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60c ■ JULY 1969

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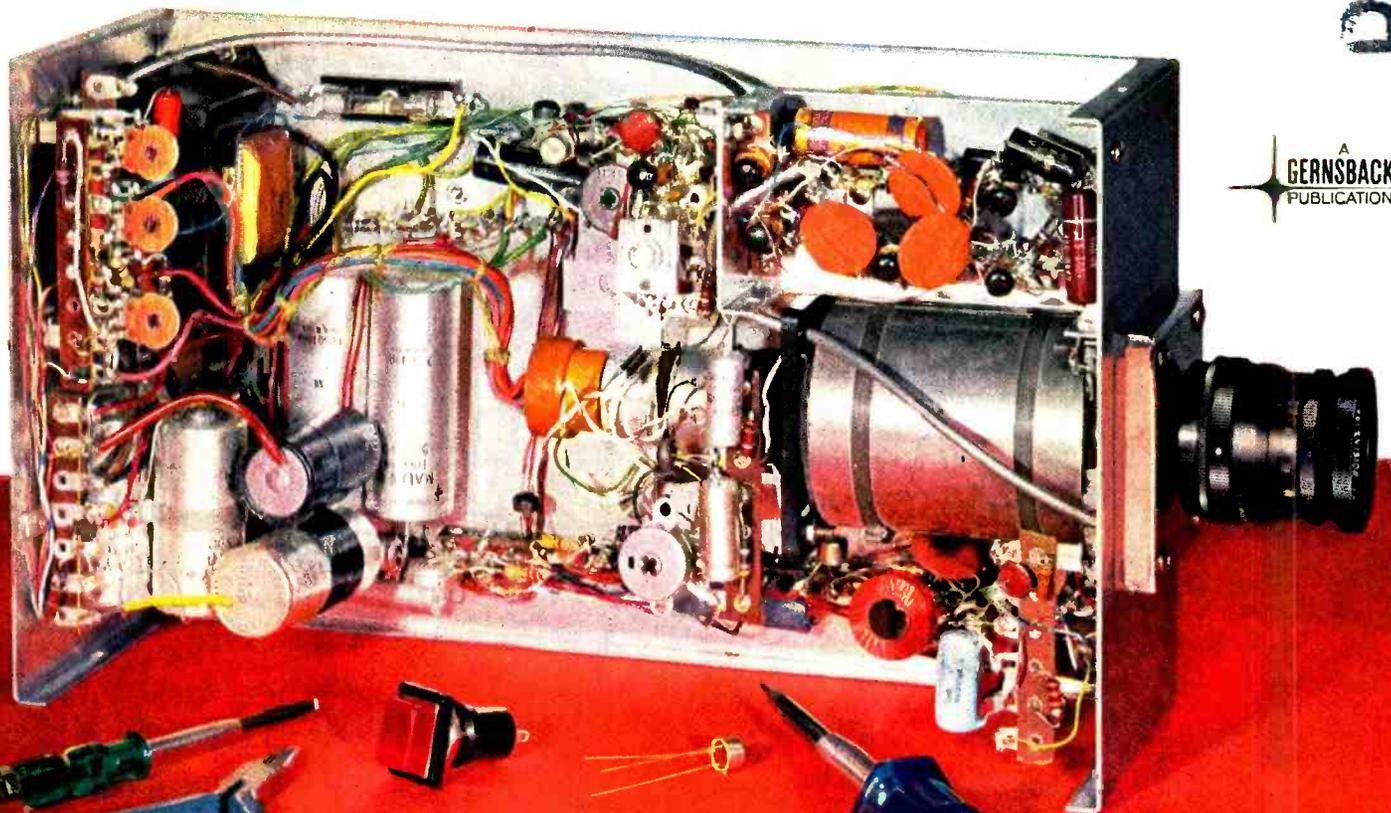
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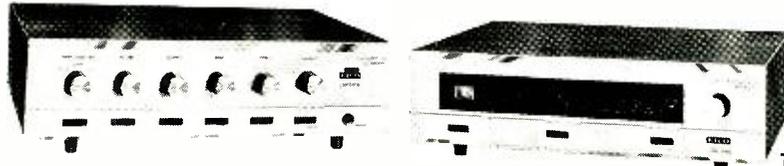
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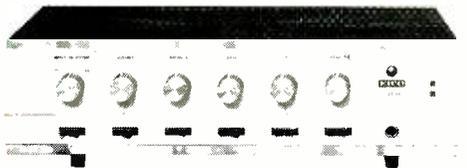


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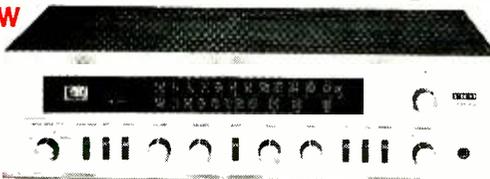
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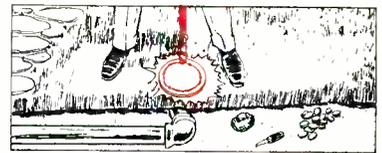
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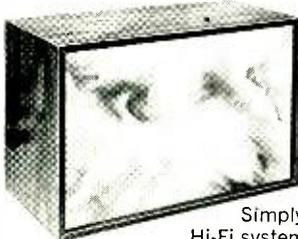


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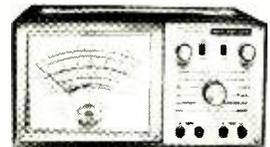
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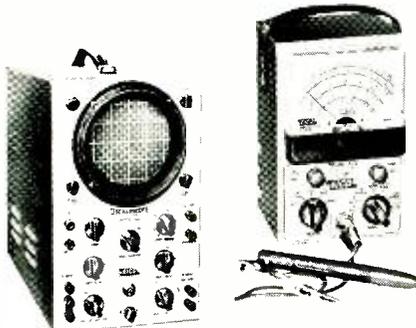
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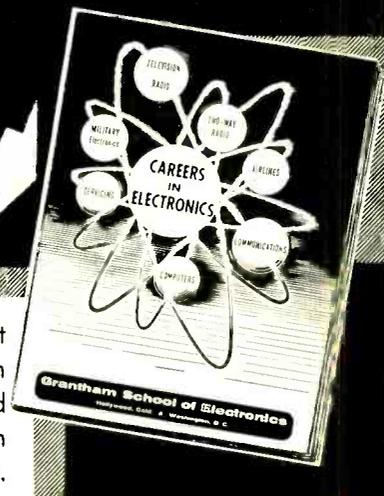
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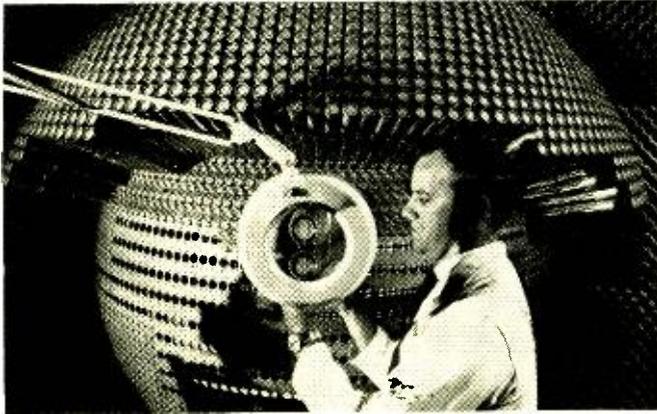
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## POWERFUL PHASED-ARRAY RADAR



Engineer Ray Lanctot adjusts one of the many energy feeds.

One of the hundreds of energy-fed elements forming this one-tenth-scale radar prototype is adjusted by engineer Ray Lanctot. The system, under construction for the Air Force by Hughes Aircraft Co., uses a phased array, which sweeps the radar beam electronically instead of with a mechanical antenna.

## NEW TINT CONTROL AT ELECTRONICS SHOW

NEW YORK—A new circuit that takes the guesswork from color tint adjusting was introduced at the Consumer Electronics Show last month by Hayakawa Electric Co. of Japan.

Instead of trying to judge flesh tones, the viewer pushes a knob and merges two vertical stripes into a single bar. The procedure, visually similar to the Westinghouse afc adjustment, eliminates phase errors between the set's color oscillator and the color-burst signal. Models with the color-phase adjustment have additional burst-gate and phase detectors.

A patent on the control was granted in Japan and has been applied for in other countries. Introduction of the models in the US may depend on its acceptance at the electronics show here.

## TRANSISTOR DEVICE HAS ATOMIC POWER

MIAMI, FLA.—A transistorlike device with a built-in radioactive power supply has been developed at Danecho R&D Labs by Daniel Speers, director of research. Named the "electristor" by its inventor, the device has been used in circuits for detection, oscillation and amplification.

The electristor consists of three dime-size wafers of strontium 90, a semiconductor material (n- or p-type) and antimony. The radioac-

(continued on page 12)



## RCA IS TRAINING 400 AS TV SERVICE TECHS

NEWARK, N. J.—Four hundred men, formerly of the urban hard-core unemployed, are attending regular classes and laboratory sessions at four RCA training centers preparing for careers as TV service technicians.

The training is part of the "Four Cities" program, operated by the RCA Service Co. under a \$2.5 million contract with the Department of Labor, to train 400 of the nation's jobless as TV repairmen. RCA is contributing more than \$1 million above the Government's cost.

Newark, with 80 trainees, is one of four cities with RCA centers participating in the 18-month program that includes courses in basic education and social development, in addition to intensive vocational instruction. Graduates of the program will be placed with RCA service branches or other companies. The other centers are in Camden, N. J., also with 80 trainees, and Chicago and Los Angeles with 120 each.

The Newark trainees range in age from 18 to 50 with an average of 24 years. Before entering the program, 75% were unemployed. Of the total students 82% are

(continued on page 14)

## LOOKING AHEAD

By DAVID LACHENBRUCH  
CONTRIBUTING EDITOR

### Doubtful X-ray testers

Another type of "X-ray detector" is being frowned upon by public health officials. This is the do-it-yourself kind offered to the public in drugstores and supermarkets. Sold in a variety of forms under several brand names, these testers usually are designed to be taped or attached to the TV set, left there for a specified period, then sent back to the tester's manufacturer or agent for analysis. The consumer eventually receives in the mail a notification of whether his set is emitting rays.

Although most of these gadgets contain materials which can adequately reflect the presence of X-rays, and even measure them, none is large enough to measure more than a tiny portion of the TV set (generally the center of the screen). Since X-ray emission is more likely to occur at the sides, top or bottom of the set than at the picture-tube face, these detectors just don't do the job, according to many public health officials. Their sale in New York City, in fact, has been banned.

### Versatile tape cartridges

The stereo tape cartridge player and the cassette recorder are continuing to take on one another's characteristics. A major Japanese producer of cassettes—TDK—will soon introduce a continuous-loop cassette which need not be turned over or rewound. It plays for 30 minutes, then repeats itself. (The same cassette could play for 60 minutes on a special player with movable heads, which switch from Track A to Track B.)

Meanwhile, it's understood that Motorola has developed an automobile eight-track cartridge player with recording ability for those who wish to dictate notes or memos while driving. Sony and others already are marketing eight-track cartridge recorder-players for non-auto uses.

(continued on page 4)

### IN THIS ISSUE

Demands for home and industrial security have created a boom in new electronic security devices. Sensitive ultrasonic and radar detectors are coming down in price for the home consumer market. Turn to page 33 for the facts.

