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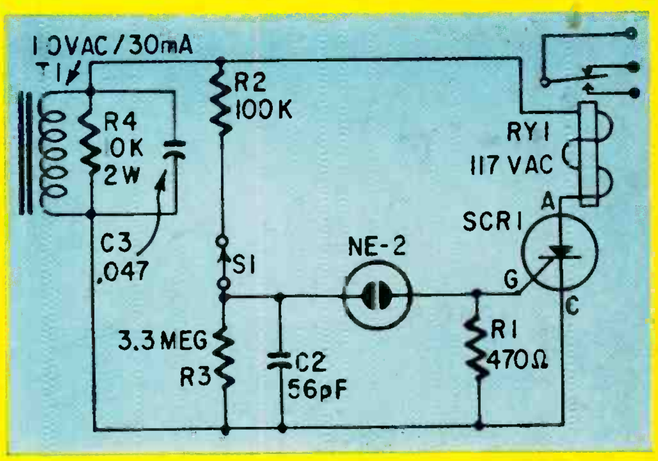
Troubleshoot Color TV

Soup Up Relay Action

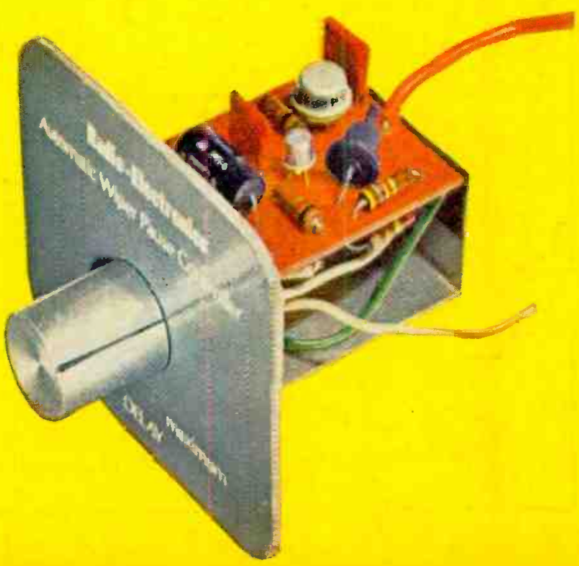


A0768 510076BLU0220D0A57
A L BALUKA
220 DOWNING DR
FLORISSANT MO 63031

BUILD—

Automatic Windshield Wiper-Pause Controller

(see page 32)



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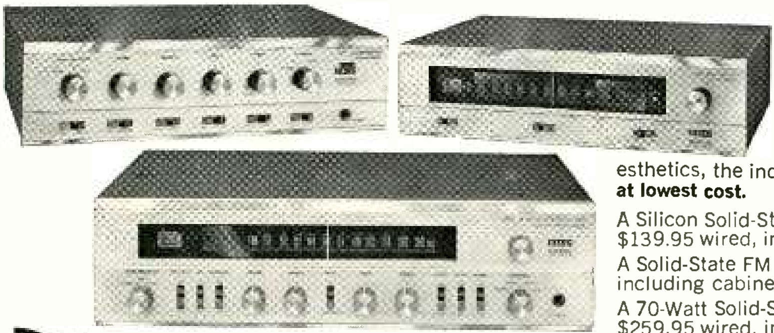

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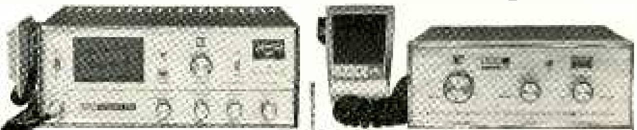
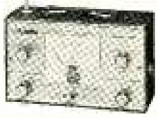


EICO Trans/Match (Model 715) is a professional test set designed for complete checking of ham and CB equipment. Kit $34.95; Wired $49.95.



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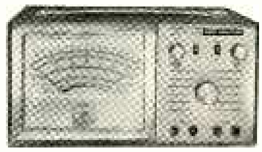
Complete with a Tune-up & Trouble-shooting Manual. Model 888; $44.95 kit, $69.95 wired.



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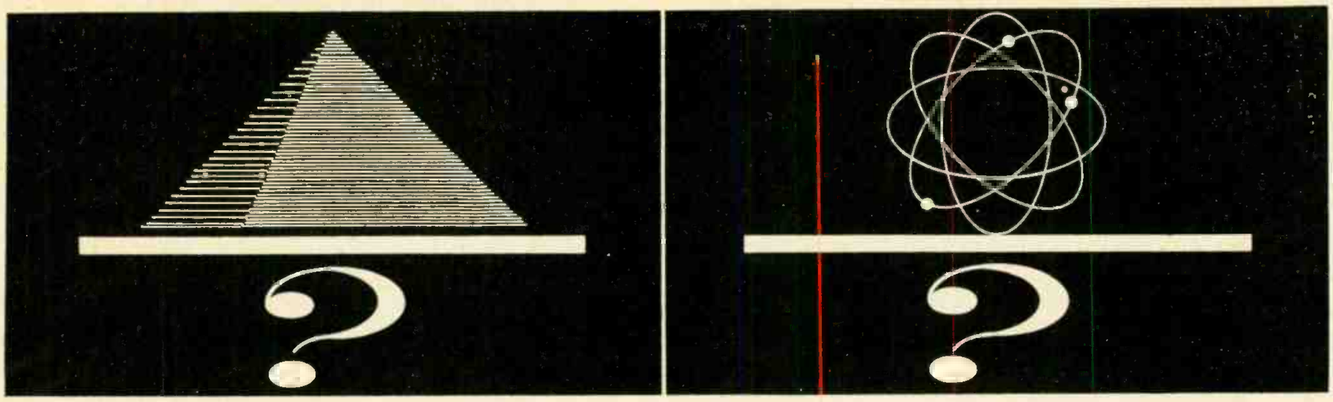

WHAT IS THE COMMON DENOMINATOR OF AN ANCIENT EGYPTIAN PYRAMID AND A MODERN ELECTRONICS CAREER?

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The ancient pyramids were built on strong foundations and thus have endured extensive changes in their environment. How about your electronics career? Is it built on a solid foundation of knowledge and understanding? Can the foundation under your electronics career endure the rapid changes now occurring in the electronics industry?

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Earn Your FCC License & Associate Degree

You have heard and read, over and over again, about how important an FCC license is to your success in electronics. It is certainly true that an FCC license is important — sometimes essential — but it's not enough! Without further education, you can't make it to the top. Get your FCC license without fail, but don't stop there. To prepare for the best jobs, continue your electronics education and get your degree.

This kind of thinking makes good common sense to those who want to make more money in electronics. It also makes good common sense to prepare for your FCC license with the School that gives degree credit for your license training — and with the School that can then take you from the FCC license level to the DEGREE level. (The first two semesters of the six-semester Grantham degree curriculum prepare you for the first class FCC license and radar endorsement.)

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LOOKING AHEAD

By DAVID LACHENBRUCH

"Newspaper of the air"

The concept of a non-facsimile TV "newspaper" is under investigation by the "Future of TV" Committee of the National Association of Broadcasters, it has been revealed by John F. Dille, Jr., chairman of the committee. In place of the print-out device required by home fax, the "electronic newspaper" system would have a memory circuit housed in the TV set or alongside it. The newspaper would be transmitted continuously in TV frames rather than pages. The viewer, at his convenience, would turn on his set and press the "index" button. An index frame would appear on his TV screen, outlining what had been transmitted that day. Then the reviewer would press the appropriate button for whatever he wished to read—news, sports, comics, obituaries—and the proper frame would appear on the screen.

Electronic contraceptive

The intra-uterine device, or IUD has been widely hailed as the best hope for population control in underdeveloped countries. It's a small mechanical device which prevents conception when properly inserted in the uterus. RCA recently was granted a patent on an electronic IUD which helps overcome some shortcomings of the mechanical version—possible insertion, displacement or loss. The RCA patent covers a tiny oscillator built into the IUD, which gives off signals when under test by an electromagnetic instrument—one type of signal if the device is properly placed, other types of signals if distorted or out of position. Of course, if the IUD is missing, there's no signal. To permit physicians to determine whether the IUD is correctly in place, women merely would walk past a detection instrument operated by a technician. If the proper signal is detected, everything is in order.

Airborne CATV

The semi-glamorous name "Quasi-Laser" is applied to a new system proposed to solve the problems of big-city cable television. To avoid the extremely high costs of laying underground cables to connect apartment buildings in high-density areas, the new proposal is to send the signals through the air. The plan which Chromalloy American Corp. and Laser Link Corp. are proposing to the FCC for testing in Brooklyn, N.Y., involves sending a wide band of information—12 or 20 TV channels—via the "upstairs" frequencies. These frequencies are so high that they are presently unassigned to any service and will not result in crowding the portion of the spectrum now used. The frequencies proposed are in the area of 42 GHz, below the infra-red light spectrum.

A new method of modulation is claimed to make it possible to beam wide bands of information at low power from a high point for several miles in all kinds of weather. Low-cost receiving antennas on building tops would receive the signals, which would be reconverted to TV carrier frequencies. To divert signals to lower buildings not within line-of-sight to the transmitter, Laser Link would use metallic "mirrors" on high buildings, deflecting signals to lower ones. The "Laser Link" name is derived from the fact that frequencies being used are toward the end of the spectrum occupied by light waves.

More on X-rays

Radiation-conscious TV set manufacturers have compiled a summary of factory quality-control tests on color sets from July 1, 1967, to March 3, 1968. Of 19,225 sets tested, 11,696 were found to emit no measurable radiation; 7525 tested below 0.5 milliroentgen (mR) per hour at 5 cm. Only four showed radiation above the unofficial standard of 0.5 mR. The four were corrected before leaving the factory.

Remote without motors

A new remote-control system that will appear on some Motorola solid-state color sets this summer substitutes semiconductor devices for motors or stepping relays. The heart of the system is an encapsulated "memory module" containing a neon bulb, which acts as an electronic switch, a capacitor and an insulated gate field effect transistor (IGFET). The capacitor's charge is varied up or down in response to the direction of the control desired (for example, to increase or decrease volume), providing a continually variable control. The capacitor is capable of retaining a charge for 1000 hours or more, thereby assuring its ability to hold at any desired setting.

Although Motorola demonstrated the system with volume control only, its color remote unit is expected to have three infinitely variable non-motorized controls, plus such conventionally activated functions as channel change (still motorized) and off-on. Elimination of the mechanical channel selection function presumably must await the widely anticipated arrival of variable-capacitance diode tuning for the American 82-channel TV system.

Cassette-leggers?

The zooming popularity of the easy-to-operate cassette recorder has some of the record companies worried. What concerns them is the danger of a roll-your-own trend, as consumers begin to make their own recordings from the radio. RCA Victor Vice President Norman Racusin, who heads the Record Division, told a recent merchandisers' convention that the cassette represents the first serious threat to the recording industry. He called for legislation or changes in marketing or technology to head off massive bootlegging. There already are several brands of combination radio and cassette recorders on the market and it's believed that some major manufacturers plan to incorporate stereo casette decks in their forthcoming phonograph consoles.

The reel-to-reel recorder never was considered a serious threat by record manufacturers because of its relatively limited market. But now they envision a possible invasion of the marketplace by tens of millions of simple, low-cost units, and you can expect a top-priority attempt to head off subrosa recording by cassetteers. **R-E**

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FEATURE

CONSTRUCTION PROJECTS

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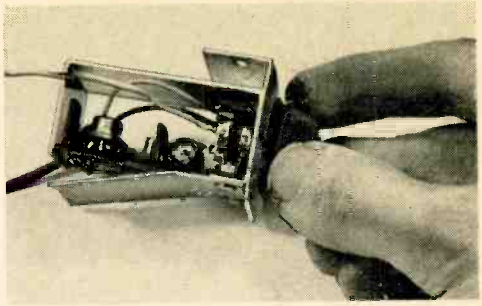
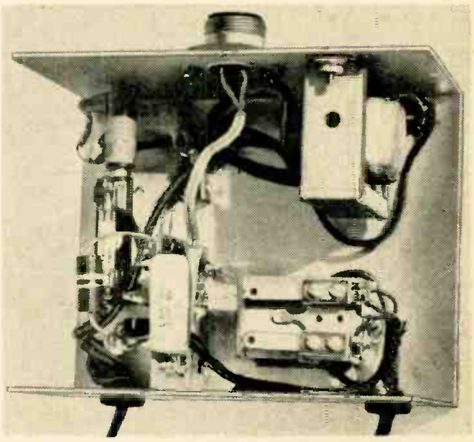


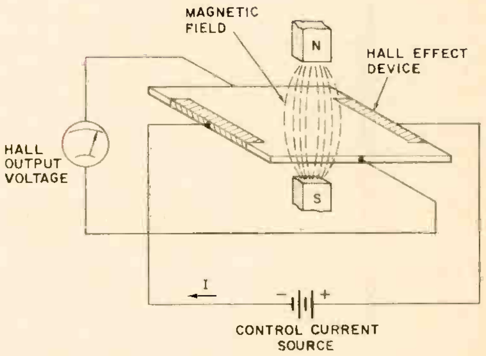
Now there's no need to reach for the windshield wiper knob every few seconds when driving through light mist or on slush-covered roads. You can set this Automatic Pause Controller to obtain any desired pause between sweeps, while the wiper still operates at normal speed.

See page 32



Power relays are useful in dozens of projects, but usually lack sensitivity because of heavy contacts. Find out how to soup-up relay sensitivity and trigger 30-amp jobs as little as 200 μA.

See page 36



Hall-effect devices are growing in number as today's technology makes possible new uses for Hall's 19th-century discovery. Learn about this important principle, and its applications in science and industry.

See page 42

RADIO-ELECTRONICS, JULY 1968. Volume XXXIX, No. 7
Published monthly by Gernsback Publications, Inc., at Ferry St., Concord. N. H. 03302.
Editorial. Advertising, and Executive offices: 200 Park Ave. S., New York. N. Y. 10003. Subscription Service: Boulder, Colo. 80302.
Second-class postage paid at Concord. N. H. Printed in U.S.A. One-year subscription rate: U. S. and possessions, Canada, $6. Pan-American countries. $7. Other countries. $7.50. Single copies: 60c.

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

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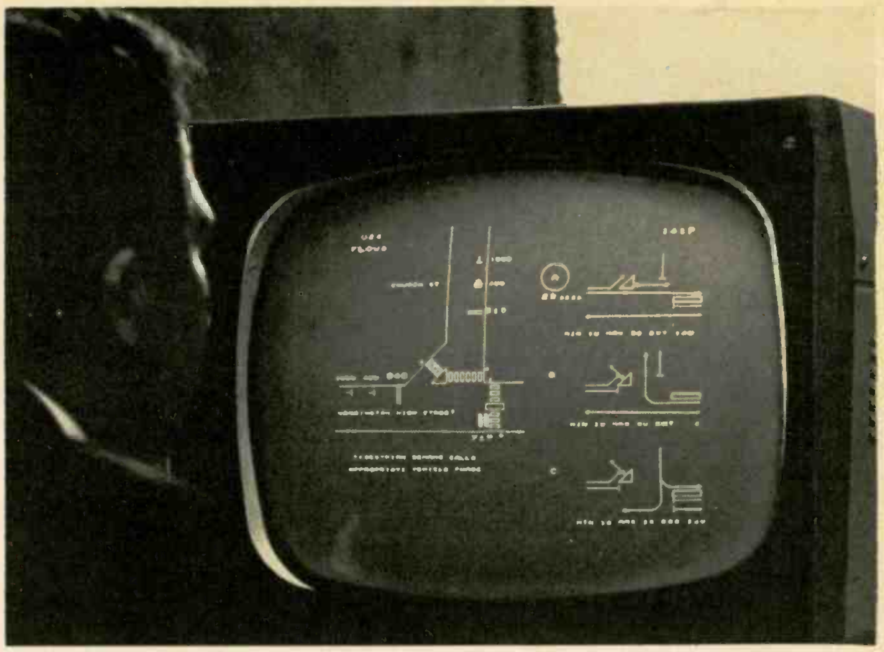
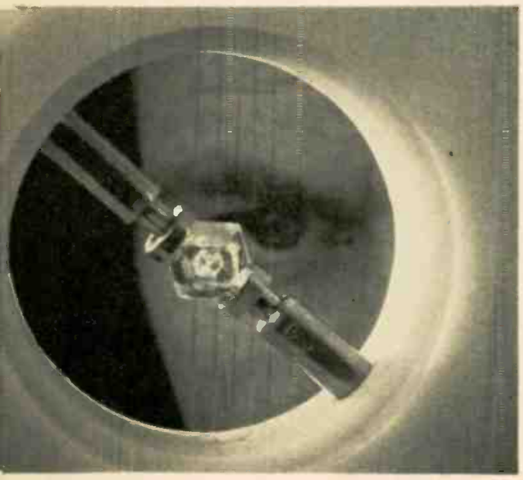
Telephone uses IC's—An experimental electronic telephone recently shown by Bell Labs uses hybrid integrated circuits and a tone ringer instead of a electro-mechanical bell. Buttons for Touch-Tone dialing are behind the earpiece. Automatic voice loudness circuits in the handset are among the features in the new design.



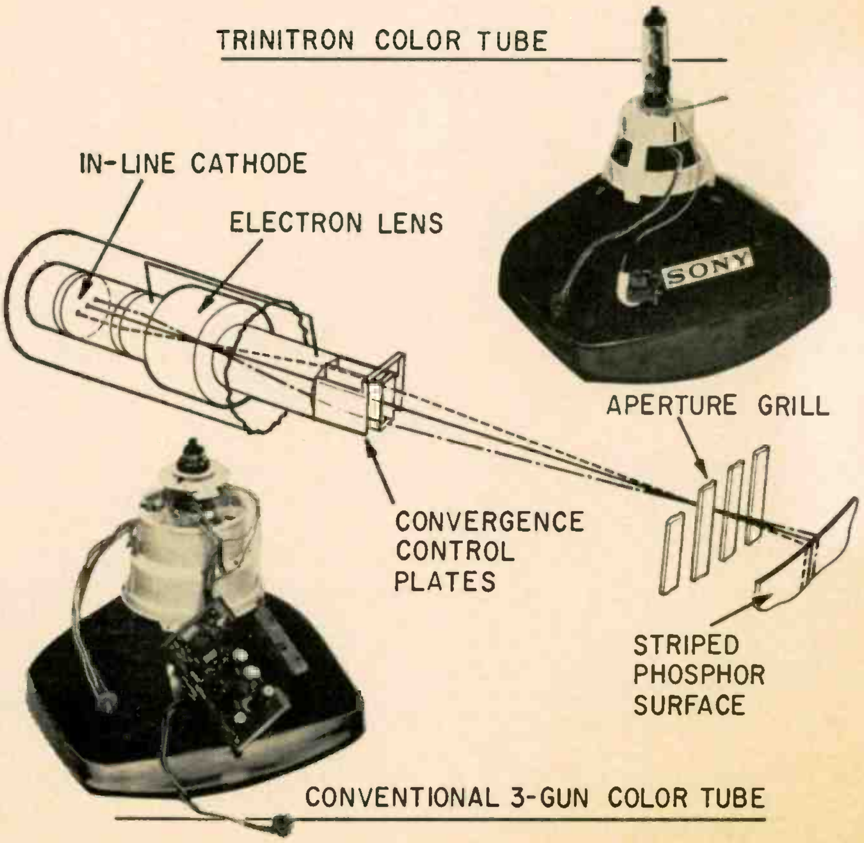
Computer monitors London traffic—Street names, traffic flow, pedestrian crossings and other information are shown on this computer-controlled display system to be installed in New Scotland Yard for experimental control of traffic. Marconi Company will build and install system.

NEWS BRIEFS



Light transducer—Light transmission through a "sandwich" of this crystal and Polaroid sheet can be varied by changing voltage applied to the crystal. The crystal (hexamethylenetetramine) is compressed for studying electro-optic and piezo-optic effects that influence light polarization. General Motors Research Labs "grew" material from original "seed" crystal.

Single-gun color TV tube—Sony's new Trinitron tube utilizes a single electron gun with three in-line cathodes. Electron beams are electrostatically converged through a vertically slitted aperture grill to vertical phosphor stripes on the screen. Sony claims tube has twice the brightness of conventional tubes. Company plans to introduce Trinitron sets to the US market in 1969.



Lightweight color TV camera—An 18-lb digital-control unit has been developed by CBS Labs for coverage of 1968 presidential conventions. A base station can focus, center and provide color registration for six cameras via microwave signals at a distance of nearly 3 miles.

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Here's a new, complete ICS course in TV Servicing that costs less than $100.

With the first two texts, you can repair 70 percent of all TV troubles.

You need no previous experience to take this complete, practical course in TV Repairing.

You don't even have to know a vacuum tube from a resistor. Yet in a matter of months, you can be doing troubleshooting on color sets!

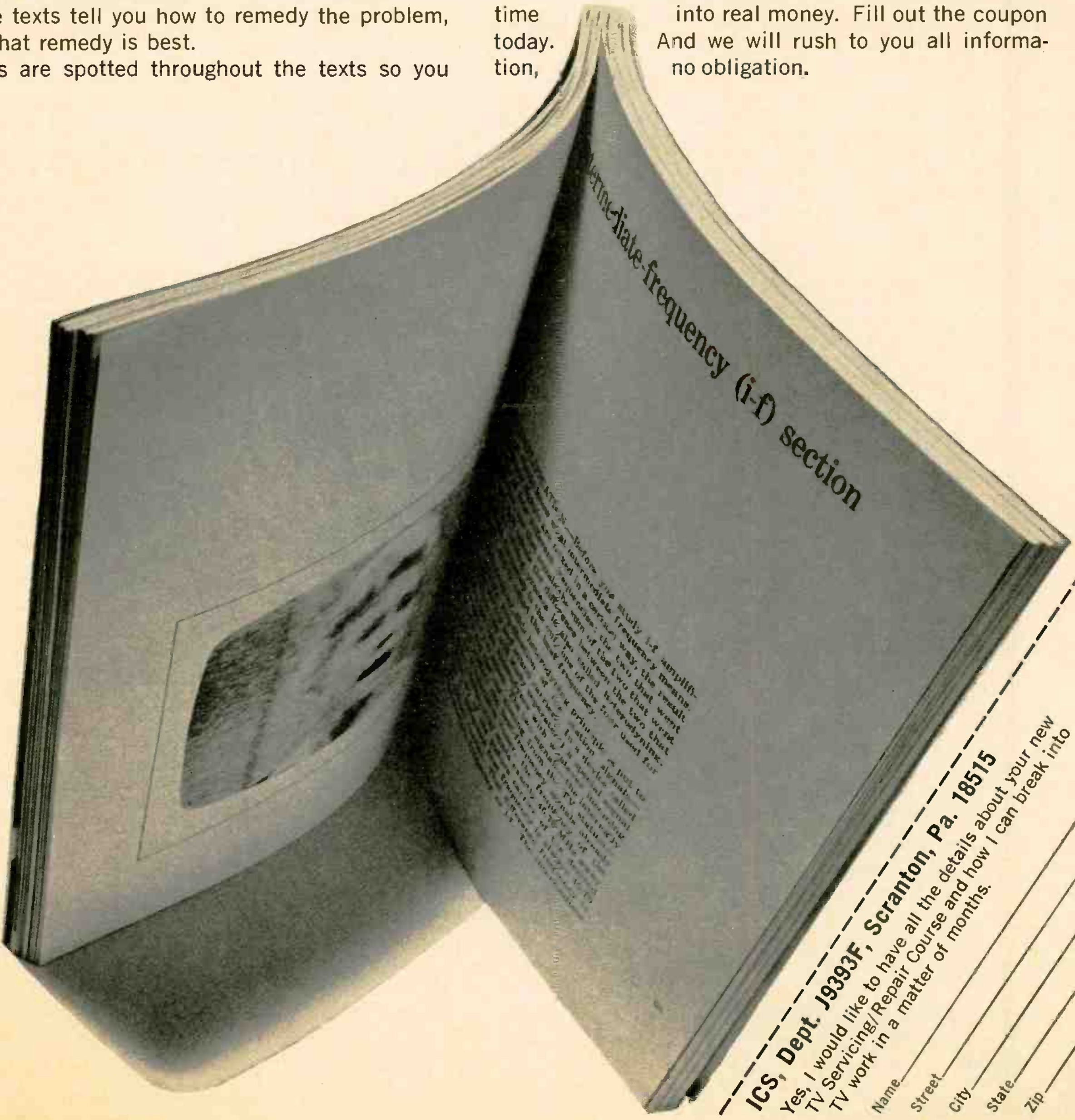
Course consists of 6 texts to bring you along quickly and easily. 936 pages of concise, easy-to-follow instruction, plus 329 detailed illustrations. You also receive a dictionary of TV terms geared directly to course material so you'll understand even the most technical terms. The dictionary will come in handy even after you've finished your course.

Instruction is simple, very easy to grasp. Photos show you what a TV screen looks like when everything is normal, and what it looks like when trouble fouls it up. The texts tell you how to remedy the problem, and why that remedy is best.

Quizzes are spotted throughout the texts so you can check your progress. At the end of the course, you take a final examination. Then you get the coveted ICS® diploma, plus membership in the ICS TV Repairman Association.

By the time you've finished the course, you should be able to handle tough, multiple TV problems, on color sets as well as black and white.

This new TV Servicing and Repair Course has been approved by National Electronic Associations for use in their Apprenticeship program. Because of its completeness, practicality and price, it is the talk of the industry. The cost is less than $100—just slightly over ½ the price of any comparable course on the market today. Remember, the sooner you get started on your course, the sooner you'll be turning your spare time into real money. Fill out the coupon today. And we will rush to you all information, no obligation.



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Yes, I would like to have all the details about your new TV Servicing/Repair Course and how I can break into TV work in a matter of months.

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One of a series of brief discussions by Electro-Voice engineers

ADDING "HIGHS" TO HIGH POWER PA

JOHN R. GILLIOM
Chief Engineer, Loudspeakers

Sound system intelligibility can often be a complex problem since it will vary with ambient noise level and type, usable system level and response, and room reverberation. As a result, there are probably thousands of sound systems with marginal effectiveness despite more than sufficient power handling capacity to overcome the measured noise.

The reason for the failure of these systems often lies in the design of the typical high power PA driver. Most drivers rated at 50 watts or more have relatively massive voice coil and diaphragm assemblies. This sharply limits high frequency response, particularly in the 2 to 7 kc range. Since this range contributes significantly to intelligibility, the loss of highs has serious consequences under severe noise conditions.

Happily, most noise decreases in intensity with rising frequency, thus helping overcome the problem. But, if a driver with flat or rising response in the 2 to 7 kc region is used, much higher intelligibility can be assured often with a significant reduction in the amount of power needed.

To achieve this desired high frequency response, E-V PA drivers have unusually light voice coil assemblies that maintain high efficiency to 7 kc yet handle up to 60 watts of power (in the case of the model 1829). This power handling capacity has been obtained by the use of high temperature materials that maintain strength without adding to the moving mass. Careful design of the loading plug, plus the use of relatively large Indox V ceramic magnets also insures better voice penetration, even when used on conventional reentrant trumpets.

To further increase efficiency, E-V has also developed a series of compound horns that have proved unusually effective in high noise environments. Each side of the driver diaphragm is coupled to a separate horn. The highs (above 1 kc) are propagated from a short horn mounted coaxially with the large reentrant bass horn. This assures minimum high frequency losses due to internal reflections plus a sharp reduction in distortion at high levels.

Two such horns are available: the wide-angle FC100 (CDP*) and the concentrating AC100 for extended reach. 30, 40, and 50 watt compound drivers are offered for either type. This combination of low-mass drivers and high-efficiency horns has been found to contribute significantly to improved intelligibility under adverse noise conditions.

For reprints of other discussions in this series, or technical data on any E-V product, write:
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NEWS BRIEFS

MAGNETIC POLLUTION

If you think you've got problems with air and water pollution, pity the scientists at the National Bureau of Standards. They've been forced from a Washington, D.C., lab site by magnetic pollution. To make precise volt and ampere determinations and conduct other sensitive tests, NBS needs a magnetically "clean" environment. Growing interference in Washington from new buildings with high iron and steel content and from more automobiles in the area made a move to Maryland necessary. The new lab site is in a uniform earth's field, and is constructed with magnetically "transparent" materials.

SOLID-STATE HIGH-VOLTAGE RECTIFIERS

A color TV set with solid-state circuitry throughout will be introduced by Motorola this summer. The only vacuum tube in the company's Quasar line will be replaced with a solid-state high voltage rectifier. Existing Quaser models can be updated with a high-voltage module. Other 1969 models will also use the solid-state rectifier.

ELECTRICAL PLUG STANDARDS SET

Uniform standards for electrical plugs and receptacles have been established by the National Electrical Manufacturers Association. The new configuration makes it impossible, for example, to plug a 125-volt device into a 250-volt receptacle or a 30-amp load into a line rated at 15 amperes.

DIAMOND HEAT SINKS

Experiments at Bell Labs show that diamonds are also a semiconductor's best friend. Engineers have found that certain diamonds displace more heat than copper when used as heat sinks. Consequently, a silicon diode on a diamond chip will handle about four times more power. Low-cost, 1/10-carat industrial diamonds are used.

FUTURE TELEPHONE SIGNALS

Your telephone conversations will be chopped into 8000 or more coded digital pulses when the telephone industry adopts the pulse code modulation technique, according to General Telephone & Electronics. A carrier system using the technique has been developed by the company. Speech signals are converted into coded pulses for transmission over telephone lines. A detector at the receiver end recovers the original voice conversation. Greatly improved fidelity and efficiency are claimed over the present method of transmission over lines. **R-E**

Radio-Electronics

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RADIO-ELECTRONICS is published by Gernsback Publications, Inc.
President: M. Harvey Gernsback
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John J. Lamson,
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New York, N.Y. 10003, 212-777-6400

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Publishing & Distributing Co., Ltd., Mitre House, 177 Regent St., London W.1, England

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Look...but don't count!

Now...if you can guess (within 100 types) how many Amperex receiving tube types there are listed on this page... you'll qualify for our drawing and you may be one of a hundred winners of the world-famous Norelco Speedshaver or Lady Norelco.

Stop Counting! You're on your honor. We'll give you some clues without spoiling the fun. We can tell you that the line includes more than 650 Amperex-quality, U.S.-made tubes . . . plus the popular line of imported interchangeable types including the famous FRAME GRIDS and other Amperex proprietary tubes . . . plus the most complete line of European replacements for the imported car and home radios and hi-fi sets that you service.

Here are the simple rules of this simple contest. Look . . . but don't count the tubes listed on this page; then, by letter or postcard, mail your "best guess", postmarked no later than July 31st, 1968, to:
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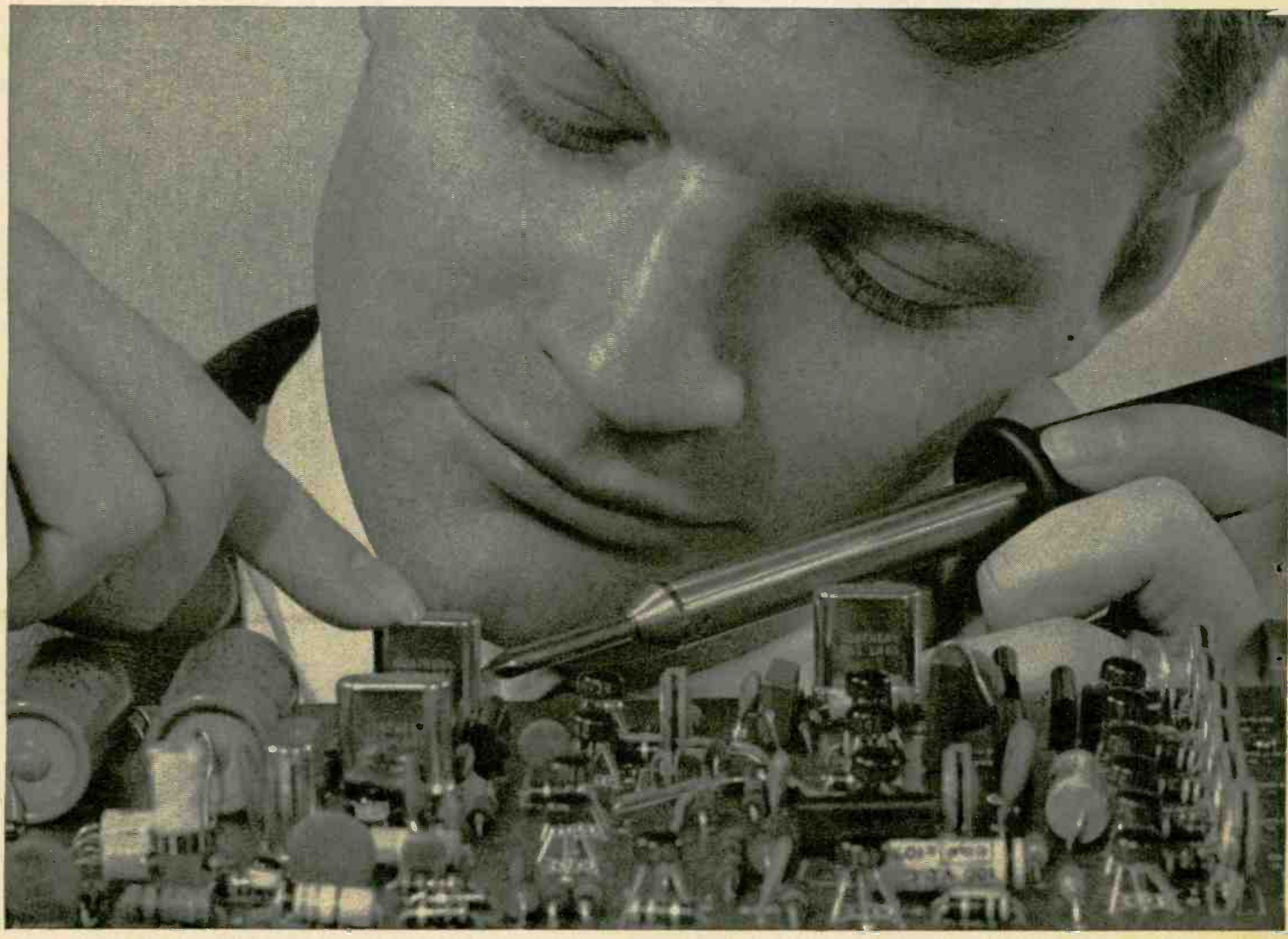

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Correspondence

IN THE SOUP WITH BLACK NOISE

The article, "Testing With Black Noise" by Peter E. Sutheim (April 1968), reminds me of a similar device which I developed in collaboration with my classmate, Sarkes Tarzian, while we were undergraduates at the University of Pennsylvania in 1923. We found that the tin coating on the soup can was too thin to form an effective Faraday shield . . . we had to enclose it in a piece of heavy aluminum foil with the edges gathered together to form a sack, fastened around the cable with a spring clothespin. Unfortunately, I can't seem to remember the purpose of our device. In those days, we had neither white or black noise, only purple noise.

RALPH A. KRAUSS
Philadelphia, Pa.

Thanks for your suggestion on improving Sutheim's methods. The diagram specified a black bean soup can. If you are substituting parts you may run into the trouble you mentioned. The device can also be used to test purple noise, with suitable filters, but nowadays there is very little need for this.

FIRE DETECTOR

I would like to see your magazine publish an article on fire-detection systems for buildings. Anything in this order proposed for the future?

WILLIAM C. METLER
New Shrewsbury, N. J.

Apparently your letter and our editorial efforts crossed in the mail, William. See June 1968 for a complete write up of Heathkit's new Wireless Alarm System Kit. Their system will protect you against smoke and unauthorized entry as well as fire.

AMATEUR RADIO

The April 1968 Noteworthy Circuits has an item on FET audio bandpass filters. In this article, *Break-In*, a New Zealand magazine, was mentioned. Could you please furnish me with the address of this magazine and any other information you have. I also enjoyed the article on the IC audio amplifier and would like to see more articles of this kind.

ROBERT H. KLAPHEKE
Louisville, Ky.

Write to Break-In, Box 1733, Christchurch, New Zealand, and they'll fill you in.

AC/DC CALIBRATOR IS NOT A POWER SUPPLY

I built the "Ac/Dc Calibrator for Scope and Voltmeter" by Peter E. Sutheim (February 1968) and it works very well. I do get a flicker on the neon bulb sometimes on dc—is that normal? It occurred to me that the calibrator might be used to power a 10-volt transistor radio, etc. with low current drain if a suitable filter could be added. Is this practical? If so, could you send me a sketch of a filter with part values?

JAMES R. SNYDER
Red Bank, N. J.

Flickering is a pretty common phenomenon in neon lamps. It shouldn't make any difference to the calibrator's operation unless the terminal voltage changes substantially during the flickering. You can power a transistor radio from the calibrator. The 10-volt terminal won't do, because the drain of a typical transistor radio (around 10 mA) would drag the voltage down to 7 or lower.

You can power the radio from the 100-volt terminal by using a dropping resistor of about 10,000 ohms, 2 watts in series between the terminal and the red (positive) battery lead of the radio. Between the two radio battery leads, connect an electrolytic capacitor of 100 to 500 μF, 15 volts. This should work nicely, but never disconnect the radio with the calibrator turned on. If you do, the load will be removed and the voltage across the added electrolytic will rise to 100 volts and destroy it.

To be completely safe, you would have to use a 100-μF, 150-volt capacitor across the battery leads, which is large and expensive. It can be done, but it's probably more satisfactory to build a simple little unregulated power supply for a few bucks.

ZENER WATTAGE

As a military instructor who on occasion teaches semiconductors, I must challenge the statement appearing in your article, "Update Your Solid-State TV Servicing," by Matthew Mandl (February 1968). It says: "The replacement [Zener diode] can

(continued on page 14)

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CORRESPONDENCE

(continued from page 12)

be of larger wattage, but must have the same voltage rating as the original. . ." Because this statement is not very specific, I feel it is a dangerous generalization. The simple regulator of Fig. 8, page 37, specifies a 5.6V Zener, but does not give the type number or specify wattage. A glance at the Dickson Diode Zener Diode Reference Chart shows that 5.6V Zeners are available with ratings from 250 mW to 50 watts.

This test current is usually appreciably less than the current that would produce maximum rated device dissipation. Device operation at appreciably less than the specified test current could possibly cause operation of the device at, or near the knee of, its characteristic curve, where its operation (if at all) would be unpredictable. The opposite extreme, operation at levels appreciably in excess of I_z could cause operation approaching maximum device dissipation levels. The higher case temperatures in most cases would make device derating mandatory for long service life. The 1000-ohm error-sensing resistor in Fig. 8 would limit current available to the Zener diode to a maximum of 12 to 20 mA, respectively, depending upon the assumptions that only the Zener is considered to be shorted or that both the Zener and the series pass transistors are considered to be shorted. With maximum available currents of these magnitudes, it is highly unlikely that anything Zeners in a range other than 400-mW to 1-watt would work effectively in this circuit.

M/SGT HAROLD L. STEPHENS
APO San Francisco

WIDER THE BAND, THE HIGHER THE FI?

I read with interest the article, "The Wider the Band, the Higher the Fi?" by Peter E. Sutheim (October 1967). I got lost in a few places during the interacting-phase discussions, so perhaps the idea presented below was discussed in the article, even though I didn't recognize it.

In square-wave testing, the square wave displayed is considered to include some finite number of multiples of the fundamental. Although some authorities place this number at 40, 10 is the commonly accepted figure. If an amplifier having poor response at 10 kHz is tested with a 1-kHz square (or sawtooth) wave, rounding of the leading corners of the waveform is observable. Most high-frequency musical sounds (castanets, blocks, etc.) are not sine waves but sharp transients whose waveforms more closely resemble short pulses or sawtooths.

If the same criteria held true for these waveforms as for test waveforms (which would seem logical), then a 20-kHz castanet sound will require a frequency response of at least 200 kHz to be reproduced accurately. It may require as much as 800 kHz! Whether or not the amplifiers driving the source or speaker dynamics prevent these waves from reaching the listener undisturbed is a consideration outside my knowledge and experience.

NOEL NYMAN
Seattle, Wash.

Your comments raise two points. First, you are correct that the vast majority of musical waveforms are not sinusoids but repetitive pulses of one sort or another. Since we're talking not about absolutes but about relative matters, in quantitative terms, the question "How short?" becomes important. So the first point is, Does music actually contain waveforms with rise times sufficiently steep to require amplifier frequency response that goes substantially beyond 20 kHz? The second point is: even if conventional musical instruments do produce significant amounts of energy above 20 kHz, can that energy make any difference to us, assuming we accept the conventionally agreed-on upper hearing limit of 15 to 20 kHz? (And that has not been successfully challenged, at least not on the basis of single-tone hearing tests.)

The only reason for producing spectacularly flat response out to 100 to 200 kHz would seem to be so that you can get nice-looking 10-kHz square waves on an oscilloscope, but that has little relevance to what we hear. Until someone demonstrates that human beings can hear sounds above 20 kHz, the question of whether musical instruments produce them is only academic.

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(continued on page 16)

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(continued from page 14)

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ELLIOT KANTER
Signetics Corp.
Rolling Meadows, Ill.

HORSEFLIES, TRACTORS AND MR. KIRCHHOFF

I certainly pity the poor fellow who is trying to obtain an understanding of the current and voltage relationships in an ac circuit on the basis of the article, "Horseflies, Tractors and Mr. Kirchhoff" (March, 1968). He will have a lot to "unlearn" when he finally is exposed to a truthful and responsible presentation of the subject. I wish to call attention to the fourth paragraph in the last column on page 71, beginning with the words, "The meter reads the highest voltage . . ."

There is *never* an instant when the voltage across one component is 7.1 and across the other component it is 2.9 volts (if a voltage of 10 volts peak to peak is applied to the circuit, as postulated in the beginning of the article). To see this, it is only necessary to plot two sine waves of equal amplitude, displaced 90° with respect to each other, and then add them up.

WALTHER RICHTER
CONSULTING ELECTRICAL ENGINEER
Milwaukee, Wis.

I read, with amusement, "Horseflies, Tractors and Mr. Kirchhoff" by Wayne Lemons (March 1968). I wonder, though, what Messrs. Kirchhoffs, Pythagoras and Bean would have to say about this: Two resistors of different values tied together in a circle, the voltage across each resistor is zero, the sum of the voltages around the loop is, of course, also zero, and all is well. However, put a changing magnetic field through the loop, perhaps by placing the loop around the core of a transformer, and it's a different story. The changing magnetic field induces a current in the loop, the same current in each resistor. The sum of the voltages around the loop is no longer zero.

Don't think harshly of Mr. Kirchhoff, though. The sum of the voltages around a loop is always zero if there is no magnetic field present. Messrs. Faraday or Maxwell could have told him that the sum of the voltages around a loop is actually equal to the time derivative of the magnetic flux through the loop. Oh, well.

HOWARD G. SCHIFFMAN
Westwood, Mass.

