OCT. 1966

# Radio-Electronics™

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HUGO GERNSBACK, Editor-in-chief

Test Camera Shutter With Scope | Acousti-Lite Santa Claus | plus Industrial Electronics Section

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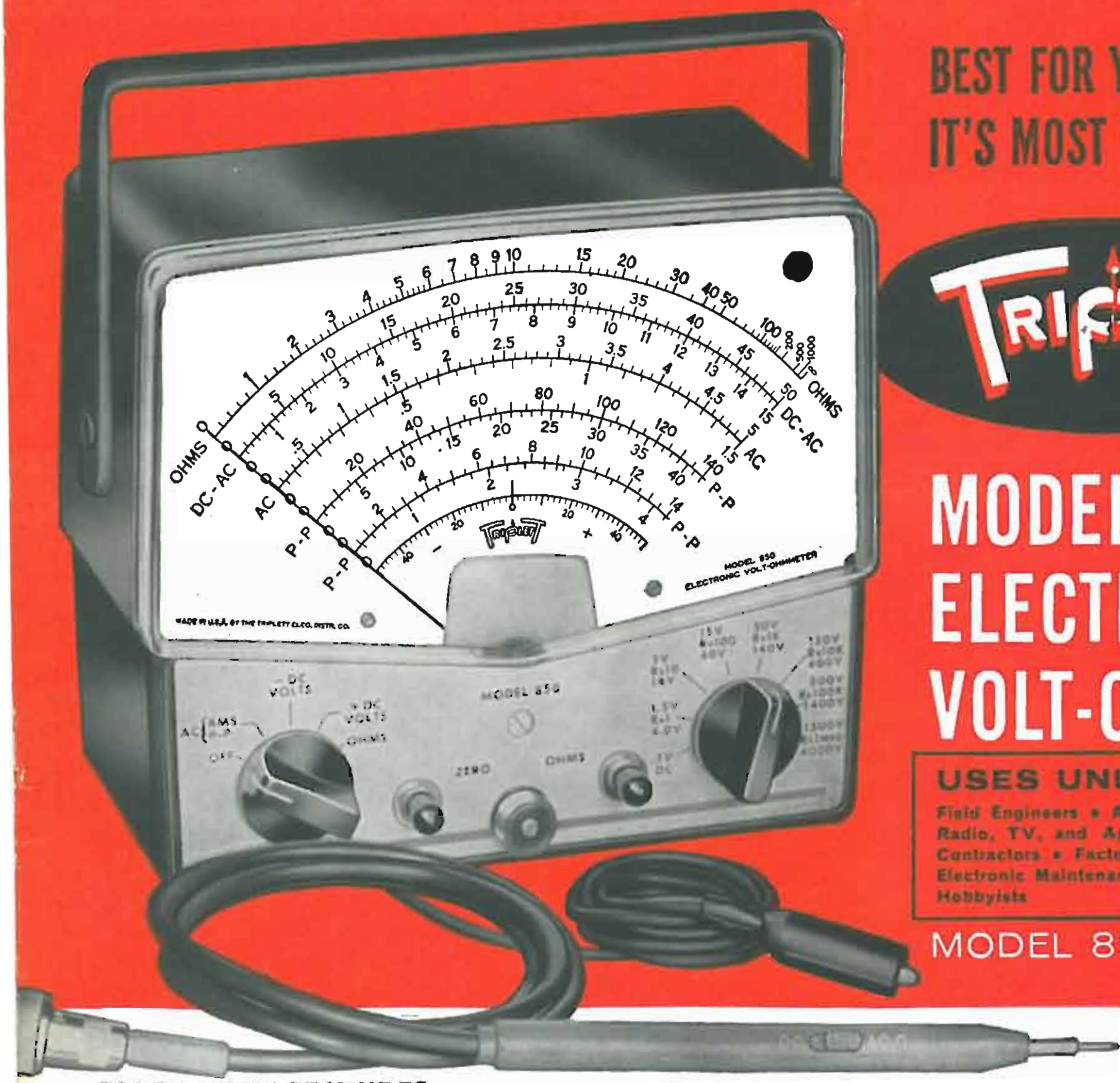
TRIPLETT




# MODEL 850 ELECTRONIC VOLT-OHMMETER

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MODEL 850 $85.00

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**1** Long 7" easy-to-read scale.

**2** .5 D.C. volt range for transistor circuits.

**3** HIGH STABILITY. Meter connected in cathode circuit of 12 AU7.

High Input Impedance (11 MEGOHMS) and wide Frequency Ranges give this extremely versatile Electronic Volt-Ohmmeter considerable advantage in the measurement of DC voltages, AC RMS and Peak-to-Peak voltages. It measures directly the Peak-to-Peak values of high-frequency complex wave forms and RMS values of sine waves on separate scales. Exclusive Triplett BAR-RING instrument is fully self-shielded; high flux magnet and spring-backed jewels for ruggedness. Wired circuit.

**ADDED PROTECTION.** Meter is shorted out in OFF position for greater damping, meter safety during transit, electrically protected against accidental overload. ZERO CENTER mark for FM discriminator alignment, plus other galvanometer measurements.

New pencil thin test probe used for all functions: DC, AC, and ohms. No need to change cables. Beautifully styled case for professional appearance and functional utility, 7⅞" x 6⁷⁄₁₆" x 3¾".

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| 8 DC VOLTS RANGES | 0-.5-1.5-5-15-50-150-500-1500 |
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| 7 PEAK-TO-PEAK VOLTS RANGES | 0-4-14-40-140-400-1400-4000 |
| 7 RESISTANCE RANGES | 0-1000-10,000-100,000 OHMS; 1-10-100-1000 MEGOHMS. |

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INPUT IMPEDANCE DC Volts 11 Megohms; AC Volts minimum of .83 Megohms.

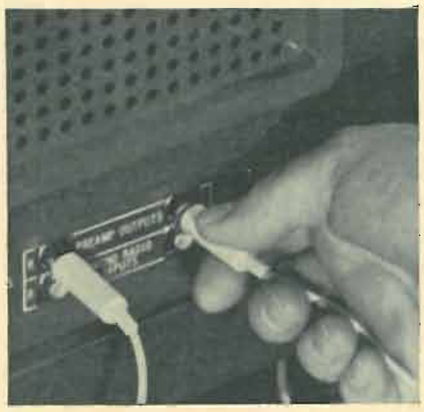

THE WORLD'S MOST COMPLETE LINE OF V-O-M'S. AVAILABLE FROM YOUR TRIPLETT DISTRIBUTOR'S STOCK

Some plain talk from Kodak about tape:

# Double or nothing... or the noble art of dubbing

One good tape deserves another. That's another way of saying that half the fun in having a good-quality, home tape-recording system should consist of being able to make tape duplicates. The reasons for dubbing can be as varied as you want. Perhaps as simple as sending your Aunt Mabel a particularly good tape of the kids—a tape you also want for your own tape library . . . or because you want to exchange tapes with a fellow audiophile . . . or because you want to edit a tape to go along with a movie or slide film without chopping up the original tape . . . or simply to preserve your early tape recordings on modern, more efficient KODAK Sound Recording Tape.

**Takes two to swing.** If you already have a second tape recorder on hand, you're ready to get started. If not, find a good friend that will lend you his. But do be particular about your friend. Because that old cliché about the weakest link applies in spades as far as dubbing equipment goes. Also be particular about the tape you use . . . but as they say on radio, more on this later.



**Read the instructions.** First off—and though it may seem obvious—make sure your two tape systems are in the best possible condition. Look at it this way—the dubbed recording will be at best a second generation recording . . . it's going to combine all the deficiencies present in your original tape recording, in the playback recorder, and in the recording equipment. So read both instruction books . . . then clean the heads with one of the commercial preparations available for that purpose . . . and demagnetize the heads if you can lay your hands on a degausser.

Next, connect your two tape machines—the "master" and the "slave." If you have a choice, take your output from the master at the pre-amp stage rather than at the amplifier. No reason to add its distortion to your dubbing. For the input to the slave, you usually have a choice—one marked "mike" or "high-impedance" (usually in the 50,000-200,000 ohms range), the other marked either "radio," "phono," "tuner," "tape" or "low-impedance" (in the 500-ohm range). You want the latter one.

**Choose your tape.** Signal-to-noise is the touchiest area in dubbing. Picking a tape that will give you the lowest noise level on the duplicate without lowered output makes a lot of sense. We've got just the tape for you: KODAK Sound Recording Tape, Type 34A. It packs five or more additional decibels of undistorted output than the usual low-noise tapes. When dubbing on KODAK Sound Recording Tape, Type 34A, set the recording level on your slave unit at 4 decibels over your normal level—that's just slightly higher than normal if you set your level by a VU meter. Because you can put a lot of signal on this tape, you can play it back at lower gain . . . and, Eureka, there's your low noise!

KODAK Tapes—on DUROL and Polyester Bases—are available at most electronics, camera, and department stores. To get the most out of your tape system, send for free, 24-page "Plain Talk" booklet which covers the major aspects of tape performance. Write: Eastman Kodak Company, Department 940, Rochester, N.Y. 14650.


EASTMAN KODAK COMPANY, Rochester, N. Y.

*Circle 8 on reader's service card*



*← Circle 7 on reader's service card*

# A Shortage of Service Technicians

Not long ago, I sat talking at lunch with three service-association leaders. All three of these men own and operate electronic service shops.

"I've been trying to hire a TV bench technician for 4 months," one of them said over a spoonful of soup. "It's next to impossible to find anyone nowadays who can fix a TV set right."

"You too?" asked another between forkfuls of salad. "I've been advertising for a tape-recorder–phono repairman for more than a year."

I buttered a roll and asked, "How much are you paying?"

The three exchanged glances. Each waited for another to answer, none of them looking at me. Here apparently was a question with an answer no one wanted to talk about.

I relieved the awkward silence myself. "I talked with the general manager of a large manufacturer the other day, and he was telling me how he attracts top men to his firm: he does it with money. He simply pays top salaries and then demands peak performance."

My three friends sat digesting that tidbit. I continued, "Do you suppose money has anything to do with the trouble you have finding good technicians?"

That started a lively conversation too lengthy to report. Coffee was cold long before we were through.

But one interesting fact emerged. A 1965 survey showed the average salary for a TV service technician to be under $110 per week. The average in 1960 was just under $104—a mere 6% increase over five years. Less than the change in the cost-of-living index. By equivalent standards, technicians now earn *less* than they did 5 years ago.

Shop owners wonder, "Where are all the bench technicians?" It shouldn't be hard to figure out. They're going to higher-paying jobs in industry—at least the young and the good ones are.

Do you blame them? Why struggle along for less than $6,000 a year when big companies offer technicians $7,000—$8,000—$10,000—and more—often throwing in a lot of training besides? Electronics schools find their television and radio courses aren't nearly so popular as their industrial electronics and advanced technology curricula.

Service dealers cry, "We don't make enough now to afford what we're already paying. How can we possibly pay more?"

I could answer, "Pay more or go slowly out of business." But that's too easy. Instead, I have suggestions for service-shop owners and technicians alike.

Take a lesson from the automotive industry. What happens when they get hit with a wage boost? They find a way to increase production or cut costs and thus absorb the higher wage cost, or else they up the price they charge for their product. Sounds simple, doesn't it?

How can you apply this procedure to your setup? It is done in several steps.

*Check your business practices.* If you're not a trained businessman, get a professional to advise you. Believe it or not, he'll save you money. I've analyzed businesses for owners who had no idea *why* they were losing hundreds of dollars every year. Some weren't even sure they were losing money; they just never seemed able to pay their bills. The causes are often easy to eliminate. A more profitable charge, a reduced cost, a better inventory system, a stronger credit system—these and many more needs can be pinned down by a trained consultant. Make sure your business is fiscally sound. Otherwise, you can never afford the kind of help you need.

*Make sure you're charging enough.* Typical service-call charge now is $6. Many get more. You can't subsidize TV and radio repairs for your customers. Leave cheap service calls to shops that can't afford good technicians.

*Hire only the best.* Sure, you have to pay them more money, but then be sure you get your money's worth from them. Let the laggards earn their peanuts at the cut-rate shops.

*Train the people you hire.* As they turn out more work, you can afford higher pay—and incidentally have more left over for profit. Training costs needn't be high, either. Manufacturers, distributors, and associations are joining with schools in battling the shortage of technicians. They do it by offering night courses, clinics, advanced classes, 3-day seminars, 1-night lectures, correspondence lessons, and so on. Some of these programs cost you nothing. All of them are worth whatever they cost when you consider the benefits of more efficient, better trained men.

*Buy modern instruments.* Factories faced with higher wages invest capital in modern equipment that will raise production enough to offset the wage hike. You can do the same. The time your technicians waste on tough dogs means money of yours down the drain. Keep your technicians equipped for peak performance.

*Check your business practices.* Sound repetitious? It is. This step is a key to all the others. Fail at this step, and the others will only prolong the agony of your dying business.

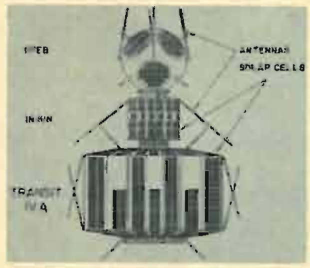
And if you're a technician? You can help yourself, too. If you're a good technician, insist that the shop owner pay you as one! If you're not a good one he won't anyway, so get the training you need to become a good one. Shortage notwithstanding, there's no room anymore for half-trained technicians, no matter how willing they are. Shops can no longer wait while you learn by practical experience. Join the classes, study the books and lessons, attend the clinics and lectures. Get the basic training you need before you try to pass yourself off as a technician. You'll find it much easier then to work your way to top pay in this great and growing business. —*Forest H. Belt*

# Radio-Electronics

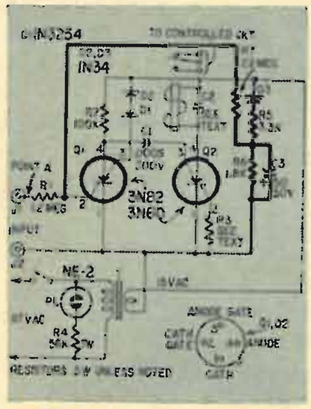
OCTOBER 1966 VOL. XXXVII No.10
Over 55 Years of Electronic Publishing



**p 41**—CAREER SERIES

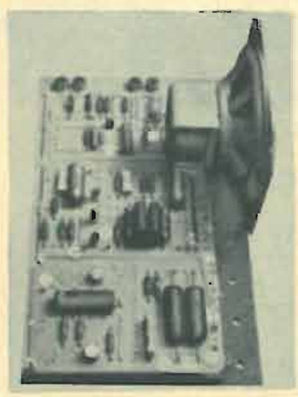


**p 44**—ABOUT PE CELLS



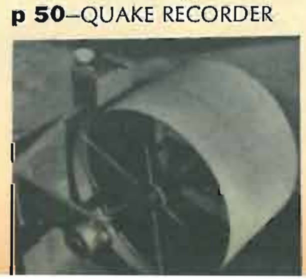
**p 59**—HI-Z RELAY

**p 38**—SANTA TALKS



**p 47**—PC BOARD USES

**p 50**—QUAKE RECORDER



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***COVER FEATURE**

**p 32**—When is a resistor not a resistor? When it's extremely cold . . . for instance at —452°F. Then its resistance can even become negative (it becomes superconductive).

**SHUTTER ANALYZER**

**p 35**—Converted bench scope lets you find out how well your camera shutter works. Shows both timing and action (bounce).

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

# NEWS BRIEFS

**OSLO SPLITS ON EUROCOLOR**

The Oslo meeting on European color standards (RADIO-ELECTRONICS, July, page 68) broke down in complete disagreement. No delegation shifted its position during the three weeks of the conference—a situation that might have been expected, since the delegations all came instructed by their governments. At the end of the session, an informal poll showed 30 countries in favor of SECAM, the French system, 15 for the German PAL, and 9 for NTSC, as used in the United States, Canada and Japan. Several European countries hope to start colorcasting late in 1967, and it is almost certain that West Germany, England (using PAL) and France will have stations in operation by the end of that year.

**SATELLITE TV PROPOSED FOR EDUCATIONAL BROADCASTING**

A coast-to-coast educational network using four satellites and carrying at least four channels of instructional TV for colleges and schools and a network of information and culture for home viewers, was proposed to the FCC by the Ford Foundation. The satellites would also carry six commercial channels which could be used for network broadcasting. The profits from the use of the six commercial channels could then be used to support the educational program.

As might have been expected, Comsat reacted furiously to the proposal, holding that it should have exclusive right to satellite communications and that the Ford Foundation plan would erode Congressional purposes and would not be in the public interest.

Ford Foundation president McGeorge Bundy held that the long-range public interest should take priority over the possible loss of a "microscopic portion of the total profits in satellite communications." He said that the technical feasibility, legal correctness, economic validity and television practicality had been tested with experts he named. He further pointed out that in spite of Comsat's statement that it should have exclusive rights in space, the legislation setting up Comsat specifically stated that the act did not "preclude the creation of additional satellite systems, if required . . . in the national interest" (Section 102-d).

Two weeks later, JFD Electronics Co. sent the FCC their proposal for a satellite-to-home TV concept. The JFD filing was supported by sketches of proposed antenna systems which could be used on TV viewers' rooftops to receive telecasts from satellites in synchronous orbit.

**HEART TROUBLES DIAGNOSED BY LONG-DISTANCE PHONE**

Heart conditions are being diagnosed over telephone circuits in a number of areas in the United States. Computers have been used to aid the diagnoses in some cases.

Northwestern Bell Telephone Co. has probably made the most extensive use of the system, acting in cooperation with the Creighton University Cardiac Laboratory in Omaha. A Data-Phone serves about 30 hospitals, clinics and rural physicians in Nebraska, Iowa and South Dakota. Nationwide service through the Bell System is expected before the end of the year.

Operation is simple. The physician prepares the patient for an electrocardiogram, hooks the output to a Data-Phone attachment which transmits it to the laboratory. There, the cardiogram is reproduced for examination by specialist. For rural use, a portable Data-Phone weighing only 6 lb can be coupled to any rural telephone.

A computer has been used experimentally to interpret 20,000 ECG's for the US Health Service, and Dr. Cesar Caceres of that service reports that the Hartford (Conn.) Hospital is sending ECG's by phone line to the George Washington University in Washington for computer interpretation. The University is also beginning experiments in the use of computers for intensive-care patients. The computer is expected to give warning if indications show a dangerous situation developing.

[Long-distance phone diagnosis and prescription has long been urged by Hugo Gernsback and has been described and illustrated by him in a number of articles for some years in RADIO-ELECTRONICS and his Christmas booklet FORECAST.]

**FLUID CONTROLS NOW PRACTICAL**

Fluid amplifiers and switches (RADIO-ELECTRONICS, February 1965, page 44) are now being employed in a variety of industrial uses ranging from controlling automatic twist-drill machines to sensing the level of liquid in a tank. Among the more interesting devices is the fluid switch that controls the Westinghouse Pad-O-Matic hospital air mattress. Ten of the 20 longitudinal cells of the mattress are automatically inflated while the other

*Dr. Anthony Carnazzo monitors incoming cardiogram at the Omaha laboratory while technician Ingrid Peters obtains pertinent data by phone from the patient's physician.*

# ELECTRONICS

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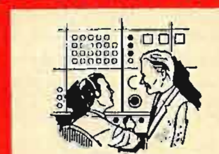
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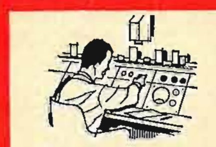
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10 are deflated. Then the process reverses, providing continual massage and movement for the patient. Fluid amplifiers are also used to control power on a New York Central diesel locomotive, and an all-fluid flight guidance control for a missile system was designated at Redstone Arsenal.

Use of fluidics has increased to the extent that the Corning Glass Works has opened a one-day school, held twice monthly. Prospective users, technicians and engineers study more than a dozen practical industrial applications of fluidics.

### TV CHANNELS FOR PAGING?

The FCC has issued an order setting up an industry-government committee to work out plans to test the sharing of unused television channels for radio paging and two-way mobile systems. The action was in response to a petition by the Communications Committee of the National Association of Manufacturers. That committee requested the FCC to permit a test by Douglas Aircraft Co. on vhf channel 6 in Los Angeles, and to permit a test for two-way mobile radio on uhf channels 14 and 15 in the same area. There has also been discussion, says *NAM Reports*, of making similar tests on channel 12 in New York.

### UNDERSEA ATOMIC BATTERY TO OPERATE FIVE YEARS

A new type of thermoelectric generator will operate continuously and unattended for five years at ocean depths down to 20,000 feet. Being built by Westinghouse for the Navy, it will be used in such underwater applications as research instrument packages, sonar generators, communication, navigation and monitoring equipment and scientific instrumentation. Some of these applications are meaningful only if the equipment can be left undisturbed for several years, according to W. E. Johnson of the Westinghouse Astronuclear Laboratory.

The 5-watt generator will be 24 inches in diameter and 29 inches long, and will weigh about a ton and a half. It consists of a number of cells of thermoelectric material, series-parallel connected, with a radioisotope heat generator in the center. The generator will heat one terminal of each cell, while cold sea water cools the other. Prototypes using electric instead of atomic heating have been built and tested. The final unit will use strontium-90 as a heat source.

### MORE COLOR TV MODELS THAN B-W

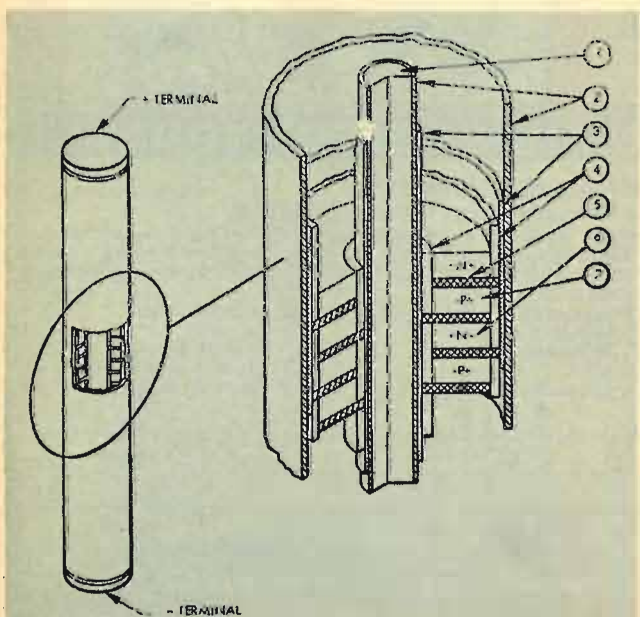
With the introduction of the new 1967 TV lines, the number of color TV models passed that of black-and-white, says *Television Digest*. The public now has 441 models to choose from, compared to 380 black-and-white models. The total number, 821, hits an all-time high, up eight models from 1966's 813.

Among the black-and-white sets, portable and table models are well in the lead, numbering 244 as against 125 console models and 11 combinations. In color, 50 models are table or portable, 298 console and 9 combinations.

### PORTABLE VIDEO RECORDER DEMONSTRATED BY SONY

A shoulder-slung video tape recorder, weighing only 9.5 lb and pow-

(*continued on page 12*)




*Cross-section of the atomic battery. The cells, of thermoelectric material, are insulated from each other and —with special heat-conducting insulation —from the heat source and the ocean. 1—Heat source. 2—Module inner and outer cladding. 3—Insulation—high thermal conductivity. 4—Electrical conductors. 5—Insulation—low thermal conductivity. 6—N-type thermoelectric material. 7—P-type thermoelectric material. Outer cell terminals are cooled by the surrounding sea water.*

**Radio-Electronics**

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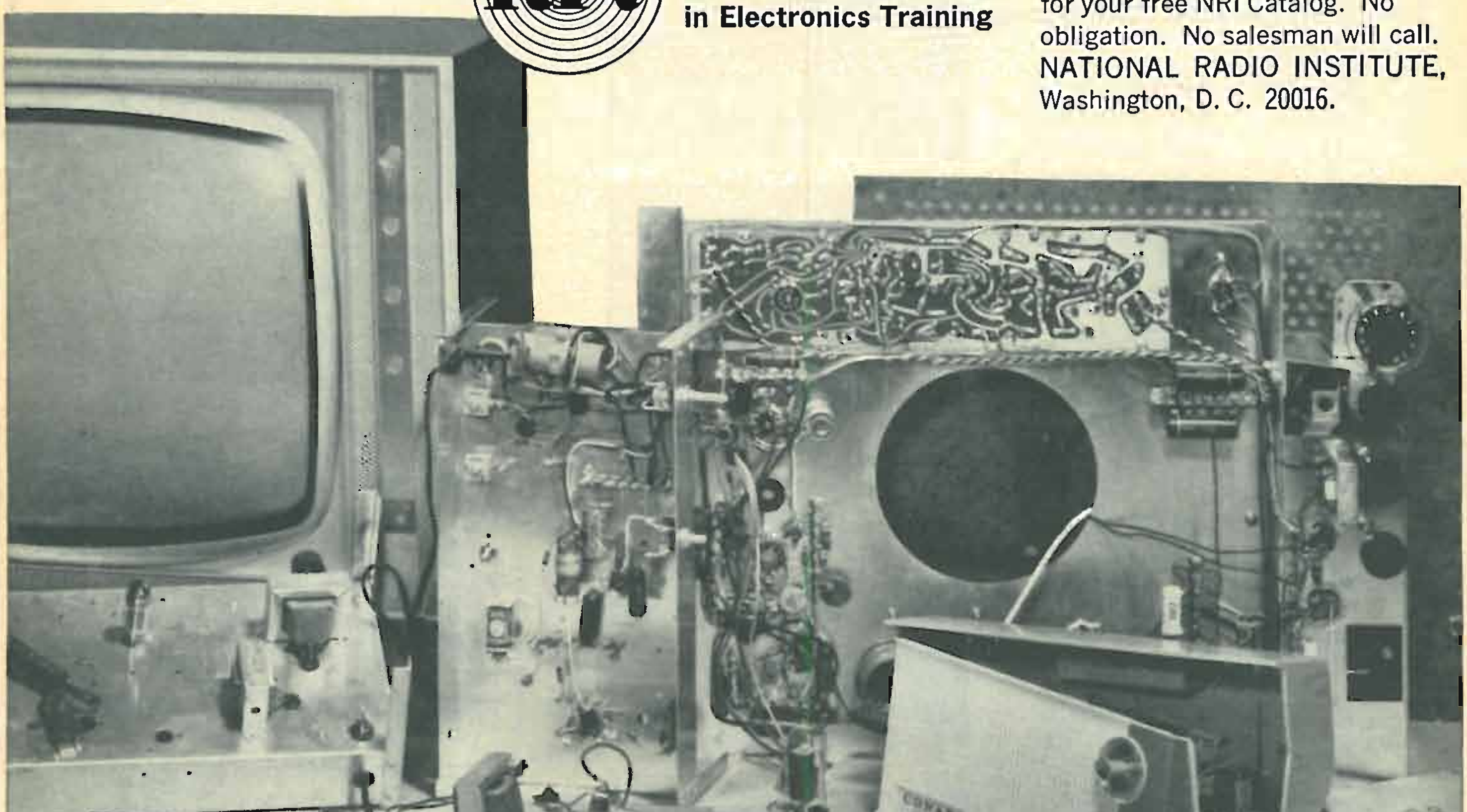


**NEWS BRIEFS continued**

ered by a lightweight battery, will be available early in 1967. Sony Corp. of America demonstrated a prototype at the NAMM (National Association of Music Merchants) Show in Chicago.

The carry-around model uses standard half-inch video tape and operates at 7.5 inches per second. Tapes recorded with it can be played back on any one of Sony's home video tape recorders.

Sony's smallest present machine is a tape deck intended for use with a separate monitor or a TV set. Described as a portable, it weighs 42.5 lb and operates only on ac.

### WORLD'S BIGGEST ANTENNA STUDIES SUN'S CORONA

The Massachusetts Institute of Technology is using a phased-array radar antenna, covering more than 9 acres of land, at El Campo, Tex. A 4,000-dipole system is in the planning stage.

The new antenna is bouncing 500 kW at 38 MHz off the sun to gain information for use in mapping the sun's corona. Even with 500 kW and the 36-dB gain of the array, the return signal is 20–30 dB weaker than the noise. The signal is fed through 20 integrators to enable it to be distinguished from the noise.

Because the array cannot be directed, the sun can be observed for only 17 minutes around local noon each day. END

**CALENDAR OF EVENTS**

**IEEE 16th Broadcast Symposium,** September 22–24; Mayflower Hotel, Washington, D.C.

**New York Hi-Fi Music Show,** September 22–October 2; New York Trade Show Building, New York, N.Y.

**IEEE Aerospace and Electronics Systems Convention,** October 3–5; Sheraton Park Hotel, Washington, D.C.

**National Electronics Conference,** October 3–5; McCormick Place and Conrad Hilton Hotel, Chicago, Ill.

**Audio Engineering Society 31st Convention,** October 10–14; Barbizon-Plaza Hotel, New York, N.Y.

**AFIPS Fall Joint Computer Conference,** November 8–10; Civic Center and Brooks Hall, San Francisco, Cal.

### Radio-Electronics Adopts Hertz

RADIO-ELECTRONICS is now using the term *hertz* in place of cycles in all references to frequency. Hz, kHz and MHz, abbreviations for hertz, kilohertz and megahertz, are replacing cycles, kc and mc in all recently edited material.

The one antenna that does the work of three! Pulls in beautiful color and crystal clear black and white pictures on both UHF and VHF channels ... plus the finest stereophonic and monophonic FM sound reproduction.

300-ohm models for normal reception areas from $18.50 to $59.95

75-ohm models for poor reception areas from $42.65 to $72.10

FINCO ALL-BAND UHF-VHF-FM ANTENNA
75 OHM Model CX-UVF-24 $72.10 List

FINCO ALL-BAND UHF-VHF-FM ANTENNA
300 OHM Model UVF-24 $59.95 List

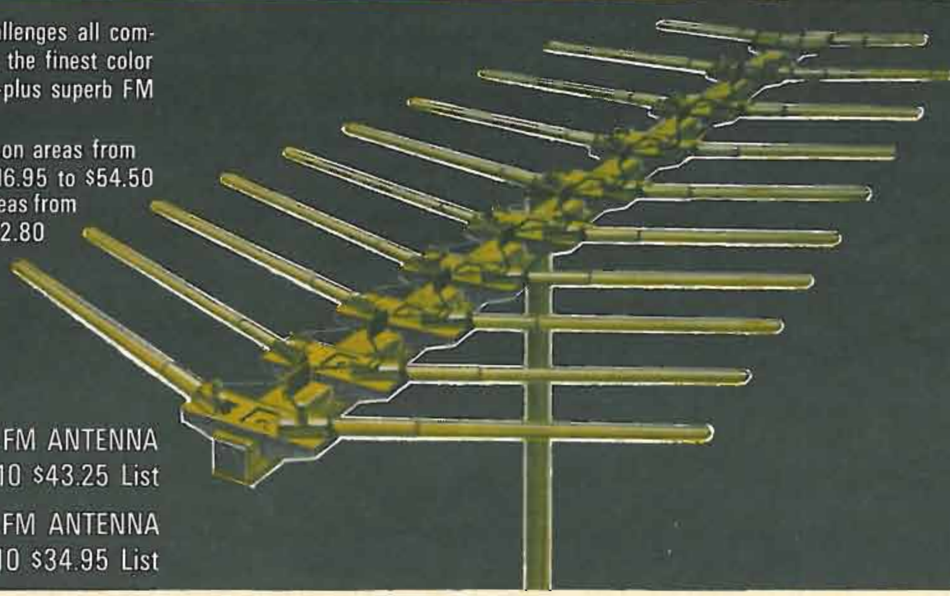
# FINCO

## *introduces* / 75-ohm COLOR VE-LOG ANTENNAS FOR UHF-VHF-FM RECEPTION

Finco's Swept-Element Antenna challenges all competition. Its unique design assures the finest color and black and white TV reception—plus superb FM and FM Stereo tone quality.

300-ohm models for normal reception areas from $16.95 to $54.50

75-ohm models for poor reception areas from $18.55 to $62.80



FINCO SWEPT-ELEMENT VHF-FM ANTENNA
75 OHM Model CXVL-10 $43.25 List

FINCO SWEPT-ELEMENT VHF-FM ANTENNA
300 OHM Model VL-10 $34.95 List

**FREE!** ALL FINCO CX-VL, CX-UVF AND UVF ANTENNAS COME WITH A FREE INDOOR SET-MOUNTED TRANSFORMER, VHF-UHF TRANSFORMER SPLITTER OR VHF-UHF SPLITTER.

MAKER OF THE WORLD FAMOUS COLOR FINCO BLACK / WHITE ANTENNA COMPONENTS AND ACCESSORIES

## *THE FINNEY COMPANY*

34 WEST INTERSTATE STREET, DEPT. RE, BEDFORD, OHIO

*Circle 12 on reader's service card*

# Correspondence

## KUDOS FOR HUGO GERNSBACK

*Dear Mr. Gernsback:*

Recently at a dinner here at The Rockefeller University, a group of us got to talking about boyhood experiences that led us ultimately to careers in science. And thus the conversation turned to you. All of us recognized our great debt to you for your prophetic stories and articles, and especially your Electro Importing Company which gave us as young experimenters access to all sorts of useful and instructive apparatus which could be bought within our limited means.

I feel that the present generation misses something through the lack of a similar institution. Of course today one can buy components and devices from a wide range of sources, but none is aimed at the awakening mind as your company was.

I thought you might like to hear some of these pleasant recollections from someone you inspired as a young boy in Bayonne, New Jersey, who sold Saturday Evening Posts in order to get money to frequent your store and carry away things for early experiences in radio and other scientific ventures that ultimately led me to the presidency of the National Academy of Sciences, The Johns Hopkins University, and The Rockefeller University.

With warm appreciation and best wishes.

DETLEV W. BRONK
*President*
*The Rockefeller University*
*New York, N. Y.*

## TV IN 3D?

*Dear Editor:*

On your editorial, "What's Next For Television?", I would offer a few thoughts. While not trying to be a wet blanket, I would be a bit wary about applying holographic techniques to television. The reason is inherent in the mechanics of a hologram. Basically, a hologram works as a reconstruction of a wave-front, made possible by wave mechanics. Coherent light from some continuous source (almost always a laser) is divided into two beams. One is directed toward a photographic emulsion, the other toward a target. The wave-front reflection from the target object interferes with the beam directed at the emulsion. Interaction of these two wave-fronts of light causes local cancellations and intensifications. The film is then developed in a normal manner.

Although there has been progress on seeing holographs with noncoherent light, the easiest way to do this is to set up a coherent light source. The three-dimensional image that can be seen is a *virtual* image. This image comes about because the coherent light passing through the interference pattern on the film causes a reconstruction of the original wave-front (the one that interfered with the other plain coherent beam), thus producing a virtual image.

In order to have holographic television, you would have to create an interference pattern on a screen medium that could interact with coherent light in such a way that it would form light wave-fronts equivalent to the original scene. I do not see personally how this could be done. This is not because I wouldn't like to see it done, since the virtual holographic image is considerably more "three-dimensional" than stereoscopic methods. Just as movie technology was not the answer for television, I am certain that holography is not the answer for three-dimensional television, although it has probably given us a handle by which we might eventually see the correct method.

STEPHEN A. KALLIS, JR.
*Huntsville, Alabama*

[There must be many ways. Anyone else have opinions?—*Editor*]

## IT STILL HERTZ

*Dear Editor:*

I have enjoyed Gernsback publications for over 45 years and still have a copy of "A Wireless Course" by S. Gernsback, A. Lescarboura and H. W. Secor (published first in 1915).

I notice you have adopted the term "hertz" in place of "cycles" in all references to frequency. I think such a move is stupid and a classic example of change for the sake of change. As anyone with an engineering background knows, frequency of alternating current has always been expressed in "cycles per second." I suggest you consider changing back, and desist from promoting such a nonsensical idea and contributing to the confusion.

STANLEY E. HOOD
*Pittsfield, Mass.*

[Your complaint is echoed in a few other letters, Stanley. But the change is for the sake of standardization, not for change itself. The National Bureau of Standards in February 1964 adopted *hertz* as part of a program to make it

← *Circle 13 on reader's service card*

easier to exchange scientific information with other countries. The term *hertz* is standard in the International System of Units.

No one seems upset over the term *ampere*. Yet, those with an engineering background also know that *ampere* is a shorthand way of saying *coulombs per second*. And ampere was named after an important man in the history of electronics, too. You see, it really depends on what you're accustomed to.—*Editor*]

### SERVICE-SHOP BROADCAST

*Dear Editor:*

With the requirements of color TV and the necessary high costs to operate a repair shop, why not have a TV station on an unused channel in a locality broadcast nothing but test patterns to be used by the subscribing shops for TV black-and-white, color and FM. The shop, instead of having to have expensive generators, can use a reasonably cheap translator to receive and convert to any channel. An appropriate way would be as an addition to NET (National Educational Television) transmitters which are usually on a college campus.

LEO E. SMITH
*Sandy, Utah*

[Problems that occur to us are: Who would pay for the service? Would owning your own equipment be less expensive than the proportionate cost of maintaining a television station transmitter and associated gear? The station can only broadcast one pattern at a time; how would you get the test pattern you want when you need it? Sounds like an interesting idea for someone to play around with.—*Editor*]

### BACK-PAT FOR NEW STAFF

*Dear Editor:*

I must take this opportunity to congratulate you and thank you for the many interesting solid-state circuits you have been printing.

Admittedly there are other publications printing solid-state material, but I am not satisfied to read two-thirds of a magazine about what some manufacturers are doing or to scan over a monster of a circuit with no technical information. This type of news is informative, but not if it approaches the style of a mail-order catalog.

In short, you are doing a wonderful job of showing not only the latest but practical circuits that can be experimented with. I know this takes a lot of consideration and hard work on the part of your staff. Please be assured that I and many more like me are extremely grateful to you and your staff.

ANTHONY ROCCO
*Bonita Springs, Florida*

END

# SERVICE CLINIC

By JACK DARR Service Editor

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.

## *Industrial Electronics? What's That?*

"INDUSTRIAL ELECTRONICS"—WHEN WE hear these words, too many of us get a mental picture of a monstrous machine about 50 feet long with banks of meters, flashing lights, and about 15 white-coated guys watching it. 'Tisn't so. Industrial electronics is anything that is *used in business*. A photocell gadget that opens the door at the supermarket, an electronic timer at the dairy, a burglar alarm at the bank—*this* is industrial electronics! And, there are a lot more of these than there are 50-foot machines with the guys in white coats!

These are "little gadgets"! They are simple, and they use the simplest principles of electronics. You can fix them easily. After digging into the flyback circuits of a color set, or repairing a color demodulator, these things will look like child's play!

If you'll take a close look around your town or neighborhood, you'll find an awful lot of this kind of stuff. Too many units have always been sent back to the factory for repair, because the users *didn't know* that there was a man right across the street with all the equipment, skill and knowledge to repair them!

Practically all such devices are really ridiculously simple. A photoelectric control unit, for instance, may have only one tube or transistor and the PE cell! If the faulty gadget is a radio-control unit—they're using lots of them in industry today to control from a distance machines, doors, fans, vents, even mobile units like tractors—you'll have three units: transmitter, receiver and the relays that do the actual switching. If this sounds like a TV remote control, you're right, and it's no more complicated (and, usually, a heck of a lot easier to get into because it's bigger).

You'll need one thing, beside your standard test equipment—a thorough knowledge of the basic principles of electronics. This you have already, or ought to have. If you find that you've forgotten a few facts here and there, or that you're not quite clear on some others, there are a lot of good books that you can read to brush up. Also, articles in this magazine will give you a great deal of information on these processes. It'll take you only a little while to update your knowledge.