# Radio-Electronics

July 1969 • Over 60 Years of Electronics Publishing

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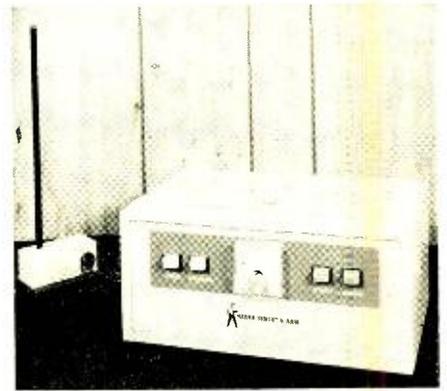
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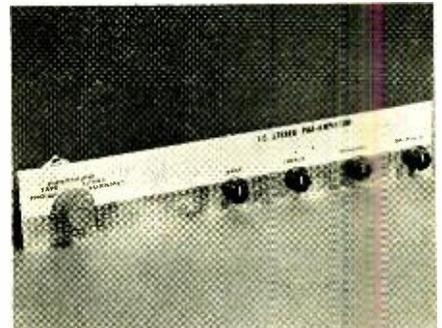
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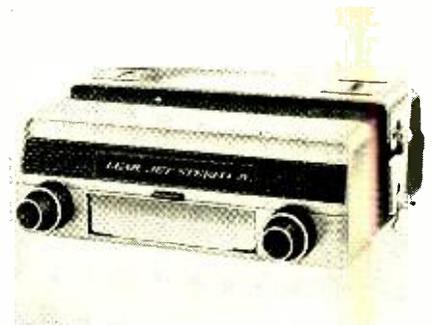
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Need real protection? Find out what's available to secure your home against theft and fire. There's a proper alarm system for everyone. [see page 33](#)



Custom stereo preamp is easy to make when you've got the right recipe. Here's the plans and the ingredients. You do the mixing. [see page 44](#)



Bugged by cartridge tape? Here's a step-by-step programmed study that tells you what to do, how to do it and why. It's even fun to read. [see page 61](#)

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, \$7.50. Single copies, 69¢. ©1969, by Gernsback Publications, Inc. All rights reserved.  
 POSTMASTER: Notices of undelivered copies (Form 3579) to Boulder, Colo. 80302.



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## 'HOT-LINE' PHONE SENDS VOICE & DATA

NEW YORK—"One second Bob." "... 110010010001..." "What's that time again?" "... 00110010..."

This mixture of voice and data was recently demonstrated between the New York City and San Juan, Puerto Rico, offices of RCA Global Communications Inc. RCA has opened a satellite-telephone "hot line" between



the two locations that permits simultaneous transmission and reception of voice and data.

The shortest pause by chief engineer Philip Schneider (photo) caused a flood of inaudible data transmission—in this case, activating a paper-fed teleprinter. The customer using the service supplies the data terminals or facsimile gear, while RCA provides the multiplexing and other equipment to separate voice and data.

When a caller picks up a hot-line phone, the receiving unit rings instantly. RCA expects to expand the service to Europe as satellite facilities grow.

### NEXT MONTH

They work! Don't miss the inside story on new stereo IC FM headphones.

## DO-IT-YOURSELF MESSAGE BOARD SAVES CASH

ALBUQUERQUE, N.M.—Hard work by engineering students and the cooperation of several manufacturers have provided University of New Mexico sports fans with a first-class electronic message board.

"We scrounged around and put the sign together with a budget of \$1500," said Joe F. Colvin II, president of the student EE society, whose members designed and built the board. Parts and labor put an estimated \$60,000 value on the board.

A solid-state power-supply kit for the 900 bulbs was donated by Westinghouse and IBM chipped in 400 relays. The 18-foot sign has 36 spaces that can display any letter or numeral.

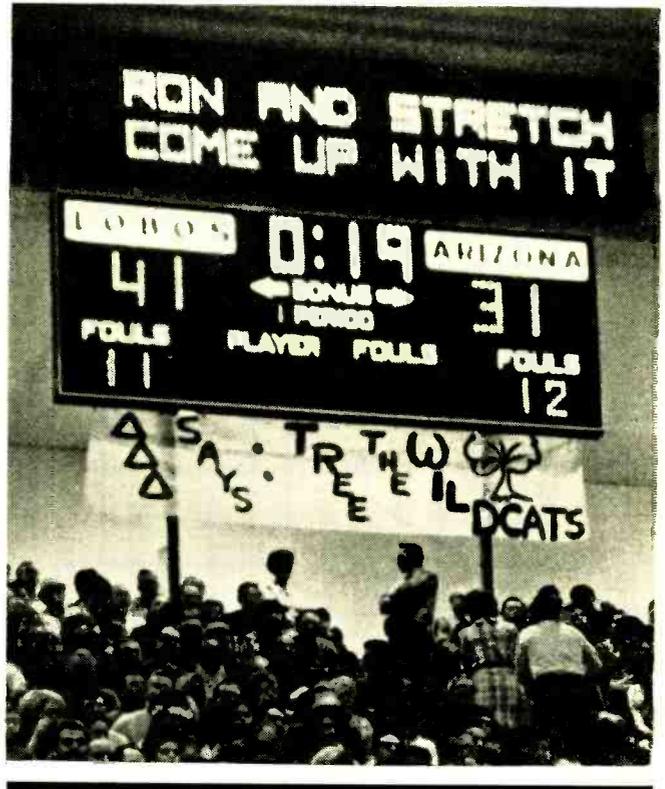
## SATELLITE DETECTS 10-MHZ EARTH PULSES

Irregular pulses of rf energy in the 10-MHz region are being beamed into space from an area near the south geomagnetic pole. The source of the sporadic bursts, over an area between New Zealand and Antarctica, was detected by an orbiting radio astronomy satellite. NASA scientist Robert Stone, who reported the satellite recordings, indicated the rf pulses may originate in a region of the earth's atmosphere beneath the radiation belts that encircle the planet. Dr. Stone suggested the intense beams of energy may be generated as charged particles trapped in the radiation belts enter the atmosphere.

## ALL-IC COLOR TV

JAPAN—A 16-inch color TV portable made entirely with hybrid and monolithic IC's was revealed by the Kansai Electronic Development Center. Three of the 22 IC's in the set are used in an all-channel tuner. The prototype took 3 years to develop, but is still not ready for production.

(continued on page 6)



## LOOKING AHEAD

(continued from page 2)

### Automatic tint control

A new circuit said to eliminate the need for readjusting the tint control, even when changing channels, will be incorporated in some new-model Magnavox color sets. This "automatic tint control" (ATC), combined with automatic frequency control and automatic chroma control, is designed to end all viewer adjustment of the color picture, even for correction of deficiencies originating at the TV station.

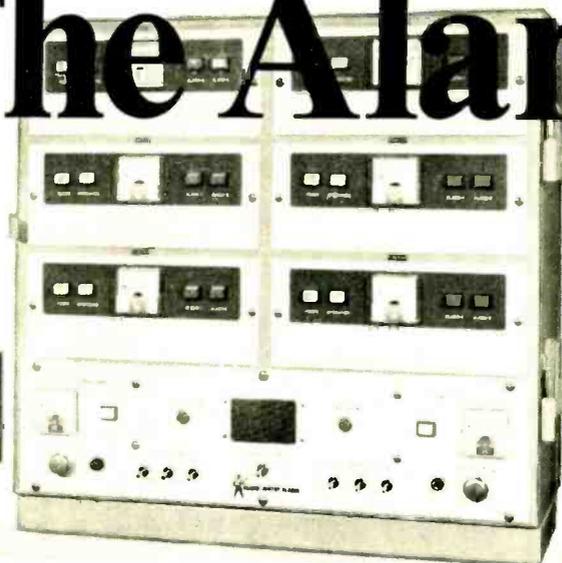
The ATC circuit operates on the principle that a pleasing color picture is one in which flesh tones are realistic. On an ATC-equipped receiver, the viewer adjusts a "preference control" until he is satisfied with flesh tones in the picture. After this basic adjustment, all flesh tones register in accordance with this preference, even when cameras, programs or channels are changed. The control need not be adjusted each time the set is turned on.

ATC is a four-transistor circuit which addresses itself to the color spectrum in the vicinity of flesh (orange) color. This area encompasses the adjacent hues of red, some purples and some yellow. When a color is received in this spectrum area, it is automatically changed to orange flesh color. This eliminates the possibility of yellowish, greenish or purplish faces, and keeps flesh tones consistent, regardless of errors in the received signal.

Colors outside this segment of the spectrum are not affected. Although there are some color shifts of objects in the area surrounding the orange portion of the spectrum, this is virtually unnoticeable.

(continued on page 12)

# The Alarmists.



## Radar Sentry Alarm supervises security from every angle.

Radar Sentry Alarm covers every angle. It works on the same principle used by the U.S. government to protect our borders. Microwaves beamed by an installation of modular units are foolproof.

Any human movement, even the slightest gesture, sets off the alarm. And what an alarm! An ear-splitting blast that would frighten anything. You can't beat it.

And there's no way to escape detection...whether the intruder comes in from the wall, window, door or ceiling. Even if he shuts off the power, the alarm sounds.

This is the newest and completely proven system that everyone's talking about.

Take any of the set-ups pictured here.

The smallest is our model 301: its remote detector unit covers up to 5,000 square feet. Can set off an alarm that's heard half a mile away. Add up to 3 antennas for a coverage of up to 15,000 square feet. Model 5006 modular unit is 6 units in one. It will cover up to 90,000 square feet. The big one on the right, 5010, will give customized coverage of up to 150,000 square feet.

Take any of these solid state numbers, add Dialtronic automatic telephone dialer, programmed to phone the police or direct-hook-up or, in case of fire, the fire department. Or add the special Radar Sentry Alarm holdup and prowler alarm. It can be used in combination with any of these set-ups, plus the telephone alarm, without the thief's knowledge.

There's no hiding place. These units are considered the best burglar traps in the world. Solid state circuitry gives effective performance, means a minimum of false alarms and reliable operation. And the heart of the electronic system is printed on one single printed circuit module. To replace, just pull out the old one, plug in the new one, no lapse in security.

Design your own inviolable customized system with Radar Sentry Alarm and accessories. You won't be able to find a more versatile, more adaptable system...nor one that is more tamper-proof against burglars.

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## SOLID-STATE DIODE CAN CUT TV X-RAYS



CLEVELAND OHIO—A solid-state replacement for high-voltage regulator tubes in color TV sets has been introduced as a cure for harmful x-ray radiation.

According to the developer, the instrument division of Victoreen Leece Neville, Inc., one major set manufacturer has already incorporated the new diode into its 1970 models. Kits will be made available to modify various makes of sets already in homes.

Prime function of the diode is to limit high voltages in color sets to below 25 kV. Regulation of the diode is 1 kV from 0.1 to 1.2 mA at 25 kV. Maximum operating current is 3 mA. Excessive or misadjusted high voltage

is a leading cause of x-rays. Since the diode cannot emit radiation, its substitution for potentially hazardous vacuum-tube regulators eliminates an x-ray source. Also, since the diode permanently sets the h-v level, controls that can be misadjusted during servicing are no longer needed.

Should the diode fail, Victoreen points out, the voltage on the picture tube would be lowered instead of increasing, as with conventional regulator failure.

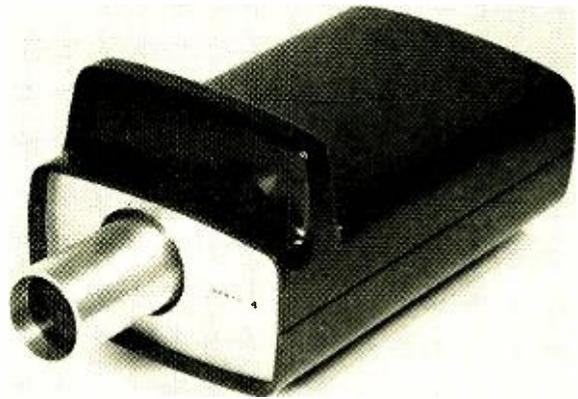
The cathode body of the device is clamped to chassis ground, while the anode is tied to a single lead wire.