R-E

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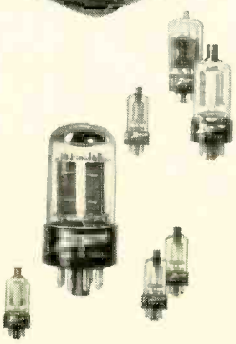

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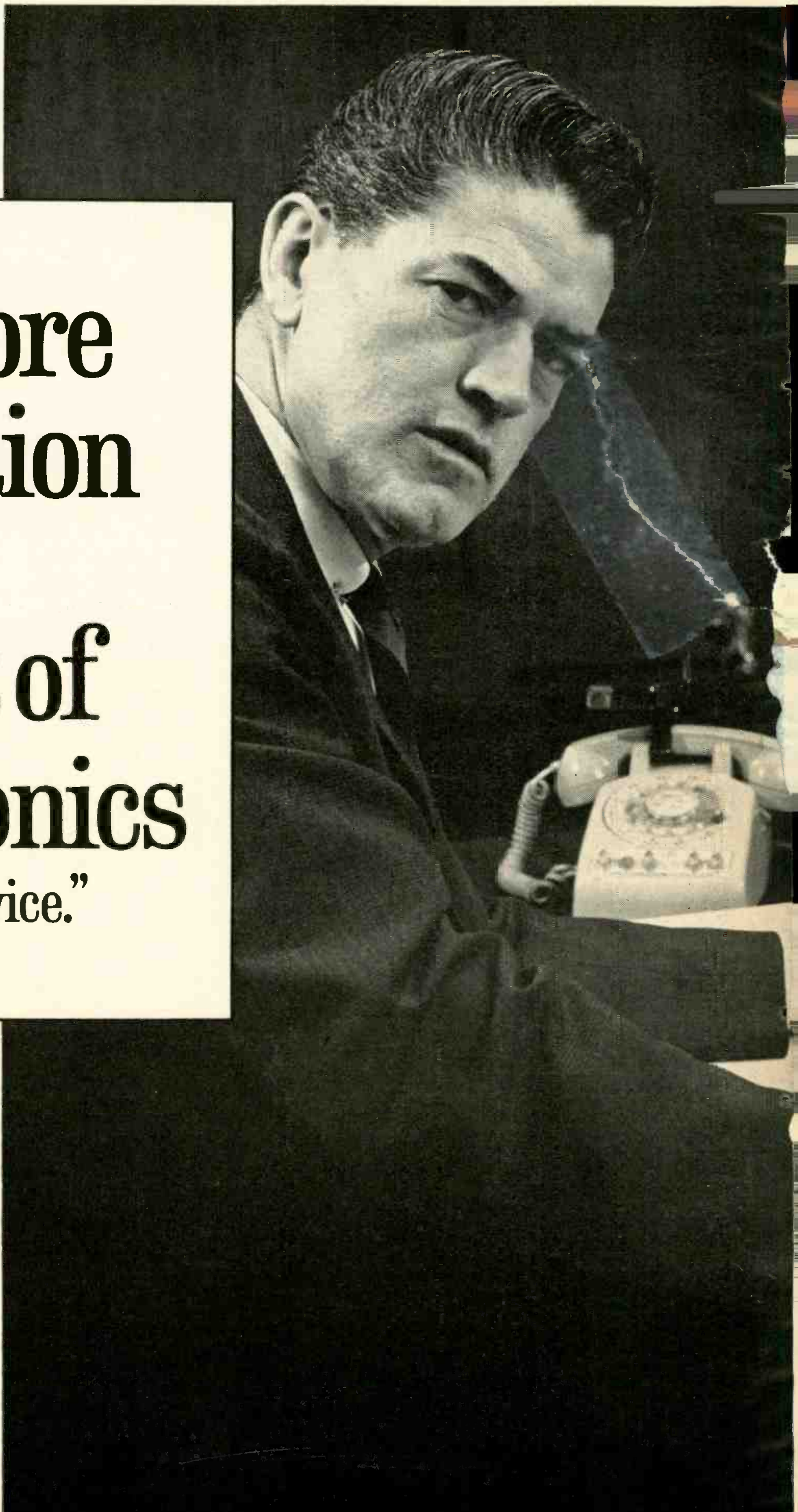

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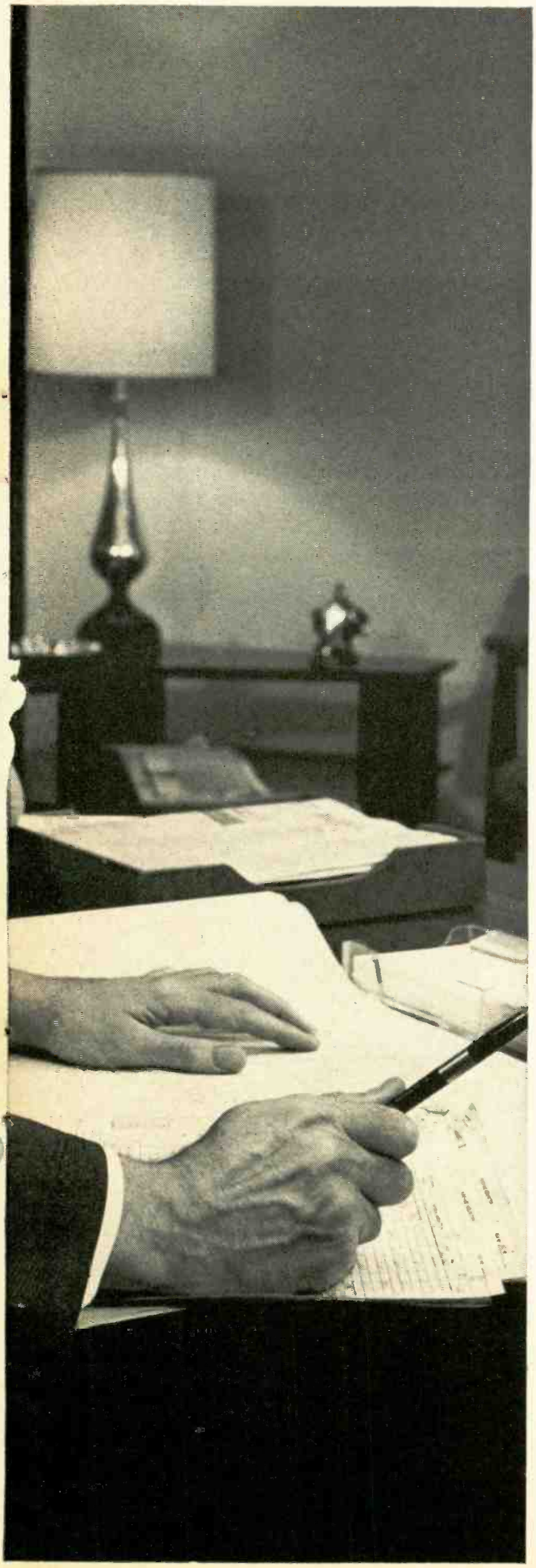

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For the man who already owns a fine stereo tuner, Heath now offers the famous amplifier section of the AR-15 receiver as a separate unit. The new AA-15 Stereo Amplifier has the same superb features: 150 watts Music Power; Ultra-Low Harmonic & IM Distortion (less than 0.5% at full output); Ultra-Wide Frequency Response (±1 dB, 8 to 40,000 Hz at 1 watt); Ultra-Wide Dynamic Range Preamp (98 dB); Tone-Flat Switch; Front Panel Input Level Controls; Transformerless Amplifier; Capacitor Coupled Outputs; Massive Power Supply; All-Silicon Transistor Circuit; Positive Circuit Protection; "Black Magic" Panel Lighting; new second system Remote Speaker Switch; 120/240 VAC. 26 lbs. *Walnut cabinet AE-18, $19.95.

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2-Meters at low cost. And the HW-17 Transceiver has 143.2 to 148.2 MHz extended coverage to include MARS, CAP, and Coast Guard Auxiliary operation. Output power of tube-type transmitter is 8 to 10 watts, AM. 4 crystal sockets plus VFO input. Relayless PTT operation. Double conversion solid-state superhet. Receiver has 1 uV sensitivity with prebuilt, aligned FET tuner, ANL, Squelch, "Spot" function, and lighted dial. Signal-strength/relative power-output meter. Battery saver switch for low current drain during receiving only. 15 transistor, 18 diode, 3 tube circuit on two boards builds in about 20 hours. Built-in 120/240 VAC, 50-60 Hz power supply and 3" x 5" speaker; low profile aluminum cabinet in Heath gray-green; ceramic mic. and gimbal mount included. 17 lbs. *Optional DC mobile supply, HWA-17-1, $24.95.

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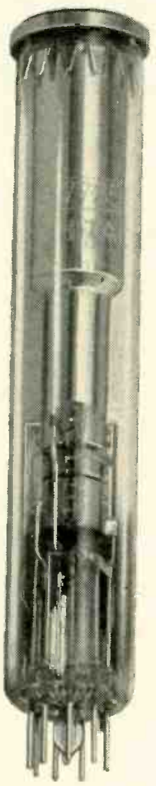

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Circle 19 on reader's service card

In the Shop . . . With Jack

By JACK DARR

THE CASE OF THE "M-SHAPED" SYNC

THE TV SET THAT "ISN'T WORKING quite right" is the worst kind. Nothing visible that you can put your finger on—just a sort of "10% off" in performance. So, you can have a problem, and not notice it in time.

I got into this with a Motorola TS-908 color chassis. I put in a new color picture tube and cooked the set on the bench for half a day. It worked beautifully. About a week after it had gone home, the irate owner called me: "It isn't working right! It jumps in and out. The color acts funny, too."

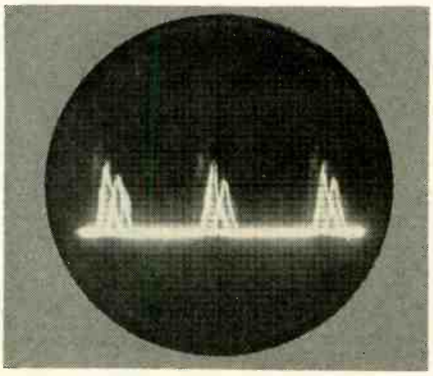

Fig. 1—This agc keying pulse strayed into the horizontal afc and color apc circuits, causing jittery sync and color.

Well, this wasn't much of a description to go on, but a look at the set itself showed me what "jumps in and out" was—unstable horizontal sync! This, of course, affected the color by fouling up the burst-phase timing and so on. So, back to the shop.

On the bench, the horizontal hold control showed a very peculiar reaction. Overall range was pretty bad, and the horizontal sync was jittery. So, up scope and at 'em!

Poking around in the horizontal afc circuit, I saw a very odd-looking waveform. Tracing this back, I got the same thing on the grid of the first sync clipper. The sync pulse (Fig. 1), instead of being nice and sharply peaked, was a distinct "M" and pretty jittery. In fact, it jittered so badly that it was hard to photograph; I had to "technically augment" the negative with a soft lead pencil to show the actual waveshape of the pulse.

While scratching around in that circuit, I found that the +200-volt line also had a 10–15-volt p-p sawtooth on it. This was jittery, too. Well, well. Things were looking up.

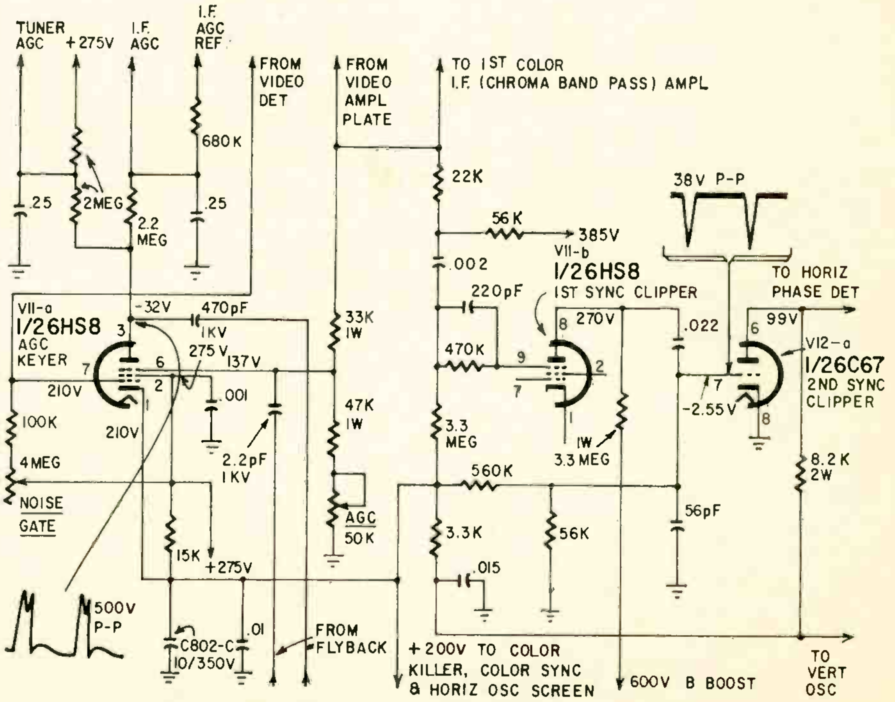

Fig. 2—Agc and sync circuits in the Motorola TS-908 color TV chassis. Unstable horizontal sweep and jittery color were caused by a defective filter capacitor (C802-c) which permitted the agc keying pulses to appear on the 200-volt line.

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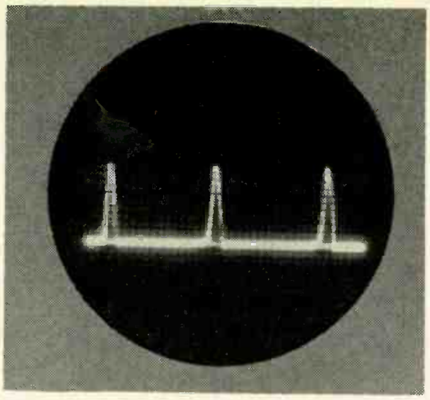

Fig. 3—The correct pulse on the first sync-clipper grid is 34 volts peak-to-peak.

This kind of junk floating around on what should be a nice clean dc supply line always means trouble, and the kind that means an open capacitor somewhere. Using the scope in the agc and sync circuits (Fig. 2), we traced the trouble to C802-c, a 10-μF electrolytic connected to the cathode of the 6SH8 (V11-a) agc keyer tube–the 200-volt B+ source.

Hooking the scope to the snyc-clipper grid, I bridged a new 10-μF electrolytic across C802-c; the "M" shape of the waveform "flipped up" and the twin peaks merged to form a much better-looking sharp spike (Fig. 3)! The horizontal sync improved, the color lock went back to normal and things looked better all around.

Now, wha' hoppen? The 6HS8 agc tube was keyed by a pulse from the flyback, as usual. This keying pulse *did* have a *normal* "M" shape, according to the waveform shown on the schematic. Apparently, the lack of proper bypassing on the agc tube's *cathode* was letting this "M"-shaped pulse stray into the other circuits. The slight delay in the pulse, together with the deformation of the peak of the pulse, was causing the horizontal afc, burst keyer and a lot of other things to go nuts trying to keep up with it! They would key first on one peak of the "M", then the other, and I got the jitter.

So, I replaced C802. If you find a bad section of a multiple electrolytic, replace the whole thing! Whatever condition exists inside the can and that made one section go bad will very soon get the others, and then you have a nice, free callback.

If there's a moral to this, it should be, "Look 'em over *very* carefully before you let 'em out of the shop!" Look out for those "just a little bit off" things, such as weak vertical sync or horizontal sync, jitters, and the like. After the average set owner has paid for repairs, he gets just a little more sensitive than he was before! So, be darn sure the thing's working *right* before you let it out of that door! **R-E**

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How to get into

One of the hottest money-making fields in electronics today–servicing two-way radios!

HE'S FLYING HIGH. Before he got his CIE training and FCC License, Ed Dulaney's only professional skill was as a commercial pilot engaged in crop dusting. Today he has his own two-way radio company, with seven full-time employees. "I am much better off financially, and really enjoy my work," he says. Read here how you can break into this profitable field.

More than 5 million two-way transmitters have skyrocketed the demand for service men and field, system, and R&D engineers. Topnotch licensed experts can earn $12,000 a year or more. You can be your own boss, build your own company. And you don't need a college education to break in.

HOW WOULD YOU LIKE to start collecting your share of the big money being made in electronics today? To start earning $5 to $7 an hour... $200 to $300 a week... $10,000 to $15,000 a year?

Your best bet today, especially if you don't have a college education, is probably in the field of two-way radio.

Two-way radio is booming. Today there are more than *five million* two-way transmitters for police cars, fire department vehicles, taxis, trucks, boats, planes, etc. and Citizen's Band uses—and the number is still growing at the rate of 80,000 new transmitters per month.

This wildfire boom presents a solid gold opportunity for trained two-way radio service experts. Many of them are earning $5,000 to $10,000 a year *more* than the average radio-TV repair man.

Why You'll Earn Top Pay

One reason is that the United States Government doesn't permit anyone to service two-way radio systems unless he is *licensed* by the Federal Communications Commission. And there simply aren't enough licensed electronics experts to go around.

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Another reason two-way radio men earn so much more than radio-TV service men is that they are needed more often and more desperately. A home radio or television set may need repair only once every year or two, and there's no real emergency when it does. But a two-way radio user must keep those transmitters operating at all times, and *must* have their frequency modulation and plate power input checked at regular intervals by licensed personnel to meet FCC requirements.

This means that the available licensed experts can "write their own ticket" when it comes to earnings. Some work by the hour and usually charge at least $5.00 per hour, $7.50 on evenings and Sundays, plus travel expenses. A more common arrangement is to be paid a monthly retainer fee by each customer. Although rates vary widely, this fixed charge might be $20 a month for the base station and $7.50 for each mobile station. A survey showed that one man can easily maintain at least 100 stations, averaging 15 base stations and 85 mobiles. This would add up to at least $12,000 a year.

Be Your Own Boss

There are other advantages too. You can become your own boss—work entirely by yourself or gradually build your own fully staffed service company. Instead of being chained to a workbench, machine, or desk all day, you'll move around, see lots of action, rub shoulders with important police and fire officials and business executives who depend on two-way radio for their daily operations. You may even be tapped for a big job working for one of the two-way radio manufacturers in field service, factory quality control, or laboratory research and development.

How To Get Started

How do you break into the ranks of the big-money earners in two-way radio? This is probably the best way:

1. Without quitting your present job, learn enough about electronics fundamentals to pass the Government FCC Exam and get your Commercial FCC License.
2. Then get a job in a two-way radio service shop and "learn the ropes" of the business.
3. As soon as you've earned a reputation as an expert, there are several ways you can go. You can move *out* and start signing up and servicing your own customers. You might become a franchised service representative of a big manufacturer and then start getting into two-way radio sales, where one sales contract might net you $5,000. Or you may even be invited to move *up* into a high-prestige salaried job with one of the major manufacturers either in the plant or out in the field.


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The United States of America

NUMBER P1-20-6490

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

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SPECIMEN

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By the time you've finished your CIE course, you'll be able to pass the FCC License Exam with ease. Better than nine out of ten CIE-trained men pass the FCC Exam the first time they try, even though two out of three non-CIE men fail. This startling record of achievement makes possible the famous CIE warranty: you'll pass the FCC Exam upon completion of your course or your tuition will be refunded in full.

Ed Dulaney is an outstanding example of the success possible through CIE training. Before he studied with CIE, Dulaney was a crop duster. Today he owns the Dulaney Communications Service, with seven people working for him repairing and manufacturing two-way equipment. Says Dulaney: "I found the CIE training thorough and the lessons easy to understand. No question about it—the CIE course was the best investment I ever made."

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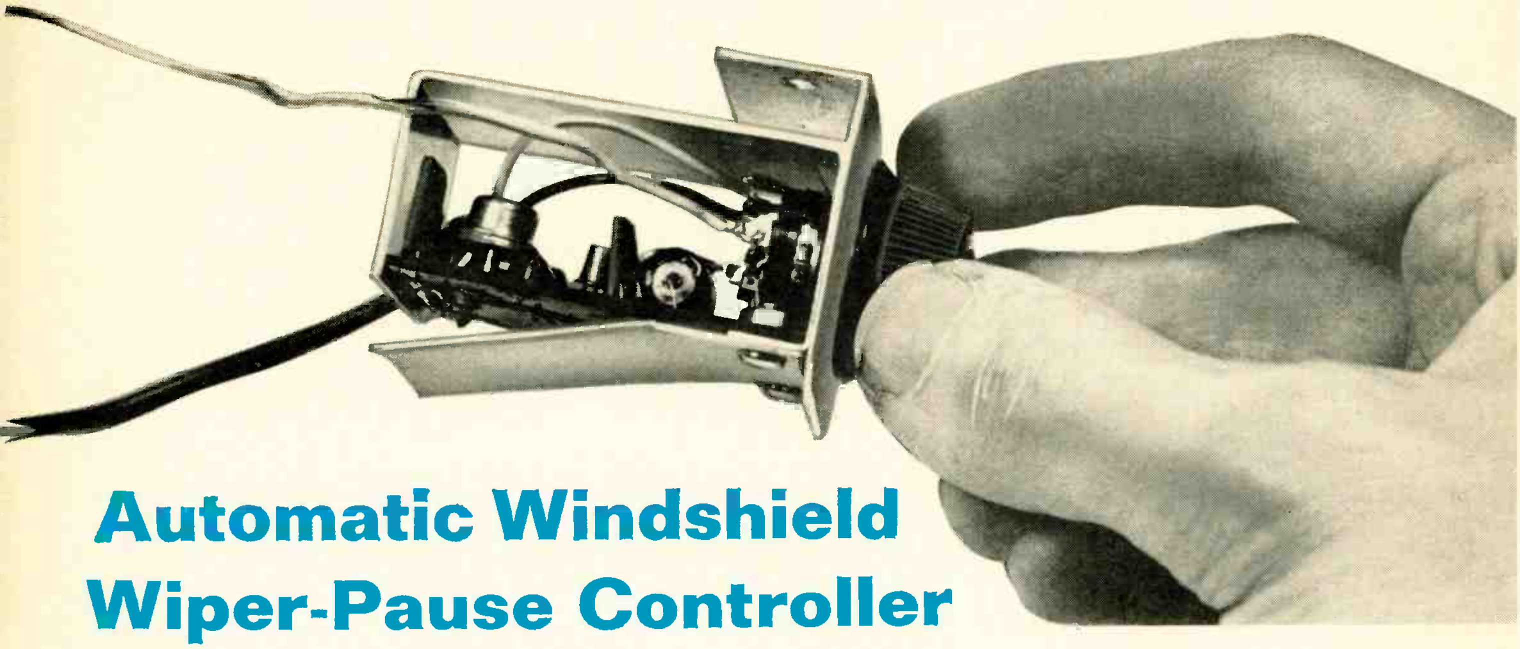

Automatic Windshield Wiper-Pause Controller

Wipe . . . 1 . . . 2 . . . 3 . . . Wipe . . . 1 . . . 2 . . . 3 . . . Wipe

By S. B. GRYNKEWICZ

LIVES THERE A DRIVER WHO HASN'T encountered this: A light mist hangs in the air. Traffic is just heavy enough so that those @#!90-drivers-in-a-hurry periodically whizzing by you leave a thin coating of dirt on your windshield.

If you're like me, you hate to see those wiper blades flicking back and forth, wearing away, and giving a grit-polish to an expensive windshield. Turning the wipers on and off and reaching for the knob every few minutes didn't appeal to me, so I decided to let electronics do the job.

With this Automatic Pause Controller (APC), you can operate the windshield wiper at its normal speeds in a normal manner (no pause between sweeps) or set the control knob to obtain a desired pause between sweeps . . . 1 second, 2 seconds . . . 15 seconds . . . It's the pause that makes the difference. However, each sweep occurs at normal speeds.

The unit will not operate with vacuum-operated wipers. Electric wipers have been in vogue for the past 15 years, and unless you have an older car the chances are you can use APC. Federal regulations require that all cars built after 1967 have two-speed wiper systems.

Mechanical layout of the automatic wiper-pause controller is not critical. See variation above. Build it to fit your car.

All windshield-wiper motors have a built-in cam-operated "park" switch (S3 in Fig. 1) to keep the wiper motor running until the wiper blades return to their park position; even after the wiper switch on the dashboard is turned off. It's this cam-activated switch that makes the APC possible.

Two silicon semiconductors, a unijunction transistor (Q1) and a silicon-controlled rectifier (SCR1) are used in the APC. The SCR, which switches the wiper motor on, is triggered by preset pulses from relaxation oscillator Q1. Once the SCR conducts, it stays on until its anode voltage is zero with respect to its cathode.

Operation of the relaxation oscillator is simple. When power is applied to the APC through S1 (S2 off), C1 begins to charge to the supply voltage through R1 and R2. The charge across C1 also appears across the emitter and base 1 of Q1. When the charge reaches a critical level, it drains off through Q1's emitter, base 1 and R3 until the emitter drops enough to stop conducting. (The critical level depends upon the transistor's characteristics.) Capacitor C1 recharges and the cycle is re-

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peated. Value of R1 and C1 and the setting of R2 determine the charging time. The greater the value of resistance and capacitance, the longer it takes to charge the capacitor and the longer the pause between wiper sweeps.

When Q1's emitter voltage goes positive enough, current flows through R3, Q1's base 1 and base 2, and R4. The greater the current flow, the greater the voltage drop across R4. This voltage is also across the SCR's gate and cathode. When the voltage drop across R4 reaches a sufficient level it causes the SCR to conduct and turn on the windshield wiper motor.

Once the motor starts to operate, the cam-activated switch closes and keeps the motor running even though it shorts out the SCR and halts its conduction. The motor will continue to operate until the cam opens S3. When S3 opens, the motor will remain at rest until the SCR is fired once again by another pulse.

To operate the wipers in a normal manner simply close S2. When S2 is closed it overtakes the APC regardless of the setting of S1 and R2. However, both S1 and S2 must be off for the wipers to remain at rest. Note: On many cars S2 is actually a 3-position switch (off, low, high). If you are fortunate enough to own a Cadillac you have still another position (medium) at your disposal.

Capacitors C2 and C3 and diode D1 prevent the SCR from "false" firing due to inductive kickback from the motor when it is shut off, and prevent other undesirable effects brought on by switching transients.

Construction

A 1½" x 2" printed circuit board was used, but a plain perforated board and push-in terminals can be substi-
(continued on page 79)

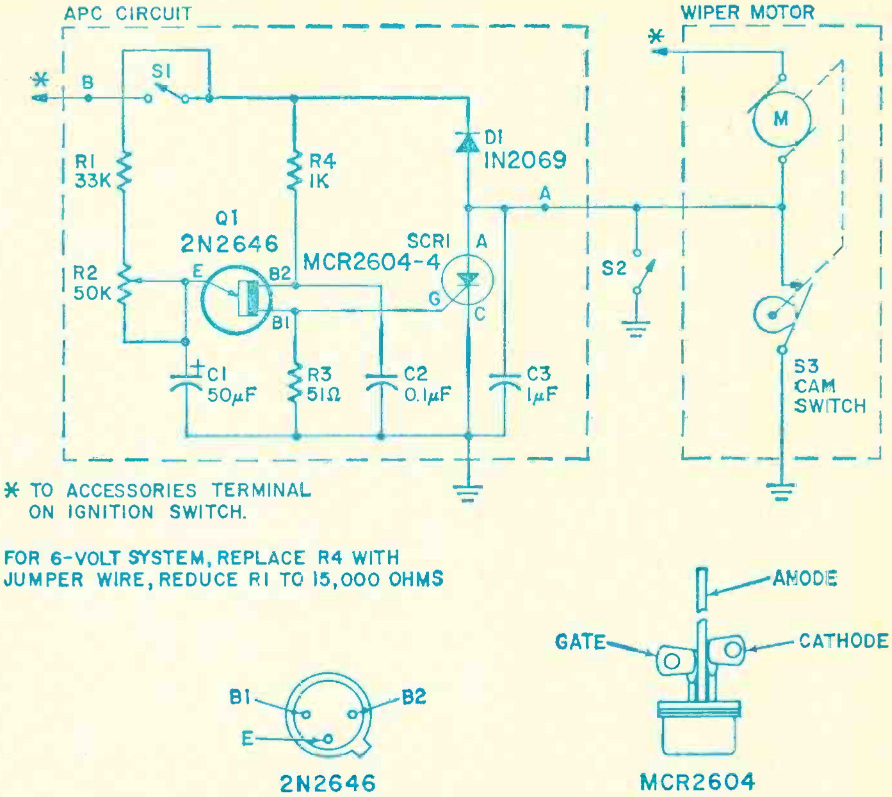
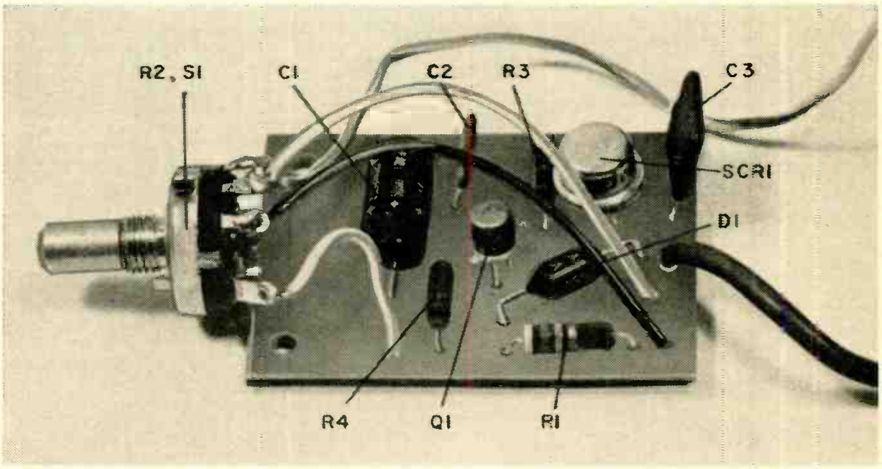


Fig. 1—Unijunction transistor controls the wiper by firing the SCR at regular intervals.

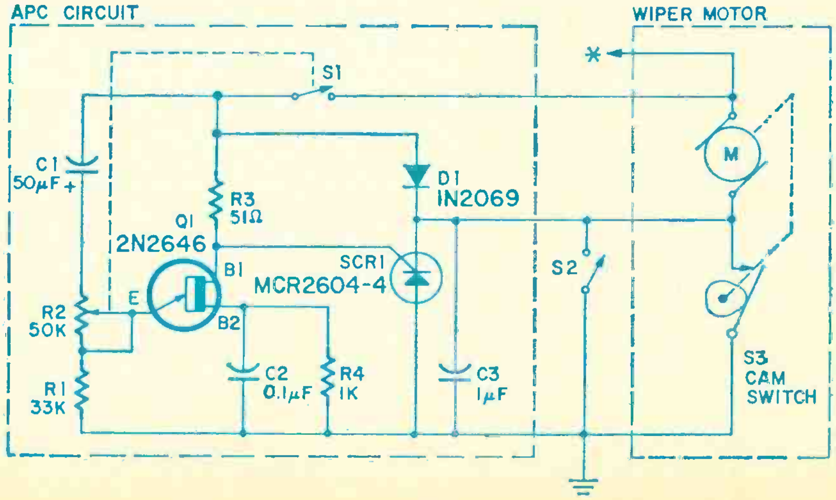


The APC can be built on a PC board or a perforated board for point-to-point wiring.

PARTS LIST

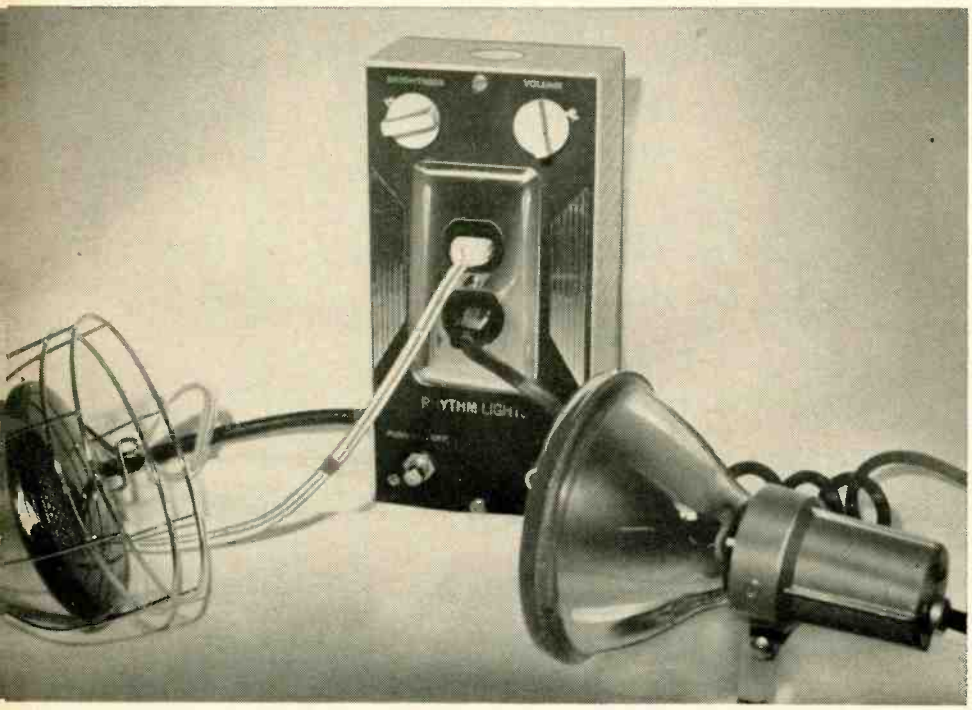
- C1—50-μF, 15-volt electrolytic capacitor
- C2—0.1-μF, 25-volt disc capacitor
- C3—1-μF, 25-volt disc capacitor
- R1—33,000 ohms (15,000 ohms for 6-volt systems)
- R2—Linear potentiometer, 50,000 ohms with switch S1
- R3—51 ohms, 5%
- R4—1000 ohms (replace with jumper for 6-volt systems)
- All resistors ½ watt
- Q1—Unijunction transistor (2N2646, GE, Motorola or similar)
- SCR1—Silicon controlled rectifier (MCR2604-4, Motorola or similar)
- D1—Silicon rectifier, 200-volt or higher PIV (1N2069 or similar)
- S1—spst, (on R2)
- S2—Standard wiper switch (see text)
- MISC—small piece of perforated board, aluminum sheet, knob, wire, solder.

Fig. 2—For cars with 12-volt positive-ground system. See text for 6-volt operation.



Simple project adds light patterns

BUILD RHYTHM LIGHTS



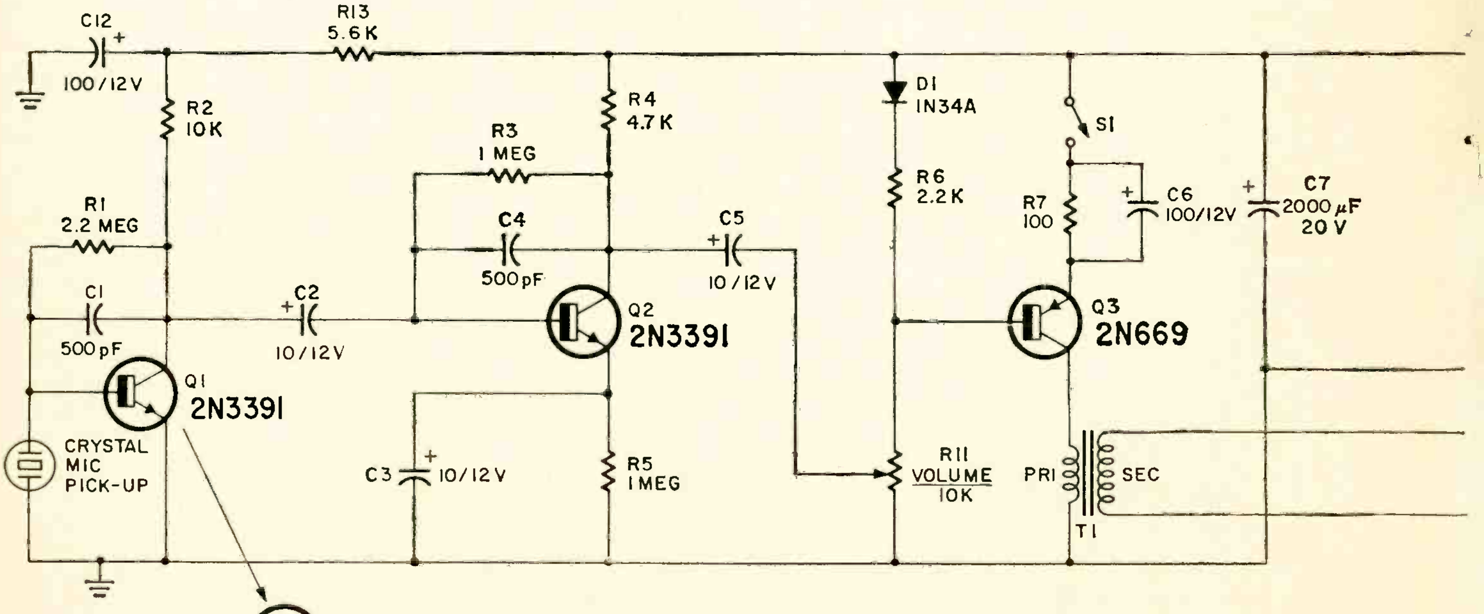
TODAY'S POP MUSIC IS WILD AND EXCITE-ing. Tie into it with a light-and-music show! Put Rhythm Lights near live musical instruments—or radio or hi-fi—and flood lamps will fill the room with color in rhythm with the music.

This sound-to-light converter is all solid-state for trouble-free operation. No special wiring is necessary—just place the unit near the sound and the lights flash dynamically filling the room

(continued on page 71)

PARTS LIST

C1, C4—500-pF, 150-volt ceramic capacitor
C2, C3, C5—10-μF, 12-volt, electrolytic capacitor
C6, C12—100μF, 12-volt, electrolytic capacitor
C7—2000-μF, 20-volt, electrolytic capacitor
C8, C11—0.1-μF, 150-volt, paper capacitor
C9—0.047-μF, 150-volt, paper capacitor
C10—0.008-μF, 150-volt, paper capacitor
D1—1N34-A diode
D2, D3, D4, D5—Diode, at least 500 mA, 100 piv (Lafayette 19H5001 or similar)
D6, D8—1N4001 diode
D7—1N4003 diode
D9, D10, D11, D12—Diode, at least 1.5 amps, 200 piv (RCA 40267 or similar)
D13—Pnpn trigger diode, T1-42 or similar
F1—Fuse, 5 amps, and holder
Q1, Q2—2N3391 transistor
Q3—2N669 transistor
Q4—2N3528 silicon controlled rectifier
R1—2.2-megohm resistor
R2—10,000-ohm resistor
R3, R5—1-megohm resistor
R4—4700-ohm resistor
R6—2200-ohm resistor
R7—100-ohm resistor
R8—68,000-ohm resistor
R9—39,000-ohm resistor
R10—5000-ohm, 8-watt resistor
R11—10,000-ohm potentiometer
R12—250,000-ohm potentiometer
R13—5600-ohm resistor



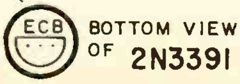


Fig. 1—Transformers isolate the signal and power section's low and high voltages. Transistors Q1 and Q2 may be substituted with similar types, as stage design isn't critical.

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to party music **By R. T. MONTAN'E**

FOR PSYCHEDELIC MUSIC

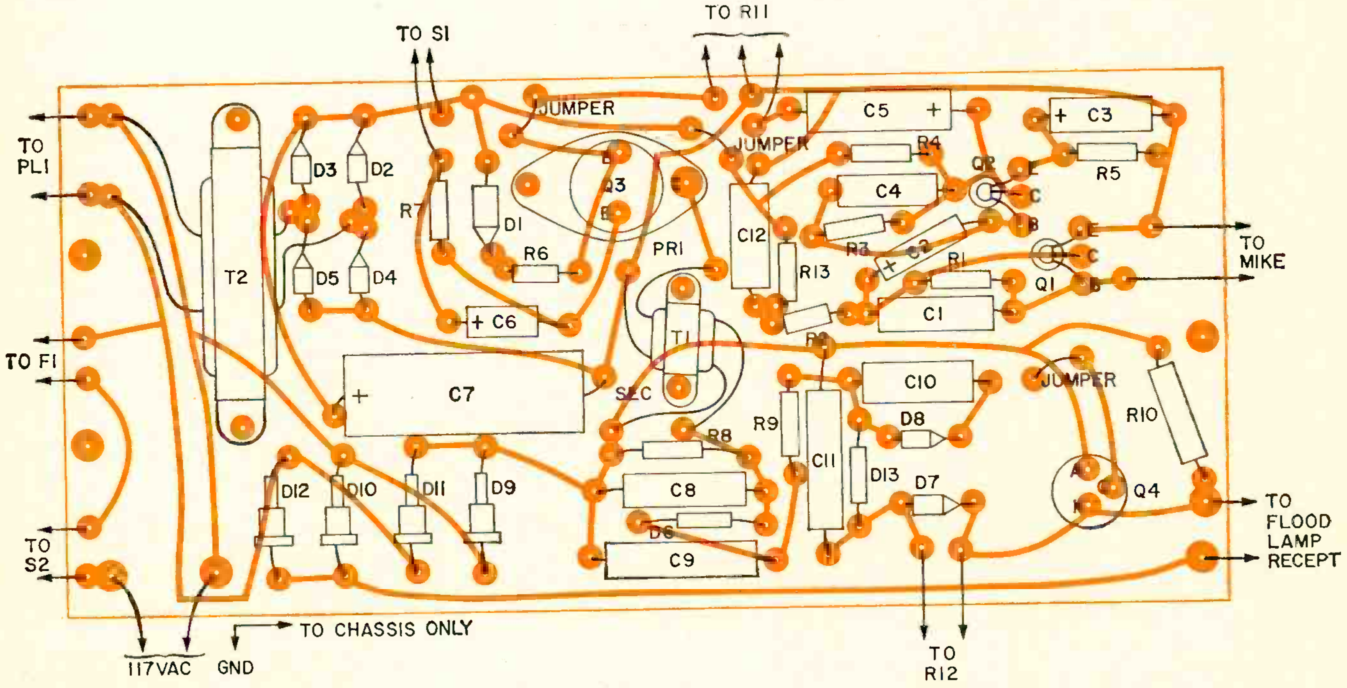
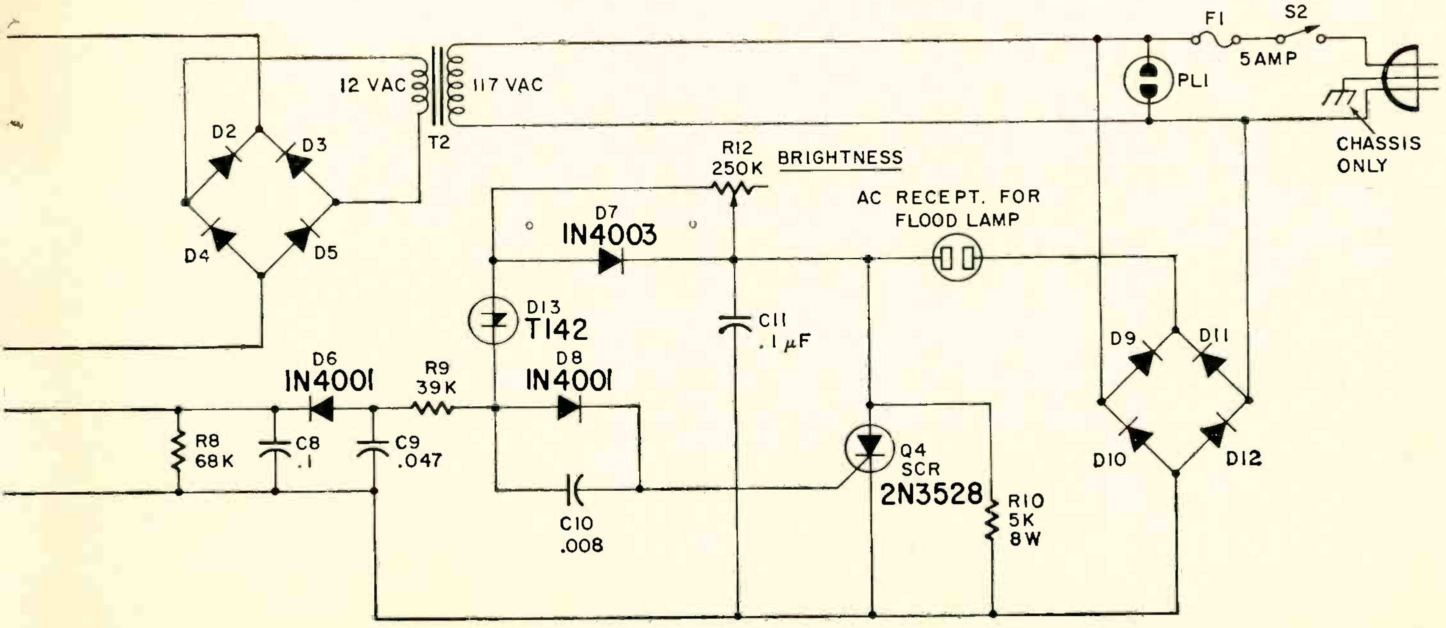


Fig. 2—Lay out parts on the board and solder carefully before mounting board to chassis. Watch electrolytic and diode polarities.