You'll find simple things: photoelectric cells, amplifiers, beat-frequency oscillators (used in metal locators, presence detectors, burglar alarms), bridges and circuits and components that you see every day. No? Too simple? The lie detector used by police departments, a moisture meter used by lumbermen—you know what they are? Ohmmeters! A simple vom will do exactly the same thing.

You'll find sensors used to control

*continued on page 22*

things. What's a sensor? A switch. Sometimes actuated by things hitting a thin metal arm, rolling over a pressure plate, breaking a light beam or entering a magnetic or electrostatic field, but simply a switch for all that. The switch turns on an amplifier, the amplifier closes a relay, and something happens.

Your best source of information, and one that should be checked whenever you run into a strange machine, is the good old instruction book! Read it. It will always have a brief description of *what* the thing does, and *how* it does it, right in the front. From there on, you'll find detailed service information, parts lists and a full schematic. It's around there somewhere, so look it up before you start.

Question the operator of the machine to find out what it is or isn't doing. Nothing at all, staying on all the time, or working intermittently? (You didn't think that TV men were the only people in the world who had intermittents, did you? Now, really!)

With the data from the instruction book, and the data from the operator, plus your own observations of how the machine is working, you should be able to find and fix any trouble in a pretty short time. After all, you've got only one thing to worry with, instead of the half-dozen interlocking reactions that you are used to dealing with in TV circuits!

This type of work ought to be a piece of cake for the alert electronics technician, and he can pick up a good bit of money doing it. If something is broken down in a business, it interferes with the progress of the work. The owner's income is being cut down, and he won't mind paying what such a job is worth to get that equipment going again, and usually without any argument! So, go get 'em!

### Works at shop, but not at home

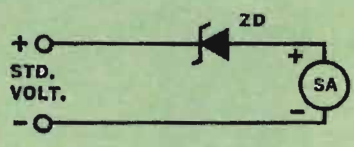
*This one is driving me up the walls! It works perfectly at my shop. But, when I take it to its home, it falls out of horizontal sync after just a little while. Can't figure out what is doing this.*

*Belongs to two old ladies, and they keep the room awfully hot, up around 75° Do you think that has anything to do with it? R. H. Marquette, Mich.*

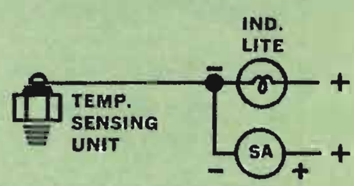
I made a similar trip up the walls many years ago! It was a different make of TV, but it sounds like the same problem! I found mine by accident, quite frankly. I was sitting, looking at the chassis, and I heaved a big sigh. The picture fell out of sync, in the shop, for the first time! Turned out I'd sighed right into the PC board for the horizontal afc! It was the moisture from my

MALLORY **Tips for Technicians**

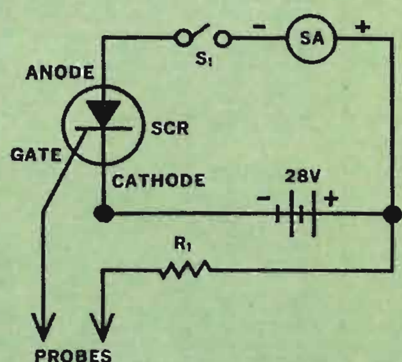
# New solid state low-drain tone signal



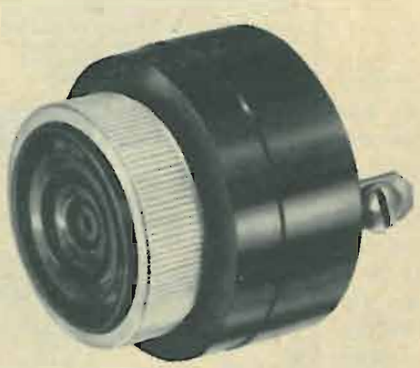

Overvoltage signal circuit




Automotive overtemperature warning




Pool splash alarm



Sonalert is a complete compact unit, mounted in a 1⁹⁄₆₄" panel hole

Ever think what you might be able to do with an audible signalling device that operates on only a few milliamps?

We've got one. It's called the SONALERT® Signal. It's a piezoelectric transducer driven by a transistorized oscillator —all in one compact package. Just hook it up to a triggering circuit, and it does the job that usually requires an amplifier and loud speaker.

DC models work on battery supply from 6 to 28 volts, and take so little current that you can connect them as "fail-safe" alarms powered by a standby battery, or use them in security circuits where opening of a switch contact will apply full voltage across the Sonalert. Mallory Batteries, with their long shelf and service life, are ideal companions.

And there are AC models that work directly off 110 volt lines, and draw only 14 milliamps—about the same as a neon pilot lamp. These are ideal for light-actuated systems. Just connect the Sonalert in series with a cadmium sulfide cell and you have a signal that sounds when a strong light hits the photocell. Or connect the Sonalert in parallel with the photocell, and the tone comes on when light goes out.

That's not all. You can get Sonalerts with either 2800 cycle tone or 4500 cycles. With appropriate circuitry, you can combine these into high and low alarm systems. And you can get a pulsed model that emits "beeps" at a rate of 3 to 5 pulses per second.

You get a lot of sound out of this little device. Intensity ranges from 68 to 80 db, depending on applied voltage. Frequency is fixed, however, and does not vary with voltage. And there's another unusual feature; Sonalert's operation depends on having an open air column in front of it. So it provides a means of detecting liquid level.

You may also be interested in knowing that Sonalert causes no RF interference. Also, it has no arcing contacts, so it's completely safe in explosive atmospheres.

If you'd like to experiment with this unusual signal, write to us for a copy of our booklet of ideas. And get Sonalert, and all the quality Mallory components that work with it, from your franchised Mallory Distributor. Mallory Distributor Products Company, a division of P. R. Mallory & Co. Inc., Indianapolis, Indiana 46206.

50th ANNIVERSARY



*Circle 21 on reader's service card*

breath! I found out that the owner used an open-flame gas heater. These liberate quite a bit of water vapor as a combustion byproduct. This moisture, condensing on the chassis, caused a leakage path from the afc to a nearby high ac voltage point in the filament circuit. Cure: move the ac voltage point, and spray about five coats of dielectric plastic on the chassis after drying it thoroughly.

You have a similar problem, apparently. Look for places around the afc where moisture could condense and cause leakage from any other circuits. Dry it out and spray it thoroughly or paint it with corona dope, etc. Anything to keep the moisture out of sensitive circuits.

Try sighing at it. Might help!

### Overload or bad circuit breaker?

*I've got a problem with a Silvertone 8154. It's got one of the little resettable circuit breakers in the power transformer primary. Replaced the rectifiers and filters, and it works fine; voltages OK. But, in about an hour, the breaker kicks out! I reset it, and it kicks out again in about 5 minutes. I've checked everything I can think of, and I can't find anything wrong in the set.—E. S., Philadelphia, Pa.*

I've had the same problem, and in a lot of cases it turned out to be the circuit breaker itself! Check: if you have a wattmeter, plug the set into it and check the input power. If it's normal, and stays that way, replace the breaker.

You can also check by tripping the breaker (open), and clipping a 1.5-amp fuse across it. If there is real trouble in the set, the fuse will blow.

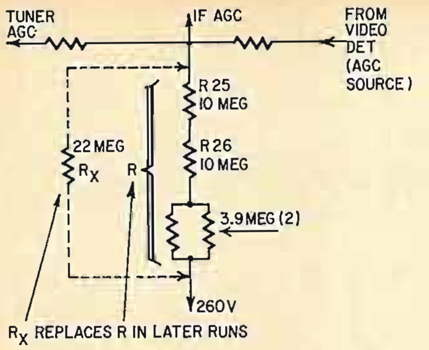
All too often, makers fail to put any wattage or current rating on breakers. However, most distributors now stock them, with recommended values. Look up the rated wattage; this is given on the first page of all Sams Photofact service data. This set draws 1.3 amps; so, get a breaker that is about 1.5-amp or even 1.75.

### VOM clears up snow

*I got a call on a Hotpoint 21T052 TV, for very bad snow. You can just barely see a picture. Tubes all replaced, no help. I measured the dc voltages on the 6BK7 with a tube-adapter, and they are all OK. When I touched the input grid with the voltmeter prod, the snow cleared up! Good picture! So I checked the agc. Sams shows two 10-meg resistors and two 3.9-meg in parallel between the agc and B+. I can't find these resistors at all! What's going on here? P. Q.—Clifton, N. J.*

You did the right thing. However, if you suspect any of the cascode rf am-


SONY




plifier tubes of causing snow (6BK7, 6BQ7, etc.) and the voltages *are* OK that is, the dc voltage on the middle plate-cathode is the normal 125-150 volts, the chances are that this stage *is* OK, and the real trouble is elsewhere.

When you touched the grid with your vom probe, you put a comparatively small resistance between it and ground (60,000 ohms for the 3-volt dc range of a 20,000-ohm-per-volt vom). So, this cut down on the highly positive agc voltage, and let the picture get through.

Now, for those agc bucking resistors: this isn't an error on the Sams schematic, but a modification. Early production of the "U" chassis did use the four resistors in the bucking network, but later models used a single, very small 22-meg resistor to replace them. This resistor is undoubtedly open; it's on the PC board right where R26 is shown on the Sams diagram, almost under a capacitor. While this isn't a common symptom (heavy snow from *positive* agc) it can and does happen, as you saw!

## High-Voltage-Probe Multiplier Resistors

*I've got a 100:1 high-voltage probe on my vtvm. I read the high-voltage on an old GE 17C103 the other day and, according to my figures, it had 28,000 volts! I have a feeling that this is a little off! What do you think is wrong?—S. S., Clearfield, Pa.*

You're right, that's wrong! 28 kv would be a little high even for a color set, which this definitely isn't. Let's figure. For a high-voltage probe, the formula is: $R_{hv} = M(R_{in}) - (R_{in} - R_e)$. Or: multiplier resistor in probe equals multiplying factor (M) times the meter input resistance minus (meter resistance minus original isolating resistor used in vtvm probe).

Your isolating resistor is 1 meg. That last factor in the formula would be 11 meg minus 1 meg or a nice even 10 meg. Now, we have this: $R_{hv}$ = 100 times 11 meg minus 10 meg. If we got the decimal point in the right place, it would come out about 1,090 meg.

The Allied catalog shows two high-voltage probes—one with a resistance of 1,090 meg and another with a resistance of 740 meg. It sounds as if you have the 740-meg probe, which would make your meter read high. Take the probe apart and check. The resistance will be printed very plainly on the resistor unit. If you do have the wrong one, get the right size and things will read a lot more closely.

With the proper 100:1 multiplier, your meter will then read 100 times whatever scale you set it on. The 0–3 volt scale will be 0–300 volts, and so on.

END

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Get sound as loud as you want it out of your low-power guitar amplifier by building this 50-watt booster into it. Simple to make and fun to use as long as you don't deafen the neighbors!

**In November RADIO-ELECTRONICS**


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The United States of America

NUMBER P1-20-6400

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PLACE AND DATE OF ISSUANCE BUFFALO, NEW YORK SEPTEMBER 11, 1963

DATE AND TIME OF EXPIRATION SEPTEMBER 11, 1968 AT THREE O'CLOCK A.M. EASTERN STANDARD TIME

SPECIAL ENDORSEMENT SHIP RADAR ENDORSEMENT - SEPTEMBER 11, 1963 - BUFFALO, NEW YORK

ISSUING OFFICER

Federal Communications Commission.

(Licensee) (Issuing Officer) (Secretary)

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SPECIMEN

## Employers are paying good money for men holding FCC tickets. Read how to get yours:

When you hold a Commercial License issued by the FCC (Federal Communications Commission) you have written proof that you know and understand basic electronic theory and fundamentals. It's worth plenty... particularly to companies on the lookout for qualified electronics technicians. Here's how one of the country's leading office machine manufacturers rates men with FCC Licenses:

> "An FCC License is an asset to any man looking to enhance his career in the field of electronics. At our Company, a licensed man is well-rewarded because an FCC License attests to his knowledge of electronics theory..."

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Yes...your opportunities are unlimited once you're carrying that FCC Commercial Ticket. AND CLEVELAND INSTITUTE OF ELECTRONICS CAN GET ONE FOR *YOU!* On the facing page, read how four ambitious men just like you have cashed in on CIE's sure-fire FCC Licensing Program. Read about CIE's exclusive money-back offer. And then send in the postage paid reply card. CIE will quickly send you complete FREE information. You will soon be on *your* way to a Commercial FCC License and the many rewards that go with it!

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**If you had active duty in any branch of the Armed Forces after January 31, 1955, you may be entitled to Government-paid tuition for any CIE course.**

# CRYOGENICS—Modern

IE INDUSTRIAL ELECTRONICS

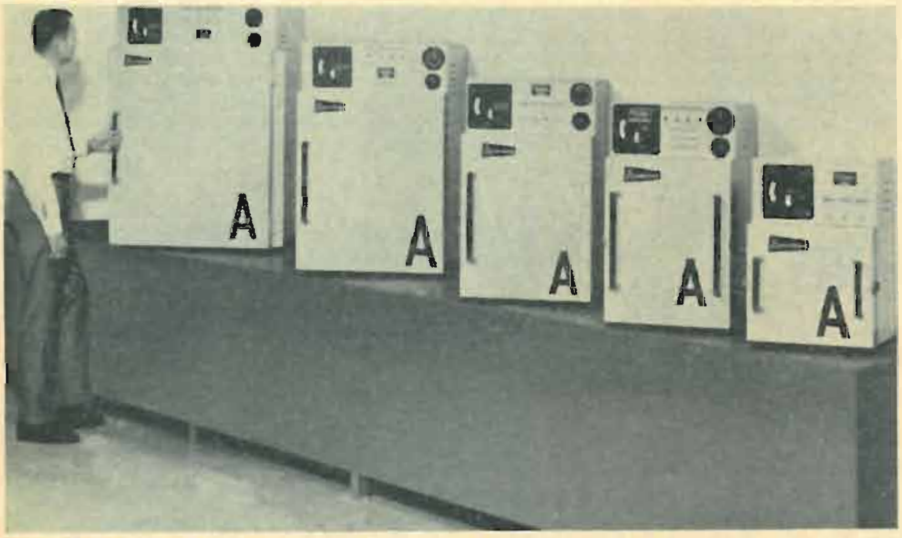
**Common materials do mighty unpredictable things when supercooled by liquid gases to temperatures near absolute zero. Some materials simply turn to dust and eventually vanish. Others lose resistance, become superconductive**

**By EDWIN WALKER**

A FASCINATING PHYSICAL SCIENCE scarcely 10 years old in its modern form promises revolutionary changes in basic electronic-circuit functions, and changes in familiar materials used in electrical and electronic equipment and systems. Cryogenics, the science of low-temperature physics, is concerned with the behavior of matter at temperatures approaching absolute zero (−273°C).

Even though applications for cryogenic theories became practical less than a decade ago, the origins of the science can be traced to the middle of the 19th century when a few elemental gases (oxygen, nitrogen, and hydrogen) first were produced in liquid form. Today, cryogenic technology makes possible exciting, even exotic, industrial developments and constitutes an important segment of the nation's defense and aerospace programs.

Shortly after World War II, modern cryogenics attained a major importance in US technology. Postwar development of the Thor, Jupiter, Atlas and Titan guided missiles demanded new techniques in science and engineering. Liquid oxygen—used as the oxidizer in liquid-fueled rocket engines—transferred a laboratory science into an important area of engineering applications and operating systems. Even though most cryogenic activity is limited to military and aerospace projects, several significant phenomena of low-temperature physics promise applications in many phases of modern life.



*Functioning as either refrigerators or ovens, these environmental testing chambers will automatically maintain preset temperatures from —100°F to +500°F. They range in volume from 0.5 to 27 cubic feet and are available from suppliers of cryogenic gear.*

### Simulating outer space on earth

What happens to materials and instruments in the high-vacuum, subzero, high-intensity-radiation environment of interplanetary space? No one knows for sure. Scientists have determined that many materials stable here on earth will slowly turn to dust and vanish when sent outside the earth's atmosphere. It's possible that plastics, bearings, slip rings, paints, and other electronic components may do likewise. Electrical insulation may break down so that short circuits occur; electrical connectors, relay contacts, and switches may weld shut or break open to put equipment out of operation.

Besides all this, the only way heat can be transferred in interplanetary space is by radiation, there being no atmosphere to conduct heat through convection. This means that the heat generated even by solid-state electronic equipment might rise to levels which would burn components and melt wiring. Such poor heat transfer also means that the side of a space probe facing the sun may become red-hot, while the side oriented away from the sun may reach a temperature near absolute zero. These temperature extremes understandably create thorny problems in the design and operation of aerospace hardware.

Several years have passed since the first Russian Sputnik focused American technology on space exploration. Until very recently, however, space engineers and scientists were hampered in many ways by an inability to re-create, on earth, a simulated outer-space environ-

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Hugo Gernsback, Editor-in-Chief

# Miracle in Deep Freeze

ment in which space-bound materials and instruments could be tested before launching. It appeared that not until we actually established laboratories in space would we be able to test under aerospace conditions.

At a time when the problem seemed insurmountable, the science of cryogenics changed everything. Now engineers can use a space-simulation chamber, several sizes of which are available. Based on techniques of "cryopumping," in conjunction with infrared and electromagnetic energy sources, these chambers create certain environmental conditions found in space that might affect a spaceship and its instrumentation. Cryopumping creates high-vacuum conditions within the space-simulation chamber by condensing and freezing gas molecules rather than by pumping them out of the chamber as is done with conventional vacuum-producing methods. This use of cryopumping is the first practical technique for creating the ultra-high-vacuum conditions of free space in an artificial environment.

The walls of the space-simulation chambers also are insulated using cryogenic techniques to prevent room temperature conditions from affecting the chamber's internal temperature. In the walls of the chamber, cryogenic liquids form a heat-insulation barrier to maintain the low-pressure, low-temperature conditions of space.

The extreme environmental conditions created by cryopumping cannot be measured using conventional instruments. As a result, engineers designed a new family of measurement devices. Research showed that an ionization gage could detect the scattered remaining molecules of gas inside the chamber after cryopumping evacuation. The ratio of the gas molecules remaining within the chamber to the gas molecules in an identical area outside the chamber is proportional to the vacuum pressure inside the chamber. Even this ionization technique, however, is not sensitive enough to measure the lowest pressures obtainable with cryopumping. Even more sensitive sensing devices must be designed.

### Measuring cryogenic liquids

Simultaneously with advances in cryogenics, there developed a need for electronic instruments to measure and control the ultra-low-temperature liquids used in cryogenic applications. An example is the need for sensing the presence of cryogenic liquids and for actuating valves to control liquid flow when a reservoir is being filled or emptied. Since cryogenic liquids are harmful to life, a severe danger exists near these containers, and the use of automatic controls is the only good safety practice. Such a control system employs a sensitive probe which determines when the tank has been filled to capacity. At that point, the instrument closes the input valve.

The sensing element of the probe consists of two plates which form a capacitor whose capacitance varies when the dielectric material changes. Until the container is filled with cryogenic liquid, the capacitor dielectric is the atmosphere within the tank. When the cryogenic liquid reaches the top of the container, however, some of the liquid becomes the dielectric of the probe capacitor. The change in capacitance controls the frequency of an oscillator in the instrument itself, and the frequency change is demodulated by a ratio detector. The detector provides an output signal which operates the input valve and stops the flow of cryogenic liquid.

A second instrument, employing a temperature-sensitive thermistor as the sensing element in one leg of a Wheatstone bridge, monitors the level of the liquid to reactuate the flow through the input valve when the level drops due to


*In-plant storage vessel with automatic controls stores liquefied gases at 250 psi.*


*Capacitive probe senses presence of cryogenic fluids, sounds alarm, controls flow.*

*Superconductivity, the absence of electrical resistivity, permits developing ultrahigh-strength magnetic fields that will consume virtually no power*

normal use or evaporation.

To measure temperatures accurately over the cryogenic range—from 0° to 100° Kelvin—special thermometers have to be used. We can again turn to thermistors for this measurement, using a slice of germanium crystal processed to provide maximum resistance change with temperature over the cryogenic range. The thermistor element is mounted within a helium-filled, hermetically sealed platinum case with its external leads connected into one arm of a bridge circuit. The bridge normally is balanced and has zero output. When subjected to cryogenic temperatures, however, the thermistor's resistance increases and unbalances the bridge. The degree of unbalance is directly proportional to the drop in temperature below the value at which the bridge is balanced. The bridge output, indicated on a suitable meter graduated in degrees, provides a precise indication of the cryogenic temperature.

### Cryogenics in the laboratory

Cryogenic temperatures often are required in the laboratory where basic research—such as that involving the interaction of free electrons and the thermal vibrations of crystal lattice structures—is being investigated.

Cryogenic refrigerators employing cryopumping techniques provide research scientists with a versatile tool for experiments at controlled temperatures as low as 0.3° Kelvin (−459.15°F). Refrigerators of this type are used in all areas of solid-state and materials research at low temperatures. In such a refrigerator, the material being tested can simultaneously be subjected to electromagnetic, nuclear, or other radiation, or placed within the poles of a magnet.

### Superconducting magnets

Application of cryogenic techniques to magnetic devices has brought about completely new engineering systems with the development of superconducting magnets. Superconductivity, the absence of electrical resistivity, permits developing ultra-high magnetic fields that consume virtually no power.

Superconducting magnets are compact and lightweight coils of special niobium-tin or niobium-titanium wire, which exhibits zero resistance when cooled to or below a certain specific temperature. These supermagnets are capable of producing ultra-strong magnetic fields previously attained only by using large amounts of electrical power and massive coils of heavy-gage wire.

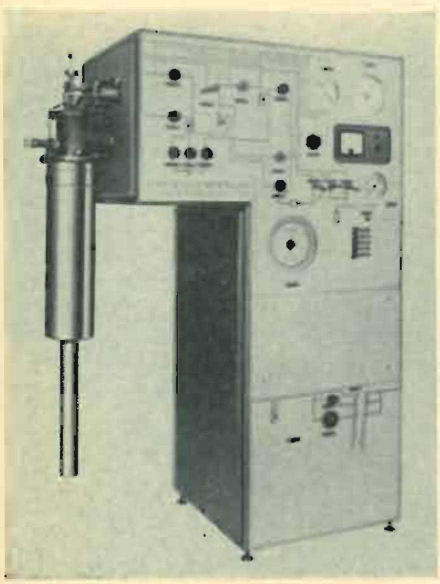
The superconducting conditions will exist as long as the wire is maintained at a temperature below that at which it became superconductive. A state of superconduction also may be controlled by placing the magnet in the path of a strong magnetic field.

When the external magnetic field is active (power applied), the coils of the cryogenic magnet become normally resistive. With the external magnetic field inactive, the coils once again become superconductive.

Computer-research scientists have directed considerable attention to this binary (off or on) character of cryogenic magnets which makes them usable as memory devices. The photo shows a stainless-steel liquid-helium dewar—an insulated flask—which includes a computer memory circuit. This dewar, when filled with liquid helium, maintains a cryogenic temperature of −452°F. After the memory circuit has reached that temperature, circuit wires are introduced into the dewar through a vacuum-jacketed inlet and connected to external computing equipment operating normally at room temperature.

In just a few years, cryogenic technology has become a familiar part of many programs tied to America's space-exploration efforts. A whole new set of terminology and hardware has been generated to define and expand various phenomena associated with extreme low temperatures. And a sizable group of scientists, engineers, and technicians has become active in developing cryogenic technology.

While much laboratory work still is exploratory, cryogenics presents continuing evidence of the exciting and ever-expanding nature of electronics and its closely allied fields. Can any other technology offer so wide a choice of interests? END

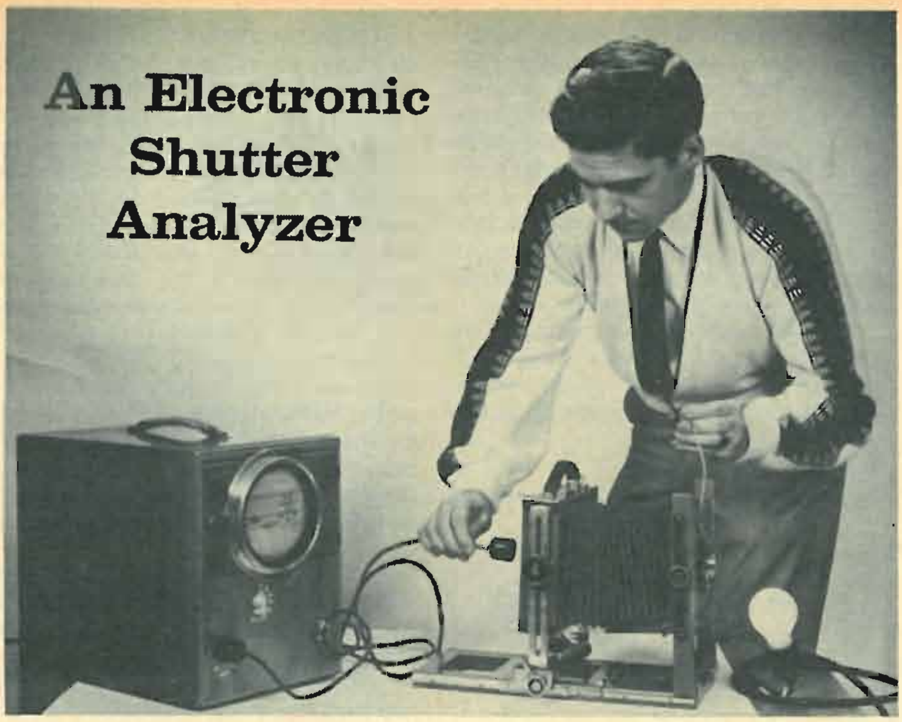


*Cryogenic refrigerator obtains temperatures below −450°F for materials testing.*

*Magnet (top) becomes superconductive by immersion in liquid-helium tank (bottom).*

*Stainless-steel dewar contains computer memory circuit that is held at −452°F.*

# An Electronic Shutter Analyzer



*Typical setup for testing shutter mounted on view-type camera. Probe is held behind open camera back. Camera shields scope face from light source in front of shutter.*

**Discarded bench-type scope is reborn as instrument to evaluate characteristics of photo shutters**

**By E. F. RICE**

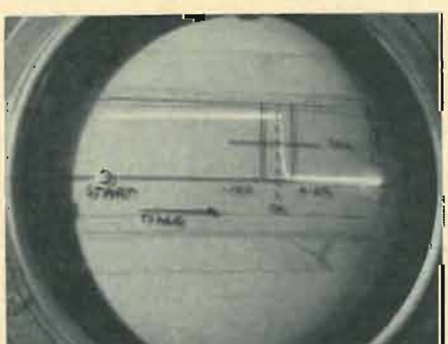
ONE OF THE THINGS THAT POSITIVELY stumps a professional photographer is whether or not his expensive equipment is operating as it should. This is particularly true of one of the most basic elements in a camera, the shutter. Shutter bothers have a habit of developing so slowly that the user is not aware of the problem until every other possible reason for substandard photos has been eliminated. The analyzer shown here gives an immediate visual picture of shutter performance. It reveals not only shutter-speed accuracy, but also the effects of dirty shutter leaves, the presence of "bounce," and other irregularities.

The instrument is particularly useful in large studios (especially those specializing in portraiture), photography schools, and newspapers where several cameras are available and a photographer may use a different one for each assignment. Unless the actual shutter speed is within its permissible tolerance, a photographer may find himself way out in left field. This device can provide a rapid, accurate check.

The unit, assembled from an oscilloscope salvaged from the service bench, uses the cabinet and power supply from a Jackson model CRO-2. Any old scope will suffice, however, even if the CRT is bad, because that tube will be replaced with one having a long-persistence (type P7) phosphor. Here's how to get started.

Remove the sync and sweep circuits from the chassis, keeping the focus, brightness, and positioning-control circuitry intact. The high- and low-voltage supplies also must be retained. It's possible, of course, to build from scratch, but it's easier to start with an old scope so you can use the cabinet and CRT mounting brackets; the front panel also is fitted for the face of the CRT. The only modification required in the cabinet is to cover the lower part of the front panel with a piece of ⅛-inch aluminum. Appropriate holes for mounting the reset button, the speed-selector switch, and the octal socket for the sensing-unit cable plug are then cut through both thicknesses of metal.

The sensing unit itself, which is positioned by hand inside the camera when checking a shutter, is made from an octal cable connector with a "dummy" socket mounted in it. Two cadmium-sulphide photocells are glued in position behind two small holes drilled in the dummy socket. A 6-foot 3-conductor cable, terminated in an octal plug, permits the sensing unit to be located far enough from the light source to keep stray light from falling on the CRT screen.



*Test trace of shutter in good operating condition and well within suggested tolerance.*

In the Jackson scope, the original CRT was a 5UP1. It was replaced with a 5UP7 (yellow), which is identical physically and electrically but has a long-persistence phosphor. The P7 phosphor holds the image long enough to permit viewing the entire shutter action from start to finish. A single horizontal sweep can be seen for several seconds in a darkened room.

## The circuit

The schematic (Fig. 1) shows the analyzer circuit. Parts salvaged from the scope are marked with an asterisk. Potentiometer R14 is the brightness control, R16 the focus control, R3 the vertical-position control, and R11 the horizontal-position control. R1 and R2 were in the original power supply, but the value of R2 is changed to produce enough starting voltage to operate voltage regulator V3. S3, the speed selector, is a double-pole 5-position rotary switch. The five potentiometers (R19–R23) and five capacitors (C7–C11) used to control the sweep speeds are mounted on a subpanel under the chassis. (The analyzer has only five ranges. You can add more or select others by choosing proper R and C values. Table I lists R and C values for different ranges.) Diode D, filter C3, and trigger-sensitivity control R8 are mounted on the main chassis.

Pin 9 of the CRT, one of the horizontal-deflection plates, receives its voltage from the appropriate capacitor (C7–C11) in the speed-control circuit. When the capacitor is fully charged, its potential is 150 volts, regulated by V3. R11 adjusts the voltage applied to pin 10, the other horizontal-deflection plate, to position the spot at its starting point at the left side of the CRT. Once adjusted, this voltage remains constant. Therefore, when the voltage on pin 9 is reduced by discharge of the capacitor, the spot on the CRT moves to the right side of the screen.

Thyratron V4 is used to discharge the capacitor. D rectifies the heater voltage and applies a negative voltage to the control grid of V4, keeping it cut off. PC1 is a photoresistive cell in the sensing unit which is placed inside the camera. When the shutter opens during analysis, light strikes PC1, lowering its resistance, which reduces the bias and allows V4 to conduct. R6 protects the photocell from the grid-current surge that occurs when the thyratron fires.

R8 adjusts the bias voltage and determines the sensitivity of the trigger. When the V4 conducts, the timing capacitor is discharged through the tube in series with the calibration potentiometer, moving the spot across the CRT from left to right at a rate determined by the time constant of the series R-C network selected by S3.

Vertical deflection occurs at the same time, because light passing through the open shutter also reduces the resistance of PC2, the second photocell mounted in the sensing unit. This cell is connected so it changes the vertical-centering voltage applied to pin 6 of the CRT. With a fixed voltage on pin 7, the spot is deflected upward.

After the shutter has tripped and produced a trace on the screen, the spot is returned to its starting position at the left side of the screen by pressing RESET button S2 momentarily. The thyratron stops conducting. When the switch is opened again, the tube remains cut off, and timing capacitor (C7–C11) recharges to 150 volts, returning the spot to the left side of the screen.

Before the unit is calibrated, the CRT screen must be marked to indicate the correct starting and ending positions for the trace. This can be done with India ink on a piece of clear plastic film fastened to the CRT face with Scotch tape (see photo). Marking the screen is a very simple operation, if it is done before the sweep speeds are calibrated, because any desired pattern can be used. The sweep is then adjusted to make the trace fit the design.

Each sweep speed is calibrated by adjusting its potentiometer against an external standard such as the 60-Hz line. An easy way to do this is to use

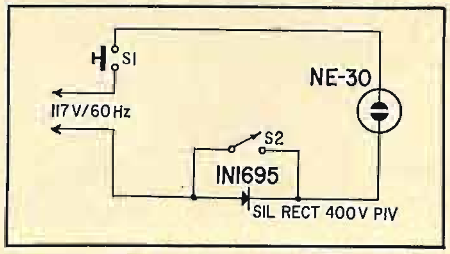



*Fig. 2—Simple calibration aid permits easier adjustment of sweep-speed controls.*

a large neon bulb such as the NE-30 to trigger the sensing unit. The lamp is taped to the sensing unit so it is in direct contact with the surface containing the two holes and so no outside light strikes the photocells. Connect the lamp in the circuit shown in Fig. 2, so you can turn it on and off easily. With the diode shorted, the lamp will flash 120 times per second; the diode cuts the speed down to 60 flashes per second.

Turn on the analyzer and allow it to warm up for about 10 minutes before calibrating. While waiting, you can adjust the controls to bring the spot to its starting position and to obtain the best focus. Don't leave the intensity turned up high for more than a few minutes while the spot is stationary, because the high intensity of the electron beam will burn the screen. Also adjust trigger-sensitivity control R8 so the light from the neon lamp just trips the horizontal sweep.

With the spot at its starting position and vertical-gain control R4 set at maximum, switch on the neon lamp and observe the number of "pips" in the trace on the screen; Fig. 3 illustrates

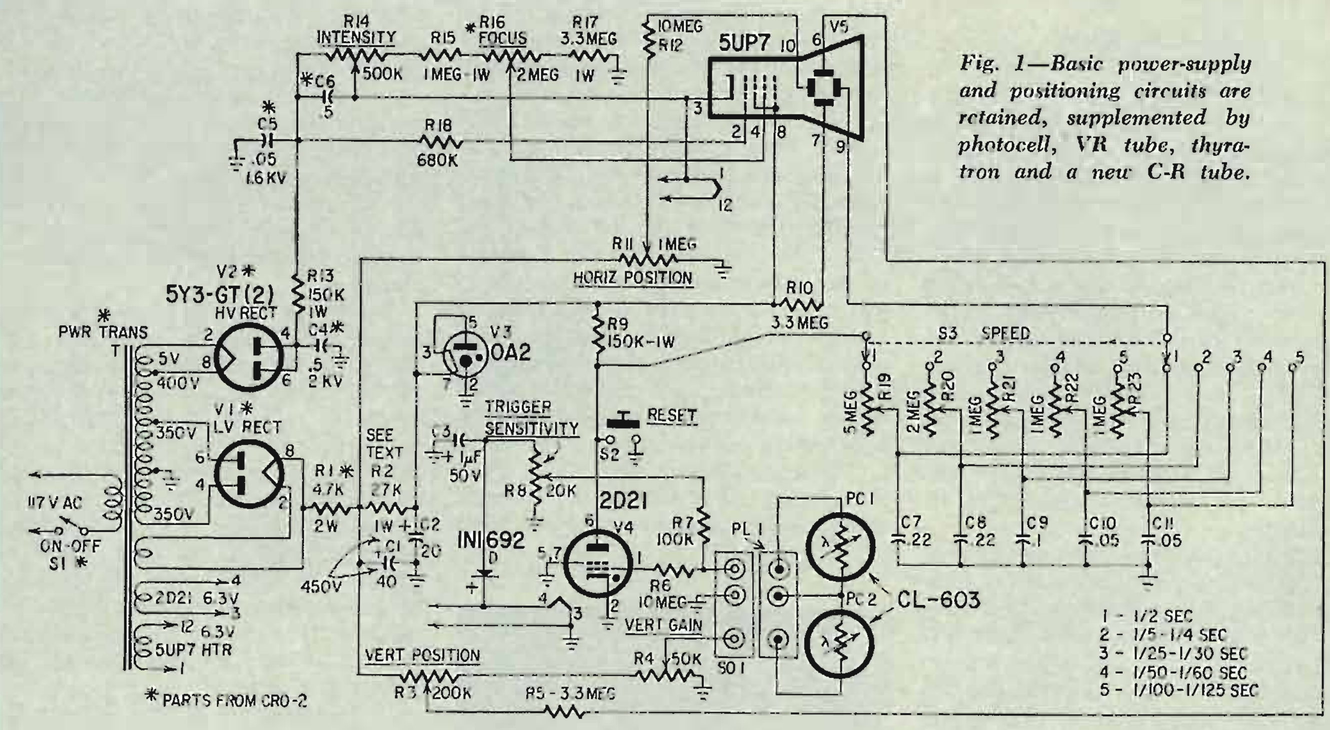



*Fig. 1—Basic power-supply and positioning circuits are retained, supplemented by photocell, VR tube, thyratron and a new C-R tube.*

**PARTS LIST**

T—power transformer
S1—spst rotary switch
S2—push button switch, spst normally open
S3—speed selector, 2 pole, 5 positions
V1—5Y3GT
V2—5Y3GT
V3—0A2 voltage regulator
V4—2D21 thyratron
V5—5UP7 or other CRT with P7 screen
R1—4,700 ohms, 2W
R2—27,000 ohms, 1W—see text
R3—pot, 200,000 ohms
R4—pot, 50,000 ohms
R5—3.3 megohms, ½W
R6—10 megohms, ½W
R7—100,000 ohms, ½W
R8—pot, 20,000 ohms
R9—150,000 ohms 1W 10%
R10—3.3 megohms, ½W
R11—pot, 1 megohm
R12—10 megohms, ½ watt
R13—150,000 ohms, 1W
R14—pot, ½ megohm
R15—1 megohm 1W
R16—pot, 2 megohms
R17—3.3 megohms, 1W
R18—680,000 ohms, ½W
R19–R23—See Table 1
C1—40 μF, 450 volts, electrolytic
C2—20 μF, 450 volts, electrolytic
C3—1 μF, 50 volts, electrolytic
C4—0.5 μF, 2,000 volts
C5—.05 μF, 1,600 volts
C6—0.5 μF, 400 volts
C7-C11—See Table 1
D—silicon rectifier, 600 mA., 100 PIV, 1N1692
PC1—photocell, Clairex CL-603 or equivalent
PC2—photocell, Clairex CL-603 or equivalent
PL1 and SO1—octal socket and plug

| TABLE I | | |
|---|---|---|
| Indicated Shutter Speed | Value of R (megohms) | Value of C ($\mu$F) |
| ½ | 5 | 0.22 |
| 1/5–¼ | 2 | 0.22 |
| 1/10–1/8 | 1 | 0.22 |
| 1/5 | 1 | 0.1 |
| 1/25–1/30 | 1 | 0.1 |
| 1/50–1/60 | 1 | .05 |
| 1/100–1/125 | 1 | .05 |

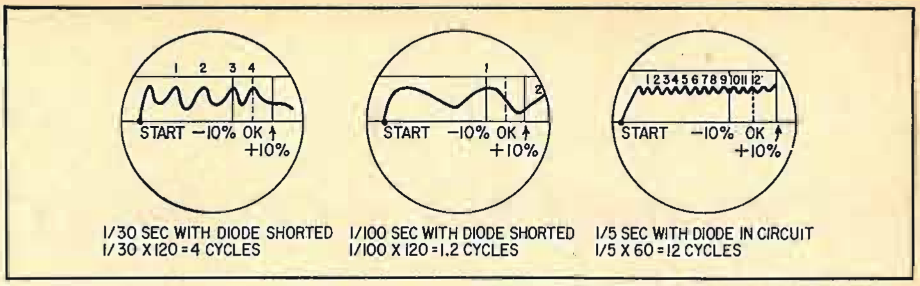



*Fig. 3—Once calibrated, sweep traces show different number of pips for each speed.*

| TABLE II | | |
|---|---|---|
| | Number of Pips | |
| Shutter speed | With Diode in Circuit | With Diode shorted |
| ½ | ½ x 60 = 30 | |
| 1/5 | 1/5 x 60 = 12 | |
| 1/30 | | 1/30 x 120 = 4 |
| 1/60 | | 1/60 x 120 = 2 |

what to expect. The lamp must be turned off to reset the spot, but take care not to switch off the lamp before the trace is complete. Adjust each potentiometer to obtain the proper number of cycles between the START position and the OK mark. Notice that you start counting from the second pip. The diode is used to reduce the number of pips that must be counted on slow speeds; on faster speeds, it can be removed from the circuit. The number of pips for any speed is found by multiplying the fraction by 60 when the diode is used and by 120 when the diode is switched out. See Table II.

