written in the Instruction Books; they give thee the straight dope and steer thee away from error.

ZENITH AND PHILCO DO IT AGAIN

For the third consecutive year, Zenith Radio Corp. and Philco Corp. have received National Alliance of Television & Electronic Service Associations' "Friend of Independent Service" Awards.

Zenith's national service manager, Brian J. Marhonic, pledged that the company would continue its policy of "straightforward design and high-quality standards in building TV receivers with the serviceman in mind."

Philco has been active in supplying low-cost technical servicing and parts information to independent technicians through its Tech-Data subscription programs. Philco's Technirama training programs have brought up-to-date service information to thousands of independent service technicians.

The awards were presented at NATESA's spring directors' meeting in Little Rock, Ark. END

Send news to .... Technicians' News, Radio-Electronics, 154 W. 14 Street, New York, New York 10011.

NEW BOOKS

PLANNING & INSTALLING MASTER ANTENNA TV SYSTEMS, by Lon Cantor. *John F. Rider Publisher, Inc., 116 W. 14 St., New York, N.Y. 10011. 6 x 9 in., 127 pp. Paper, $3.95*

"Master Antenna TV Systems" covers multiple-set installations from the 2-set coupler to community TV and translators. Intended not only for TV technicians, but for hotel, motel and apartment-house owners, architects, consulting engineers, institutional authorities and others concerned with the use as well as the installation of MATV systems.

RADAR LICENSE ENDORSEMENT HANDBOOK, by Edward M. Noll. *Howard W. Sams & Co., Inc., 4300 W. 62 St., Indianapolis 6, Ind. 5½ x 8½ in., 175 pp. Paper, $2.95*

The questions and answers you need to help you pass Element 8 (marine radar) of the FCC license exam. Includes principles, circuits and available equipment, plus FCC rules.

SOUND WAVES AND LIGHT WAVES, by Winston E. Kock. *Doubleday & Co., 277 Park Ave., New York, N.Y. 10017. 4¼ x 7 in., 165 pp. Paper, $1.25*

Simply written book that starts from fundamental principles and continues to describe some sophisticated types of antennas, waveguides and lenses for both sound and rf. A valuable book for the beginner as well as for the more advanced electronics man who is still not quite sure how a polystyrene rod can be used as a directional antenna.

FUNDAMENTALS OF TELEVISION, by Walter H. Buchsbaum. *John F. Rider Publisher, Inc., 116 W. 14 St., New York 11, N.Y. 6 x 9 in., 291 pp. Cloth, $9.95*

A brief description of TV receivers, section by section, for the technician who knows radio. Tube and transistor schematics are analyzed and discussed from the standpoint of operation, alignment and repair.

SHORT WAVE LISTENER'S GUIDE, by H. Charles Woodruff. *Howard W. Sams & Co., Inc., 4300 W. 62 St., Indianapolis 6, Ind. 5½ x 8½ in., 64 pp. Paper, $1.25*

More than 300 stations are listed by city, frequency and time schedule. Also included are time conversion, station log, and even a list of clandestine stations now on the air.

PHYSICAL ELECTRONICS, by G. F. Alfrey. *D. Van Nostrand Co., Ltd., 358 Kensington High St., London, W.14, England. 6 x 9 in., 220 pp. Cloth, $8.50*

After a study of electrons and atoms, the author discusses such practical applications as the electron microscope, electron tube, transistor, ferrites and maser. The treatment is concise and logical, suitable for undergrads in engineering and physics.

RADAR SYSTEM ANALYSIS, by David K. Barton. *Prentice-Hall, Inc., Englewood Cliffs, N. J. 6 x 9 in., 608 pp. Cloth, $16.95*

Theory and practical design for radar engineers. Uses a minimum of math, and has an extensive bibliography.

TV RECEIVER TUBE USAGE GUIDE. *Howard W. Sams & Co., Inc., 4300 W. 62 St., Indianapolis 6, Ind. 5½ x 8½ in., 96 pp. Paper $1.95*

All tubes, semiconductors and fuses used in 1963–64 TV receivers. Indexed by TV model and by tube type.

TECHNICAL REPORT WRITING, by Rufus P. Turner. *Holt, Rinehart & Winston, Inc., 383 Madison Ave., New York, N.Y. 10017. 6 x 9 in., 210 pp. Paper, $3.50*

Ten chapters cover the subject from the "Nature of Technical Writing" to "Preparation for the Printer." Especially valuable are the 6 specimen reports—89 pages of actual technical writing.

KNOW YOUR COLOR-TV TEST EQUIPMENT, by Robert G. Middleton. *Howard W. Sams, 4300 W. 62 St., Indianapolis 6, Ind. 5½ x 8½ in., 160 pp. Paper, $2.50*

The TV technician can get information on troubleshooting almost anything—except the very equipment he is using. This book fills a gap in the literature, with complete chapters devoted to such things as white-dot and crosshatch generators or video-frequency sweep generators. Explains first principles, shows partial schematics and normal and abnormal waveforms describing common troubles. The last chapter is entitled "Maintenance of Color-TV Test Equipment."

SPACE AGE ACRONYMS, by Reta C. Moser. *Plenum Press, 227 W. 17 St., New York, N.Y. 10011. 6½ x 10 in., 427 pp. Cloth, $17.50*

This remarkable book devotes 413 pages to acronymic abbreviations from A (can mean *absolute*, or 11 other things from *acceleration* to *attack*), to ZZB (Zanzibar). There are a number of appendices, including designations for missiles, rockets, aircraft, ships, and electronic equipment.

MATHEMATICS FOR ELECTRONIC ENGINEERS & TECHNICIANS. (A programmed text) by Norman H. Crowhurst. *Howard W. Sams, 4300 W. 62 St., Indianapolis 6, Ind. 5¾ x 8¾ in., 256 pp. Cloth, $6.95*

The author uses the programmed-text method in a manner especially designed to develop problem-solving ability. All the problems have a direct application to electronics. END

NEW SEMI-CONDUCTORS AND TUBES

SOLID-STATE LIGHT EMITTERS

Tiny planar gallium arsenide diodes are expected to replace subminiature incandescent lamps as sources for light-sensors, according to Texas Instruments, Inc., producer of a line of solid-state light-emitting diodes.