S1, S2—S.p.s.t switches
T1—Interstage audio transformer, primary 10,000 ohms, secondary 200 ohms (Allied Radio 54E2386 or similar)
T2—Filament transformer, primary 117 volts, secondary 12 volts, at least 1 amp (Allied Radio 54B4136 or similar)
PL1—Neon lamp with series resistor for 117 Vac operation
MISC—High-impedance crystal microphone; 5" x 10" x 3" aluminum chassis (Bud AC-404 or similar) with bottom plate (Bud BPA-1591 or similar; 4-2" standoffs; 3-conductor line cord; ac receptacle; hardwire and wire.



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How to trigger power relays

SOUP-UP YOUR RELAYS

By LYMAN E. GREENLEE

ARE YOU AT YOUR WIT'S END TRYING to find a sensitive relay with husky contacts to complete a pet project? If so, you've probably found that relay sensitivity (rated in milliwatts input per single-pole contact) drops sharply as contact current rating increases. Really sensitive relays with heavy contacts are generally very expensive or not readily available. If this is your problem, don't despair, I may have a simple solution.

You can use an ordinary power relay and multiply its sensitivity many times by using an SCR to drive it. Typically, a relay handling up to 30 amps at 600 volts can be triggered by only 200 μA at 0.8 volt on the SCR gate. The basic SCR/relay circuits in Figs. 1 and 2 work well, but must be modified to make them immune to power-line transients that are produced when oil burners, air conditioners and similar devices are turned on or off.

In Fig. 1 resistors R1 and R2 form a voltage divider to limit gate current to a safe value. The SCR, one of G-E's low-cost C106 series, will carry up to 2 amps. This is adequate to handle power relays that switch 30 amps at up to 600 volts. When S1 is closed, the gate is biased on; the SCR conducts on positive half-cycles of the ac input voltage and keeps the relays energized. The SCR stops conducting on the next half-cycle following the opening of S1.

If we add a diode and capacitor as in Fig. 2, we have a self-locking circuit. When S1 is closed momentarily, the SCR fires and keeps the relay energized until released by opening S2. S1 and S2 may be momentary-contact switches with S1 normally open and S2 normally closed.

A locking circuit such as this is useful in alarms and similar devices. Reset (by opening S2) may be either manual or automatic. The value of R3 is selected to clamp the voltage across C1 at about 120 volts dc. R4 is the surge-limiting resistor for D1—a 200-piV, 500-mA silicon diode.

The circuits in Figs. 1 and 2 are okay for experimenting, but are not practical because they are subject to random triggering by transients. So let's see how we develop a practical, reliable circuit.

Noise-immune circuits

First, in Fig. 3 we add transformer T1 to isolate the relay coil and SCR from the power line. This, in itself, does not eliminate all random triggering, so a filter (R5–C4–C5) is connected in the primary circuit. The drop across R5 is about 20 volts when the relay is energized. Idling or "relay off" current will produce a drop of about 10 volts across R5.

Resistor R4 and capacitor C3 provide additional filtering across the secondary of T1. A NE-2 neon lamp isolates the SCR gate from the triggering circuit. The advantage of using the neon lamp is that the gate cannot be triggered until the lamp is conducting. Thus random pulses below the firing voltage of the lamp cannot trigger the SCR.

Resistor R3 and C2 eliminate any secondary or electrostatic discharge

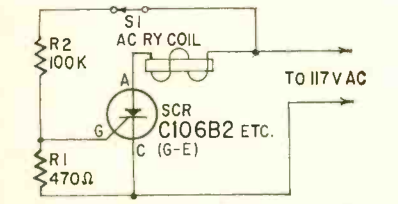


Fig. 1—Basic SCR relay driver. Switch S1 carries only the SCR gate current.

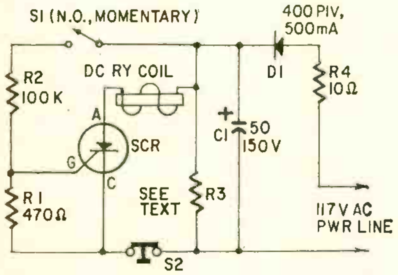
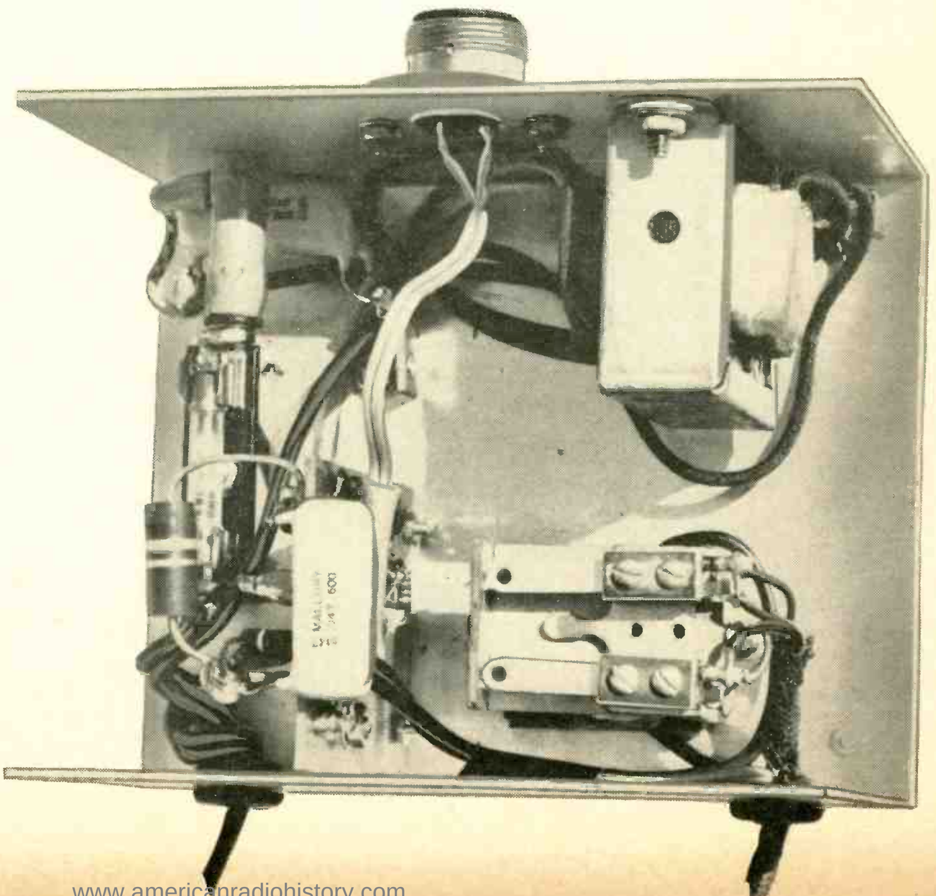


Fig. 2—A locking-type circuit. Closing S1 triggers the SCR and locks-in the relay. Opening S2 releases the relay.



A typical SCR/relay combination as in Figs. 3 and 4 fits neatly in a small metal box. The trigger leads run to the switch or LDR through the connector.

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with a 200-microampere, 0.8-volt signal

WITH SCR DRIVERS

across the NE-2. An electrostatic charge will lead to false triggering. The optimum value of R3 is around 3.3 megohms, but it may be reduced to as low as 1 megohm, if necessary, to eliminate secondary glow in the lamp.

The stray capacitance of long leads to the tripping contacts (S1) will tend to drive the NE-2 and make necessary the use of lower values for R3. Use the shortest possible length of low-capacitance, low-leakage cable to connect S1 to the circuit. If R3 has to be less than 1 megohm, you will have to move the control circuit closer to S1 or use leads with lower capacitance.

The circuit in Fig. 3 is useful for many relay applications in which the actuator is an on–off switch capable of handling 200 μA. This includes such low-current devices as meter relays where contact current is limited. Easy to construct, it can be fitted into a 5″ x 4″ x 3″ utility box with room to spare. The relay may be almost any 117-volt ac type with contact combinations handling up to 10 amps. Its contacts may range up to 6-pole double-throw for polarity reversing, line transfer and other complex switching. Heavier relays may require a larger box.

The C106 SCR will handle up to 2 amps but should be used on an adequate heat sink when used to drive a relay whose coil draws more than about 300 mW.

Parts layout is not critical except for R4 and R5. They get quite hot and must be kept away from the other components, particularly the SCR. The SCR, C2, C3, R2, R4 and the NE-2 are all mounted on a 1¾″ x 2″ piece of linen Bakelite board. Use a heat sink when soldering the SCR into the circuit. A fuse is desirable but can be eliminated if space is needed for a larger relay.

Note that no part of the circuit is grounded or connected to the metal case. If grounded duplex ac receptacles are available, use a three-wire ac cord and ground the case through the third wire in the cord.

If you use a different relay or transformer, adjust the value of R5 for about a 10-volt drop when the SCR is cut off and not more than 20 volts when it is conducting and the relay is energized. Adjust R4 to balance the load and allow about 100 volts across the coil of the relay when the SCR is conducting.

Using temperature or light control

Figure 4 shows how the circuit can be modified so the relay can be triggered at any predetermined level of light or temperature. Here, the resistance of R2-a, R2-b and the LDR or thermistor in series is equal to 100,000 ohms, the value of R2 in Fig. 3. R2-a is adjusted to compensate for the resistance added by the LDR or thermistor. Potentiometer R2-b is selected to limit SCR trigger current to a safe value at the minimum resistance of the LDR and R2-a in series. R6 controls the sensitivity.

The circuit can be adjusted to provide 200 μA at 0.8 volt to trigger the SCR at any desired light or temperature level. The 5AJ/NE-86 (G-E) neon lamp has been doped with a radioactive material so it has low firing-voltage characteristics that are independent of light intensity. **R-E**

Parts List (Fig. 3)

- R1—470-ohm, ¼-watt resistor
- R2—100,000-ohm, ½-watt resistor
- R3—3.3 meg, ½-watt resistor
- R4—10,000-ohm 2-watt resistor
- R5—500-ohm, 5-watt resistor
- C2—56-pF 500-volt mica capacitor
- C3, C4, C5—.047-μF, 600-volt Mylar capacitor
- NE1–NE-2 neon lamp
- F1—¼-ampere, slow-blow fuse
- T1—Isolation transformer, 117-volt primary, 110-volt 30-mA secondary (Olson Electronics No. T-173 or equal)
- RY1—General-purpose ac relay, 115-volt coil, 10 amp or heavier contacts as needed.
- SCR1—C106-B2 silicon controlled rectifier (G-E)

Additional parts for Fig. 4

- NE1–5AJ/NE-86 (G-E)
- R2-a, R2-b—100,000-ohm miniature pot or as required to match the LDR or thermistor resistance. Be sure that the SCR gate is not overloaded at the minimum setting of R2-a. Select R2-b to keep the minimum circuit resistance at 100,000 ohms.

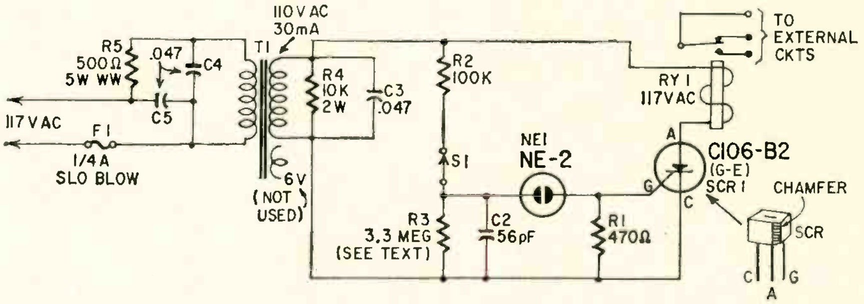

Fig. 3—This improved SCR/relay circuit is extremely sensitive but is immune to noise and transients on the power line. The neon lamp isolates the SCR from the trigger.

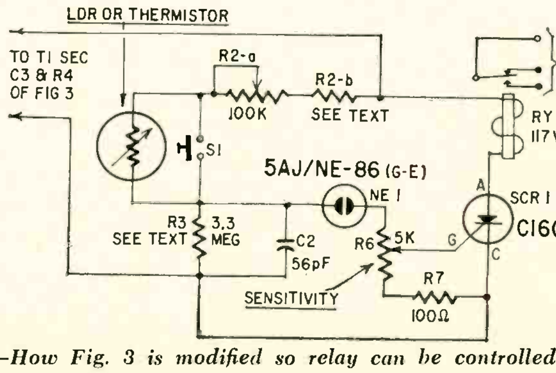

Fig. 4—How Fig. 3 is modified so relay can be controlled by a desired level of light falling on a photocell or by temperature change sensed by a thermistor.

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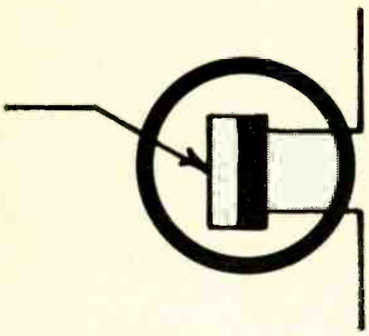

20 UNIJUNCTION

Part II of 2 parts—to acquaint you

IN PART I OF THIS SERIES (JUNE 1968) you were introduced to the unijunction transistor. You saw how it works, and were given 11 applications for it. Here are 9 more. For your convenience, the basing diagram (Fig. 1) and the characteristics (Table 1) of the 2N2646 UJT used in these circuits are shown once again.

Diode-pump counter

Circuit shown in Fig. 2 acts as a frequency divider or counter, but gives a nonlinear staircase output. It has the advantage, however, that counting is almost independent of the shape of the input signal.

With no input applied, Q1 is cut off and C3 charges via R3, C2 and D1; C2 and C3 act as a voltage divider, and a fixed fraction of the supply voltage appears across C3. When an input pulse is applied, Q1 is driven to saturation and C2 is discharged via Q1 and D2; C3 is prevented from discharging by D1. When the pulse is removed again, C2 again charges via D1 and C3, and places another fraction of the supply voltage on C3.

Thus, at the end of each pulse, the C3 voltage increases by a fixed step (smaller than the previous one) until eventually the UJT fires, discharges C3, and the counting cycle starts over again. Pulse shape has virtually no effect on circuit operation.

The division ratio, $\frac{f_{out}}{f_{in}}$, is roughly equal to $\frac{C2}{C2 + C3}$. The ratio is, however, affected by a number of variable factors, including operating frequency, so the values of these two components are best found by trial and error. Once components have been selected, the circuit will give stable division over quite a wide range of input frequency variation. Stable division ratios up to 10 to 1 can be easily obtained.

Synchronized frequency divider

Divider shown in Fig. 3 generates precise frequency or timing-interval signals. Positive-going pulses from a 100-kHz crystal oscillator are fed, via C1, to base 2 of Q1. R1 is adjusted so that the UJT locks firmly to an operating frequency of 10 kHz, the 100-

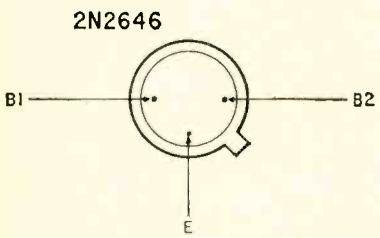

Fig. 1—Base connections of 2N2646 UJT. B2 is electrically connected to case.

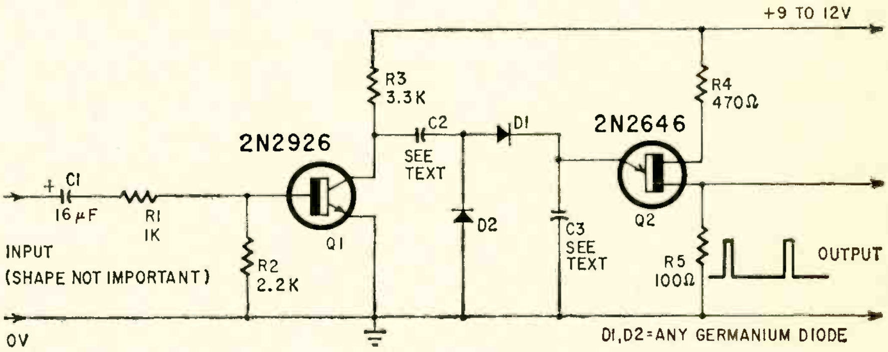

Fig. 2—Diode pump counter.

Table 1—2N2646 Characteristics	
Emitter reverse voltage (max)	30 volts
Interbase voltage (max)	35 volts
Peak emitter current	2 amps
Rms emitter current	50 mA
Power dissipation (max)	300 mW
Intrinsic standoff ratio (η)	0.56–0.75
Interbase resistance (R_{BB})	4,700–9,100 ohms
Peak-point emitter current (I_P) (max)	5 μA (1) 25 μA (2)
Valley-point current (I_V) (min)	4 mA
Case	TO–18
(1) GE	
(2) Motorola	

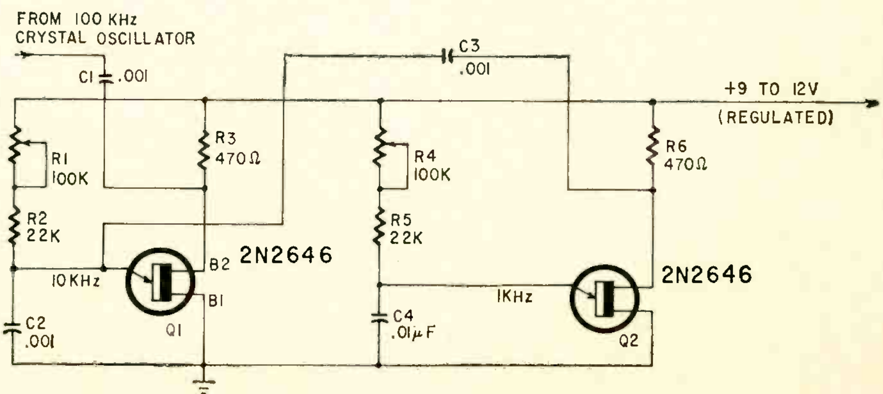

Fig. 3—Synchronized frequency divider.

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TRANSISTOR APPLICATIONS

further with this useful solid-state device

By R. M. MARSTON

kHz signals acting as sync pulses. The 10-kHz signal from Q1's emitter is fed to Q2 via C3, and R4 is adjusted so that Q2 locks to an operating frequency of 1 kHz. Thus, the circuit makes available standard frequencies (and timing intervals) of 100 kHz (10 μsec), 10 kHz (100 μsec), and 1 kHz (1-msec). Stability is very good if a Zener-regulated power supply is used for this circuit.

Division ratios other than 10 can be obtained by adjusting R1 and R4. Outputs can be taken, via a high-impedance emitter-follower buffer stage, from the emitter of each UJT and from the crystal oscillator.

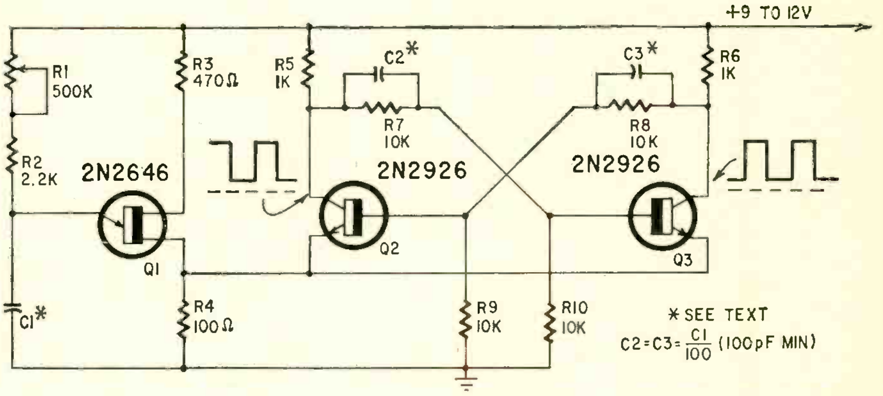

Fig. 4—Wide-range square-wave generator employing npn transistors.

Wide-range square-wave generators

The unijunction transistor can be used as the heart of a whole range of waveform generators. Figs. 4 and 5 show how it can be used to generate square waves.

In Fig. 4, Q2 and Q3 form an npn bistable multivibrator or divide-by-2 circuit. At the end of each UJT cycle, the positive-going pulse from R4 is fed to the emitters of Q2 and Q3 and causes the multivibrator to change state. Two cycles of the UJT produce a single complete cycle of the multivibrator. The multivibrator output, taken from either collector, is therefore a perfect square wave at half the UJT frequency. The two collector signals are opposite in phase.

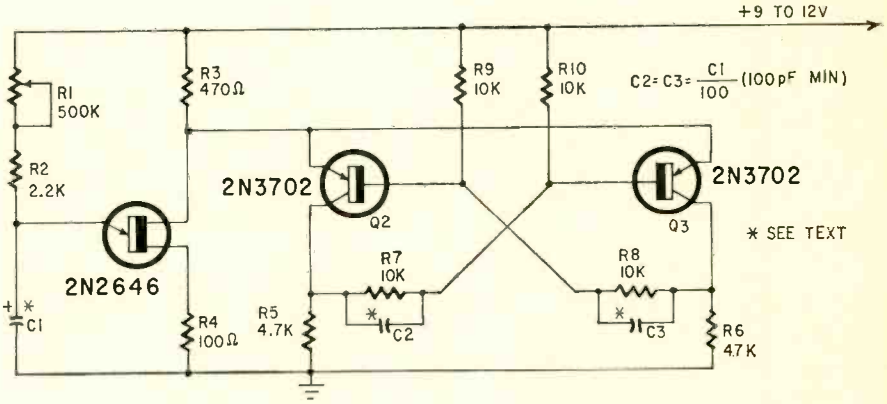

Fig. 5—Pnp transistors in a square-wave generator.

Fig. 5 shows the pnp version of the same circuit. In this case, the circuit uses the negative-going pulses from R3 to trigger the bistable multivibrator, but the two circuits are otherwise similar to each other.

It's important to note that in both these circuits C2 and C3 are of equal value — approximately $\frac{C1}{100}$ That is, if Cl is 0.1 μF, C2 and C3 should be .001 μF (1000 pF). C2 and C3 should, however, have a minimum value of about 100 pF.

Both circuits (Figs. 4 and 5) will

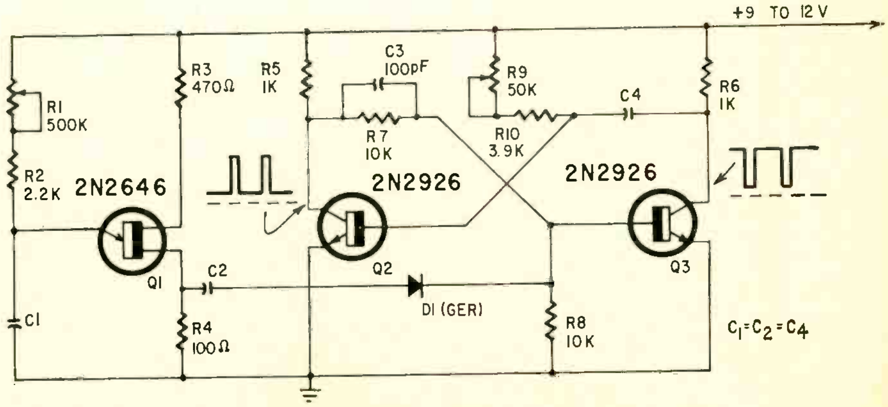

Fig. 6—Variable-frequency pulse generator.

generate square waves over a 100:1 frequency range, using a single set of component values.

Variable-frequency pulse generator

The circuit of Fig. 6 generates a constant-width pulse that can be varied in repetition frequency over a 100:1 range. It may, for example, generate a pulse with a constant width of 500 μsec, at repetition frequencies ranging from 10 to 1,000 Hz. The actual pulse width can be adjusted, on any particular range, over a 10 to 1 range, i.e., from 50 to 500 μsec.

In this quite simple circuit, Q2 and Q3 are wired as a monostable or one-shot multivibrator, with pulse width controlled by R9, R10 and C4. The multivibrator is triggered by positive-going pulses fed from R4 to Q3 base via C2 and D1. Thus, repetition frequency is controlled by the UJT, and pulse width by the multivibrator.

Different sets of C1–C2–C4 values are needed for each range of operation, but all three capacitors will usually be of equal value. The main point here is that the maximum period of the pulse must be less than the minimum period of the UJT cycle. Otherwise the pulse will not be ended by the time a new trigger pulse arrives, and stable operation will not be obtained.

Pulse outputs can be taken from either collector, the two outputs being opposite in phase.

Variable on/off-time pulse generator

This circuit (Fig. 7) generates a series of pulses in which the on and off times are independently controlled. Furthermore, each can be varied over a 100:1 range.

The circuit is similar to the square-wave generator of Fig. 4, Q2 and Q3 forming a bistable multivibrator that is triggered by positive-going pulses from R6. In the circuit of Fig. 7, however, two different C1 charging circuits (R1–R2 and R3–R4) are available, and the multivibrator operates diode gates that select the charging circuit that may be used at any particular moment.

Assume that when the power is turned on, Q2 is on and Q3 is off. Q2's collector is at zero volts, so D4 is forward-biased and D3 is thus back-biased. No charge current flows to C1 via R3–R4. Q3's collector is at near full positive supply potential, so D2 is back-biased. D1 is thus forward-biased and C1 charges via R1–R2 only. At the end of this timing cycle, the UJT fires and triggers the multivibrator, so Q2 switches off and Q3 switches on. D2 is forward-biased and D4 is back-biased, so R1–R2 are cut out of circuit and C1 charges via R3–R4 only. At the end of this new cycle, the circuit goes back to its original state.

C2 and C3 are of equal value and equal to $\frac{C1}{100}$, down to a minimum value of about 100 pF. When C1 is 0.1 μF, the on and off times of the output pulse can be individually controlled over the approximate range 500 μsec to 50 msec.

Variable frequency/M-S ratio generator

Figure 8's circuit generates a series of pulses in which both the mark/space (on time/off time) ratio and the frequency can be independently varied over a wide range. If, for example, the M–S ratio is set at 9 to 1, the operating frequency can be varied from, say, 10 to 1000 Hz without any resulting change in M–S ratio.

Similarly, if the operating frequency is set at, say, 100 Hz, the M–S ratio can be varied over the range 1 to 100 or 100 to 1 without any resulting change in operating frequency.

Both frequency and M–S ratio can be simultaneously varied, without interaction. This type of generator is used at the transmitter end of analog proportional two-channel remote-control systems, such as the "Galloping Ghost"—a radio control system.

In Fig. 8, Q2 and Q3 form a super-alpha-pair (Darlington pair) emitter follower, and permit a sawtooth output to be taken at low impedance from the R6–R7–R8 chain without affecting the operating frequency of Q1. This sawtooth is then

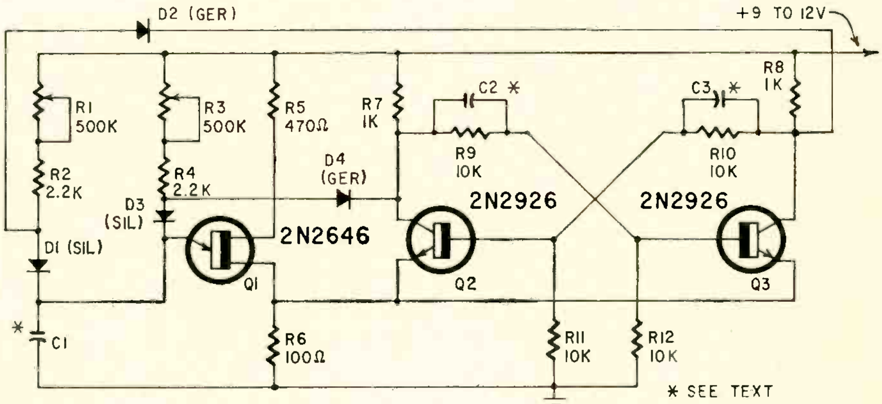

Fig. 7—Variable on/off-time pulse generator.

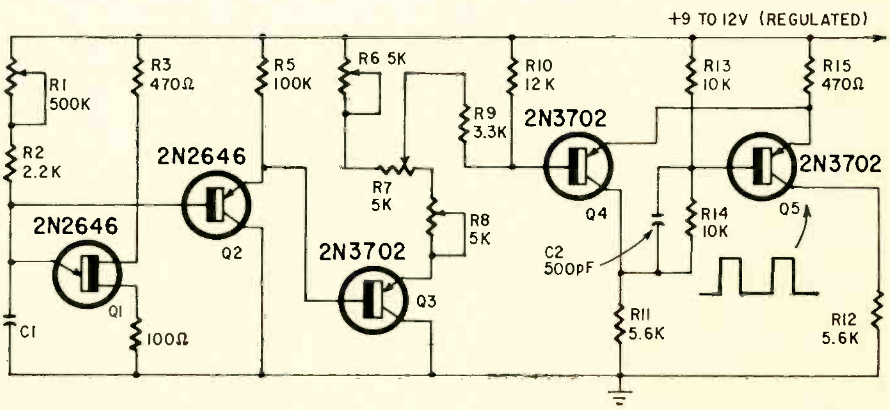

Fig. 8—Variable frequency, mark-space ratio generator.

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fed, via R9, to the Schmitt trigger formed by Q4 and Q5. By adjusting R7 the Schmitt can be made to fire at different points on the sawtooth, and so generate different M–S pulse signals at Q5's (or Q4's) collector. R6 and R8 allow the maximum and minimum mark-space ratios to be preset. Different frequency ranges can be selected via C1—as in the case of all UJT circuits given in this article.

Radio control enthusiasts will have noticed that this circuit uses a total of five transistors, compared to the three used in some other pulsers. That's because this circuit is designed to give a total lack of channel interaction—an advantage you don't get with other less-complex circuits.

One-shot lamp/relay driver

For most lamp or relay sequential operations, where you want switching or delay times of only a few seconds, the unijunction offers no real advantage over conventional transistor circuits. It's only when you want very long sequential periods—ranging from tens of seconds up to several minutes—that the UJT is really useful. Fig. 9 shows just such an application.

This is a one-shot lamp or relay operator. The lamp is normally off, but as soon as you operate a pushbutton it comes on, and stays on for a preset period that can be adjusted from about 4 seconds to 8 minutes. At the end of that period, the lamp switches off and the circuit resets, ready for the next pushbutton operation that you select.

Q2 and Q3 form a bistable multivibrator in which Q2 is normally on and Q3 is off. Thus, Q2's collector is at zero volts, so D2 is forward-biased and D1 is back-biased. Capacitor C1 is prevented from charging via R1–R2. Q3's collector is at near full positive supply voltage, so no forward bias is applied to Q4, and the lamp is off. (R11–D3–R12 form a voltage divider, and insure that the small voltage at Q3's collector is not enough to turn transistor Q4 on.)

When start pushbutton S1 is momentarily operated, Q2's base is shorted to ground and the bistable multivibrator changes state. Q2 goes off, removing the forward bias from D2. C1 now takes on a charge via R1–R2–D1. Transistor Q3 goes on, drives Q4 hard (via D3–R12) and switches the lamp on. After a preset period, the UJT fires, and the positive-going pulse from R4 is fed to Q2's base via C2 and D4, turning Q2 back on and resetting the circuit to its original condition, with D2 forward-biased and the lamp off.

Only lamps or relays with operating currents less than 300 mA can be used in this circuit. Q4 can, however, be used to drive a power transistor to handle larger currents, so long as the collector current of Q4 is limited to less than 300 mA by a series resistor.

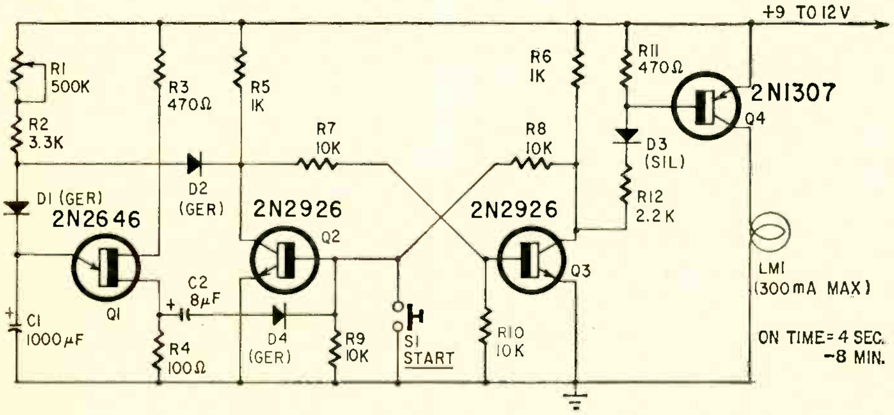

Fig. 9—One-shot lamp or relay driver.

Variable on/off-time lamp flasher

Another sequential UJT lamp-driving circuit is shown in Fig. 10. Here, the on and off times of the lamp can be individually varied over the approximate range of 4 seconds to 8 minutes (giving a maximum possible cycle period of 16 minutes). Operation is repetitive.

The circuit is like the one in Fig. 7, with the addition of the lamp-driving transistor stage given in Fig. 9. Maximum output current is again limited to about 300 mA. The on time of the lamp is controlled by potentiometer R3 and the off time is controlled by potentiometer R1.

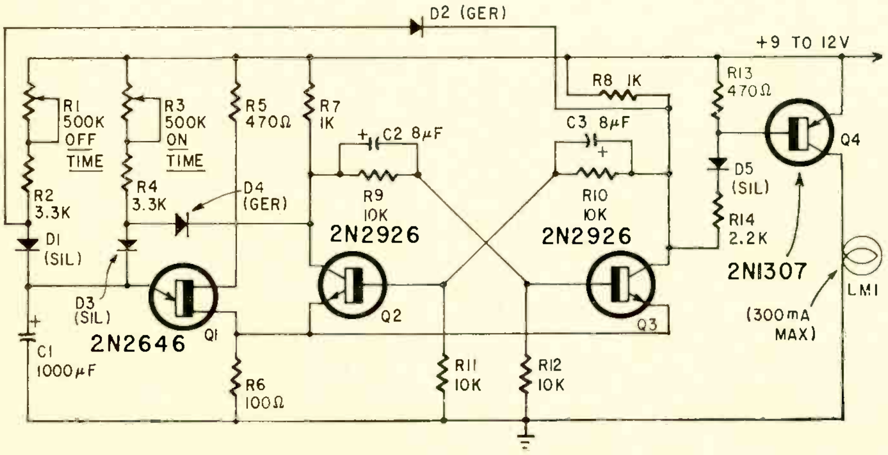

Fig. 10—Variable on/off-time lamp flasher.

Conclusions

If you decide to build any of these circuits, bear a couple of points in mind: Power supplies must be well filtered and reasonably stable. That doesn't mean they have to be fully regulated; it simply means that they may give trouble if they contain a lot of ac, or if you use batteries that are half dead. In most circuits, I've designed the UJT sections to cover a 100:1 frequency range. As a result, control may be coarse; if it's too coarse, wire a 10,000-ohm "fine" control in series with the main potentiometer. If you want a range less than 100:1, increase the value of the fixed series control resistor. **R-E**

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Introducing the Hall Effect —a most useful phenomena for science and industry

HALL EFFECT IN SOLID

By JOHN POTTER SHIELDS

ELECTRONICS IS RICH WITH MARVELous "effects." Many of them, decades old, have remained laboratory curiosities until the time was ripe—until there was a need for them, or suitable materials were discovered to make applications of the effects practical. The thermoelectric effects of Peltier and Seebeck are among the most fascinating. They have been known since the mid-19th century, but practical thermoelectric coolers had to await the coming and application of sophisticated semiconductor materials.

Something similar happened with the Hall effect. At first poorly understood and considered virtually useless, the Hall effect now has a secure and deserved place in several areas of the electronics industry.

What is the Hall effect?

The whole Hall-effect story started in 1878 with a Mr. Edward H. Hall. He discovered that, when current is passed through a metal strip subjected to an intense magnetic field, a minute voltage is developed along the edges of the strip. Mr. Hall also noted that this rather strange effect is relatively weak in such materials as iron and gold, but much stronger in the metals bismuth and tellurium.

More recently, it has been found that this effect is much more pronounced in a variety of semiconductor materials, including, for example, silicon, germanium, indium antimonide and indium arsenide.

Figure 1 gives an idea of the basic Hall-effect concept. The Hall-effect device proper is fabricated from a thin slice of semiconductor material to which are attached suitable electrodes and conducting leads. This assembly is encapsulated in a protective coating to protect it from contamination. As shown, the Hall-effect device has four leads. Two are connected to the *con-*

Fig. 1—Control current and the magnetic field interact to generate a voltage between opposite edges of a Hall crystal.

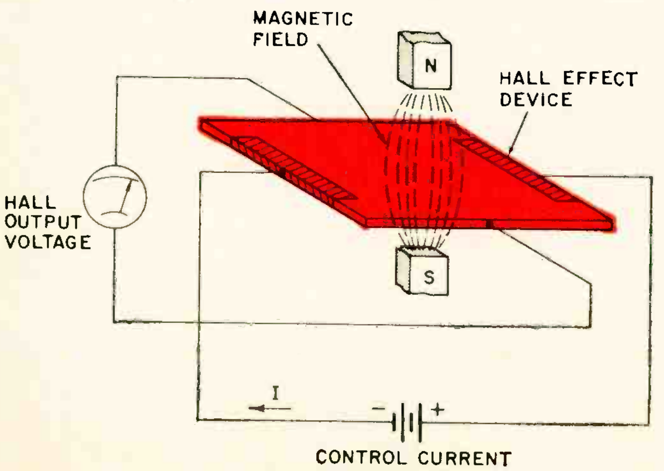
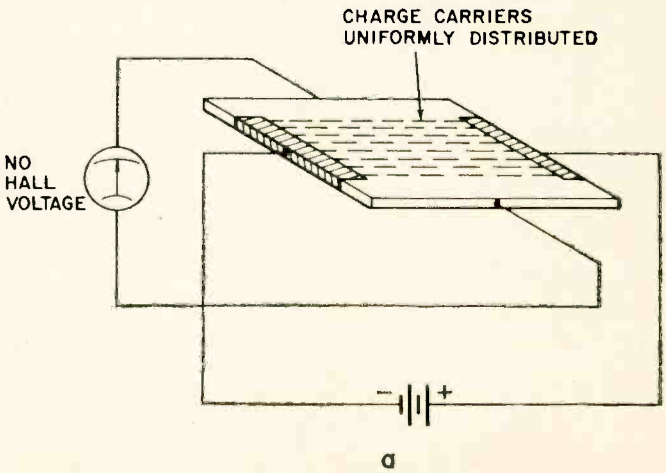


Fig. 2-a—Outside a magnetic field, charge carriers are uniformly distributed in the Hall element and voltage is zero.



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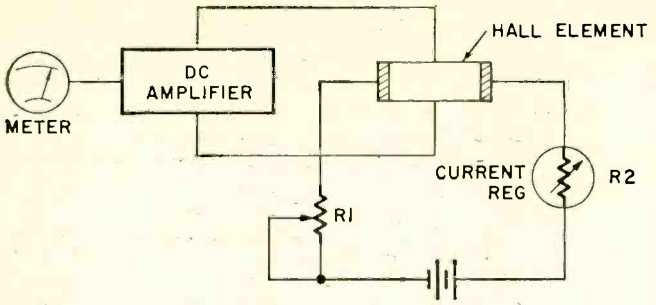


Fig. 3—Basic setup for measuring magnetic field strength with Hall device. As battery ages, R2 regulates current.

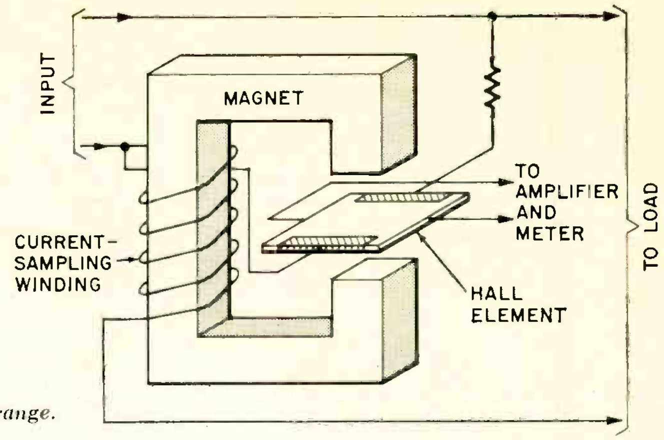


Fig. 4—Hall-effect wattmeter responds to frequencies over a wide range.

trol-current source, while the other two leads deliver the *Hall voltage*.

When the Hall-effect device is placed in a magnetic field and the control current is applied to it, a voltage appears across its Hall-voltage terminals. The amount of Hall voltage developed is directly proportional to the intensity of the magnetic field and the amplitude of the control current. For example, if the magnetic field intensity is doubled while holding the control current at a constant value, the Hall output voltage will double.

Similarly, the Hall output voltage will double if the value of control current is doubled while the magnetic field strength is held constant. Doubling both the magnetic field intensity and control current, the Hall voltage will increase four times, the Hall voltage thus being a product of the magnetic field and control current.

To see more clearly how a Hall-effect device works, let's take a look at Fig. 2, which gives us an "X-ray view" of Hall-effect operation. In Fig. 2-a, no magnetic field is applied to the Hall-effect device. Under these conditions, the control current passing through it causes a flow of charge carriers, either electrons or holes, down the length of the device. Since no charge carriers collect at the edges of the Hall-effect device, no Hall voltage is developed.

In Fig. 2-b, the setup is the same except that a magnetic field is applied. Notice that the charge carriers are now deflected so that they strike one edge of the Hall-effect device. This causes a difference in potential between its two edges. If we now reverse the polarity of the magnetic field (north pole for south pole and vice versa) the charge carriers will be deflected in the opposite direction, as shown in Fig. 2-c. This will reverse the polarity of the Hall output voltage. A good analogy of this deflection of charge carriers is the cathode-ray tube, in which a beam of electrons is deflected by a magnetic field within the tube.

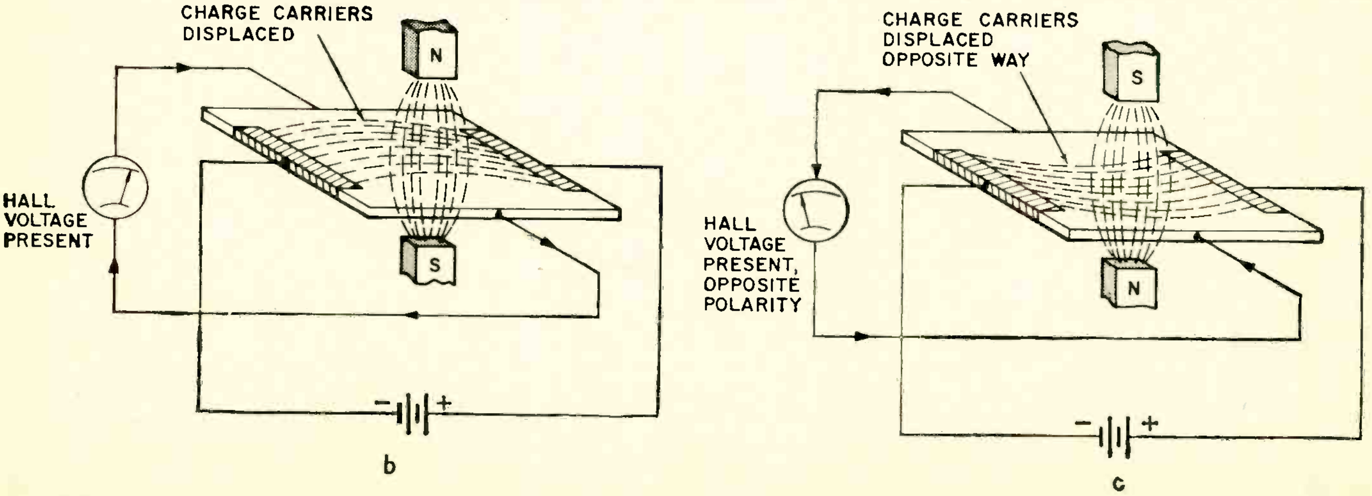
The Hall output voltage obtainable from a typical Hall-effect device is small—in the neighborhood of 100 millivolts or so with a magnetic field strength of 1000 gauss. Therefore, it is generally necessary to amplify the Hall output voltage.