Using this method, you can calibrate the sweep for any other speed you may need, and by using a switch with more positions, you can have as many speeds as you want.

On slow speeds, you may want to recycle the spot a few times and count some of the pips during each sweep. It helps, when counting a large number of pips, to darken the room to make the trace more visible. Fortunately, extreme accuracy is not necessary, and you may find it feasible simply to calibrate against another shutter that you know works well. Other cameras then can be compared to the "standard" shutter.

We added the ±10% tolerance marks to help us decide which shutters needed overhauling. A small error of 12–15% of the distance from START to OK can be tolerated in any shutter. If you want to place the 10% marks accurately, here is how to do it.

Use the setup that you'd use to check a shutter at 1/30 second, using a 60-Hz calibrating signal. You'll see two cycles of 60-Hz signal as in Fig. 4. The line going up from the START position is slanted because the shutter takes a small amount of time to open wide enough to energize the vertical-deflection photocell. This is not important. The second cycle of the signal is expanded because the horizontal sweep is faster on the right side of the screen. This is good because this is the area where critical measurements are to be made.

Adjust the analyzer controls so the peak of the wave is on the OK line. (Note that this differs from the procedure for shutter-speed measurements in which the wave crosses the OK line at the 50% point.) Two cycles equal 720° as shown in Fig. 4. When the calibrating wave is centered properly, the distance between A and B—measured along the zero axis of the wave—equals 90°. Thus 10% of the full sweep time (not distance) is one-tenth of 720, or 72°. The 72° point is easy to find. It is simply ⅘ of 90.

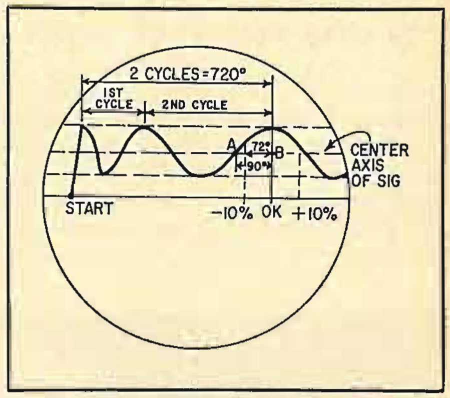



*Fig. 4—How the 10% points are adjusted.*

### Testing a shutter

Allow time for the analyzer to warm up, and use the positioning controls to set the spot at its starting position. Plug in the sensing unit and place the photocells inside the camera—or behind the shutter, if you are testing an unmounted shutter. Open the diaphragm to maximum aperture. Set up a light source—a 50-watt lamp bulb, for example—so that, as the shutter opens, light will pass through the lens and strike the photocells. Keep stray light on the CRT to a minimum, because ambient light reduces the apparent persistence of the trace. *Note*: *The intensity of the light, or the distance between the light and the lens, does not affect the calibration in any way.*

Cycle the shutter through several trial runs, resetting the spot after viewing each trace. If horizontal or vertical deflection fails to occur, check to see that the sensing unit is held directly behind the lens opening so the light strikes both photocells. Be sure the diaphragm is open wide. Remember, to reset the spot, the sensing unit must be in complete darkness.

Using the vertical-gain control, adjust the height of the trace on the screen. For the calibration pattern used in this model, the line marked 50% indicates the point at which the shutter is half-closed. Since different shutters vary in the linearity of their opening and closing rates, all calibrations are based on the time when the shutter is half-closed. The trace of a perfect shutter crosses the junction of the dotted line marked OK and the 50% line.

A shutter should be checked several times in succession to permit observation of different characteristics on each trial. In addition to timing, which should be within 10%, you can see evidence of dirt in the shutter leaves: it causes irregularities along the slanted part of the trace while the shutter is opening and closing. "Shutter bounce," the tendency of a shutter to close slightly just after it has opened, makes a telltale dip in the horizontal part of the trace, usually near the beginning.

Focal-plane shutters also can be checked in a similar manner with one precaution: the sensing unit must be placed at the back of the camera where the film is normally held. In timing focal-plane shutters, the sensing unit must be held perfectly stationary with respect to the camera, and the two holes must be in a horizontal plane.

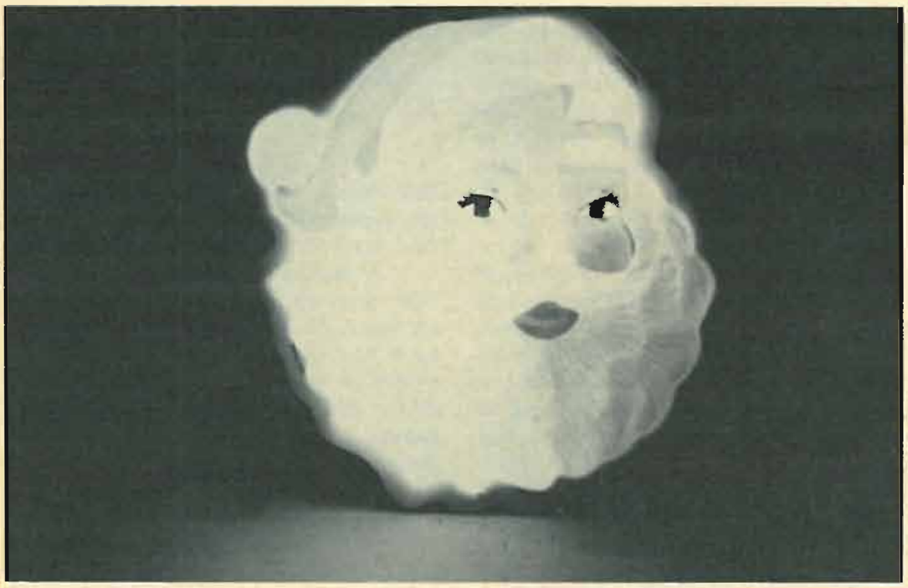
This instrument has a few shortcomings—it won't tell you the actual shutter speed, only indicate an out-of-tolerance condition, for example—but it's a mighty handy device for photographers who have many cameras. Institutions and newspapers also should find practical applications for the unit in maintenance and quality control. Since shutters have no simple do-it-yourself speed control anyway, knowing when to send a bad one to a camera-repair center can mean a great deal to anyone who depends on the accuracy of fractional seconds for his living. END

# Acousti-Lite Santa Claus

**Simple, inexpensive device produces dramatic "talking display" effect**

**By FRED BLECHMAN, K6UGT**

HOW WOULD YOU LIKE TO HAVE A "talking" Santa Claus at your door this Christmas to greet visitors? Or perhaps an unusual "animated" display in your shop window for the holiday season? For just a little over $8 and a few hours of your time, you can build a basic Acousti-Lite unit to power a standard illuminated Santa Claus that will appear to speak! This unit can be used to power any incandescent light up to 10 watts and make the light from it vary in brightness with any audio input. Add another dollar in extra parts and a $9.95 control unit, and you can do the same thing with a light display up to 500 watts!



*Santa's talking or singing is emphasized by variation in light intensity of display.*


*Pilot-lamp jewel is at top. Control determines how much audio signal reaches PL1.*

The block diagram in Fig. 1 shows the complete Acousti-Lite system. An audio signal from a phono amplifier or similar external source is applied to a one-transistor audio amplifier, powered from a regular 117-volt outlet. The output of the amplifier varies the brightness of a small incandescent bulb, normally used as a pilot light. The light from this bulb falls on two photocells whose resistance changes as the light falling on them varies. One photocell is a power type, used directly to control the brightness of a 10-watt display light. The other photocell acts as a sensor whose output is fed to a high-power light-control unit that handles up to 500 watts of display lights.

A better understanding of the Acousti-Lite's operation can be obtained by studying the schematic in Fig. 2. The audio output of any speaker (radio, recorder, phonograph, or TV) is fed to input J1, where potentiometer R1 adjusts the level of signal reaching the base of power transistor Q through coupling capacitor C1. Resistors R2 and R3 provide bias and a little feedback for Q. The transistor amplifies the input signal and varies the brightness of its collector load PL1, a No. 49 pilot lamp.

Power is provided from the ac line through switch S and filament transformer T, the output of which is rectified and filtered by diode D and capacitor C2. Overload protection is provided by inexpensive glass circuit breaker CB or a conventional fuse. Pilot lamp PL2, a neon unit, and series resistor R5 indicate when power is applied to the unit.

The light output of PL1, varying with audio-signal strength, falls on power photocell PC2, which is in series with output socket J2. Shunting resistor R4 allows enough current to flow constantly to keep the display light almost at the point of visible brightness. As the brightness of PL1 increases, the resistance of the photocell drops, allowing more current to flow through the display light. Consequently, the brightness of the display light follows the variations in brightness at the output of the amplifier. A display light of from 7 to 10 watts may be plugged into J2, but higher wattage will destroy the power photocell with current surges.

Up to 500 watts may be controlled in a similar manner with an external light-control unit, such as the Knight-Kit

KG-201 Motor-Speed/Light Control, slightly modified (Fig. 3). Small-signal photocell PC1 acts like a variable resistor in the circuit of the light-control unit. The light control is modified by adding resistor R6 and socket J3. The 500-watt (or less) display plugs into the output of the light-control unit, and is biased almost on by the knob setting on the panel of the unit. The big display then varies in brightness with the signal from Acousti-Lite photocell PL1.

**Putting it together**

The Acousti-Lite unit is built in a prefabricated aluminum 5¼ x 3 x 2⅛-inch cabinet. Wiring is simple, straightforward and noncritical. A subassembly (shown in the photo) consists of the diode, the capacitor, PC1, PL1, Q, R2 and R3 mounted on a piece of perforated board 1⅝ x 2⅝ inches. This subassembly is mounted to the cabinet with bent sheet-metal clips or plastic spacers. The transformer, potentiometer, pilot lamp, switch, and input jack are mounted directly to the box with appropriate hardware, and then wired to the subassembly. A four-lug terminal strip mounted to the box is used for interconnections.

Placement of the photocells is important. They should be located so that both receive light from PL1, and should be as near to PL1 as is practical. In the author's unit, PC1 (the small photocell) is placed right next to PL1, and power photocell PC2 is placed on the box cover together with J2 and R4. Since R4 is intended to shunt the dark resistance of PC2 and allow enough current to flow through the display lamp so it is just below the point of glowing, the value of R4 depends on the type of light in the display. The 3,300-ohm value shown in Fig. 2 is for a standard 7-watt nightlight bulb. Lower resistance and higher wattage will be required with larger bulbs. If desired, a 5,000-ohm 5-watt pot could be used for R4 in place of a fixed resistor, so that you can accommodate any light in the display in the range from 7 to 10 watts.

When mounting the power photocell, use some silicone grease to aid in heat transfer to the case. [The manufacturer of the power photocell recommends using a *copper* heat sink of at least 6 square inches which should not be allowed to rise above 35°C. Use a good silicone grease between the cell and the heat sink and protect the unit against transients by bridging the power line with a 0.1-μF capacitor rated at 600 volts or more.—*Editor*]

Be sure none of the parts connected to the power line are connected electrically to the case, or a severe shock hazard will be present. Since parts placement and wiring are not critical in this unit, the builder may exercise his imagination in using other forms of construction, just so long as PL1 is close to the photocells and the photocells are protected from external light.

Regarding parts substitutions, only PC1, PC2 and the Knight-Kit Light Control unit are "critical." Substituting for these parts would probably require design changes for satisfactory operation. You may use any neon bulb for PL2, and a No. 48 pilot lamp will work as well as an No. 49 for PL1. The transistor may be any inexpensive pnp medium-power unit. However, 10K ohms for bias resistor R3 is an average. Should you desire more sensitive operation, select a value for R3 slightly above that which allows PL1 to start glowing with no signal applied to the input.

The modification to the Knight-Kit is quite simple. A 100-ohm ½-watt resistor, which we'll call R6, is added to the circuit between the existing potentiometer and the 2,500-ohm 5-watt resistor. Two wires are added at the circuit points

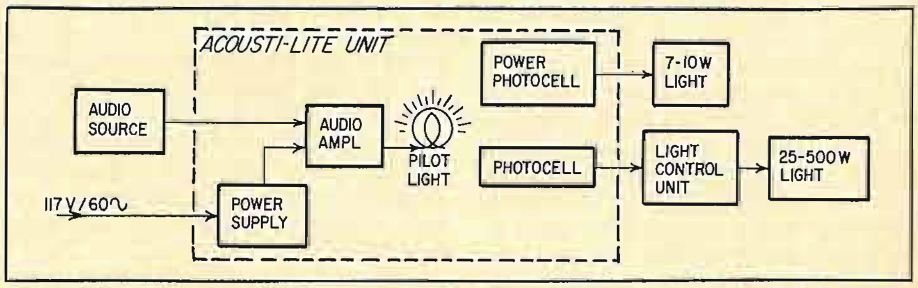



*Fig. 1—Operation of Acousti-Lite is uncomplicated. Photocells constitute main control to vary intensity of display lights when triggered by spoken words or music.*

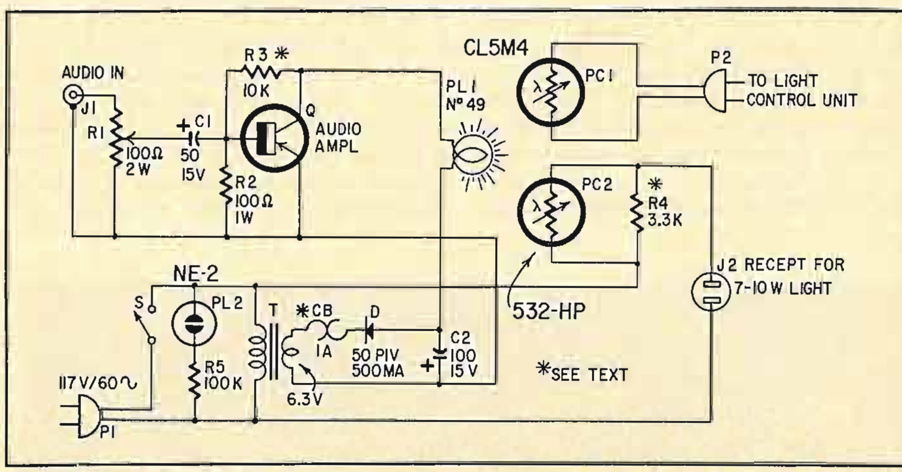



*Fig. 2—Single-transistor amplifier, using power-type pnp unit, is heart of device. Contains its own power supply, designed around an inexpensive filament transformer.*

Parts List
R1—Pot, 100 ohms, 2 watts
R2—100 ohms, 1 watt
R3—10,000 ohms, ½ watt (see text)
R4—3,300 ohms, ½ watt (see text)
R4 (optional)—5,000 ohms, 5 watts, pot (see text)
R5—100,000 ohms, ½ watt
* R6—100 ohms, ½ watt
C1—50 μF, 15 Vdc, electrolytic
C2—100 μF, 15 Vdc electrolytic
D—Silicon rectifier, 500 mA, 50 piV
T—Filament transformer, 6.3 volts, 1 amp
PL1—No. 49 pilot lamp, 2 volts, 60 mA
PL2—NE-2 neon lamp
S—Spst toggle switch
P1—Ac line cord with plug
* P2—Insulated 2-prong male connector
J1—Mike or phono connector
J2—Chassis-type ac receptacle
* J3—Insulated 2-prong female connector
PC1—Cadmium sulphide photocell (Lafayette 19 R 2101, Clairex CL5M4 or equivalent)
PC2—Cadmium sulphide power photocell, 10 watts, NSL 532-HP (available from Harvey Radio Co., 103 W. 43d St., New York, N. Y., 10017, and James L. McCoy Co., 940 Alma St., Glendale, Calif. 91202, $1.50)
CB—Sylvania MB-315 Mite-T-Breaker (Allied 34 Z 075)
Q—Medium-power transistor, pnp (Lafayette 19 R 1507, 2N176, 2N255, 2N301 or equiv.)
Box—5¼ x 3 x 2⅛ aluminum case (Bud CU-2106, LMB 880, Lafayette 12 R 8390)
* Light control—Knight-Kit KG-201 motor-speed/light control (Allied 83 U 335MW)
Perforated board, screws, nuts, spacers, wire, solder, etc.
* Used only if external light-control unit will be used

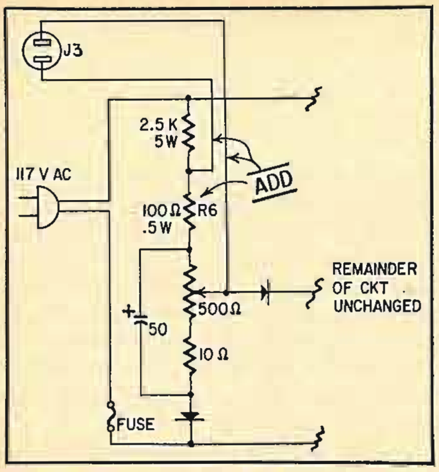



*Fig. 3—Modification of heavy-duty light-control unit needed if displays are used that have more than a 10-watt lamp each.*

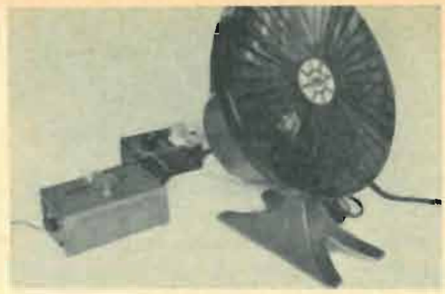
shown in Fig. 3 and are brought out to insulated socket J3. A miniature two-prong socket was used by the author, but any insulated connector socket can be used. When P2 from the Acousti-Lite is plugged into J3, the resistance of PC1 shunts the combined resistance of R6 and the potentiometer leg. Therefore, when the resistance of PC1 is varied by the light output of PL1, it's as if the light-control knob were being rapidly rotated back and forth.

**Other display ideas**

Any number of display ideas could be used with the Acousti-Lite. The "talking" Santa Claus can be made from any one of many standard illuminated Santa Claus figures abundantly available around Christmastime. No modification to the purchased unit is required. Simply plug the display into J2 (make sure the bulb is 10 watts or less) and place it near a speaker that is also providing the Acousti-Lite input. If the audio source is a man talking, the variations in brightness of the Santa Claus in step with the speaking will give an audio-visual effect as if Santa were doing the talking. You may want to put a small speaker inside the display itself to heighten the effect, so both sound and light emanate from the same display.

Rotating color-wheel displays using 150- or 300-watt bulbs are also popular. They are used for lighting Christmas trees and house exteriors. As color filters in front of a bulb turn, projected color changes. These are inexpensive units, often available for less than $4. The Acousti-Lite, with the additional light-control unit to handle the high wattage, can be used to vary the brightness of these lights as the wheel turns. A modification must be made to the wiring of the color-wheel units, however. The motor and bulb are wired in parallel, and the motor would not operate properly when fed with the fluctuating voltage output of the light-control unit. Therefore, simply locate the motor leads and wire them to a separate ac plug. Now the motor is plugged into the house outlet as usual, and the bulb is plugged into the light-control unit.

If you want to experiment with nonstandard displays, feel free. White or colored bulbs may be wired in parallel in various physical arrangements, with tinfoil reflectors, glass-fiber front panels and even small motors to provide motions and reflections from attached mirrors. (Another simple display you may want to try is a jack-o-lantern pumpkin with a bulb inside, for Halloween. Units can be purchased around Halloween with bulbs installed, and shells of translucent orange plastic; a red bulb works great in these. A microphone amplifier fed to J1 makes an unexpected way to greet trick-or-treaters at the door!)



*Rotating colored lights and other displays will work if external light control is used.*

As for the sound source, you can tap the signal going to any speaker, or plug into the earphone jack of a radio or recorder. A continuous-loop tape cartridge can be used with a tape player for continuous messages.

There are only two precautions to observe in operating the Acousti-Lite. First, be sure not to exceed the power rating of the output used: 10 watts for J2, 500 watts with the light-control unit. Second, always turn potentiometer R1 to its minimum-signal (zero-resistance) position when connecting the audio input.

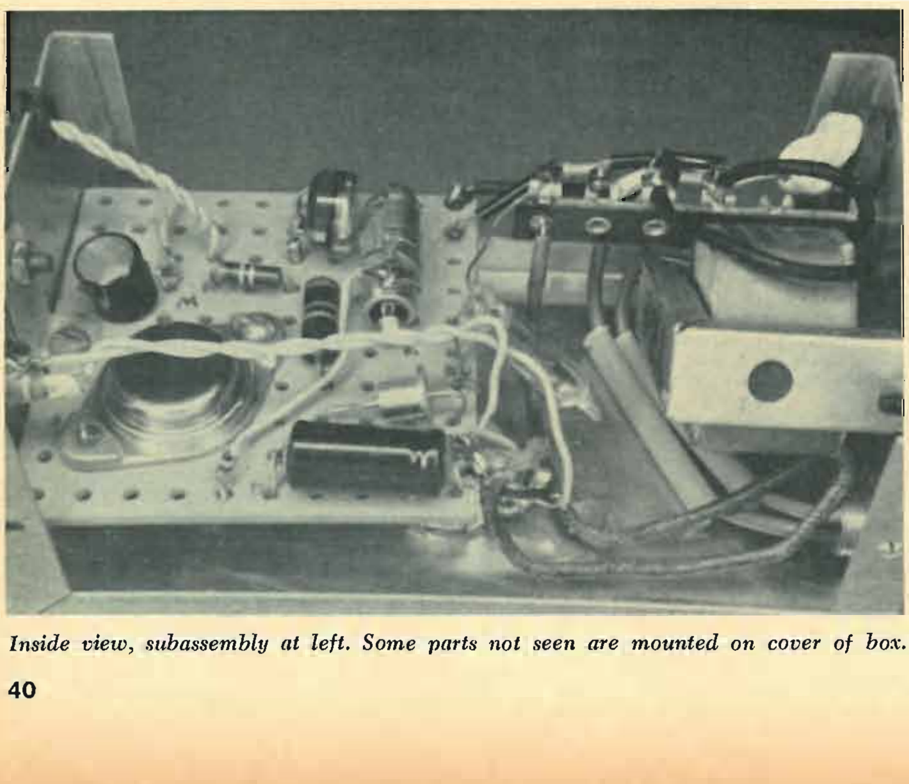
Overdriving Q will burn out PL1! Set the source volume at a comfortable level, plug the source into J1, plug the display into J2 or into the output of the light control unit, and rotate R1 until the display responds properly. PL1 is pretty rugged, but will burn out if overdriven. This can be prevented by inserting a short piece of Nichrome wire (about 2 ohms) in series with PL1, but this reduces the sensitivity of the unit.

When using the external light-control unit, first adjust the display to a just-below-glow condition with *no* signal, by rotating the light-control knob. The modification made to the light-control unit does not affect normal operation; it can still be used to light the display to anything from low to full brilliance without any connection to the Acousti-Lite.

Troubles can usually be traced pretty easily. Diodes or capacitors connected backward are a common wiring fault. Be sure you have positive voltage on the emitter and negative on the collector of Q. Check PL1 to see that it hasn't been burned out by a transient. Make sure R1 is not at the minimum input position. And, of course, don't forget to turn on the power!

The low cost and versatility of the Acousti-Lite unit make it a worthwhile project for experimenters, school classes or store owners who want an eye-catching display for their Christmas windows.

END



*Inside view, subassembly at left. Some parts not seen are mounted on cover of box.*

*LeRoy German, president of MODEMCO, INC., makes a final connection before checking out a piece of remote equipment. This gear is an important part of a phone-company testing device.*

# THE INSTALLERS

**You've got to be good or get that way fast to join the ranks of contract installers. The work is demanding, often tedious, sometimes lonely, but rewarding**

**By RAY D. THROWER**

THE EXPLOSIVE IMPACT OF THE ELECTRONICS INdustry on the American economy and its vital technological growth offer an unprecedented variety of career choices to youngsters and oldsters alike. There are jobs for the genius, the average, or the below average; for the active, the sedate, or the handicapped. It might truly be said that in electronics there is something for everyone who wants to meet the challenge.

A particularly demanding segment of the profession offers long hours on difficult jobs under sometimes almost impossible conditions. In compensation it promises good-to-excellent pay, an opportunity to travel widely, and a chance to demonstrate individual responsibility and initiative. Working as an installer of complex electronic systems won't be everyone's cup of tea, but those who have chosen to follow the sweep of electronic technology into the world marketplace seldom return to an easier or more comfortable line of work.

Requirements for the position of installer vary from company to company, but they have basic similarities. An apprentice installer usually must have a high-school education. Also, some background in electronics, as from amateur radio activity, may be required, but this generally can be waived for equivalent math or science courses. In all cases, employers require passing scores on aptitude and problem-solving-ability tests.

A master installer must be part technician, part engineer, administrator, mechanic; some companies also require at least a Second-Class Radiotelephone license. Extensive background and training in electronics are necessary as are a thorough familiarity with test equipment and the ability to read schematics, blueprints, and engineering specifications. At the same time, the master installer must be able to act as a public relations man for the company he's working for and supervise those subordinate to him.

To obtain a deeper understanding of what's involved in this branch of the industry, RADIO-ELECTRONICS visited MODEMCO, Inc., of Decatur, Ga., and spoke at length with three installers who joined abilities in January 1965 to form their own company. Corporation president LeRoy German, vice president Jimmy Hays, and secretary-treasurer William Bowers are all under 35, yet their combined industry experience totals that figure—35 years.

LeRoy German became interested in electronics while still in high school. His father, a Nebraska farmer, had taken a course in radio from National Schools of California during the 1930's, and young German happened across the old texts one day while exploring the attic. He studied them and took related courses in school, all of which eventually helped him pass Air Force qualification tests. As a result, he was able to attend many technical schools during his 4 years in the service.

After his discharge in 1960, LeRoy went to work for a major manufacturer of communications equipment, installing carrier, data, microwave, and power equipment for almost 3 years. In 1963, when the opportunity came to advance himself, he transferred to another company to become an installation supervisor. There he met Bowers and Hays.

Since its inception, MODEMCO has installed communications and control systems for power and pipeline companies, communications systems for independent telephone companies, intercom systems for banks, and battery/rectifier power plants for communications systems. Equipment manufacturers normally have their own installation crews, but subcontract their installation work to companies such as MODEMCO when their own installation crews are taxed to keep up with the expanding workload of the communications industry.

We interviewed MODEMCO to get some firsthand ideas about employment opportunities in installation work and spoke first with LeRoy German.

RADIO-ELECTRONICS: To begin with a topic of particular interest to our readers, are there really a lot of job opportunities in installation work?

MODEMCO: Very definitely. It's hard to find enough installers who can be depended on and who are willing to travel almost continuously. Probably the most difficult to find are the less-experienced installers. Apprentices are necessary in any occupation, and electronic installation work is no exception.

RADIO-ELECTRONICS: Why would beginners be any harder to find than more experienced installers?

MODEMCO: Well, when an experienced man is needed, he *knows* he is needed and has the experience—he has the self-confidence to apply for jobs. Also, he's more stable and, once hired, usually stays with a company. The beginner thinks there is no need for his inexperience, so he hesitates to try for what he thinks is an unattainable job. The beginner who does get into electronic-installation work can learn as much about practical electronics on the job as in a formal classroom.

RADIO-ELECTRONICS: We understand an installer often works in remote areas under difficult conditions. Was this true in your experience?

MODEMCO: Absolutely! From April to November of 1957, while in the service, I was stationed as one of a two-man team on Tern Mountain, installing and maintaining radio-relay equipment. Tern Mountain is an extinct volcano, about 500 feet above sea level, in southeastern Alaska. The mountain wasn't big enough or level enough to build an airstrip on, so everything was dropped in by parachute or flown in by helicopter. There was a small lake about 3 miles from the site where float planes occasionally would land but, for the most part, all our equipment and supplies were paradropped in.

RADIO-ELECTRONICS: How did the equipment hold together during air-drop delivery? Ever have any parachute failures?

MODEMCO: No failures on opening, but once the canopy failed to collapse on a deep-freeze unit that was dropped in. The winds were too high, and the unit was dragged across the rocky tundra and dumped into the Bering Sea. That was a real "deep" freeze! Oh, and another time, a generator was dropped in from too low an altitude, and the chute opened too late; we had a pulverized generator that time. All considered though, it is surprising that well-packaged material, including sensitive electronic equipment, can survive being dropped into a remote site by parachute. Of course, a lot of our food was delivered this way, too.

RADIO-ELECTRONICS: Where was the most-distant-from-home job you've encountered as an installer?

MODEMCO: After I left the Air Force and got into industrial communications work, I unexpectedly found myself installing equipment in Turkey!

RADIO-ELECTRONICS: That must have been quite an experience for you.

MODEMCO: It sure was. First, it was a great chance to get in some tourist activity in a part of the world where civilization is said to have started. Then, from the pure job aspect, there was the chance to work with technicians from different nations. I think the toughest thing there was the language barrier. Anyone thinking about installation work for a living should study the language of a country he would like to visit someday. Chances are he'll wind up there, especially if he knows the technical language. On this particular job I was on, we had Americans, Englishmen, Italians, Germans and, of course, Turks. Once our American group needed to talk to an Italian cable splicer. We had a Turk who spoke both English and German. He relayed our questions to the German, who spoke both German and Italian, and thus to the Italian.

RADIO-ELECTRONICS: Would you prefer to work in any other phase of electronics?

MODEMCO: I don't think so. To me, installation work provides circumstances where you can enjoy just about all phases of electronic activity. There is inevitably some on-site engineering to be done, as well as installation, fabrication, testing, alignment, calibration, and administration. It's one of the few personally rewarding jobs in which a man can see the finished product performing its intended function.

(As this point Jim Hays and Bill Bowers walked in. We reviewed the discussion and asked for their ideas.)

MODEMCO: Well, I sure agree with LeRoy. The rewarding part comes when power is first applied to a piece of equipment and there are no great flashes of light or billowing clouds of smoke. The equipment seems to stand there almost like a monument to your efforts.

RADIO-ELECTRONICS: What would you say is the most difficult thing about installation work?

MODEMCO: Some people might say travel. Being a small company to start with, we're working executives. Our jobs include, not only the corporate functions, but also some installation work and test and acceptance evaluations of equipment. We also act as company sales representatives, so we are kept on the move a good percentage of the time. But, it is enjoyable. It gives us the opportunity to work with new gear, meet new people, and perform a needed service.

The most difficult technical thing seems to be the ability to strike a balance between quality and quantity of work. This is true of any job, but it's especially so in electronics installation work. There is the pressure of working against a deadline, yet you must have the equipment operating in top-notch shape when you finish.

MODEMCO (Hays): That means you can't cut corners on the alignment of an i.f.-amplifier baseband curve in a carrier-communications system. A corner cut here and another there, and you're going to have trouble for sure. Aside from the job, though, one of the most demanding things about being an installer is that you must either be a bachelor or have a very understanding family, since this work requires extensive traveling. Actually, many wives and families like the mobility of the installers' life, especially when the family transfers as a unit. Many installer's wives seem to revel in a new house to work on every year or so. Even motel living is different and welcomed for shorter periods.

RADIO-ELECTRONICS: Do companies usually pay for these family moves?

MODEMCO (Hays): Yes, on the long-term transfers of, say, 6 months or more, they do. They pay all moving expenses, and they'll put the family up in a motel at the new job location for a week or two while you look for more permanent housing. Out on the road though, when you're traveling constantly from location to location, it's pretty hard to take a family. Usually on the shorter jobs, you work out of the company's area office, anyway, and it's more practical to find permanent housing for the family near the area office.

RADIO-ELECTRONICS: How about expenses when you're on the road?

MODEMCO (Bowers): Well, this sort of varies with the company and the job, but they're usually paid for by the company. The way it works is that each installer has an expense account which he submits on a regular basis. Some companies just pay a regular daily expense rate, and there is very little expense reporting to get involved with then.

RADIO-ELECTRONICS: Okay, suppose a guy wants to be an installer. How does he get this kind of job?

MODEMCO (Hays): The first thing to do is to find out who needs installers. Trade journals and the large metropolitan newspaper ads are good sources for these. Then, when you read the ads, don't read too much into them. That is, don't be afraid to apply.

RADIO-ELECTRONICS: What do you mean by that?

MODEMCO (Hays): These ads are written on a general basis. It may look like they want the proverbial 18-year-old Ph. D. with 25 years of experience. Usually, from the experience of most everyone I've known, they spell out everything the company may be looking for in the hope of finding several individuals with at least a partial combination of the experience they need. Then they will work these men together as a team, forming a composite of the experience they need. If necessary, in some cases, the company may even provide specific training to qualify the installers in certain areas.

RADIO-ELECTRONICS: About this experience—what does a man have to know or do to be an installer?

MODEMCO (Bowers): Probably, above all else, he should excel in alignment and calibration techniques. This means a better-than-usual knowledge of different types of test equipment and how to use them. Installation work isn't just putting up pieces of hardware with channel and angle iron and shoving equipment into racks. Once it is installed and power is connected, it has to be completely checked out and aligned.

RADIO-ELECTRONICS: Working close to the heart of the industry, in installation work, what do you see in the future for the installer?

MODEMCO (Bowers): The electronics industry is expanding so rapidly that the installer always will have a future. And, he will be more in demand if he keeps up with techniques.

MODEMCO (Hays): That's right. Keeping up with technical advances means a lot of things. Reading all the technical and trade journals a guy can get his hands on, for one thing; correspondence schools for another. Magazines alone are an education, and those reader-service cards are ideal for the guy who wants to explore specific areas in a little more detail.

MODEMCO (German): Technical education is fine, but the guy who is really making long-range plans should also take some business and management studies, correspondence courses, and the like. As Jim just mentioned, a traveling job is ideal for correspondence-school work.

LeRoy J. German, Jimmy H. Hays and William F. Bowers have progressed far in a few short years, from apprentice installers, through various levels of responsibility, to executive positions in their own corporation, specializing in electronic installation. The need for communication and electronic apparatus will continue to grow, and so will the need for installers. Good, qualified men who are willing to travel are always in demand in the industry—the requirements are high, but so are the rewards. END

# INDUSTRIAL PARTS IN RECEIVERS

**By KENNETH ALLEN**

THE SCR AND THE REED RELAY have usually been considered industrial components. But now both appear in home receivers.

### Spot-killer circuit

Dc-coupled transistor sets pose a problem that has been solved quite simply with a reed relay. Although most transistor TV sets use low voltage on the i.f. and first video amplifiers, a separate dc supply is used with the last video amplifier to develop sufficient swing to drive the CRT.

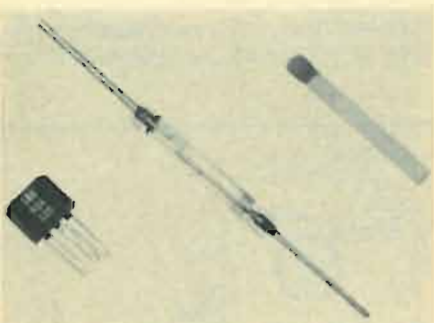
When the set is turned off, the voltage on the last video amplifier rises to the power-supply voltage. This high positive voltage, which is also on the CRT, cuts it off. Without a spot killer of some sort, however, as the B+ on the picture-tube cathode drops, the electrons in the still-hot gun are attracted to the screen by the remaining high voltage and form a spot. Although the spot isn't always damaging, it is annoying.

Simple spot-killing schemes have until now been only partially successful since they usually rely on operation of the on–off switch. When a set is turned off by a wall switch, the spot killer is ineffective.

The magnetic-reed relay is a simple device, consisting of two reeds sealed in the ends of a glass tube. The reeds overlap slightly in the tube and are separated by several thousandths of an inch. Since the reeds are made of a magnetic material, they pull together when placed in a magnetic field.

The magnetic-reed relay is actually the only part in the spot-killer circuit (Fig. 1). It is mounted near the B+ supply choke, whose magnetic field causes the relay to close whenever the set is on. The contacts inside the reed-relay bulb are in series with B+ to the last video amplifier. While the set is on, the B+ is supplied to the video amplifier through the relay contacts. When the set is turned off, the reed relay opens and removes B+ from the video-amplifier plate. That puts the CRT cathode at nearly ground potential and causes the CRT to conduct heavily before the raster collapses. The heavy conduction "bleeds" electrons from the gun and the high voltage, thus eliminating the spot.

If the relay needs replacing, the only caution is that the new relay should be positioned the same as the original.



*Glass tube contains magnetic-reed relay. SCR has three leads, resembles transistor.*

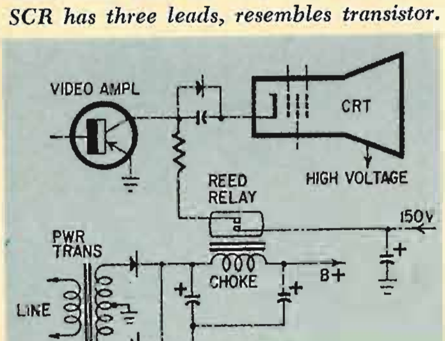



*Fig. 1—Magnetic field of power-supply choke operates nearby coil of reed relay.*

### The SCR circuit

An SCR operates very much like a thyratron. A positive voltage—either steady or pulse—applied to the SCR gate readies the device to conduct heavily whenever a positive voltage is present on the anode. Even though the positive voltage on the gate is later removed, the SCR continues to conduct until the anode voltage is removed or reversed. Fig. 2 shows how different anode and gate voltages affect current through the SCR.

An SCR stereo-indicator circuit is seen in Fig. 3. Because the 19-kHz pilot signal is present only when stereo is broadcast, it is used to operate the stereo-indicator light. The output of the last 19-kHz amplifier feeds the gate of a C106 SCR directly. Since only a positive gate can affect the SCR, it is not even necessary to rectify the 19-kHz signal. The first positive-going 19-kHz excursion will turn the SCR on, and other positive or negative excursions will have no effect on the gate.

The anode of the SCR is connected to 6.3 volts ac through the stereo-indicator lamp. The SCR can conduct only on each positive 60-Hz excursion. When the SCR is conducting, the lamp lights. The SCR can be turned on only by positive excursions if the 19-kHz pilot signal is present. It is turned off every half-cycle by the negative 60-Hz excursion, so actual power consumed in the bulb is only about half what it would be if the bulb were placed directly across 6.3 volts. A special 3.2-volt bulb is used.

When the stereo broadcast is finished—or the 19-kHz pilot is lost for some other reason—the SCR turns off on the anode's next negative-going cycle.