A recent disclosure of excessive radiation from color sets has prompted demands for tighter standards.

## NEW THERMAL BATTERY

TOKYO—A new thermal battery with a storage life of five years or more is being marketed commercially in Japan by the Matsushita Electric Industrial Co. A special thermite heat source and hermetic sealing are used to reduce gases produced when the battery is electrically ignited. The new battery burns to 400°C, generating 38 volts, and is slightly larger than a regular flashlight cell.

## APOLLO TO USE SEQUENTIAL TV



NEW YORK—Color TV broadcasts expected from space this summer by Apollo astronauts will originate from a tiny field-sequential camera similar to the one used for the first color TV broadcast in 1940.

The field-sequential system, developed by Dr. Peter Goldmark of CBS Labs, was rejected by the FCC in favor of RCA's dot-sequential system.

Because of its simplicity, the special Apollo TV camera requires one-third as many components as a standard color camera. Color information is transmitted as color filters on a spinning disk

pass in front of a CRT. Earth-based stations will pick up the sequential red, blue and green signals and convert them for transmission around the world.

The CBS system, which relies on the human eye's persistence of vision to complete a color picture, is still being used in medicine and industry. A miniature 20-pound unit (photo), similar to the one used on Apollo flights, has been developed by CBS Labs to probe the interior of the human body to detect cancer and other disorders. The spinning disk is enclosed under the camera hood.

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Cover by Harry Schlack

RADIO-ELECTRONICS is published by Gernsback Publications, Inc., 200 Park Ave. South, New York, N.Y. 10003 (212) 777-6400

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Calif. 90069, (213) 653-5841;  
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### UNITED KINGDOM

Publishing & Distributing Co., Ltd.,  
Mitre House, 177 Regent St.,  
London W.1, England  
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# Here's More Alarming News From The Alarmists!



## Dialtronic Automatic Telephone Communicator Model DT-1000

### Radar Sentry Alarm announces a new powerful way to stop crime . . . "Dialtronic"

Radar Sentry Alarm announces a new powerful way to fight crime. Imagine a security system that automatically and silently delivers any emergency message for which it is programmed. Dialtronic adds a new dimension to your security needs. Advanced concepts in technology and design bring you a new level of security. Providing unlimited application, the Dialtronic uses solid state circuitry to bring help immediately. Use it with existing alarm systems or any other sensing device. Dialtronic is the ideal personal protection for anyone who is vulnerable to intruders. Dialtronic will perform with never a lapse in security . . . You are assured of highly reliable protection.

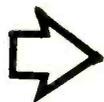
Also used to protect premises while they are being occupied, the Radar Dialtronic gives push button protection to businesses and home owners alike. This system is triggered by a hidden push button or portable transmitter. Once set into action, it automatically dials the phone—delivering any pre-recorded message for which it is programmed without the would-be-thiefs' knowledge. In effect, the Dialtronic gives you a direct line to police, fire departments, in-plant security, key personnel . . . whoever you designate.

Dialtronic's built-in programmer lets you magnetically store "error free" messages on cassette type tape cartridges. Stored information is instantly available to notify proper officials, delivering correct message in each case.

### Advantages of Dialtronic Telephone Communicator

- Eliminates costly leased telephone lines.
- Simultaneously stores up to ten separate messages on magnetic tape.
- Automatically dials the right people and delivers the correct message in each case.
- Battery operated (optional) Rechargeable "Nic/Cad" batteries with built-in charger.
- Converts existing local alarm to central station system. Easily and quickly installed.
- Silent "on premises hold up alarm with the ability to get the facts out" instantly.
- Can be used with optional wireless control.
- Home prowler alarm, fire alarm, emergency alarm for invalids. Can be programmed for any emergency.

## The Crimebusters Want You! . . . Now!



. . . To make the biggest profits of your career—filling ready-made demand for the dramatic new RADAR SENTRY ALARM systems. Get started NOW as dealer or distributor—step into five-figure income at once, with unlimited potential and wide-open opportunity to grow as you go! MAIL COUPON AT ONCE!

RADAR DEVICES MFG. CORP.  
22003 Harper Avenue  
St. Clair Shores, Michigan 48080

- Send me the alarming details.  
 Also send me booklet outlining available dealerships.

Name .....

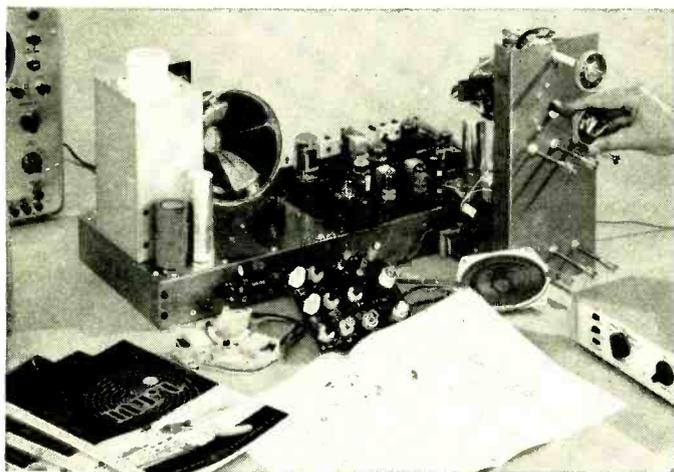
Address .....

City .....State .....Zip .....

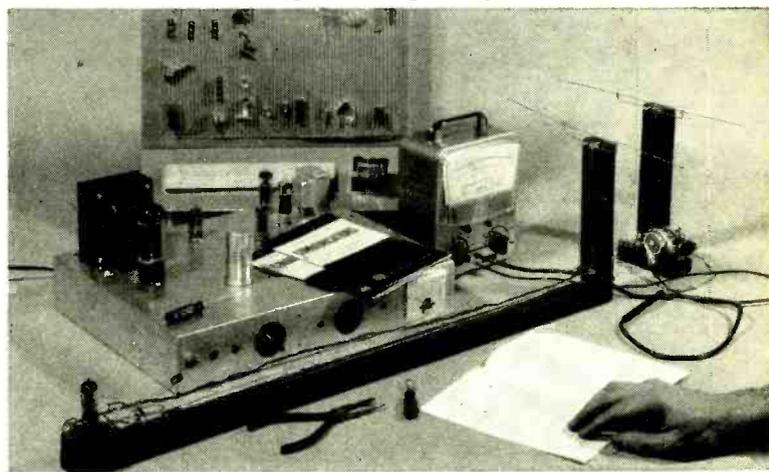


# **nri** **firsts** make learning **Electronics at home** **fast and fascinating —** **give you priceless** **confidence.**

Some NRI **firsts** in training equipment



**first** to give you Color Television training equipment engineered specifically for education — built to fit NRI instructional material, *not* a do-it-yourself hobby kit. The end product is a superb Color TV receiver that will give you and your family years of pleasure. You “open up and explore” the functions of each color circuit as you build.



**first** to give you transmission lines and antenna systems that include experiments not otherwise attempted outside of college physics laboratories. The experience gained with this kind of Communications training equipment is matched only by months — sometimes years — of on-the-job experience.

# NRI's "discovery" method is the result of over half a century of leadership simplifying and dramatizing training at home

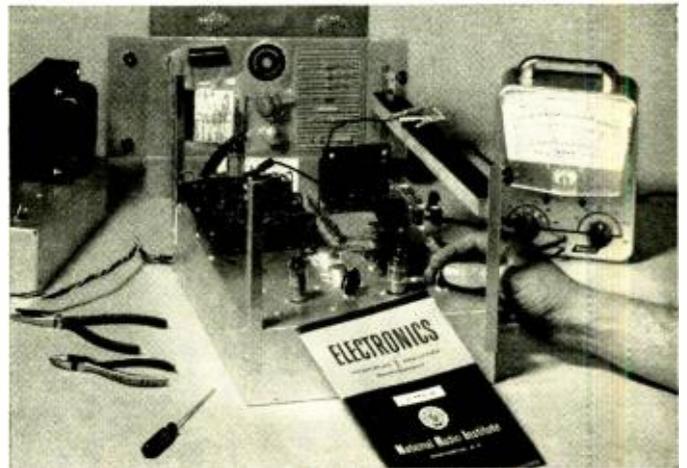
The FIRSTS described below are typical of NRI's half century of leadership in Electronics home training. When you enroll as an NRI student, you can be sure of gaining the in-demand technical knowledge and the priceless confidence of "hands-on" experience sought by employers in Communications, Television-Radio Servicing and Industrial and Military Electronics. Everything about NRI training is designed for your education . . . from the much-copied, educator-acclaimed Achievement Kit sent the day you enroll, to "bite-size" well-illustrated, easy to read texts programmed with designed-for-learning training equipment.

## YOU GET YOUR FCC LICENSE OR YOUR MONEY BACK

There is no end of opportunity for the trained man in Electronics. You can earn \$6 or more an hour in spare time, have a business of your own or qualify quickly for career positions in business, industry, government. And if you enroll for any of five NRI courses in Communications, NRI prepares you for your FCC License exams. *You must pass* or NRI refunds your tuition in full. No school offers a more liberal money-back agreement. The full story about NRI leadership in Electronics training is in the new NRI Catalog. Mail postage-free card today. No salesman is going to call.  
NATIONAL RADIO INSTITUTE, Washington, D.C. 20016

**APPROVED UNDER NEW GI BILL** If you have served since January 31, 1955, or are in service, check GI line on postage-free card.

## designed from chassis up for your education

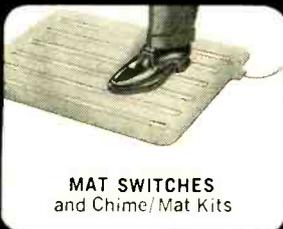


**first** to give you true-to-life experiences as a communications technician. Every fascinating step you take in NRI Communications training, including circuit analysis of your own 25-watt, phone/cw transmitter, is engineered to help you prove theory and later apply it on the job. Studio equipment operation and troubleshooting become a matter of easily remembered logic.

**first** to give you completely specialized training kits engineered for business, industrial and military Electronics. Shown above is your own training center in solid state motor control and analog computer servo-mechanisms. Telemetering circuits, solid-state multi-vibrators, and problem-solving digital computer circuits are also included in your course.

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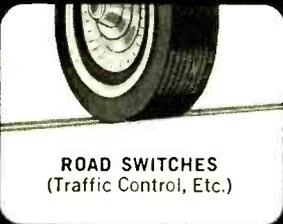
**FOOT SWITCHES**  
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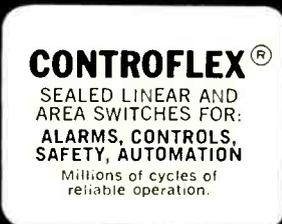
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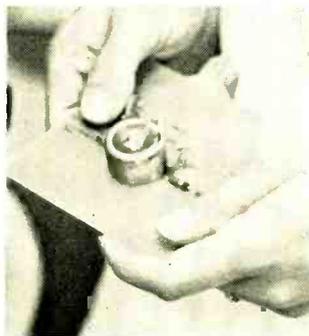
Circle 14 on reader service card

## New & Timely

(continued from page 6)

strontium 90 is partially shielded from the middle semiconductor layer by a

conductor, electrons are released, which flow from the top antimony layer to the semiconductor wafer when the two are joined.



thin-film radiation screen.

When particles from the strontium 90 strike the semi-

conductor, electrons are released, which flow from the top antimony layer to the semiconductor wafer when the two are joined. Although it is now only a laboratory device, the company predicts field-effect transistor and IC applications. Electristors using strontium 90 would theoretically power a portable radio for about 40 years.

So far, however, outputs of the test devices have been in the milliwatt range and frequency-capabilities are low. Size (photo) is another problem, due to the shielding.