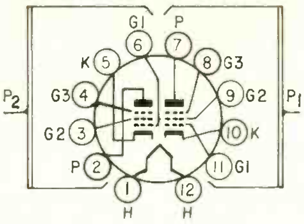
A new device, called the TIXL01, is a GaAs diode that emits near-infrared light, spectrally matched to many light sensors. Its life is far greater that that of a filament lamp, and it is much more resistant to vibration and other stresses. It is practically free of the characteristic "catastrophic failure" of filament lamps (burnout or filament breakage).

The TIXL01 is only $\frac{1}{16}$ in. in diameter and $\frac{1}{10}$ in. high. It can be mounted in $\frac{1}{16}$-in.-thick printed-circuit boards, which simplifies circuit assembly. And its narrow beam reduces optical crosstalk in applications such as punched-card readers where many light emitters and light sensors are packed together bumper to bumper.

9BJ11

A new compactron with two high-transconductance pentodes in one 12-pin envelope has been announced by General Electric. It is intended as a two-stage 45-mc video i.f. amplifier in home TV sets, and the manufacturer claims that in properly designed circuitry it can offer "sensitivity equal to some three-stage amplifiers." The 9BJ11 is not the first twin-pentode compactron.

The tube has a heater rating of 9.6 volts and 0.45 ampere. Its warmup time is controlled to 11 seconds for series-



9BJ11

string sets. Maximum plate and screen voltage is 160; plate dissipation in section 1, 2.8 watts, screen dissipation, 1.25 watts; in section 2, 2.2 watts and 0.55 watt. The two units are not identical, and they should be used in numbered order as first stage, second stage. Transconductance in section 1 is 7,500 μmhos; in section 2, 9,600 μmhos.

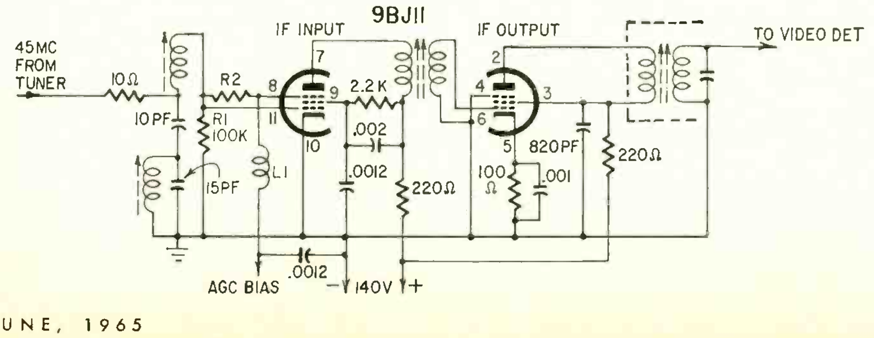
Used in the circuit shown below, a single 9BJ11 will give approximately 90 db gain (more than 30,000) with a bandwidth of 3.25 mc, with a supply voltage of 140 and a total current drain of 27 ma.

"SELENICON" CAMERA TUBE DOUBLES COLOR SENSITIVITY

A new broadcast color camera tube recently announced by RCA will provide "richer and more uniform" color TV pictures. The tube has been named "Selenicon" for its selenium-containing photosensitive plate.

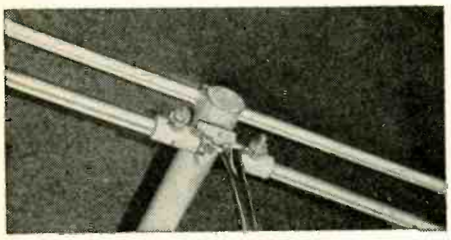
Selenium is far more sensitive to light than materials now used in video pickup tubes, but until now it has been unstable at the temperatures in a camera tube. A stable selenium alloy developed by RCA is claimed to overcome the disadvantages and offer several advantages other than the higher sensitivity. Among them are quicker response time, truer colors over a wide range of scene lighting, and a more uniform picture background.

The new tube was demonstrated at the National Association of Broadcasters convention in March. Three selenicon camera tubes generate the three color signals–red, green and blue. A fourth tube, an image orthicon, provides a separate complete black-and-white picture. This approach is claimed by RCA to yield sharper-detailed, richer-hued pictures than the present three-tube cameras. END



TRY THIS ONE

FASTENING LEAD-IN TO ANTENNA TERMINALS

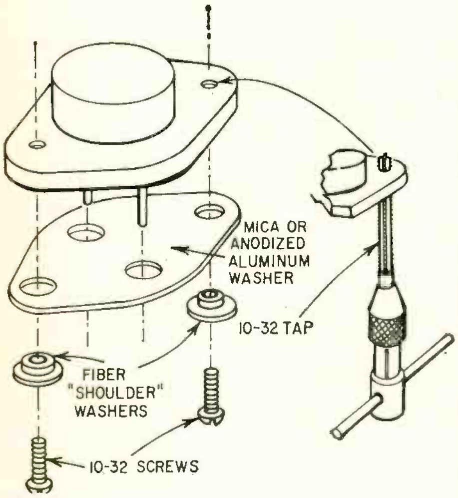


When it comes to placing the bared loops of the lead-in around the terminals of the antenna, we install the usual star lockwasher first, then follow this with the loop, then add the nut. That way the lockwasher bites firmly into the loop to insure perfect contact.

This arrangement lets us remove the nut without twisting the wire loop and possibly breaking it.—*Harry J. Miller*

SIMPLIFIED POWER TRANSISTOR MOUNTING

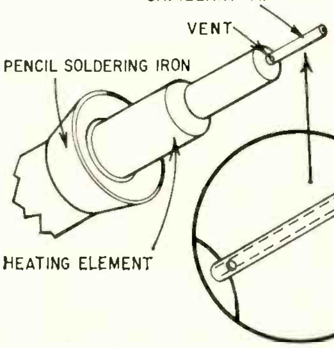
To simplify the installation of TO-3 type power transistors, tap the holes in the base with a 10-32 tap. Installing the transistor this way avoids the need to hold a nut on the other side of the chassis, and ensures better electrical and thermal contact. The base of these transistors is solid copper, and no damage can result from the tapping operation.—*Tom Jaski*



DESOLDERING IRON

Many service technicians have found the modified soldering-iron tip shown in the drawing very useful for desoldering operations. The old iron tip is removed and replaced with a length of hollow tubing or refrigeration capillary tubing. A small vent hole is then drilled at the top of the tube, near the body of the iron. To remove solder from a connection, apply this hot desoldering tip to the connection. The molten solder is drawn up into the hollow tube.