These developments are two good reasons for technicians continuing their electronic education. END

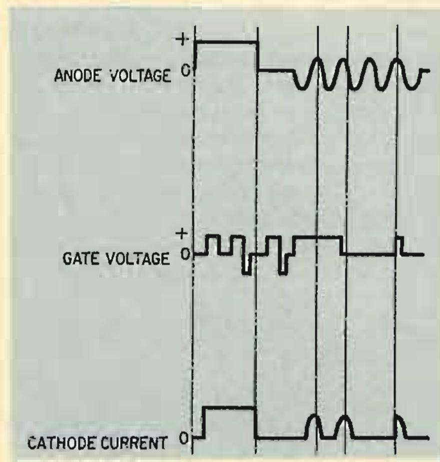



*Fig. 2—Positive gate and anode turn on SCR; only nonpositive anode turns it off.*

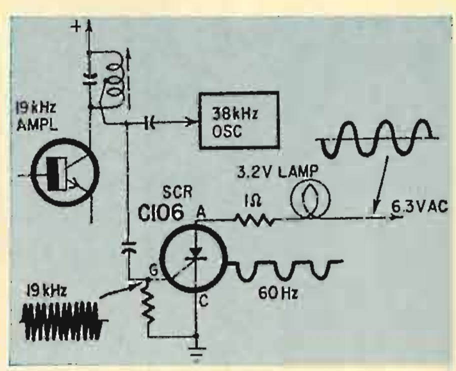



*Fig. 3—Pilot signal gates SCR, which is turned on by positive half-cycles at anode.*

# Industrial Applications For Photoelectronics

**A tiny photocell, sensitive to minute changes in light, is the nucleus of complex production-control and materials-handling instrumentation**

By **ALLAN LYTEL**

IN THE FIELD OF INDUSTRIAL electronics, we've come to expect ever-increasing complexity, speed and precision in the mechanisms and systems that support high-speed materials-handling and production machinery. Even in so relatively simple an area as that of the photoelectric devices we most often see—door-openers, alarm-ringers, or light-control switches—industry has worked its usual wonders.

Television and newspapers keep us up to date on the use of photovoltaic cells that provide operating voltages for the equipment in orbiting satellites and interplanetary probes, but less newsworthy uses of photoelectric cells pass general notice. Among recent applications are high-speed computer tape readers, production-inspection systems, and carton-handling conveyor systems capable of identifying individual cartons and delivering them to predetermined destinations.

All photoelectric systems include three basic elements—a light source, the photoelectric detector, and the control circuitry. The source normally consists of a tungsten-filament lamp and the optical components to form a beam of light. Though specifically designed for long life and operated at conservative voltages, the lamp should be replaced within its expected lifetime, even though it is still operating normally. Spare lamps should be easily available, and, wherever possible, the system should be fail-safe in operation.

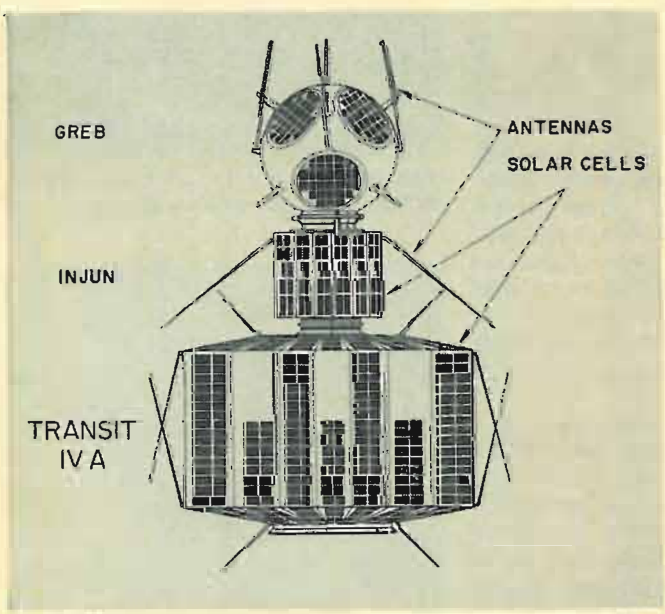
The photoelectric detector uses light to generate electricity which can be controlled or which controls one factor in an electrical circuit. Although the photoconductive cell is the most common type, there are three basic photo devices: the photoconductive cell or photoresistor, in which the total resistance of the cell material (cadmium-selenide or cadmium-sulfide) varies in indirect proportion to the intensity of light falling on it; the photoemissive cell, which emits electrons when its cathode is illuminated, and the photovoltaic cell, which produces a voltage when illuminated.

Small size, low cost and long life make the photoconductive cell a logical choice for many industrial systems. Typical units have a dark resistance ranging from 10,000 ohms to several megohms and an illuminated resistance of a few hundred ohms or less.

The control circuitry consists of various triggers, amplifiers, and relays that determine the function of the system. There literally is no end to the type or complexity of operations attainable through proper design of the control circuitry. Most systems, however, have in common the need for fail-safe circuits to protect the mechanism from serious damage when a lamp failure occurs and also to prevent unwanted operation under certain controlled circumstances. The control circuitry accomplishes the task designed into the system by the engineer.

### Typical photoelectric unit

The solid-state photorelay control device shown in Fig. 1 is a unit of moderate sensitivity with an operation capability of 300 counts per minute. It uses a




*Photocell groups produce operating voltages for orbiting satellites; generate power to recharge nickel-cadmium batteries.*

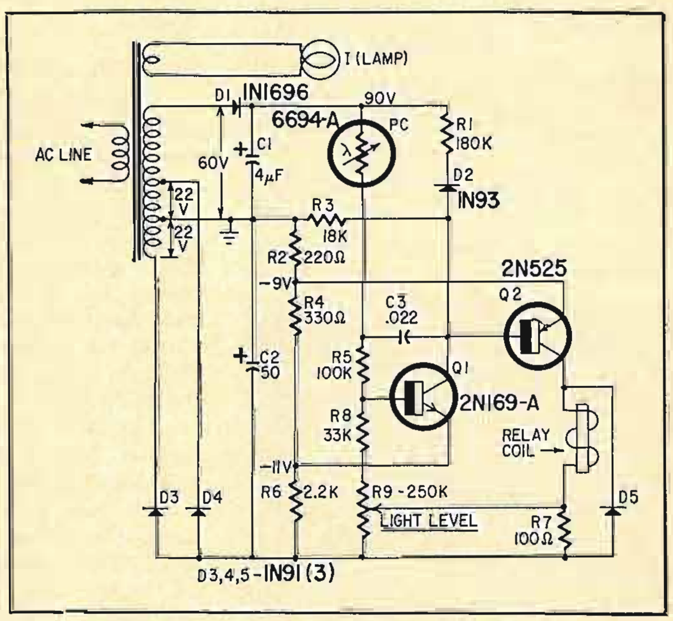
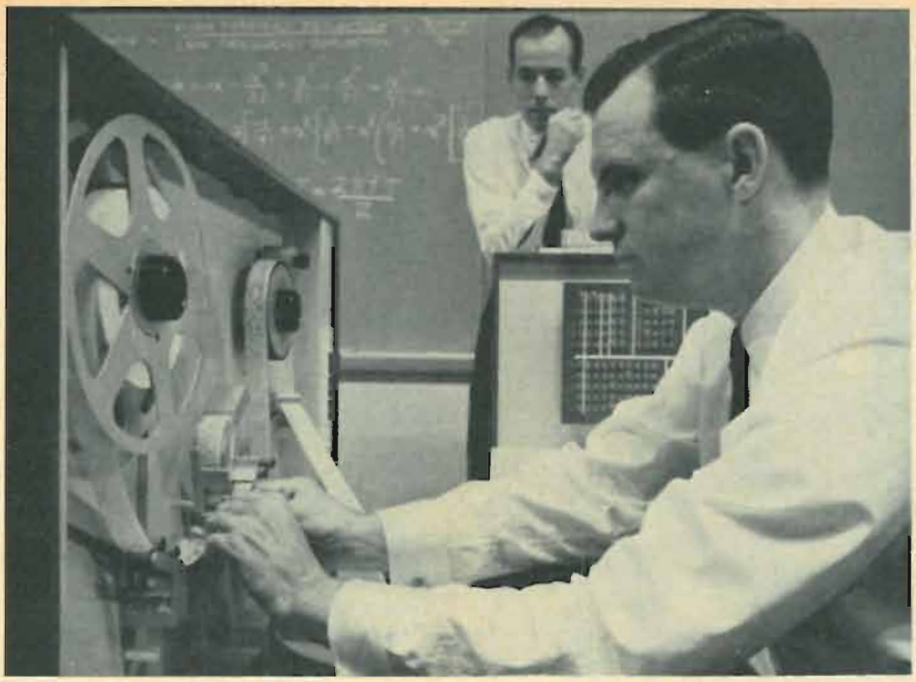
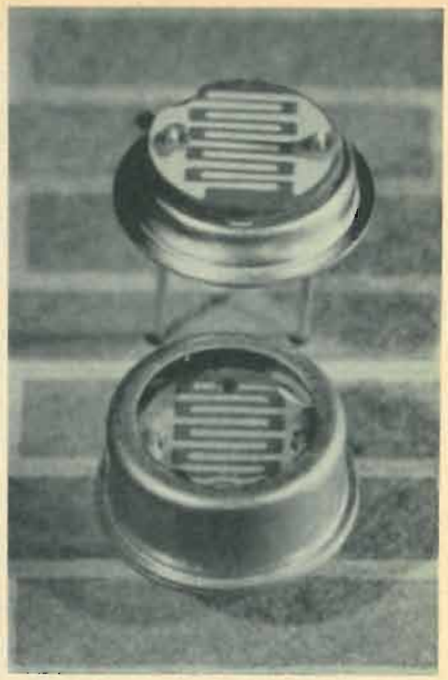



*Fig. 1—Response time of this typical photocell device is approximately 45 milliseconds with average cell illumination.*



*High-speed tape readers use photocell groups to decipher code of holes punched in tape. System is widely used as basic language for modern computer applications.*



*Solid-state photoresistor is mainstay of new production-control industrial devices.*

photoconductive cell and two transistors.

Across the 60-volt and −30-volt sources are resistors R5, R8, photocell PC, R7, and potentiometer R9. When not illuminated, the photocell has a high resistance. The base of Q1 is more negative than its emitter (base −30 volts, emitter −11 volts). In this nonconducting state, the transistor has only a small value of collector current due to leakage; D2 and load resistor R1 compensate for any change in collector current as temperature increases.

When light strikes the photocell, its resistance drops sharply and permits an increased current flow through series resistance string R5, R8, R9 and R7. Since the drop across R8 will allow Q1 to conduct, its value is the important one in this circuit; R5 is used only to limit the current flow through the photocell to a safe value at all times. When R9 is set at minimum resistance, the photocell requires more light for a given voltage drop across R8. This control, then, is for *light level.*

When the drop across R8 becomes greater than 26 volts, Q1 conducts, because its base-to-emitter bias voltage is overcome. Collector current flows through R3, coupled directly to the base of Q2. Because the base of Q2 is positive relative to its emitter, the amplifier is normally cut off. Therefore, Q1 conducts, the Q2 base voltage is reduced, and Q2 collector current flows through the relay coil and R7 and back to ground through R2. This feedback voltage lowers Q1's emitter voltage, increasing the current flow through both transistors in a regenerative action, and the relay armature pulls in sharply.

The photocell does not respond instantly when light is applied or removed, and this characteristic limits the maximum operating rate of the relay. The greater the intensity of light, the shorter the delay in energization. There also is a delay in dropout time due to cell-current delay time; this delay increases as light intensity is increased. For rapid dropout, the light intensity should be kept relatively low.

Obviously almost any kind of relay with very simple or highly complex contact arrangements can be used with this device, depending on the exact function expected of the overall system. An examination of two complete systems will give a better understanding of how photoelectric controls contribute to industrial development.

## Electronic inspection

The light-sensing photoelectric inspection system illustrated was designed for detecting and removing imperfect items from production conveyor lines. It can detect any variations that cause a 3% or greater variation in light reflected or transmitted from the items being inspected and is designed for use with conveyor belts up to 10 feet wide traveling at speeds as high as 600 ft/min. The system can be used to inspect plastics, metals, glass, processed foods, and textiles, among other manufactured products.

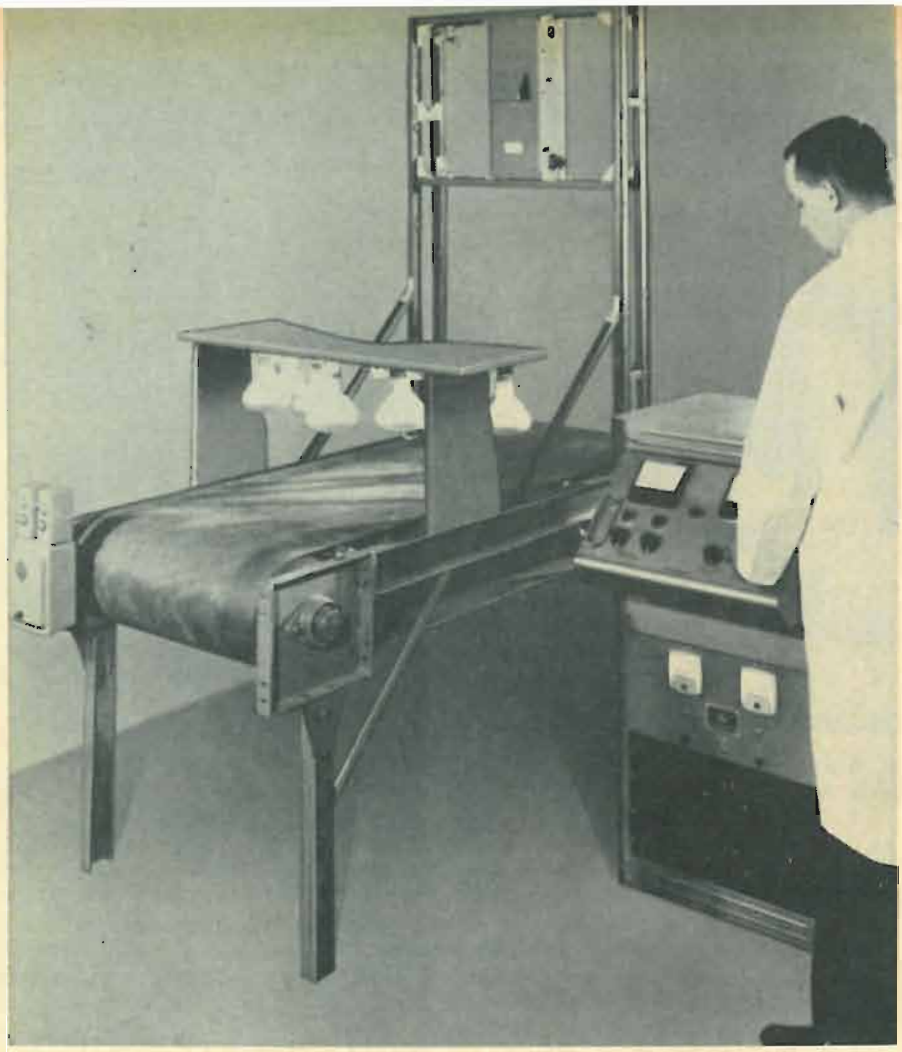
Like the human eye, the system detects the difference in reflected light intensity between the flaw and its surrounding area. The system consists of an illumination source over the conveyor, an optical scanner which gathers information on light-intensity differences, a data processor which analyzes the information, a control, and a power supply. The mechanism which removes or marks the flaw is specially designed for each application.

The scanner, also positioned above the conveyor, sweeps its optical field 14,000 times a minute. Light-intensity variations are then fed into the data processor which converts them to digital form. The digital signals then energize the mechanism which removes the imperfect item, marks the flaw, or executes any other design function.

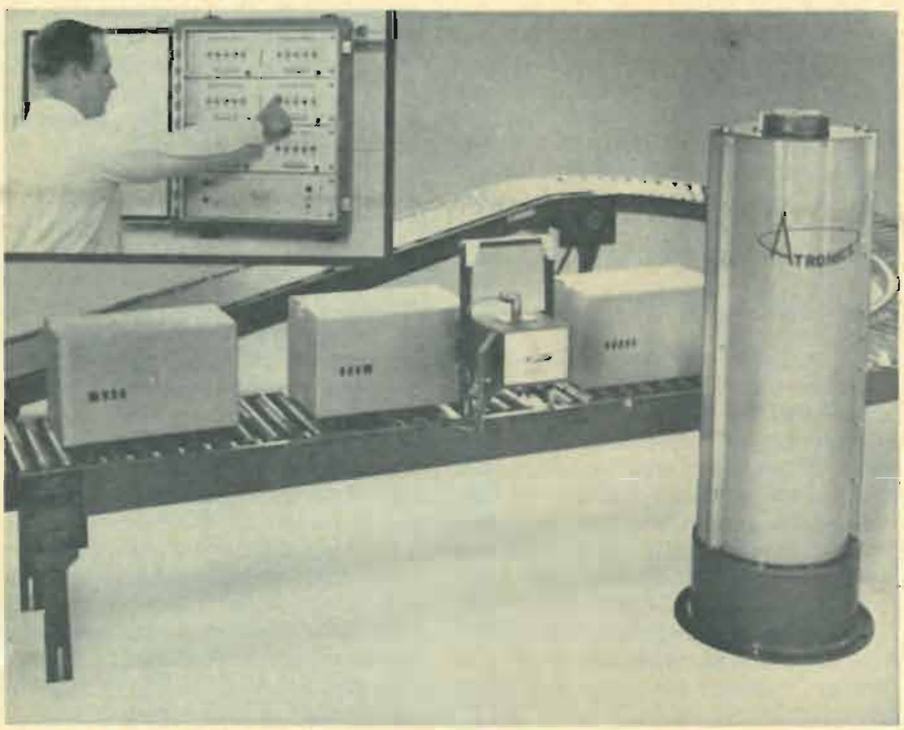
## Automatic carton selection

Materials-handling functions can be automated in a photoelectrically controlled, fully automatic carton-selector system, which differentiates among 31 types of packaged products on a moving conveyor and diverts each to its preselected destination. The entire operation is accomplished at one setting of the system's toggle-switch control console. Each packaged product is identified by its own individual code which is printed on the carton and read photoelectrically by the selector system. This system, which also counts and totals the passing cartons, can be used at conveyor speeds as high as 200 ft/min.

The automatic carton selector also can be used in conjunction with a proportional-speed memory system in which the output signal from the selector is retained in the memory unit until the package arrives at its divert point. This



*This demonstration setup of a quality-control photoelectronic system shows its capability of flaw detection, and rejection of faulty components at belt speeds as high as 200 feet per minute. The device responds to 3% variation in reflected light off belt.*



*Photocells form heart of central routing device, which "reads" black code squares on sides of cartons traveling along conveyer. Then routing device automatically diverts each carton to its proper destination. Up to 31 different codes may be used, as desired.*

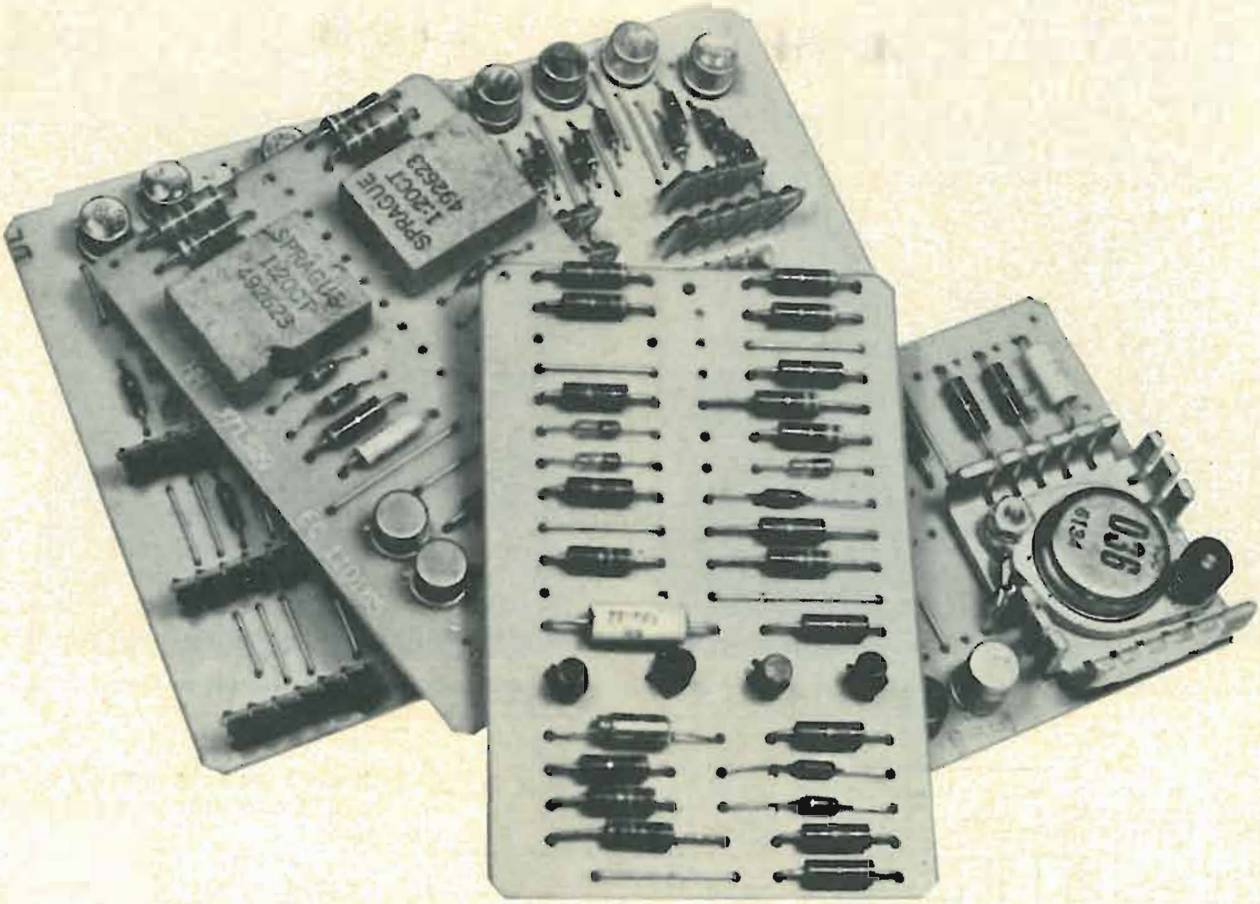
combined system is particularly well suited where mixed products combined on a single conveyor must be separated for specific handling operations, or where many units of the same product on a single conveyor must be scheduled for a number of destinations.

In operation, the photoelectric code reader is located adjacent to the conveyor and recognizes each code as the cartons move by. Plug-in selection modules, one for each code, are installed in a remotely located selector panel. By positioning toggle switches in the selection modules, an operator quickly selects the products to be counted and sorted.

The 31 codes consist of as many as 5 sequential bars. In the carton area provided for the code markings, the presence or absence of the bars triggers a response in the code reader and allows it to determine whether the passing carton is to be selected. An area ½ x 5 inches must be provided on the carton for the code, since this is the total area viewed by the 10 photocells in each reader.

When the system is in operation, the divert cycle begins as a carton containing the code for a specific divert station moves downstream on the conveyor. Shortly before the carton reaches the desired station, the code is read and the divert mechanism of the selected station elevates a small rubber wheel, located in the main conveyor line, so the tire projects above the level of the conveyor rollers. The approaching carton reaches the protruding rotating wheel whose axis is at an angle of 30° to the path of the carton. As the front edge of the carton touches the moving tire, it is raised slightly and the carton is pivoted in the direction of the divert conveyor. A second rubber-tired wheel—electrically powered and revolving 10% faster than the first wheel—receives the carton, aligns it with the divert conveyor, and propels it onto the divert conveyor. The entire operation is accomplished quickly and without disturbing the rapid flow of closely spaced cartons on the conveyor.

Throughout industry, in numerous monitoring, sensing, controlling, limiting, and counting applications, photoelectric cells and their supporting electronic circuitry speed production of vital goods. Although basically a simple device, the photocell's unique properties make it a mainstay of high-speed production and material-handling lines. Industrial engineers and equipment designers daily find new applications for photoelectronic devices. While it's doubtful that the American economy would suffer a major setback without them, they hold a position out of all proportion to their diminutive size. The lowly photocell is mighty, indeed. END



*Boards like these are often available as end-of-production surplus items, can be used with little modification.*

# Surplus Printed-Circuit Boards Give That Professional Touch

**A little study turns up some excellent circuits in pc boards which can be used after slight changes**

By **CLEMENT S. PEPPER**

THIS IS THE GOLDEN AGE OF ELECTRONICS. The enterprising hobbyist never had it so good. The state of the art is moving so fast that fascinating devices are conceived, constructed and thrown out at such a pace that they often end up on the surplus market but little the worse for the trip. Never used—obsolete before they were delivered!

I'm thinking primarily about innumerable computer boards found on the counters of all the surplus stores (and sometimes out in front, in boxes on the street) at prices as low as 5¢ a board. Some of these are shown in the photos. For the most part they are really loaded with the most delectable of electronic goodies—first-rate components, right out of the computer.

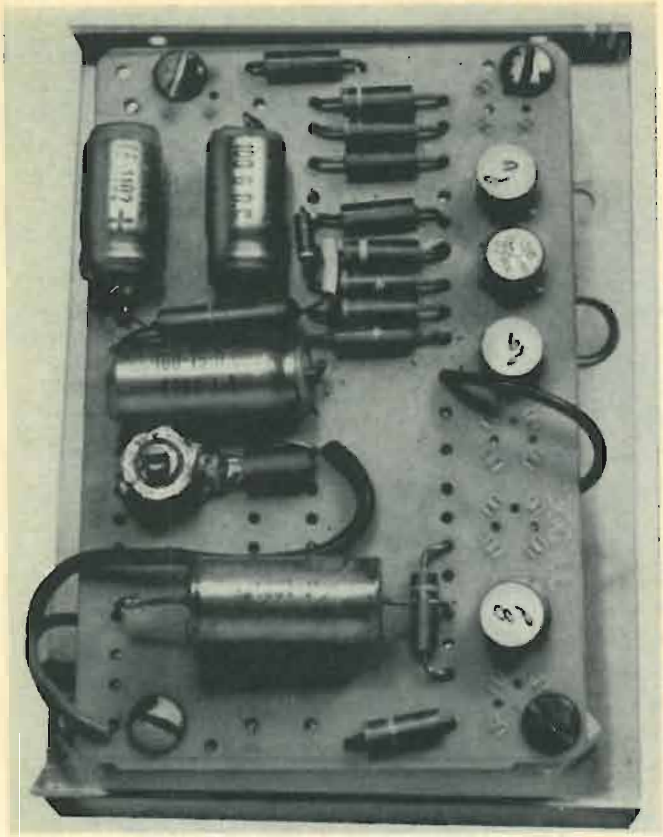
In the beginning I happily stripped off the parts and chucked the boards. The circuits on the back were just too tough to figure out—it would take hours, I thought.

But the boards look so darn neat. Very professional. They would really add class to the things I had in mind to make. So I went to work on a fast, efficient way of doping out the circuits.

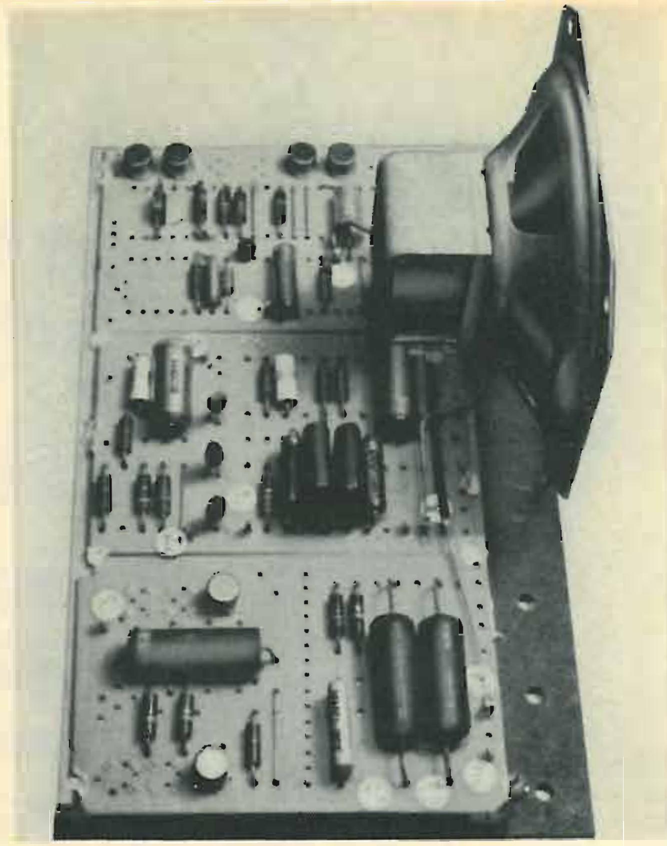
When you think about it, the real problem is that the parts are all on one side of the board and the connections are all on the other. What you need is a transparent board. Aha! There is a solution. Transparent paper! First draw the parts on the top. Then flip over the board and draw the connections on the back. Problem solved!

The best paper is semitransparent drafting paper with a faint blue-line grid, 10 divisions to an inch. You can get it in drafting-supply stores. The grid isn't essential, but it helps.

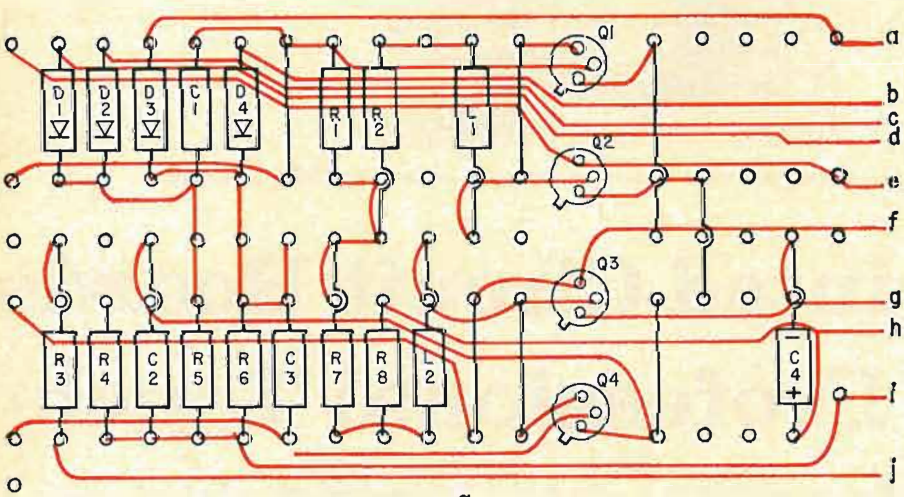
Now set the printed-circuit board before you, component side up. Lay out the hole pattern on your paper and outline the parts. The grid lines are useful here. Roughly scale the spacing; keep components in their correct relative po-



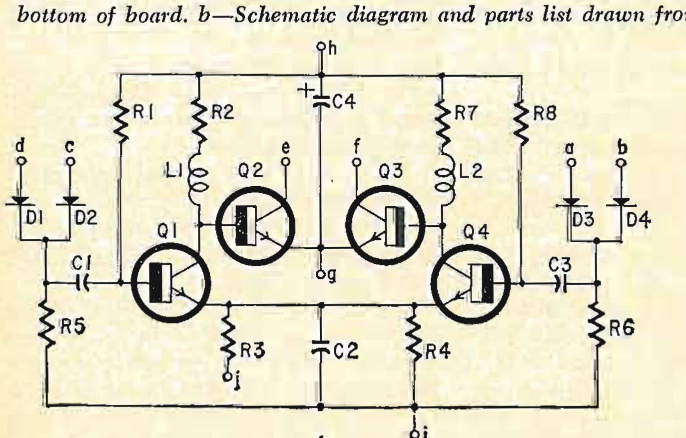
*Slightly modified board contains amplifier with gain of 1,000.*



*Breadboard made by selecting circuits on three printed boards.*




a




b

*R1 TO R8 5%*
R1 = 18K/.5W
R2 = 820Ω/1W
R3 = 560Ω/2W
R4 = 510Ω/.5W
R5 = 3.3K/.5W
R6 = " "
R7 = 820Ω/1W
R8 = 18K/.5W

C1 = .0015/100V, MYLAR
C2 = .1/100V, DISC
C3 = .0015/100V
C4 = 10/20V, TANTALUM

*Fig. 1—Black lines are components and leads on board top. Orange lines are leads on bottom of board. b—Schematic diagram and parts list drawn from board shown above.*

sitions. I use a red pencil to outline the parts. Don't write part designations in yet.

Now flip over both your board and the paper. Be sure they flip the same way. so corresponding parts maintain their positions. If you have the right kind of paper, the hole pattern and components will show through very nicely.

Go ahead and sketch out the circuit patterns on the back of the paper. Try to follow the general contours of the conducting strips. Check carefully—don't leave any out.

Return the board and paper to right side up. Circuit patterns are visible through the paper. Now assign designators to each part. Be sure to do this, because the designator really helps when you sketch out the circuitry. Put arrows in the diodes. If the board is a plug-in type, assign letters to the outgoing strips. Working from the board pattern you have just drawn, connect an ohmmeter to convenient points and identify the transistors as npn or pnp.

You are now ready to sketch out the circuits. The first go-around will produce a messy diagram. So at this stage I bring up a scratch pad and give myself a lot of room. Take the transistor you have labeled "Q1" and draw its symbol. Trace out its base, emitter and collector circuits as you go. Draw in parts symbols where you find them. Identify them by their designators or you'll lose track in a hurry. Pay some attention to their positions in the diagram, but don't use too much time now trying to make a neat schematic. Look for dc supply lines, ground, bias lines, etc.

Now study the rough diagram you have just made. Look for familiar circuits. Mentally move things around; make a few tentative sketches.

After you've got it in mind, put a neat sketch of the diagram below your circuit-board arrangement. Put in the parts list. It should now look like the sketch in Fig. 1. After you've done a few you'll be surprised at how quickly you can draw up a board. Put your drawings in a three-ring binder or manila folder for safekeeping.

I have about 250 boards like those shown. I have diagramed 40 varieties so far, with about 30 to go. So you can see that there is a real diversity of circuits. There are flip-flops, Schmitt triggers, oscillators, ac and dc amplifiers, regulated power supplies, diode gates, NOR gates, along with a lot of weirdies. It can become an education. I wouldn't want to say this is the most exciting way to use up an evening, but I have found a number of valuable uses for the boards and I consider the time well spent.

## Applications, too!

Let's talk about how to use 'em after you've got 'em. I take two approaches here. Some boards stand right out and yell to be used. One glance says this is an amplifier, that is a flip-flop. Then there are the others. You hope the circuits are a credit to the inventor, but you can't say for sure.

The first category is set aside, waiting for the day I want to use one in the manner for which it was designed. I usually have to replace some or all the components, and work in a few jumper wires on the back of the board. It's rare luck when you can hook one up to a power supply with no changes whatever and turn on the switch, though it does happen.

The second category is used when the circuit to be assembled doesn't sufficiently resemble any of the boards available or where I only need a small portion of a board and don't want to goof up a better circuit. The example application of Fig. 2 illustrates the situation where only a few components in an unconventional diagram are needed. This board ended up in the regulated power supply, Fig. 3.