Now that you are aware of what the Hall-effect device is and how it operates, just what is it good for? Perhaps its most obvious application is in the measurement of magnetic field intensity. Fig. 3 shows a simple arrangement for this. The Hall-effect element is supplied with its rated control current by the battery. Potentiometer R1 is adjusted to supply the rated control current while current regulator R2 maintains a constant value of control current as the battery ages.

The Hall-voltage output signal is applied to a direct-coupled amplifier, which amplifies the signal and applies it to a calibrated meter. The direct-coupled amplifier is generally a balanced (differential) type, so that in the absence of a magnetic field the slight residual Hall voltage can be zeroed out, and the meter will be deflected only when the Hall-effect device is in a magnetic field. There are, of course, more complicated Hall-effect magnetic-field measuring arrangements, but the basic principle just described is generally followed.

The Hall-effect wattmeter is another Hall-effect device. The Hall-effect wattmeter has an advantage over

A magnetic field perpendicular to plane of the Hall element (b) deflects charge carriers, producing a potential difference between opposite edges. When the magnetic poles are reversed, the polarity of voltages generated are reversed.



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conventional direct electromagnetic-movement type wattmeters in that it will respond equally well to a much wider range of frequencies (for example, 10 to 100,000 Hz). Fig. 4 shows the basic arrangement of the Hall-effect wattmeter. As you can see, the Hall-effect device is placed between the pole pieces of an electromagnet whose winding is in series with the load to which the wattmeter is connected. The Hall-effect element's control current is derived directly from the supply voltage through a current-limiting resistor. By this hookup, the element's control current is proportional to the supply *voltage* while the magnetic field applied to the element is proportional to the load *current*. Since the Hall output is the product of the applied magnetic-field intensity and control-current intensity, its value indicates the power consumed by the load: power = voltage × current.

Metal detector

Figure 5 shows how the Hall effect may be applied to detect ferrous (iron and steel) objects. This type of metal detector, while sensitive only within about an inch, is nevertheless very useful as a ferrous-object counter, etc. It responds to both stationary and moving ferrous objects and, unlike photocell detectors, can operate in cloudy atmospheres which would disable photocell systems.

As you can see from Fig. 5, the Hall-effect element is mounted with a permanent magnet in a small U-shaped assembly. When a ferrous object comes close to the open ends of the U, it shortens the magnetic path between the ends of the U. As a result the magnetic field applied to the Hall element is increased. This in turn produces a larger Hall output voltage, which is amplified and can then be used to energize a relay or as a electromechanical counter.

The Hall effect can also be used to measure extremely small mechanical movements. As shown in Fig. 6, the Hall-effect element is mounted midway between two small permanent bar magnets. In this position, there is minimum Hall output voltage from the element, because magnetic fields of equal strength and the same polarity (north-north) are on each side of the Hall element. If the Hall element is displaced to one side, there will be a stronger magnetic field on one side of the Hall element and a Hall output voltage will be generated. If the element is moved to the opposite side of center, a Hall output voltage will also be generated, but of opposite polarity. Thus, this arrangement will register the amount and the sense of the movement.

As shown in Fig. 7, the Hall effect can also be used for current measurement. As you know, any conductor carrying an electric current has a magnetic field around it. The intensity of the field is proportional to the current strength. By placing the Hall element in the gap of a *flux concentrator* (a device which concentrates a magnetic field into a small area) placed around the conductor, the conductor's magnetic field will be applied to the (north–north) are on each side of the Hall element. The Hall output voltage will be proportional to the strength of the magnetic field around the conductor, which, in turn, is proportional to the current flowing through the conductor. The Hall output voltage is amplified and applied to a meter calibrated in amperes or milliamperes.

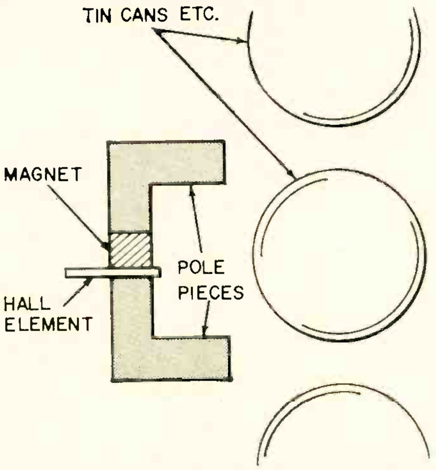

Fig. 5—Sensitive to changes in magnetic flux, the Hall device is useful for counting ferrous objects such as beer cans.

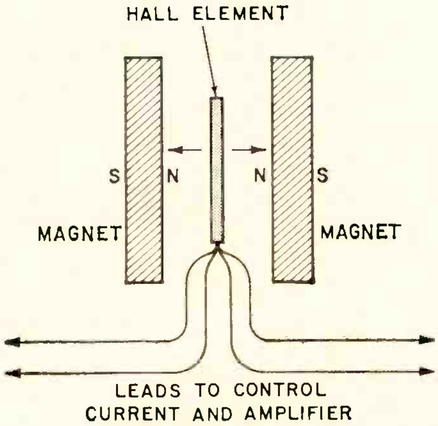

Fig. 6—Minute movements of Hall device or magnets can be detected and measured.

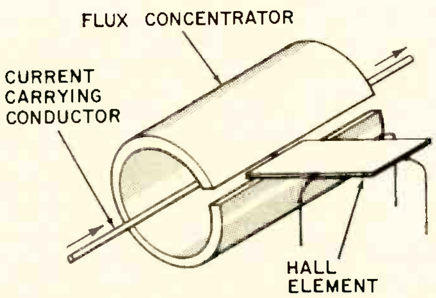

Fig. 7—Magnetic field around conductor (or ion beam, see "Some Commercial Applications") is concentrated on Hall device and the output is measured as current.

There are other useful applications for the Hall-effect, but the ones we've mentioned are probably the most common.

Experimenting with the Hall effect

Now that you have a good understanding of the Hall effect and how it is used, you might like to try putting it to practical use.

You will need a Hall-effect element. An inexpensive source is the F. W. Bell Co., 1356 Norton Ave., Columbus, Ohio 43212. I used one of Bell's BH-700 Hall-effect elements in all the following experiments. It is available direct from the manufacturer for $10.75.

To boost the low Hall output voltage obtained from the Hall-effect element, a dc amplifier is required. There are, of course, a number of circuits that can do the job, and the simple differential (balanced) transistor amplifier shown in Fig. 8 will do the job nicely. This circuit is identical to that of the completely packaged printed-circuit amplifier available from the F. W. Bell Co. as part of their Hall Pak Kit. The kit, available for $21.95, also contains one BH-700 element, two small bar magnets and an instruction booklet with applications.

The amplifier can be powered by a 9-volt transistor-radio battery, with a 6-volt lantern battery supplying the Hall control current. The output of the amplifier can be applied to either a vtvm with a low range of 5 volts or less, or to a 100-μA meter. Now, on to the experiments.

Measuring magnetic field strength

With the element, batteries and amplifier connected as shown in Fig. 8, apply power to the amplifier and control current to the Hall element. With no magnetic materials near the Hall element, adjust the amplifier's balance control, R1, for a mid-scale meter reading. Bring a small permanent magnet near the Hall element. The meter deflects, indicating the presence of a Hall output voltage from the element. As the magnet is moved closer to or farther from the Hall element, the Hall output voltage will vary proportionally, as indicated by the meter. Notice that the direction of meter movement

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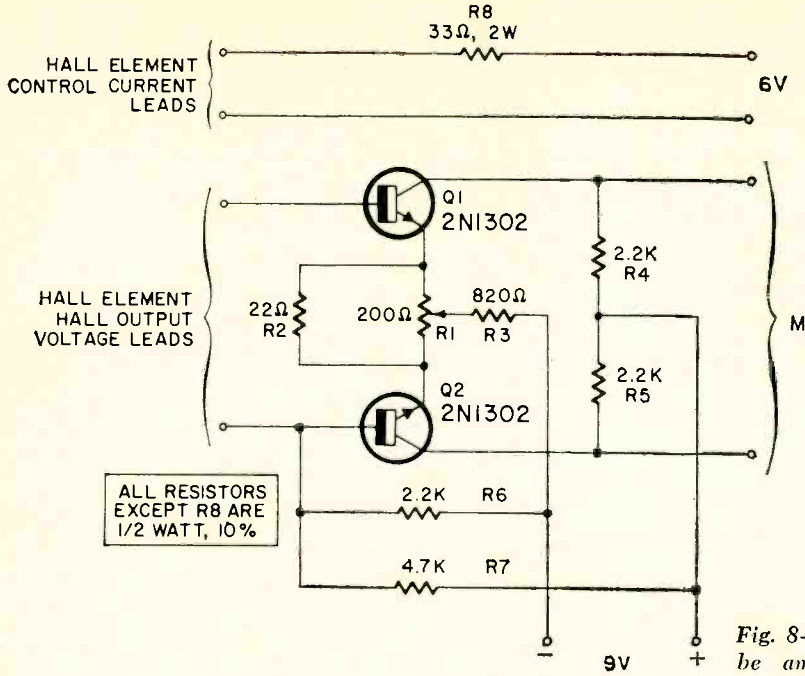


Fig. 8—Low output voltage from Hall-effect element can be amplified with this differential amplifier circuit.

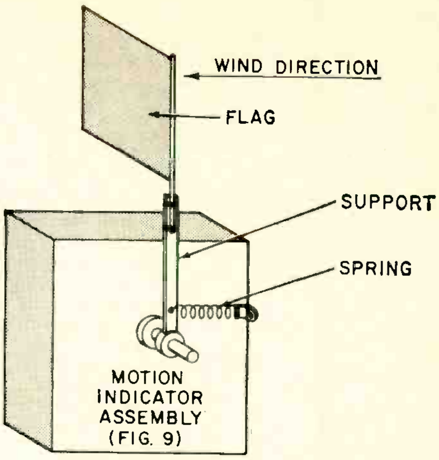


Fig. 10—Using the shaft-position indicator (Fig. 9) to show wind velocity.

is determined by the polarity of the magnetic field.

A noncontacting position indicator

Here's a Hall effect project for which you can find a number of applications. Basically a direction-sensing rotational-motion indicator, it can be used as a wind-speed indicator, a liquid-level indicator, for "electronic scales," or as a source of low-frequency ac signals, to name but a few.

Figure 9 shows the setup. A small permanent-magnet rotor (type DM-662, Dura Magnetics, 5354 Whitford Rd., Sylvania, Ohio, 43560; $1.45) is mounted on a shaft supported between two panel bearings so that it rotates freely when the extended portion of the shaft is turned. A BH-700 Hall-effect element is mounted approximately 1/16" from the edge of the rotor, as shown in Fig. 9. When the shaft is rotated, the rotor edge moves past the Hall element, generating a Hall output voltage proportional to the magnetic field intensity at the edge of the rotor. The Hall output voltage will vary from a maximum negative value, decrease to zero, then rise to a maximum positive value. The polarity and amplitude of the Hall output voltage will depend on the position of the shaft.

This arrangement is better than devices such as a potentiometer-type position indicator, because there is no wiper to wear down a wire or carbon resistance element. Also, there is less friction on the rotating shaft and less torque is required to turn it.

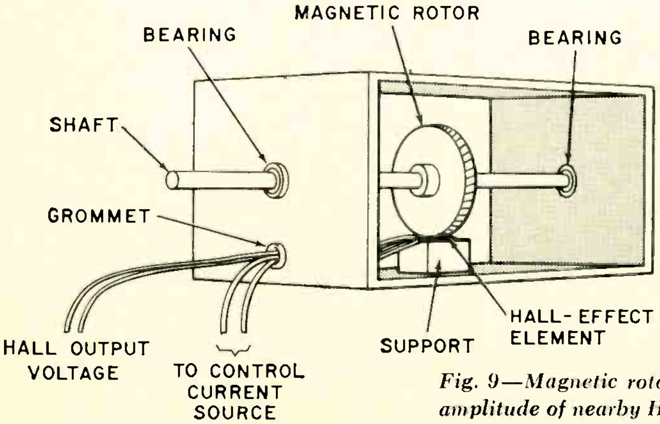
Now let's put our little gadget to several practical uses. Fig. 10 shows the position indicator as a wind-speed gage. The shaft of the indicator is fitted with a small clamp to which is attached a metal flag. A spring is attached to the bottom of the flag support. The spring returns the flag to its rest position when no pressure is applied to the flag. Spring tension is adjusted so that the rotor is turned approximately 45° when there is maximum wind pressure.

The differential amplifier is connected to the Hall output-voltage leads of the element. With power applied to the amplifier, its balance control, R1, is adjusted for a zero meter reading when the flag is at rest. Moving the flag with a finger should cause the meter to read upscale. If the meter reads backward, simply reverse its leads for correct polarity.

To calibrate the meter scale, take it to a clear spot outdoors. Check with your local weather bureau to obtain the current wind speed, and adjust the indicator's spring tension to get an appropriate meter reading. By "appropriate," I mean a half-scale meter reading for a 50-mph wind, quarter-scale reading for 25 mph, or less for lower velocities.

Figure 11 shows how the position indicators can be used to furnish low-

(*continued on page 93*)



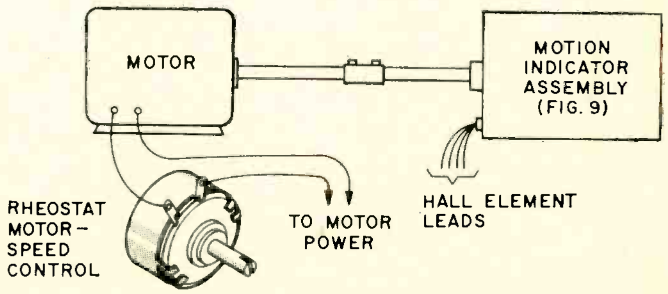


Fig. 11—Spinning shaft in Fig. 9 generates alternating voltage.

Fig. 9—Magnetic rotor supported on freely rotating shaft changes polarity and output amplitude of nearby Hall element. Setup can be used to sense direction or indicate speed.

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TV INTERFERENCE

How to identify and cure TVI from adjacent channels

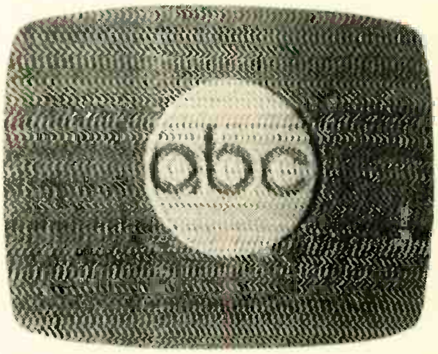

Fig. 3—Herringbone pattern superimposed on the picture is result of sound interference from the lower adjacent channel.

By MATTHEW MANDL

CORRECTLY ADJUSTED I. F. TRAPS ARE vital to proper operation of a TV receiver. They help shape the i.f. response curve, eliminate interference from adjacent-channel stations and prevent the i.f. carrier of the station being received from causing interference (sound bars) in the picture.

In most areas around the country, adjacent-channel traps are probably the most neglected of all TV circuits. Adjacent channels are not assigned to two stations in any one area, so there is no continuing problem of adjacent-channel interference.

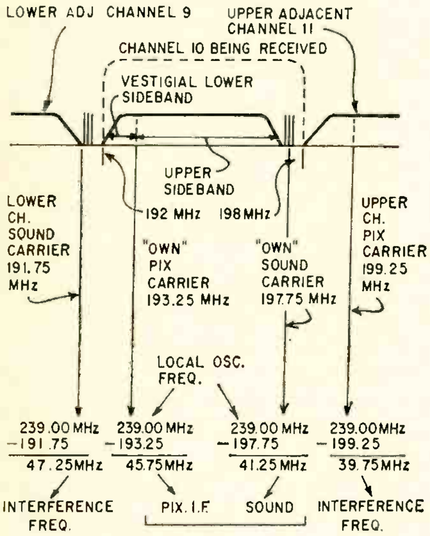

Fig. 1—Distribution of other signals in and around TV channel 10. The intermediate and interference frequencies are identical on all other television channels.

For the purpose of this article, adjacent channels are those with no separation between the upper limit of one channel and the lower limit of the next channel above it. For example channel 2 (54–60 MHz) and channel 3 (60–66 MHz) are adjacent channels. Channel 4 (66–72 MHz) is the upper adjacent channel to channel 3 but channel 5 (76–82 MHz) is not the upper adjacent channel to channel 4 because there is a 4-MHz gap between the upper end of channel 3 and the lower end of 4.

Complaints of interference are common when portable TV sets are taken into an area between two metropolitan TV centers that have stations on adjacent channels. Sometimes the complaints are blamed on automobile ignition noise or other man-made interference. While these may be contributing factors, adjacent-channel interference is often the culprit and should not be ruled out.

However, the problem situation is equally serious on console-type sets in "midway" areas or when a CATV system brings in adjacent-channel stations from distant areas. On interference complaints, always check the traps, not only to minimize interference, but also to make sure that a mistuned trap is not affecting the overall response curve and cutting down on fine detail in the picture. This happens when a trap is mistuned and falls within the i.f. bandpass curve.

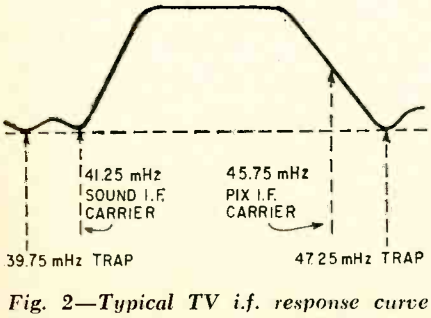

Fig. 2—Typical TV i.f. response curve showing the carrier and trap frequencies.

Why traps?

An understanding of why traps are necessary will help you diagnose symptoms. On both vhf and uhf channels the local-oscillator signal in the tuner heterodynes (mixes) with the incoming sound and picture carriers to produce the sound and picture i.f. signals. If adjacent channels produce reasonably strong signals in the area, their sound and pix carriers can ride into the tuner and also mix with the local oscillator. The result is the production of spurious signals which ride through the video i.f. stages and produce interference in the form of bars, herringbone lines and double images. At the same time the desired station's own sound i.f. signal must be trapped to prevent it getting to the picture tube and producing horizontal bars.

The entire mixing process is shown in Fig. 1 for channel 10 as an example. Here, the channel-10 picture carrier of 193.25 MHz mixes with the local-oscillator frequency of 239 MHz to produce the picture i.f. of 45.75 MHz, which is now standard with almost all receivers.

Channel 10's sound carrier of 197.75 MHz also mixes with the local-oscillator frequency of 239 MHz, and the result is the 41.25-MHz sound i.f. carrier. Note, however, that the lower adjacent channel (9) has its sound carrier near the start of the channel-10 picture carrier. If this lower adjacent-channel sound carrier mixes with the local oscillator the result is a signal with a frequency of 47.25 MHz. Similarly, if the upper-channel picture carrier mixes with the local-oscillator frequency, an interference signal is produced, now having a frequency of 39.75 MHz.

The tuner operates the same way when turned to other channels. The channel-3 picture carrier, for instance,

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TRAPS SIMPLIFIED

Fig. 4—TVI from upper adjacent channel results in "floating" background picture. TVI blanking produces framing lines.

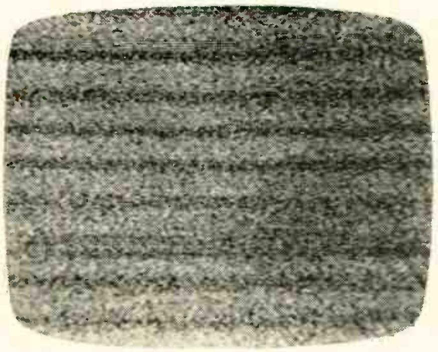

Fig. 5—Interference of faint sound bars can be traced to adjacent TV station by tuning the set toward next higher channel.

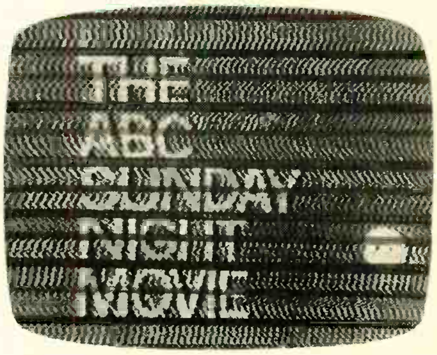

Fig. 6—Multiple interference. Herringbone pattern and horizontal bars are due to sound and lower channel traps.

is 61.25 MHz, and now the local oscillator is 107 MHz. When these two mix, the resultant is again a 45.75-MHz pix i.f. Note the trap frequencies which result when channel 3 is tuned:

107.00 MHz local oscillator at channel 3
67.25 MHz channel-4 picture
39.75 MHz interfering signal

107.00 MHz local oscillator at channel 3
59.75 MHz channel-2 sound
47.25 MHz interfering signal.

Misadjusted traps can also interfere with the i.f. bandpass. Fig. 2 is a typical i.f. response curve showing the dips which result with properly tuned traps. The picture i.f. is higher than the sound i.f. due to the mixing process when the set oscillator is higher in frequency than the incoming signal. Hence, the lower adjacent-channel trap is *higher* in frequency than the upper adjacent-channel trap, as was also shown in Fig. 1.

If the 47.25-MHz trap is tuned too low in frequency it will put a dip on the right slope of the response curve, affecting fine detail and crispness. Similarly, if the 41.25-MHz sound trap is shifted higher in frequency, it will cut into the left-hand slope of the curve, attenuating low video frequencies and causing large objects in the television picture to appear smeared.

In solid-state portable receivers, the bandpass determines how many traps are used. Some receiver designs call for a 3-MHz or 3.2-MHz bandpass. This is sufficiently narrow to permit elimination of all traps except perhaps the 47.25-MHz lower adjacent-channel trap. If a wider bandpass is used, all three traps are necessary for best results.

Thus, with standard i.f.'s of 45.75-MHz picture and 41.25-MHz sound, the traps will be 41.25 MHz, 39.75 MHz and 47.25 MHz. On rare occasions, however, a special trap may be used where the receiver is found to be susceptible to a specific interfering frequency. This special trap may have a frequency of 37.5 MHz instead of the usual 39.75 MHz. Such a change from the normal is usually indicated on the schematic of the television receiver in question.

Symptom identification

Lower adjacent-channel interference is shown in Fig. 3. Note the herringbone pattern. The constant change of the interfering signals shifts and wiggles the lines constantly.

Interference from the upper adjacent channel causes the interfering picture to be visible, as in Fig. 4. With the interfering picture not properly synchronized, faint "framing" lines may be visible as the vertical and horizontal blanking of the interfering siganls shifts across or up the screen. The phasing may be such that the blanking bars appear white against a dark background on the TV screen.

The fine-tuning control can be adjusted to favor the interfering station to accent symptoms and make identification easier. If very faint shifting bars are visible, tune toward the upper channel and note if the interference increases. Similarly, for very faint herringbone lines, shift the fine tuning toward the lower adjacent channel to see if the lines become more visible.

If the 41.25-MHz sound trap is not adjusted, you will see horizontal bars that change with sound intensity and frequency. The sound bars will not be evenly spaced nor will they stay in one position for any length of time. If the sound carrier produces a stronger signal than the video, you may see faint sound bars (Fig. 5) and not the video. Sound bars on weak stations are a positive indication of the need for trap adjustment.

When both the lower adjacent-channel trap and the sound trap (41.25 MHz) are maladjusted, multiple interference patterns may result, as shown in Fig. 6. Such multiple symptoms may not occur for each channel tuned in because of frequency gaps between some stations. Channels 4 and 5, for instance, are separated by 4 MHz; channels 6 and 7 by 86 MHz and channels 13 and 14 by over 200 MHz.

Trap circuits

In tube-type receivers, traps were often found in various sections of the i.f. amplifiers (to minimize loading effects). Because of the low-impedance

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characteristics of transistors, however, all traps can be included in the input to the first video i.f. amplifier. In many cases a trap consists of a series capacitor and variable inductor, as shown for the solid-state Sylvania AO7-1 receiver of Fig. 7. A series-resonant circuit has a low impedance for the signal to which it is tuned, hence shunts such an interfering signal. The complete trap circuit consists of C1 and slug-tuned L1. Inductor L2 and C2 are not part of the trap circuit, but comprise part of the i.f. resonance tuning.

Note the low value of R1, the series isolating resistor. Where multiple traps are used, several such low-value resistors will be found in the solid-state systems. If traps do not function, the fault is rarely with such resistors or associated parts, but rather with the slug-tuning mechanism.

Full trapping is used in the Airline 1967-A receiver shown in Fig. 8, where L1, L2 and L3 are slug-tuned coils. Transformer T1 is used between the tuner input and the base of the first picture i.f. stage using an npn transistor.

Some receivers have two traps tuned to the same frequency to provide maximum interference reduction. An example of this is the twin 47.25-MHz traps (Fig. 9) in the Magnavox T908 chassis. Here, a series-resonant 47.25-MHz trap (L2–C2–C3) is connected across the tuner output to shunt the unwanted signal to ground. In addition, a parallel-resonant absorption-type trap (L3–C1) is coupled to i.f. input coil L4 to "suck out" the interference frequency. Some sets use two traps for 41.25-MHz sound rejection. The Magnavox T908 chassis does not have a 39.75-MHz adjacent-channel video trap.

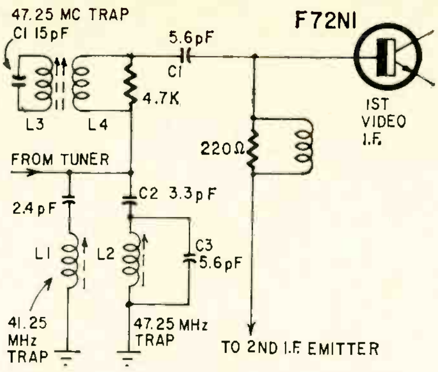


Fig. 9—The Magnavox T-908 has a series-resonant shunt trap and a parallel-resonant absorption trap to obtain better adjacent-channel signal rejection.

At first glance, trap L2–C2–C3 appears to be a parallel-resonant circuit coupled to the i.f. circuit by C2. If this were the case, it would boost the 47.25-MHz signal it is intended to attenuate. However, the parallel-resonant circuit L2–C3 is tuned to some frequency *higher* than 47.25 MHz so it appears as an inductor at all frequencies *below* resonance. Thus L2–C3 appears as an *inductor* in series with C2. This series-resonant combination can be tuned to the desired frequency (47.25 MHz) by adjusting the slug in the coil.

Adjustments

A trap can usually be adjusted without test equipment by watching the screen while slowly turning the trap tuning slug clockwise or counterclockwise. Initially try to determine which type of interference is present and adjust only the appropriate trap. Check results for several stations and for slight variations of the fine-tuning control.

If meters are used, a vtvm can be placed across the video detector output and a signal injected into the tuner or the first i.f. stage. The signal frequency should correspond to that of the trap. In such procedures the agc line should have a fixed bias applied (2 or 3 volts, depending on the average bias for the receiver). The trap is then tuned for a *minimum* reading on the vtvm. It is very important that the signal used for trap adjustments be as accurate as possible.

Sometimes adjacent-channel interference cannot be eliminated from receivers having only a single trap. The most likely causes are poor i.f. alignment and improper antenna orientation. If the antenna checks out all right, use a sweep and marker generator to realign the stages to obtain the curve recommended in the receiver service notes. If the i.f. bandpass is too wide, gain will be down and adjacent-channel interference will be difficult to eliminate. With proper realignment, there should be greater contrast and less interference.

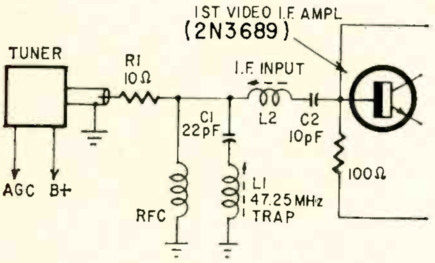


Fig. 7—I.f. input circuit of a Sylvania AO7-1 solid-state TV. Trap C1-L1 is used to reject adjacent-channel sound.

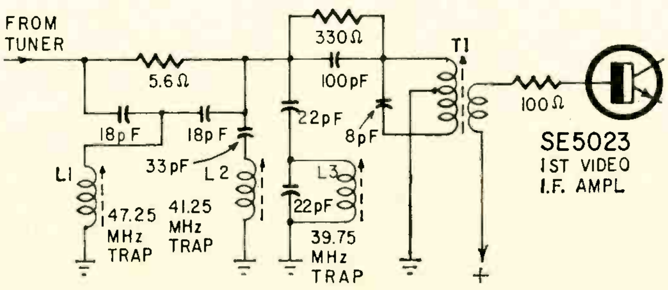
What about color sets?

Trap adjustment procedures are the same in solid-state color receivers. Color sets have the full quota of traps because of the wider i.f. bandpass needed to handle color signals. Before adjusting the traps, however, make sure the antenna system is properly oriented and is providing a good signal. With a weak signal, the colors will not be vivid with normal fine-tuning control settings. If the fine tuning is advanced to increase color contrast, some wiggly lines may appear as well as herringbone interference from the adjacent channel. It is also a good idea to check the setting of the color-killer control as well as the color-killer tube if slight instability occurs in fine detail.

To check operation of the killer control, set the channel selector to an unused station and back off on the color-killer control (usually counterclockwise). Now advance the killer control slowly until no colored snow appears on the screen. Check operation of the tint control during color reception to make sure it has full range. If the tint control produces a black-and-white picture for its extreme range settings, back off slightly on the color-killer control. If the slight herring-bone pattern still persists for normal color levels (with good signal input from the antenna), try adjusting the traps to clear up the interference.

For horizontal-bar interference, remember that sound interference produces bars that vary in intensity in sync with the sound coming from the speaker. If the pattern remains fixed, a circuit may be oscillating and generating a fixed interfering frequency. In one color receiver the killer circuit produced colored horizontal bars because of a faulty transistor! **R-E**

Fig. 8—I.f. input of a receiver with full trapping. The Airline GEN-1967-A set has i.f. traps for adjacent-channel sound and video and for accompanying sound.



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Color Blanking Circuits

Correct blanking action insures sharp, high quality pictures

By ROBERT L. GOODMAN

WHEN BLANKING CIRCUITS ARE IN top operating condition, your color picture is sharper and crisper. Poor or absent blanking degrades the picture. The circuits involved are simple to understand and troubleshoot.

Horizontal and vertical blanking pulses are fed to the picture tube to cut off the electron beams during retrace time. If these pulses are not present, retrace lines appear on the screen throughout the picture. Horizontal retrace blanking is also necessary to prevent the burst from appearing on the screen. Since the burst rides on the back porch—just after the horizontal sync pulse, with no blanking a yellow stripe appears on the right screen edge. Finally, horizontal blanking also sets the dc level for the red, green and blue amplifiers, preventing undesirable color shift.

A basic blanker circuit

Three functions are performed by the blanker in Fig. 1. It blanks the red, green and blue amplifiers during horizontal retrace. It supplies a negative pulse which clamps the grid of the color i.f. amplifier at the start of each scanning line. It provides a negative voltage for the brightness control in the second video amplifier stage.

Blanker drive comes from the flyback transformer, which supplies a 300-volt pulse during horizontal retrace. This pulse is coupled to the blanker grid (Fig. 2), driving it positive. Current flows from cathode to plate at this time, producing a large positive pulse on the cathode. The blanker cathode is tied directly to the second color i.f. cathode, cutting off the i.f. tube during horizontal retrace. Only color video information—not sync—is therefore passed to the demodulators. Color sync on the demodulars during retrace superimposes a veil-like pattern on the picture.

The positive pulse at the blanker grid produces a negative plate pulse (180° phase reversal). This pulse clamps the red, green and blue amplifier grids, preventing color shift in the picture. The grids of these amplifiers are capacitance-coupled to previous stages; without grid clamping (dc restoration) gray-scale shift occurs.

Grid clamping occurs as follows:

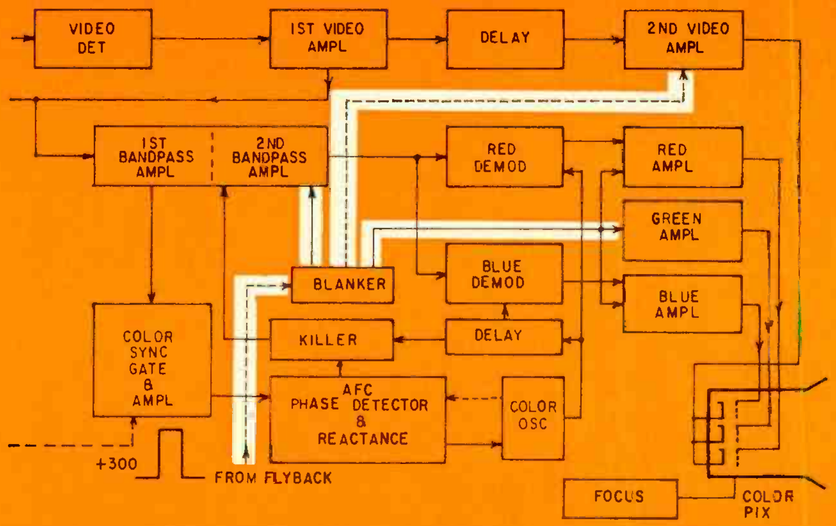

Fig. 1—Typical blanking circuit in today's color sets performs three functions.

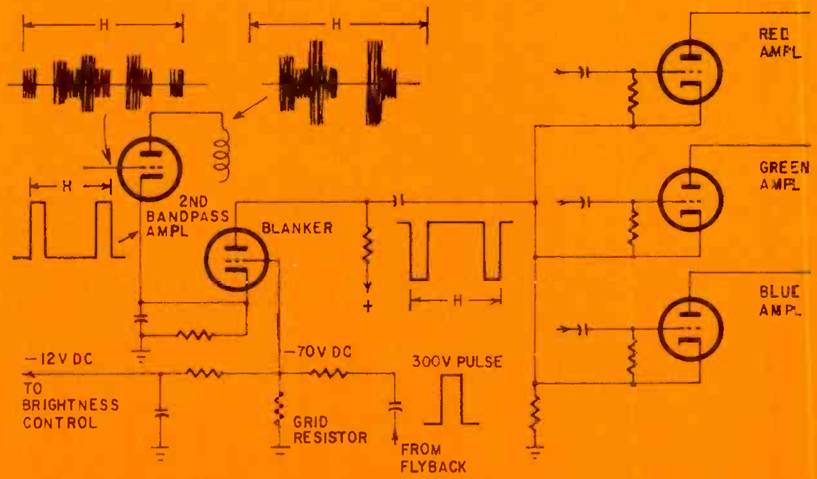

Fig. 2—Blanker tube is keyed on by flyback pulse during retrace, cutting off the second color i.f. amplifier and passing only the color video information.

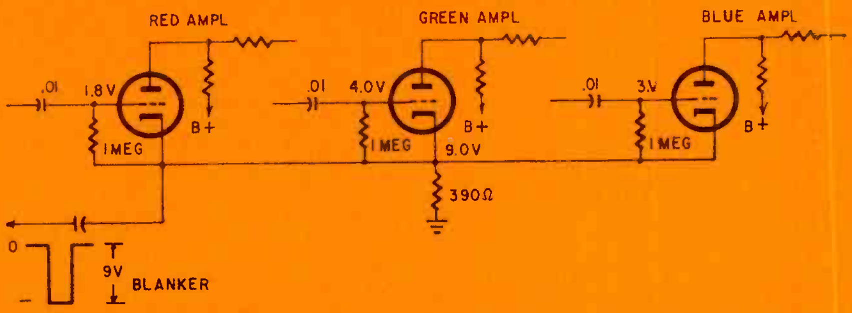

Fig. 3—Red, green, blue amplifier cathodes are clamped line-to-line by blanking pulse, preventing an undesirable shift of the color values due to RC coupling.

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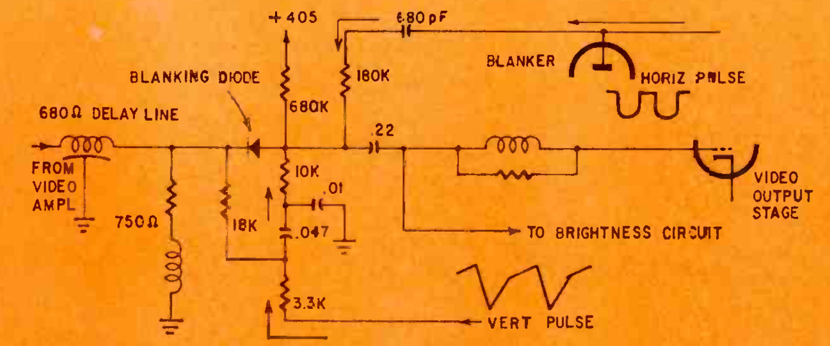

Fig. 4—Blanking circuit of the RCA CTC31 chassis. The diode is reverse-biased by blanking pulses, which cut off color video during the horizontal retrace period.

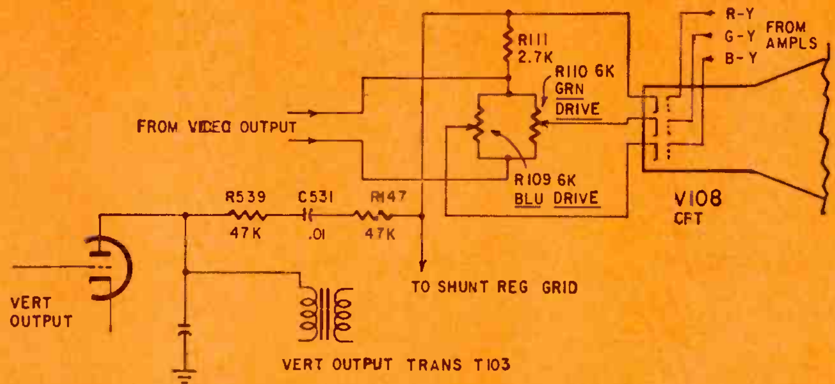

Fig. 5—Vertical blanking circuit used in the G-E 12-inch color TV CB chassis.

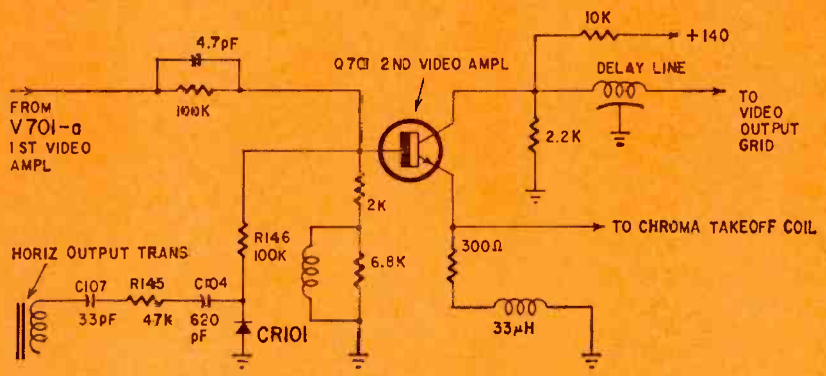

Fig. 6—Horizontal blanking in the G-E CB chassis at second video amp. stage.

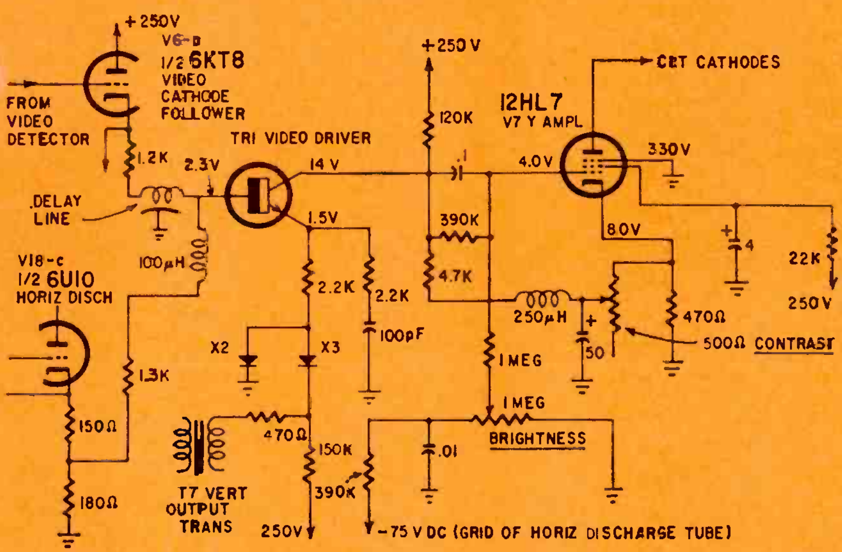

Fig. 7—All blanking in the Zenith 20X1C36 chassis is done in video driver stage.

At the end of one scanning line, the R, G and B amplifier grids have the voltages shown in Fig. 3. (These differences in grid voltages cause different place currents through the three amplifiers, and of course, a different potential on each CRT grid. Should the plate voltages on these amplifiers be different from those originally set up for a white raster, the screen would be some other color than white.)

At this point (horizontal retrace) a negative-going 9-volt blanker pulse is coupled to the R, G and B cathodes. The pulse overcomes the 9-volt positive potential normally on these cathodes during the active portion of the sweep. Thus the cathodes are now at zero potential, the grids remaining at the indicated voltages.

Why do the grid potentials remain the same? Because the time constant of the .01-μF capacitor and the 1-megohm resistor in the grid circuit is too large to permit grid voltage to change during the short pulse. Since each grid is positive with respect to its cathode, electrons flow from cathode to grid, dropping the grid voltages to the same potential as the cathodes. The time constant of the coupling capacitor and the grid resistor keeps this grid voltage at that point for the start of the next line; whatever ac voltages are coupled through the capacitors cause grid fluctuations at this voltage.

The cathode voltage returns to its average 9-volt level when the blanking pulse is removed, and the amplifiers start the next line with the same grid-to-cathode bias voltages.

RCA retrace blanking

In the RCA CTC31 (Fig. 4) the horizontal-retrace blanking signal is fed to the CRT cathodes through the video output stage along with the vertical retrace blanking pulse. In previous chassis, this blanking signal was fed to the CRT grids through the color amplifiers. RCA now uses a diode clamp circuit for retrace blanking. In the early CTC19 and the CTC24 color chassis, vertical blanking was applied in the second video amplifier grid, using a diode circuit.

The blanking circuits in the CTC31 work like this: Negative vertical retrace pulses are taken from the vertical yoke winding. They are differentiated by the 0.047-μF capacitor, which removes the sawtooth portion of the waveform while retaining the retrace portion. This waveform is then integrated by the .01-μF capacitor and 3300-ohm resistor to widen and delay the retrace portion. To this waveform are added negative horizontal blanking pulses from the blanker plate, through the 180,000-ohm resistor and the 680-pF capacitor.