When the tube is full, empty it by shaking the iron. This method provides a very clean solder joint. Another advantage is that the hollow tube tip fits over many of the solder lugs on a Perma-Circuit panel, thus applying the heat evenly to the connection. The hollow tip also acts as a "soldering aid"—it can be used to pry up and bend straight any wires or lugs that are bent flush with the panel.—*Advanced Perma-Circuit Service Techniques* (*Philco*) END



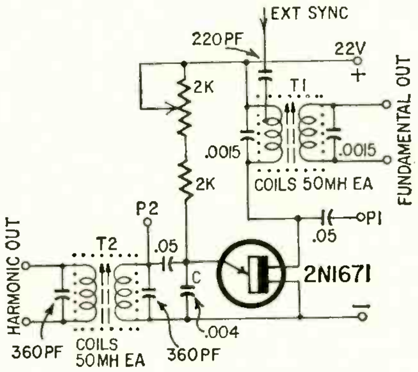
NEW PATENTS

LOCKED-OSCILLATOR HARMONIC GENERATOR

PATENT NO. 3,142,024

George Mordwinkin, Norwalk, Conn. (Assigned to Laboratory for Electronics, Inc., Boston Mass.)

In FM stereo, a 38-kc subcarrier must be generated at the receiver. This may be obtained as doubled output from a 19-kc oscillator. The oscillator is synchronized by a pilot signal from the transmitter.



The circuit here may be used for FM stereo or wherever a harmonic generator of this type is needed. C charges from a dc supply through a variable resistance. At a critical value, it discharges through the unijunction transistor. Both windings of T1 are tuned to 19 kc. and output is available either from the secondary or from P1.

T2 is tuned to 38 kc, and output may be taken either from the secondary or from P2.

The fundamental is synchronized by an external signal (pilot) connected to a tap on T1.

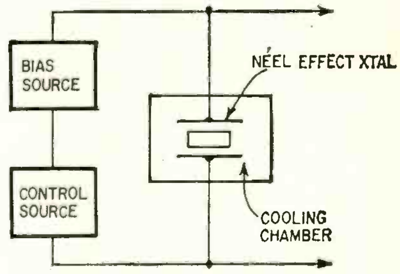
SOLID STATE SWITCH

PATENT No. 3,149,298

Eileen T. Handelman, Short Hills, N.J. (Assigned to Bell Telephone Labs, Inc.)

Certain compounds, classed as Néel effect materials, change their conductivity abruptly at a critical temperature. For example, vanadium sesquioxide (V_2O_3) undergoes a million-to-one change at —110°C.

A slice of this material, .03 x .03 x .01 inches, is placed in a chamber of liquid nitrogen and alcohol at —115°C. A dc bias flowing through the crystal raises its temperature to —109°. The con-



trol voltage, about 5 volts, can raise the crystal temperature through its critical value, and switch it on in less than 1 microsecond.

SUPERCONDUCTIVE MAGNETIC-FIELD INTENSIFIER

PATENT NO. 3,158,793

Paul S. Swartz, Schenectady, N.Y. (Assigned to General Electric Co.)

A superconductor is a metal or compound (like niobium-tin) which loses its electrical resistance when cooled to nearly absolute zero. Once started, current through the superconductor will continue indefinitely, with an accompanying mag-

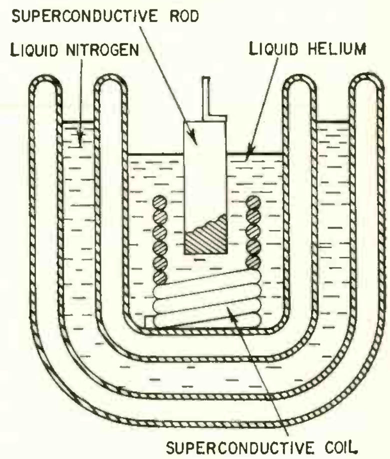


Fig. 1

netic field. Another characteristic of a superconductor is its resistance to penetration by magnetic fields.

Fig. 1 shows a superconductive device for generating intense magnetic fields. An outer container is filled with liquid helium. The superconductive coil is thereby cooled. A rod made of superconductive material may be lowered inside the coil as shown.

An external magnetic field (not shown) sets up a superconductive current in the coil, as well as an accompanying field. After this, the external field is not needed and may be switched off. Now, as the rod is lowered, it compresses and intensifies the flux trapped inside the coil because of the coils magnetic impentrability. If the rod is step-tapered (Fig. 2), different values of field intensity may be obtained. END

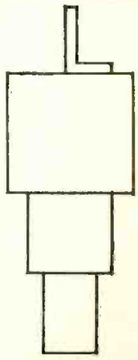
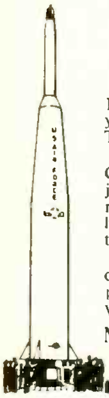


Fig. 2

SCHOOL DIRECTORY



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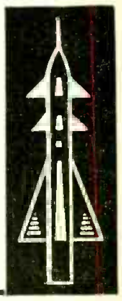