I have used a dozen or so of the boards. Some of the results are illustrated in the photographs. The boards do make a difference. With a small investment of time and effort, you can really dress up your construction projects with a professional touch that only the printed-circuit board can give. END

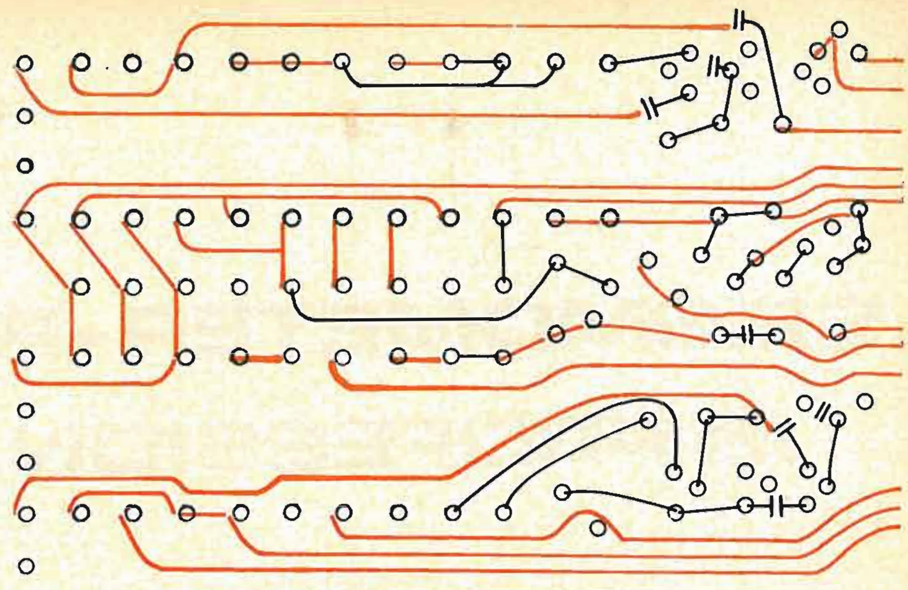


*Fig. 2-a—In modifying a board, some connections must be broken, as indicated by the contactor-like symbols. b—(drawing below) Layout of the portion of the board that was used.*

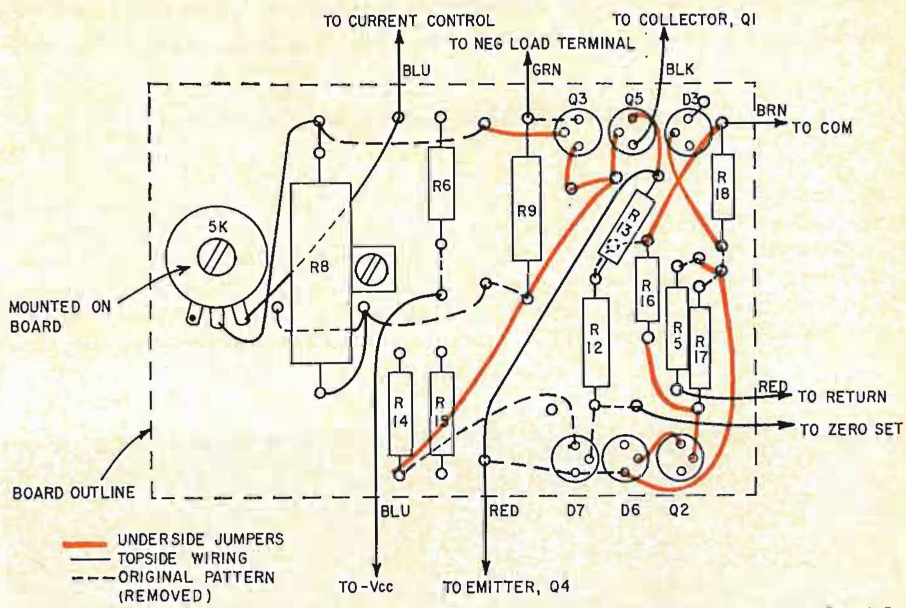
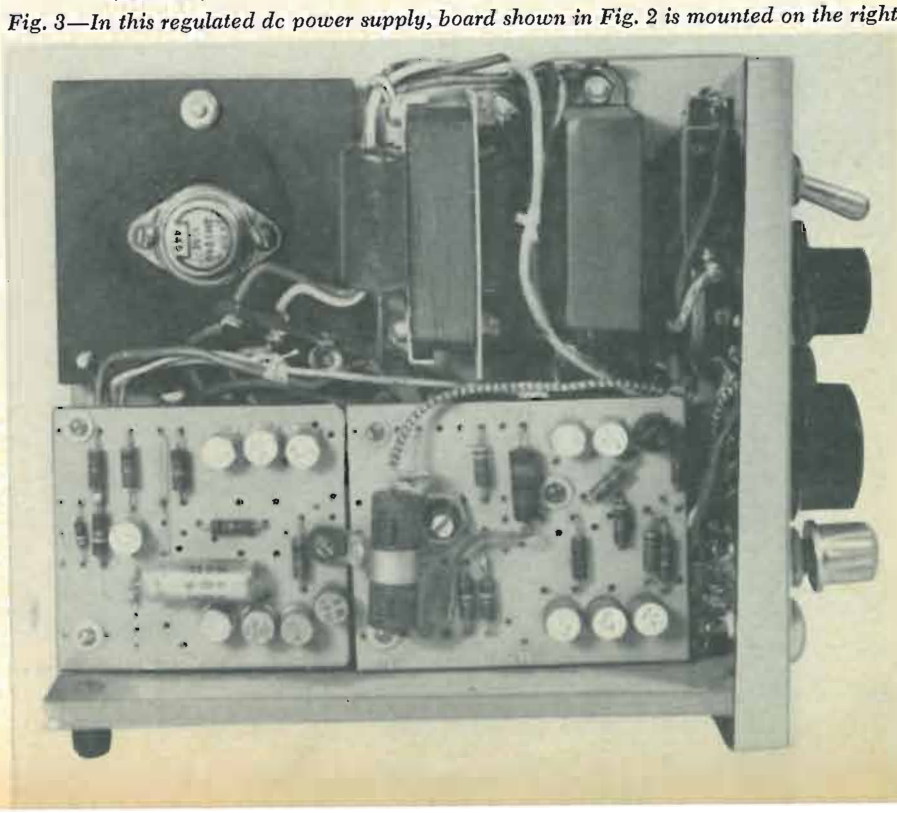



*Fig. 3—In this regulated dc power supply, board shown in Fig. 2 is mounted on the right.*



# SEISMOMETER-RECORDER IS PROFESSIONAL TYPE

**You can use this instrument, along with the low-frequency amplifier described in a previous construction article, to measure and record the intensity of earthquakes and tremors. Readout is by means of a chart**

**By EARL HANSEN and MERLE MONIA**

THE SEISMIC AMPLIFIER STORY WHICH appeared in the September 1966 issue of RADIO-ELECTRONICS only briefly mentioned the seismometer, marker clock, and recorder. These three items must be used with the amplifier if you wish to record distant earth disturbances. The cost of building them is very much less than the cost of similar commercially available units. *However, the builder must have access to machine tools and the know-how to use them.*

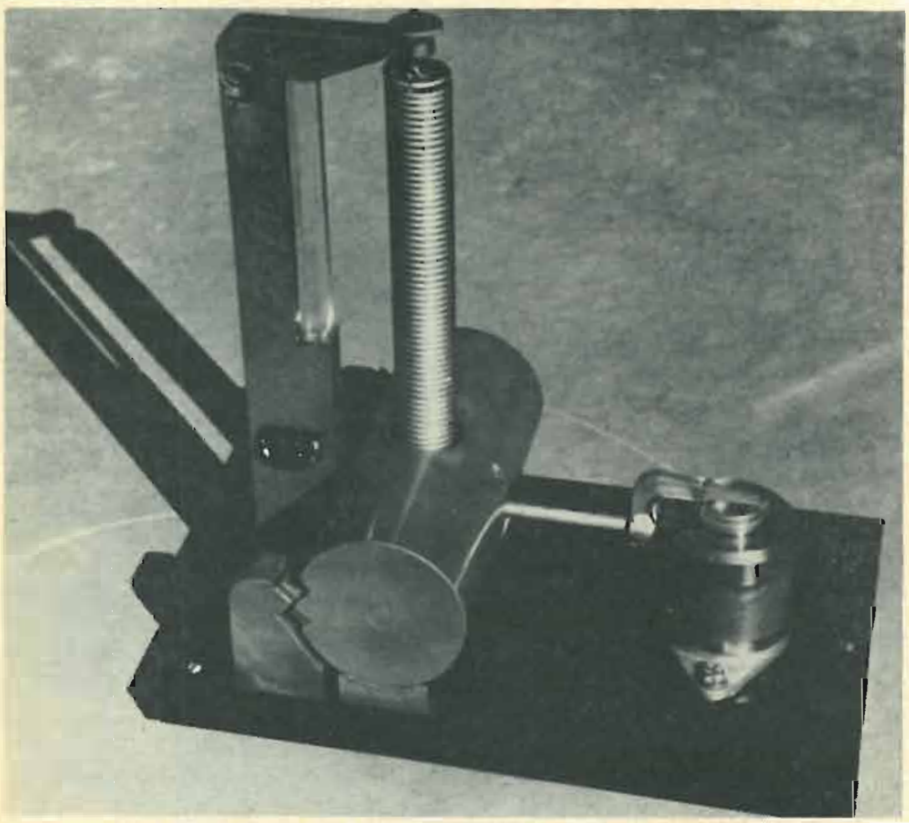


*Photo A—With careful construction, this seismometer can approach lab performance.*

He must also be able to improvise parts and dimensions not specifically detailed in this story. Space permits only basic hints and information. The experimenter can often make good use of items he has on hand, though they may not resemble closely the ones we used.

The seismometer, shown in Photo A and Fig. 1, is a vertical responding instrument. This is the most generally satisfactory axis of response for single seismo operation. The mechanical resonance period of the mass and spring is adjustable from 1 to 3 seconds per cycle. This assures response to very low frequencies, considerably below the resonance period rate. The reduced output below the resonance point is partially compensated for by the rising low-frequency response of the seismic amplifier. Actual oscillation of the mass is greatly reduced by a relatively low-resistance damping load on the coil (part of the amplifier's input circuitry). Output voltage from the seismo coil is typically less than 100 $\mu$V for a moderately distant tremor.

### Construction: mass and springs

The mass is made from an 8-inch piece of thick-wall (½-inch) tubing, 3¾ inches in diameter, filled with lead. A piece of steel plate was pressed into one end, the lead poured in, and the other end covered with another sheet, for appearance. The pivoting of the spring within the mass must have very low friction. The pivot knife edges are made of hardened steel. The pivot is a hook-and-eye affair, with the contacting surfaces ground to knife edges. Tool steel is used, so the edges can be hardened. The suspension spring threads over a round piece of iron, into which the hook is threaded (Fig. 2-a). The seismo's natural period of oscillation may be varied by changing the vertical position of the pivot point with respect to the center of the mass. The adjust-

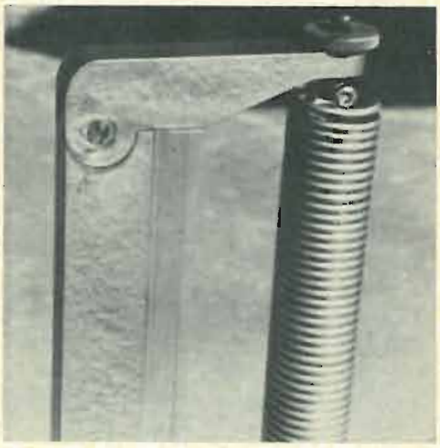


Photo B—Top adjust and pivot detail.

Photo C—Pivot springs/mass positioning.

Photo D—Closeup of the sensing coil.

ment at the top of the spring (Fig. 2-b) is to center the coil in the gap.

The seismo mass weighs about 30 lb. All the mass weight is suspended on the large spring. The pivot springs serve as a low-friction zero-movement point and do not support any appreciable weight. The sensor coil movement is three times that of the center of the mass. The coil moves in an air gap of 4,000 gauss. The suspension-spring support is pivoted and rests on a piece of acrylic (Photo B). This provides temperature compensation for the spring, and keeps the coil within the gap over a wide temperature range. As the spring

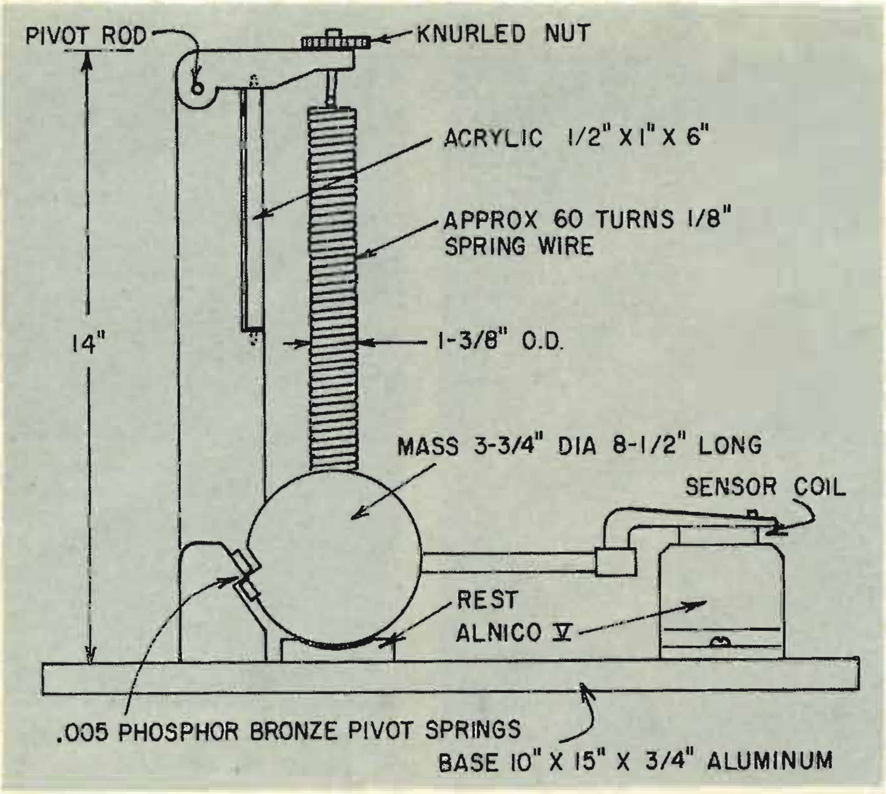



*Fig. 1—This end view of the seismometer shows the heart of the instrument—the mass which responds to movement of the earth. Movement of mass is then coupled to sensor.*

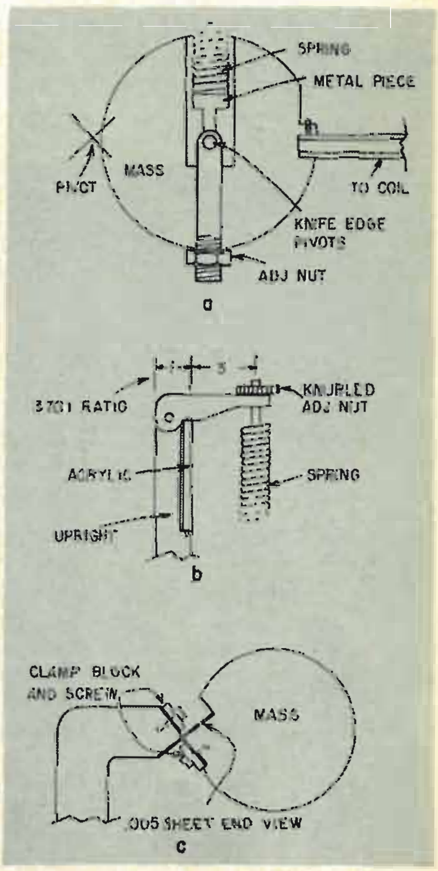



*Fig. 2-a—Detail of suspension-spring mounting and bottom adjustment. b—Top adjustment. c—Mounting of pivot spring.*

expands with heat, lowering the mass, the acrylic expands and presses upward against the hinged spring support, to keep the mass centered on the pivot springs. The acrylic is positioned a quarter of the distance from the pivot to the spring suspension. Rest blocks are provided under each end of the mass. These are necessary when installing the pivot springs, suspension spring, and when transporting the instrument. They provide a stop for the mass for large shocks.

The pivot springs (Fig. 2-c) are made from 5-mil phosphor bronze sheet, 7/16 inch wide, and long enough to be clamped under the blocks. There are two springs at each end of the mass, at right angles to each other (Photo C). About 1/16 inch is exposed, with the ends being clamped.

The suspension spring is wound of 1/8-inch spring wire with an initial tension slightly less than the 30-pound weight of the mass. This allows the greatest number of turns in the shortest spring length, while supporting the mass.

### The sensing unit

The sensor coil (Fig. 3-a) is wound on a turned form of acrylic, with about 3,900 turns of No. 36 enamel wire. The dc resistance is about 500 ohms. The coil supporting bracket and coil form must be nonmagnetic.

Fig. 3-b is the sensor magnetic assembly. The Alnico V magnet should be remagnetized after assembly into the

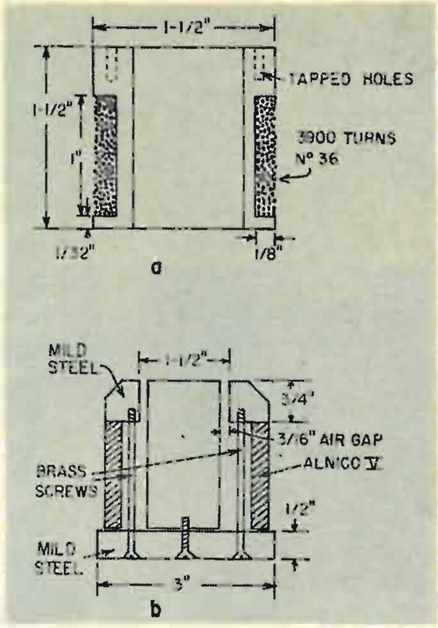



*Fig. 3-a—How the sensing coil is made. b—Cross-section of sensing-magnet unit.*

pole pieces, to be sure of the maximum gap flux density. If the special equipment is not available, it will probably be satisfactory as is. [From Photo D, it would appear that an old PM speaker would furnish the magnets, as well as the raw material for the pole pieces.—*Editor*] The leads from the coil to the rear of the mass are insulated wire; 4-inch loops of No. 36 enameled wire extend from the hinged side of the mass to the terminal strip on the post.

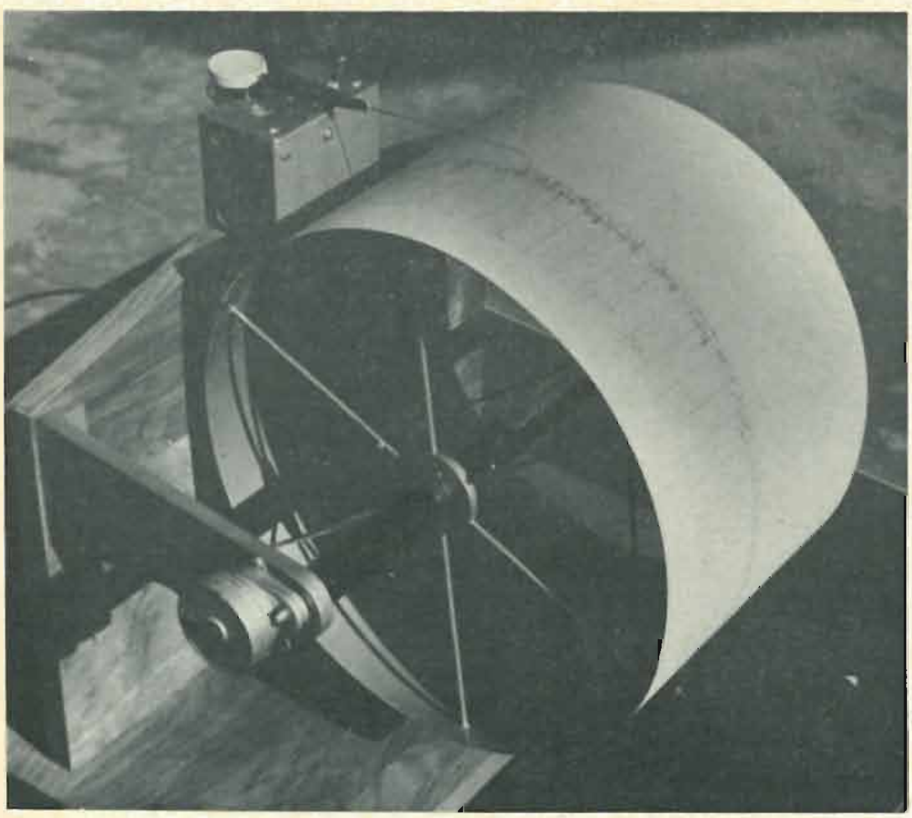
The basic recorder (Photo E) is similar to those used extensively in industry and research. The unique feature of this instrument is the large drum and feed screw which provide maximum recorded information on a moderate-size sheet of plain paper. One change of paper lasts 2 days, without crowding the recorded traces. Time of disturbance may be easily interpolated to the nearest 10 seconds. The recorder has a sensitivity of 5 mA from center to either side extreme (half of full scale). The recorder's frequency response is much higher than any signals that can be passed by the amplifier, and of course extends down to dc.

### Recorder and pen

The recorder unit has a sheet-metal drum, 8 inches wide and 12 inches in diameter. It is driven by a Cramer timing motor turning 1 revolution per hour. A lead screw of 8 pitch per inch inside the tubular shaft (Photo F) moves the drum laterally 1/8 inch per turn.

The pen-motor coil (Fig. 4-a) is wound of 600 turns of No. 40 enamel wire on a 2 x 2¼-inch form. The coil cross-section is about ¼ x 1/16 inch, and the coil is made self-supporting with epoxy. The form is removed after the epoxy sets.

The bottom of the coil is supported by a ½-inch length of music wire which serves as a torsion spring to return the



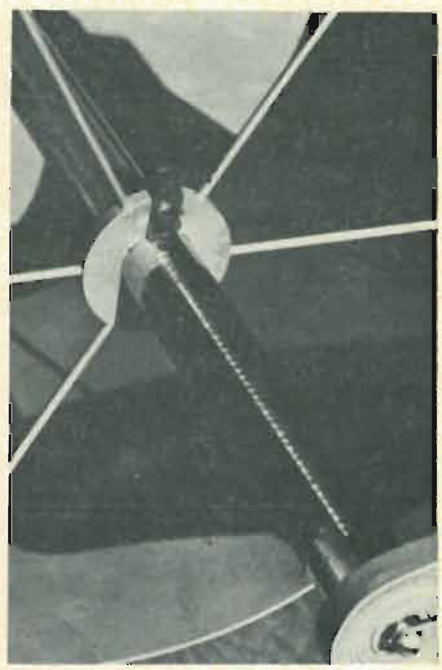


*Photo F—Drum shaft is slotted so follower will contact the stationary lead screw.*

*Photo E—Recorder assembly. White object on pen unit at rear is ink-supply well.*

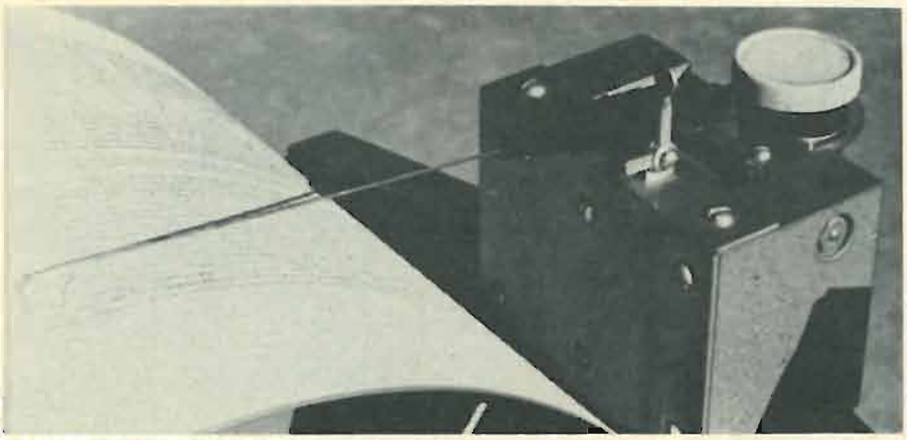


*Photo G—Closeup of pen motor assembly. Upright lever lifts recording pen off strip chart.*

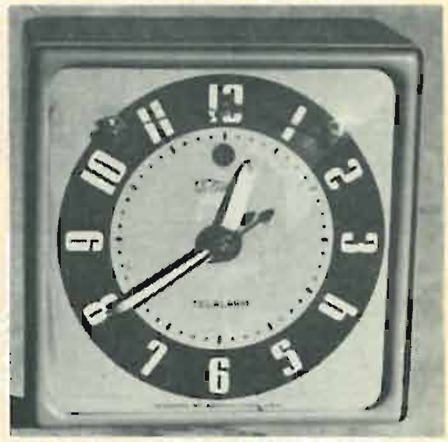


*Photo H—Clock marks minute and hour.*

arm to center. The top of the coil has a steel rod which fits into a brass bearing, and on which the pen assembly is mounted (Fig. 4-b).

The pole pieces (Fig. 4-c) form a ⅛-inch gap on each side for the coil, providing an overgrown meter movement. The pen arm (Fig. 4-d) is hard stainless-steel tubing 6 inches long mounted on the top of the coil. Its light sheet-metal housing is pivoted so the tip rests lightly on the recording cylinder (Photo G). The ink is fed to the tube through thin-wall plastic tubing from an inkwell on the rear of the pole-piece assembly. The drum and pen motor are mounted on a wooden base. Small flexible leads are used for electrical connection to the coil.

### Installation and results

The seismo is best placed on a large hard mass, such as concrete. It should, of course, be located as far as possible from roads or large machinery. The line from the seismo to the amplifier may be several hundred feet long if a twisted shielded pair is used. Connect one end of the shield to the seismo frame and the other to the amplifier ground. The coil leads should not be grounded.

The marker clock can be made from almost any type of electric clock. Two contact springs are installed and insulated from the frame. See Photo H. The second and minute hands each contact one spring momentarily, each time around, at the 12 o'clock point. These contact closures make the minute and hour marks for the recorder.

Fig. 5 shows a recording of a serious earth disturbance later found to have originated in the Gulf of California on December 22, 1964, and several hours of relatively uniform local disturbances known to have been caused by earth-moving equipment about a quarter of a mile away. Note the relatively straight line in the center of all the confusion. That came while the earth movers were taking time out for lunch, just before the Gulf disturbance, which was great enough to cause the recorder to hit the limit stops. The recordings were made with the gain on the amplifier (September 1966, page 54) set to position 5 and the filter on 4. END

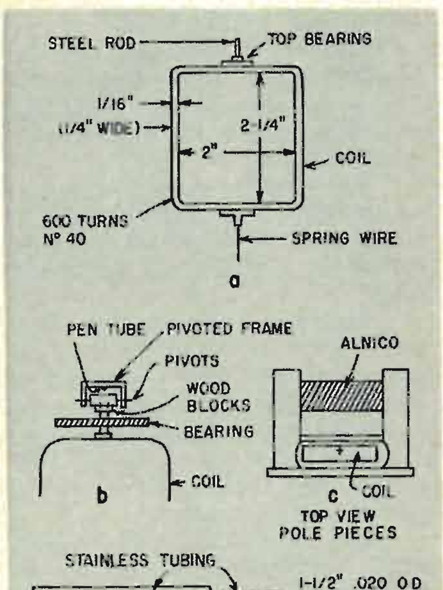



*Fig. 4-a—The pen motor coil. b—How the pen is mounted. c—Top view of the magnetic assembly. d—Recorder pen detail.*

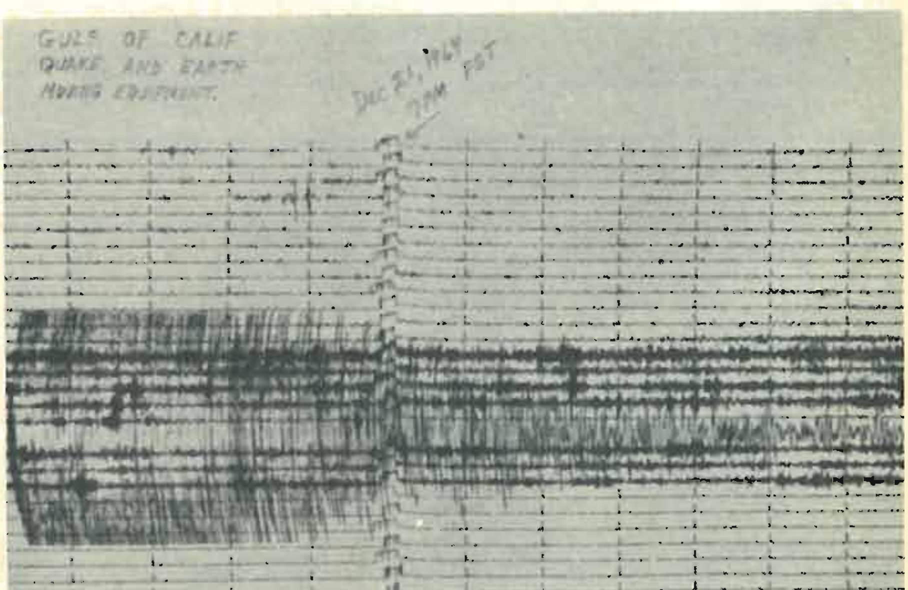
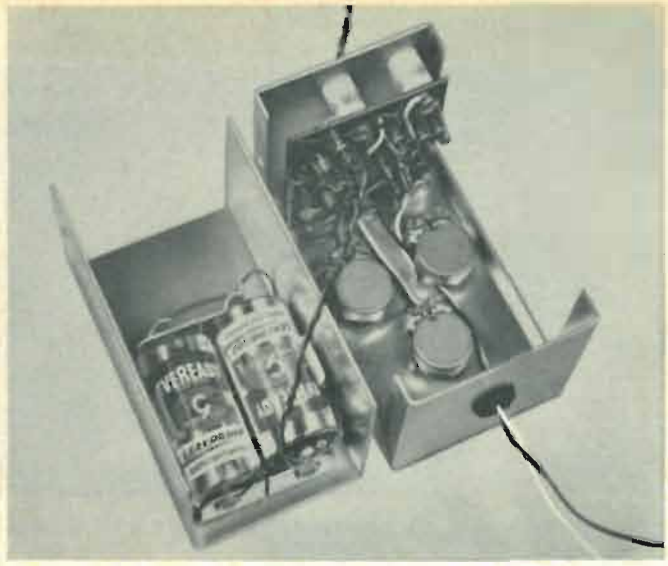


*Fig. 5—Result of careful construction of sensor and amplifier—seismographic record of tremor in Gulf of California on December 22, 1964. Disturbance began at 12:55 pm, nearly 18 hours after the 7 pm marker, and just after the smooth "lunch time" line.*



*Output of high-impedance adapter connects to regular input of vom, while clip leads couple adapter input to measured circuit.*

*Perforated board, at top, can be used for easy mounting and wiring of components. Battery holder is attached to box lid.*

# High Input Impedance for Multitesters

**Change your ordinary 20,000 ohms-per-volt meter so it doesn't load hi-Z circuits**

**By J. H. PHELPS**

THE ADVENT OF TRANSISTOR CIRCUITRY, with its higher current, lower voltage levels and lower impedance levels, has not eliminated the need for high-impedance voltmeters. Converting a good-quality vom to high impedance is a practical way to fill the occasional need to measure voltage in sensitive circuits without affecting the result by drawing significant current through the meter.

The circuit shown draws 1 $\mu$A for full-scale deflection on the 1-volt scale and 100 nA for full-scale deflection on the 10-volt scale; it provides an input sensitivity of 1 megohm per volt.

The dc amplifier is a two-stage differential amplifier using high-gain silicon transistors. It has a zero adjustment and a full-scale adjustment for both voltage ranges.

The differential connection assures temperature stability. Zero-position drift during warmup does not occur as it does in vacuum-tube voltmeters. Standby current drawn from the two 1.5-volt batteries is only several tenths of a microampere, so no on–off switch is required.

The amplifier connects to the meter through pin or banana plugs. The amplifier will work with most multitesters having a 60–100-$\mu$A basic movement.

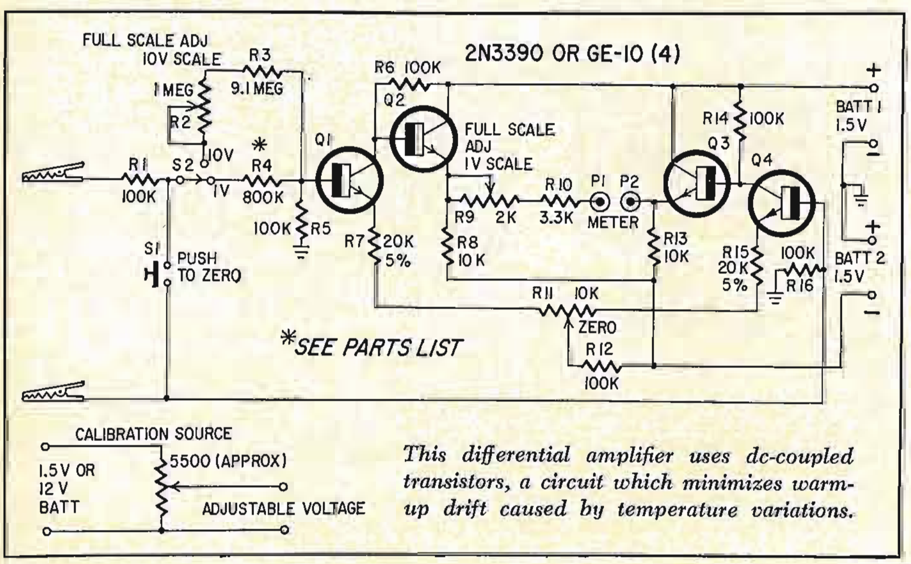
After power is applied, zero is adjusted by shorting the input terminals and setting the 10K pot (start near the center of rotation). Next, the 1-volt scale is set. A low-voltage source may be devised using a 1.5-volt battery and a pot of 100–500 ohms. Set it (using the parent vom) to 1 volt.

The 10V scale can be calibrated with a 12-volt car battery and the same 500-ohm pot. Be sure to select a pot in the range specified. If a lower value is used, make certain that heating of the pot is not excessive. The 10V-scale pot is adjusted to correspond with the vom voltage reading of the calibration source.

END

**PARTS LIST**

R1, R5, R6, R12, R14, R16—100,000 ohms
R2—pot, 1 megohm
R3—9.1 megohms, 5%
R4—800,000 ohms (selected 820,000-ohm resistor or 732,000- and 68,000-ohm 1% resistors in series)
R7, R15—20,000 ohms, 5%
R8, R13—10,000 ohms
R9—pot, 2,000 ohms
R10—3,300 ohms
R11—pot, 10,000 ohms
S1—spst normally open pushbutton switch
S2—spdt toggle switch
Q1, Q2, Q3, Q4—2N3390 or GE-10 (G.E.)
BATT 1, BATT 2—1.5 volt C- or D-cells
P1, P2—Pin or banana plugs to match multitester
Miniature utility box, perforated board, test leads, miscellaneous hardware




*This differential amplifier uses dc-coupled transistors, a circuit which minimizes warm-up drift caused by temperature variations.*

# SIMPLE ELECTRICS

**Those seemingly abstract electrical quantities we work with are as real as inches, hours or pounds**

**By ROBERT G. MIDDLETON**

WHAT ARE WE TALKING ABOUT when we say that 2 volts will push 1 ampere through 2 ohms of resistance? These are conventional dimensions with which we measure the things we deal with in electronics. And "if you can measure a thing, you know it," as any television troubleshooter will tell you.

Electric quantities—voltage, current, charge, resistance, capacitance, inductance—are the foundation of electronics. But what are these so-called electric quantities? It is highly frustrating to use these dimensions unless we understand what volts and amperes and coulombs and ohms and farads and henrys are, and where they come from.

### Where it all starts

Simple electrics are a part of ordinary physics, and our familiar physical units go back to Newton's laws of motion. As we learned (or forgot) in high school, things remain at rest or continue in a state of uniform motion (like a satellite in "free fall") unless they're acted upon by some external force. Force is equal to mass times acceleration. In other words, if you want to move a thing you have to apply a force to it. The amount of force you have to apply depends on two things: the mass of the object you are moving, and how fast you are accelerating it. (The reason we say "accelerate" instead of "move" is that once you get a thing moving at a certain rate it will keep on moving at the certain rate unless friction, gravity or some other force slows it down and stops it.)

So force is equal to mass times the rate of change in velocity. Suppose you have a drag racer that accelerates smoothly from a standstill to 100 mph in 20 seconds. Obviously, your acceleration is equal to a rate of change in velocity of 5 mph per second. At the end of each second you are traveling 5 mph faster than you did the second before.

We see that the basic quantities in this law of motion are length (distance), time and mass. Believe it or not, these same basic quantities apply in electronics. We may consider, for convenience, that the mass of an object is equal to its weight. This is not true for satellites between the earth and Mars where an object of considerable mass can be weightless, but we will keep our feet on the ground for present purposes.

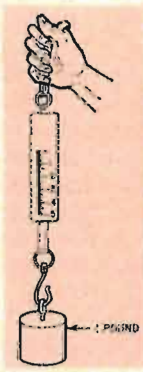



*Fig 1—The practical unit of mass is the pound (in the US, UK and Canada). On the surface of the earth at the equator, 1 pound of mass weighs 1 pound. It weighs slightly more at the poles. Ultrasensitive spring balances are constructed and then used with known masses to measure the intensity of the earth's gravitational field at any point.*

Of course, our choice of basic physical units (meters, seconds, etc.) is not really fundamental except in a practical sense. Nature knows nothing of miles, pounds (see Fig. 1), or hours. We have bundled distance, mass and space into units that are convenient to us—the length of our own feet, for example. (One unit, the meter, was supposed to be a natural one, a 10-millionth of the distance between the earth's surface and its center, but the scientists who made the original calculation didn't get quite the right answer.) Physicists have guessed that the truly basic units of nature are the electrons and the quantities of mass and energy associated with them. But no physicist would go further than to say this is a shrewd guess.

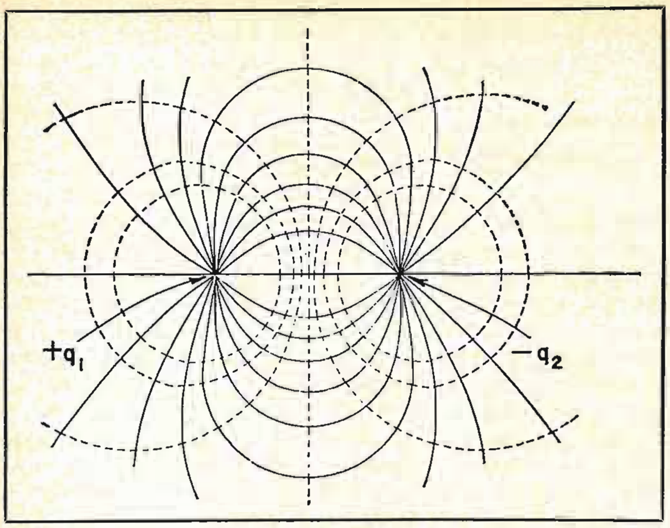
Even though we cannot claim sure access to the absolute in nature's scheme of things, we feel that we are quite practical in expressing physical units in terms of length, mass and time—foot, pound, minute (or better, if we want to calculate with them—meter, kilogram, second). We are not so familiar with the units of force, even though we throw around terms like watts or horsepower. For calculations, the fundamental unit of force is the *dyne*, the unit that will accelerate a mass of 1 gram 1 centimeter per second per second. Since in electronics, we deal mostly with forces, this is an important quantity to us.

In the realm of electricity, Coulomb's law is as fundamental as the law of mechanics: $F = ma$. Coulomb observed how the force between two electrical charges varies with the distance between them. He determined the law that the force between two charged bodies varies inversely as their distance and directly as a product of the two charges. $F = \frac{q_1 q_2}{r^2}$, where F is the force of attraction or repulsion, $q_1$ and $q_2$ are the quantities of charge, and r is the distance between the two charges (Fig. 2). The force is attractive if the charges are positive and negative, and repulsive if both charges have the same sign. But it is the same strength in either case.

### Getting down to dimensions

So what is all this about? We have shown that electricity can be defined in terms of force and distance. The electric charge q is a given number (mass) of electrons, and the force depends on how large these groups of electrons are and how far away they are from each other. Let us put this into units. The fundamen-


*Simple circuit symbolizes basic principle of electric current flow between two points.*



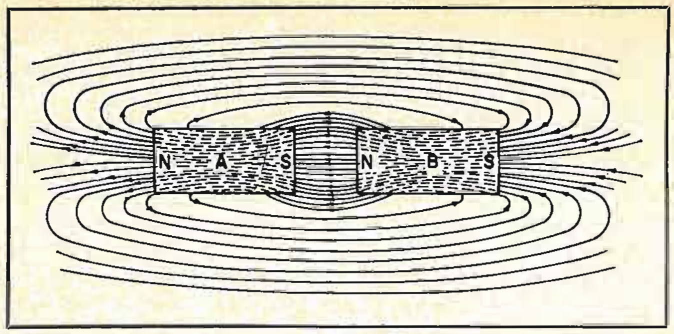




*Fig. 3—Nobody knows what magnetism "really is." We can define the magnetic poles N and S only in terms of the force which exists between them when separated a given distance.*

*Fig. 2—Coulomb's Law: If $q_1$ and $q_2$ are each equal to 1 coulomb of electric charge, and the distance between them is 1 centimeter, the force that they exert on each other is 1 dyne.*

tal electrostatic unit (esu) of electric charge is called a *statcoulomb,* and is that quantity of electricity which exerts a force of 1 dyne on an equal charge 1 cm away. This is a fundamental electric unit, but a little small for practical use. We have accepted the coulomb as the practical unit of charge. It is equal to $3 \times 10^9$ statcoulombs. If a coulomb passes a given point in one second, the current is 1 ampere. So we have defined charge in terms of length and mass. Time enters when we define current flow.

#### Magnets, too

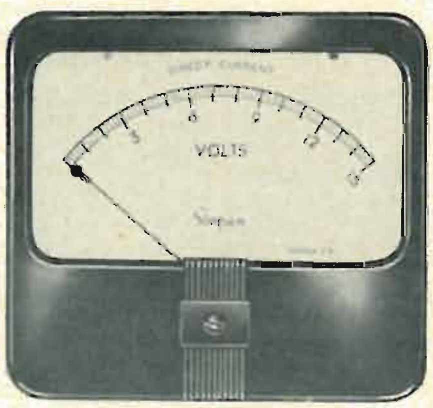
The electromagnetic unit (emu) of magnetic charge was defined, also by Coulomb, in the same way. The *unit pole* is one that will repel a like magnetic pole or attract an unlike pole 1 centimeter from it with a force of 1 dyne (Fig. 3). So magnetism also has the dimensions of time, length and distance (remember that time enters into the dyne—it is a force that will accelerate a gram 1 cm per second in 1 second). Incidentally, we use the magnetic unit in practical work. One unit pole creates a flux density of one line per square centimeter, and flux is measured in lines per square centimeter, or *gauss.*

#### The units we use

But we are chiefly interested in practical units, like volts, amperes and watts. We already have one: the coulomb, a quantity of electricity (or a number of electrons—$6.28 \times 10^{18}$, if you wish). And we have more or less defined the ampere in terms of mass and time in defining the coulomb. An ampere is the rate of current flow when 1 coulomb passes a given point in 1 second.

Potential, or electromotive force, is the force required to move a charge of electricity from one point to another against whatever force is acting against it in an electric field (in technicians' language, to get it "above ground"). In fundamental terms (esu's) the figures mean little to the practical man, but: *1 volt is that amount of electric potential required to transfer 1 coulomb of charge between two points (Fig. 4) by the expenditure of 1 erg of work.*

So, as soon as we find out what an erg is, we will know the volt. The erg is a unit of work, and is better known to the electrical man as a part of a watt. It also goes back to the fundamental units of force, distance, and time; the erg is a dyne-centimeter, or the work done when a force of 1 dyne is applied through a distance of 1 centimeter. When 1 erg of work is performed in 1 second, this constitutes 1 erg/second of power. $10^7$ erg/seconds equals 1 watt.