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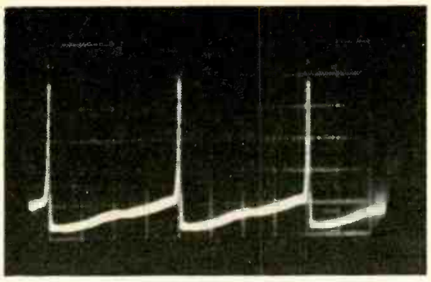


Fig. 8—Negative-going vertical retrace pulse (10 volts p-p) taken from vertical output transformer shown in Fig. 7.

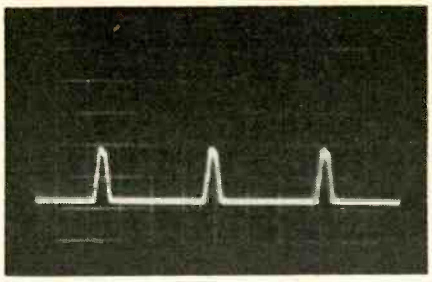


Fig. 9—Horizontal blanking pulse (4 volts p-p) taken from cathode circuit of horizontal discharge tube in Fig. 7.

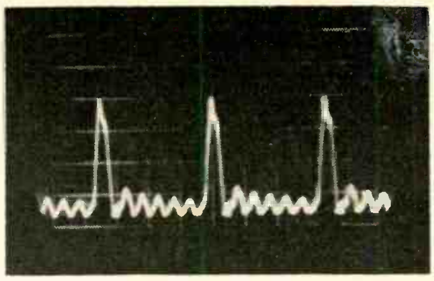


Fig. 11—Shorting of diodes X2 or X3 makes horizontal blanking pulse ring. Six-volt p-p signal taken on TR1 collector.

During the active-scan interval, the diode is forward-biased by the 680,000-ohm resistor connected to B+. The diode then directly connects the delay-line output to the 0.22-μF capacitor and to the grid of the video output stage. Should the blanking diode short, a multiple ghost image appears on the screen. This is caused by the horizontal blanking pulse making the delay line ring.

During the negative-pulse portions of the blanking waveforms, however, the diode is turned off, disconnecting the video output of the delay line. In place of video, negative-going pulses are fed to the video output grid. These pulses cut off that stage, and of course the CRT—regardless of the setting of the contrast or brightness controls.

G-E CB chassis blanking

Vertical blanking in this receiver is developed (Fig. 5) by positive-going vertical pulses from the plate circuit of the vertical output stage. The sequence is through R539, C531 and R147 to the CRT red cathode. These pulses are then coupled from the red cathode to the blue and green cathodes via the drive controls.

Horizontal blanking is applied to a different stage (Fig. 6). Positive-going horizontal flyback pulses are coupled and shaped by C107, R145, C104 and R146 from the horizontal output transformer to the base of Q701, the second video amplifier. Diode CR101 is connected to the junction of C104 and R146.

The negative portion of each horizontal pulse forward biases CR101, making it conduct. The negative portion of the flyback pulse, which contains some ringing, is removed by CR101. Accordingly, only the remaining positive pulse is fed to the base of Q701. This pulse is amplified by Q701 and the video output stage. Finally, it appears at the CRT cathodes as a positive-going blanking pulse, which cut off the CRT beams during retrace.

Zenith's 20X1C38 color chassis doesn't use direct CRT blanking. Instead (Fig. 7) both horizontal and vertical blanking pulses are fed to a video amplifier stage.

A negative-going vertical retrace pulse (Fig. 8) is taken from the vertical output transformer and fed to the emitter of transistor TR1, the video driver, through diode X3. Horizontal blanking is done with a positive-going pulse (Fig. 9) from the cathode circuit of V18-c, the horizontal discharge tube. The pulse is applied to base TR1's.

If transistor TR1 shorts or otherwise fails to pass signals, the Y or luminance signal disappears from the screen, leaving only color-difference information and retrace lines (Fig. 10). If the set is tuned in to a black-and-white program, the killer tube removes color-difference information and you get nothing but a blank raster on the screen.

If diode X2 or X3 shorts, the horizontal blanking pulse rings, as shown in Fig. 11 (taken on TR1's collector), and the picture looks like Fig. 12.

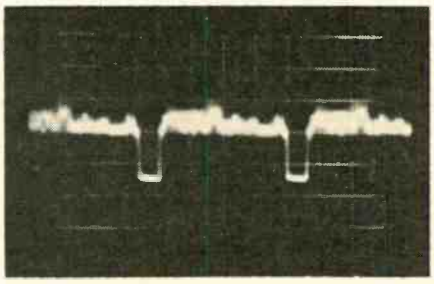


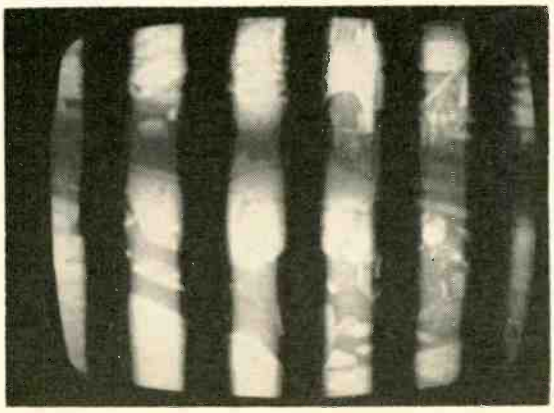
Fig. 13—Proper retrace blanking at CRT grid-cathode circuit. Total p-p amplitude is 8 volts, cutting off CRT beams.

Both pulses—the negative vertical and the positive horizontal—have the same effect on transistor TR1; each produces a negative pulse in the collector circuit of the transistor. This negative pulse is coupled to the grid of yellow amplifier V7, and causes a positive pulse in that tube's plate circuit. Since the plate is de-coupled to the three CRT cathodes, the large positive pulse makes the cathodes positive with respect to their grids, and the beams are blanked. Fig. 13 shows horizontal blanking pulses and video at the CRT grid–cathode circuit.

Most blanking circuit troubles are simple if you understand their operation. A scope is the most effective tool with which to troubleshoot blankers. But you should also be aware of what the picture looks like with proper and improper blanking pulses. **R-E**

Fig. 10—Failure of video driver in Fig. 7 removes the luminance (Y) signal from screen.

Fig. 12—Screen displays ringing bars caused by diode failure generating Fig. 11 waveform picture.



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COLOR TV TROUBLE

Practical benchman's approach to servicing shortcuts

By VIC BELL

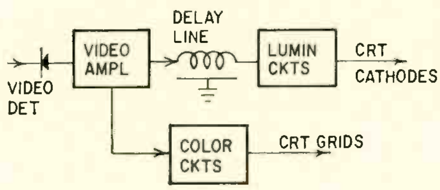
ABOUT 80% OF COLOR CHASSIS NOW use the same basic physical circuits and electrical configuration. Consequently, their problems are often identical. Even those chassis using a radically different physical layout are often electrically similar and therefore plagued by the same problems.

Some of the problems these sets develop are "easy" while others are downright tricky. In either case, the novice or pro may have difficulty finding his way around the schematic or the chassis.

If the chassis which has you stumped is not a common one, check the schematic. The chances are good that the circuitry is similar and with only a little more effort you can chase down the trouble. The troubles described here are not caused by tubes but you must understand that tubes can cause almost any conceivable trouble and we will assume that you have substituted all possible suspects. Don't forget to use your best test equipment first: eyes, nose and hands. These three tools will be the quickest road to a lot of repairs. Use them regularly and you will find a surprising number of troubles before you could warm up your scope.

Complaint: Color only—screen blank on black-and-white. This trouble can cause a lot of wasted time unless you are on the ball and look for all the symptoms. Do not overlook the fact that the screen is not blank all the time; color programing does come through when the color control is advanced. The cause can be an open or short almost anywhere beyond the color takeoff point but the most common cause is an open delay line.

Remedy: Most delay lines have only three leads; one is grounded. Connect a jumper between the two that are not grounded. If the delay line is open, the picture should appear *almost*



normal with the jumper in place.

Delay lines can often be repaired since they are simply a single-layer coil. Opens usually occur at or near the terminals. The grounded terminal is connected to a copper-foil cylinder on which the coil is wound.

Complaint: Poor focus. When the focus on a color set is poor but can be changed, the CRT is bad or, more likely, the focus voltage is wrong. When focus can't be controlled, it generally means that the focus voltage is nonexistent or is not reaching the CRT focus grids.

The horizontal-output pulse voltage is passed through a transformer (the focus coil), rectified (by a tube or a selenium rectifier), filtered with a 130-pF capacitor and applied to the CRT focus grid.

Remedy: If it appears that you have no focus voltage, give a light tug on the wire (usually black) going into the CRT socket. The lead may be loose and will pull out. Then all you have to do is replace the socket. If the lead doesn't pull out, try a continuity check just to be sure.

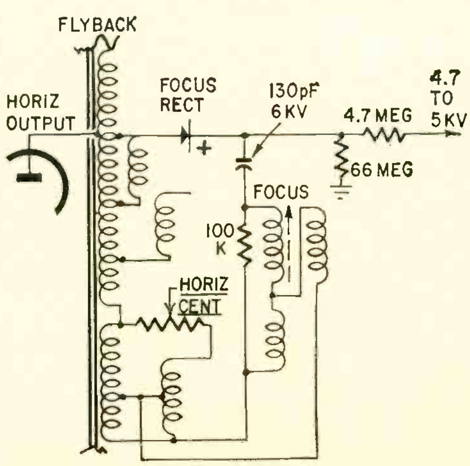
A good socket calls for other checks. The first is a voltage check. You should have about 5,000 volts positive at the output end of the rectifier. Other problems in this area usually leave burned components, so they aren't difficult to track down. When the focus coil is bad, it too is usually burned.

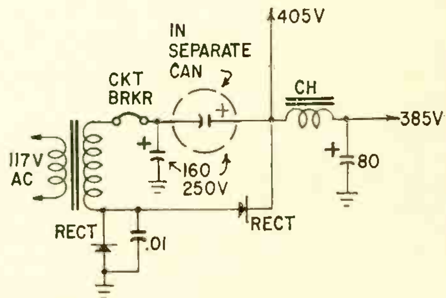
Don't try to measure the front-to-back resistance on a selenium focus rectifier. This unit is actually a number of selenium cells in series and the forward resistance appears to be about the same as the back resistance. A good "sniff" will tell you more about seleniums.

Complaint: Insufficient height and width—little or no sync. These symptoms generally indicate that something is wrong in the B+ circuitry. The offending part is almost always an open voltage-doubling capacitor. In our typical color set, the unit is a 160-μF, 250-volt single-unit can.

Remedy: Using a similar capacitor to bridge the suspect will confirm the suspicion if the capacitor is open. Shorts rarely develop and will open the circuit breaker, and sometimes ruin the rectifiers when they do.

If the voltage doubler is completely open, the set will not function at all. A few quick voltage measurements will still lead you to the faulty





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SHOOTER GUIDE

part, however. and the same bridging technique proves the fault. If you are looking for the screen or the speaker to come to life when the capacitor is connected to the circuit, be sure the volume is turned up and that the brightness and screen controls are at their normal settings. The best way to be sure the suspected capacitor is at fault is to monitor the voltage while jumpering the part. *The set may have more than one faulty component!*

Complaint: No high voltage—burned smell. When the flyback transformer burns, it may or may not be obvious.

Remedy: Late models often have the flyback "tire" insulated with a material that does not burn under normal conditions. If you suspect the flyback has burned. feel the "tire" gently. If it is "crunchy", peel the silicone back slightly. If the flyback is burned, this will make it obvious.

All bad flybacks don't look bad nor are all bad-looking flybacks faulty. A few drops of wax which have dripped from a transformer is sometimes normal. If you must replace a flyback, be sure the high-voltage cap and associated wiring are in good shape. All tubes in the horizontal and high-voltage section should also be replaced since any one of these could be intermittent and cause flyback failure. Heat may have damaged selenium focus rectifiers in extreme cases and these should also be replaced to prevent future difficulties.

Complaint: Circuit breaker trips—either immediately or after the set has operated normally for a few seconds or a few minutes.

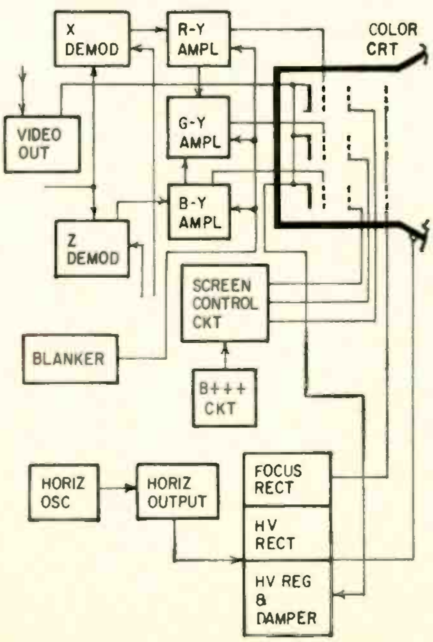
Causes and remedies: If the circuit breaker trips as soon as the set is turned on, the most likely suspect is one of the B+ rectifier diodes. No need to disconnect the diodes; a quick check with the ohmmeter will show a short. Make sure you check the diode both ways.

Another common cause is a 0.0033-μF, 1600-volt capacitor used between the vertical output plate and one side of the yoke in some vertical amplifiers. This sometimes shorts. The convergence wiring may have to be replaced in the area of the capacitor and the resistor feeding the vertical circuit.

If the horizontal-output plate starts to turn red, the trouble may be the tube itself, the high-voltage rectifier or the horizontal oscillator. A quick check of output-tube grid voltage should show about -55 to -45 volts. A more positive voltage usually indicates oscillator trouble. Voltage and resistance checks in the oscillator circuit will pinpoint the trouble. Be sure to check the output grid coupling capacitor for leakage.

Another frequent offender, and last on many technicians' lists. is the circuit breaker itself. One good check is to simply short out the breaker for a short period.

Complaint: Blooming. Very likely this condition is caused by excessive drain on the high-voltage supply rather than on the high-voltage source, as is more common in b-w sets. Measure voltages at all elements of the CRT to



pin down the exact area of the problem.

Causes and cures: The most frequent offenders are the color-difference (R − Y, G − Y, B − Y) amplifier and the drive circuits in the luminance-channel output section. Anything that reduces the drive at the CRT cathodes or increases the voltage at the CRT grids can cause blooming and possible loss of raster.

An open heater in one of the color-difference amplifiers, for example, can cause B+ in that stage to go high enough to cause loss of the raster. Similarly, an open cathode resistor (common to all color-difference amplifier circuits), a shorted coupling capacitor in the grid of any of these stages, or a plate load resistor greatly reduced in value causes loss of raster conditions. Again, simple voltage checks will isolate the problem area.

If the video amplifier or the associated CRT cathode-drive circuitry is suspected, these areas can be isolated by operating the service switch. If a horizontal line appears at a normal setting of the screen controls, the drive circuitry is probably normal. Also. the color amplifier can be disregarded. All suspicion would be placed on the last video amplifier and direct-coupled stages ahead of it.

These are the only stages isolated from the CRT when the service switch is operated.

When the trouble has been traced to the drive circuits. look for an open resistor. You may save time by checking the resistors located in the kine-bias switch circuit first; a 5600- or 6800-ohm resistor will usually be found open. Also, don't fail to check the kine bias switch for failure.

Don't overlook checking the high voltage. A no-raster condition often presents itself even when the high voltage is normal. Check the B+++ voltage. It should be about 1200 volts and can be measured at the screen controls. The B+++ rectifier is often the culprit when this is low (800 volts indicates a shorted B+++ rectifier).

Complaint: No color—Loss of

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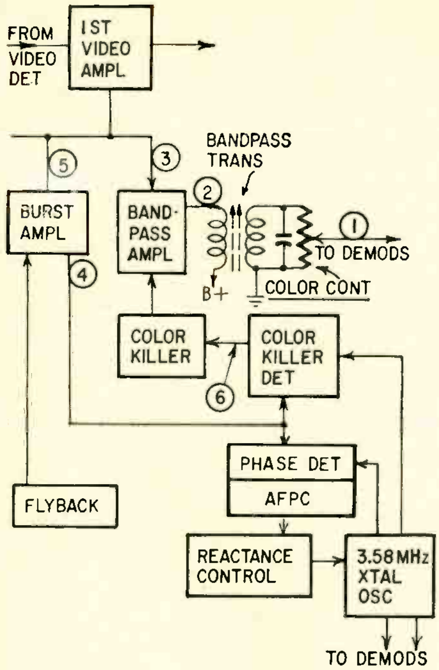


color is a common trouble which is easy to localize and repair because very few stages are involved in a no-color problem.

Before you start troubleshooting, make sure the color-killer adjustment is turned up and that the color-level or color-intensity control is fully open. This may solve the problem before you go any further.

Causes and cures: There is no reason to suspect the demodulators or color amplifiers since a malfunction there usually causes a color problem rather than a color loss and may cause color temperature trouble on black-and-white programs.

If the problem is related to color sync, the killer circuit usually activates and cuts off color. Consequently, the search can be immediately narrowed to the color oscillator and sync circuits. Frequently, only a reactance-coil adjustment is required to restore normal operation.

If you still haven't found the trouble, it's time to use a scope. A convenient starting test point is the arm of the *color* control just ahead of the demodulators. Then proceed as shown in the diagram above.

An open bandpass transformer is a frequent cause for loss of color. A continuity check will show if it is the culprit.

Complaint: Insufficient height. This problem often reflects troubles in the convergence circuits. Defects in the vertical oscillator can be localized quickly by voltage and resistance measurements and waveform checks.

Causes and cures: The convergence circuitry represents the total load (or a substantial portion of it) on the cathode circuit of the vertical output stage. If the stage does not have a separate cathode resistor, the resistance from cathode to ground will be around 5600 ohms in most sets. A higher resistance indicates a possible defect in one or more of the convergence controls.

To determine whether a convergence control is causing insufficient height, pull the convergence-board plug and connect a 120-ohm resistor from pin 2 (cathode circuit) on the convergence socket to ground. If height returns to normal the trouble is on the convergence board.

A cathode-bypass electrolytic, usually 50 μF, is also a frequent cause of trouble. Try shunting it with a similar type. If the sweep returns to normal the capacitor is bad.

Some sets have a cathode resistor shunting the convergence circuitry. If it has darkened or appears to have been overheated, replace it with a higher-wattage unit of the same resistance.

In many circuits, the B+ voltage to the vertical output transformer is dropped through a 3 to 5-watt resistor ranging from around 500 to 1500 ohms, depending on the set. A change in resistance can cause a drop in vertical sweep voltage.

Check for a leaky capacitor in the feedback network between the vertical output plate and the oscillator grid. Leaky capacitors generally cause the raster to collapse but they *can* be responsible for insufficient height.

Checking the output transformer can be a real problem. If the B+ and sweep waveform are good, there is every reason to believe that the output transformer is bad. The only sure check is to substitute it. Since the yoke is easily substituted, try this before a transformer change.

The rest is "Old Hat"

Most of the circuits in a color set have been mentioned in this article. But what about the rest? If you've been working on black-and-white sets, you should have no trouble. Agc, tuner, afc and i.f. circuits are all similar and display symptoms identical to corresponding malfunctions in black-and-white sets.

If you get stuck, look for variations of the problems discussed here. When you come to the end of your rope again, start over, you have probably skipped something too obvious.

And finally, don't forget that two tubes could be bad or that one of your new tubes could be bad. It happens every day and can be the toughest trouble you will ever encounter if you don't keep it foremost in your mind.

R-E

FIVE COLOR TROUBLESHOOTING TIPS

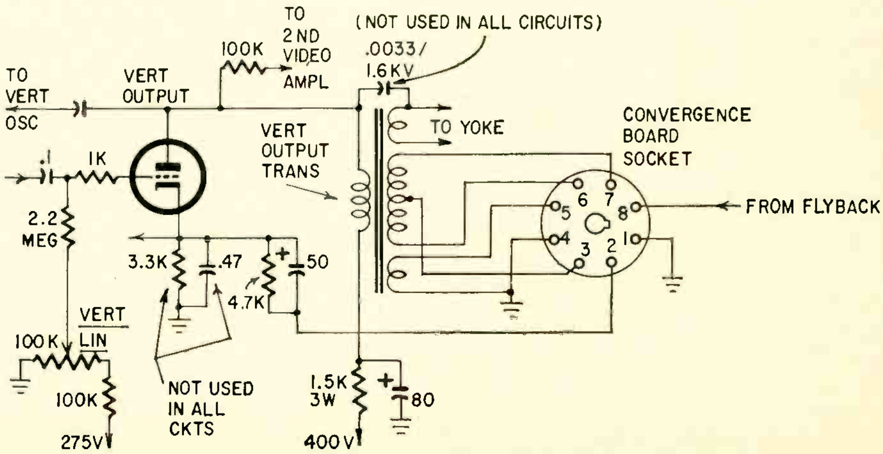
Color only—raster blank on black-and-white: Check for open delay line.

Poor focus: Measure focus voltage. Check CRT.

Blooming and possible loss of raster: Trouble not always in high-voltage section. Check color-difference amplifiers and luminance drive circuits.

No color: Check color controls. Check color oscillator and sync circuits.

Insufficient height: First test vertical circuits, then convergence circuitry.



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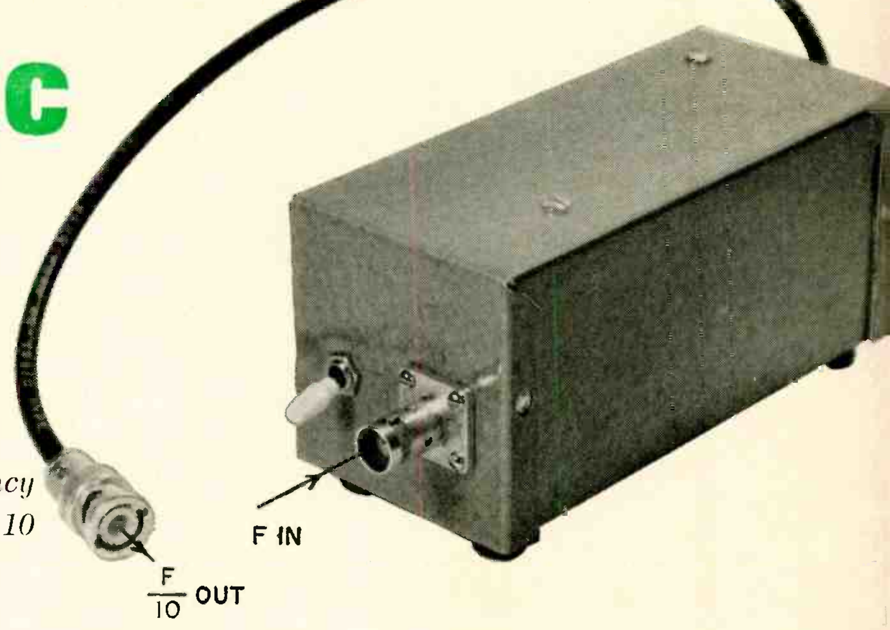

By DEWEY W. EPPLEY

WANT TO UPGRADE THAT OLD 100-kHz electronic counter to 1 MHz? Then read on and find out how you can easily and cheaply construct a battery-powered, in-line type decade divider (semiconductor cost less than $7.50). At the same time you will get a chance to work with a few of the many applications afforded by today's low-priced logic circuits.

The µL914

This article deals with only two of the many IC's available at very low cost. First is the Fairchild µL914, priced at only $0.80 in an epoxy package. The manufacturer calls this module a "Dual Two Input Nand/Nor Gate," but don't let this fool you—it has many applications. Fig. 1 shows the base connections and internal components of the µL914. Pin 8, identified by a flat spot on the epoxy case, is the positive supply voltage input. Pin 4 (counted in the same fashion as tube pins are numbered) is the ground terminal. Pins 1 and 2 are inputs to the transistor bases for one section, while pins 3 and 5 are the corresponding inputs for the other section. Pin 7 is the collector output for the first section, and pin 6 has the same function for the second section.

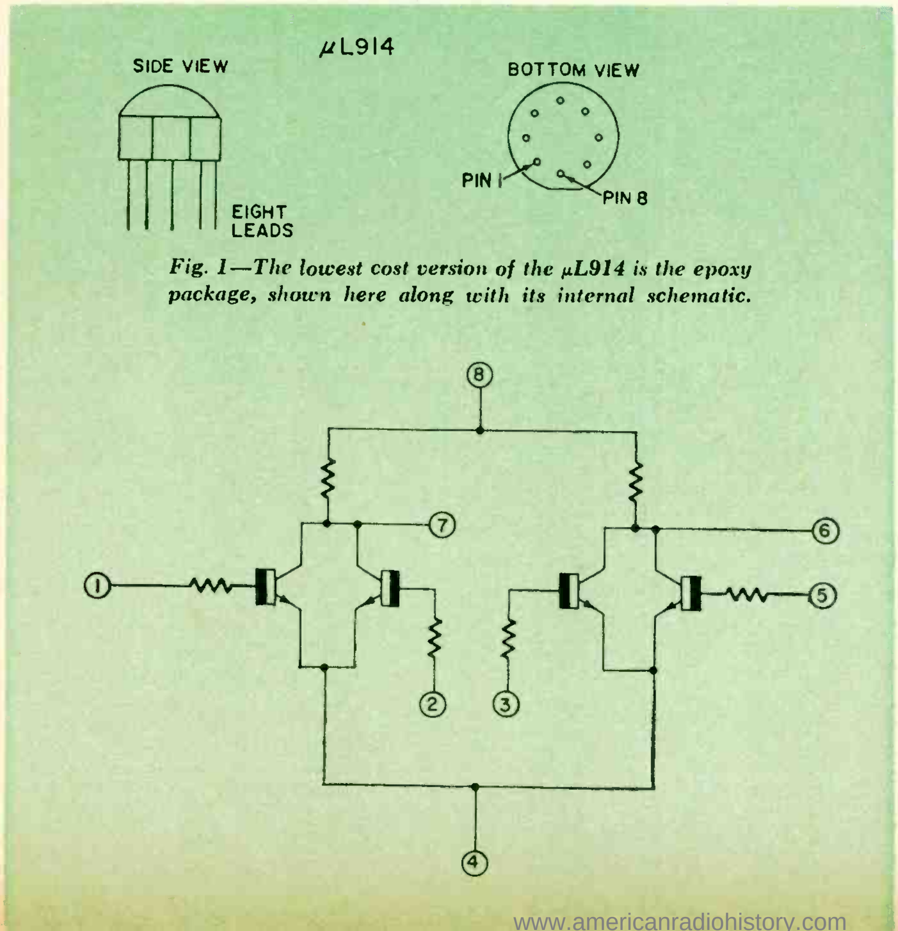

Fig. 1—The lowest cost version of the µL914 is the epoxy package, shown here along with its internal schematic.

The µL914 is a dandy amplifier. All it needs is a 3-volt supply—positive to pin 8 and negative to pin 4. A low-level input signal (high side through a capacitor to either pin 1 or 2, low side to ground) will produce an amplified output at pin 7 to ground. The unused input is left floating.

Note the use of that phrase "low-level input." Actually the output is linear until the input is about 150 mv. Levels exceeding this value will result in an overdriven, clipped output. In no case should the level at the input pin exceed ± 4 volts.

What about the other half of the device? Well, you can either hook it in cascade by connecting pin 7 to 3 or 5 or you use it for another function. If you desire a noninverted output, cascade the amplifiers—since each amplifier inverts output with respect to the input pulses.

Now for another application—the Schmitt trigger. This circuit has the unique property of changing output level when the input exceeds a certain value, then returning to the

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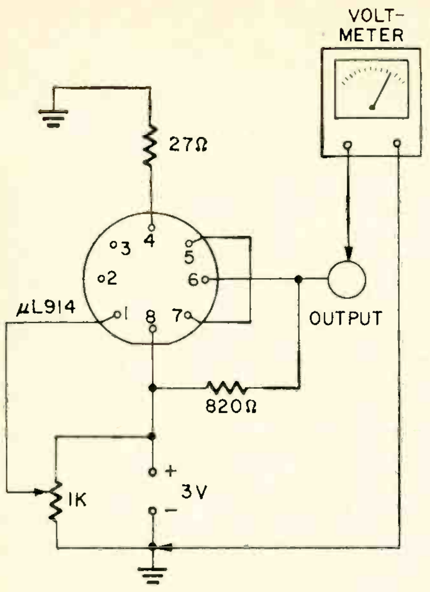

Fig. 2—External circuit connections shown will adopt μL914 as a Schmitt trigger. Critical firing point is determined by adjusting pot while monitoring output.

original level when the input falls below the critical value. Since the transition from one state to the other is very rapid, the output is very nearly a square or rectangular wave with a sine-wave input. Furthermore, the Schmitt trigger does not care what type of waveform it sees so long as the triggering level is exceeded.

For the μL914 to act as a Schmitt trigger several things must be done externally. First, since emitter coupling is needed, pin 4 is not connected directly to ground, but through a 27-ohm resistor. Also, to provide the necessary hysteresis, one collector resistor is shunted with an 820-ohm resistor. Finally, pin 7 is connected to either pin 5 or pin 3. Now the circuit should look like Fig. 2.

Apply a voltage from the wiper of a potentiometer connected across the 3-volt supply to pin 1. Hook a voltmeter across pin 6 to ground. You will see that, at the critical point, a slight variation in input level results in a sharply defined output change.

The MC790P

The second type of logic circuit used in this project is the J-K flip-flop or binary. A flip-flop is a bistable device; that is, it has two stable states. A J-K flip-flop is a more sophisticated device; retailed explanation is beyond the scope of this article. Instead you might call the J-K a black box. In addition to the power supply terminals the black box has four inputs and two outputs. The outputs are called 1 and 0 and are complementary. That is, if there is a high level at the 1 output, the 0 output must be low-level and vice-versa. One of the inputs is labeled the S or SET input. Another input is the C or CLEAR input. The next input is called the T or TOGGLE input. The final input is the PRECLEAR input.

The PRECLEAR input is not used in this application, so it is simply grounded. The particular module used is the Motorola MC790P, which contains two flip-flops in one package.

Grounding the CLEAR input will

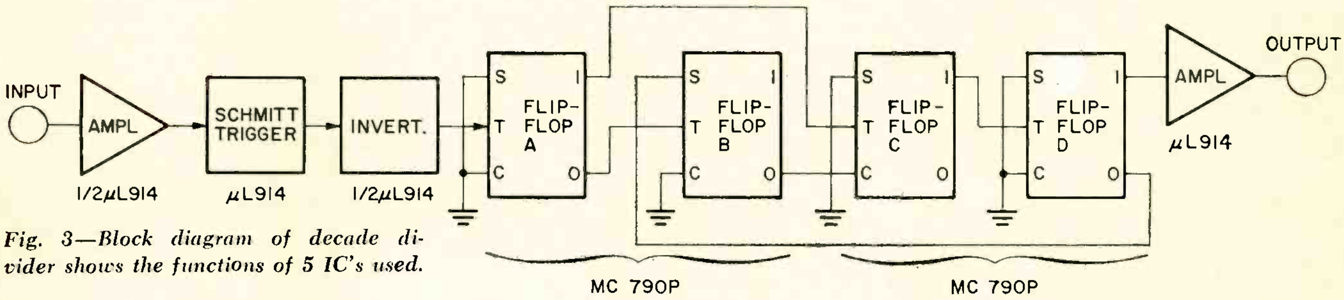

Fig. 3—Block diagram of decade divider shows the functions of 5 IC's used.

PARTS LIST

IC1, IC2, IC5—Fairchild μL914 integrated circuit
IC3, IC4—Motorola MC790P integrated circuit (Both IC's available from Semiconductor Specialists, Inc., P.O. Box 8725, O'Hare International Airport, Chicago Ill. 60666, which has a minimum order of $3.00)
B1, B2—1.5-volt C cells
C1, C2—.01-μF disc capacitor, any voltage rating
R1—82,000-ohm, ¼- or ½-watt resistor, 10%
R2—27-ohm, ¼- or ½-watt resistor, 10%
R3—820-ohm, ¼- or ½-watt resistor, 10%
S1—S.p.s.t. toggle or slide switch
J1, J2—Input and output coaxial jacks, BNC or other as desired to match existing equipment
MISC.—Aluminum box 5" x 2¼" x 2½" (Bud CU2104A or similar); 1/16" or ⅛" perforated board, battery holder, connectors.

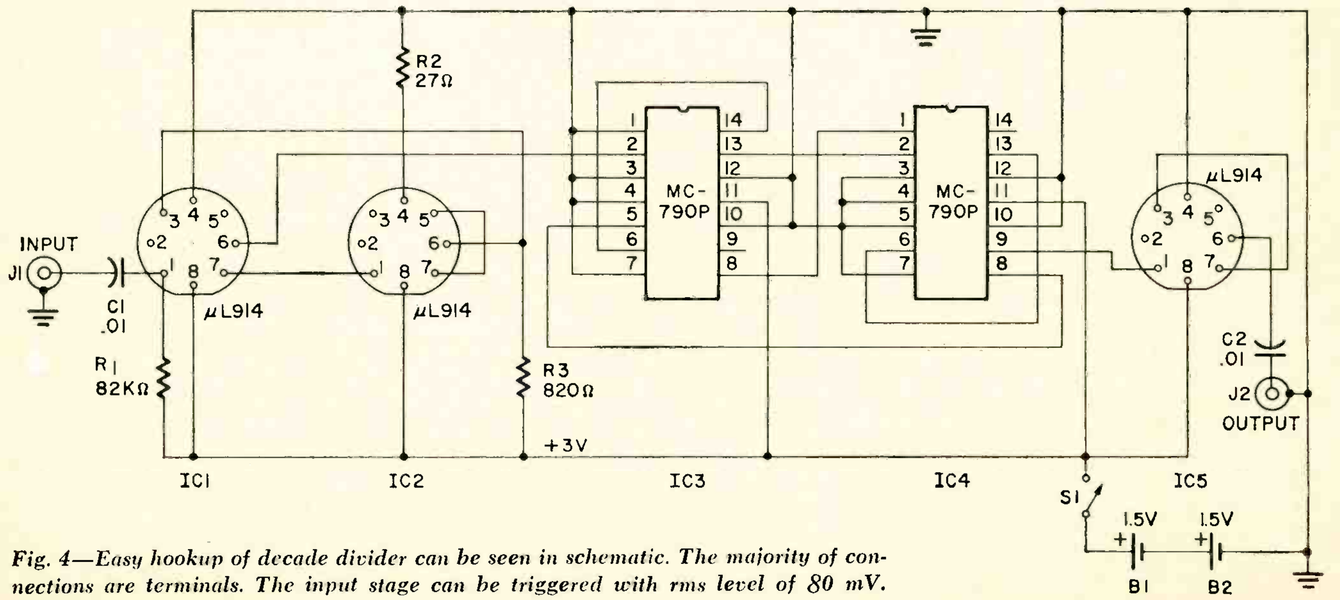

Fig. 4—Easy hookup of decade divider can be seen in schematic. The majority of connections are terminals. The input stage can be triggered with rms level of 80 mV.

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reset the unit to its normal condition, when the first clock or toggle input pulse arrives. In this condition the 1 output has a logic 1 and the 0 output has a logic 0. Now if the SET input is grounded, the flip-flop will change states at the next clock pulse, and the 1 output will have a logic 0 out. If both the clear and set inputs are grounded, the device will change output states with each input toggle pulse. Since it requires two pulses to return the unit to the original condition, the input frequency has been divided by a factor of 2 by the flip-flop.

Through the use of an ingenious interconnection system devised by logic designers, the state of the flip-flops can be set so division by practically any number is possible. In this application four flip-flops are interconnected to give division by 10. You can easily see that if the units did not have interconnections—instead, a straight output from one flip-flop to the input of the next—the division would be 2 × 2 × 2 × 2, or 16.

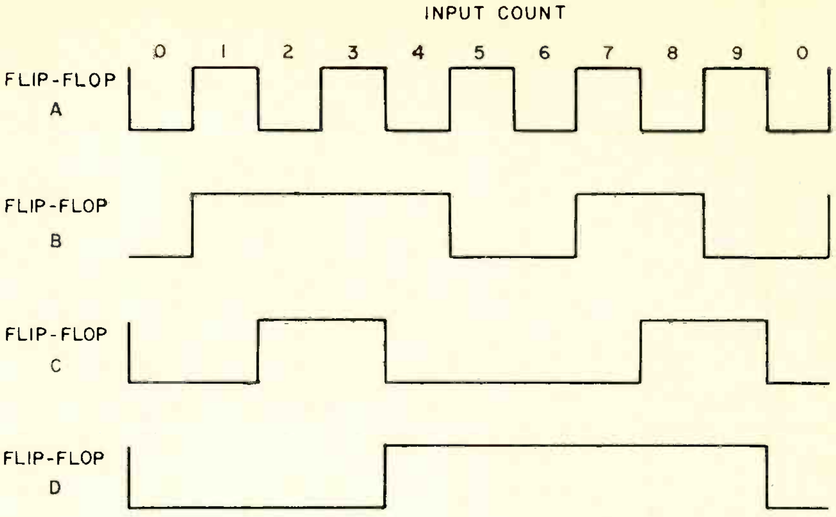

Fig. 5—Divider action is shown by these flip-flop output waveforms.

Divider circuit

A block diagram of the decade divider is shown in Fig. 3, and the complete schematic in Fig. 4. The first stage is half of a μL914. The extra resistor from pin 8 to pin 1 provides a bias voltage on the base of the input transistor, producing greater sensitivity. Use of an 82,000-ohm resistor permits triggering the stage with an rms input level of 80 mv or less.

Output taken from pin 7 is directly connected to the input of the Schmitt trigger whose output is the rectangular waveform described before. This waveform is inverted by the second half of the first μL914. The inversion stage is desirable for isolation from the Schmitt trigger. The negative-going slope—that is, the transition from a high level to a low level—is used to trigger the TOGGLE input of the first flip-flop. The remaining flip-flops are interconnected, as stated before, to produce a total division by 10. Fig. 5 shows the output waveforms of each flip-flop with respect to the various input pulse counts.

The final circuit consists of a μL914 with both halves operating as a cascade amplifier. This gives the required isolation or minimum loading of the flip-flops. Although the prototype does not have an output capacitor it would probably be advisable to install a 0.01-μF unit (C2) in series with the output.

Construction

All ready? Begin by cutting a piece of 1/16" or 1/8" phenolic or glass fiber board about 1/8" smaller on all dimensions than the inside of your aluminum box. Lay out the components on the board approximately as shown in Figs. 6, 7 and 8. Placement isn't really critical here (a bonus when using IC's). On the first version of this unit I used a double-sided printed circuit board, but the care and precision required to make and wire the board was later deemed prohibitive. It is much simpler to drill holes for the leads to stick through and then bend and solder on the reverse side of the

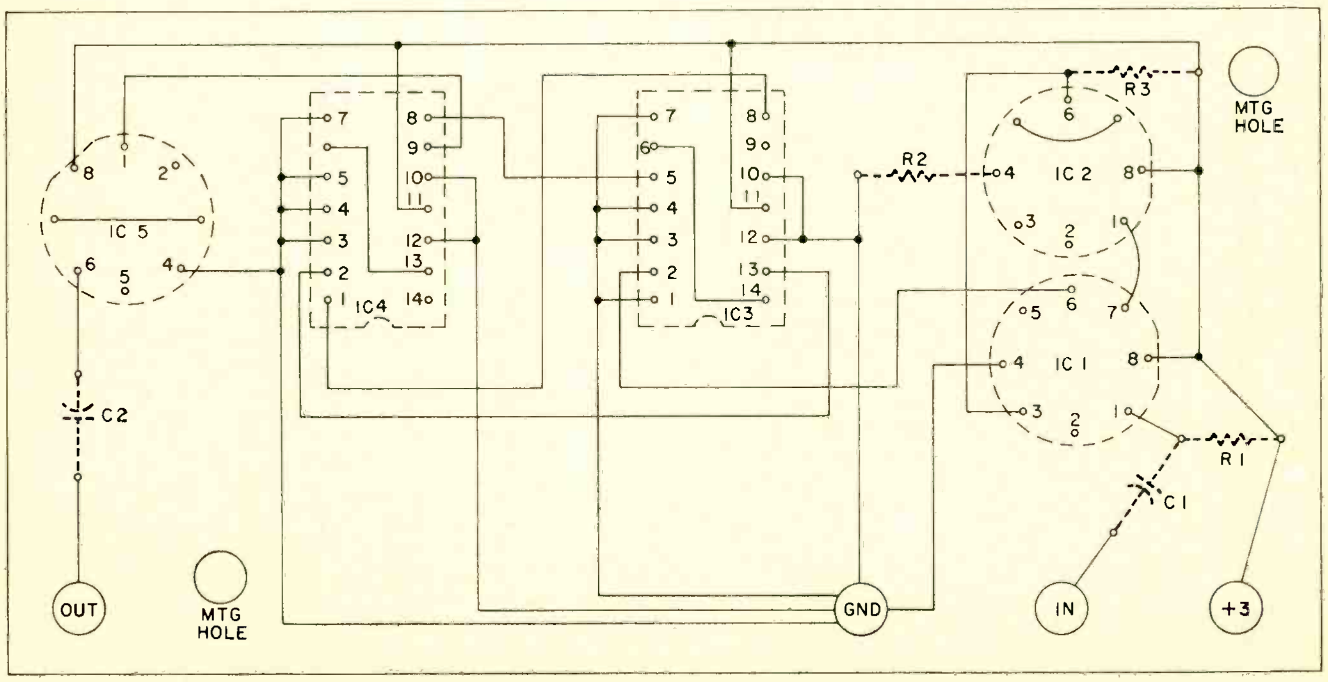

Fig. 6—Author used a glass fiber board for parts mounting; a perforated phenolic board would do just as well.

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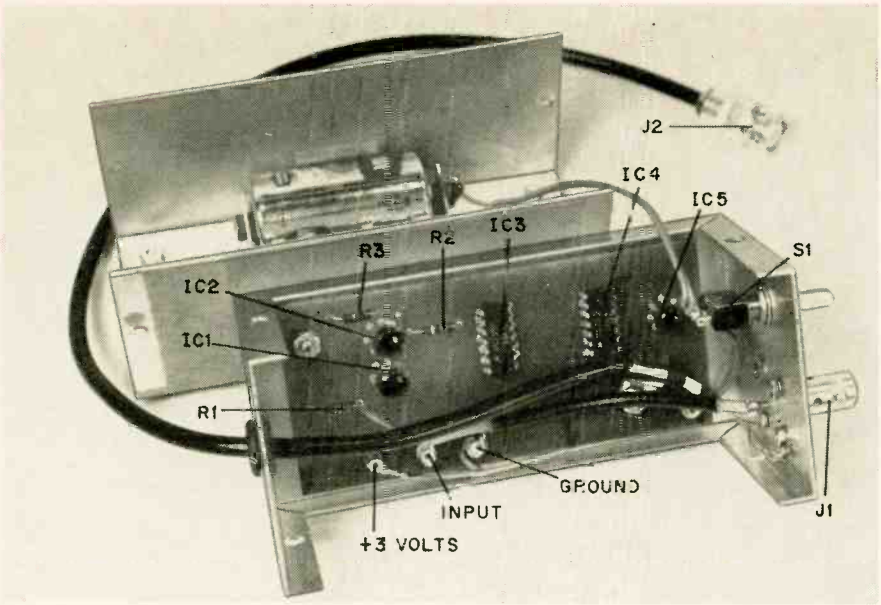

Fig. 7—Circuit board should be just a little smaller than the aluminum box you use. Mount the board on standoffs. Carefully recheck pin indentifications.