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TYPE	PRICE
0A2	.90
0A3	.90
0A4G	1.55
0B2	.80
0B3	1.20
0C3	.85
0D3	.75
0G3	2.75
0Y4	1.20
0Z4	.95
1A3	1.49
1A5	1.49
1A6	1.49
1A7	1.95
1AB5	.75
1AD4	1.75
1AE4	1.30
1AF4	1.45
1AG4	2.20
1AJ5	1.05
1AU3	1.25
1AX2	.95
1AY2	.98
1B3	.88
1B4P	2.00
1C5	1.00
1C6	.98
1D5GP	.98
1D7	1.25
1DN5	.53
1E5GP	.98
1E7	.99
1F4	.95
1F5	.95
1F6	1.20
1G3	.88
1G4	1.75
1G6	1.50
1H4	1.25
1H5	2.59
1H6	.98
1J3	.88
1J5	.98
1J6	.98
1K3	.88
1L4	.66
1L6	2.35
1LA4	1.30
1LA5	2.60
1LA6	1.49
1LB4	1.80
1LC5	1.05
1LC6	1.80
1LD5	1.95
1LE3	1.25
1LG5	1.98
1LH4	1.80
1LN5	1.25
1N5	1.75
1P5	2.00
1Q5	1.95
1R4	.80
1R5	.90
1S2A	1.90
1S4	1.45
1S5	.90
1T4	.79
1T5	.80
1U4	.70
1U5	.87
1V	1.05
1V2	.79
1X2B	.84
1Z2	3.25
2A3	2.50
2A5	1.95
2A6	3.75
2A7	1.50
2AF4A	1.10
2AH2	1.34
2AS2	1.30
2B3	2.70
2B7	.95
2BN4	.98
2CY5	.95
2D21	.75
2DZ4	1.95
2EA5	1.45
2EN5	.83
2ER5	1.60
2FH5	1.40
2FQ5	1.95
2FS5	2.55
2GK5	1.57
2GU5	1.65
2GW5	2.40
2HK5	.98
2X2	.60
2X2A	1.30
3A2	1.45
3A3	1.29
3A4	.74
3A5	1.10
3AF4	.99
3AL5	.87
3AT2	1.23
3AU6	.55
3AV6	.44
3AW3	1.31
3B2	3.35

TYPE	PRICE
3B7	1.35
3BA6	.95
3BC5	.61
3BE6	.85
3BN4	1.18
3BN6	.73
3BU8	.76
3BY6	.56
3BZ6	.54
3CB6	.54
3CE5	.90
3CF6	1.05
3CS6	.56
3CY5	1.18
3D6	1.48
3DG4	1.25
3DK6	.58
3DT6	.52
3DZ4	1.59
3EH7	1.00
3EJ7	1.00
3ER5	1.35
3FH5	.95
3FS5	1.18
3GK5	1.49
3GS8	1.21
3GW5	.98
3HA5	1.49
3HK5	1.23
3HS8	1.29
3Q4	1.35
3Q5	2.00
3S4	.75
3V4	.61
4AU6	.89
4AV6	.70
4BA6	.85
4BC5	.90
4BC8	1.02
4BL8	1.00
4BN6	1.45
4BQ7	.99
4BS8	.96
4BU8	1.20
4BZ6	.85
4BZ7	1.00
4CB6	.87
4CS6	.59
4CY5	1.10
4DE6	1.01
4DK6	.58
4DT6	.87
4EH7	1.47
4EJ7	1.47
4EM6	1.19
4ES8	1.79
4EW6	1.01
4GK5	1.59
4GM6	1.25
4GS8	1.19
4GZ5	.91
4GZ6	1.19
4HA5	1.85
4HC7	1.39
4HM6	.91
4HS8	1.18
4HT6	1.24
4JC6	1.35
4JD6	1.35
5AM8	.77
5AN8	.88
5AQ5	.52
5AR4	1.75
5AS8	1.75
5AT8	.81
5AU4	1.25
5AV8	.98
5AW4	1.00
5AZ4	1.98
5B8	2.09
5BC3	.89
5BE8	1.27
5BK7	.89
5BQ7	.99
5BR8	.81
5BT8	.79
5BW8	1.31
5CG8	1.20
5CL8	1.19
5CM8	1.47
5CQ8	1.45
5CZ5	1.70
5DE8	1.15
5DJ4	1.00
5EA8	1.21
5ES8	2.21
5EU8	1.29
5EW6	1.01
5FG7	1.07
5FV8	1.21
5GH8	1.53
5GJ7	1.62
5GM6	1.00
5GX6	.89
5HC7	1.49
5HG8	1.65
5J6	.72
5KE8	1.24
5T4	2.95
5T8	.96

TYPE	PRICE
5U4	.60
5U8	.84
5V3	1.59
5V4	1.45
5V6	.65
5W4	1.75
5X4	.99
5X8	.84
5Y3	.47
5Y4	1.45
5Z3	2.00
5Z4	1.90
6A3	2.75
6A4	2.20
6A6	1.75
6A7	2.65
6A8GT	.95
6A8M	1.75
6AB4	.52
6AB5	3.00
6AB7	1.00
6AC5	1.95
6AC7	.91
6AD7	3.25
6AE5	2.50
6AF3	1.10
6AF4	.99
6AF4A	.99
6AF6	2.65
6AF11	1.98
6AG5	.68
6AG7	1.75
6AH4	1.11
6AH6	1.25
6AJ5	2.25
6AJ8	1.73
6AK5	.90
6AK6	.94
6AL3	1.00
6AL5	.45
6AL7	1.95
6AL11	1.65
6AM8	.76
6AN4	2.59
6AN5	1.95
6AN6	2.45
6AN8	1.50
6AQ5	.52
6AQ6	1.05
6AQ7	1.55
6AQ8	1.20
6AR5	1.03
6AR6	1.50
6AR8	2.00
6AR11	1.65
6AS5	.79
6AS6	1.00
6AS7	2.85
6AS8	1.30
6AS11	1.95
6AT6	.49
6AT8	.84
6AU4	.95
6AU5	1.60
6AU6	.52
6AU7	.54
6AU8	.87
6AV5	1.45
6AV6	.44
6AV11	1.52
6AW8	.88
6AX3	1.05
6AX4	.64
6AX5	.74
6AX7	1.25
6AX8	1.34
6AY3	1.05
6AZ8	2.15
6B4	3.95
6B5	4.00
6B7	2.75
6B8	2.50
6B10	1.35
6BA3	1.05
6BA6	.49
6BA7	1.50
6BA8	1.48
6BA11	1.22
6BC4	2.10
6BC5	.62
6BC7	1.47
6BC8	1.49
6BD4	7.00
6BD5	1.20
6BD6	.94
6BE3	1.15
6BE6	.53
6BF5	.88
6BF6	.48
6BF8	1.65
6BG6	1.67
6BH6	1.00
6BH8	.94
6BJ6	.69
6BJ7	1.19
6BJ8	1.35
6BK4	3.15
6BK5	1.30
6BK7	.89
6BL7	1.19