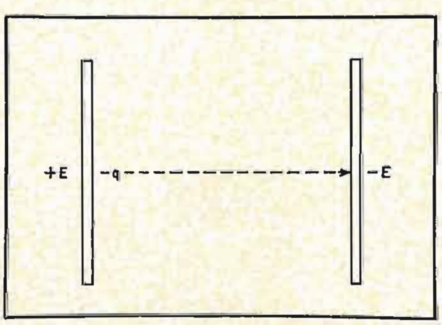




*Fig. 4—Voltmeters are calibrated in electric potential—work that must be done to move charge q from point +E to point −E.*

The unit of capacitance is a description of an electric container, rather than a directly electrical unit. But we use it and are interested in it. The unit of capacitance is the farad, the size of capacitor that will store 1 coulomb of electricity with a potential of 1 volt across its terminals. So you can trace that back to time, distance and force, too.

Inductance and resistance are measured by the force required to drive electrons through them. Inductance is related to time: *When a current change of 1 ampere in 1 second in a circuit magnetically induces in the circuit an electromotive force of 1 volt, the circuit has an inductance of 1 henry.* And if 1 ampere flowing through a circuit produces a continuous drop of 1 volt across it, that circuit has a resistance of 1 ohm.

These dimensions of electrical quantities not only give us a better idea of their significance but also show how they are defined in a particular system of measurement. (Dimensions change from one system of electrical measurements to another. This is inescapable because these dimensions have the essence of definitions, and it has been found convenient to define electrical quantities somewhat differently in the various systems of measurement.)

We have started with *fundamental* electrostatic and electromagnetic units and shown how they are related to those we use in practical work. And although simple electrics is not difficult, we see that we have to know our physics, and we have to mind our p's and q's. Electronics becomes more interesting when we see how it is tied into the laws of mechanics. Electronics grows out of mechanics, and dimensional analysis shows us this process of growth. END

# The Ground—Is It Grounded?

**You too can learn this simple, do-it-yourself way to get erroneous resistance readings—it's easy to overlook what you take for granted**

**By JACK DARR**

THE HORIZONTAL OSCILLATOR'S NOT working right; plate voltage off. Measure resistances in plate circuit (Fig. 1). Aha! Zero resistance across R52. Bad resistor. Replace it.

Huh? Same symptoms? Same *voltages?* Measure resistor just removed. Hmm . . . 56K, just what the schematic calls for. What's going on here? An intermittently shorted resistor, that healed up when we took it out? Ohmmeter gone bad all of a sudden? Check test resistor, 1 meg at 1%, kept for the purpose. Nope. Ohmmeter right on the nose! Well, what *is* it, then?

We have just been led up the garden path by a common, but often unnoticed, phenomenon. One that I've run into many, many times in the past, cursed, but never traced out till lately. Many of us are led astray by this thing, unless we understand just what causes and know how to avoid it.

The hidden cause of these readings is built into the ohmmeter section of most vtvm's: the case of the instrument is at ground. In many jobs, all test instruments are grounded: cases connected together and returned to a common ground. This is a common safety measure, and a very good one.

When we take resistance readings in B+ circuits of a TV chassis (for example) the ground lead of the ohmmeter must of necessity be above ground (Fig. 2). If there is another path to ground, we'll find that we can get some very peculiar readings, since this path is in parallel with the resistor we're measuring!

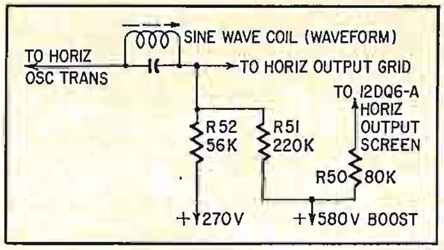



*Fig. 1—R52 was the guilty (?) resistor.*

This other path is automatically completed if we leave anything else connected to the chassis under test—ground leads of other instruments, the antenna lead-in, the ac line cord (one side of the ac line is *always* ground, remember?). So, when we hook up our ohmmeter, we get something like Fig. 2. Now, we have at least two paths back to chassis, and some pretty weird resistance readings.

### Parallel-circuit theory

For instance, here's what we got in an actual check on the circuit of Fig. 1. In each case, we checked the resistor, then reversed the ohmmeter prods and took a second reading: R51 (actually 220K), 25K/185K; R52 (56K), 56K/0; R55 (80K), 14K/70K. (Incidentally, the ohmmeter of a vom showed the right resistance across each one.)

We made these tests with the ac line cord plugged in—set not turned on, of course! Reversing the line cord made no difference. But when the line cord was pulled out of the socket, the vtvm ohmmeter read the same as the vom.

This effect is worse in transformerless sets, such as the Truetone 2DC-1030A we took Figs. 1 and 2 from. In such circuits, we have a permanent path to chassis from one side of the ac line. On the other side, we have several "directional" components—selenium or silicon rectifiers, electrolytic capactitors.

In testing any of these parts by itself we expect a difference in reading when the ohmmeter prods are switched (ohmmeter polarity reversed). In a circuit, we get the same thing. In many cases, the various paths come out in parallel, and the total resistance to ground is pretty small. For example, measuring from the ac line plug of the Truetone to chassis, we got zero on one prong, and 14K on the other. From B+ to ground, we got about 6K.

This even shows up in sets with power transformers, although we tend to think of those as completely isolated from the line. True, in that respect, but many sets use resistors from the primary connection to chassis! We checked three transformer chassis on the bench, just to see, and found resistors in all of them—from 100K to 470K. So, you'll get the same results, although not as bad, if you leave these sets plugged in while testing. Proof that this is the basic cause of the trouble: we hooked all our test sets up through an isolation transformer, and the effect disappeared completely!

### The old reliable

There is a simple cure for this problem. Just be very sure that *all* other connections are taken off the chassis before making any resistance tests. Quick-check, and a positive one: Leave the ground lead of the ohmmeter completely off, and jab the "hot" lead of the ohmmeter to the *chassis* of the set you are testing. Set the ohmmeter on about a ×1K scale, since this is where the effect is the worst. It's also the scale you'll

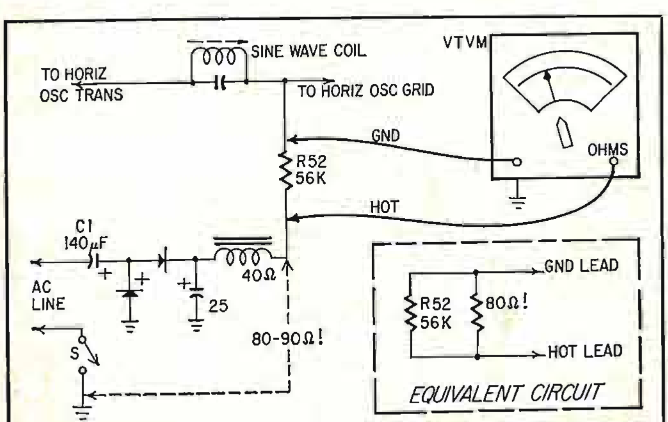
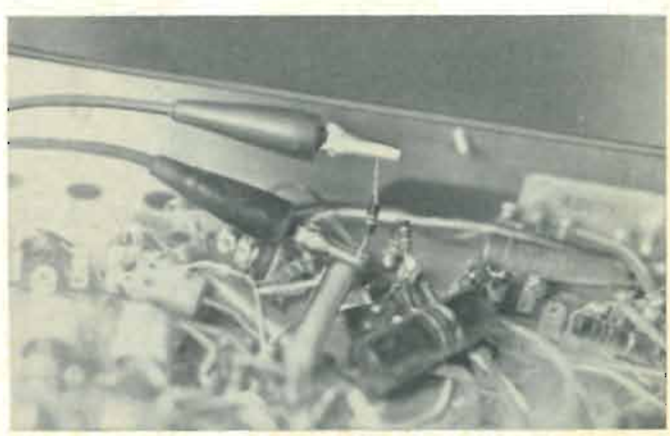



*Fig. 2—Why we get funny readings—unseen ground returns.*

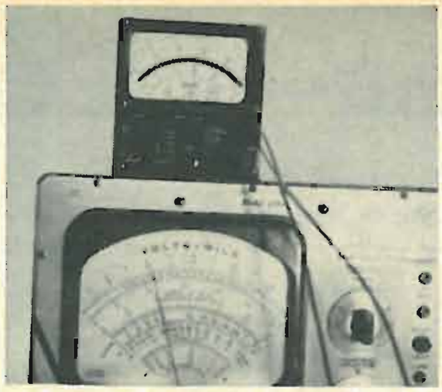


*Measure resistor with one end disconnected from the circuit.*

use to check large resistors in the B+, agc, etc., circuits. If a parallel path exists, you'll see a deflection on the meter. This can range from zero up to about 20,000 ohms, on the ones we've checked.

Even on power-transformer sets, you will find this true. Reversing the ac line cord makes no difference on ac-dc's but will kill the effect completely on transformer sets! That is because the resistor is connected from one side of the primary to chassis, and is isolated by turning off the switch.

If you get any reading at all, on a high ohmmeter scale, without the ohmmeter ground lead hooked up, you *still* have something hooked up to it that shouldn't be. Find it, and get it off! If you don't, you're in for another trip up the garden path, and more wasted time.



*Why this difference in meter readings? The vom is isolated, but the vtvm isn't.*

The photo shows the best method, especially for those circuits where parallel paths abound: agc circuits, B+ networks in stacked-i.f. stages, and so on. Open one end of the resistor; connect the ground lead to the end still in the circuit, and your hot ohmmeter lead to the open end. No matter what kind of connections you have, you'll get the exact value of the resistor *that* way!

(If you must know, the real trouble in the horizontal oscillator circuit mentioned in the introduction turned out to be a bad tube!) END

# Handy Way to Adjust Bias

**By DANIEL R. VON RECKLINGHAUSEN***

IF YOUR AMPLIFIER IS TO OPERATE WITH LOW DISTORTION AND with good efficiency, it must have the proper supply voltages and a selected zero-signal current. This requirement is severe in push-pull output stages, and more severe in class-B than in class-AB or class-A operation.

Since tubes vary from unit to unit, their bias voltage has to be adjusted for proper zero-signal current. Customarily, this current is measured with a dc milliammeter, or with a voltmeter reading the voltage drop across a small-value resistor inserted in one of the supply leads of the output stage. This simple zero-signal current-test circuit has been developed for use when a suitable meter is not available.

In the circuit of H. H. Scott model 200-B amplifier, tubes V2 and V3 (Fig. 1) are the push-pull output stage for the left channel. B+ voltage is supplied to the screen grids and to the plates through the center tap of the transformer. Grid bias is supplied from the B− supply through bias adjustment potentiometer R211 and resistors R36, R37, R38 and R39. Cathode current for both tubes flows from ground by way of resistors R45, R46 and R40. Components for the right channel are identical in value and function.

*Chief Research Engineer, H. H. Scott, Inc.

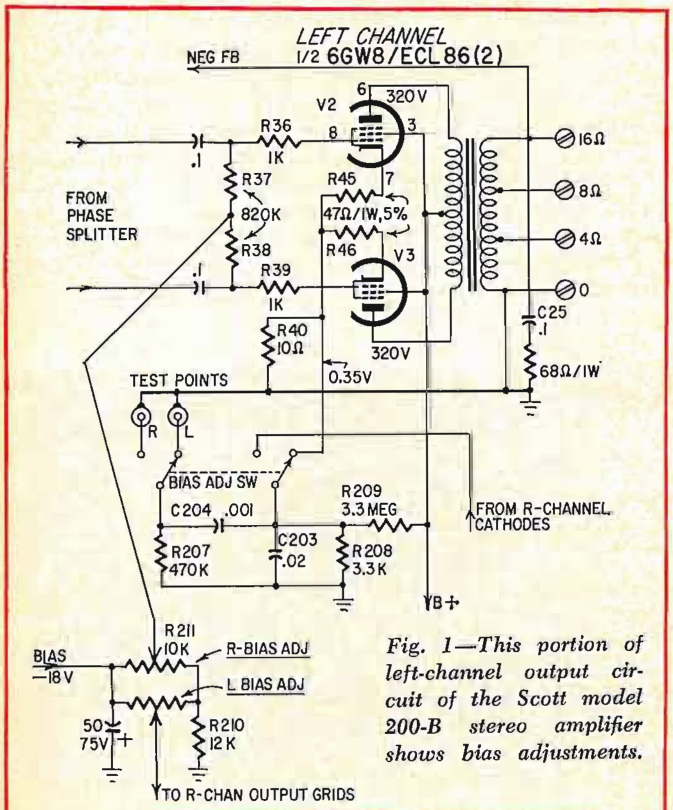



*Fig. 1—This portion of left-channel output circuit of the Scott model 200-B stereo amplifier shows bias adjustments.*

Tubes V2 and V3 are connected in parallel and may therefore be represented as an equivalent adjustable resistance R. The value of R is equal to the tube's voltage drop divided by the total cathode current.

As shown in the simplified schematic of Fig. 2, resistors R40 and $R_L$ can be regarded as two arms of a resistance bridge, the other two arms being reference resistors R208 and R209. (Similarly $R_R$, R140, R208 and R209 form a second bridge.) When the cathode currents are properly adjusted (which makes resistor $R_L$ or $R_R$ its desired value), there will be no voltage difference and the bridge is balanced.

A jumper must be connected between the test point of the channel being adjusted and the *input* of the other channel.

If the cathode current is not adjusted properly, a voltage difference will exist. When the BIAS switch is closed, the voltage difference will become zero, and this changed voltage is transmitted as a pulse through capacitor C204 and the other section of the bias switch to the LEFT test point. This pulse is amplified to produce a click in the right-channel loudspeaker.

The bias-adjustment switch is nonshorting, i.e., the contacts break before they make. The values of capacitor C204 and resistor R207 are chosen so that C204 can fully charge or discharge in the switching interval. Therefore, repeated switch operation will cause audible clicks as long as the bridge is out of balance. Proper adjustment of bias control R211 is thus possible by setting for minimum click loudness.

The second half of the bias adjustment switch is included so that current in either output stage may be adjusted. The clicks due to the left output-stage adjustment go only to the left test point, and clicks for the right-channel adjustment go only to the right-channel test point. In either case, the opposite channel is used as the click amplifier. END

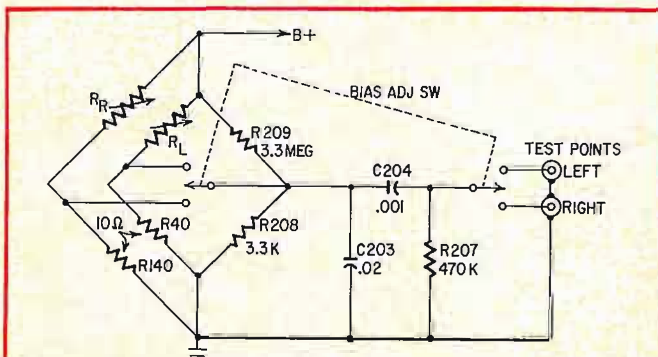



*Fig. 2—Simplified circuit of dual bridge used to adjust bias.*

# Sensitive Electronic Relay

**Easy to build, this unit requires less than a microwatt for triggering**

**By REGINALD W. NEALE**

HAVE YOU EVER WISHED FOR A relay with high input impedance that required negligible input power? If an occasional project seems to need something special, this device may be it! It features a low, stable pull-in voltage. Hysteresis—the difference between pull-in and drop-out levels—is reduced to less than 1% of input voltage.

Ordinary electromagnetic relays don't even approach these specs. Commercially available solid-state relays are expensive, and usually require substantial amounts of driving power. They are also subject to failure if their ratings are even momentarily exceeded.

The device described here satisfies the requirements quite well by using a novel circuit to drive a conventional relay. The resulting electronic relay is inexpensive, but remarkably precise and reliable.

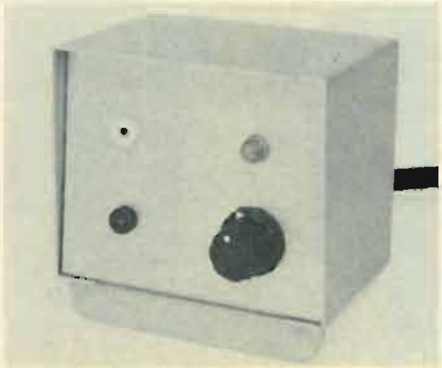
Pull-in voltage is about 1 volt. Input impedance is 1.2 megs; input power less than 1 μW. Compensation is provided for temperature and line-voltage variations. Almost any sort of transducer can be used to activate the relay circuit. Ac-powered loads such as motors or lamps can be controlled precisely by thermistors, photocells, etc.

The characteristics of this circuit are due to two silicon controlled switches (SCS), which are related to the silicon controlled rectifier. In addition to the cathode gate used by an SCR, the SCS has an anode gate, which can trigger it with a negative-going pulse. Once triggered, the SCS will continue conducting until its anode voltage is momentarily reduced to zero.

Fig. 1 shows the circuit. Q1 provides the high input sensitivity and low hysterisis. Q2 supplies the electronic "snap-action" that operates the mechanical relay positively. The anodes of both SCS's are fed by 10–20 volts ac from transformer T.

As the input voltage at point A reaches a level which will trigger Q1, usually about 1 volt, the SCS will latch *on* during each positive half-cycle and turn off during each negative half-cycle. Fig. 2 shows the Q1 anode-voltage waveform for this condition.

The steep negative step, which occurs in Q1's anode waveform as the switch suddenly conducts at turn-on, is



*Front view of electronic relay is an indication of its simplicity, small size and utility.*

coupled by C1 to Q2's anode gate. Q2 triggers, and C2 charges to about 20 volts. As the supply voltage crosses zero, beginning the negative half-cycle, Q2 stops conducting. The charge on C2 holds the relay in and keeps the anode of Q2 negative, preventing it from turning on again until most of the charge has leaked off through the relay coil. When C2 has nearly discharged, Q2's anode will no longer be reverse-biased. If Q1

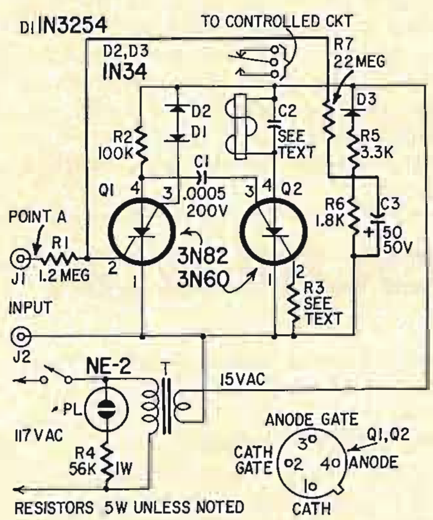



*Fig. 1—Heavy-line components compensate for effect of line-voltage fluctuations.*

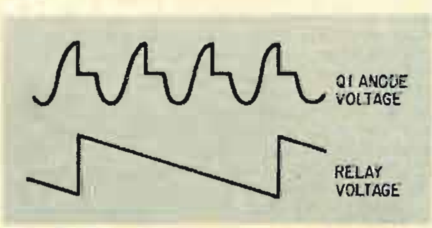



*Fig. 2—Waveforms show circuit function.*

is still coupling pulses to Q2's anode gate, Q2 will latch on, recharging C2 for another interval. This sequence, repeating about every third or fourth positive half-cycle, keeps the relay actuated as long as the input voltage remains above Q1's triggering level.

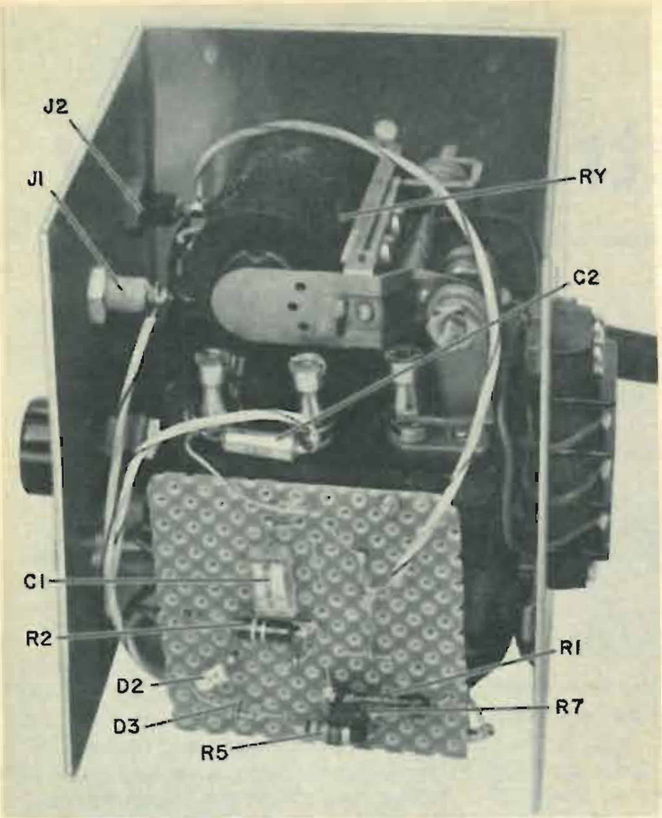
In some applications, the exact value of trigger voltage may be critical. Two refinements help maintain a stable operating point. The components shown in heavy lines in Fig. 1 compensate for line-voltage fluctuations. Increased line voltage would ordinarily allow a smaller dc input to trigger Q1. D3, R5, R6 and C3 develop a small negative bias and feed it to Q1's cathode gate through R7. This compensating bias changes with line voltage, and offsets any effects on sensitivity.

Temperature compensation is provided by diodes D1 and D2. Reverse leakage in D2 is all that reaches Q1's anode gate on positive half-cycles. A positive voltage reverse-biases the anode gate, making it more difficult for Q1 to trigger. Since diode leakage increases with temperature, it helps cancel cathode-gate sensitivity changes that occur with higher temperatures. "Bargain-type" diodes work well in this application, since their leakage doesn't hurt anything. Variations in SCS characteristics may make it necessary to alter voltage divider R6-R7 slightly for optimum temperature compensation, and you may have to hand-pick D2.

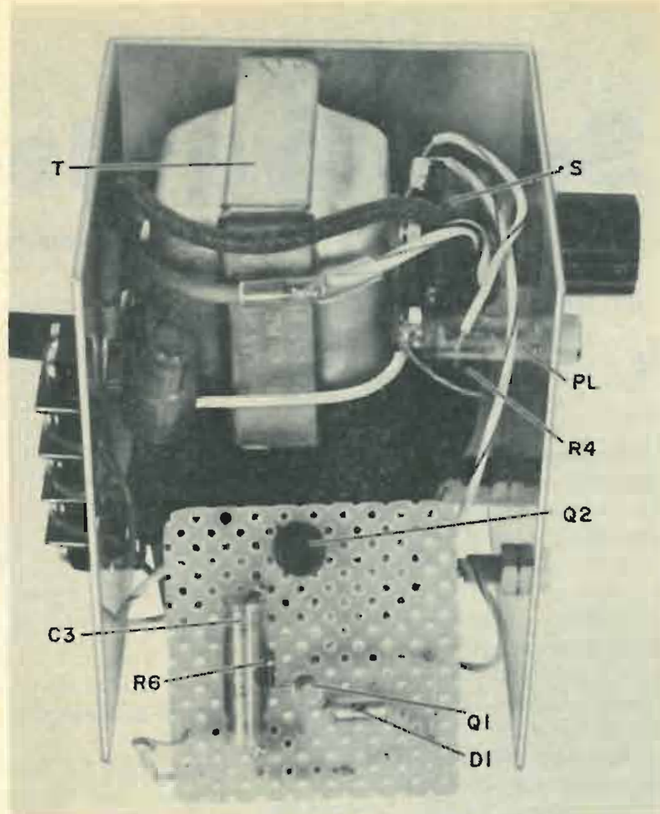
Construction technique is not critical. The unit shown in the illustration has small parts mounted on a perforated circuit card. The "doorbell" transformer, relay and other hardware are fastened to the 3 x 4 x 4-inch cabinet.

**Parts List**

C1—.0005 μF, 200 volts
C2—see text
C3—50 μF, 50 volts
R1—1.2 meg, ½ watt
R2—100,000 ohms, ½ watt
R3—see text
R4—56,000 ohms, 1 watt
R5—3,300 ohms, ½ watt
R6—1,800 ohms, ½ watt
R7—22 meg, ½ watt
Q1—3N82 (G-E)
Q2—3N60 (G-E)
D1—1N3254 or equivalent
D2, D3—1N34 or equivalent
J1, J2—pin jacks
S—spst on-off switch
T—door-chime transformer, 117/15 volts ac, Foster Transformer Co. catalog No. 15C or equivalent
RY—Struther-Dunn relay type 112XAX spst (C2 = 6/8 μF) or P & B KRP 11D dpdt (C2 = 100 μF)
PL—neon indicator lamp, NE-2 or equivalent



*Most of the components are mounted on the perforated board.*



*Solderless connector (wire nut) is to the left of transformer T.*

Relay contacts are brought out to a terminal strip at the rear of the cabinet.

The original unit used a rather expensive Struthers-Dunn relay, but others can be substituted. The alternate relays in the parts list have the advantage of heavier dpdt contacts. Moderately sensitive relays having a dc coil resistance of more than 200 ohms can be used, with the value of C2 depending on coil resistance. Response time also depends on the relay. It's typically 20–50 msec for pull-in and 100–200 msec for dropout.

If the relay actuates in the absence of a signal, or does not actuate when a signal is applied, try changing the value of R3. Optimum value for different SCS's ranges from 100 meg down to 100K. [R3 was omitted and Q2's cathode-gate circuit was open in the unit shown in the photos.—*Editor*]

As the input voltage approaches the triggering value, a few millivolts of noise superimposed on the signal can cause the relay to trip. The noise can be from a nearby appliance being switched on or off, from stray 60-Hz hum fields, etc. As with any high-sensitivity, high-impedance device, maximum performance may require external noise-reduction techniques.

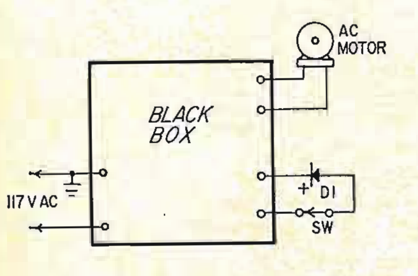
The completed instrument may be used for any application in which a feeble sensing signal at some predetermined level must switch a heavy load. It's a natural for automatic control of battery chargers, lighting systems, heating elements, chemical processes and humidifiers. END

# WHAT'S YOUR EQ?

**Conducted by E. D. CLARK**

## Diode Motor Control?

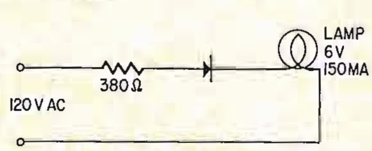
This black box is powered by a 117-volt ac line and has an ac-motor




load. If the switch is opened or the diode D1 reversed, the motor does not run. The box contains four components; no tubes, transistors, relays or resistors are used. Can you determine these components?—*Thomas Mayfield*

## Too-Bright Lamp

A 150-mA, 6-volt pilot lamp is to be powered from a 120-volt, 60-Hz power line through a dropping resistor. In an attempt to reduce power dissipation in the resistor, a diode is added to allow conduction only on half-cycles. This resistor is 380 ohms which, without the diode, would allow 300 mA to flow on each half cycle.




Addition of the diode should cut the average current in half, to 150 mA. However, the lamp burns too brightly and fails. What's wrong?—*Donald E. Phillips* END

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

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

**Answers to this month's puzzles are on page 105.**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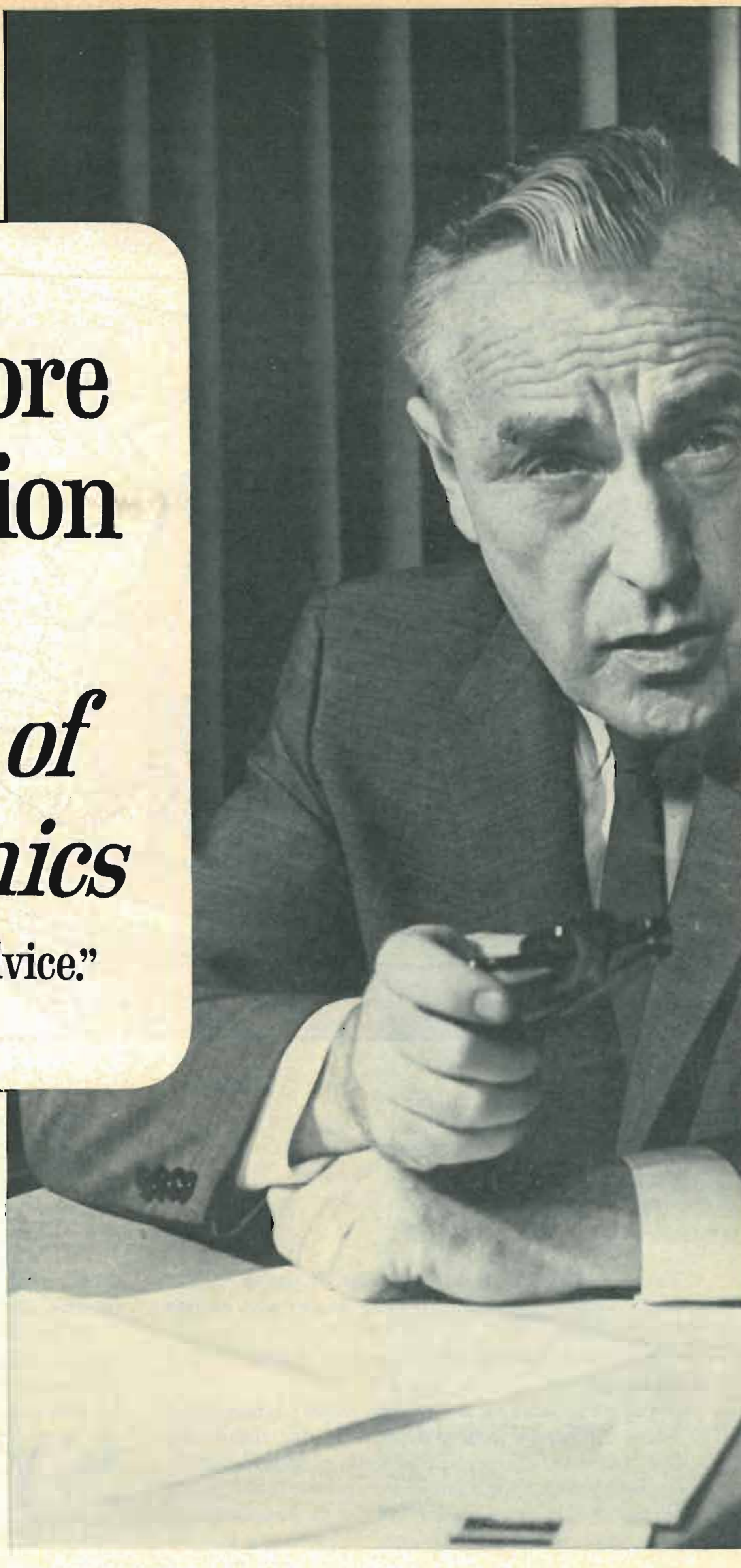
*Circle 28 on reader's service card*

# "Get more education or *get out of electronics*

...that's my advice."



*Don't just take our word for it...*

# READ WHAT THE EXPERTS HAVE TO SAY ABOUT THE NEW knight-kit® TAPE DECK


## Knight-Kit 4-Track Stereo Tape Deck With Solid-State Stereo Record-Playback Preamp

Unmatched performance, quality and value! And so easy to build, too. You need only follow simple, illustrated, step-by-step instructions to assemble six solid-state plug-in modules. The Viking tape transport, built to Knight-Kit specs, is completely preassembled.

When you complete your Knight-Kit Tape Deck you'll enjoy stereo of unsurpassed realism, plus monophonic sound of highest fidelity . . . plus many features found only on professional quality decks: Separate monitor switch with monitor-level controls, mixing facilities, exclusive low impedance stereo headphone amplifier module, bias test oscillator, switch-selected sound-on-sound and echo, push-to-reset digital counter for quick indexing of recorded selection, easy-edit head cover, studio-type VU meters for accurate control of record and playback on each channel, and more.

Complete with all parts, instructions and 7" take-up reel (less base and tape) . . . . . . . . . . **$249.95**

**Read the unique money-back guarantee below . . . exclusive in the industry . . . then rush the coupon at right for full details and Special Introductory Offer.**

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Build a Knight-Kit in accordance with our easy-to-follow instructions. When you have completely assembled the kit, you must be satisfied or we will return your money, less transportation charges, under the Allied guarantee of satisfaction.

**ALLIED RADIO**

### Excerpts from Hirsch-Houck Laboratories Equipment Test Report in July, 1966 HI FI/STEREO REVIEW:

"Until quite recently, it was rare to find a tape recorder selling for less than $400 to $500 that could record and play back an FM radio broadcast with such fidelity that it could not be distinguished from the direct broadcast. The Knight-Kit KG-415 satisfies this requirement of a true hi-fi tape recorder, yet costs only $249.95.

Wow and flutter, 0.02 and 0.09 per cent, respectively, at 7½ ips, were negligible and significantly bettered the Knight rating of 0.2 per cent. The KG-415 worked flawlessly, producing recordings which at normal listening levels could not be distinguished from the original FM program. Other recorders can do this, too, but they generally cost $500 or more. The Knight KG-415 is, without a doubt, one of today's best values in tape recorders. It is made to order for the hobbyist on a budget who will not compromise his quality standards."

### From April, 1966 AMERICAN RECORD GUIDE:

"At $249.95 FOB Allied Radio in Chicago, this recorder is not inexpensive. Still, I think it is remarkably cheap considering what it is and what it provides in the way of features and qualities.

It took me 14 leisurely hours to build the unit—start to finish . . .

Right off the bat, this kit performed right up to, or better than, all its specifications. I am jaded enough not to impress easily, but this got to me.

It all comes down to this in the end: the test bench indicates that this KG-415 should sound good. And it does."

### From January, 1966 AUDIO:

"This is a kit which is a perfect delight to profile for two reasons—it was a pleasure to construct it, and it performed so well after it was completed.

At the relatively low price of $249.95 plus some 20 hours of pleasurable work, we think the KG-415 is an excellent buy."

### From March, 1966 ELECTRONICS ILLUSTRATED:

"When the job is complete the builder has a deck of unquestioned high quality with all the functions and conveniences of a professional model. A comparable factory-wired deck would cost upwards of $400.

The instruction manual is well done, being logical and easy to follow.

Our KG-415 met or exceeded all Knight's specs."

### From March, 1966 POPULAR SCIENCE:

"Judging by the almost flawless way it records and reproduces sound, the Knight-Kit KG-415 stereo tape deck costs a full third less than it's worth."

**ALLIED RADIO, Knight-Kit Div.**
**Dept. 2-KK, P. O. Box 8528**
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Please rush Special Introductory Offer on the **Knight-Kit KG-415 Tape Deck.**

Name ____________________
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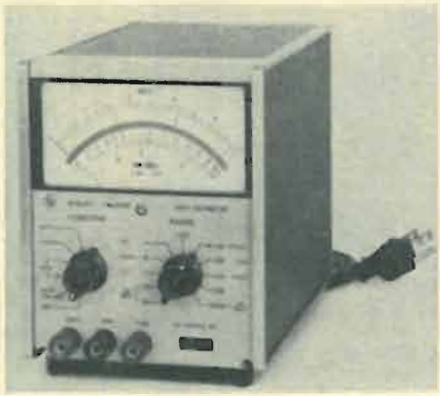
*Circle 30 on reader's service card*

# EQUIPMENT REPORT

## Hewlett-Packard 427A Multi-Function Meter

*Circle 32 on reader's service card*

FOR A TEST-EQUIPMENT-HAPPY TYPE like me, it's a real joy to have the chance to evaluate a fine unit like the Hewlett-Packard 427A Multi-Function Meter. The manufacturer of this little jewel specializes in laboratory test equipment, most of which the average service technician seldom sees. The 427A, however, has been designed to provide laboratory accuracy within the price range of ordinary shop-type instruments.



The 427A is a compact instrument —only 5 x 6 x 8 inches—with king-sized qualifications. It can read dc voltages from 100 mV to 1,000 volts full scale, ac volts from 10 mV to 300 volts full scale, and resistance from 10 ohms to 10 megs, center scale. A dBm scale permits reading ac voltage values in dBm (0 dBm = 0.775 volt across a 600-ohm load). A conversion chart in the comprehensive instruction book is used to obtain accurate readings when the load is of any other value and to convert directly from dBm to dB or from dB to dBm.

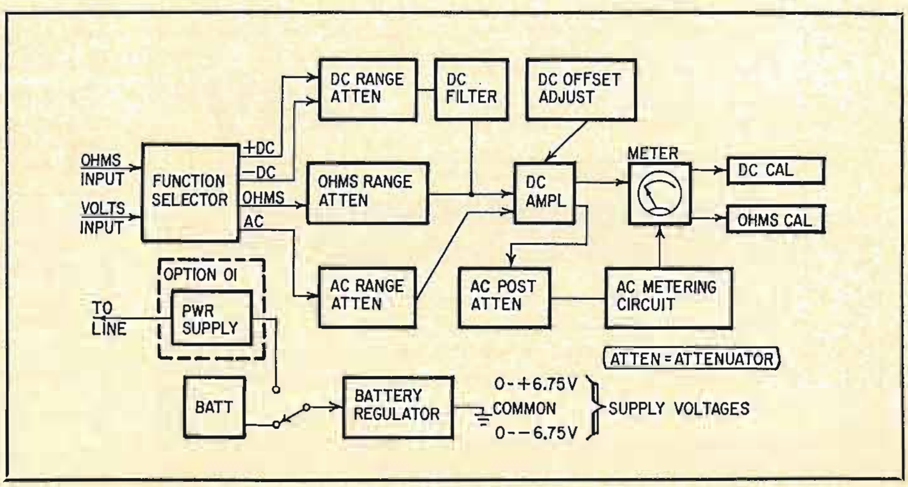
Input impedance is 10 megs on all ranges, and accuracy is ±2% of full scale on all ranges. The instrument will withstand accidental overloads as great as—to quote the manufacturer—"not more than 300 volts on the 0.1-volt scale and 425 volts on scales over 1 volt." An accessory capacitive voltage divider (1,000:1) will extend the ac voltage range to a maximum of 25 kV.

The voltage sensitivity of this little instrument is amazing. On dc-volt scales, you can see a .002-volt (2.0 mV!) deflection of the meter. On ac-volt scales, more so than that: you can see a deflection of .0002 volt (that's *two-tenths* of a *millivolt!*). This range is so sensitive you may have trouble getting the needle to stand still. With unshielded test leads lying on the bench, I noticed what appeared to be an erratic meter deflection. It turned out the leads were picking up rf voltage from a radio station over a mile away! However, when the test leads were hooked into the i.f. section of a transistor radio, the indicator needle was stable. The low-impedance circuitry damped things down so that there was no trouble. For best results in very low-level work, however, shielded test leads probably should be used.

The range of scales is very useful for low-voltage work; it's likely the designers had transistor circuits in mind when they chose them. Only two basic scales are used, 0-1 and 0-3. This provides center-scale readings of 0.5, 5, 50 and 500 volts, and 0.15, 1.5, 15 and 150 volts, etc.

I had an assortment of transistorized items on the bench when the 427A arrived, and it's really a pleasure to work with in troubleshooting transistor circuits. It's especially handy for reading bias voltages down in the tenths-of-a-volt range.