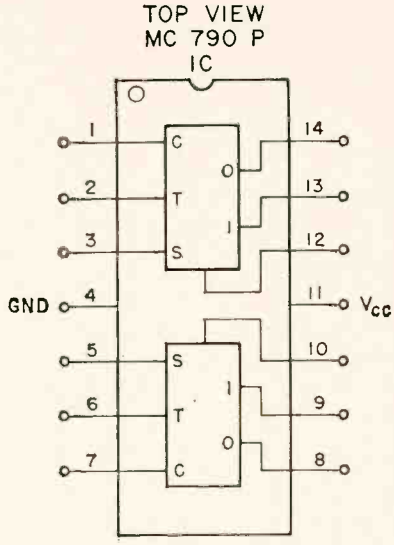

Fig. 9—Pin connections for the Motorola MC790P integrated circuits (IC3, IC4).

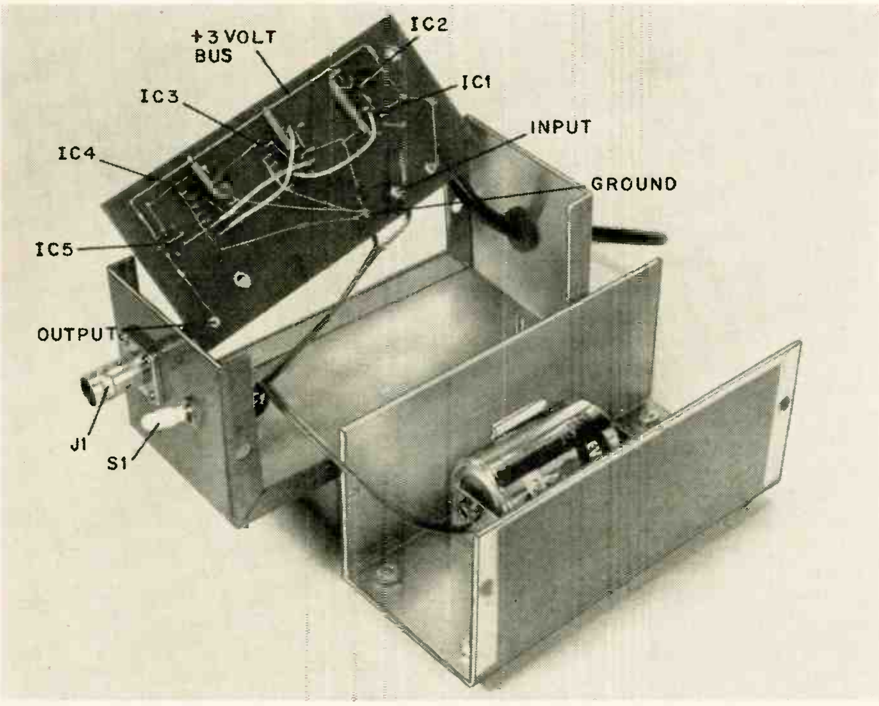

Fig. 8—An underside view of the board before final installation in the box.

parts mounting board.

The easiest approach for mounting the μL914 is to lay out a 3/8" diameter circle and drill through with a No. 60 drill every 45 degrees around the circle. The MC790P is a rectangular package with two rows of 7 pins. The rows are spaced 0.3" apart and pin to pin spacing in the row is 0.1". Again use a No. 60 drill. Pin numbers are shown in Fig. 9.

One word of caution: It is very easy to mistake pin numbering after the MC790P is inserted in the board. Take extra care in identifying pins before you solder.

Figure 6 shows all the wiring on the underside of the board. Use this illustration rather than Fig. 7 or 8, as minor wiring differences are evident. If you elect to omit the terminals, simply drill larger holes for the input and output leads and solder in the same fashion as the integrated circuits.

Double-check the wiring after you finish the board. When you are satisfied everything is in order, make a temporary test setup. Connect an oscillator—set to approximately 100 kHz—to your frequency counter. Observe the frequency readout on the counter. Now connect the oscillator to the input of the decade divider and apply 3 volts to the positive bus and ground. Connect the decade divider output to the counter. The counter should read exactly 1/10th the previous reading. You may have to increase the level of the oscillator at this frequency because of the relatively small value of the input capacitor.

Troubleshooting

I have constructed several decade dividers and have found no difficulties. If you have any difficulties, troubleshoot the unit with your scope. Output at pin 7 of the first μL914 should be a clipped sine wave, the amount of clipping depending upon the input level. The output of the Schmitt trigger (pin 6 of the second μL914) is a rectangular waveform with an amplitude of approximately 1.5 volts p-p. The inverter output, pin 6 of the first μL914, will be the inversion of the Schmitt trigger output. There is some tendency for a scope to couple in noise, but with a little care to keep leads short you should be able to see the on/off states of the flip-flop.

Once you have established that the circuit is working, the board can be mounted in the box. Drill holes through the board and the box for the mounting bolts. Use a spacer or a nut on the bolts to hold the board away from the metal. Although the unit pictured uses a miniature toggle switch for the power switch, there is plenty of room for a standard size switch. Mount a connector on the box which will mate your counter input cable and mount the corresponding mate on the end of a piece of coax line connected to the output. Install the battery holder in the bottom of the box, connect your wires and you are ready to measure frequencies up to 1 MHz. **R-E**

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Capacitors As Transducers

They can be made to count, measure and gauge

by **J. MERINO Y CORONADO***

A CAPACITOR IS NOT JUST AN ELECtronic component wired into a circuit. Dozens of kinds of unusual capacitors are used in labs and along production lines throughout labs and industry. They count objects, gauge liquid levels or pressures, measure vibration or angles of rotation. Capacitors of this type are classified as capacitive *transducers*.

A transducer is a device with two input terminals and two output terminals. It converts mechanical energy to electrical, or vice versa, according to a known law. It is reversible, which means that both the input and output are interchangeable.

The cartridge in an inexpensive phonograph is a good example of a piezoelectric transducer: the mechanical vibrations of the needle are transmitted to a piezoelectric element (usually made of Rochelle salt or of a certain type of ceramic containing titanates). The element generates electrical charges when twisted by the movement of the needle. Conversely, if we put an alternating voltage across the cartridge, the crystal will produce vibrations and sound, which is a form of mechanical energy.

The *condenser microphone* (Condenser is an old name for *capacitor*, which has persisted in conjunction with microphones.) is a capacitance transducer that transforms the mechanical energy of sound waves into electrical energy to operate an amplifier. In its simplest form it consists of a thick, fixed, circular metallic plate in front of which is a very thin conductive diaphragm separated from the plate by an insulating ring a few thousandths of an inch thick (Fig. 1). The diaphragm moves back and forth with the variations in air pressure caused by sound. As the distance between diaphragm and plate varies, the electrical capacitance of the microphone varies proportionally.

A battery of usually 50 volts or more is connected to the plate and diaphragm in series with resistor R. An increase in capacitance allows the microphone to admit more electrons from the battery. A decrease forces some electrons from the mike back to the battery.

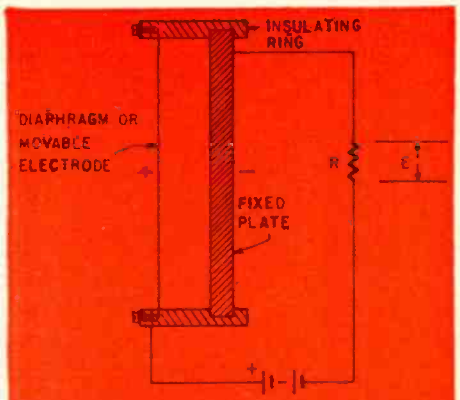

Fig. 1—Common capacitive transducer is the capacitor (condenser) microphone.

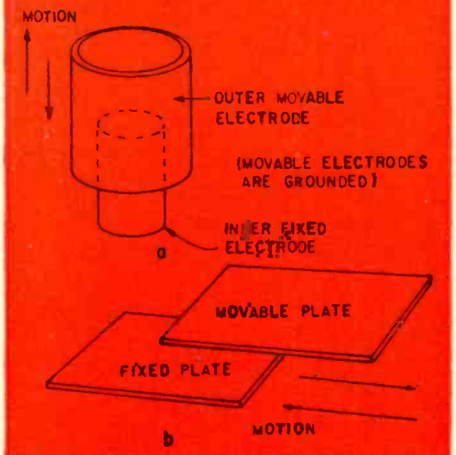

Fig. 2—Two forms of displacement-measuring capacitors (a) cylindrical; (b) plane. Moving element varies the capacitance by changing effective plate area.

As everyone knows, a flow of electrons is an electric current and this current produces (Ohm's law) a variable voltage (E) across resistor R. This voltage is applied to the grid of an amplifier tube or to a transistor.

The condenser microphone is reversible. If an alternating voltage is applied between the diaphragm and plate in Fig. 1, the diaphragm will move accordingly, pushed by variations in electrostatic force, and, if the signal voltage is audio, a sound will be heard. This is the principle behind electrostatic loudspeakers.

It is possible to increase the capacitance of a capacitor in three ways. Two are mechanical methods: increasing the area of the plates, or decreasing the distance between them. The first is used in rotary variable-tuning capacitors with meshing plates. The second is used in the compression-type of trimmer capacitor.

Figure 2 shows two forms of capacitance transducer widely used for industrial and scientific purposes. In *a* we see a cylindrical configuration, in *b*, a flat or plane transducer.

If one electrode is movable, both types produce a variation of capacitance linearly proportional to the amplitude of the movement (arrows).

The capacitance of both transducers can be readily computed from the following formulas:

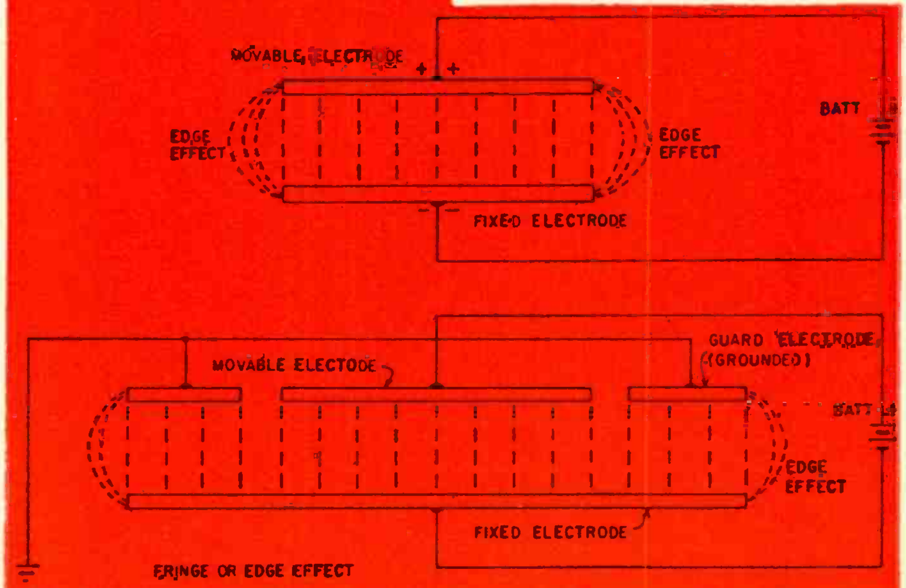

Fig. 3—Edge-effect capacitance (top) is prevented by grounded guard electrodes.

*Research physicist and professor of acoustics and electronics, Institute of Geophysics and Polytechnic Institute of Mexico.

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For the cylindrical configuration we use:

$C_{(pF)} = 0.644\ KL/\log(b/a)$

in which L is the length in inches of the overlapping portions of the cylinders. The constant K is the dielectric constant of the material between the cylinders. The inner diameter of the outer cylinder is b, and a is the outer diameter of the inner cylinder, which is also in inches.

For a capacitor made of two plane parallel plates the capacitance in picofarads is computed by

$C_{(pF)} = 0.225\ KA/D$

where A is the area in square inches of the portion of the movable plate which is actually over the fixed one, D is the distance in inches between the two plates, and K is, as before, the dielectric constant of the material between the plates. (For air it is very nearly 1.)

Plane parallel plates and cylindrical capacitors are much used in industry and science to measure linear displacements.

To measure angles of rotation, variable capacitors of the type found in radios are used, because their capacitance changes linearly with the angle, provided the rotor plates are semicircular and measurements are made between 15% and 85% of the rotation angle.

There is a third way to change the capacitance of a capacitor: to change the dielectric.

Oil, for instance, has a dielectric constant of 25.8. For distilled water the constant is 81.07. An air capacitor will have 25.8 times its capacitance when it is in alcohol, or 81.07 times its capacitance when submerged in *distilled* water. (Tap water cannot usually be used because the minerals dissolved in it make it too conductive.)

Not all the capacitive transducers used for instrumentation purposes are built in the simple form shown in Fig. 2. The electrostatic lines of force at the edges of the plates or cylinders are not parallel, but bulge outward, producing stray capacitances that make the actual capacitance greater than the computed value. This *edge effect* or fringing must be kept to a minimum, since some transducers are made to measure capacitance variations of the order of 0.2 pF. This is accomplished by using a third, grounded electrode, called a *guard ring* or guard electrode. Fig. 3 shows the edge effect and how to eliminate it with a guard electrode for a capacitive transducer using plane plates, one of which moves either up and down or in and out, perpendicular to the plane of the paper. The arrangement is similar for cylindrical capacitive transducers.

If the rotor shaft of a variable capacitor of the type used in ordinary radios is coupled to a rotating piece of machinery, rotation angles from 0° to some 150° can be measured. The coupling can be made to multiply the angle of rotation by a known factor—as by the use of gears, levers, or pulleys and strings.

The transducer itself may have many forms. In most cases it has a guard electrode. Very small angles can be measured.

A capacitive transducer used to generate audio tones works on the same principle as the condenser microphone. In Fig. 4, W is a wheel of bakelite or any convenient insulating material. This wheel has sectors of aluminum foil connected to the shaft, which is grounded.

In front of these is a fixed metallic plate or screw. As the wheel rotates, the capacitance between the conductive sectors and the fixed plate or screw varies and so does the charge. An alternating voltage appears across resistor R, with a frequency equal to the number of revolutions per second of the wheel multiplied by the number of sectors. This frequency can be amplified and measured with a frequency meter, and we have an electrostatic tachometer. The same principle is used to generate musical tones in some types of electronic organs.

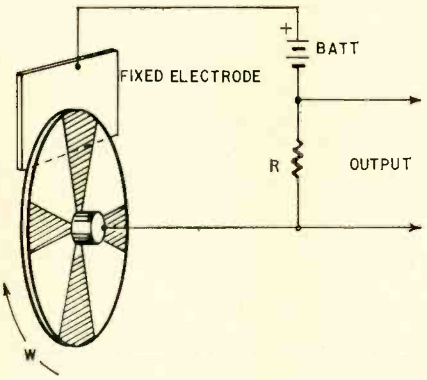

Fig. 4—Variation of rotary meshing-plate variable capacitor is used to generate audio tones . . . useful in electronic organs.

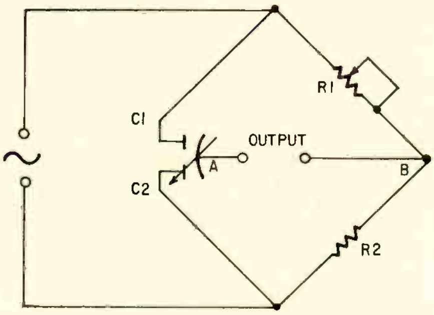

Fig. 6—This ac bridge is detecting device for capacitive "tiltmeter" (Fig. 5). C1 and C2 are cylindrical transducers; changing voltage across A, B is amplified.

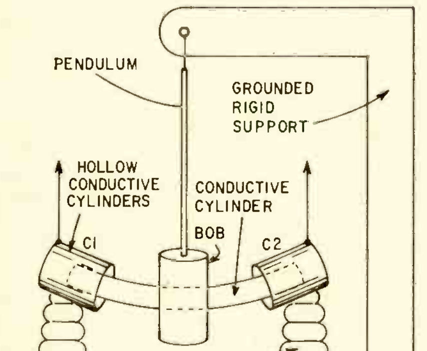

Fig. 5—This capacitive pendulum can measure very small tilts or vibrations. Transducers are cylindrical type (Fig 2a).

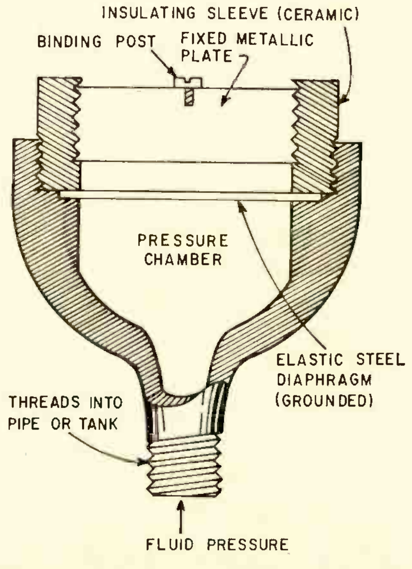

Fig. 7—Pressure sensitive capacitive transducer (similar to condenser mike).

Measuring vibrations and tilting

Capacitive transducers are much used in instruments for measuring vibrations caused by passing vehicles or heavy machinery, or tilting caused by heavy loads in bridges or buildings. The principle of a tilt meter or vibration meter is shown in Fig. 5. The bob of a pendulum carries a curved metal cylinder that moves in or out of two lateral hollow cylinders mounted on porcelain or bakelite insulators. The two fixed cylinders and the grounded movable cylinder together make up a differential capacitor.

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If the pendulum support is tilted or otherwise set in motion, the capacitance between the pendulum and one of the other plates increases, while it decreases by the same amount between the pendulum and the second fixed electrode. A simple ac bridge can be used to measure and record such variations. In Fig. 6, C1 and C2 are halves of the differential capacitor in a tilt or vibration meter. If R1 is adjusted so that the bridge is *not* balanced when the pendulum is at rest, an ac voltage is present between points A and B. This is called the *carrier voltage,* and it is amplitude-modulated when the pendulum moves. The modulated waves are amplified and detected in the usual way to be recorded or telemetered to another receiver.

Guard electrodes are a must in this type of instrument. In Fig. 5 they are not shown for simplicity.

Some time ago I designed and built a very sensitive seismograph using this principle.

Capacitive pressure gauges

When the indicator or recording device is at some distance, or when the pressure variations in pipelines carrying fluids are to be used for remote control, capacitance transducers are second to none.

A pressure-sensitive transducer is shown in Fig. 7. It has a movable elastic metal diaphragm, grounded for obvious reasons. An insulating ceramic or porcelain sleeve holds a fixed conductive plate, strong enough to stand the full pipeline pressure in case the diaphragm fails. It is made quite stiff, with a resonant frequency of 10 kHz or higher to reduce its response to vibrations or shock. The pressure gauge is nothing but a condenser microphone working at high pressures.

Level measurement of liquids in tanks

For this a simple cylindrical capacitor is used. The inner electrode is a rod or heavy metal cylinder, 1″ or 2″ in diameter. The outer electrode is a metal tube with holes in it, grounded to the tank (Fig. 8), while the inner rod is insulated. Nonconductive liquids cause the capacitance to increase according to their level and dielectric constant. For conductive liquids such as water or saline solutions, the inner rod is covered with plastic or any other type of convenient insulating material.

A simple ac bridge measures capacitance variations, as described in Fig. 6. More elaborate devices are often used in these applications, such as the trf receiver that is shown in Fig. 9, to measure distance, rotation, pressure or liquid level in a tank. A very stable rf oscillator is coupled to a resonant input circuit in an rf amplifier. The capacitor of this tuned circuit is the capacitive transducer (in series or in parallel with a fixed or adjustable capacitor used for calibration or adjustment). A linear detector and power amplifier complete the instrument. Its output is used to operate a recording instrument or another controlled device of some kind.

The resonance curve of trf receivers is very much like Fig. 10. The "receiver" used to measure capacitance variations is *never* tuned to resonance, but to one side of the curve where its slope may be considered linear, let us say to the point marked 0 in the figure. The corresponding point, 0′, is the operating point. An increase in capacitance from 0 to B displaces the operating point to B′ and the output of the detector decreases. Very rapid variations in capacitance can be measured by this method.

A phase-sensitive detector (Fig. 11) is used with capacitive transducers in many industrial and scientific instruments and applications.

What about using a superhet? This more complex receiver is used to measure very small variations in capacitance. One grid of a mixer tube is fed by the output of a crystal-controlled oscillator, while the other is fed by a variable-frequency oscillator whose frequency is controlled by variations in capacitance caused by a capacitive transducer.

In this way a variable i.f. is obtained. When both oscillators have the same frequency, the i.f. difference is zero. As soon as the capacitance of the transducer changes, the frequency of the variable oscillator shifts and an i.f. is produced in the mixer. Differences in frequency of a few hertz are easily detected by ear or by a frequency counter. **R-E**

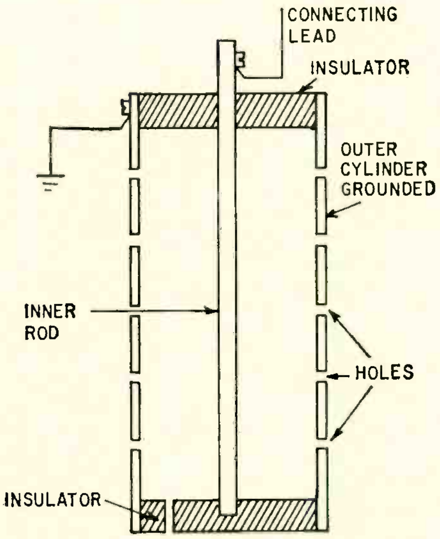

Fig. 8 (left)—This device provides a continuous indication of liquid level without moving parts. Nonconductive liquids vary the capacitance between two electrodes.

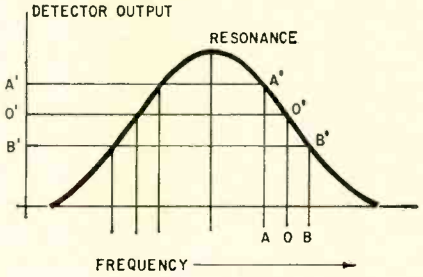

Fig. 10—In slope detection, carrier is tuned to point 0. Capacitance changes may cause carrier shift to points A or B.

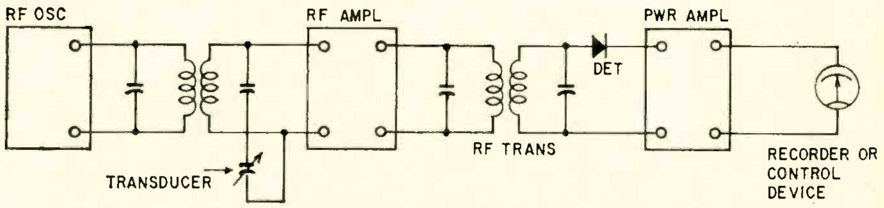

Fig. 9—Tuned radio frequency (TRF) method uses capacitive transducer to generate amplitude, phase or frequency variation in rf carrier for detection, amplifying.

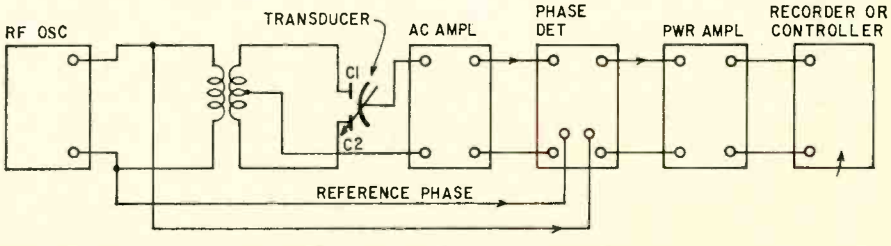

Fig. 11—Transducers C1 and C2 are used in phase-detector (discriminator) circuits.

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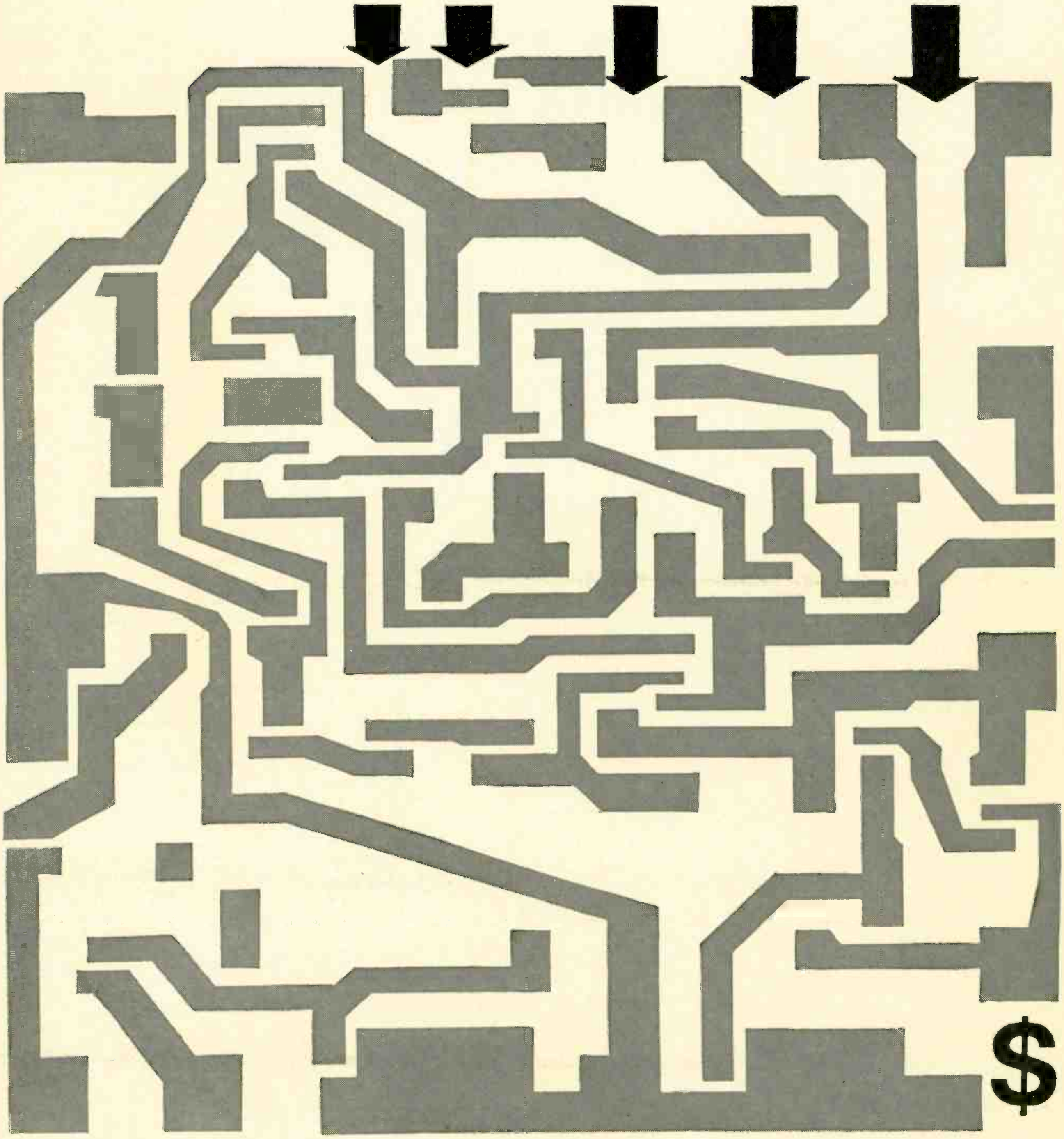

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EQUIPMENT REPORT

Sony TC-230 Stereo Tape Recorder

Circle 25 on reader's service card

SONY'S TC-230 IS JUST THE KIND OF tape recorder that warms my equipment lover's heart. It is a beautiful piece, remarkably free of the little stupidities and oversights that often creep into an otherwise good device.

Technically, the TC-230 is excellent, both by measurement and by listening test. Most attractive are the 50-dB signal-to-noise ratio, about the highest ever attained in a medium-priced home machine, and the wide frequency response even at slow tape speeds. The TC-230 records and plays at 7½, 3¾ and 1⅞ ips.

Most unusual feature of the 230 is that it can be easily made to serve as a complete home music center. Besides the usual microphone and "line" (high-level) inputs, it has a pair of RIAA-equalized phono inputs, into which any ordinary stereo phono pickup can be plugged. By adding a record changer and perhaps a tuner, you have a compact but complete stereo system . . . including four-track stereo tape recording and playback. The direct phono inputs make it unusually easy to copy discs onto tape. No external amplifier or preamp is needed.

Sound quality is somewhat limited by the small speakers and the 4-watt-per-channel output of the built-in amplifiers, but it is remarkably clean and well balanced. While I had the machine for testing I set it up in a large loft to play some tapes for friends. Several of them were astonished at the fullness and naturalness of the reproduction via the built-in speakers. However, you can plug external speakers of your choice into a pair of jacks provided on the back panel. There is also a stereo headphone jack, on the front panel. If for any reason more amplifier power is needed, the output of the machine can be fed into an external amplifier.

Cardioid mikes are supplied with the TC-230 rather than the usual omnidirectionals. They allow for flexibility in mike placement, and are particularly useful in typical home recording setups and other locations having considerable reverberation and background noise.

Controls for the Sony TC-230 are few and simple. They have a solid feel with promise of long, reliable operation. A pause control stops the tape without "switching" the electronic circuits, allowing for clickless stops and starts. It can be locked in the pause position indefinitely, and released with a slight downward push.

Volume control (a single unit for both recording and playback) has two sections, one for each channel, friction-coupled so that both knobs turn as one unless one of them is held. This arrangement is easy to use and serves simultaneously for volume and channel balance. A single tone control provides variable treble boost or cut during playback only. A noise-suppressor switch puts in a fixed upper-high-frequency cut to reduce tape hiss. Equalization is switched automatically as tape speed is changed.

Recording function is fitted with a mechanical interlock to prevent accidental tape erasure. A red indicator lamp in the level-meter assembly lights when the machine is set to record. A digital counter helps keep track of the position of a particular recording.

The recorder is so easy to thread that one can hardly speak of threading. In the stop position of the transport control, the capstan pinch roller drops out of the way, below the tape path. It is unnecessary to fumble the tape into or around anything. Simply grab the end, run it around the head housing and onto the takeup reel.

I was especially impressed with the sturdiness of the TC-230. It seems to have been built to be kicked around a bit. It is a heavy machine, but that heaviness is reassuring.

Except for the fact that it has only two heads and so cannot make sound-on-sound or echo recordings, the TC-230 is a very desirable all-around tape recorder, especially if you like to make and play tapes away from your hi-fi system with a minimum of fuss.

Another model, the TC-230W, cased in walnut and without speakers, has the same tape deck and electronics package. An accessory speaker system, SS-23, is available for the TC-230W.—*Peter Sutheim* **R-E**

MANUFACTURER'S SPECIFICATIONS

Tape Speeds: 7½, 3¾, 1⅞ ips
Reel size: up to 7"
Tracks: four, stereo or mono
Frequency response: 30–18,000 Hz at 7½ ips
30–12,000 Hz at 3¾ ips
30–6,000 Hz at 1⅞ ips
Signal-to-noise ratio: better than 50 dB at peak recording level, 7½ ips
Flutter and wow:
less than 0.1% at 7½ ips
less than 0.15% at 3¾ ips
less than 0.2% at 1⅞ ips
Harmonic distortion: less than 3% at 0 dB recording level and 0.775-volt output level
Inputs: microphone—low imoedance, 0.14 mV; auxiliary (tuner), 100,000 ohms, 44 mV; phono (equalized)—2 mV
(voltage figures are for 0-dB recording level)
Outputs: line—into 10,000 ohms or higher, 1.1 V during playback; 0.87 V during recording
headphone—into not less than 8 ohms
speaker—4 watts maximum per channel
Dimensions: (Model 230) 17" x 9⅝" x 14"
Weight: (Model 230) 29 lb
Power consumption: 55 watts
Price: Model 230: $229.50
Model 230W: $209.50
Model SS-23: $69.50

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The "C" is the new workhorse of color television.

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It's been so designed that it acts as a superior heat sink. It holds more heat. Radiates it out from a larger surface. Dissipates it more quickly.

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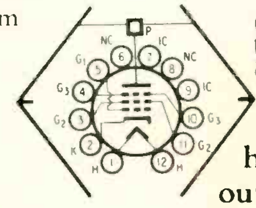
And it still costs the same as the "A".

It should mean fewer replacement calls.

Try the "C" and see.



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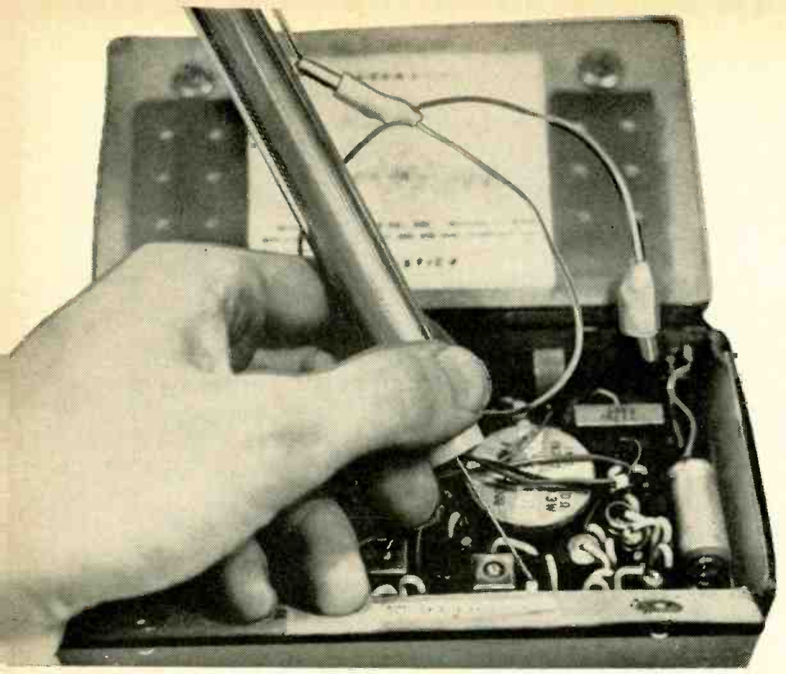

AN UNUSUAL DIODE OSCILLATOR

Solid-state analog for a neon-lamp pulse generator

By IRVING M. GOTTLIEB

THE GLOW-LAMP RELAXATION OSCILLATOR—one of the simplest and most useful of all electronic circuits—has one drawback in today's electronic technology. Its relatively high operating voltage (around 70 volts minimum) makes its use impractical in semiconductor devices.

After a lot of research, I came up with a solid-state equivalent of the glow lamp. To qualify, it had to be cheap, operate at voltages in the same range as transistors (6 to 10 volts) and work in a relaxation oscillator circuit using no more than the resistor and capacitor needed for the neon glow lamp.

Solution of the problem was not simple. Such standard semiconductor devices as four-layer diodes, unijunction transistors, tunnel diodes, avalanche transistors and SCR's all qualify, in one or more respects, as solid-state analogs of the neon lamp. None, however, comply completely with the original specifications.

Glowlamp oscillator

In the relaxation oscillator circuit of Fig. 1, capacitor C begins to charge through resistor R as soon as the switch is closed. The voltage across the capacitor rises exponentially and, without the neon lamp, for all practical purposes will eventually reach the battery-voltage level. However, before this value can be reached, the gas in the lamp ionizes (fires) and abruptly begins to discharge the capacitor. The discharge continues until the voltage across the capacitor drops to the point where the gas in the lamp de-ionizes and extinguishes the lamp. (The de-ionization or extinguishing voltage is only a few volts lower than the ionization or firing voltage.)

The capacitor, now rid of the short circuit produced by the ionized lamp, resumes its charging cycle. Thus, after the relatively long initial charging time, repetitive charge-discharge cycles occur with peak amplitude equal to the firing voltage minus the extinguishing voltage.

Solid-state switch

I felt that the avalanche transistor would satisfy all conditions as a replacement for the glow lamp *if* its breakdown voltage (see Fig. 2) could be reduced to a value much lower than the several tens of volts of commercially available units. Aside from the incompatibility with transistor circuit supply voltages, the big disadvantage of breakdown voltages of 25 to 50 is the high power that the junction must dissipate.

High power dissipation develops heat which, in turn, leads to unreliable and unstable oscillations. Clearly, what was needed was a transistor with reverse-voltage breakdown below 10 volts. After some seeking, I found that such transistors are produced but they are not readily identifiable from their published characteristics.

Circuit designers rarely consider the *reverse-breakdown* ratings of the emitter-base diode in conventional transistors because most transistor applications do not involve this parame-

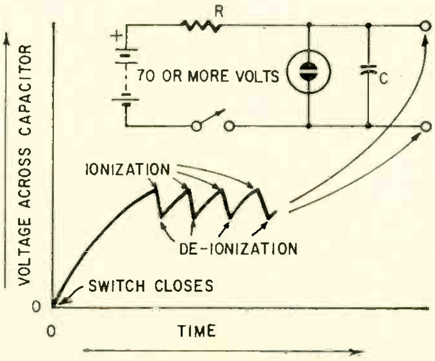

Fig. 1—Glow-lamp relaxation oscillator and output waveform. High voltage need makes lamp impractical for solid state.

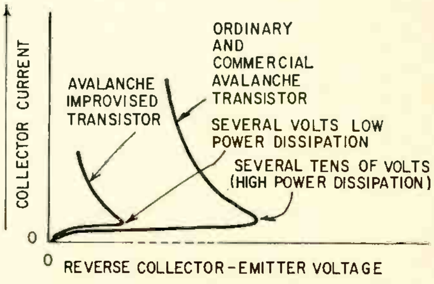

Fig. 2—Comparative I_C–$V_{CE\ (rev.)}$ curves for ordinary and avalanche transistors and for the avalanche transistor adapted for use as a low-voltage oscillator. Low power dissipation aids circuit stability.

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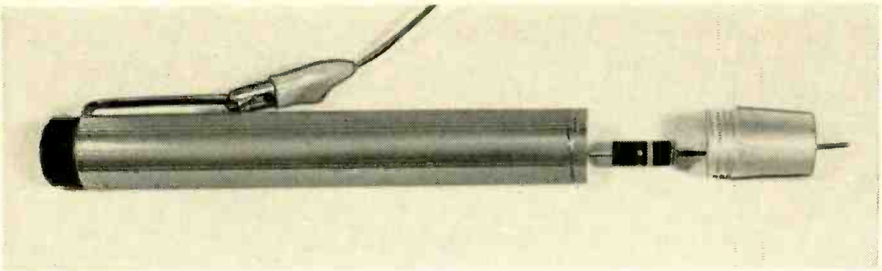


Use the solid-state "glow-lamp" oscillator as signal injector to test radios and amplifiers. The 47K series resistor in the hot output lead minimizes circuit loading.

ter. Keep in mind for a moment that this breakdown potential is only 4 or 5 volts for many transistors. A second important fact about transistors is that the connections to collector and emitter can be *interchanged*. This was done in some circuits in the early days of the junction transistor. Some of the first junction transistors had an alpha of about 0.925 in a grounded-base circuit. The same transistor would develop an alpha around 0.875 when the emitter and collector connections were interchanged, together with bias polarities.

Thus, it can be demonstrated (Fig. 3) that the transistor is a bilateral device, capable of producing power gain in both directions. [At least one manufacturer of solid-state SSB transceivers uses the bilateral characteristic of transistors to simplify circuit design.—*Editor*] Most modern transistors have very high alphas in the intended connection and relatively low alphas when the collector and emitter leads are interchanged. Therefore, all we need is a transistor that will develop sufficient current gain when emitter and collector are transposed.

After much research and experimentation, I found that the 2N3643 (Fairchild) filled the bill nicely. It is a low-cost epoxy-encapsulated silicon npn transistor. When connected as a two-terminal device as in Fig. 4 (no connection to the base) strong oscillations develop as the result of the 4- or 5-volt breakdown of the reverse-biased emitter-base diode.*

As an avalanche device the 2N3643, with its breakdown potential of only a few volts, is much more stable, more practical and less costly than commercial units with breakdown voltages many times higher.

The circuit of the low-voltage avalanche oscillator is shown in Fig. 5. By merely transposing the emitter and collector, together with voltage polarities, we have a solid-state "neon lamp" with ionization and de-ionization potentials of only 4 or 5 volts. As a pulse generator, it is extremely useful as a low-cost substitute for such more complex and expensive devices as feedback oscillators and multivibrators.

In addition, this diode oscillator is superior to the glow lamp in all respects. It is immune to electrostatic and electromagnetic fields, light, mechanical shock and vibration and is much less affected by temperature than are glow lamps. **R-E**

*This bias appears across the base-emitter junction as a result of the collector-emitter voltage being polarized for forward conduction. This is the normal operating mode for avalanche transistor oscillators. For details, refer to *"avalanche transistor"* and *"charge, carrier* or *collector multiplication"* in semiconductor manuals, handbooks and textbooks.

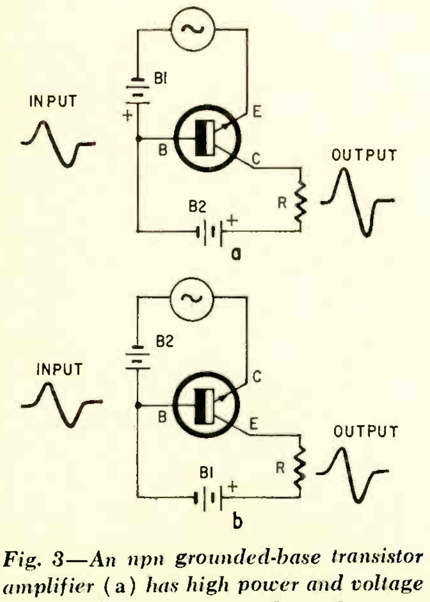
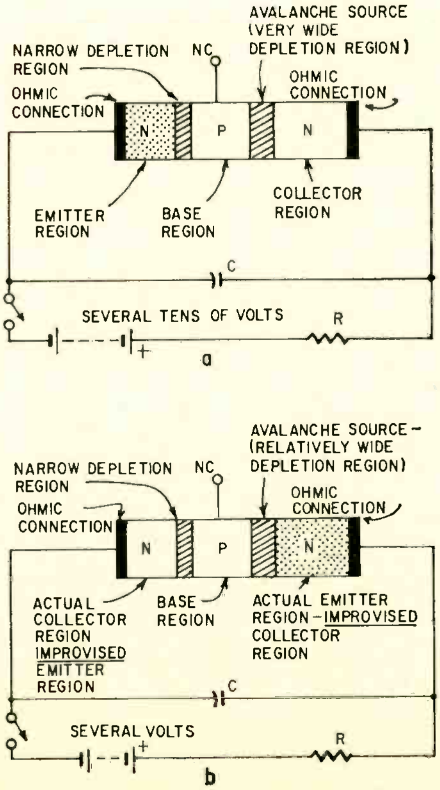


Fig. 3—An npn grounded-base transistor amplifier (a) has high power and voltage gains with slight current loss. Transposing emitter and collector and reversing bias polarities (b) results in considerable current loss, moderate voltage gain and possibly some power gain as well.



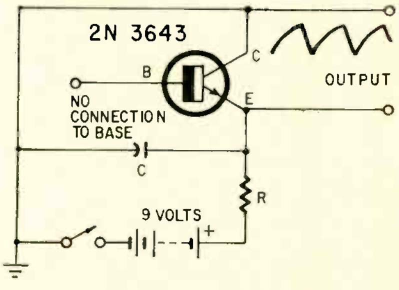


Fig. 5—Circuit of the solid-state "glow-lamp" oscillator. Pulse rates up to about 100 kHz are possible with appropriate values of R and C. Frequency is about 1 kHz when R is 1200 ohms and C is 1 μF.

*Fig. 4—Avalanche oscillators. In a conventional transistor (a), the depletion region (an area spanning a pn junction and containing comparatively few free electrons) around the collector–base junction is very wide and the one around the base–emitter junction is narrow. The improvised avalanche transistor at **b** operates with a much lower power supply and with emitter and collector transposed.*

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Circle 27 on reader's service card

Service Clinic

By JACK DARR

> 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, 200 Park Ave. S., New York 10003.