TYPE	PRICE
6BL8	1.52
6BN4	.98
6BN6	.74
6BN8	1.18
6BQ5	.83
6BQ6/6CU6	1.08
6BQ7	.99
6BR8	1.34
6BS8	1.42
6BU8	.74
6BV8	1.19
6BW8	1.35
6BX7	1.46
6BY5	1.65
6BY6	.98
6BY8	1.01
6BZ6	.72
6BZ7	1.19
6BZ8	1.35
6C4	.54
6C5M	1.45
6C6	2.00
6C8G	2.95
6C10	1.53
6CA4	.77
6CA5	1.20
6CA7	1.95
6CB5	3.25
6CB6	.55
6CD6	1.65
6CF6	.95
6CG7	.63
6CG8	.85
6CH8	2.00
6CK4	1.00
6CL6	1.12
6CL8	.94
6CM6	1.29
6CM7	.95
6CM8	1.45
6CN7	.92
6CQ4	1.25
6CQ7	1.80
6CQ8	1.15
6CR6	.91
6CS6	.85
6CS7	.99
6CU5	.84
6CU6	1.10
6CU8	1.59
6CW4	1.69
6CW5	1.39
6CX8	1.49
6CY5	.99
6CY7	1.22
6CZ5	1.59
6CZ7	1.95
6D4	1.75
6D6	2.50
6D10	1.59
6DA4	.99
6DA5	1.05
6DB5	1.99
6DB6	1.01
6DC6	1.29
6DC8	1.22
6DE4	1.03
6DE6	.93
6DE7	1.29
6DG6	.95
6DJ8	1.65
6DK6	.89
6DN6	2.74
6DN7	1.35
6DQ5	2.75
6DQ6	1.10
6DR7	1.29
6DS4	1.55
6DS5	1.21
6DT5	.95
6DT6	.75
6DT8	1.35
6DV4	2.39
6DW4	1.39
6DW5	1.55
6DX8	1.19
6DZ4	1.53
6E5	1.89
6EA5	1.55
6EA7	1.47
6EA8	1.19
6EB5	1.75
6EB8	1.45
6EH5	1.10
6EH7	.79
6EH8	1.21
6EJ7	.79
6EM5	1.29
6EM7	1.79
6EQ7	1.10
6ER5	1.35
6ES5	1.15
6ES8	2.19
6ET7	1.40
6EU7	1.03
6EU8	1.25
6EV5	1.10
6EW6	.92
6EW7	1.50

TYPE	PRICE
6EY6	1.23
6EX6	2.79
6EZ5	1.39
6EZ8	1.41
6FA7	1.10
6FD7	1.73
6F4	3.95
6F5GT	1.50
6F5M	1.69
6F6G	1.95
6F6M	2.19
6F7	3.95
6F8	3.25
6FG5	1.99
6FG6	1.25
6FG7	1.12
6FG8	1.75
6FH5	.92
6FJ5	2.25
6FJ7	1.39
6FM7	1.31
6FQ7	.89
6FS5	1.19
6FV6	1.33
6FV8	1.15
6FW5	1.59
6FW8	3.49
6FY5	1.11
6G5	1.95
6G6G	1.55
6G11	1.69
6GB5	1.81
6GC5	1.19
6GE5	1.59
6GE7	1.19
6GF5	1.42
6GF7	1.69
6GH8	1.19
6GJ5	1.69
6GJ7	1.37
6GK5	1.55
6GK6	.99
6GL7	1.99
6GM5	1.21
6GM6	.91
6GN8	1.35
6GQ7	1.89
6GR7	1.42
6GT5	1.49
6GV5	1.65
6GV6	1.85
6GW6	1.55
6GW8	1.21
6GX6	.88
6GX8	1.31
6GY5	1.89
6GY6	.87
6GZ5	1.16
6HA5	1.45
6HB5	1.69
6HF5	2.79
6HF8	1.45
6HG8	1.69
6HJ8	1.25
6HK5	1.19
6HL8	1.19
6HS8	1.21
6HT6	1.19
6HZ6	.99
6H6M	.79
6J4	2.95
6JB6	1.76
6JC8	1.15
6JE6	2.99
6JE8	1.49
6J5M	1.30
6J5GT	1.20
6J6	.72
6J7	1.85
6J7G	1.25
6J8	2.50
6J11	1.82
6JH6	.99
6JH8	1.69
6JK8	1.30
6JS6	2.95
6JT8	1.69
6JV8	1.49
6JZ8	1.44
6K6GT	.64
6K7	1.70
6K7G/GT	1.49
6K8GT	1.25
6K8M	2.50
6K11	1.49
6KD8	1.39
6KT8	1.23
6KU8	1.15
6LB8	1.49
6L5G	1.50
6L6G	.98
6L6GA	1.50
6L6GB	1.50
6L6GC	1.61
6L6M	3.25
6L7M	2.50
6L7G	1.75
6M11	1.81
6N7M	1.85

TYPE	PRICE
6N7GT	1.75
6Q7GT	1.95
6Q7M	2.00
6Q11	1.29
6R7	1.75
6S4	.56
6S7	1.95
6S8GT	1.50
6SA7GT	1.39
6SA7M	1.49
6SB7Y	2.20
6SC7	1.49
6SD7	1.49
6SF5	1.19
6SF5GT	1.05
6SF7	1.95
6SG7	1.65
6SH7	1.21
6SJ7GT	1.19
6SJ7M	1.49
6SK7GT	1.25
6SK7M	1.45
6SL7GT	1.10
6SN7GT	.75
6SQ7GT	1.25
6SQ7M	1.45
6SR7	1.25
6SS7M	1.95
6SS7GT	1.49
6SZ7	1.25
6T4	1.15
6T8	.85
6U5/6G5	1.95
6U8	1.29
6U8GT	1.10
6V3	1.42
6V4	.59
6V6GT	.66
6V6M	2.39
6W4	.89
6W6GT	.89
6X4	.60
6X5GT	.75
6X8	.82
6Y6	1.25
6Y10	.98
7A4	1.15
7A5	1.29
7A6	1.29
7A7	1.35
7A8	1.95
7AD7	1.25
7AF7	1.65
7AG7	1.75
7AH7	1.49
7AU7	.67
7B4	1.50
7B5	1.25
7B6	1.25
7B7	2.25
7B8	1.25
7C4	1.15
7C5	1.25
7C6	2.25
7C7	1.20
7E5	1.25
7E6	1.25
7E7	1.33
7EY6	.75
7F7	2.10
7F8	1.95
7G7	1.65
7H7	1.65
7HG8	1.29
7J7	2.50
7K7	2.45
7L7	1.99
7N7	2.25
7Q7	1.85
7R7	1.79
7S7	1.79
7V7	1.81
7W7	1.95
7X6	1.35
7X7	1.95
7Y4	1.79
7Y7	1.79
7Z4	1.95
8AU8	.98
8AW8	.99
8BH8	1.36
8BQ5	.99
8CG7	.95
8CM7	1.07
8CN7	.99
8CS7	.98
8CX8	1.25
8EB8	1.25
8EM5	1.19
8ET7	1.39
8FQ7	.95
8GJ7	1.31
8GN8	1.27
8JV8	1.42
8KA8	1.39
9A8	1.29
9AU7	1.05
9BR7	1.32
9CL8	1.10