The ac voltage scales are useful for signal tracing. The manufacturer's specifications for this instrument indicate a frequency range flat from 5 Hz to 1 MHz, and within ±3 dB from 1 Hz to



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But do it now. This offer is good only for equipment purchased between September 1, and November 15, 1966. To allow for postal delay, we will honor cards received up until December 1, 1966. Here's your chance to equip your shop for color servicing while we train your people for FREE!

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almost 4 MHz. While I didn't verify the spec, I got very good readings while signal tracing through i.f. stages of radios —for audio frequencies, signal tracing's a snap. By feeding in a steady sine-wave signal, I could go through the audio stages and make about the fastest stage-gain checks I ever made. In fact, the first time, I found an open coupling capacitor in less than 45 seconds! I am *not* joking! I hooked an af signal to the top of the volume control, took three voltage measurements, and there it was. Signal here—no signal there.

In further checks, I got such typical readings as 10 mV on the base and 170 mV on the collector of an af-amplifier transistor; the drive stage showed 0.1 volt base and 1.2 volts collector, and so on. Such tests as these are as simple as making dc-voltage readings in a tube-type radio.

The 427A is battery-powered, using a standard 22.5-volt battery (Eveready 763, RCA VS-102, etc.) There also is an ac-powered version which functions on either ac or battery; a slide switch on the back selects the desired power supply. A five-transistor, one-Zener power-supply regulator circuit works even during battery operation and holds supply voltages to very close limits.

In the DCV position, the dc range attenuator (voltage divider) is connected across the voltage to be measured. In steps of 10 dB, the selected fraction of the input voltage is fed to the dc filter circuit. This rejects any superimposed ac, noise or whatever other non-dc signal might be present. In fact, this instrument will read dc voltages accurately, according to the manufacturer, even if there is ac present up to 100 times greater than full scale! One of the tests mentioned in the instruction-manual maintenance section involved applying 10 volts peak ac to the 0.1-volt dc range: the needle must not deflect more than 1 scale division (±1%).

In the dc amplifier an FET is used, because of its very high input-impedance characteristic. In this circuit, a dc-offset circuit compensates for the very minute (a fraction of a nanoamp) gate-leakage current of the input transistor, the presence of which could cause a few millivolts deflection on the meter during high-impedance dc measurements. A reverse-biased diode bucks this current. The compensating diode and the input transistor have nearly identical temperature characteristics, so the overall circuit remains compensated at all times. When an increased temperature causes the gate leakage to increase, the bucking current from the dc-offset circuit also increases.

On ac-voltage ranges, the input goes to a frequency-compensated attenuator and then to the dc amplifier. Feedback stabilization is used liberally on all ranges for maximum linearity.

Seven ohmmeter ranges provide center-scale readings from 10 ohms to 10 megs. The ohms scale reads from 0 to 50 full scale, and multiplier-switch positions (×*10*, ×*100*, etc.) cover the range. The only oddity, to those of us used to reading service-type ohmmeters, is the lack of a ×*1* scale. The lowest scale is ×*10*. After you get used to it there's no bother, and even a 10-ohm reading can be made easily.

The instrument uses a total of 12 transistors—all silicon types—and 2 Zener diodes. A 100-μA taut-band meter movement is used.

This is the kind of test equipment we're going to need in the near future. We're moving rapidly into a technology where precise measurements of very small voltages are going to be an every-day necessity. These aren't any harder than others to make, if we have the right kind of meter; and we'd better have, if we're going to survive. Remember, too, there's no such thing as an "expensive" piece of test equipment, if it will really do the job. This one certainly will.—*Jack Darr*

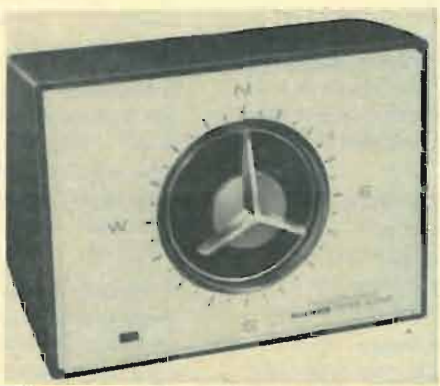
MANUFACTURER'S SPECIFICATIONS

**DC Voltmeter**—Nine ranges, ±100 mV to ±1,000V, full scale; ±2% accuracy, full scale (0°C to 50°C); 10-meg input resistance; permissible overload to 1,200V, any range.
**AC Voltmeter**—Ten ranges, 10 mV to 300 Vrms, full scale; accuracy .01V to 30V ±2% full scale from 10 Hz to 1 MHz, and 100V to 300V ±2% full scale from 10 Hz to 100 kHz; frequency response flat ±0.5 dB 5 Hz to 2 MHz, and ±3 dB 1 Hz to 4 MHz; 10-meg input impedance; permissible overload to 1V range, 300 Vrms and to ranges above 1V, 425 Vrms.
**Ohmmeter**—Seven ranges, 10 ohms center scale to 10 megs center scale; accuracy ±5% of reading at mid-scale (0°C to 50°C).
**Power**—22.5-volt battery; option 01 provides battery operation and ac operation, selectable by switch.
**Weight**—5.25 lb
**Price:** $195.00 with battery

END

## Alliance Solid-State Tenna-Rotor

*Circle 33 on reader's service card*



A totally electronic concept based on a *phase-sensitive* bridge is used in a transistorized control for the Alliance C-255 Tenna-Rotor automatic rotator for TV, FM, amateur and CB antennas. The control is self-syncing, controls the antenna within 3°, and is completely silent.

Fig. 1 shows the basic phase bridge that controls the electronic circuit. Arms BC and BD are halves of a center-tapped winding, part of the power transformer. The voltages across BC and BD are equal and 180° out of phase. Arm AC (R3) is a 511-ohm precision unit and AD consists of two 520-ohm rheostats, R1 and R2. R1 is the direction control in the control box, and R2 is the sensing resistor ganged to the rotor. The bridge is balanced when the sum of R1 and R2 equals R3.

If R1 is changed, the bridge is unbalanced and an error voltage is developed across terminals AB. If R1 is increased, the voltage will be in phase with voltage BC. If R1 is decreased, the error voltage is in phase with voltage BD. Thus, when the bridge is unbalanced, the voltage amplitude indicates the amount of imbalance and the phase indicates the direction.

Fig. 2 shows the basic circuit in more detail. The transistor is zero-biased and operated as an electronic switch. Its collector is fed through two paths—one through diode D1 and loads 1 and 3, the other through D2 and loads 1 and 2.

D1 and D2 supply pulses that are 180° out of phase, but negative with re-

*continued on page 76*

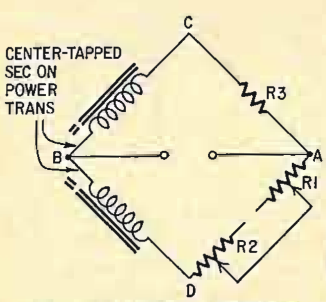



*Fig. 1—Basic phase bridge.*

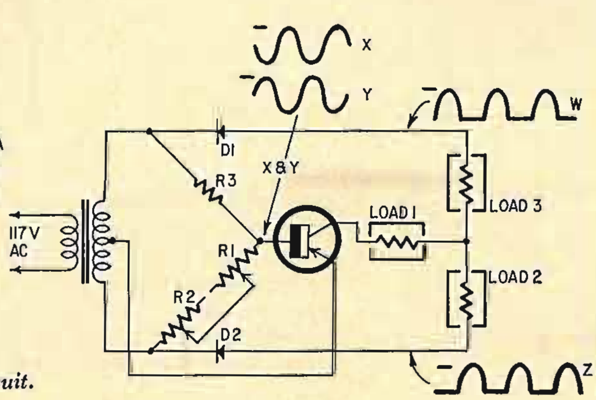



*Fig. 2—Simplified control circuit.*

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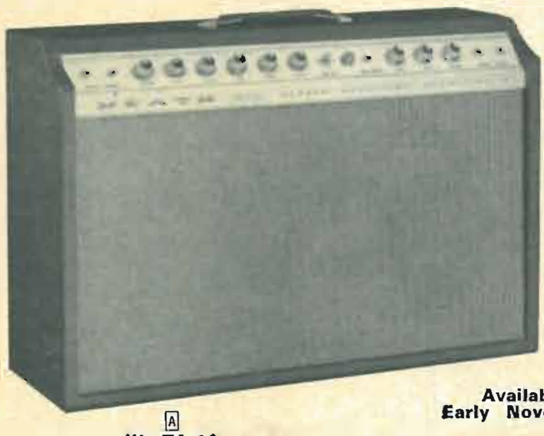

Available Early November

[A] Kit TA-16 **$129⁹⁵**

[B] Kit TG-46 **$219.95** (save $109.55)

[C] Kit TG-26 **$99.95** (save $45)

[D] Kit TG-36 **$119.95** (save $38.55)

**[A] NEW Heathkit Transistor Guitar Amplifier — Compare It To Units Costing Several Times As Much**
60 watts peak power; two channels — one for accompaniment, accordion, organ or mike, — the other for special effects . . . with both variable reverb and tremolo; two 12" heavy-duty speakers; line bypass reversing switch for hum reduction; one easy-to-wire circuit with 13 transistors, 6 diodes; 28" W x 9" D x 19" H leather-textured black vinyl cabinet of ¾" stock; 120 v. or 240 v. AC operation; extruded aluminum front panel. 44 lbs.

### Famous American Made Harmony-By-Heathkit Guitars

All guitars include instruction book, tuning record, pick, connecting cord, deluxe red leather cushioned neck strap and chipboard carrying case. All wood parts assembled and factory finished — you just mount metal parts, pickups & controls in pre-drilled holes and install strings.

**[B] Deluxe Guitar . . . 3 Pickups . . . Hollow Body Design**
Double-cutaway for easy fingering of 16 frets; ultra-slim fingerboard — 24½" scale; ultra-slim "uniform-feel" neck with adjustable Torque-Lok reinforcing rod; 3 pickups with individually adjustable pole-pieces under each string for emphasis and balance; 3 silent switches select 7 pickup combinations; 6 controls for pickup tone and volume; professional Bigsby vibrato tail-piece; curly maple arched body — 2" rim — shaded Cherry red. 17 lbs.

**[C] Silhouette Solid-Body Guitar . . . 2 Pickups**
Modified double cutaway leaves 15 frets clear of body; ultra-slim fingerboard — 24½" scale; ultra-slim neck for "uniform-feel"; Torque-Lok adjustable reinforcing rod; 2 pickups with individually adjustable pole-pieces under each string; 4 controls for tone and volume; Harmony type 'W' vibrato tailpiece; hardwood solid body, 1½" rim, shaded cherry red. 13 lbs.

**[D] "Rocket" Guitar . . . 2 Pickups . . . Hollow Body Design**
Single cutaway style; ultra-slim fingerboard; ultra-slim neck, steel rod reinforced; 2 pickups with individually adjustable pole-pieces for each string; silent switch selects 3 combinations of pickups; 4 controls for tone and volume; Harmony type 'W' vibrato tailpiece; laminated maple arched body, 2" rim, shaded cherry red. 17 lbs.

---

### Deluxe Heathkit® /Thomas "Coronado" Transistor Organ . . . Save Up To $350

Kit GD-983 **$849⁰⁰**

Versatile Enough For The Professional . . . Simple Enough For The Beginner. And yet you don't have to be an "electronics wizard" to build it nor a professional organist to play it. Features all genuine Thomas factory-fabricated parts . . . 17 voices, two 44-note keyboards, 2-speed rotating Leslie plus 2-unit main speaker system, 28 notes of chimes, 13-note heel & toe pedalboard, color-tone attack & repeat percussion, handsome handcrafted walnut cabinet & matching bench. Assembles in 70 hours. 242 lbs.

### Now Play In Minutes Instead Of Months . . . Heathkit® /Thomas COLOR-GLO Organ

Kit GD-325B **$394⁹⁰**

Color-Glo Key Lights Show You the correct notes and chords . . . you play melody, harmony and bass notes instantly . . . even if you've never played an organ before! When you're finished, just flip a switch and the key lights disappear, leaving a beautiful spinet organ. Includes 10 voices, repeat percussion, 13-note bass pedals, two 37-note keyboards, assembled walnut cabinet & bench and more. Fully transistorized. Builds in around 50 hours and you save up to $150! 172 lbs.

# Plus New FREE 1967 Catalog

**NEW Heathkit® /Magnecord® 1020 Professional 4-Track Stereo Tape Recorder Kit . . . Save $170**

Kit AD-16
**$399.50**
(less cabinet)

**Assembles Easily In Around 25 Hours . .** and you enjoy the $170 savings. Features all solid-state circuitry; 4-track stereo or nomo playback and record at 7½ & 3¾ ips; sound-on-sound, sound-with-sound and echo capabilities; 3 separate motors; solenoid operation; die-cast top-plate,flywheel and capstan shaft housing; all push-button controls; automatic shut-off at end of reel; two VU meters; digital counter with push button zero reset; stereo microphone inputs and headphone outputs . . . front panel mounted for easy access; individual gain controls for each channel; vertical or horizontal operation, plus a host of other professional features. Requires speakers and amplifier for playback. 45 lbs. Optional walnut base $19.95, adapter ring for custom or cabinet installation $4.75

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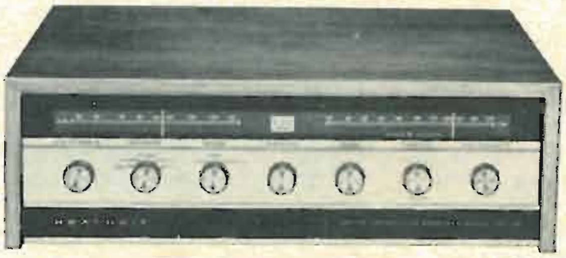
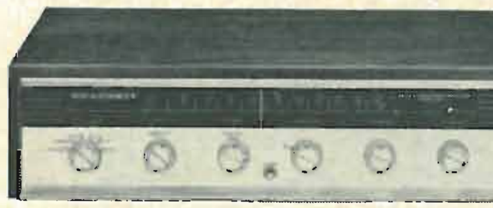
**66-Watt Solid-State AM/FM/FM Stereo Receiver**



**Just Add 2 Speakers For A Complete Stereo System.** Boasts AM, FM and FM stereo tuning; 46 transistor, 17 diode circuit for cool, instant operation and natural transistor sound; 66 watts IHF music power (40 watts RMS) at ± 1 db from 15 to 30,000 Hz; automatic switching to stereo; preassembled & aligned "front-end" & AM-FM IF strip; walnut cabinet. 35 lbs.

Kit AR-13A
**$184.00**

**30-Watt Solid-State FM/FM Stereo Receiver**



**World's Best Buy In Stereo Receivers.** Features 31 transistors, 10 diodes for cool, natural transistor sound; 20 watts RMS, 30 watts IHF music power @ ± 1 db, 15 to 50,000 Hz; wideband FM/FM stereo tuner; plus two preamplifiers; front panel stereo headphone jack; compact 3⅞" H x 15¼" W x 12" D size. Custom mount it in a wall, or either Heath cabinets (walnut $9.95, beige metal $3.95). 16 lbs.

Kit AR-14
**$99.95**
(less cabinet)

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**NEW 12" Transistor Portable TV Kit**

Kit GR-104
**$119.95**

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*Circle 38 on reader's service card*

*continued from page 71*

spect to the center tap. Phase of the ac signal on the transistor base depends on the direction of bridge imbalance. The transistor conducts only when the base is negative.

If you unbalance the bridge by *decreasing* R1 (turning the direction control), the signal on the base takes on the shape of sine wave X (Fig. 2). This signal is in phase with signal Z, and collector current flows through loads 1 and 2 on alternate half-cycles.

If the imbalance was caused by *increasing* R1, signal Y turns the transistor on during alternate half-cycles for collector current to flow through loads 1 and 3. In this case, it is signals Y and W that are in phase.

In effect, then, load 2 is energized by decreasing R1; load 3 is energized by increasing R1. Load 1 is energized in either case.

In Fig. 3 you'll see how the transistor circuit controls the rotor. In the basic control circuit (Fig. 3) RY1 replaces load 2; RY2 replaces load 1, and resistor R4 replaces load 3. Q2 is the control or switching transistor shown in Fig. 2, and Q1 is a preamplifier. The motor is a capacitor-reversible-type supplied through S1-b and the contacts of RY1. RY1's contacts replace the manual reversing switch in the usual rotor control box.

The control knob is ganged to R1 and S1. S1-a is normally open and S1-b normally closed. When the knob is turned in *either* direction, the first two or three degrees of rotation close S1-a and open S1-b. This energizes the bridge and *opens* the circuit to the motor. Opening S1-b prevents the motor from starting before the bridge has determined which way the rotor must turn. The switch contacts return to their normal positions as soon as the knob is released.

Assume that the antenna is pointing east and we turn the control knob to the south position. This *decreases* R1's resistance and unbalances the bridge. The error voltage at the junction of R1 and R3 is fed to the base of preamplifier Q1. It is in phase with the voltage at B and out of phase with that at A.

When A is positive, the error voltage applies a negative biasing pulse to Q1's base. This increases the collector current through R5. A positive pulse through C3 keeps Q2 completely cut off, even though its collector receives a negative pulse from D2.

On the next half-cycle, point B and the error voltage are positive. Q1's collector current drops, developing a negative pulse at Q2's base. At the same time, point A is negative and D1 delivers a negative pulse to Q2's collector. A half-wave pulse of current flows through R4 and RY2. (Collector current cannot flow through RY1 at this instant because D2's cathode is positive and the circuit through RY1 is effectively open.) C2 filters these half-wave pulses and holds RY2 closed. RY2's contacts are in parallel with S1-a so the transformer remains energized after the control knob is released. Releasing the knob closes S1-b and applies voltage to the armature of RY2.

RY1 is not energized so the motor is actuated through the normally closed contacts and the motor runs clockwise. As the antenna turns, the motor also turns R2 clockwise, increasing its resistance to rebalance the bridge. When the antenna is pointing in the desired direction, the bridge output drops to zero, RY2 releases and the primary circuit opens.

Now, suppose you want to swing

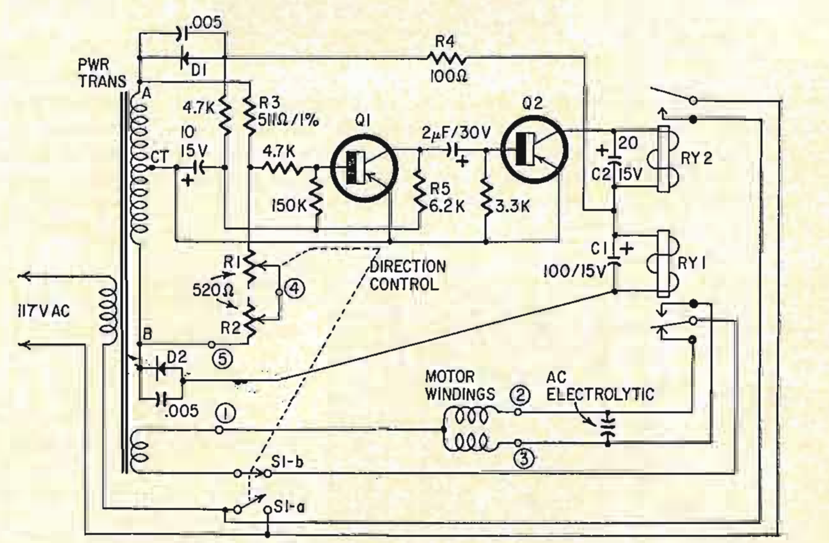



*Fig. 3—Schematic of the C-255 automatic antenna rotator. Circled numbers indicate leads in the 5-conductor control cable. Bridge circuit accomplishes direction control.*

the antenna back east. Turning the control counterclockwise increases R1's resistance, and the error voltage is now *in* phase with the voltage at A. As point A swings positive on alternate half-cycles, the positive peaks of the error voltage drive Q1 toward cutoff. This develops negative pulses on Q2's base that are in phase with negative pulses fed to Q2's collector from D2. C1 and C2 filter the pulses and hold both relays closed.

RY2 closes the primary circuit as before. RY1 completes the circuit through its normally open contacts so the motor turns counterclockwise. RY2's resistance decreases until the bridge balances and RY2 drops out, again opening the primary circuit.

The time constant of RY1–C1 is longer than that of RY2–C2 so RY2 is always the first to pull in and to drop out. This insures that the entire unit is turned off before RY1 switches. This prevents the motor from starting in the wrong direction and also avoids any last-second reversals just as the circuit is de-energized.

The C-225 uses five-wire control cable. Three leads are for the motor and two for the bridge circuit. The antenna can be installed pointing in any direction. The control is aligned by removing the knob and replacing it so its pointer indicates the correct antenna direction.

The electronic circuitry is on a small plug-in printed-circuit board inside the control box. All troubleshooting tests can be made with an ohmmeter. The rotor can be checked from the control end of the cable by taking resistance measurements between the various control leads. The service and installation manual has detailed resistance measurements.—*Robert F. Scott*

**Price: $35.25** END

**CORRECTION**

There is an error in the large PC board for the metal locator on page 56 of the July issue. In the left-hand part of Fig. 2, there should be a foil link between the lower mounting hole for C9 and the left mounting hole for R12. When the link is added, it completes the necessary connection between C9 and R11 and the base of Q2.

Our thanks to Mr. Garland Hiestand, of Elmira, N.Y., who also pointed out that the author's description of the modifications on the Lafayette amplifier are not always valid. Some units have the red and orange leads transposed. In either case, the two switch leads can be soldered together. Mr. Hiestand also mentioned that he did not detect any errors in the pictorial diagram supplied with his amplifier.

# NEW SEMICONDUCTORS, MICROCIRCUITS & TUBES

## TRANSISTORS FOR OTL AMPLIFIER

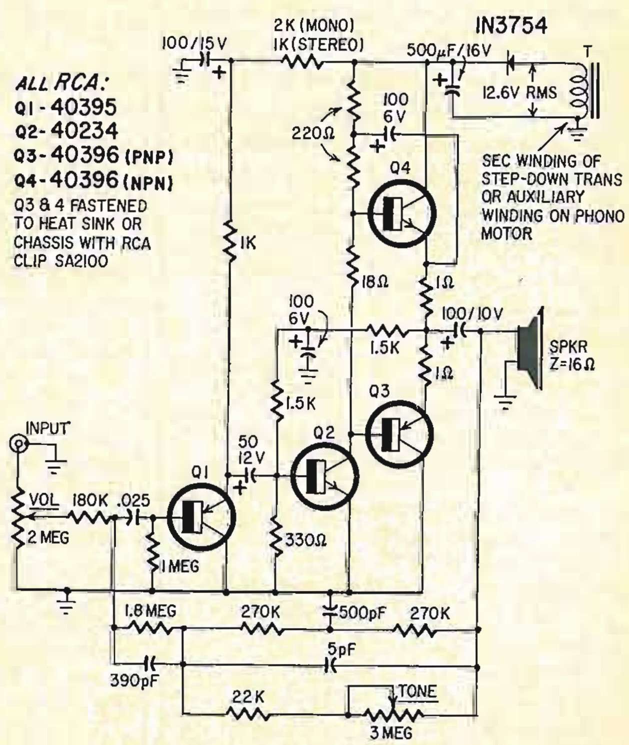
The RCA 40234, 40395 and 40396 are a group of four transistors especially designed for complementary-symmetry OTL output circuits in audio amplifiers. The 40234 is a silicon npn designed for service as a direct-coupled driver for the complementary-symmetry output stage. The 40395 is a high-gain pnp germanium transistor with controlled noise current, for use in input and other low level stages operating at signal levels as low as 1/8 $\mu$W.

The 40396 is the designation for a *matched pair* of germanium power transistors, one npn and one pnp type. The pair can deliver up to 1 watt rms into a 16-ohm speaker with 10% total harmonic distortion, when used in the circuit shown. Maximum ratings are:

| | 40395 | 40234 | 40396 (npn) | 40396 (pnp) |
|---|---|---|---|---|
| $V_{CBO}$ | −20 | 18 | 18 | −18 |
| $V_{CEO}$ | — | 18 | — | — |
| $V_{CER}$ ($R_{BE}$ = 4,700) | −18 | — | 18 | −18 |
| $V_{EBO}$ | −20 | 5 | 2.5 | −2.5 |
| $I_C$ (mA) | −50 | 100 | 500 | −500 |
| Diss. (mW to 50°C case temp) | — | — | 300 | 300 |
| Diss. (mW, amb. temp to 50° C) | 120 | 400 | — | — |

The phono amplifier shown is designed for a crystal cartridge with approximately .001 $\mu$F capacitance and 1.5 to 2 volts output. At 0.5 watt output, the total harmonic distortion, hum and noise combined do not exceed 2%. With the tone control in the "flat" position, response is flat from 180 Hz to 20 kHz. The tone (treble) control is a feedback type providing a maximum boost of about 9 dB and cut of 20 dB at 18 kHz when the volume control is set at maximum. The turnover point is approximately 700 Hz.

When the volume control is set 20 dB below maximum output, the frequencies between 200 and 1,000 Hz are boosted with a peak of about 8 dB at 150 Hz. The turnover point moves to about 1,500 Hz and the treble boost and cut slopes are sharper. The matched-pair output transistors should be mounted on a heat sink of at least 4 square inches per transistor. They should be clamped to the chassis or heat sink with clips such as the RCA type SA2100.




## PLASTIC-PACKAGED TRANSISTORS

Motorola Semiconductor Products has some new Unibloc (plastic encased) low-cost silicon transistors, the 2N3903–6 series. Specifications for the complementary 2N3903 npn and 2N3905 pnp transistors are: $BV_{CEO}$ 40 volts, $h_{FE}$ (@ 1 mA/1V) is 50 to 150, $C_{ob}$ at 5 volts is 4 and 4.5 pF, respectively. $f_T$ (@ 10mA/20V) is 250 MHz for the former and 200 MHz for the latter.

For the complementary 2N3904 npn and 2N3906 pnp transistors, $BV_{CEO}$ is 40, $h_{FE}$ is 100 to 300. $C_{ob}$ is 4 and 4.5 pF, respectively. The 2N3904 has an $f_T$ rating of 300 MHz while the 2N3906 is rated at 250 MHz.

Another "new from Motorola" is a line of matched-pair transistors—called Twins—in a *single* package. Twins are available as matched pnp/npn transistors or two of the same type. They are available as complementary pairs, Darlingtons and differential amplifiers with power and switching speeds to meet almost any need.

### HIGH-POWER NPN'S

The B-143009–B-143014 and B-143024–B-143029 are in a series of Bendix 5-amp npn silicon transistors for rf power amplifiers and oscillators to be used in hf and vhf communications transmitters, pulse generators, high-frequency inverters and ultrasonic applications.

$V_{CBO}$ ranges from 50 to 90 volts, depending on the transistor. The units are supplied in TO-5 and MT-27 packages. Introduced at the same time is a series of eighteen 10-amp silicon power transistors. Information and specifications can be obtained from Bendix Semiconductor Division, Holmdel, N. J.

### COMPACTRONS FOR COLOR TV

General Electric has introduced five new multifunction compactron tubes for color sets. Six of these tubes can replace up to 13 non-compactron types.

**6AG9**—Ultrahigh transconductance video output pentode and general-purpose triode.

**6AG10** and **10AG10**—High-level color demodulator drives picture tube without additional amplification.

**6EF4**—Improved 40-watt high-voltage regulator tube with new shield to prevent destructive arcing.

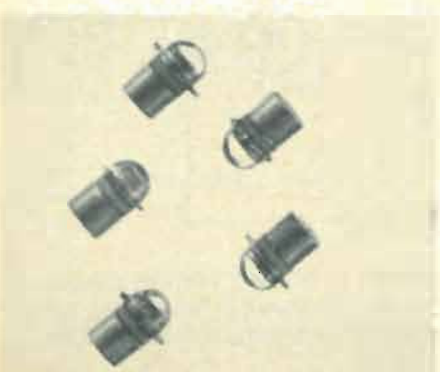
**40KD6**—Series-string version of 6KD6. Has high perveance to minimize snivets and other spurious oscillations within the tube.

### INFRARED DIODE

The 4107 gallium arsenide electroluminescent diode is a high-intensity solid-state infrared light source for card and tape readers, optical encoders and similar applications where available space is limited. It is also useful in cases where vibration would destroy tungsten-filament lamps.

The 4107 is contained in a .062-in. diameter ceramic-kovar package with a lens that concentrates the light output into a 20° cone. Typical radiant power output is 75 mW for an input of 50 mA at 1.25 volts.

The diode emits light with a wavelength of 9,000 Angstroms which can be efficiently detected by a silicon photodiode such as the 4205. The 4107 and 4205 are available through Hewlett-Packard Associates.



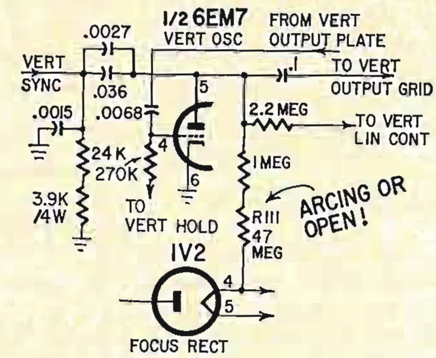
### HIGH-POWERED RECTIFIER

The Westinghouse 790 high-voltage silicon rectifier is designed for improved efficiency in 1,000- to 2,400-volt applications. Its compression-bonded encapsulation withstands a 1-cycle surge of 4,500 amps. The rugged ceramic seal lengthens the potential current leakage path. END

# TECHNOTES

### VERTICAL TROUBLES IN CTC12

In this chassis, low or unstable vertical sweep may be caused by an arcing 47-meg resistor (R111) connecting the focus voltage through the 1-meg resistor to the vertical oscillator plate (pin 5) and making vertical sweep and focus erratic. If the resistor is open, vertical sweep is weak. By readjusting height and vertical linearity controls it is possible




to fill out the screen, but then vertical hold gets critical and the picture starts to roll with the slightest bit of interference or line-voltage fluctuation.

The replacement resistor should be dressed in the open, away from all other parts and the chassis.

On rare occasions, a 6BK4 leaky shunt regulator may lower B-boost and cause poor focus and low vertical sweep.—*V. Karitons*

### OLYMPIC 23-INCH MODELS

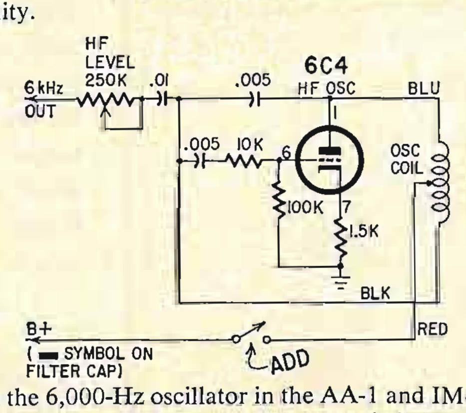
Weak or snowy uhf reception may be caused by a weak uhf diode or a defective uhf tuner in sets using the NCP chassis (runs 11 and 12).

Check the tuner. The ceramic stud which supports the oscillator tuning element may have cracked loose from inside the case. This is a very difficult repair to make, so replace the tuner with one bearing the same part number.

Replace the uhf diode if the tuner is OK.—*Olympic Service Bulletin*

### KILLING SQUEAL FROM HEATH AUDIO ANALYZERS

The Heathkit AA-1 and IM-22 Audio Analyzers (same instrument, different panels) contain an amplifier–rectifier ac vtvm with full-scale ranges from 10 mV to 300 volts. It is often convenient to use this meter for measuring gain, power output, etc., entirely apart from the intermodulation measuring facility.



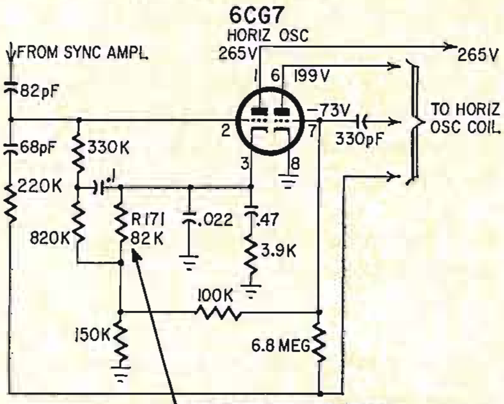

But the 6,000-Hz oscillator in the AA-1 and IM-22 keeps on working no matter how the instrument is being used, and in many models it emits a faint but annoying tone at 6,000 Hz.

To kill the sound without affecting the operation of the power and voltage measuring circuits, install a single-pole single-throw switch in series with the B-plus feed to the 6C4 oscillator (red wire from the oscillator coil—see diagram).

There are two ways to do this. One is to drill a hole in the panel at some convenient spot (near the HF LEVEL control, for instance), and mount a toggle or rotary switch there. The other is to replace the 250,000-ohm HF LEVEL control with a simliar control that has a switch attached. If you can find one with a pull-on push-off switch, so much the better: you won't have to reset the HF LEVEL control for a 4 to 1 ratio each time you use the IM analyzer section. With this second method, you don't have to drill any holes.—*Peter E. Sutheim*

### RCA KCS97W—BAD SYNC

Symptoms on this TV screen looked like horizontal sync or agc trouble. All the tubes and voltages were checked, with no input signal to the sync circuit. When the sync stabilizer control was advanced, the set would perform a little better.



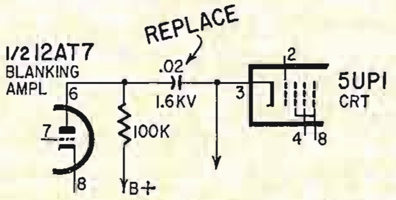

The horizontal hold control had little effect and was quite critical in adjustment.

When signal was injected into the sync section with an Analyst at pin 1 of the sync output stage, the picture would hold, but not well enough. The whole sync section was checked and voltages were quite good, except for a −47 volts on pin 7 instead of −73 volts.

The tube was pulled and resistance measurements were made across capacitors and resistors. Resistor R171, 82K, had increased to 2 megohms. The resistor was replaced and we were back in business.—*Homer L. Davidson*

### HEATH 0-12: FEEBLE TRACE

A Heath model 0-12 oscilloscope became inoperable within a few minutes of being turned on. The trace would become progressively weaker and finally disappear even at full brightness setting. Occasionally it would reappear faint-




ly, pulsate, then disappear again. All tubes, including the CRT, were good. Replacing the high-voltage filter capacitors failed to cure the trouble. The .02-$\mu$F 1,600-volt capacitor that couples the output of the blanking amplifier to the cathode of the CRT tested good on a capacitor checker. On the megohm scale of a vtvm, however, it showed very slight leakage. Further checks showed that in the presence of high voltage and heat leakage increased. Replacing this capacitor restored the scope to normal.—*Klaus Halm* END

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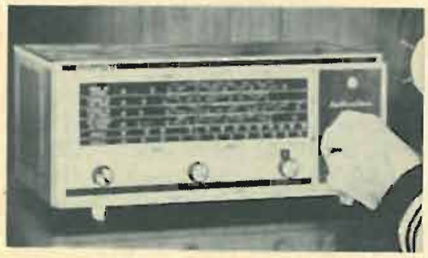
*Hz = hertz = cycles per second; kHz = kilocycles; MHz = megacycles*



FM/AM/SW RECEIVER, *model S-210.* 6 bands including AM and FM broadcast, plus 4 short-wave bands. Bandspread tuning on short-wave bands. 3 dual-purpose, 3 single-purpose tubes. Power supply 105–120 volt 60-Hz ac. 14½ x 7½ x 5¾ in.—**Hallicrafters Co.**

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AEROSOL WINDOW CLEANER, *Colorclear.* Contains ammonia-base glass cleaner, plus antistatic agent to discourage dust accumulation on TV picture-tube screens. Increases clarity of picture, which is more important in highly-critical color receiver. Pressure-spray can.—**GC Electronics**

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VERTICAL AUTOMATIC REVERSE STEREO RECORDER, *model 776.* Records and plays in both directions without reel turnover or rethreading. Records through unit's twin cardioid microphones or direct from other source. Plays back through any stereo amplifier or own high-fidelity system. Also monaural on all 4 tracks with same automatic reverse and electronic shutoff. Dual VU meters and tone controls, digital counter, cue control, monitor position, 4 flux-field heads and automatic tape lifters. Detachable speakers. 6 x 12 x 20 in. with 6 x 6 x 10-in. speakers.—**Concord Electronics Corp.**

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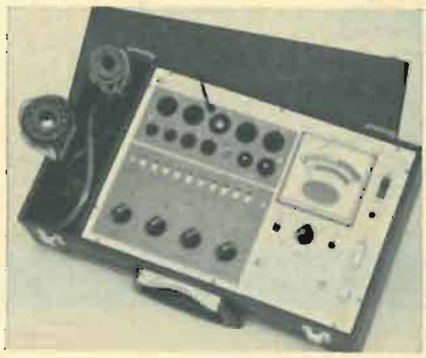
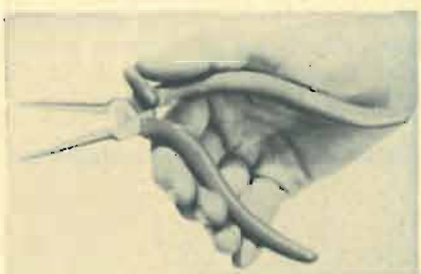


*Circle 50 on reader's service card*



PLIERS, *catalog No. D 366-6C,* minimize bending of wrist. Curve of handle fits in palm, thumb rests on shield. Long nose reaches into confined space. Handles cushioned in red plastic. 7½ in.—**Mathias Klein & Sons, Inc.**

*Circle 51 on reader's service card*

HEATHKIT VERSION OF MAGNECORD 1020 STEREO TAPE RECORDER, *model AD-16.* Total assembly time approx. 25 hr. Precut, prestripped, and marked connecting wires and shielded cables. 4-track stereo or mono playback and record from microphones or auxiliary sources. Has 3 motors, 3 tape heads;

2 VU meters, front-panel-mounted inputs and outputs, vertical or horizontal operation, individual gain controls. Solid-state 21-transistor, 4-diode circuit. Requires amplifier and speakers for playback.—**Heath Co.**

*Circle 52 on reader's service card*

THERMOELECTRIC GENERATOR. Uses kerosene. Thermoelectric modules exposed on one side to hot metal chimney of burner, attached thermally to cooling fins on the other. In 6-volt 0.5-amp *model 672* (illustrated) bismuth telluride alloy junctions are exposed to approx. 300°F. Other voltages and currents available.—**Electro Impulse Laboratory**

*Circle 53 on reader's service card*

2-CHANNEL WIRELESS INTERCOM, *model 8221/8222* (single intercom is *8221*, pair, *8222*). Transistorized, uses any 117-V outlet. Two units independent, any number of intercoms usable in single system. Calling station can select one or more separate remote stations. Adjustable squelch control, rocker-type talk/listen switch with lock position.—**Fasco Industries**

*Circle 54 on reader's service card*

MICROPHONE MIXER, *Shure M68*. Frequency response 20–15,000 Hz. Has 4 Connon XLR-3-14 type inputs for high- or low-level dynamic or ribbon microphones. "Aux" high-level input accepts tape recorder or tuner signal. Has

volume control for each of the 5 inputs, plus master volume control. Connects up to 4 microphones and tape recorder, tuner, phonograph (with accessory) to any amplifier or tape recorder. 2 outputs: 1 low-level, 1 for 0.5 to 2 volts.—**Shure Brothers, Inc.**

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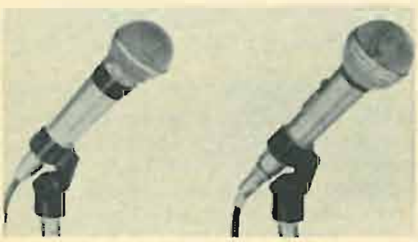

**UNIDIRECTIONAL DYNAMIC MICROPHONES,** Shure *565 Unisphere I* and *585 Unisphere A*. Unidirectional microphones with strong, build-in wire-mesh spherical front that contains effective filter against wind and breath noises. Frequency response; *model 565*—50–15,000 Hz; *model 585*—50–12,000 Hz. *Model 565 Unisphere I* is for professional use; the *585 Unisphere A* is a lower-cost unit.—**Shure Brothers, Inc.**

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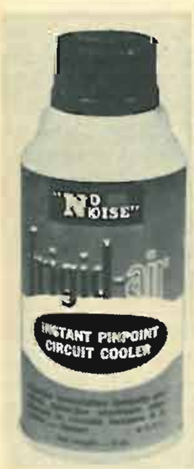
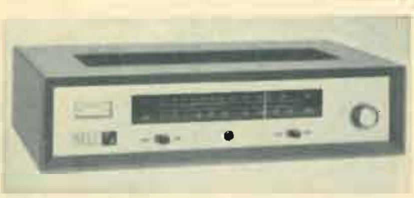



**INSTANT PINPOINT CIRCUIT COOLER,** *No Noise Frigid-Air*. Nonflammable, nontoxic, no carbon tet; won't affect plastics. Delivers coldest possible temperature. Locates defective components without removal from circuit. Comes with 5-in. plastic extender, by means of which serviceman can apply spray precisely where needed. — **Electronic Chemical Corp.**

*Circle 57 on reader's service card*



**SOLID-STATE AM/FM TUNER,** *model TT-100*. Background music source for commercial sound system. All-transistor. FM sensitivity 3μV, 200-kHz bandwidth; AM sensitivity 10 μV, 8-kHz bandwidth. Flywheel balanced dial, tuning meter, multiplex adapter output.—**Bell P/A Products Corp.**

*Circle 58 on reader's service card*

**SOLID-STATE COLOR GENERATOR,** *model 1900.* Line-width adjuster. Separate horizontal and vertical bars. Connects to antenna for most tests. Crystal-controlled keyed-rainbow display. Color-level control to check color sync circuits. High rf output on channels 3, 4 or 5. 117 volts, 50–60 Hz, 3 watts. Color-coded gun-killer switches, voltage-regulated transistor and timer circuits.—**Mercury Electronics Corp.**

*Circle 59 on reader's service card*

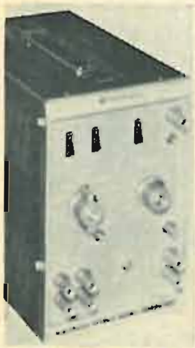
**INSTANT-LOADING CARTRIDGE RECORDER,** *model F-100.* Battery-powered. Records 1 hr on standard cartridge, 2 hr on double-play cartridge. Playback through built-in speaker or high-fidelity system. Remote start-stop controlled microphone. Flux-field record and playback heads. Recording-level and battery-condition meters. 8 x 4⅞ x 2⅜ in., 3 lb.—**Concord Electronics Corp.**

*Circle 60 on reader's service card*

**PUSHBUTTON SOLID-STATE 4-TRACK RECORDER,** *model RK-840.* Frequency response ±3 dB, 40–18,000 at 7.5 ips, 40–12,000 at 3.75 ips. Wow and flutter less than 0.2% at 7.5 ips, 0.3% at 3.75 ips. Power output 6 watts. Input sensitiv-

ity 0.2 mV, 0.7 mV; 2-aux., 100 mV. Outputs: 2 external amplifiers, 2 external speakers, stereo headphones. 12 transistors and 4 diodes. 105–125-volt 60-Hz.–Lafayette Radio Electronics Corp.