Matching speakers

I have a mail-order TV set with a 10-watt audio output. I'd like to hook up two 3.2-ohm speakers, rated at 10 watts each, to the output. The set now has three speakers, 6–8 ohms, and one 6AQ5 tube.—R. K., Glendale Heights, Ill.

Your three original speakers are hooked in parallel; therefore, your output transformer has a 3-ohm impedance. If you want to get full power, you'll have to replace the original transformer with one rated at 5,000 ohms plate to 6–8 ohms voice coil. Then, you can hook the two new speakers in parallel and get 6 ohms.

Incidentally, if your set has a *single* 6AQ5 tube (electrical equivalent of 6V6) you have only about 4.5 watts of power! Not 10. Advertising men often get carried away! The RCA tube manual shows only 4.5 watts *maximum* power from a single 6V6/6AQ5.

By the way, 5 watts of *audio* power is a good deal—more than you can stand to use in the average room. However, if you do want more, I'd suggest building a small two-tube push-pull output stage, using two 6V6's, with their own power supply, and mounting this somewhere inside the cabinet. For a schematic on such a booster, use the push-pull output stage of any PA system of this wattage, hi-fi, radio set, etc. Standard circuit.

No contrast

I'm working on a Motorola TS-534 chassis, and the contrast is very poor. Even with the contrast control all the way up, it's pale. Schematic calls for +75 volts on the video amplifier plate and I'm reading +160 volts. The agc keyer grid calls for +70 volts; I read +150. Could this be agc trouble?—M.M., Hawk Run, Pa.

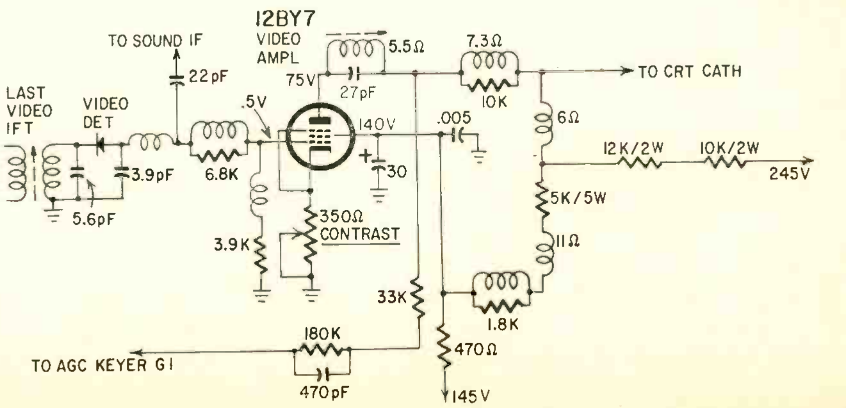
High plate voltage on an amplifier stage (of any kind) with normal supply voltage means only one thing—low plate *current*. This, of course, means low stage *gain*.

Several things can cause this: incorrect grid bias, low plate-load resistors, weak tube, and so on. In this set, your voltage is fed through 10,000- and 12,000-ohm resistors in series (see diagram). This also feeds dc to the grid of the keyer, thus accounting for the higher than normal voltage there.

In some of these chassis, we've found the plate dropping resistors burned up, from a short in a previous 12BY7 video-amplifier tube. Check those resistors; if okay, check the control grid voltage on the video-amplifier tube. This should be almost zero.

You can make a gain check on this stage with an audio signal. Feed in about 1.5 volts p-p, and check for an output 45–50 volts p-p on the plate. Any values can be used, as long as you get a gain ratio of about this much. Loss of contrast can be loss of gain in a video-amplifier stage; it can also be weak signal *input*. Check the grid signal, on a normal TV channel. If this isn't up around 1.5 volts p-p, your trouble is "farther forward"—i.f., tuner, antenna or agc.

Check the agc by overriding it. Also, check that 8.2-meg resistor from the 245-volt B+ line to the agc line. If the resistor changes in value, it'll cause trouble. **R-E**



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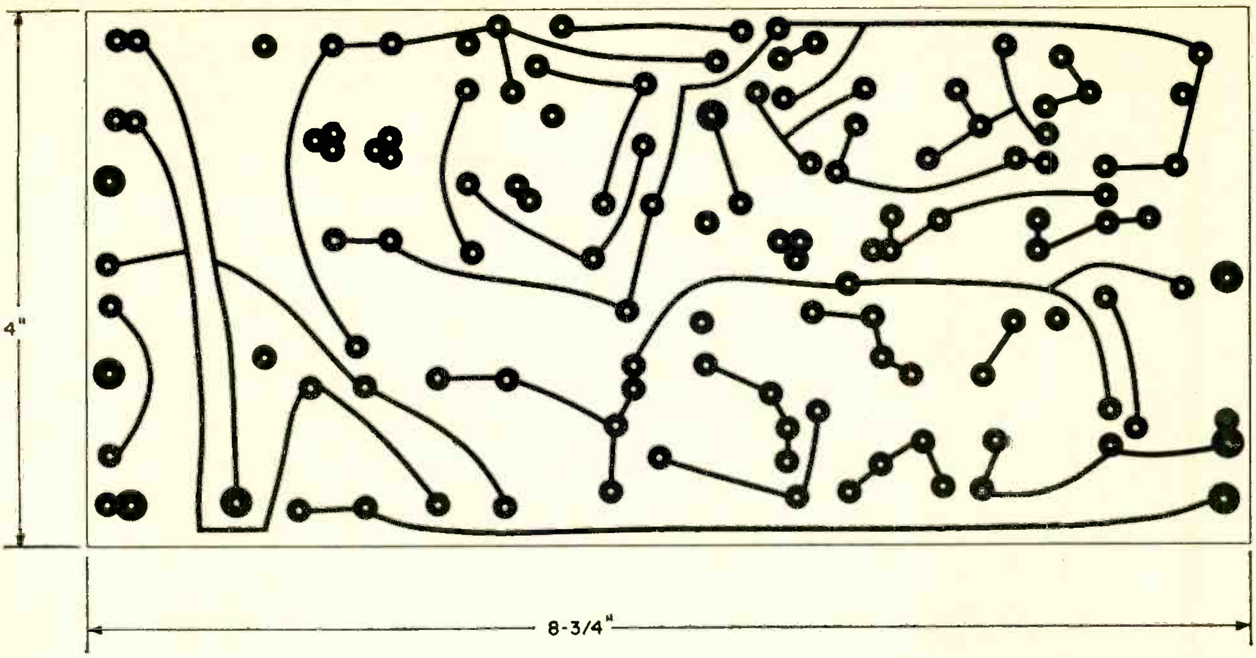

Fig. 3—Use this pattern to make the printed board for Rhythm Lights. You will need a copper-clad board 9½" x 5½", a pint of etching liquid, 1/16" resist tape, 3/16" resist circles, and a plastic container in which to immerse the board for etching.

BUILD RHYTHM LIGHTS

(continued from page 35)

with a brillant color array.

Assembly and wiring of Rhythm Lights is easy. All the components are laid out on a printed-circuit board which is enclosed in a simple, one-piece chassis. All components used are available at most electronic distributors.

Circuit operation

A crystal microphone picks up sound from radio, hi-fi or musical instruments. The high-impedance microphone is directly coupled to transistor Q1 (Fig. 1); this transistor is a grounded-emitter stage with feedback from collector to base for stability. A 100-pF capacitor (C12) decouples the power supply from this low-level first stage. The signal next goes to transistor Q2. Resistor R3 established Q2's operating point and capacitor C4 reduces high-frequency signals. Final amplification takes place at transistor Q3. Volume is controlled by 10,000-ohm pot R11, which acts as part of the bias network for Q3. Diode D1 compensates for temperature effects on Q3.

Transformer T1 isolates the low-voltage amplifier stages from the high-voltage, lamp-driving stage. The signal is rectified by diode D7. Capacitors C8 and C9 limit the frequency response to about 500 Hz. Trigger diode D13, and R12—BRIGHTNESS—set the level at which the SCR (Q4) conducts. The SCR drives the lamps to various brightness levels and is powered through bridge rectifier circuit D9–D12.

Neon lamp PL1 indicates power is on. Transformer T2 supplies 12 volts for the amplifier.

Construction

If you use the printed board layout shown in Fig. 3 you should have no trouble with assembly. Parts placement is shown in Fig. 2. I put the assembled board in an aluminum chassis covered with contract paper on which I lettered the names of the controls. I punched a hole in one end of the chassis for the microphone.

All controls and the flood-lamp receptacle are mounted on the front cover. Use a three-wire power cord for safety—the ground wire should be connected internally to the chassis and go to a grounded receptacle. Keep all wires insulated and cover all line-voltage terminals with electrical tape to reduce possible accidents. A neat wiring job can keep you out of trouble.

The microphone can be mounted externally or you can mount it inside the chassis as I did. Sensitivity of the amplifier is good; therefore, mike location isn't critical. Transistors Q1 and Q2 are soldered directly into the printed circuit board—be sure to heat sink the leads when soldering. A low-wattage soldering iron is recommended. Use a heat sink with SCR Q4; this precaution will extend its life.

Four standoffs are used to mount the printed board to the cover. The cover in turn is screwed to the aluminum chassis with sheet-metal screws. Transformer T1 and T2 are mounted on the printed board. Very little hardware is needed for the construction, wiring is simple, so assembly time is not long. If good quality components are used, your Rhythm Lights should operate satisfactorily for many years.

Using Rhythm Lights

Apply power to the unit and turn on S2. Turn BRIGHTNESS and VOLUME controls fully counterclockwise. Then plug a flood light or spotlight into the receptacle. Advance the BRIGHTNESS control until the light barely glows. Furnish music at a normal level and turn up VOLUME until the music turns on the light. For best results, two 150-watt flood lamps of different colors should be used in a semi-dark room. The results are dramatic.

Switch S1 is a remote on–off device. You can use lamp cord of almost any length, since only 12 volts dc is present in the circuit. This switch opens the emitter circuit of the final amplifier stage (Q3), disconnecting the input signal. Lamp intensity can still be controlled, however, with the BRIGHTNESS control. Another effect you might want to try: Hook up a string of Christmas-tree lights to the unit. Use your imagination; you'll find many interesting applications for Rhythm Lights. **R-E**

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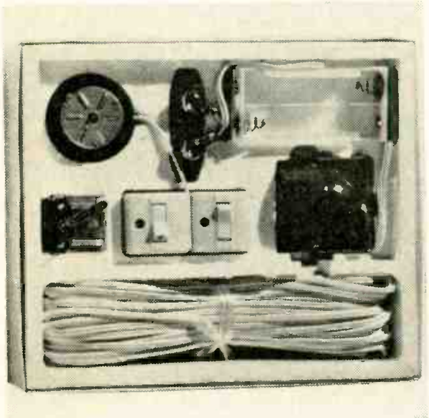

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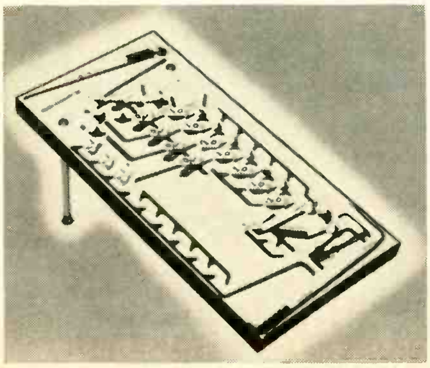
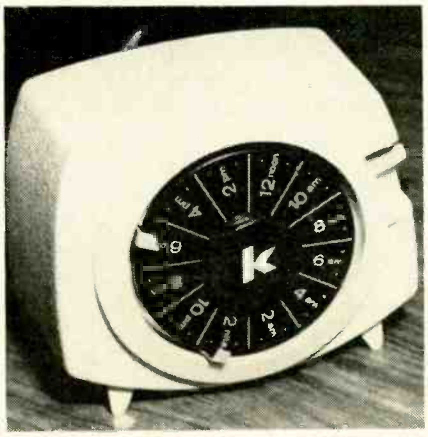
SIMULATED COMPUTER, *Digicomp II.* This model digital computer is designed to solve problems; is said to be the first mechanical computer that has automatic switch action. Requiring no



power source, the unit visually simulates electric currents of an electronic computer by marbles rolling through its mechanism. Features a 4-unit memory register, 3-unit multiplier–quotient register, 7-unit accumulator register and an overflow switch. $16.—**Edmund Scientific Co.**

Circle 47 on reader's service card

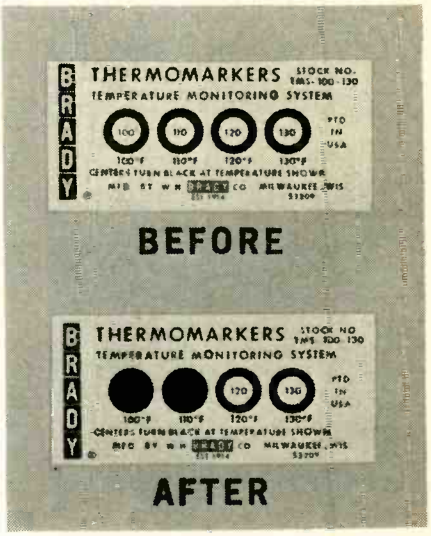
ALL-PURPOSE TIMER. Designed to handle loads of up to 185 watts, the



device turns lights and appliances on or off at preset times. The operation automatically repeats every 24 hours. Minimum "on" interval is 15 minutes, maximum is 23¾ hours. No special wiring is needed . . . equipment to be controlled is simply plugged into the timer. Supplied with 6' line cord. $8.77—**ALLIED RADIO CORP.**

Circle 48 on reader's service card

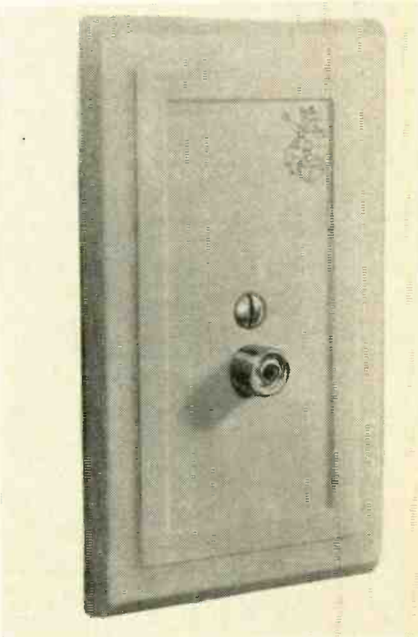
PLASTIC FILM MARKERS, *Thermo-markers.* Markers with one heat-indicating circle are 7/8" square. They are available from 100°F in 10° intervals per marker through 500°F. Markers with four progressively higher heat-indication circles are 7/8" x 1¾" and range from 100°F. When temperature at each circle is attained, the circle turns permanently black. Thermomarkers are suitable for



monitoring temperatures where more elaborate methods are impractical and accuracy is essential.—**W. H. Brady Co.**

Circle 49 on reader's service card

WALL TAPS. *Model MC-1* with no resistors and an swr of 1.5/1 or better is used as a single lead-in outlet. One to four taps possible to coax lead-in. For larger amplified systems, three wall tap models are available in varying isolation



values with a low insertion loss and an swr of 1.5/1 or better. All feature solderless connections with crimp-on ferrules. Taps may be mounted in a plaster ring or in a standard electrical box.—**Mosley Electronics, Inc.**

Circle 50 on reader's service card

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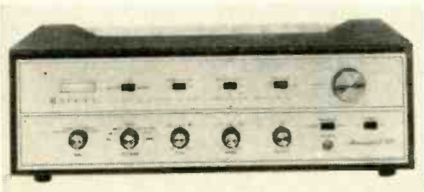
NEW AUDIO EQUIPMENT

RECEIVER/TURNTABLE, *Nocturne Plus*, Model SC 7. Combination of a 60-watt AM/FM/FM-stereo Nocturne receiver with a professional Dual 1009SK automatic turntable in walnut case. Enables use of any speaker system regardless of size, efficiency or impedance. Re-

ceiver will drive up to four speakers simultaneously. Employs a MOSFET FM front end for better performance. Microcircuits in the i.f. strip for good performance with stereo separation and noise rejection, ultra-sensitive AM delivers clear broadcast reception without noise or fading. $450.00—**Harman-Kardon, Inc.**

Circle 51 on reader's service card

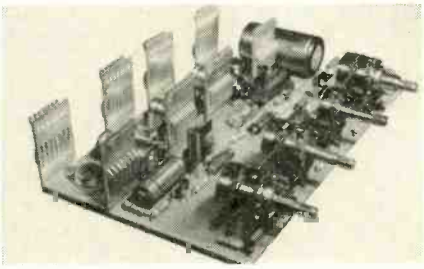
AMPLIFIER KIT, *Scott LK-60B*. 120 watts, solid-state stereo. If a wiring error has been made, a fail-safe circuit absorbs excess power when the unit is first turned on. It causes a light bulb to glow thus warning the kit-builder that he



must recheck wiring. Uses pre-tested components including heat sinks, printed circuit boards and silicon output transistors. Features circuit monitor, rumble and scratch filters, headset output, and dual-speaker switch for selecting main, remote or both sets of speakers.—**H. H. Scott, Inc.**

Circle 52 on reader's service card

STEREO AMPLIFIER, *PCA-6A-25*. Assembled unit 20-watt comes ready to use when connected to a sound source and speaker system. Circuit has a three-stage dc-coupled power amplifier with a thermistor for temperature stabilization. Also available as a two-piece assembly for mounting into compact phonographs (PCA-6A-25S CS). Load impedance: 8 ohms; input impedance: 500,000 ohms; input sensitivity: 0.5V; power output:



10W (per channel) at 1 kHz and 8 ohms; current: 35 mA (idle) 560 mA (max.). Frequency response: 30 Hz–50 kHz at —3 dB.—**Amperex Electronic Corp., Distributor Sales Dept.**

Circle 53 on reader's service card

AM/FM STEREO RECEIVER, *LR-1500T*. Offers 63-transistor performance using 4 IC's, each containing 5 transistors and 2 resistors, 2 high-performance field-effect transistors, 41 transistors, 40 diodes and 2 thermistors. Power output: 175 watts IHF at 4 ohms; harmonic distortion:

under 1%; frequency response: 20–20,000 Hz. Power bandwidth: 25–35,000 Hz; selectivity: 40 dB at 400 Hz; S/N ratio (100% modulation): 68 dB. Spurious response rejection: 95 dB; sensitivity: 1.5 μV. Output impedance: 4-8-16 ohms. $279.95—**Lafayette Radio Electronics**

Circle 54 on reader's service card

VIDEO TAPE RECORDER AND CAMERA. Battery-operated and easy to carry, the recorder is about the size of a small attaché case. VTR weighs only 11

lb and operates on a self-contained battery. It records black-and-white pictures, with sound, for immediate playback on CV-2000 series video tape recorders. Device uses a 20-minute, ½" tape with a 7½" ips speed. Only 2 buttons are used for simple operation. Video camera connects to VTR with single cable for video, sound and power. Total price, including VTR, camera, zoom lens, microphone, battery and charger, is $1250.—**Sony Corp. of America**

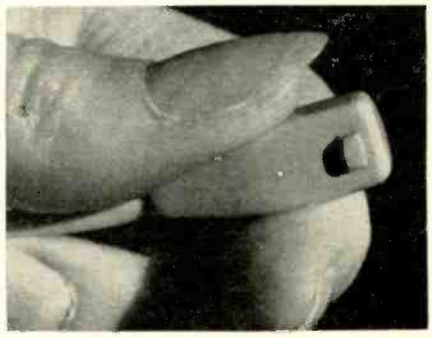
Circle 55 on reader's service card

AUTOMATIC TURNTABLE, *Module SLx*. Has a new light and thin tone arm to permit a counterbalance of small size and light weight and to keep tracking force to a minimum. Features Synchro-Lab motor, magnetic cartridge with diamond stylus, cuing and pause control, adjustable stylus pressure gauge, over-

sized turntable, interchangeable spindles. Compact unit is housed in a simulated walnut and ebony case highlighted by silver trim. $69.50—**Garrard, Div. British Industries Corp.**

Circle 56 on reader's service card

SUBMINIATURE MICROPHONE, *Micro-Mike*. Self-shielded against external fields, it has a nominal impedance of 5000 ohms at 1 kHz. Response is from 400 to 5000 Hz and typical sensitivity is 80 dB below 1 volt per dyne/sq cm rms pressure. Measuring only 1" x 0.365" x 0.285", the new microphone is ideal for



pocket transmitters, tape recorders or other applications where extremely small size and weight are important. The 3-wire shielded cable supplied matches the flesh-colored plastic case.—**Unex Laboratories**

Circle 57 on readers' service card

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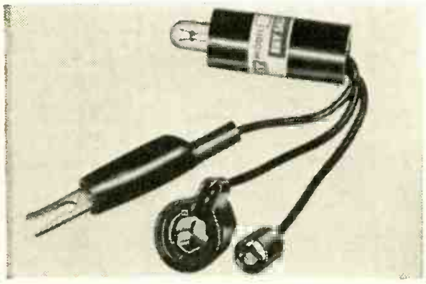
NEW TEST EQUIPMENT

MINIMUM-CATHODE-CURRENT INDICATOR, *No. MCC-1*. Permits technicians to replace or adjust horizontal output tubes for minimum cathode current quickly, easily and accurately. Has universal application and can be used with all novar, compactron octal and noval tubes in use as horizontal outputs. After attaching the indicator as directed its bulb will glow and the tube can be adjusted for minimum output. $3.00—**Eby Sales Co., Inc**.

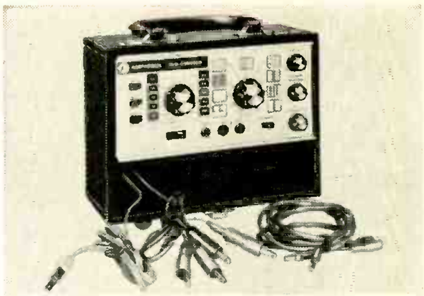


Circle 58 on reader's service card

PUSHBUTTON BATTERY-OPERATED VOM, *Model 601 Type I*. Measures dc voltage, ac rms values, resistances, ac/dc, decibels on 10 ranges and the condition of its batteries. Accuracy: ±2% on dc and ±3% for ac. Frequency response on ac is 50 Hz to 50 kHz. Decibels: −40 dB to +60 dB. Four functional pushbutton selector switches are located at the left side of the aluminum front panel for easy selection of dc volts (+) ohms; dc volts (−) ohms; ac volts and low-power ohms. A complement of AA penlight cells powers the unit, and are furnished with each set. Price is $125, complete with test probes and operating instructions. Leather carrying case is available at $14.70.—**Triplett Electrical Instrument Co.**

Circle 59 on reader's service card

COLOR ALIGNMENT GENERATOR, *Model 865 Deluxe Color Commander*. New instrument provides nine patterns. The three-bar color pattern eliminates all but the three bars used for color demodulator alignment: Red (R − Y) is at 90°; blue (B − Y) at 180°, and green (R − Y) at 270°. Calibrated crosshatch display provides a pattern with a 3:4 aspect ratio: 15 horizontal and 20 vertical lines. Unit is styled in a smart, luggage-type case featuring a large storage area for probes, tubes, etc. Operates on 117 V ac or on self-contained batteries. Automatic shut off when lid is closed. $189.95 less batteries.—**Amphenol Distributor Div.**



Circle 60 on reader's service card

Circle 106 on reader's service card

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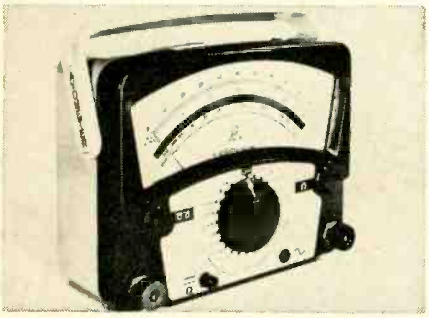
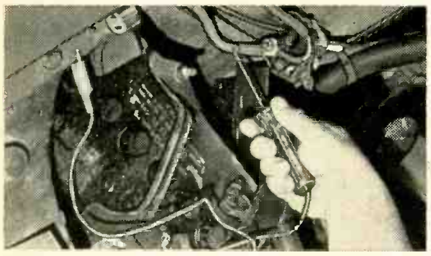
MULTIMETER, *AVOmeter Model 16.* Has 36 ranges and features 20,000-ohm/volt sensitivity. Metal-film resistors are used throughout, guaranteeing an accuracy of 1%. Unit is fully protected by a



velocity-actuated cutout in addition to solid-state protection of the rectifier and fused resistance ranges.—Whittaker Corp., Gencom Div.

Circle 61 on reader's service card

CIRCUIT TESTER, *No. TK 550.* Tests 6- and 12-volt circuits for automotive electrical systems, lamps, bulbs, wire connectors, field coils, switches, etc. Consists of a pointed prod attached to a han-



dle which has a ground wire with alligator clip. If circuit being tested is alive, the handle lights up when the prod pierces a wire's insulation. $2.50.—VACO Products Co.

Circle 62 on reader's service card

IC DIGITAL PRINTER, *Model PR-4900.* Records voltage, frequency, time period, resistance, capacitance or event counts. Up to 10 lines of numeric and coded data can be printed from one or

two independent digital systems. Print can be remote, local or at calibrated time intervals. Maximum print rate from external command pulses is 1/sec.—Hickok Electrical Instrument Co. R-E

Circle 63 on reader's service card

NEW LITERATURE

All booklets, catalogs, charts, data sheets and other literature listed here with a Reader's Service number are free for the asking. Turn to the Reader's Service Card facing page 72 and circle the numbers of the items you want. Then detach and mail the card. No postage required!

TECHNICAL DATA BROCHURE. 80 pages of data on 15 functions in the MTTL I IC family and 9 functions which feature a typical propagation delay of 10 nanoseconds. High-speed MTLL II IC circuits have a propagation delay of 6.0 nanoseconds. Sections are indexed by function, and an introduction to each section provides reader with typical characteristics, breadboarding suggestions, package dimensions and additional information.—**Motorola Semiconductor Products, Inc.**

Circle 64 on reader's service card

NEON GLOW LAMPS. 8-page illustrated brochure gives a complete description of how to evaluate and apply glow lamps. It includes discussions on light output, lamp longevity, and external conditions acting on the glow lamp. Features an ionization time vs percent overvoltage graph, a circuit drawing showing various breakdown measurements and a compilation of clearly defined, relevant terms. Charts give breakdown voltages, lamp measurements and electrical characteristics.—**Signalite, Inc.**

Circle 65 on reader's service card

HI-FI LOUDSPEAKER SYSTEM COMPONENTS. *Instruction Note No. 242* gives information for custom assembly or upgrading of 2-, 3- and 4-way loudspeaker systems. Six-page folder has charts illustrating specs and hookup procedures for 25 systems with comparisons of orchestral frequency ranges. Also describes 26 loudspeaker components. Instructions include: circuit connections, mounting system components, constructing acoustic enclosures, adjusting balance controls and locating speaker systems within a room.—**Jensen Manufacturing Div./The Muter Co.**

Circle 66 on reader's service card

ELECTRONIC COURSE. You can break into electronics. It will call for some training, but you won't have to quit your job or turn your life upside-down to get it. CIE will teach you at home. Auto-programmed lessons help you to master the electronics you will need for a rewarding career. Two free books. *HOW TO SUCCEED IN ELECTRONICS* and *HOW TO GET A COMMERCIAL FCC LICENSE,* tell about careers in the field and how you can prepare for them in your spare time.—**Cleveland Institute of Electronics**

Circle 67 on reader's service card

COLOR ELECTROLYTIC CAPACITORS. Six-page brochure lists over 250 wide-range lytics of the single-, dual-, triple- and quadruple-section types. These units will replace 2500 varieties. Listing provides a blank space beside each rating which is useful in inventory taking, price notations, product movement indication, etc.—**Cornell-Dubilier Electronics**

Circle 68 on reader's service card

SHORT-FORM CATALOG. 25-page book covers major product categories such as jacks, plugs, switches, connectors, indicating devices and audio accessories. Information is condensed. The electronic components illustrated and described are items stocked by Switchcraft's nationwide network of industrial distributors. Covers computers, analyzers, transmitters, receivers, intercoms, etc.—**Switchcraft, Inc.**

Circle 69 on reader's service card

COLOR TV COILS. Four-page cross-reference guide for 12 new color TV coils is now available. Listing provides exact replacements for 550 video and chroma coils for sets produced by virtually all manufacturers. Guide is easy to follow, informative and to the point. This booklet will be useful to TV service technicians, hobbyists and do-it-yourselfers who need a quick-reference guide to replace coils on color TV's.—**J. W. Miller Co.**

Circle 70 on reader's service card

BASE STATION ANTENNAS, *Models BB-2534* and *BB3450.* First model covers 25–35 MHz and second covers 34–50 MHz. Brochure gives specs, features, benefits and ordering instructions. Also lists a variety of mobile antennas in 25–50-MHz range.—**New-Tronics Corp.**

Circle 71 on reader's service card

POTENTIOMETERS, RESISTORS, 32-page illustrated catalog includes photos, engineering drawings and descriptions of field-assembled controls, sound-system attenuators and many more. Complete technical specs and dimensional information are included. Special section describes military-qualified potentiometers.—**Clarostat Mfg. Co., Inc., Distributor Div.**

Circle 72 on reader's service card

PHONOGRAPH NEEDLES/ACCESSORY PRODUCTS. *Form 6707.* 14th edition of catalog and reference guide provides complete information on phonograph needles plus expanded line of accessories, including reel-to-reel tapes, cassettes, and tape recorder, tape cartridge, guitar and record accessories. Needles are indexed by cartridge number and/or manufacturer, competitive needle number and by phonograph model. 44-page catalog includes photos, specs and features.—**Recoton Corp.**

Circle 73 on reader's service card

1967/68 CB CATALOG, *No. C-175.* 12 pages of CB equipment, antennas and accessories. Lists features, model numbers and nearest stores for ordering convenience. Flyers also available.—**Mosley Electronics Inc.** R-E

Circle 74 on reader's service card

Write direct to the manufacturers for information on items listed below:

NOISE CALCULATOR. Ten scales incorporated in this slide rule-type noise calculator enable the user to perform various noise computations. Included are scales to determine thermal noise voltage and current developed by a resistor; shot-noise voltage and current developed by a transistor or diode junction, and noise figure for a given source resistance from the spectral density. Other scales permit conversion of resistor noise index to μV/V and determination of noise in a given bandwidth from the spectral density. Available when requested on **your company letterhead** from: **Quan-Tech Laboratories,** 43 South Jefferson Road, Whippany, N.J., 07981.

MANUFACTURING QUALITY CONTROL. 120-page programed workbook provides practice problems and assignments in quality-control training. Furnishes the major essentials plus simplified data based on experience in actual industrial applications and production situations. Emphasis is on methodology and philosophy of statistical control as a practical working tool. Available without charge if requested **on your company letterhead** from: Advertising Dept., **General Instrument Corporation,** P.O. Box 600, Hicksville. New York 11802.

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Windshield Wiper Pause Controller

(continued from page 33)

tuted, wiring and parts layout is not critical. However, you must observe polarity of the capacitors and must hook up D1, Q1 and SCR1 properly.

A minor modification of the SCR is necessary to allow insertion into the board. Carefully cut off the solder lugs brazed to the end of the gate and cathode terminals. The SCR is not mounted flush with the board, but inserted only enough to make a good solder connection to the shorter gate terminal. You can shorten the longer terminal after soldering it to the board.

Mounting brackets can be made from 1/32" aluminum sheet, cut and bent as shown. The mounting bracket can be custom fitted for installation on the bottom edge of your dashboard if you don't want to drill any new holes on the dashboard's face. The sides of the unit should be left open to help dissipate heat. Insulation paper or plastic tape should be used where necessary to prevent short circuits. A coat of paint will dress up the mounting bracket. Install a suitable pointer knob to match the car's decor to complete the construction.

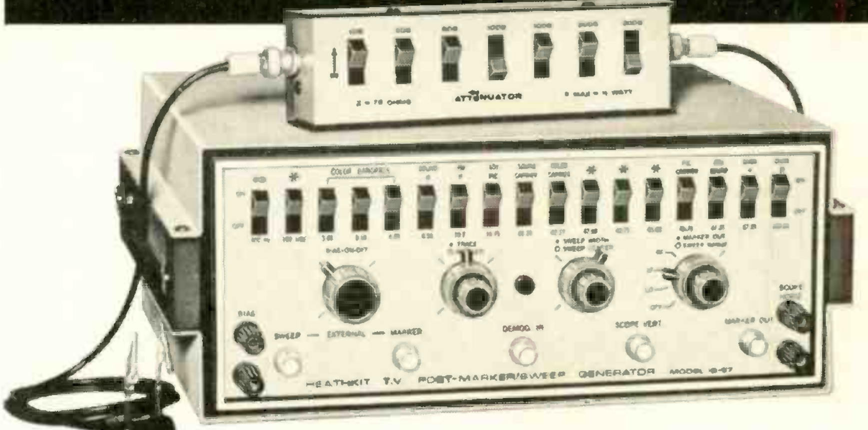
Installation

Mount the APC within easy reach of the driver. Since the APC circuit is grounded through its metal case, as are most automobile electrical devices, it is necessary for the case to make good electrical contact with the dashboard. If for any reason a good ground connection cannot be made in this manner, run a wire (about No. 20) from the APC's ground bus to a good ground on the car. Connect the B lead from S1 to the accessories terminal of the ignition switch, or to a lead already attached to this terminal, if you can't get to the ignition switch. Connect the A lead from the anode of the SCR to the windshield wiper motor switch S2. Use No. 16 stranded wire for the A lead. A smaller gauge wire (about No. 20) can be used for the B lead.

If the wiper-motor switch is not accessible in your car or if you prefer not to work under the dash, connect the number 16 wire directly to the wiper motor wire going to the dashboard switch.

A schematic for constructing an APC for a 12-volt positive-ground system is shown in Fig. 2. For 6-volt operation, reduce R1 to about 15,000 ohms and replace R4 with a jumper wire. [*Positive ground circuit and modification for 6-volt operation were not tested.—Editor.*] **R-E**

15 CRYSTAL MARKERS
3 SWEEP RANGES
ONLY $135



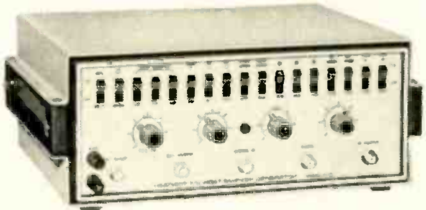
New Heathkit IG-57 Solid-State Color TV Marker/Sweep Generator

The IG-57 combines the features of both a post marker and a sweep generator for less than you'd expect to pay for just one of these functions.

• Three linear sweep ranges for TV tuned circuits in sound IF, color bandpass, video IF circuits and proper overall RF/IF response • External attenuator provides 1, 3, 6, 10 and 20 dB steps up to 70 dB maximum • Can also be used with external sweep or marker • 15 crystal-controlled markers provided for color bandpass alignment; picture and sound carrier frequencies for channels 4 and 10; FM tuner, FM IF and discriminator alignment; TV sound IF adjustments • All crystals included • Completely isolated 1-15 VDC variable voltage supply for positive or negative bias • Built-in 400 Hz modulation for trap adjustment and checking and adjusting FM tuners • Phase Control and Trace Reverse Switch so markers will appear from left to right as in set manufacturer's instructions, regardless of 'scope used • Blanking Switch eliminates return sweep and provides base line • Circuit Board Construction — three circuit boards, 27 transistors, 3 silicon diodes, 2 crystal diodes and 2 Zener diodes combine to make assembly faster with less chance of error • Bias and Scope Horiz. leads, Attenuator, Demod In, Scope Vert., RF and Demodulator cables included in kit.

Kit IG-57, 14 lbs. **$135.00**

IG-57 SPECIFICATIONS — Marker frequencies: 100 kHz; 3.08, 3.58, 40.8, 4.50 MHz, ±.01%. 10.7, 39.75, 41.25, 42.17 42.50, 42.75, 45.00, 67.25, 193.25 MHz ±.005%. **Modulation frequency:** 400 Hz. **Input impedances:** External Marker, External Sweep, & Attenuator — 75 ohm. Demod In — 220 k ohm. **Output impedances:** Marker Out, Sweep Output & Attenuator — 75 ohm. Scope Vert — 22 k ohm. **Bias voltage:** Positive or negative 15 volts DC at 10 milliamperes. **Type of marker:** Birdie. **Controls:** Bias control with pull-on/push-off switch; Marker/Trace — dual concentric; Sweep Width/Sweep Center — dual concentric; Marker Out — concentric with Sweep Range switch; Phase. **Switches:** Rocker type — separate switch for each of the above listed frequencies; Blanking, On/Off; Trace Reverse; Modulation On/Off. **Transistor — Diode Complement:** (19)-2N3692 transistor. (7)-2N3393 transistors. (1)-2N3416 transistor. (3)-silicon diode rectifiers. (2)-crystal diodes. (1)-13.6 volt zener diode. (1)-20 volt zener diode. **Sweep frequency ranges and output voltage:** LO Band — 2.5 to 5.5 MHz ±1 dB at 0.5 volts RMS fundamentals, and 10.7 MHz on harmonics. IF Band — 38 to 45 MHz ±1 dB, at 0.5 volts RMS, fundamentals. RF Band — 64 to 72 MHz ±1 dB at 0.5 volts RMS fundamentals, and 192 to 198 MHz on harmonics. **Attenuator:** Total of 70 dB of attenuation in seven steps — 1, 3, 6, 10, 10, 20 and 20 db. **Power requirements:** 120 volts, 60 Hz AC at 20 watts. **Dimensions:** 13 3/8" W. x 5 1/2" H. x 12 1/2" D.



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The IG-14 has the same features and specifications — without the sweep.

Kit IG-14
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Circle 107 on reader's service card

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Build High Efficiency Lab Power Supply

Solid-state dc supply delivers zero to 6 amperes into 15-ohm load

By MELVIN CHAN and ROBERT BROCK

A LABORATORY PROBLEM REQUIRED A variable-voltage dc power supply capable of delivering from zero to 6 amperes into a 15-ohm load. Ripple voltage could not exceed 1%. We wanted a supply that was more efficient than most and did not require exceptionally large filter capacitors. Fig. 1 shows the circuit of the supply that met our requirements. Ripple is only 0.1% at full load.

If we had used a conventional supply with brute-force filtering, we would have needed 50,000 to 100,000 μF to hold ripple down to 1%. On the other hand, power supplies using simple series-element regulation waste a lot of power. Fig. 2-a shows that the power dissipated in the filtering and regulating circuits rises from approximately 80 watts at 1 ampere to 160 watts at 3 amps and then drops to around 60 watts at 6 amps. Too, efficiency increases linearly with load current and reaches approximately 45% at a mid-range current of 3 amps (see Fig. 2-b).

Compare these curves with those in Fig. 3 showing the performance of the supply shown in the schematic. Note that the power dissipated within the supply (Fig. 3-a) ranges linearly with output current from 0 (zero current) to 30 watts with a 6-amp load current. Efficiency (Fig. 3-b) ranges from 75% at 1 amp to 95% at 6 amps. Total effective filter capacitance is only 1650 μF instead of the 50,000 to 100,000 μF required for a brute-force filter in such a supply.

The circuit

The voltage source is a 6-amp variable-voltage autotransformer. The selected ac voltage is fed to a full-wave bridge rectifier assembly (D1), filtered to reduce ripple to about 6 volts peak to peak at full load and then applied to the control-current network consisting of these components: D2, R3, C3, C4, Q2 and Q1.

The transistors are connected in a Darlington "super alpha" configuration to reduce control-current requirements. Zener diode D2 is selected for an operating voltage that slightly exceeds the amplitude of the initially filtered ripple voltage and provides the filtered bias voltage for the base of Q2. Capacitor C3 charges rapidly through D2 toward a voltage level which is the difference between the Zener voltage of D2 and the input voltage at point A. Capacitor C4 charges more slowly through R3 and

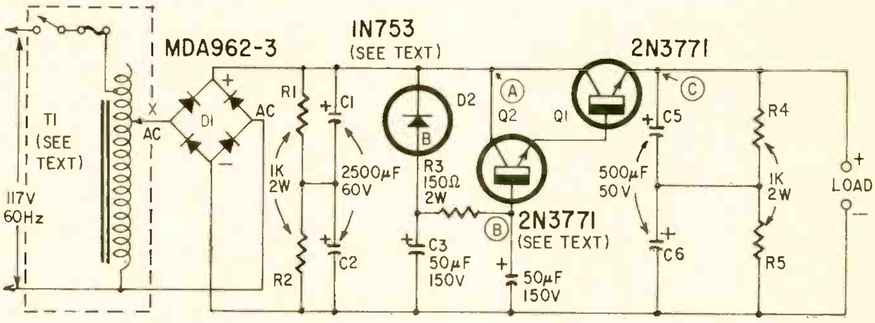

Fig. 1—High-efficiency dc supply for delivering up to 6 amps into 15-ohm load. C4, the 50-μF electrolytic tied to Q2's base, is part of current-control network.

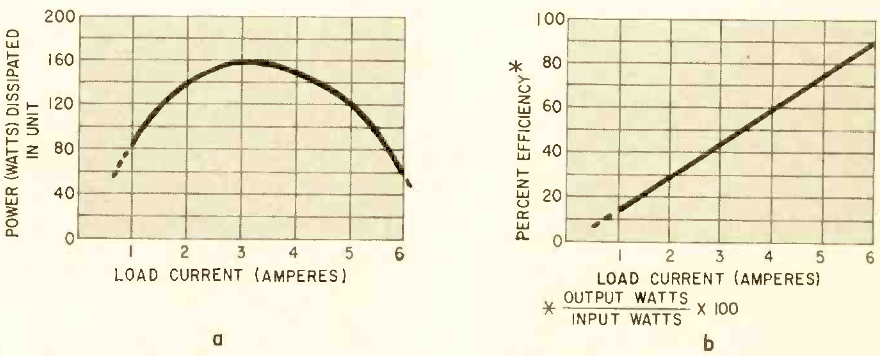

Fig. 2—Performance curves for a conventional series-regulated variable-voltage supply driving a 15-ohm load. Fig. 2-a shows dissipation. Fig. 2-b, efficiency.

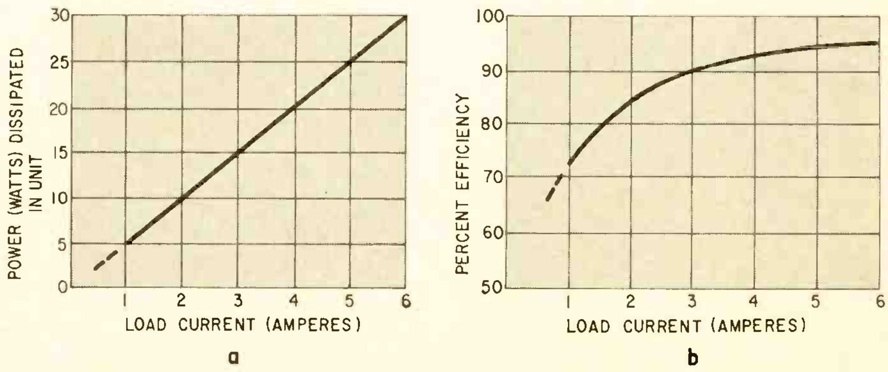

Fig. 3—Dissipation in the supply in Fig. 1 is shown in graph a; efficiency in b.

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D2 toward the charge voltage on C3. Transistor Q2's base bias is the difference between the voltage at point A and the charge on C4.

The load voltage at point C equals the voltage at B minus the total base-to-emitter voltage drops of Q1 and Q2. Capacitors C5 and C6 reduce residual ripple voltage to less than 0.1% at full load (6 amps).