TYPE	PRICE
9EA8	1.49
9U8	.99
10AL11	1.69
10BQ5	1.45
10C8	1.49
10DE7	1.29
10DX8	1.37
10EG7	1.49
10EM7	1.75
10EW7	1.45
10GN8	1.30
10HT8	1.21
10JA8	1.35
10JY8	1.49
10KU8	1.15
10Y	.95
11CY7	1.10
11JE8	1.49
11KV8	2.35
12A4	.95
12A5	1.25
12A6	.89
12A7	1.95
12A8	2.95
12A11	1.69
12AB5	.95
12AC6	.75
12AD6	.79
12AE6	.79
12AE7	1.25
12AF3	.95
12AF6	.98
12AG6	1.49
12AJ6	.94
12AL5	.69
12AL8	1.95
12AL11	1.69
12AQ5	.79
12AT6	.55
12AT7	.92
12AU6	.69
12AU7	.69
12AV5	1.50
12AV6	.53
12AV7	.89
12AW6	1.10
12AX3	1.03
12AX4	.75
12AX6	.91
12AX7	.79
12AY3	1.05
12AY7	1.55
12AZ7	.89
12B4	.89
12BA6	.60
12BA7	1.90
12BD6	.72
12BE3	.99
12BE6	.61
12BF6	.68
12BH7	.91
12BK5	1.22
12BL6	.89
12BN6	1.48
12BQ6/CU6	1.15
12BR7	.98
12BV7	1.19
12BW4	1.07
12BY7	.83
12BZ6	.76
12BZ7	.95
12C5/12CU5	.76
12CA5	.89
12CN5	.98
12CR6	.89
12CS6	.95
12CT8	1.60
12CU6/BQ6	1.11
12CX6	.95
12D4	1.05
12DB5	1.05
12DE5	.92
12DE8	1.19
12DK7	1.05
12DL8	1.95
12DQ6	1.15
12DQ7	1.29
12DS7	1.19
12DT5	1.15
12DT7	1.10
12DT8	1.25
12DW7	1.19
12DW8	1.25
12DY8	2.90
12DZ6	.98
12EA6	.99
12EC8	1.35
12ED5	.98
12EG6	1.03
12EK6	.98
12EL6	.71
12EL8	.95
12EM6	1.14
12EZ6	.83
12F5	1.60
12F8	.99

TYPE	PRICE
12FA6	.97
12FK6	.83
12FM6	.81
12FQ8	1.19
12FR8	1.48
12FX5	.96
12FX8	1.27
12GA6	.91
12GC6	1.15
12GE5	1.46
12GW6	1.15
12J5	1.21
12J8	1.21
12K5	1.19
12K8G	1.50
12K8M	2.95
12L6	.79
12L8	.50
12Q7GT	1.39
12Q7M	1.50
12R5	1.18
12SA7	1.49
12SA7GT	1.25
12SC7	1.50
12SF5GT	1.19
12SF5M	1.50
12SF7M	1.75
12SG7GT	1.20
12SG7M	1.39
12SH7	1.55
12SJ7GT	1.25
12SJ7M	1.39
12SK7GT	1.10
12SK7M	1.35
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12W6	.89
12X4	.59
13DE7	1.12
13DR7	1.29
13EM7	1.83
13FD7	1.89
13FM7	1.15
13GF7	1.79
14A4	1.45
14A5	1.35
14A7	1.39
14AF7	1.65
14B6	1.69
14B8	1.95
14C5	1.75
14C7	2.19
14E6	1.39
14E7	1.39
14F7	2.59
14F8	1.95
14GT8	.95
14H7	1.95
14J7	1.95
14N7	1.95
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14S7	1.95
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14X7	1.75
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16GY5	1.90
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17BS3	1.15
17C5	2.35
17C9	1.95
17D4	1.03
17DE4	1.25
17DM4	1.19
17DQ6	1.15
17DQ7	1.75
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17GJ5	1.75
17GV5	1.69
17GW6	1.49
17H3	.93
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17JB6	1.95
17JM6	1.65
17JN6	1.70
17JZ8	1.19

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17LD8	1.35
17W6	1.15
18A5	1.55
18FW6	.75
18FX6	.79
18FY6	.69
18GD6	.81
19	1.00
19AU4	1.21
19BG6	1.95
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19CL8	1.25
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21HB5	1.65
22BH3	1.15
22BW3	1.21
22DE4	1.15
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25AC5	2.50
25AK4	1.19
25AV5	1.35
25AX4	.95
25BK5	1.15
25BQ6	1.45
25B8	1.93
25C5	.66
25CA5	1.15
25CD6	1.69
25DK4	.63
25DN6	1.95
25EH5	.82
25F5	1.29
25L6	.75
25W4	.83
25Z5	1.49
25Z6	.98
27GB5	1.49
32ET5	.89
32L7	.85
33GY7	1.95
34DG5	.95
34GD5	.83
35A5	2.19
35B5	1.10
35C5	.73
35EH5	.83
35L6	.87
35W4	.40
35Y4	1.63
35Z3	1.49
35Z5	.65
45Z3	.55
50A5	2.25
50B5	.89
50C5	.72
50DC4	.64
50EH5	.87
50FY8	1.50
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50HK6	.86
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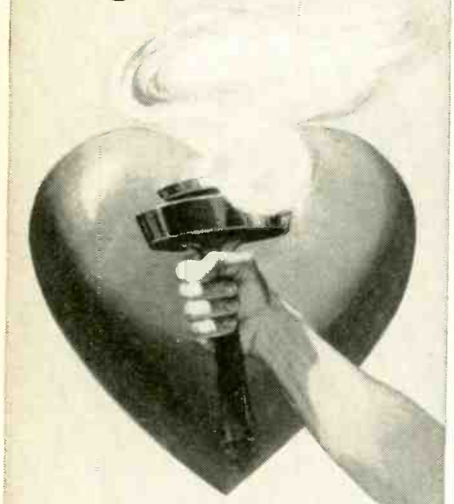