## LOOKING AHEAD

(continued from page 2)

### Cable TV growth

The growth of cable TV (CATV) systems accelerated in 1968, in spite of new restrictions imposed by the FCC. According to a survey by the trade newsletter *Television Digest*, 3,600,000 American homes received their television by cable as of January 1, 1969, up from 2,800,000 one year earlier.

As this year started, there were 2260 CATV systems in operation, an increase of 260 during 1968. By Feb. 10, date of the survey, 2301 were in operation. Some 46 of these had more than 10,000 subscribers each. The largest, in San Diego, served 35,429 subscribers. Of all the systems, 29 offer subscribers more than 12 channels each, 1558 have six to 12 channels, 512 have five, 62 fewer than five (140 didn't report the number of channels).

### Anti-X-ray device

When color TV receivers emit X-rays, the fault almost always lies with excessively high voltage or a faulty shunt regulator tube, or both. Six television receiver manufacturers have been testing a new voltage-regulating diode which should remedy this situation and eliminate the cause of perhaps 90% of the cases of excessive radiation. At least one manufacturer is expected to incorporate the diode in sets this fall.

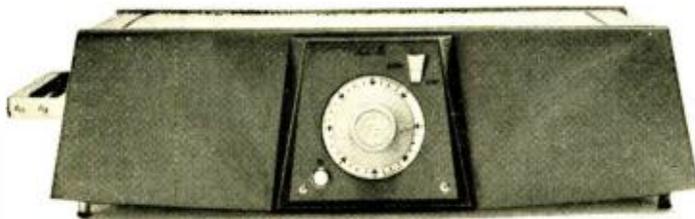
The diode, manufactured by Victoreen Leece Neville, Inc., is claimed to be the first to positively regulate voltages of the magnitude of 25 kV at low current levels. The solid-state diode replaces the vacuum-tube shunt regulator and associated circuitry, and its manufacturer claims it eliminates the possibility of the voltage "creeping up" or surging due to component failure.

The same firm will offer service technicians an X-ray fighting arsenal. The principal weapon is a new radiation meter calibrated especially for color sets. It provides instant go-no go readings when held against the various surfaces of a set. The instrument will cost \$440.

(continued on page 14)

# There's a reward

# on their heads.



**FREE:**  
The Copymate Dry Copier, with 20 sheets of copymate paper, with your purchase of the RCA WR-52A Stereo FM Signal Simulator or WO-91C oscilloscope!



The WR-52A Stereo FM Signal Simulator only \$248.00\*

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Now you can own one of the fastest, most accurate trouble-shooters in the East (West, North and South), and receive, absolutely free, the new all-electric Copymate!

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The Copymate, with paper, has a retail value of \$31.94, but you can get it free . . . Here's how.

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Good deal? You know it is.

Mail your card and label to: RCA Electronic Components, Test Equipment Headquarters, Bldg. 17-2, Harrison, N.J. 07029.

\*Optional distributor resale price.

*Circle 15 on reader service card*

# RCA

JULY 1969

13

# MATV DISTRIBUTION AMPLIFIER KITS

for Color/B&W TV



Model AMP-25/2

For the TV serviceman who has avoided amplified distribution systems as too involved, Mosley has developed four simple and easily installed MATV Distribution Amplifier Kits for VHF Color/B&W TV. Each kit contains all the components necessary for a two-outlet amplified system, designed for easy expansion with additional outlets. Four models for four widely-used types of lead-in: two coax, two twin-lead. Instructions offer suggestions for system planning and simple block diagrams with coax loss factors already figured. Write Dept. 180A for details.

**Mosley Electronics, Inc.** 4610 N. Lindbergh Blvd.,  
Bridgeton Missouri 63042

Circle 16 on reader service card

## New & Timely

(continued from page 2)

black, 15% Spanish American and 3% white. About 28% have served in the armed forces and 14% have some previous electronics background. All become RCA employees upon entering the program and earn \$2 per hour for the duration of their respective training periods of from 6 to 18 months, depending on the trainee's individual rate of progress. In the photo, instructor Archie Banks (right) demonstrates a color dot-bar generator during a laboratory class at the RCA Newark Training Center.

The training is geared toward developing highly competent color TV technicians. **R-E**

### COMING NEXT MONTH

- Build—200-MHz Digital Counter
- Capacitors—Which Type to Use?
- How to Use Triggered Scopes
- Build a Universal Pwr. Supply
- Solid-State Your Car Gauges
- How IC's Work—Part 3

## LOOKING AHEAD

(continued from page 12)

When a technician discovers a set radiating beyond the recommended limit of 0.5 milliroentgen per hour at 5 centimeters (as read directly on the instrument), he can either lower the high voltage to the proper setting or install the regulator diode. The diode will be available with associated components in a variety of retrofit kits for all major color TV makes and models.

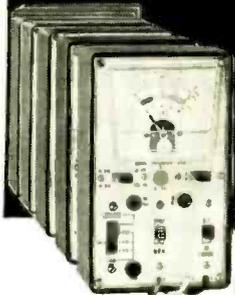
New Government radiation standards will go into effect next Jan. 1. Although they still haven't been finalized, they may well require some type of fail-safe, high-voltage, hold-down device in future sets. So far, the Victoreen is the only such device to be publicly announced.

### TV set a life-saver

The Weather Bureau laboratory at Norman, Okla., is evaluating a tornado warning system this summer whose only piece of equipment is a common household product—a television set. Developed by an electronics experimenter and amateur climatologist, Newton Weller of West Des Moines, Iowa, the system already has provided Iowans (who used it on the basis of instructions printed in a Des Moines newspaper) with accurate tornado warnings.

Weller's system is based on his theory that all tornadoes are accompanied by large bursts of electrical energy at a frequency close to that of television's channel 2. After 12 years of experimentation, he says his method can give a set owner 20 to 30 minutes warning that a tornado is in the vicinity. If an area tornado alert has been issued or if storm clouds gather, he advises the following procedure: (1) Turn the set to channel 13 (at the opposite end of the band from the channel 2 frequency of 55 MHz, and therefore unaffected by the tornado's electrical charge), and turn down the brightness control until the screen is dark. (2) Switch to channel 2 without readjusting brightness. If the entire screen lights up, it indicates a nearby tornado. Broad horizontal white bands warn of a severe electrical storm. **R-E**

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- Milliammeter
- Battery Tester
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### Transistor Analyzer Model 212

Factory Wired & Tested — \$19.50  
Easy-to-Assemble Kit — \$13.50

**YOU DON'T NEED A BENCH FULL OF EQUIPMENT TO TEST TRANSISTOR RADIOS!** All the facilities you need to check the transistors themselves — and the radios or other circuits in which they are used — have been ingeniously engineered into the compact, 6-inch high case of the Model 212. It's the transistor radio troubleshooter with all the features found only in more expensive units. Find defective transistors and circuit troubles speedily with a single, streamlined instrument instead of an elaborate hook-up.

#### Features:

Checks all transistor types — high or low power. Checks DC current gain (beta) to 200 in 3 ranges. Checks leakage. Universal test socket accepts different base configurations. Identifies unknown transistors as NPN or PNP.

Dynamic test for all transistors as signal amplifiers (oscillator check). In or out of circuit. Develops test signal for AF, IF, or RF circuits. Signal traces all circuits. Checks condition of diodes. Measures battery or other transistor-circuit power-supply voltages on 12-volt scale. No external power source needed. Measures circuit drain or other DC currents to 80 milliamperes. Supplied with three external leads for in-circuit testing and a pair of test leads for measuring voltage and current. Comes complete with instruction manual and transistor listing.

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Send me **FREE** catalog of the complete value-packed EMC line, and name of local distributor.

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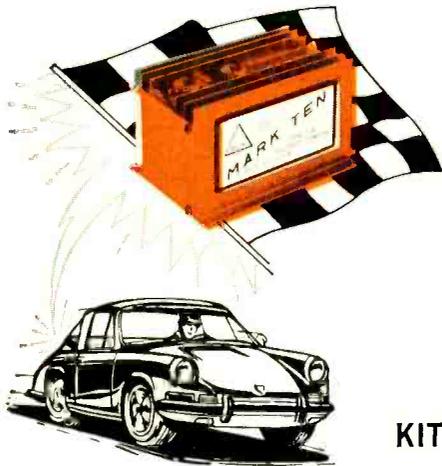
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## CAPACITIVE DISCHARGE IGNITION SYSTEM

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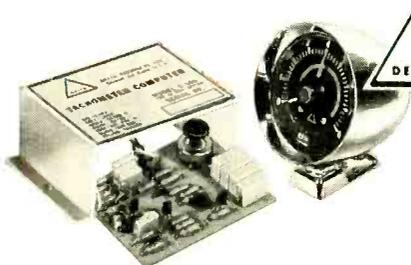
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- Model 3000 FET VOM  Kit  Assembled)
- Computach (Kit only)

Please ship immediately.

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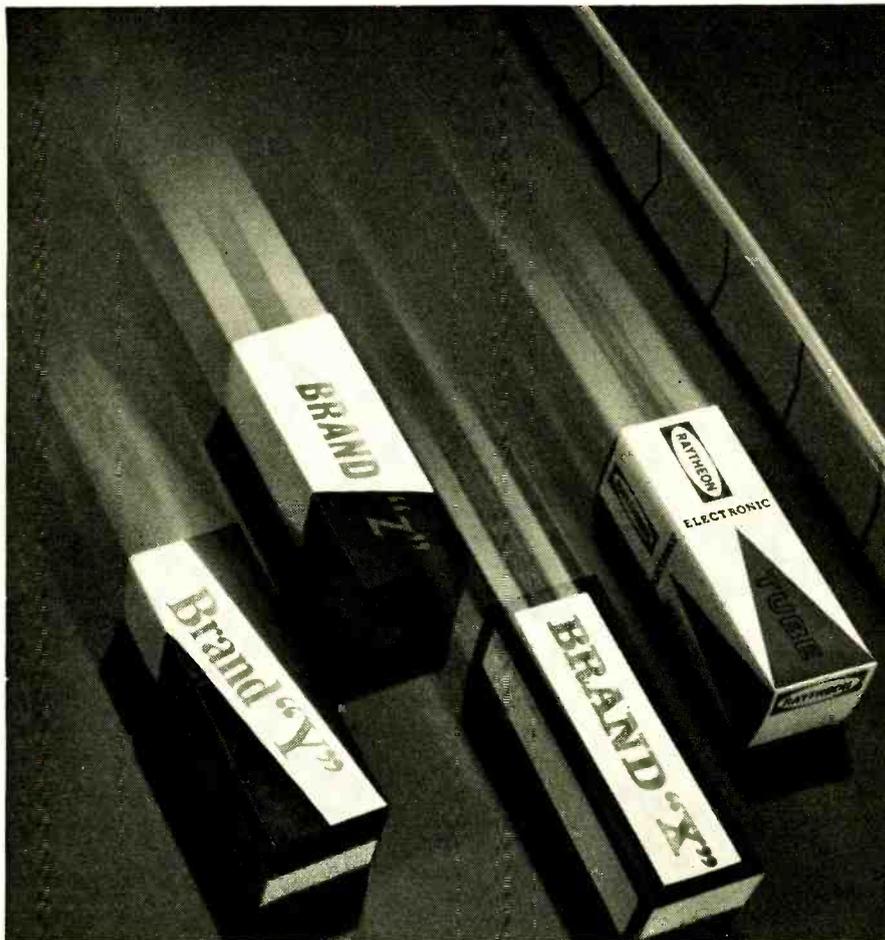
\*My car is (Model) \_\_\_\_\_ (Year) \_\_\_\_\_



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It could be us. We're getting there...working our way up...because we put quality first. We're already the leading independent tube manufacturer serving independent servicemen.