*Circle 61 on reader's service card*



**FM STEREO MULTIPLEX SIGNAL GENERATOR,** *model SM-109.* Built-in audio oscillator permits internal modulation at 1,000 and 50–60 Hz; built-in FM signal generator produces carrier wave at 98 MHz ±2 MHz; pre-emphasis circuit. – **Kenwood Electronics, Inc.**

*Circle 62 on reader's service card*

**MOBILE ANTENNA,** the Larsen *DB Plus.* 144–174 MHz. Stainless-steel silver-plated whip. 3 dB gain on transmit, 6 dB complete system gain. 100 watts continuous-duty load. 1.3:1 or less SWR. Fits all standard mounts.–**Larsen Electronics, Inc.**

*Circle 63 on reader's service card*

**REMOTE MICROPHONE—SPEAKER FOR 2-WAY RADIOS.** Telephone-type base and handset, mounts on floor "hump" of car. 3-in. speaker monitors incoming calls, cuts off automatically when

handset is lifted for receiving. Choice of carbon or crystal microphone. Compatible with most mobile 2-way radios. Squelch control, green and red "on" and "transmit" lights. Frequency-selector switch available.–**Marshall Engineering Corp.**

*Circle 64 on reader's service card*

**BATTERY MODULE FOR HAND-CARRIED OR PORTABLE OPERATIONS.** The Johnson *Power Pack* attaches to *Messenger 100, III* or *350* transceivers to make them portable units. Provides approx. 8 hr operation. Battery 1.2

ampere-hr. Normal recharge cycle 14-16 hr. 3 in. long; width and height same as transceiver. 2 lb.—*E. F. Johnson Co.*

*Circle 65 on reader's service card*

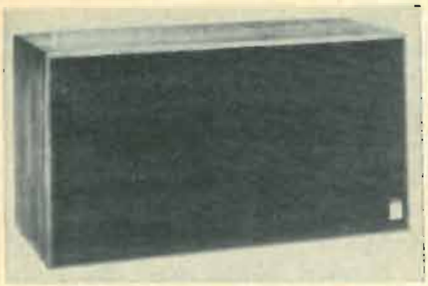
CONTROL PANEL, AMPLIFIER, *CIA* (Central Instrument Adjustment) control board and *Saturn 80* instrument amplifier (items can be purchased separately). *Saturn 80:* 80-watt amplifier, two 12-in. speakers, tweeter. Can be used alone or in series. Amplifiers connect to *CIA* for single panel control, add reverb and tremolo, can accommodate 6 instruments.—**Gregory Amplifier Corp.**

*Circle 66 on reader's service card*

MARINE, AIRCRAFT PORTABLE RADIO/DIRECTION FINDER, the *Pilot II*, picks up planes in flight, airport control towers, police calls, standard broadcasts, short-wave and entire marine band. Four bands: 190–400 kHz, 540–1600 kHz, 1.6–4.5 MHz, 110–135 MHz. Has rotating antenna and null meter, squelch control, Morse-code plate, calibrated optical sights, mounting bracket, 2 headphone jacks, pushbutton dial light, 3 extendable whip antennas. Operates from internal or external batteries, regular house current or optional solar battery. 8 x 5 x 2 in., 2 lb.—Nova-Tech Inc.

*Circle 67 on reader's service card*

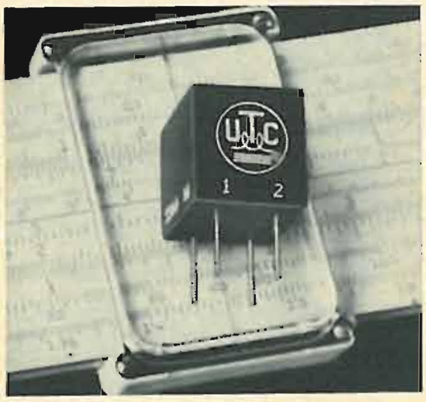
ULTRA-COMPACT HI-FI SPEAKER SYSTEMS, *models X-40 and X-45.*



Audio range from 30–16,000 Hz. Closed acoustic chambers. 19½ x 10½ x 9¼ in.—Jensen Manufacturing Division, The Muter Co.

*Circle 68 on reader's service card*

**ULTRASONIC INPUT TRANSFORMER.** Primary impedance 75 ohms,



secondary 135 ohms. Frequency range: 50 to 125 kHz ±¼ dB. Maximum level: 0 dB. Straight-pin gold-plated terminals suit it for printed circuits. ½ x ½ x ½ in., ¼ oz.—United Transformer Corp.

*Circle 69 on reader's service card*

*Write direct to the manufacturers for information on the item listed below:*

**WATERPROOF FLOATING RADIO** is round and has 2½-in. speaker; guaranteed for 6 months.—The Aapal Co. 3240 Gentilly Blvd., New Orleans, La. **END**

**Build a Burglar Alarm into Your Intercom:**

So simple you'll wonder why you didn't think of it yourself. It works with any kind of intercom system and costs almost nothing to set up.

**In November RADIO-ELECTRONICS**

*Circle 117 on reader's service card*



*Circle 118 on reader's service card*



*Circle 119 on reader's service card*

# NEW LITERATURE

*All booklets, catalogs, charts, data sheets and other literature listed here are free for the asking with a Reader's Service number. Turn to the Reader's Service Card facing page 82 and circle the numbers of the items you want. Then detach and mail the card. No postage required!*

**CATALOG OF SCIENCE,** *Optics, Math, No. 665* More than 4,000 hobbyist and experimenter items including such new ones as: metal detector, vacuum-base vise, dental burr assortment, wire bending and cutting jig, plastic scratch remover kit.—**Edmund Scientific Co.**

*Circle 71 on reader's service card*

**HOME ELECTRICAL SUPPLIES CATALOG,** *M6,* illustrated, 32 pages. Descriptions and pricing information on 750 switches, outlets, cord sets, fuses, wall plates, plugs and connectors, heating tapes, specialty wiring devices.—**General Electric Wiring Service Dept.**

*Circle 72 on reader's service card*

**DATA SHEET,** *GEA-7283,* describes high-voltage reed relays for special applications.—**General Electric**

*Circle 73 on reader's service card*

**PEC REPLACEMENT GUIDE AND CATALOG,** 20 pages, universal-punched, lists 209 packaged electronic circuit (PEC) encapsulated R-C networks currently available from parts distributors. Indexed by type of circuit and circuit function.—**Centralab.**

*Circle 74 on reader's service card*

**HEP CROSS-REFERENCE GUIDE,** *HMA07,* 28-page shirt-pocket guide lists 4,465 semiconductors for distribution through HEP (Hobbyist, Experimenter, Professional technician) program.—**Motorola Semiconductor Products Inc.**

*Circle 75 on reader's service card*

**CONDENSED SEMICONDUCTOR CATALOG,** 24 pages, looseleaf-punched. Type numbers and specs for transistors, diodes, integrated circuits, hybrid circuits, special MOS, FET components. Case and package drawings with dimensions.—**Fairchild Semiconductor**

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**ELECTRONIC COMPONENTS CATALOG,** *No. 32.* 42 pages, universal-punched. Charts, curves, drawings, specs of potentiometers, switches, capacitors, etc.—**Centralab**

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**MAJOR SPECIFICATIONS SEMICONDUCTOR CATALOG** *(640.12),* illustrated, 60 pages, gives, as well as specs, 130 outline drawings and dimensions of semiconductors, including many new SCR's and other "highest powered and lowest priced units."—**General Electric**

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**1966-67 RECTIFIER CATALOG,** *F-66,* 34 pages, looseleaf-punched, of rectifiers, diodes, exact replacements for color TV crystals, silicon bridge assemblies, transistors, solar cells, photocells. With specs, photos, part-number index.—**International Rectifier, Distributor Div.**

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**CHASSIS-PUNCH CATALOG,** *No. E-730-15,* 8 pages, covers standard round, square, "key", "D", double "D" punches, and many special punches.—**Greenlee Tool Co.**

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**COMPACTRON CATALOG,** *ETG-3983A,* 24 pages, lists general and maximum ratings of 121 types; specs given on chart; diagrams and outline drawings.—**General Electric Co., Electronic Components Div.**

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**COMMERCIAL SOUND CATALOG,** *No. 566-67,* 10 pages, gives specs and application information on full line of PA loundspeakers, microphone stand, baffles and other accessories.—**Atlas Sound, Div. of American Trading & Production Corp.**

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**DIGITAL AND LINEAR INTEGRATED CIRCUITS,** *Quick-Reference Guide 91-000.* Presents schematic diagrams, design features, and complete model designations of more than 60 digital and linear integrated circuits. Includes operational and differential amplifiers, amplifiers and pre-amps for audio, video, and servo applications. 8 pages.—**Westinghouse Molecular Electronics Division**

*Circle 83 on reader's service card*

**RF CONNECTOR, CABLE CATALOG,** *RF-2,* 28 pages. Rf connector-selection guide. Connector and accessories illustrated; dimensions, UG designations and cable matching info given. Coaxial cable section cross-references RG-/U and Amphenol catalog numbers. Ratings tables for all RG and Amphenol cables. Cross-reference index of military and Amphenol Rf connector numbers. Mounting specifications for all cataloged connectors.—**Amphenol Distributor Division**

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**EDUCATIONAL TELEVISION COMMUNICATIONS BOOKLET,** 36 pages. Basic types of systems outlined and evaluated. Includes: ETV broadcasting stations, 2,500 MHz instructional TV systems, interschool cable, and conventional microwave link. Covers master-antenna TV distribution and closed-circuit TV distribution.—**Jerrold Electronics Corp.**

*Circle 85 on reader's service card*

**TRANSISTOR CROSS-REFERENCE,** *Form IR-7018-G,* gives 7 replacement numbers for substitution of over 4,000 transistor types. Diodes and rectifiers also included. 7 pages.—**GC Electronics**

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**PORTABLE 2-WAY RADIO,** the *Handie-Talkie,* booklet gives details of new *PT series.* Models illustrated, also accessories and replacements.—**Motorola Communications & Electronics, Inc.**

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**POTENTIOMETERS,** *Catalog P-3,* 59 pages. Includes chart illustrating models by size and wattage, list of applications. Describes terminals, switch availability, number of sections, operating temperature and resistance ranges. Many available from local Centralab distributor. Cross-reference to distributor part number provided.—**Centralab, Division of Globe-Union Inc.**

*Circle 88 on reader's service card*

**COMPONENTS CATALOG,** *No. 670,* 512 pages. Complete selection in stereo high-fidelity, Citizens-band 2 way radio, tape recorders, ham gear, test equipment, radios, TVs and accessories, cameras, optics, marine equipment, auto accessories, tools, books, etc. All major manufacturers included.—**Lafayette Radio Electronics Corp.**

*Circle 89 on reader's service card*

**MARINE RADIOTELEPHONE HANDBOOK,** *How to Use and Choose Marine Radiotelephones,* explains how a radiotelephone works. Gives performance information, operational laws, licensing procedures, Coast Guard and telephone company services. Listing of all FCC field offices and up-to-date listing of all marine-channel frequency allocations in US, Alaska, and Caribbean area.—**Pearce-Simpson, Inc.** END

*Circle 90 on reader's service card*

# Solving Delta and Wye Networks By Transformation

**What if a circuit is not simply series or parallel?**

**By S. R. SIMMONS**

MOST TECHNICIANS AND ENGINEERS FEEL CONFIDENT ABOUT solving simple series- and parallel-resistance problems. But sometimes you encounter circuits that cannot be classified as either series or parallel. They are combinations of both. Delta and wye circuits are examples of these more complex networks.

Many delta and wye circuits have capacitively or inductively reactive components; solutions to problems with those require the use of complex values. Circuits of a purely resistive nature, however, aren't so difficult. Once you understand how to handle these, you may want to tackle the tougher ones, keeping in mind that reactive circuit problems are solved in the same manner while using complex numbers.

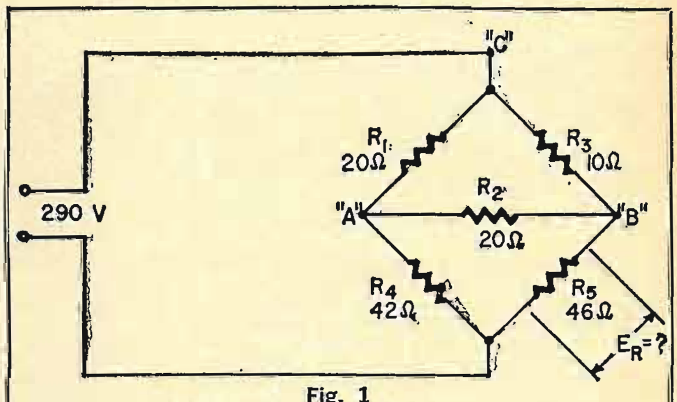



Fig. 1

One resistive-network problem appears in Fig. 1. Suppose you, as an engineer, need to know what voltage will be developed across resistor R5. At first glance, you might conclude that resistors R3 and R5 are the ones to be concerned about. But careful study reveals that, because resistor R2 is connected to the junction of resistors R3 and R5, the entire circuit is involved. This type of problem can be solved by using simultaneous equations, but chances for error are rather high. A simpler method is a form of calculation known as *delta-wye transformation.*

In Fig. 2-a is a network known as a delta connection. Let's *transform* it to a wye connection, as shown in Fig. 2-b. To accomplish this, draw the wye circuit inside the delta (Fig. 3). This helps you to see the relationship between the two networks. Label all components and connection points.

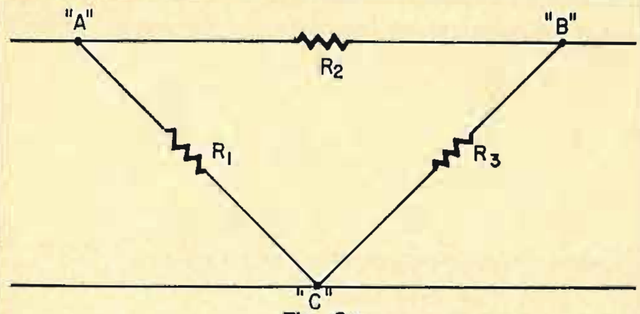



Fig. 2-a

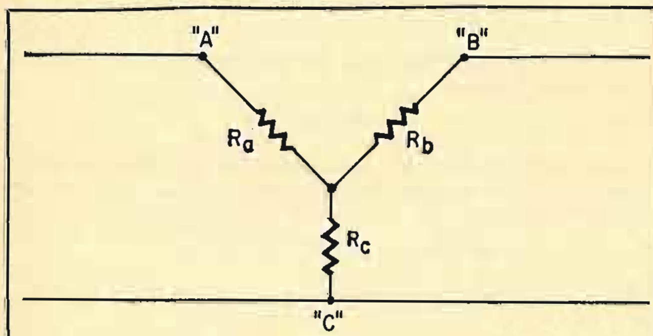



Fig. 2-b

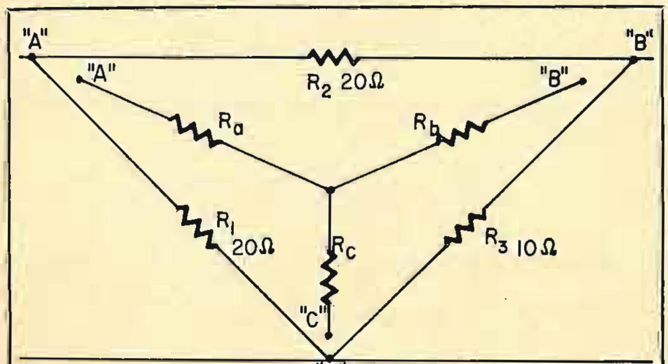


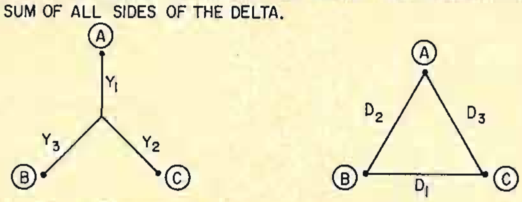

Fig. 3

Determine the values of resistors $R_a$, $R_b$, and $R_c$. Skipping the derivations till later (box), the formulas are:

$$\left.\begin{aligned} R_a &= \frac{R_1R_2}{R_1+R_2+R_3} = \frac{20\cdot 20}{20+20+10} = \frac{400}{50} = 8\,\Omega \\ R_b &= \frac{R_2R_3}{R_1+R_2+R_3} = \frac{20\cdot 10}{20+20+10} = \frac{200}{50} = 4\,\Omega \\ R_c &= \frac{R_3R_1}{R_1+R_2+R_3} = \frac{10\cdot 20}{20+20+10} = \frac{200}{50} = 4\,\Omega \end{aligned}\right\} a$$

These formulas are a form of the familiar product-over-sum formula for parallel resistances. The denominators are identical in all three formulas, but the numerators vary in value. You can figure out what the numerator will be in each formula by noticing the points where the resistors connect. That is, if you solve for resistor $R_a$, the numerator will be composed of the two resistors in the delta that connect to point A. In like manner, the numerator for resistor $R_b$ contains resistors R2 and R3. Finally, the resistors that determine the numerator in solving for $R_c$ are R3 and R1. Bear this relationship in mind when you perform other transformations.

DERIVE THE EQUIVALENT WYE FROM THE DELTA. THE SYMBOL S DENOTES THE SUM OF ALL SIDES OF THE DELTA.




COMPARE THE RESISTANCE BETWEEN POINTS A AND B

$$Y_1 + Y_3 = \frac{D_2(D_3+D_1)}{S}$$

$$Y_2 + Y_3 = \frac{D_1(D_2+D_3)}{S}$$

$$Y_1 + Y_2 = \frac{D_3(D_2+D_1)}{S}$$

ADD THE FIRST 2 EQUATIONS, THEN SUBTRACT THE THIRD, AND YOU HAVE THE SIMPLE FORMULA

$$2Y_3 = \frac{2D_2D_1}{S} \quad \text{OR} \quad Y_3 = \frac{D_2D_1}{S}$$

$Y_2$ AND $Y_1$ MAY BE DERIVED BY A SIMILAR PROCESS, BUT THERE IS NO NEED FOR IT, SINCE THE DIAGRAMS ARE SYMMETRICAL. WE MAY WRITE AT ONCE, BY INSPECTION,

$$Y_2 = \frac{D_1D_3}{S} \quad \text{AND} \quad Y_1 = \frac{D_2D_3}{S}$$

THEY ARE IDENTICAL WITH EQUATIONS (a) IN THE TEXT.

2. DERIVE THE EQUIVALENT DELTA FROM A WYE CONFIGURATION

$$D_1 \equiv \frac{D_1(D_3+D_2+D_1)}{S}, \text{ AN IDENTITY}$$

$$= \frac{D_1D_3+D_1D_2+D_1^2}{S} = Y_2 + Y_3 + \frac{Y_2Y_3}{Y_1}$$

IN CASE YOU DON'T UNDERSTAND THE LAST TERM OF THIS EQUATION, WRITE

$$\frac{D_1^2}{S} = \frac{D_1^2(D_2D_3)S}{S^2(D_2D_3)} = \frac{(D_1D_2)}{S}\cdot\frac{(D_1D_3)}{S}\cdot\frac{S}{(D_2D_3)} = \frac{Y_3Y_2}{Y_1}$$

BY SYMMETRY, YOU CAN ALSO WRITE

$$D_2 = Y_1 + Y_3 + \frac{Y_1Y_3}{Y_2} \quad \text{AND} \quad D_3 = Y_1 + Y_2 + \frac{Y_1Y_2}{Y_3}$$

THESE ARE EQUIVALENT TO EQUATIONS (b) IN THE TEXT.

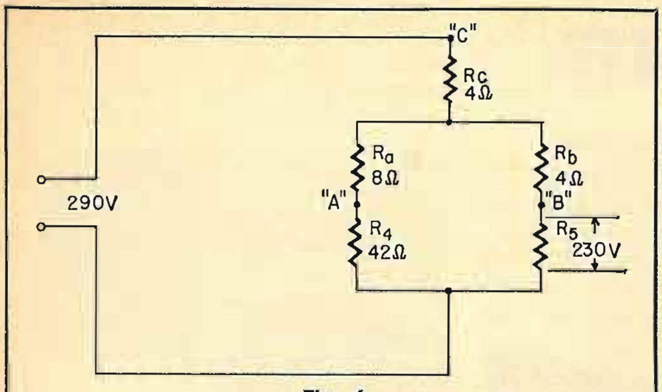



Fig. 4

You develop an easily understood equivalent circuit for the network in Fig. 1 by transforming the upper half (R–R2–R3) into a wye circuit. The equivalent circuit then appears as in Fig. 4, which is a simple series-parallel circuit. From that point on, solving for the voltage across resistor R5 is easy. By Ohm's law, you should get 230 volts for an answer.

A study of transformations would not be complete without an explanation of how to transform a wye circuit back to a delta. The procedure is similar except for the formulas.

Begin the transformation by enclosing the wye network with the delta equivalent, as in Fig. 5. Again minus the derivations, the formulas are:

$$R1 = \frac{R_aR_b + R_aR_c + R_bR_c}{R_b} = \frac{8\cdot4 + 8\cdot4 + 4\cdot4}{4} = \frac{32+32+16}{4} = \frac{80}{4} = 20\Omega$$

$$R2 = \frac{R_aR_b + R_aR_c + R_bR_c}{R_c} = \frac{8\cdot4 + 8\cdot4 + 4\cdot4}{4} = \frac{32+32+16}{4} = \frac{80}{4} = 20\Omega$$

$$R3 = \frac{R_aR_b + R_aR_c + R_bR_c}{R_a} = \frac{8\cdot4 + 8\cdot4 + 4\cdot4}{8} = \frac{32+32+16}{8} = \frac{80}{8} = 10\Omega$$

b

In these formulas, it is the numerators that are identical, while the denominators vary in value. The critical thing to remember is which resistor to use as the denominator for each formula. Rule of thumb is to use the wye resistor directly opposite the delta resistor that you are solving for.

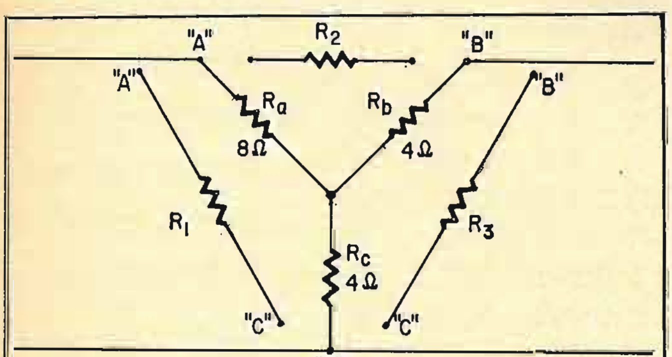



Fig. 5

Thus, the resistor opposite R2 will be $R_c$, and that value is the denominator. Likewise, resistor $R_a$ is opposite R3, and $R_b$ is opposite R1.

Look through any electronic text, manual or magazine and you'll see such complicated-looking circuits as bridges, filters, attenuators, and voltage dividers. If you look closely, you'll see that these circuits are usually one form or another of delta or wye. END

# TRY THIS ONE

### MAST MOUNTING WITH ONLY TWO HANDS

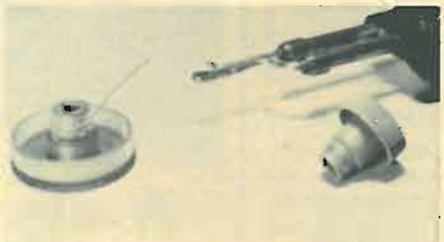
Ever try to fasten a heavy antenna mast in an antenna rotator and find that you need three hands? One to support yourself, one to fasten the clamps and a third to support the mast in the correct position?

Try this: Before placing the mast in the rotor, fasten one of the C-clamps directly on the mast, a sufficient distance from the bottom end to permit the mast to pass through the rotator. Now you can just slip the mast into the rotator and the clamp will hold it at the correct depth, permit you to adjust the antenna's direction, and still support its weight while you fasten the bottom clamp. Then tighten the bottom clamp in its correct position just enough to support the weight of the mast. Finally, move the top clamp to its correct spot on the rotator and tighten it there.

The procedure can easily be reversed, letting you remove the mast without supporting its weight while doing so.—*Jon H. Larimore*

### USE WIRE FOR KNOB REPAIR

You can repair that broken or cracked plastic TV knob by imbedding a piece of No. 22 hookup wire into the plastic shank. Remove the insulation and bend a sharp L in one end of the wire. With your soldering iron, heat the

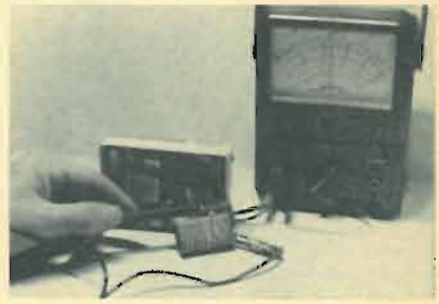


bent end and push it into the plastic knob. This will hold the wire in place.

Now wind the wire into the shank. Pull the wire tight and press it into the plastic with the hot soldering iron. The wire will easily pull into the plastic material and reinforce the knob shank. File off rough edges. Use about an 8-inch piece for most large TV tuning knobs.—*Homer L. Davidson*

### CHECKING TRANSISTOR BATTERY DRAIN

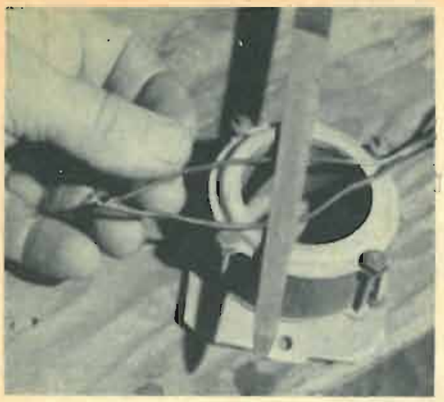
It is easy to check current in a small transistor radio when the battery connector is on a flexible cable. Unclip the connector from the battery. Turn the



connector halfway around and clip the positive terminal back on the battery. Insert a milliammeter in series with the negative terminal and the battery. You can quickly tell if your receiver is pulling too much current, shortening battery life.—*David Held*

### USE FOR FOCUS MAGNET

The permanent-magnet picture-tube focus ring from an old TV set can be used as a magnetic vise or clamp. It is particularly useful for soldering—for example, joining or attaching lugs to wire ends.



Arrange the items to be soldered as needed, then place a metal strip "keeper" across the magnet as shown. This will hold light items securely without cooling them. The magnet is an excellent holder for small pins, keys and washers which otherwise become lost or misplaced.—*Glen F. Stillwell*

### HANDY TOWER CADDY

A youngster's caddy coaster wagon enables *one man* to install a 30-30 (60-foot) double tower. Drop the heavy end of the tower off the service truck onto the wagon and then, lifting the lighter end, pull it and the wagon to the installation site. Lay the tower on the ground and install the guy and other components. Fasten the tower's base to its concrete foundation; then get up on the roof and pull the tower up.—*D. Bernius*

### GROUND BUS FOR WORK BENCH

A piece of ordinary copper tubing flattened with a hammer or a bench vise makes a fine ground bus in the home lab. Tying all test equipment to a safety ground eliminates shock hazards and keeps noise and hum out of test circuits. Connect one end of the tubing to a water pipe or the grounded third wire in your house wiring.

There are a number of ways to attach leads to the tubing. Some are shown in the photo. Use a five-way binding post, a bolt and wing nut, a nut-bolt-solder lug combination, or just clip test leads to it.—*Don Lancaster*

[When you work on transformerless sets with grounded instruments—or in any case, for that matter, either use an isolation transformer or be certain the set is connected to the line so that the chassis is grounded.—*Editor*] END



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Prepared for the National Aeronautics and Space Administration, the book treats almost every phase of magnetic recording on tape. Covers the tape recorder itself, recording methods, tape transport systems, tape heads, the magnetic tape, the electronics in a recorder, and methods of testing and evaluating recorders. A little wordier than necessary, but covers the topic thoroughly.

FIELD-EFFECT TRANSISTORS, by Leonce Sevin. *McGraw-Hill Book Co., 330 W. 42nd St., New York, N. Y. 10036. 7 x 10 in., 130 pp. Cloth, $10*

Prepared under the sponsorship of Texas Instruments, this is a well-illustrated treatise on the theory of these devices. Quite mathematical, although not written in a stilted manner. There's a lot of practical information in here, and anyone who's really interested can get it out. Covers just about every kind of transistor, including power FET's. Even goes into FET's in integrated circuits.

COMPUTER DICTIONARY, by Charles J. Sippl. *Howard W. Sams & Co., Inc., 4300 W. 62nd St., Indianapolis, Ind. 46206. 6½ x 9 in., 336 pp. Paper, $4.95*

Filled with comprehensive explanations of more than 5,000 computer terms. 130 pages of appendices add considerable data about computers, computer companies, the human factor, mathematics and statistics, computer language, and acronyms that apply to the field. Definitions are a little stiff, but complete.

HOW TO BECOME A PROFESSIONAL ENGINEER, by John D. Constance. *McGraw-Hill Book Co., 330 W. 42 St., New York, N. Y. 10036. 5½ x 8½ in., 294 pp. Cloth, $7.50*

A readable work on how to develop a career as a professional engineer. Includes state registration laws, training, qualifying experience, and tells you how to prepare for the examination. Even tells you how to go about making the grade if you aren't a college graduate. Well organized and easy to read. Second edition.

BUILD USEFUL ELECTRONIC GADGETS FOR YOUR HOME, by Stuart Hoberman. *Skillfact Library, Editors and Engineers, Ltd., New Augusta, Ind. 5 x 7 in., 96 pp. Paper, $1*

Instructions on constructing five simple electronic devices. Illustrated with pictorial diagrams and schematics. Part of a series of three dozen books containing such titles as "TV Tube Replacement," "Transistor Projects," "Electronic Accessories for Your Car," "Dictionary of Electronic Terms" and "Know About Electronic Organs" among other electronic titles. END

# SCHOOL DIRECTORY

# NOTEWORTHY CIRCUITS

### INTERMITTENT LOCATOR

The lowly neon bulb can perform some amazing tasks at very low cost. Here is one illustration of how neons can be used to cut circuit complexity and cost drastically.

The setup was used to run a 50-hour test on an rf transmitter and power supply. All supply voltages and the output had to be continuously monitored by meters (meter relays) with contacts set to detect any abnormal readings. An abnormal reading on any one of the meters was to actuate circuitry to turn off the entire setup. But some kind of memory was needed so that the attendant could tell, after the power was shut off, what had caused the failure. Normal use of relays would have resulted in a schematic that looked like part of a telephone exchange, and the cost of all those relays would have been prohibitive.

The circuit that was used is simplicity itself. The basic principle is that only one lamp can remain on at any time.

Hook up the circuit of Fig. 1 and turn the power on. One of the neons will fire and remain lit. Even if both lamps have precisely the same starting voltage, the 500K resistance will sustain only one of them. Now open the switch connected to the lamp that is lit. Immediately the other lamp will fire and will remain lit even though you close the switch again. As you can see, this simple little circuit has the ability to remember which switch you opened last, i.e., a memory.

Now let's go to Fig. 2. Apply power and push the reset button to force lamp A on. A typical neon lamp will have 55 to 60 volts drop across it. The voltage at the junction of R and the lamps will be approximately 60. If we now apply 50 volts to the bottom of lamp A through a push-button switch or any similar device, lamp A will have only 10 volts across it. It will extinguish and lamp B will immediately light and remain lit.

A simplified version of the circuitry used with control meters is shown in Fig. 3. Connect them to the circuits to be monitored. Press the reset button after the monitored circuits are set up and all meters are indicating normal. All lamps A will be lit until a failure causes one of the meter indicators to make its contact. The associated lamp B will light, telling the operator at any time later which circuit failed, even if it was only a momentary failure. Another pair of lamps could be used on each meter to indicate whether the reading went high or low. The low ends of the 10K resistors can be returned to ground through a sensitive relay so that failure in any one circuit can operate an alarm or shut off the power.

I would be interested to hear from anybody who finds other practical applications for this novel circuitry.—*L. F. Goldsmith*

END

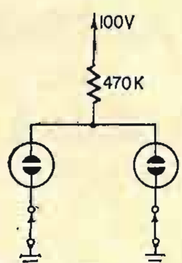


Fig.1

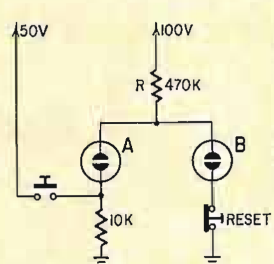


Fig.2

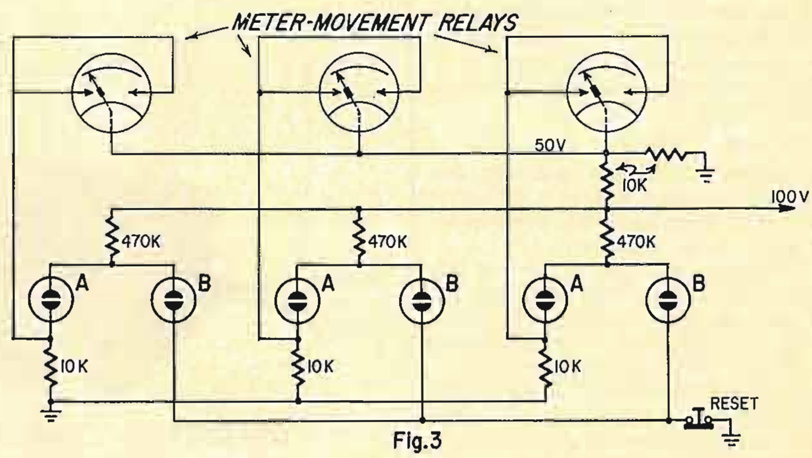


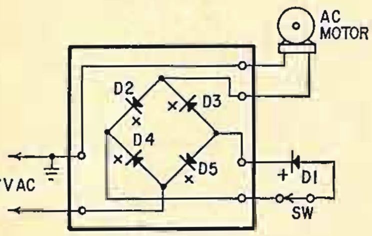
Fig.3

# WHAT'S YOUR EQ?

These are the answers. Puzzles are on page 60.

**Diode Motor Control?**

The box contains four diodes connected in a bridge-rectifier configuration. These, in addition to D1, allow ac to flow to the motor load. During the positive alternation, current flows through D4,




D1 and D3. During the negative alternation, current flows through D5, D1 and D2. If D1 is reversed or switch opened, no current flows to the motor.

**Too-Bright Lamp**

The diode cuts the average current in half but the lighting effect of the lamp depends upon the rms or effective value. Without the diode, doubling the current to 300 mA increases the lamp dissipation four times. The diode cuts this in half but the lamp is still averaging twice its rated power. The rms current is proportional to the square root of the power so the required rms current is: $I = 0.15 \times \sqrt{2} = 0.2121$ amp.

Therefore, the dropping resistor needs to be about 537.5 ohms. $\frac{120 - 6}{0.2121} = 537.5$

END

**TWO TECHNICIANS KILLED BY CADMIUM IN SILVER SOLDER**

The US Public Health Service warns that two deaths have been traced to improper use of silver solder containing cadmium. The most recent report was of a television-station engineer in New Mexico who had been using silver solder with a high cadmium content. One death was in Utah. In California, a third, nonfatal case was reported.

The Department of Health, Education and Welfare warns that:

Warning labels, which should be on all packages, must be read carefully and followed.

Working areas must be properly ventilated, preferably with specific exhaust systems.

Workers must avoid breathing emitted fumes.

The Division of Occupational Health states that not all silver solders contain cadmium, but emphasizes that the above precautions should be taken when using any type of this material.

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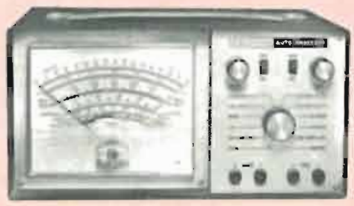

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