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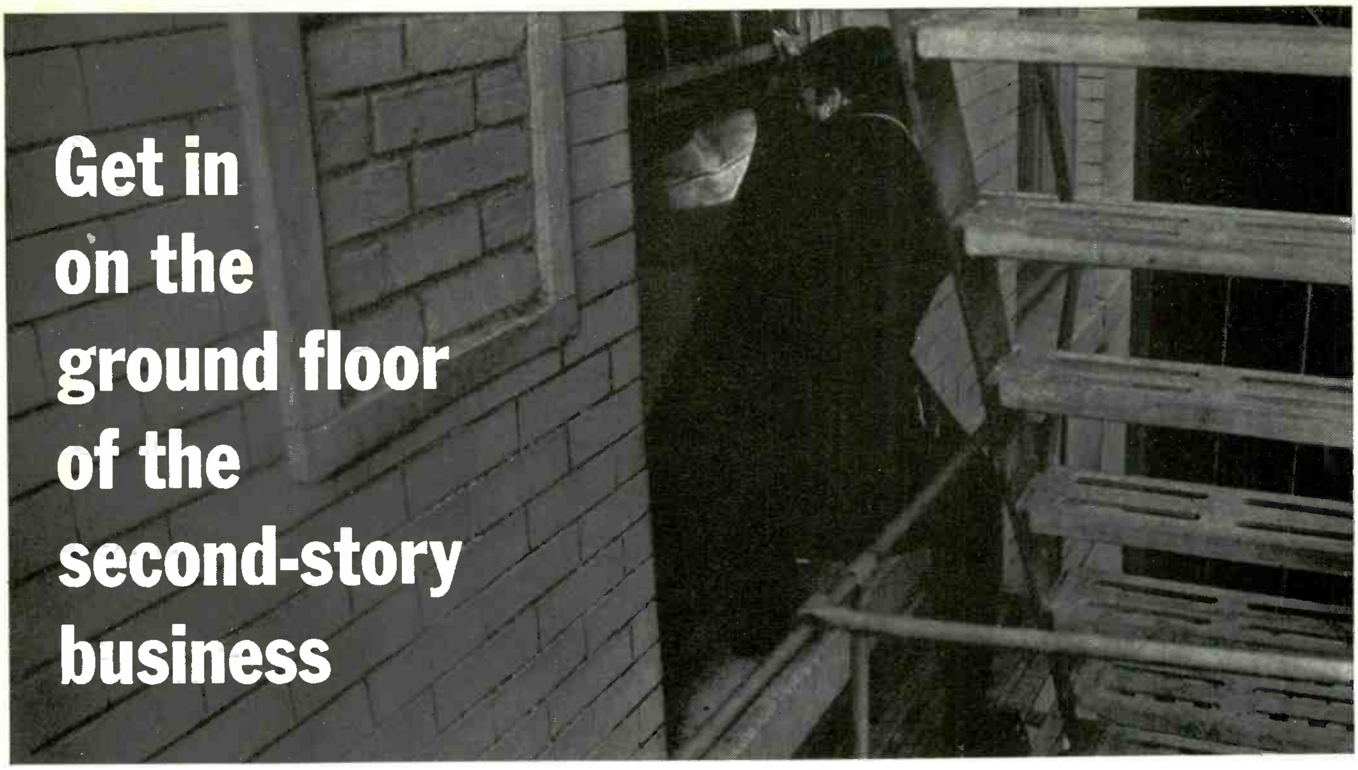


Every 40 seconds a burglary takes place in the United States.

TECHNICAL INFORMATION

The RADAR SENTRY ALARM is a complete U.H.F. Doppler Radar System which saturates the entire protected area with invisible r.f. microwaves. It provides complete wall to wall—floor to ceiling protection for an area of up to 5,000 square feet. Without human movement in the protected area, the microwave signal remains stable. Any human movement (operation is unaffected by rodents and small animals)in the area causes the doppler signal to change frequency approximately 2 to 4 cps. An ultra-stable low frequency detector senses this small frequency change, amplifies it and triggers the police type siren—which is heard up to a half mile away.

In addition, the RADAR SENTRY ALARM's protection can be extended to other areas with the use of the following optional accessories:

- *remote detectors for extending coverage to over 10,000 sq. ft.*
- *rate of rise fire detector U.L. approved for 2,500 sq. ft. of coverage each (no limit on the number of remote detectors that can be used)*
- *hold-up alarm*
- *central station or police station transmitter and receiver (used with a leased telephone line)*
- *relay unit for activating house lights*
- *battery operated horn or bell which sounds in the event of: powerline failure; equipment malfunction or tampering*

At that rate, it's a multi-million dollar a year business . . . for burglars.

And an even better business opportunity for you.

Why? Because burglary can be stopped...with an effective alarm system.

In fact, police and insurance officials have proved that an alarm system reduces, and in many cases, eliminates losses—even helps police apprehend the criminal.

Here's where you come in.

Only a small percentage of the more than 100 million buildings—stores, offices, factories, schools, churches and homes are protected by an effective alarm system.

That means virtually every home, every business is a prospect.

You can sell them!

And you don't have to be a super-salesman to sell the best protection available—a Radar Sentry Alarm unit. All you have to do is demonstrate it . . . it sells itself.

A glance at the technical information shows why.

It's the most unique and effective alarm system ever invented.

And here's the proof.

In the past six years, thousands of RADAR SENTRY ALARM units have been sold in the Detroit, Michigan area alone—sold by men like yourself on a part-time and full-time basis.