Resistors R1 and R2 equalize the voltages across C1 and C2 and discharge these capacitors when the supply is turned off. Resistors R4 and R5 perform the same functions for C5 and C6. (A single 1250-μF, 120-volt capacitor could have replaced C1 and C2 and eliminated R1 and R2 but was not readily available. Similarly, a single 250-μF, 100-volt capacitor could have replaced C5 and C6 and eliminated R4 and R5.)

This power supply can be used for any fixed-load applications requiring variable voltages, good filtering and high efficiency within its voltage-current ranges. Its voltage regulation is poor but this is unimportant when driving fixed loads.

Construction hints

A severe shock hazard and a possibility of damaging the equipment exist when the power supply is used to drive a separately grounded load. This hazard may be eliminated by using a 1:1 isolation transformer between the ac power line and the autotransformer.

Parts for the supply can be purchased for around $50 (including $20 for T1). Transistor Q1 should be mounted on a 35-watt heat sink. Transistor Q2 may be a 2N3771 or a less expensive transistor such as the Motorola MJ2255 (8 amps, 120 watts), MJ2801 (10 amps, 120 watts) or any similar npn transistor whose I_C is 1 ampere or higher. It, too, should be mounted on a heat sink.

The full-wave bridge rectifier assembly (D1) is rated at 200 piV, 10 amps. It may be a molded assembly such as the Motorola MDA962-3 or may be made up of individual 200-piV, 10-amp diodes. Zener diode D2 may be a 1N753 (6.2 volts $\pm$10%, 400 mW), a Z1106 (6.8 volts, 20%) or a 1N4735 (6.2 volts, 20%).

The fuse and switch are assumed to be parts of the autotransformer assembly. If they are not, install a 10-amp, 120-volt d.p.s.t. switch. Ground the transformer through a three-conductor line cord and plug to the ac power receptacle. A 6-amp, 125-volt fast-blow fuse inserted at X between the transformer and D1 will provide short-circuit protection. **R-E**

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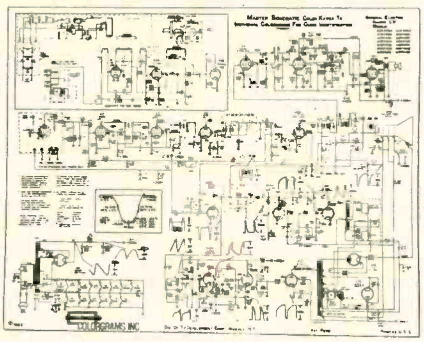

Easy to read complete master schematic is color-keyed to the colors used in the Colorgram Charts.

Second, the Pak includes color-keyed master schematic providing an overall view of the receiver circuit. It shows the Tuner, IF, Video, Audio, Vertical and Horizontal sections, color-keyed to the colors used in individual COLORGRAM charts. It also shows test points, waveforms, voltage, resistance, capacitance, practical alignment data, etc.

CONTENTS

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EMERSON	(24 CHASSIS,	100 MODELS)
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MAGNAVOX	(1 CHASSIS,	27 MODELS)
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RE 78

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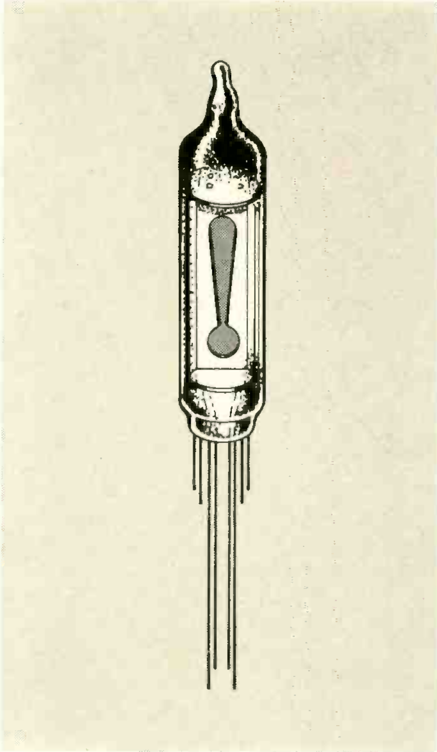
Signal and Voltage Indicators

Cut cost of experimental projects by using substitutes for expensive meters

By LEO G. SANDS

IN THE LONG-GONE AND OFTEN-lamented days right after World War II, inexpensive surplus equipment virtually flooded the parts market. Every experimenter worth his salt had a large and highly varied collection of voltmeters. Often selling for a couple of dollars or less, top-quality movements were available in almost any size, shape or range. Today, however, the well-mined mother lode of military voltmeters has pretty much played out, and the cost of a new one for the latest experimental project often can equal the combined cost of all other components.

Fortunately, there is a way around the dilemma. Many types of common indicator tubes and other indicating devices can be used for signal and voltage displays. Probably the most well known of these money-savers is the electron-ray indicator tube often called a "magic eye." Used in AM radio circuits as long ago as the late '30's, the indicator still is used in test instruments and in some FM tuners. It has several other possible uses as a voltage indicator as well.

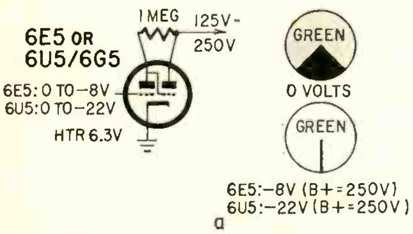


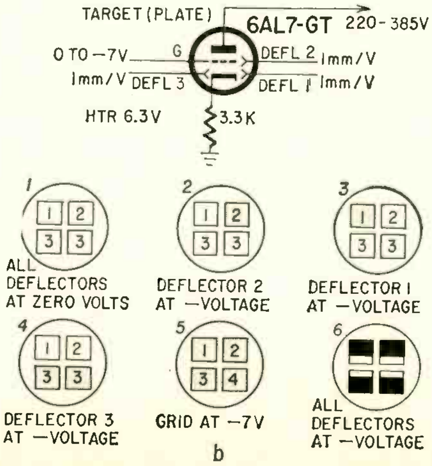
The original electron-ray indicator tube was the 2E5 with a 2.5-volt heater, and its 6.3-volt counterpart—the 6E5—shown in Fig. 1-a. The plate of one triode section (a dc amplifier) is connected internally to the ray-control electrode (grid). The plate of the second triode is known as the target.

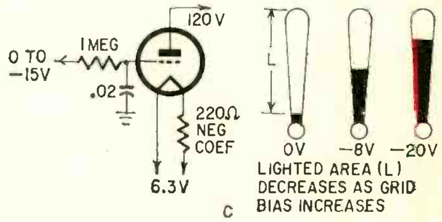
When the voltage at the amplifier-triode grid is zero, the circular target at the end of the tube glows a bright green, except for the shaded triangular wedge known as the shadow. As the grid is made negative, the shadow gets smaller. When grid voltage reaches approximately −6.5 to −8 (depending upon target voltage), the entire screen is green, and the shadow angle is zero. If the grid is made more negative, the edges of the illuminated area overlap. (The 6U5/6G5 is similar, but the grid voltage for zero shadow angle is about −22.)

Indicator bars

More novel is the type 6AL7GT indicator tube which displays two glowing rectangular bars divided into four







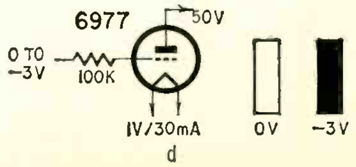


Fig. 1 (a-d)—"Magic eye" tubes provide a variety of these small signal display patterns. (1M3/DM70 is shown at c.)

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segments. As shown in Fig. 1-b, this tube has a target (plate), a grid and three deflector electrodes. The grid varies the brilliance of the illuminated bars. Deflectors 1 and 2 control the size of the shadow on segments 1 and 2, and deflector 3 controls segments 3 and 4. The width of shadow area produced by each deflector is about 1 mm/volt.

The 1M3/DM70 tuning indicator displays an illuminated bar which is reduced in length through application of a negative grid voltage. As shown in Fig. 1-c, this tube employs a directly heated cathode which can be energized from 6.3 volts ac through a 220-ohm, negative-coefficient resistor.

The type 6977 indicator tube shown in Fig. 1-d also displays a glowing bar, the brilliance of which is reduced as the grid is made more negative. At a grid voltage of about −3, the glow is extinguished. This is also a filament-type tube drawing 30 mA at 1 volt ac or dc.

Then, of course, there are neon lamps which glow when a high enough

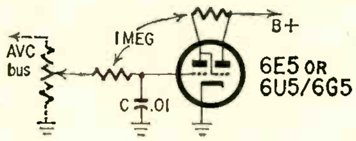

Fig. 2—Maximum avc voltage in AM receiver causes the smallest shadow angle.

voltage is applied initially (striking voltage) and continue to glow until voltage is reduced to a certain level (extinction voltage). Neon lamps are used as pilots, gates, oscillators, voltage regulators and excess-voltage indicators, to name a few.

Having reviewed briefly some basic types of voltage-indicating tubes, let's now see how they may be incorporated into some simple—and useful—circuits. In most cases, the full parts list is omitted, but no trouble should be had in duplicating any or all of them.

Type 6E5 and 6U5/6G5 tubes often are used as tuning indicators in AM receivers, connected directly to the avc bus as in Fig. 2. When the receiver is correctly tuned to a station, avc voltage is maximum, and the shadow angle is smallest. Use a 6E5 if avc measures from 0 to −8 volts maximum; a 6U5 can be used for voltages to −22.

Adding a pot (dotted lines) makes a simple S-meter. Use a dial scale with the pot and calibrate it in S-units or microvolts. Then, with a signal tuned in, adjust the pot for zero shadow angle and read the pot setting.

Another application for the 6E5 or 6U5/6G5 is as an FM-receiver tuning indicator. It can monitor limiter voltage using the same circuit as in Fig. 2, but with the input connected to the limiter grid-return circuit instead of the avc bus. A more meaningful indication is obtained by monitoring discriminator or ratio-detector dc voltage (Fig. 3). The cathode pot is adjusted for zero shadow angle when the receiver is correctly tuned to a station; off channel, the shadow angle increases.

The 6AL7-GT is a popular FM-receiver tuning indicator. In the typical circuit shown in Fig. 4, the grid and deflector 1 are biased negative by the cathode resistor. Deflector 3 is connected to the limiter grid return, and deflector 2 is connected to the discriminator or ratio detector as in Fig. 3. The illuminated bars are of equal length and shortest when the receiver is correctly tuned (deflector 2 at zero voltage and deflector 3 at maximum negative voltage).

The circuit of Fig. 2 can be used as

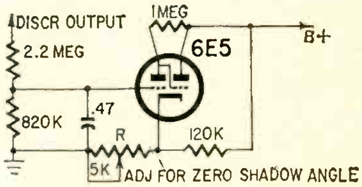

Fig. 3—FM discriminator or the ratio-detector voltage is monitored and pot R adjusted for zero shadow angle.

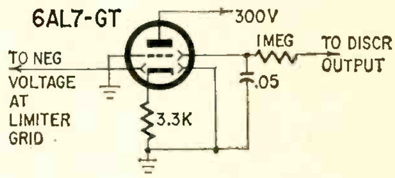

Fig. 4—6AL7 light bars are shortest when deflector 2 has zero voltage and deflector 3 has a maximum negative voltage.

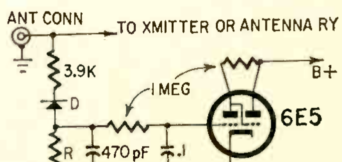

Fig. 5—Transmitter monitor: Output is rectified by the diode. Voltage across R controls 6E5 shadow width.

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a dc vtvm by calibrating the pot dial scale in terms of voltage for zero shadow angle. It can be used as an ac vtvm by connecting a diode from the arm of the pot (anode) to ground (cathode) or in series with the hot end of the pot (cathode toward voltage being measured).

Electronic indicator tubes also can be used to monitor CB and ham transmitter circuits. Relative transmitter output can be monitored with a 6E5 using the circuit shown in Fig. 5.

The output signal is tapped at the antenna connector and rectified by a high-frequency diode; the resulting dc voltage appearing across R is monitored by the 6E5. Sensitivity is changed by altering the value of R. Signal strength determines the width of the shadow, and proper (upward) modulation is indicated by further reduction or overlapping of the shadow angle.

An 1M3/DM70 also can be used as a relative rf-output indicator. As shown in Fig. 6, rectified rf is fed to the indicator grid, causing the illuminated bar to enlarge with increased output and upward modulation. The value of R1 is selected to provide the desired range. Values of R2 and R3 should be chosen to reduce B+ to 150–170 volts at the plate of the indicator.

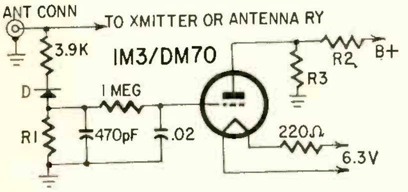

Fig. 6—Transmitter output varies the bar width in 1M3/DM70. Rectified rf signal appears on the indicator grid.

Overmodulation indicator

A 6E5 can be used as a CB overmodulation indicator (Fig. 7). Here, modulated B+ voltage is tapped from the modulation transformer and fed to the 6E5 grid through diode D. Since modulated B+ voltage ordinarily is positive, the diode conducts only on negative overmodulation peaks, causing the shadow angle to flicker. Pot R is used to balance out diode leakage current in the circuit.

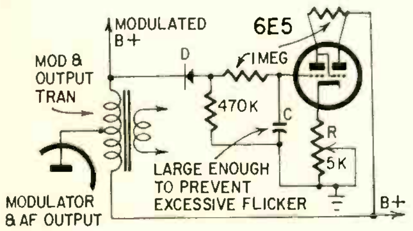

Fig. 7—Overmodulation indicator: The modulated B+ is rectified and fed to the grid of 6E5, varying the shadow angle.

In Fig. 8 a 6977 tube is used as the indicator in a combination field-strength/wavemeter. Diode D rectifies the rf signal and forward-biases the transistor, causing the 6977 to glow. The tube glows when the tuned circuit is resonant and is dark at other times.

What else you can do with indicator tubes depends upon your imagination. Just keep in mind that they're simply vtvm's without a calibrated scale. Using the basic circuits of Fig. 1 and adapting the examples shown and described, you should be able to save the cost of an expensive meter in many of your experimental projects. **R-E**

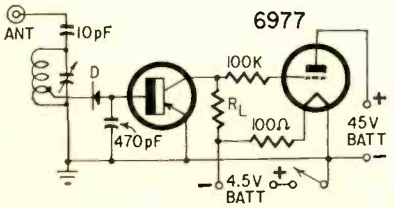

Fig. 8—Field-strength/wavemeter: rectified rf signal foward biases the transistor, lighting the 6977 indicator lamp.

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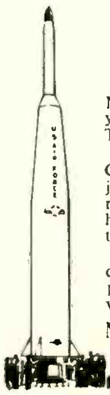

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Do It Yourself Language Lab

Put your tape recorder to work and learn another language

By BYRON G. WELS

Languages are easier when correct pronunciation is heard while reading English word.

IF YOUR YOUNGSTER IS FACING THE problem of foreign-language study at school for the first time, you know that the largest hurdle is memorizing the necessary words and phrases. In school, the teacher can convey usage and sentence structure. But it's the student's job to learn the words.

At our house, it became the whole family's problem, for whenever an odd minute was available, we had to start vocabulary drill. Something had to be done, and we solved the problem.

To begin with, you need a small tape recorder with a slow speed: 3¾ ips is good, 1⅞ even better. The machine must have capstan drive.

The next step is to buy a couple of packs of file cards. Use the 3" x 5" cards if your machine runs at 1⅞ ips speed, 5" x 7" for 3¾ ips. Remove the head cover from the tape machine, and place a card so it "bottoms" on the tape transport's base plate. Hold the card near the head, and mark the position of the bottom of the head gap on the card, and the location of the top of the gap (see the drawing).

Now stick a length of recording tape across the bottom of the card, placed so it completely covers the gap area. To do this, paint a line of cement (preferably rubber cement) on the bottom of the card. Place the tape (dull side down) on a piece of paper, and smear some rubber cement on the back of the tape. When both the card and tape have dried, pass the tape to the card. Place it right the first time. Tape and card will not readily slip, and they will be bonded permanently. Trim the excess tape off both ends with a razor blade. With the tip of a finger, rub the excess cement from the card. Be sure not to leave any traces of cement on the surface of the tape or card—it can literally gum up the works.

Repeat this on as many cards as you have words to be learned. When you have finished applying the tape to the cards, set up the tape recorder, and remove the supply and takeup reels.

Place a card in the head area, and put the machine in the record mode. Slide the card toward the capstan and capstan idler until the card is caught in the pinch between the two. They will pull the card past the heads and eject it at the other side. While the card is moving past the heads, speak the foreign word correctly into the microphone. If your pronunciation, or your youngster's is less than perfect, enlist the aid of someone who pronounces the language correctly.) It is now recorded on the tape at the bottom of the card.

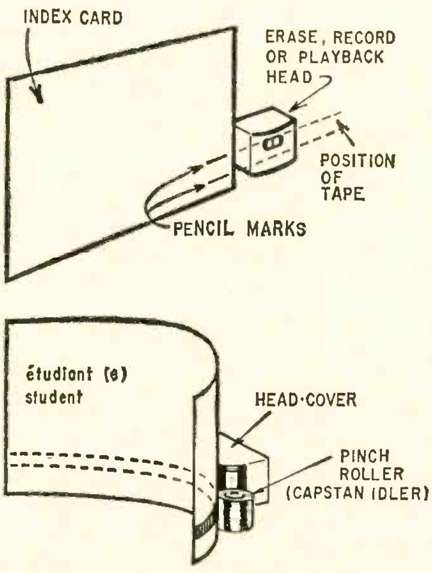
After the card has been expelled out the other side, write the word in English on the card. Continue this procedure until you have recorded all the words in your vocabulary list.

Foreign words often look perplexing when spelled. It is sometimes difficult to tie the spelling to the pronunciation, so it helps to write the word in the foreign tongue on the back of the card.

To use the language lab, take the cards in any order and sit down in front of the tape recorder. Read the English word written on the face of the card. Try to say it aloud in the foreign language. Then slip the card into the tape machine to hear proper pronunciation.

This process makes learning fun, as it should be. Our other kids, quite taken with the system, have asked us to prepare language cards for them.

Ich am having une bon tiempo with the whole chose! **R-E**



To prepare language cards, remove tape-head cover and position file card near head and flush with baseplate. Mark top and bottom of playback-head gap on card. Next, apply rubber cement to the card (where marked) and the glossy side of tape. Carefully position tape on card, removing all excess glue. Record words while feeding cards between capstan and capstan idler. Write words on card backs.

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A series of articles designed to tell all about two-way radio and shortwave listening, and how to benefit from emergency, land mobile and other VHF transmissions.

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GETTING STARTED IN 2-WAY RADIO . . . Going on the air is easier than ever. Virtually no one is excluded from mobile communications. Giant corporations, small business and individuals can be accommodated. How modern CB and commercial gear works, how to select and how to service equipment.

IS YOUR SKY PIECE FIRST CLASS? . . . Today's CB transceiver equipment is the best that engineers can design. But the best of equipment is worthless unless the antenna system can efficiently transmit the signal to where it is needed. An explanation of how to select the right antennas for specific mobile applications, how to install them and how to check out the entire system.

TUNING IN THE WORLD ON SHORTWAVE . . . There's fascinating activity on the shortwave bands . . . propaganda from Radio Peking, a Japanese language course for English-speaking audiences, guided tours of foreign lands, etc. Get to know how to select, what features to look for and about how much you will have to pay for a receiver.

COMPUTERIZE YOUR CAR LIGHTS . . . First of a three-part series tells how to build a miniature computer into your car to instantly tell you when a lamp burns out and whether you've forgotten to turn the lights on or off. Estimated cost is about $20.

DIPPER AND CRYSTAL OSCILLATOR . . . Experimenters, hams and shortwave fans will find many uses for this dipper construction project. A single, inexpensive transistor circuit is used to check the resonant frequency of a tank, or to find the value of an unknown coil or capacitor.

THE CASE OF THE MYSTERIOUS FLYING GLITCH-HAUSEN . . . Another unusual problem in a color TV receiver comes to light. Trouble in a set under repair manages to find its way into a set being repaired nearby. Something new—certain TV ailments could be catching.

ADJUSTING AUTOMATIC CHROMA CONTROL CIRCUITS . . . TV men have patiently explained for years that nothing is wrong with a color receiver when flesh tones change from pink to green after changing channels. The problem is usually a long line of "unequals." They range from studio color cameras to lighting conditions. Now, to help solve this problem, color TV set manufacturers have introduced automatic chroma control circuits. Learn how the new circuits work and how to service the sets using them.

TROUBLE-SHOOTING TV DETECTOR DIODES . . . Solid-state diodes play an important part in the detection systems of black-and white and color TV receivers. Because of their two-terminal simplicity, one expects little trouble from these tiny units. Yet diodes do develop open circuits and changes that seriously affect picture quality and sound. Learn how detector diodes function in TV receivers and how to recognize the problems they can cause.

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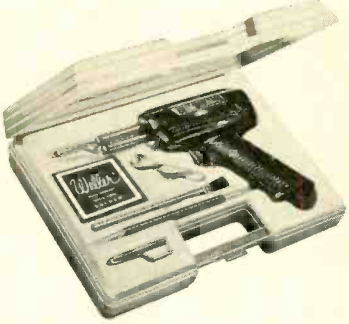

Utility Kit includes Weller 100/140 watt gun, extra tips, tip-changing wrench, flux brush, soldering aid and solder. **Model 8200PK**

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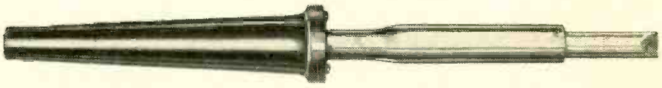

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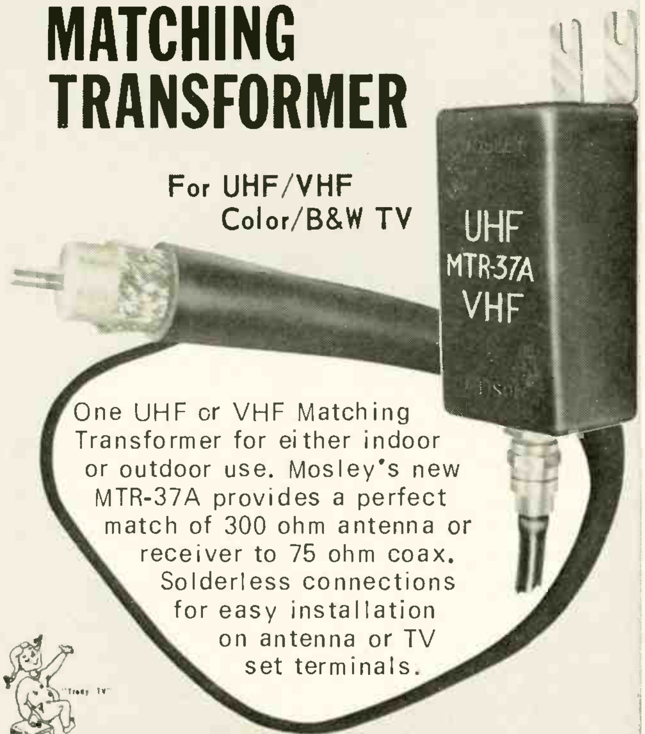

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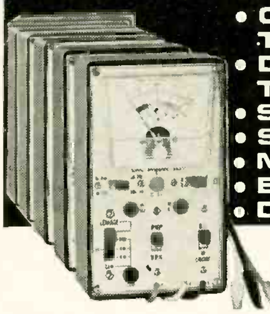

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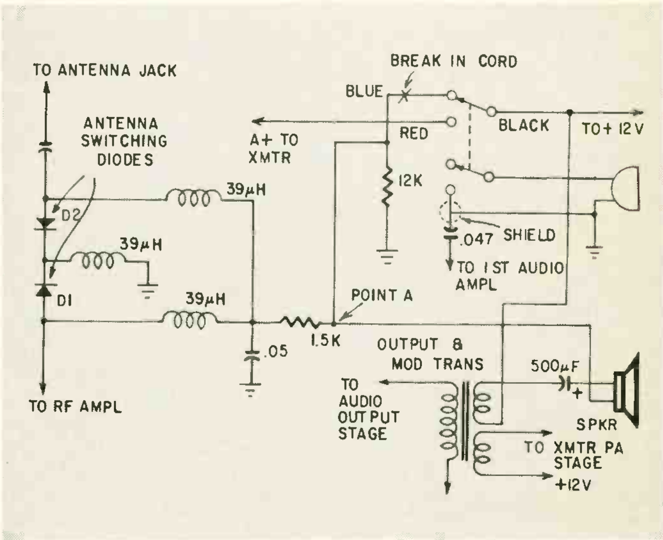
CB Troubleshooter's Casebook

Compiled by Andrew J. Mueller*

Case 1: No receive; only motorboating.

Common to: Hallicrafters **CB-20.**

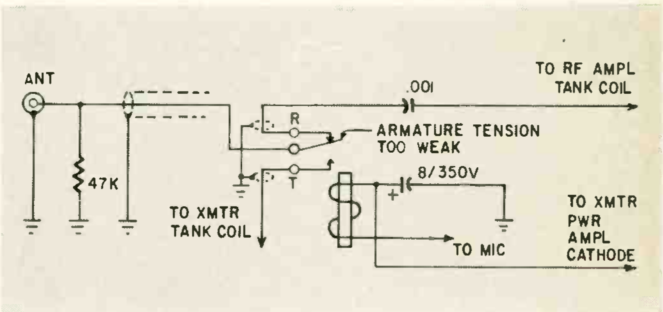


Remedy: Replace or repair microphone cord.

Reasoning: When the blue wire in the mike cord opens, the speaker circuit isn't completed directly. In addition, A+ voltage isn't fed to the antenna switching diodes. This produces feedback through D1 and D2, which causes motorboating. The quickest way to find this problem is to measure the voltage at point A instead of first bridging the electrolytics.

Case 2: At high volume, receiver motorboats.

Common to: Johnson **II.**



Remedy: Repair or replace T-R relay.

Reasoning: The transmit-receive relay is the most common trouble. At high volume levels, the whole chassis vibrates. Without proper tension, the relay armature will also vibrate. This causes the incoming signal to break up at the audio rate. Replace the relay to eliminate future trouble.

* Service manager, Tel-Air Communications, Inc., Pewaukee, Wis.

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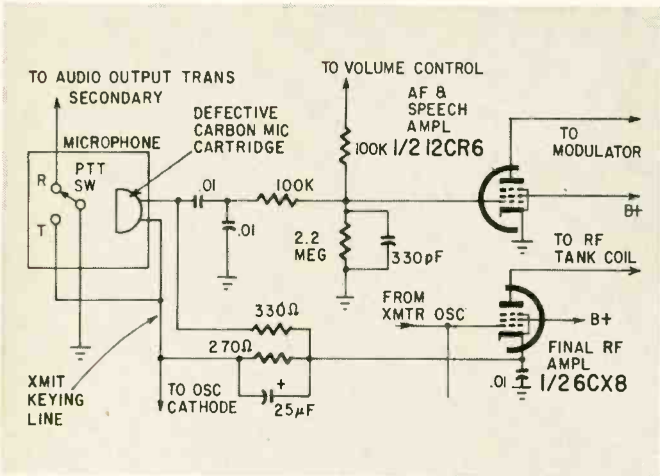
Case 3: Distorted and low modulation. Receive OK.

Common to: Ray-Tel **TWR-1.**

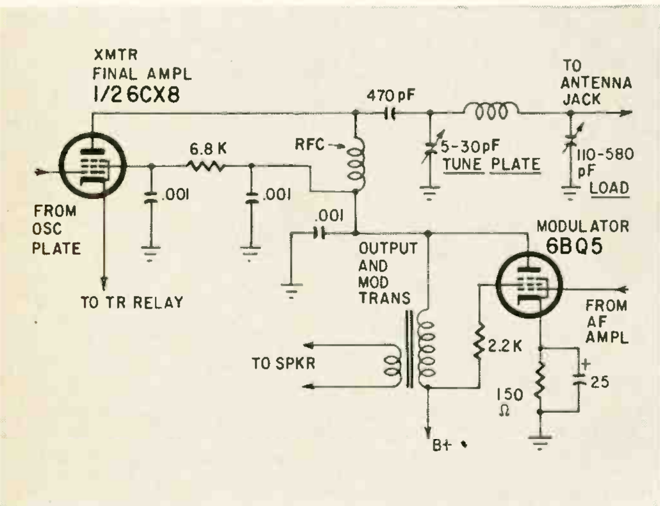


Remedy: Replace microphone cartridge.

Reasoning: Even though carbon mikes are hard to damage, they still fail occasionally. When this happens, the mike output signal becomes weak and distorted rather than disappearing. To check, substitute a new mike cartridge and note any difference.

Case 4: Distorted modulation. Receive OK.

Common to: Gonset **G-12.**



Remedy: Replace the final tube, VI.

Reasoning: This tube frequently becomes microphonic; its elements vibrate when modulation is applied, causing distortion to the modulated rf signal. You can easily be misled to believe the problem is in the audio section when it is really in the PA stage. All tubes should be substituted first before checking separate sections of the modulator and other audio sections. **R-E**

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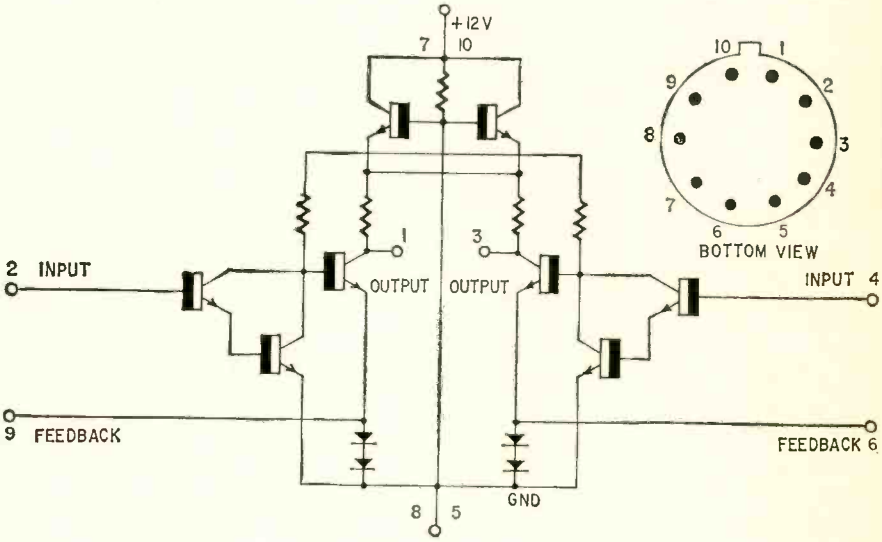

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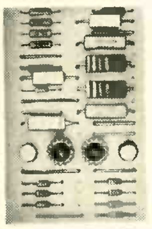

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Supply current (@ 12 V)	10 to 15 mA
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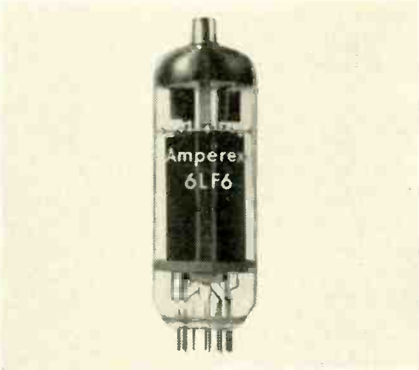

utes without drive; a few seconds without drive will damage or destroy conventional horizontal output tubes. Complete specifications and application data may be obtained from Amperex Electronic Corp., Semiconductor and Receiving Tube Div., Slatersville, R.I. 02876. **R-E**

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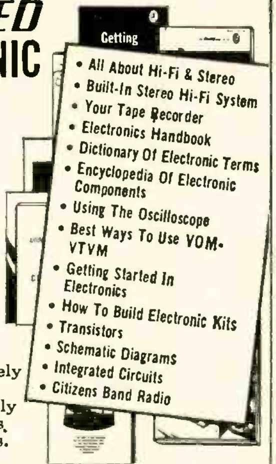

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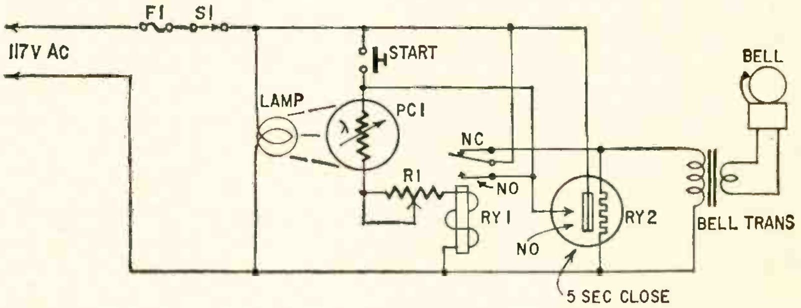
NOTEWORTHY CIRCUITS

VISITOR OR INTRUDER ALARM

This photoelectric alarm was developed to alert the busy housewife to the approach of visitors or intruders. The photocell and exciter lamp are aligned on opposite sides of a walk or driveway so anyone approaching the house breaks the light beam. The circuit, described by R. F. Adams in the *Clairex Photocell Forum,* is set up so the alarm sounds for 5 seconds and then shuts off automatically.

Circuit operation is simple. When S1 is first closed, power is applied to the exciter lamp and to the transformer primary and the heater in transformer and the heater in RY2. The bell starts ringing. After a 5-second delay—determined by the delay characteristic of RY2—the contacts in RY2 close and apply power to the LDR and the coil of RY1. Light falling on the LDR causes RY1 to pull in, disconnecting the bell transformer and resetting the alarm.

The photocell, pot and RY1 have not been specified because the characteristics of each must be determined by the characteristics of the other two. The most important factors are the photocell's maximum power dissipation rating and the relay sensitivity. For example, assume that we select a CdS photoconductive cell whose re-



time-delay relay RY2 through the normally closed contacts of RY1. The bell will start ringing and can be turned off by pushing the START button.

Pushing the button applies line voltage across photocell PC1,—a light-dependent resistor (LDR), current-limiting potentiometer R1 and the coil of relay RY1. The relay is energized, opening its normally closed contacts to disconnect the bell transformer and RY2. RY1 locks in through its normally open contacts. Now, RY1 remains energized as long as light continues to fall on the photocell.

Whenever anyone breaks the light beam, the LDR's resistance rises sharply and RY1 opens. The normally closed contacts now feed power to the sistance at 2 foot-candles is 1500 ohms and whose maximum dissipation is 500 mW. This limits the current through the cell to 18 mA. With the line voltage at 120 maximum, we can take 12 mA as the maximum current through the cell, pot and relay coil. Thus, the total series resistance is 10,000 ohms.

Catalogs show several 2500-ohm sensitive relays that operate at 10 mA. Therefore, with a 2500-ohm relay and 1500-ohm photocell, the minimum resistance of the pot is 6000 ohms. A 10,000-ohm, 2-watt pot will do. RY2 is a thermostatic delay relay with a 115-volt heater and normally open contacts. These relays are available with delays ranging from 2 seconds to 3 minutes.

NEW TV-TYPE TUBE SHOWN

A novel TV-type tube whose images can be held for long periods with the power off and erased with an outside light source was recently demonstrated by RCA. The experimental device may simplify electronic equipment for displaying stock quotations, airline schedules, computer data and other information that changes periodically instead of constantly. The unit, called a cathode ray storage tube, has a photochromic instead of a phosphor layer on its inside face. Photochromic materials do not emit light like phosphors but change color when struck by an electron beam. Information "written" on the tube will remain about a half hour before fading.

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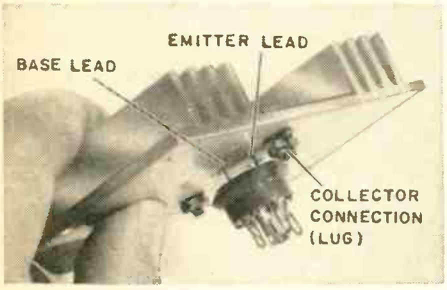
TRY THIS ONE

SEVEN-PIN MINIATURE SOCKETS FIT POWER TRANSISTORS

The base and emitter leads of TO-3 ("diamond" case style) power transistors are about the same thickness as seven-pin miniature tube pins, and it turns out that their spacing is such that you can fit a whole seven-pin socket right onto the transistor (see photo). If you wish, you can remove individual clips

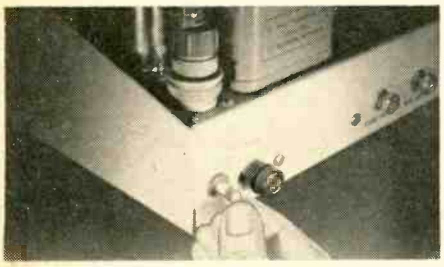


from the complete socket and use them.

If you use a whole socket, you may want to break off the unused connections to prevent confusion and wiring errors. Or, if you like, use them as tie-points.—*Peter E. Sutheim*

SPARE-FUSE HOLDER

A standard ¼"-I.D. rubber grommet inserted in a hole near an active fuse makes a handy holder for a spare. This size grommet will hold the widely used 3AG type fuse with a snug grip. The mounting hole should be reamed a



little oversize if the fuse is difficult to insert or remove. Be sure the spot you choose to mount the holder is clear of obstructing components and leads inside the chassis.—*Robert E. Kelland* **R-E**

HALL EFFECT IN SOLID

(continued from page 45)

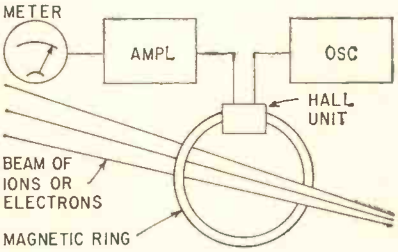
frequency ac signals from less than 1/60 cycle per second upwards to 100 Hz or more. The shaft of the position indicator is coupled to the shaft of a small, variable-speed motor. The speed of the motor is controlled by rheostat R, and the Hall output-voltage leads from the Hall-effect element are connected to an amplifier.

As the motor spins the rotor past the Hall-effect element, a Hall output voltage is generated. It will vary in accordance with the varyingly magnetized edge of the rotor as it passes by the element. The rate of these variations is determined by the speed of the rotor, which, in turn, is governed by the motor speed.

From here, you're on your own. The number of aplications for Hall-effect elements seems to be limited only by imagination. So dig in! **R-E**

SOME COMMERCIAL APPLICATIONS OF HALL-EFFECT DEVICES

The measurement of magnetic field strength with Hall generators (crystals) can be carried out with a number of measuring instruments of different sensitivities. One typical magnetic-field-strength meter is the Magnatest Hall Effect Instrument. It can be used for field measurements on magnet systems, measuring magnetic leakage flux, nondestructive material testing, and determining the magnetic behavior of individual grains of



various orientations in transformer core materials.

A simple and handy device for measuring small direct currents is sketched in the diagram. A small magnetic core is arranged around the current carrier, and the Hall unit is inserted in an air gap. When the dc input to the Hall crystal is supplied by a small battery, it is possible to measure currents down to 100 mA without amplification. With an amplifier, currents as small as 5 mA, such as ion- and electron-beam currents, can be measured.

If the Hall crystal is placed in a waveguide so that the electric field is parallel to its surface and the magnetic field is perpendicular to it, the output of the Hall unit will be proportional to the magnetic field strength. This output can be amplified and used to drive a wattmeter calibrated to read microwave power.

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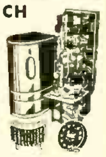

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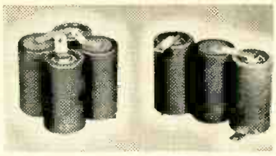

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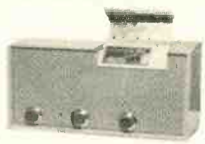

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100	☐	48	☐	70
200	☐	70	☐	1.05
300	☐	1.05	☐	1.60
400	☐	1.30	☐	2.10
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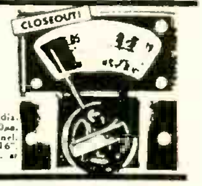

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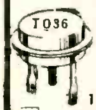

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100	☐	9¢	800	☐	25¢
200	☐	12¢	1000	☐	39¢
400	☐	17¢			

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PIV		Sale	PIV		Sale
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400	☐	16c	1200	☐	59¢
600	☐	19¢	1400	☐	69¢
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100	☐ .07	☐ .22	☐ .25	☐ .75
200	☐ .09	☐ .30	☐ .39	☐ 1.25
400	☐ .16	☐ .40	☐ .50	☐ 1.50
600	☐ .20	☐ .55	☐ .75	☐ 1.80
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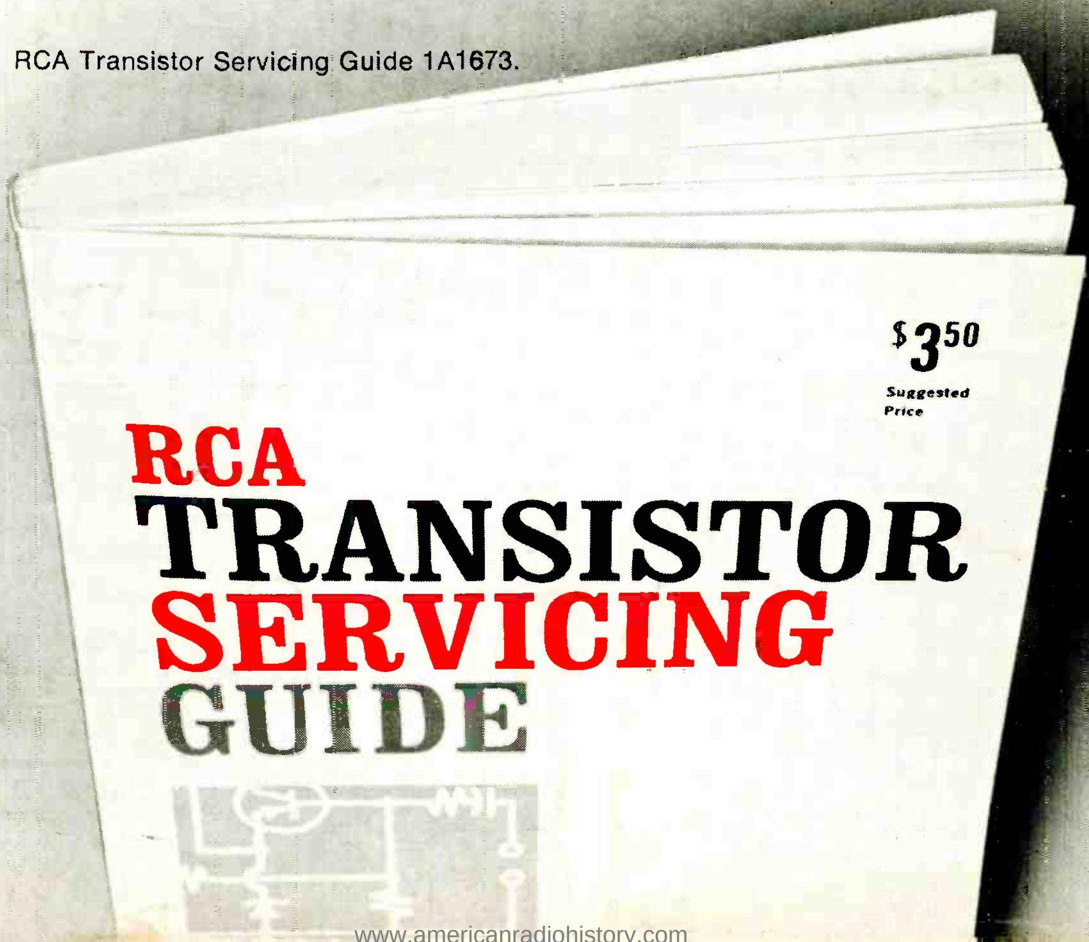

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