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Why not? You earn greater customer satisfaction...make more profit per tube. Ask your distributor about the current Raytheon promotion.

Raytheon Company, Receiving Tube Operation, Fourth Avenue, Burlington, Massachusetts 01803.



Remember to ask "WHAT ELSE NEEDS FIXING?"

Circle 19 on reader service card

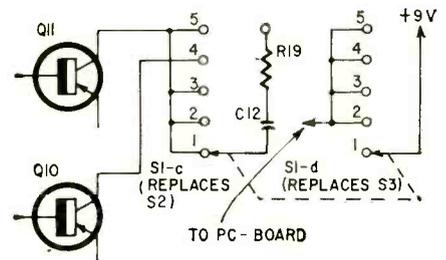


### DOT-BAR MODS

I just finished building your "Beginner's Dot-Bar Generator" (January 1969 R-E). I made a few modifications and substitutions which may be of interest to others planning to build the generator.

First, Olson TR-134 transistors at two for 99¢ work fine for Q1—Q10. That's half the price of the 2N2219. A Motorola HEP-50 was used for Q11.

For S1, I used a 4-pole 5-position rotary switch and wired the additional sections to replace S2 and on-off switch S3, as shown below.



This eliminates the necessity of switching S2 when selecting dots.

I also found it necessary to insert a 25,000-ohm pot in series with the output to control the intensity of the lines. They were so bright they tended to lose their edge definition.

Finally, I included gun-killer switches in the cabinet: this is a necessary item for convergence setups and not all sets have them.

Total cost of the unit was around \$15—about half the cost of a service call for a convergence setup.

JAMES G. KRIZ  
Parma, Ohio

### COLLECTOR'S CORNER

I'd like to inform your readers that I have issues of RADIO-ELECTRONICS from the 1950's and 60's. I also have many issues of electronics magazines that have ceased publication.

DONALD SCHUTZ  
Box 722  
Patchogue, N.Y.  
(continued on page 22)

®

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Turn your whole house into a home entertainment center. Operate up to four sets, or be able to move your entertainment equipment from room to room. Kit includes all necessary parts, fittings and instructions.



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Finally, a course for less than \$100 that will train you as a professional TV repairman. In fact, with the first two texts, you can repair 70 percent of all TV troubles.

And you need no previous experience to take this complete and practical training program.

The 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.

Whether you now know a vacuum tube from a resistor, you can be doing trouble-shooting on color sets in a matter of months.

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 Institute of TV Servicing.

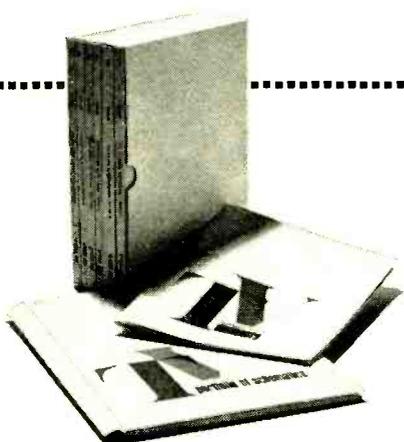
#### **Cost Less Than \$100**

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Get all the facts. Free. Mail the reply card on the attached flap or return the coupon. Learn how you can become a professional TV repairman—and find out about the bonus offer—an invaluable portfolio of 24 late-model schematics. Do it now.

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**all regular transistors plus the new field effect transistors.**

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Circle 22 on reader service card

CORRESPONDENCE  
(continued from page 16)

### CERTIFICATION VS. REALITY

I have read with interest various viewpoints in your magazine concerning certification of technicians. There has been a lot of drum beating or literary noise with only a very small amount of reason tempered with reality.

Most people engaged in a profession, trade or skill are favorably inclined toward an upgrading or improvement in their trade. However, reality indicates that to be effective there must be a way to control who practices or engages in that particular regulated field. Licensing by the government or a government-approved agency or group is one method, but legislatures generally include a grandfather provision and, if not, the courts do when a new field is licensed.

The idea of re-examination as expressed in the February 1969 R-E is fine in some respects, but impractical.

First of all, there are too many fields and types of technicians. In a recent Sunday paper, one company advertised for seven kinds of electronic techs, with a total of 15 electronic techs wanted. This is only a portion of the different, diversified, unrelated specialties the expanding field of electronics has. It is not difficult to assume that TV techs may share to a great extent the fate of the grid scratchers of the All American Five. It is impractical to cover all specialties.

Second, the examining and retesting as stated in that issue is much too far divorced from reality. The AMA, bar associations, CPA boards etc., do not require what is proposed for the TV and other techs. That in itself nullifies any hoped-for gain, and in the light of hard reality, it becomes an absurdity. Basics do not change. The degree of current proficiency is determined by the employer.

Third and last, I have no knowledge of the NEA, but any improvement must logically originate in a national organization for the technician. Even a mail order license or magazine subscription is a more acceptable alternate than the authoritarian organization proposed. To those concerned with incompetency, I say that I have never met an incompetent with a first-class FCC license.

JOHN A. WALKER  
Clearwater, Fla.

Thanks for your comments, John. The certification issue, now under discussion in a number of state legislatures, may eventually be resolved through Federal standards. **R-E**

**COVER  
PROJECT**

# Build All-Transistor TV Camera for \$100

INCREASING INTEREST IN HOME VIDEO TAPE RECORDERS, ham TV and closed-circuit television has created a demand for a low-cost, compact, solid-state, TV camera. Such a camera is described here. If you have a well stocked scrap box you can build it for less than \$100. If you've got to buy all the parts your cost might run to \$175.

This camera was developed on the premise that an advanced ham or experimenter could build it with off-the-shelf parts and a minimum of hard-to-locate parts. The camera has both rf and video signal outputs so it can be connected directly to the antenna terminals of any TV receiver, or with a video line amplifier can drive a video tape recorder, ham TV transmitter or video monitor.

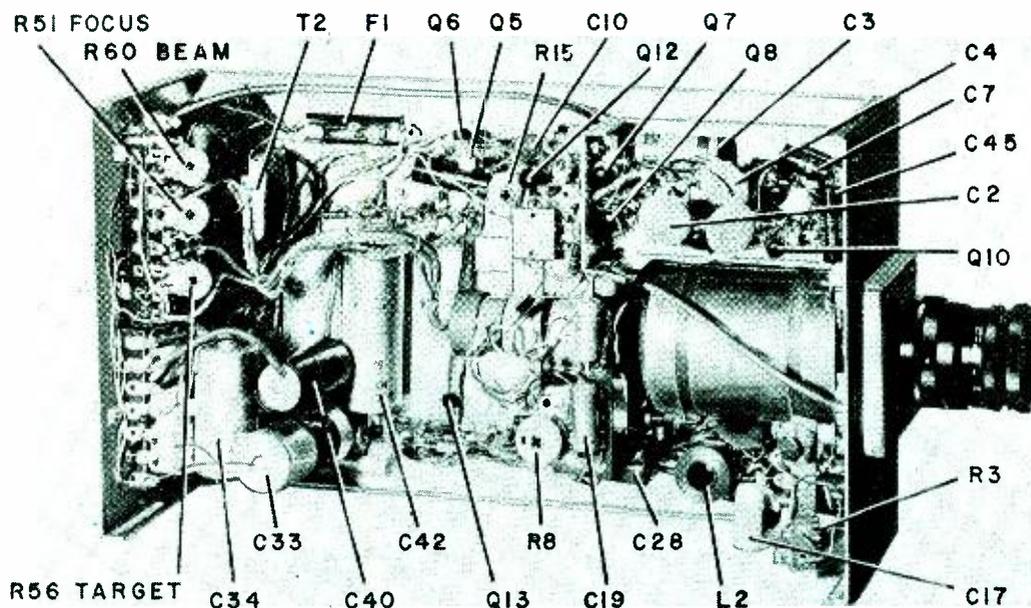
The camera uses 16 transistors and 11 diodes. The yoke and focus coil are readily available. The ones I used came from Denson Electronics, P.O. Box 85, Rockville, Conn. Total cost was \$34.50. They can also be obtained from GDC Electronics, 74 Fifth Ave., New York, N. Y. for \$33.60.

To insure good linearity, I recommend purchasing a commercially wound yoke. I have built yokes myself, but have discovered that without the proper mechanical gear you run into linearity problems.

## Mechanical Layout

The complete camera is mounted in a Bud mini-box No. CU-2111, 12"x7"x4". Most of the circuits are not extremely critical, however, the video amplifier should be mounted in a small aluminum box within the camera cabinet itself. Layout is not critical with the exception of two general rules. Locate the power transformers as far away from the yoke as possible. Also locate the horizontal

output stage, especially the horizontal flyback coil, away from the video amplifier. Drill the tripod mounting hole at the balance point. My camera after completion weighs 7 lb.



by GARY DAVIS JR.

Set up a TV studio at home.

Solid-state design.

Rf and video outputs connect  
to antenna terminals or amplifier

## The Vidicon Tube

Before we discuss the camera circuitry itself, let's briefly examine the operation of a vidicon image pickup tube. The tube contains a signal plate of a conducting metallic film, so thin that it is transparent. One side of this plate is coated with a thin layer of photo-conductive material, such as amorphous selenium. The optical image is focused on the opposite side of the signal plate. The photo-conductive material is scanned with an electron beam originating at the vidicon cathode.

The scanning beam deposits just enough electrons on each spot that it touches to reduce the potential of that side to the cathode potential. However, during the interval between successive scans, a charge leaks through the photo-conductive material in proportion to the illumination to which this part of the photo-conductive material is subjected. The charge deposited on any particular spot of the photo-conductive material the next time it is

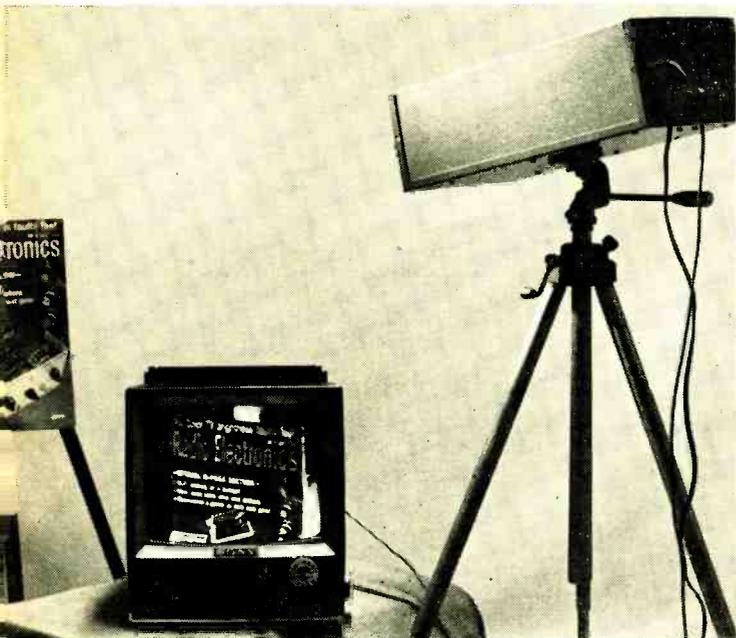
scanned, is enough to replace those electrons that have been lost by leakage since the last passage of the beam.

The total current of the electron beam and the capacitance of the photo-conductive material is in series with the external load resistance. Therefore the current through the load resistance, 56,000 ohms here, and hence the output voltage reproduces the variation in the light intensity of the successive portions of the optical image being scanned. The electron beam is electromagnetically deflected vertically and horizontally by the yoke current. Axial grids accelerate and decelerate the beam. The focusing coil provides an axial magnetic field that causes all electrons to focus at a common point on the photo-conductive surface.