Here are just a few customers who are protected by RADAR SENTRY ALARMS:

U.S. Government
U.S. Air Force
Detroit Board of Education
Hundreds of Churches,
Banks, Businesses and
Homes.

Everyone is a prospect.

So take advantage of your profession. Put your technical knowledge and experience to work for you in a totally new area—an area that will make money for you!

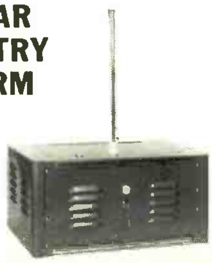
Don't wait!

Get in on the ground floor of this new money-making business.

Become a distributor.

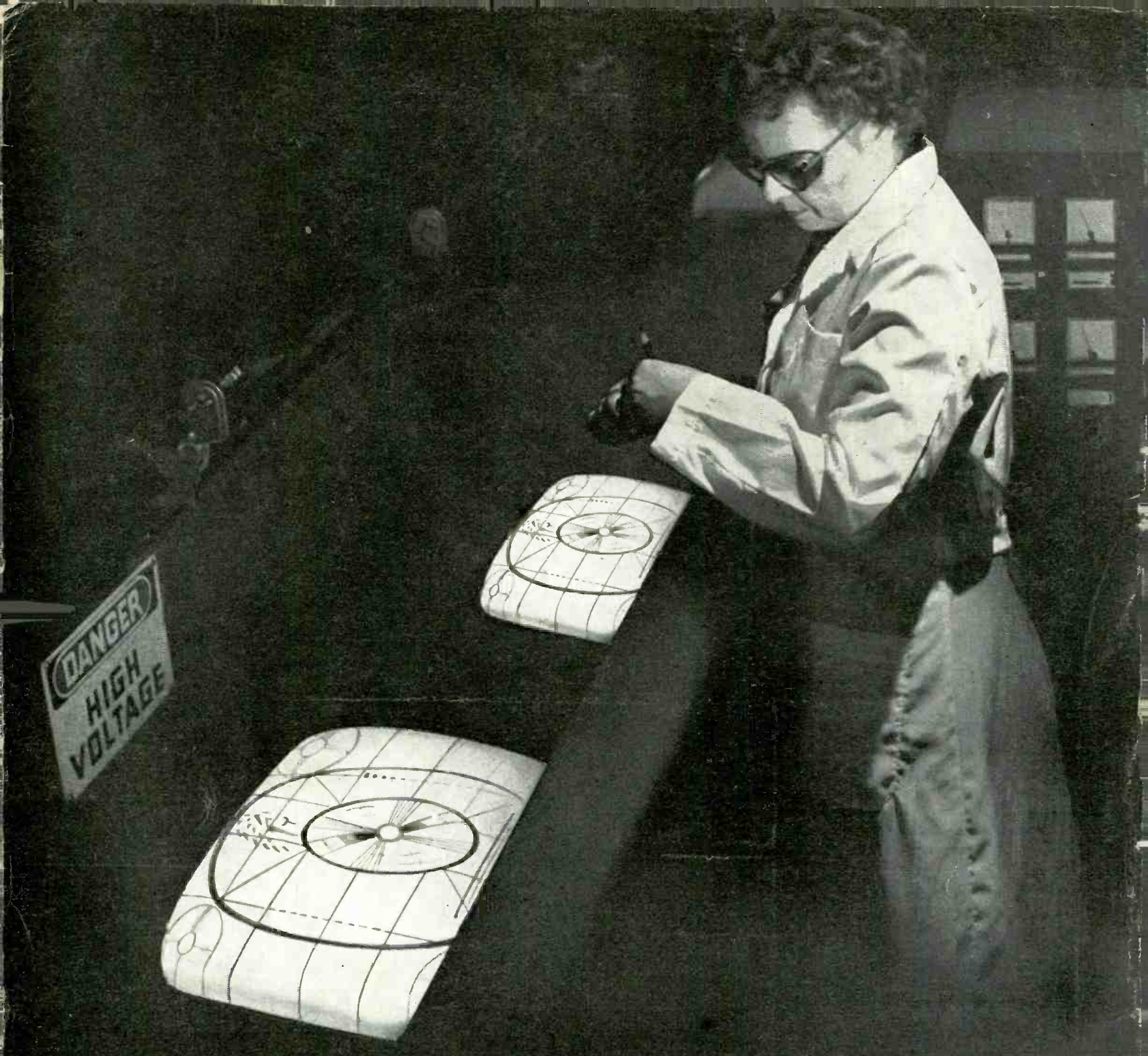
Write now for free details.

RADAR SENTRY ALARM



RADAR DEVICES MANUFACTURING CORP.

22003 Harper Ave.
St. Clair Shores, Michigan 48080
(313) PR 1-1333



TRAP FOR FAULTY PICTURE TUBES

RCA Guards Against Callbacks 26 Ways

Under the watchful eyes of trained inspectors, RCA Silverama® Picture Tubes are carefully scrutinized for screen quality and focus.

All Silverama replacement picture tubes as well as those destined for original equipment undergo a battery of 26 automated tests. These include: warm-up, emission, gas, leakage, electron-gun performance, and other critical factors that can spell the difference between long-term performance or costly callback. Tubes failing a single test are automatically tagged and rejected. In addition to automatic testing, every tube lot leaving the RCA plant has been sampled by Quality Control.

Nothing is left to chance; part by part, inside and out, from base to faceplate the quality of each tube has been carefully controlled and assured prior to assembly. Even the Silverama envelope is carefully inspected prior to re-use, and is internally scrubbed, buffed, and restored to the peak of its optical capabilities. Result: a superior picture tube, an RCA Silverama. Make it your next installation choice.

RCA ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

RCA® **The Most Trusted Name in Electronics**

CARRY EACH SILVERAMA FACTORY-FRESH INTO YOUR CUSTOMER'S HOME. New Foam-Lined RCA Picture Tube Tote Bag makes scratched, marked, or scuffed faceplates a thing of the past. Makes carrying both easier and safer. Two sizes: one for 16" to 19" tubes, one for 20" to 24" tubes.

SEE YOUR AUTHORIZED RCA PICTURE TUBE DISTRIBUTOR FOR DETAILS