Vidicon tubes are available from GBC Electronics, 74 Fifth Ave., New York, N.Y., ATV Research, Box 396, So. Sioux City, Nebr. and also Denson Electronics Corp. Many vidicons suitable for closed circuit TV and ham TV are priced from \$30.00 to \$40.00. The tube we used is a 1" 7038 Grade B. Another, higher sensitivity tube that is a direct replacement for the 7038 is the 7735A. It can be purchased for \$37.95 from GBC Electronics.

### The video amplifier

The output of the vidicon is taken off the 56,000-ohm



Solid-state camera is put to the test. Here you can see the picture it delivered to a portable TV when it was set up to photograph a typical issue of Radio-Electronics.

vidicon load resistor and applied to a high impedance Darlington input stage. This represents an input impedance approximately equal to the Beta<sup>2</sup> of the first two stages. Bandwidth is obtained by using negative feedback from the fourth to the second stage, and high frequency compensation is in the emitter circuits of the third and fourth stages.

The values of emitter bypass capacitors were selected to bypass the higher frequencies, but offer more reactance to the lower frequencies. Therefore, by inserting lower frequency degeneration, we raise amplitude with increasing frequency, overcoming high-frequency losses from shunt capacitance at the high impedance input.

Transistor Q11 serves as an emitter follower output stage. Video output is taken from this stage, and is approximately 0.2 volt at the output jack. This same point also drives the rf oscillator. The entire video amplifier

### PARTS LIST

#### RESISTORS—1/2-watt 10% unless noted

R1, R14—5,600 ohms  
R2—4,300 ohms, 5%  
R3—33,000 ohms  
R4, R10, R32—56,000 ohms  
R5, R6—1,500 ohms  
R7, R21, R22, R45—47 ohms  
R8, R15, R30—500 ohms, 2 watts, wirewound linear pot  
R9, R11, R28, R37, R40—2,200 ohms  
R12—1,200 ohms  
R13, R33, R41, R50, R53, R54, R55—100,000 ohms  
R16, R65—150 ohms, 5%  
R17, R47—10,000 ohms  
R18, R24, R25—6,800 ohms  
R19—22,000 ohms

#### CAPACITORS

C1—0.02  $\mu$ F, 200V ceramic  
C2, C4, C44—0.5  $\mu$ F, 10V ceramic  
C3—5  $\mu$ F, 150V electrolytic  
C5—.0082  $\mu$ F, 100V tubular  
C6—0.03  $\mu$ F, 100V tubular 5%  
C7—50  $\mu$ F, 25V electrolytic  
C8—5  $\mu$ F, 10V electrolytic  
C9—0.02  $\mu$ F, 100V ceramic  
C10—.0047  $\mu$ F, 50V ceramic  
C11—2.7-30 pF, 50V trimmer  
C12, C13—5 pF, 50V ceramic  
C14—25  $\mu$ F, 25V electrolytic  
C15, C17, C18, C21, C22, C31—0.1  $\mu$ F, 200V tubular  
C16, C26—0.47  $\mu$ F, 50V ceramic  
C19, C20—50  $\mu$ F, 25V electrolytic

#### TRANSFORMERS

T1—Thordarson 26R32

#### INDUCTORS

L1—4T No. 20, 1/4" dia, 3/8" long

#### SEMICONDUCTORS

D1, D2, D3, D4, D5, D6, D7—GE-504  
D8, D9, D10, D11—1N60  
Q1, Q2, Q6, Q7, Q8, Q9, Q10, Q11, Q12, Q13—2N3638

#### MISCELLANEOUS

Mini-box (Bud 2111A)  
Mini-box (Bud 3002A)  
Lens & Mount (see text)  
Fuse holder and 1A fuse  
Toggle switch, spst  
Line cord  
Terminal strips  
Vidicon (see text)

R20, R56, R60—500,000 ohms, 1/2 watt, linear pot  
R23, R44—82,000 ohms  
R26, R61—1,000 ohms  
R27, R42, R46—220 ohms  
R29, R62, R43—680 ohms  
R31—15,000 ohms  
R34—1 megohm  
R35—2.2 megohms  
R36—330 ohms, 5%  
R38—470,000 ohms  
R39, R63—100 ohms, 5%  
R48—33,000 ohms  
R49—3,300 ohms  
R51—100,000 ohms, 1/2 watt, linear pot  
R52—222,000 ohms  
R57—8,200 ohms  
R58, R59—270,000 ohms  
R64—150 ohms, 2 watts, 5%

C23—50  $\mu$ F, 50V electrolytic  
C24, C25—0.001  $\mu$ F, 50V ceramic  
C27—0.04  $\mu$ F, 600V tubular  
C28—100  $\mu$ F, 25V electrolytic  
C29, C30—.0039  $\mu$ F, 300V ceramic  
C32—0.1  $\mu$ F, 400V tubular  
C33, C34, C35—50  $\mu$ F, 450V electrolytic  
C36, C37—100  $\mu$ F, 25V electrolytic  
C39—0.1  $\mu$ F, 400V tubular  
C40—20  $\mu$ F, 450V electrolytic  
C41—0.5  $\mu$ F, 300V tubular  
C43—10  $\mu$ F, 150V electrolytic  
C45—0.15  $\mu$ F, 100V tubular

T2—Thordarson 26F68

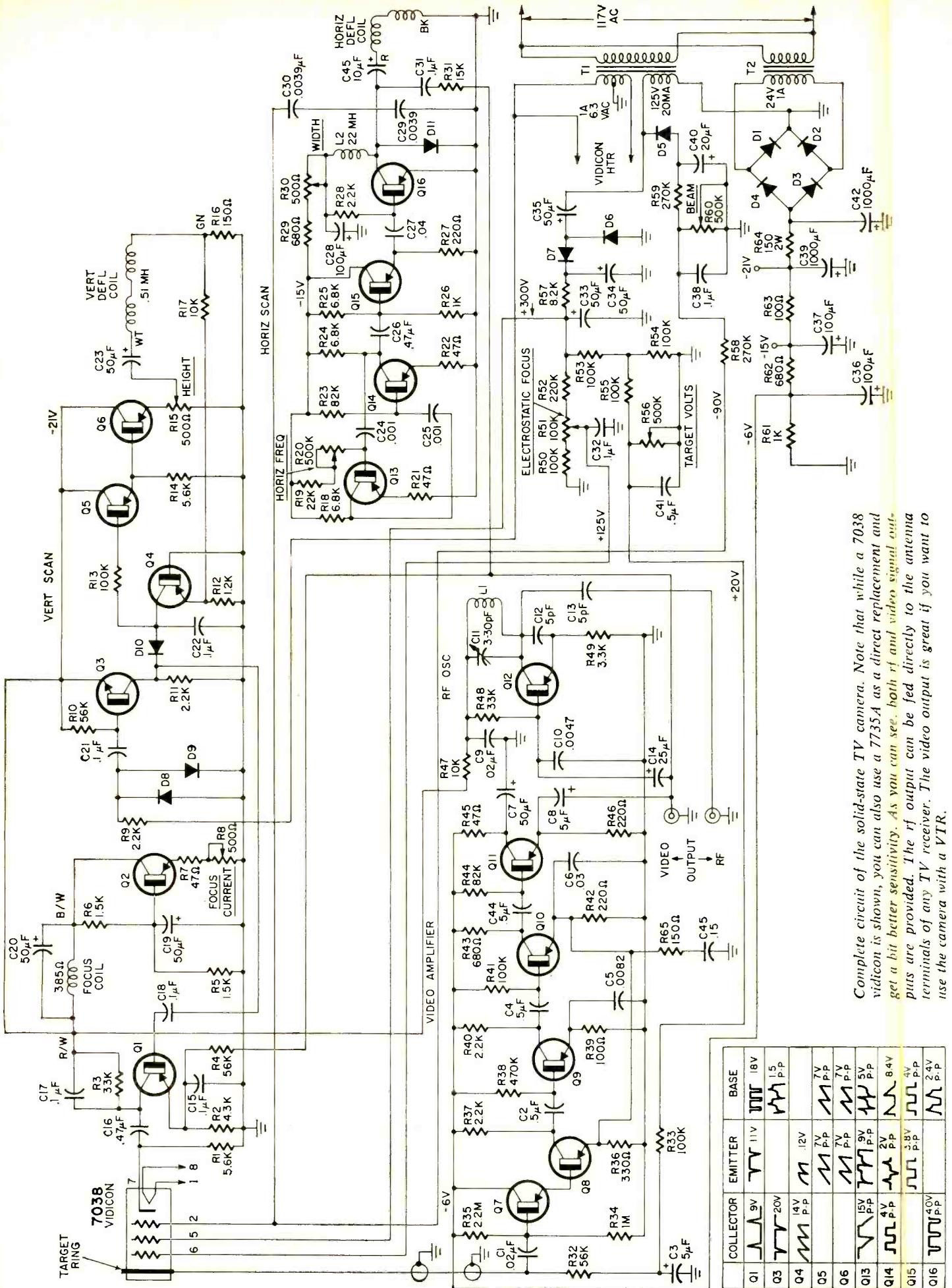
L2—22 mH (Miller 986)

Q3—2N2926 (see text) green dot  
Q4, Q5, Q14, Q15, Q16—SA599

Vidicon socket (see text)  
J1, J2—video and rf output jacks  
Yoke assembly (see text)  
Focus coil (see text)  
Shielded cable  
Miscellaneous hardware

has a frequency response of approximately 4.75 MHz. A general tip to observe in the video amplifier is good shielding to prevent hum and rf pickup. The input signal from the vidicon target ring should be run through shielded cable. R33, C3 and R32 should be located inside the metal video amplifier box.

Q12 and its associated components form a vhf rf oscillator, tunable from channels 2 through 6. Composite sync is added to the video at the input to the oscillator. Although the oscillator output is very low, it will trans-

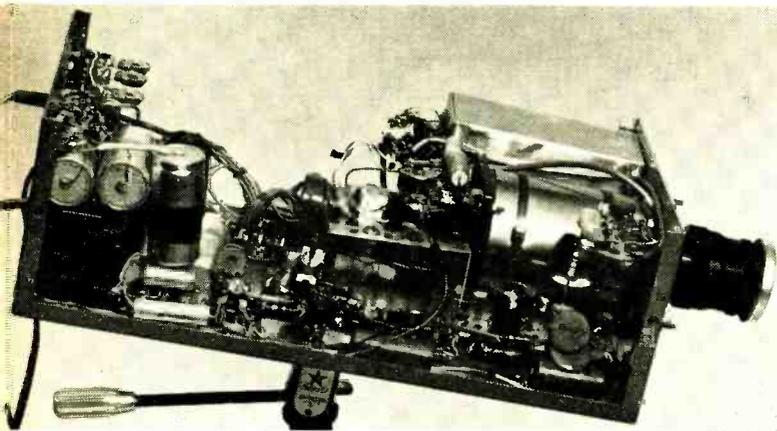


TRANSISTOR	COLLECTOR	EMITTER	BASE
Q1	9V	11V	18V
Q3	20V		15V P.P.
Q4	14V P.P.		7V P.P.
Q5		12V	7V P.P.
Q6		7V P.P.	7V P.P.
Q13	15V P.P.	9V P.P.	5V P.P.
Q14	4V P.P.	2V P.P.	84V
Q15		3.8V P.P.	4V P.P.
Q16	40V	24V	24V P.P.

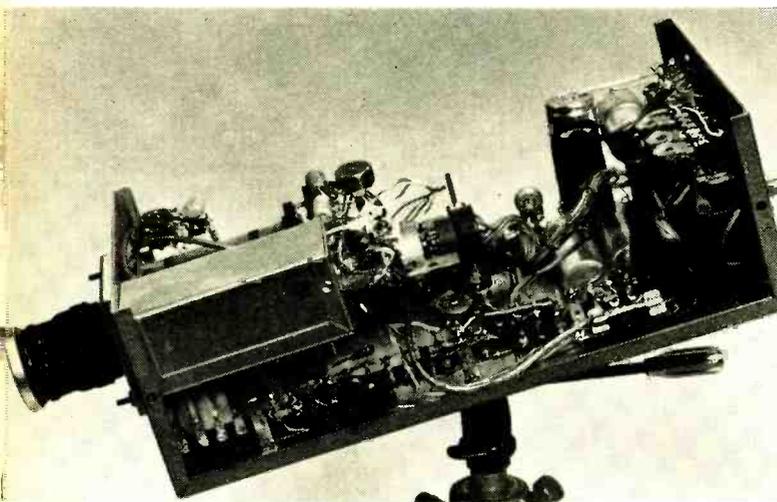
Complete circuit of the solid-state TV camera. Note that while a 7038 vidicon is shown, you can also use a 7735A as a direct replacement and get a bit better sensitivity. As you can see, both rf and video signal outputs are provided. The rf output can be fed directly to the antenna terminals of any TV receiver. The video output is great if you want to use the camera with a VTR.

mit a picture to a TV receiver about 50 ft. away with a short whip antenna connected to the rf output.

A 60-Hz sine wave is taken from the vidicon filament transformer through R9 and clipped to form a square wave by diodes D8 and D9. Capacitor C21 differentiates the square wave so that a positive-going pulse saturates the normally cutoff Q3. A negative-going 20-volt pulse is



This side view provides details for mounting most of the parts.



Use photo and one above with the labeled photo to build yours.

obtained at the collector side of R11. This pulse forward biases diode D10 which charges C22. After the pulse leaves R11, D10 is reverse biased and therefore C22 must discharge through the relatively high resistance of Q4. The resulting action generates a sawtooth waveform, which is applied to Q5.

Transistor Q5 acts as an emitter follower with its high input impedance preventing sawtooth generator loading. Transistor Q5 then in turn drives Q6, the vertical output. Resistor R15, Q6's emitter load resistor also serves as the height control. The yoke is coupled via C23 which provides ac coupling to the yoke and prevents decentering of the beam. Negative feedback in the form of yoke correction current is obtained from R16 and fed back to R12 which forward biases Q4.

Transistor Q4 then serves as a constant current discharge for linearity correction and permits using a smaller coupling capacitor for C23. Current correction for temperature changes in the yoke windings are also included in the negative feedback loop. The vertical yoke induc-

tance at 1000 Hz should be 54 mH with a dc resistance of 163 ohms.

Vertical blanking consists of Q1 and its associated components. A negative-going pulse is taken from the vertical scan circuit at R11 and fed via C18 to the normally cutoff Q1. When the pulse arrives, Q1 saturates providing a positive-going 9-volt pulse at the collector. This pulse blanks the vidicon cathode through C16 during the vertical retrace interval. At the same time, a negative-going vertical sync pulse is taken from R2 and fed through R4 to the video output. Capacitors C17 and C15 stretch the vertical blanking and sync pulses. Resistor R4 controls the ratio of vertical sync to horizontal sync at the output.

Transistors Q13 and Q14 along with their associated components form a collector coupled astable multivibrator whose frequency is controlled by R20. A square wave output at the horizontal line rate (15,750 Hz) is obtained at the collector of Q14, and in turn is fed to emitter follower Q15, which serves as a buffer stage and horizontal driver.

Transistor Q16, the horizontal output stage, is normally held in saturation by R28. The square wave from Q15, differentiated by C27, brings Q16 out of saturation. Through flyback action from L2 this pulse is raised to approximately 40 volts peak to peak at the collector of Q16 and applied to the horizontal yoke through C43. Because the inductive reactance of the horizontal yoke at 15,750 Hz, the yoke requires a pulse waveform of this type to produce a sawtooth of current through its windings. The horizontal sync pulse is taken off through C31 and R31. C30 also sends this same pulse to the vidicon to provide horizontal blanking during horizontal retrace. Diode D11 serves as a conventional damper while C29 forms a yoke ringing capacitor. The horizontal yoke inductance at 1000 Hz should be 8 mH with a dc resistance of 26 ohms.

Transistor Q2 serves as focus current regulator. Current regulation is provided by establishing the bias for Q2 from the positive end of the focus coil. Any voltage variation caused by temperature changes of the focus coil will either move the bias for Q2 toward saturation or cutoff and thereby control Q2's collector to emitter current which is in series with the focus coil.

The low-voltage supply consists of a simple bridge rectifier system and voltage dividers with capacitance filtering. Each frequency and signal processing section of the camera is operated at a different supply voltage to prevent interaction between sections which could result in poor interlace. The high voltage supply consists of a voltage doubler circuit to provide adequate supply voltages to operate the vidicon from the 125-volt transformer.

Almost any 16-mm camera lens equipped with a mounting flange will work on the camera. However, a larger lens will deliver a much better picture. I used a 48-mm television lens. It is desirable to choose a lens that will stop down to F:1.9. Lenses of all types are available from ATV Research, Denson Electronics, and GBC electronics.

During the original camera development, we tried approximately 50 to 75 of the following transistors with excellent results while checking circuit stability. The 2N3638 may be replaced by the GE Universal replacement transistor GE22 or 2N4125. The Beta range when substituting for the 2N3638 should be around 50 to 70  $H_{FE}$ .

When substituting for the 2N2926, a high Beta transistor must be used, around 300  $H_{FE}$ . The 2N2926 I used has a green dot on the top, which indicates an  $H_{FE}$  range (according to GE) of 235 to 470. If a high Beta transistor is not used, Q3 will not completely saturate

(continued on page 92)

# The prize you get depends on how many tubes you buy.

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*Circle 23 on reader service card*

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.**

**H**OW 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.

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.

The first step—mastering the fundamentals of Electronics in your spare time and getting your FCC License—can be easier than you think.

Cleveland Institute of Electronics has been successfully teaching electronics by mail for over thirty years. Right at home, in your spare time, you learn electronics step by step. Our AUTO-PROGRAMMED® lessons and coaching by expert instructors make everything clear and easy, even for men who thought they were "poor learners." You'll learn not only the fundamentals that apply to all electronics design and servicing, but also the specific procedures for installing, troubleshooting, and maintaining two-way mobile equipment.

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ment 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."

Find out more about how to get ahead in all fields of electronics, including two-way radio. Mail the bound-in postpaid reply card for two FREE books, "How To Get A Commercial FCC License" and "How To Succeed In Electronics." If card has been removed, just mail the coupon below.

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RE-62

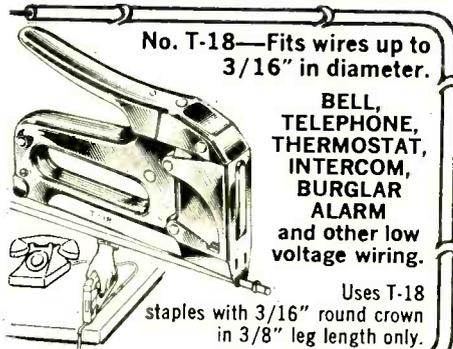
Circle 24 on reader service card

# ARROW AUTOMATIC STAPLE GUNS

## CUT WIRE & CABLE INSTALLATION COSTS

... without cutting into insulation!

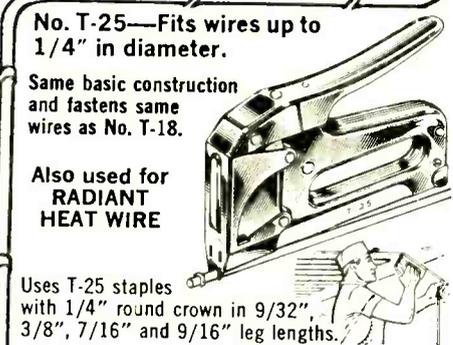
**SAFE!** Grooved Guide positions wire for proper staple envelopment! Grooved Driving Blade stops staple at right depth of penetration to prevent cutting into wire or cable insulation!



No. T-18—Fits wires up to 3/16" in diameter.

BELL,  
TELEPHONE,  
THERMOSTAT,  
INTERCOM,  
BURGLAR  
ALARM  
and other low  
voltage wiring.

Uses T-18  
staples with 3/16" round crown  
in 3/8" leg length only.



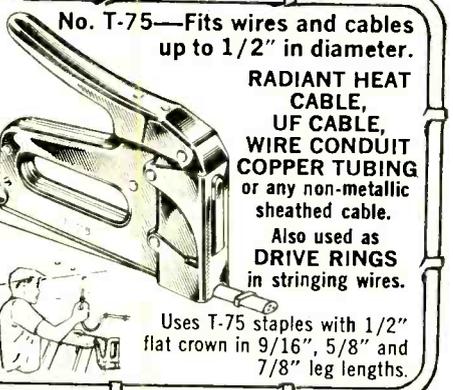
No. T-25—Fits wires up to 1/4" in diameter.

Same basic construction  
and fastens same  
wires as No. T-18.

Also used for  
**RADIANT  
HEAT WIRE**

Uses T-25 staples  
with 1/4" round crown in 9/32",  
3/8", 7/16" and 9/16" leg lengths.

T-18 and T-25 staples also available in Monel and  
with beige, brown and ivory finish at extra cost.



No. T-75—Fits wires and cables  
up to 1/2" in diameter.

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CABLE,  
UF CABLE,  
WIRE CONDUIT  
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or any non-metallic  
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Also used as  
**DRIVE RINGS**  
in stringing wires.

Uses T-75 staples with 1/2"  
flat crown in 9/16", 5/8" and  
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Arrow Automatic Staple Guns save 70% in time and effort on every type of wire or cable fastening job. Arrow staples are specially designed with divergent-pointed legs for easier driving and rosin-coated for greater holding power! All-steel construction and high-carbon hardened steel working parts are your assurance of maximum long-life, service and trouble-free performance.

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"Pioneers and Pacesetters  
For Almost A Half Century"

Circle 25 on reader service card

# NEW FOR YOU

For manufacturer's literature, circle No. 26 on Reader Service Card.



## Garrard SL95 Automatic Turntable

In any record player, turntable or changer constant speed operation is a must. Common practice has resulted in most turntable makers using a synchronous motor to insure constant speed operation despite changes in line voltage. This works, as you know, because the synchronous motor's speed is not voltage sensitive—at least not unless there is a vast change.

In changers it is not possible to use a synchronous motor as these units require rather high power during the change cycle—more power than the synchronous motor can deliver. As a direct result the changer has traditionally been susceptible to wow caused by speed changes resulting from line voltage variations.

But the Garrard SL95 is different. It has a rather special motor which is a combination of synchronous and induction motor and it provides *the best of both*. As a result you get enough power for the changer and a distinct lack of speed variations.

We hooked the changer up to a metered, variable ac power supply. In our tests, with a strobe disk on a record on the changer, we varied ac line voltage between 70 and 130 volts. There was no visible change in the speed of the changer. In fact the only speed change we noted occurred when the voltage was dropped below 50 volts. Then the changer simply stopped.

Other features of the SL95 include 3-speed operation—33 1/3, 45 and 78 rpm. A selector knob indexes the arm set down point.

An adjustable weight permits adjusting tracking force in 1/4-gram steps. There is also an anti-skating adjustment.

Two spindles are provided—one for turntable type operation, the other for record changer use. When used as a changer the center post does not drop the recorders. Instead an edge of the record "pusher" does the work.

An arm-lift lever permits raising and lowering the stylus into the record grooves without making any horrible scratching sounds, protecting the records as well as your nerves.



Overall impression is that the Garrard SL95 is a superior record changer from the viewpoints of both listening quality and mechanical operation. It certainly deserves more than a passing glance.

The changer sells for \$129.50. The plastic base is \$5.95 additional.—  
Chester H. Lawrence **R-E**

# INTRUDER ALARMS

FIRE • SMOKE • BURGLARY

Protection first means no regrets later

by LARRY STECKLER  
MANAGING EDITOR

LIGHT A LIGHT TO STOP A THIEF. SOUNDS GREAT, SOUNDS cheap. But it doesn't work very well. Ask any police chief. He'll tell you lights on are almost completely disregarded by the professional housebreaker. He'll phone your home first. When no one answers he's reasonably certain no one is there even if you do leave a light on. He can make sure by coming up to your door and ringing the bell. If you don't answer you aren't there.

The only real protection is an alarm system that takes over when you aren't there. An alarm system that rings bells, flashes lights, and perhaps even calls the police when someone enters your house and you aren't home.

There are several different ways to do this. They are detailed on the following pages. But here let's take a look at how the criminal thinks, what risks he will and won't take and how you can best safeguard your home and property.

First. The everyday housebreaker will not enter a home where he knows people are present. This is simply a matter of what happens to him if he's caught. If you're not home its burglary. If you are its theft. And the difference in penalties to him is quite severe. So if you can give the impression of somebody being at home you'll keep him out.

Unfortunately, this is hard to do as it is relatively easy for him to find out if you're really in or not. So it is still best to have a working alarm hooked up. What you want that alarm to do is to scare the burglar away. You do this in one of two ways. Either hook up the alarm system to ring some loud bells both inside and outside the house. There isn't a burglar alive that is likely to stay at work in a house with an alarm bell blasing away in his ears. At the least it will give him a major heart attack.

Flashing lights all over the house will scare the burglar away too. Couple this in with the bells and you have it made. By the way, to maintain good relations with your neighbors make arrangements for someone to turn off the alarm and reset it if it should trigger inadvertently while you are out.

One other major form of protection you can give yourself is to publicize the fact that you have an alarm system. Demonstrate it, show that it works and the word will spread. Put decals in your windows. It works, because again the average housebreaker can find a guy next door who doesn't have an alarm system to pick on. Why should he risk setting off your alarm if he can go next door and not have to contend with one.

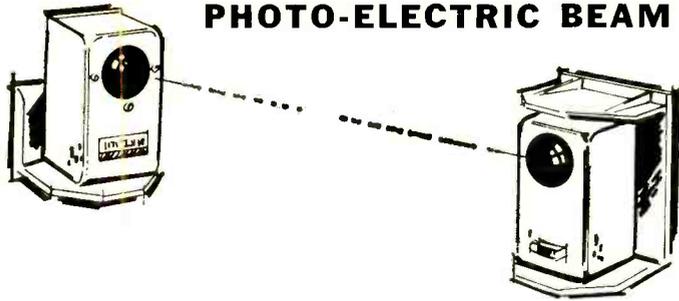
No matter what type system you choose, make sure it can't be disabled by a power failure. If it can, all the burglar has to do is cut the power line coming into your house. And if you've got an automatic telephone dialing system hooked in, don't tell anyone. A quick clip of the phone line puts it out of operation.

Now that you've got an alarm system, that doesn't mean you don't have to take any precautions at all. Still make sure you've locked all the windows and doors before you go out. And be doubly certain you've hooked up the alarm, turned it on and tested it to make sure it's working.

The testing aspect is important. You must test an alarm system daily. Almost every system has some kind of test circuit that enables you to make sure it is actually operative. Use that circuit at least once a day and every time you set the system. If you don't you might not have any protection when you need it most.

# INTRUDER ALARMS

## PHOTO-ELECTRIC BEAM

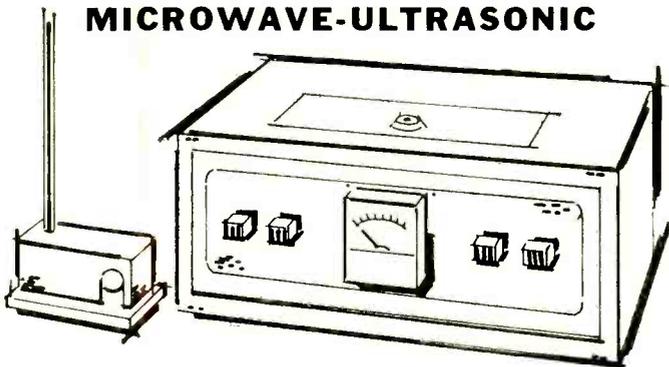


That old light beam and photocell combination still make a strong defense against the burglar. No matter what type of system you use they all consist of two basic elements—a light source and a photocell. The light from the source is focussed into a beam, projected across the area to be protected and detected by a photocell assembly. As long as light falls on the photocell, the alarm is held off. But if the beam is interrupted and no light reaches the photocell the alarm goes off.

Modern systems go a few steps beyond this basic description. Some use ultraviolet light so the beam cannot be seen by the intruder. Others use a light source that is modulated so the intruder can't simply shine his flashlight on the photocell while he strolls into the protected area. Another vital reason for a modulated beam is so the system can be used in daylight. Without modulation, the system couldn't tell the difference between the proper light beam and light striking the photocell that came through a window of a room.

There are couple of tricks to getting the most out of a light-beam system. Obviously you don't want the alarm triggered every time a cat or a mouse breaks the beam, so the beam must be located at least 18-inches above the floor. Also if you have a severe protection requirement you might use a series of units, located one above the other, spaced about one foot apart. Again to get the most protection possible, this is not the kind of system that you can effectively install yourself. An expert estimate of your requirements is a must for this kind of system. (A complete listing of manufacturers is on page 70.)

## MICROWAVE-ULTRASONIC



The newest and perhaps most convenient alarm systems made today are the "radar" type alarms. These units operate by emitting a continuous stream of signals (microwave or ultrasonic depending upon the particular type unit). These signals bounce around the protected area and

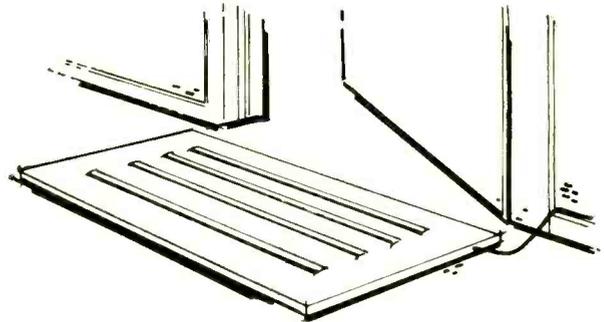
return to the alarm unit. Once turned on any movement in the area upsets the pattern of these signal setting off the alarm.

Advantages of such a system are numerous. The system can be easily installed—just set it up in the desired location and turn it on. It is portable. If you want to protect a conference table during lunch, just set a unit down in the middle of the table and turn it on. I know from my own experience that you won't be able to get near that table without setting off the alarm.

I'll never forget the first demonstration of these "radar" systems that I ever witnessed. There was the alarm sitting on a table and right next to it was a magnum of prime imported champagne. The offer was, "get to touch the bottle without setting off the alarm and you can keep it." Needless to say a good effort was made to take that bottle home. No one did!

Though I have stressed that this alarm can be easily installed, a professional installation is best and will insure maximum protection for your home or business. (Complete directory of manufacturers is on page 70.)

## ENTRANCE PROTECTION



If you cover the normal entry routes—doors, windows and skylights, you'll have blocked the entry of all but the most dedicated criminal. Yet protecting doorways and windows is relatively easy. A contact switch that is closed when a window is moved or a door is opened works well. Foil tape across glass areas that sets off an alarm if the glass is broken is also excellent.

One fairly new technique is to place a reed switch in the frame of the door or window and a magnet in the door itself. When the door is closed the magnet holds the switch open. Open the door and the switch closes setting off the alarm.

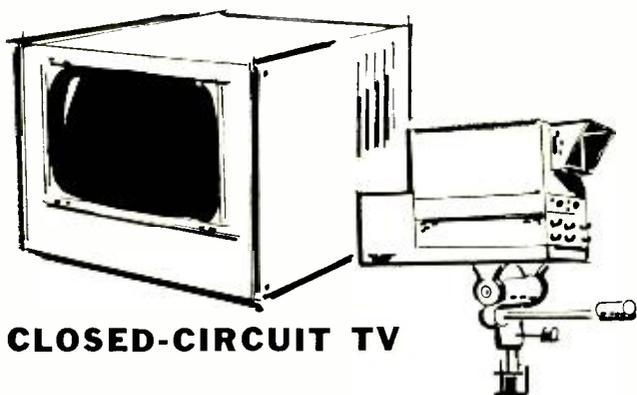
One recent problem described to me was the protection of wholesale milk trucks. The final system combined a radio-control system and switch mats. To leave or enter the truck the driver triggers his radio control transmitter which turns off the system long enough for him to get in or out. The rest of the time just one foot set on the mat sets off the alarm even when the driver is in the truck.

The only thing to remember when using this type system is to set it up so that if a wire between any detector and the alarm is cut, it sets off the alarm. If you don't, you'll have a system that is all too easily put out of commission by the prowler.

In the home, this type system can be costly to install unless each window is connected to an individual alarm. Otherwise wiring from all detectors must be run through the walls and ceilings to some central location. Of course, if you have an unused attic this job is simplified. Just run the wires from the individual doors and windows straight up through the ceiling and do all the interconnecting above. Also works if you have a basement. Use the same technique. (Complete directory of manufacturers is on page 70).

which permits you in your apartment on say the 20th floor see who's at the door downstairs before you let him in.

In the photo you can see how a CCTV system plus tape is being used in a bank. The camera is located behind the teller where it can take the customers picture. At the remote monitoring point a permanent record can be made if necessary. A remote switch at the tellers foot can trigger the recorder. Later, black & white Polaroid photos from the screen can serve for identification. (Complete directory of manufacturers is on page 70.)



**CLOSED-CIRCUIT TV**

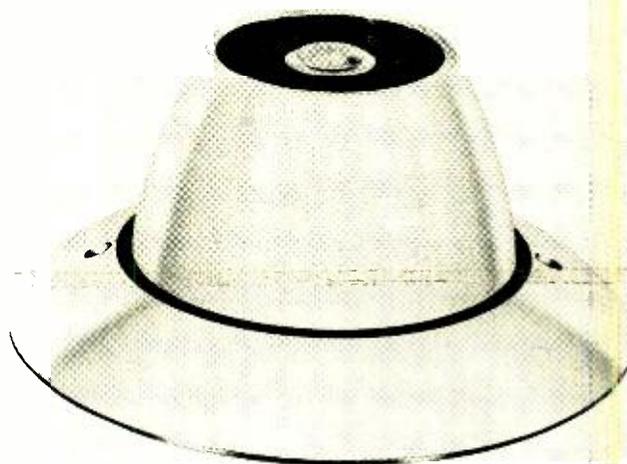
A most modern system for protecting against theft is the closed circuit television system (CCTV). Today it is common to find such a system in a department store. Here it is used to watch for shoplifters as well as dishonest sales clerks. The one big advantage of a CCTV system is that the prospective criminal can see the system—he can see the cameras scanning the floor. But he never knows for certain if someone is watching the monitor or not. As a result the system has a high deterrent value. The only potential disadvantage is that you must have someone watching the video monitor at all times for it to be really effective.

Couple a video tape recorder to a CCTV system and you make it even more useful.

One new attachment for a CCTV system makes it even better. It's called a motion detector. With this device hooked up the video signal is fed into a computer. Should the picture change—when someone enters the protected area for example—an alarm sounds and a video tape recorder is turned on to record the events.

Obviously costs will restrict CCTV systems to the larger establishment and prevent wide-scale use at home. Several new apartment houses now have a CCTV system

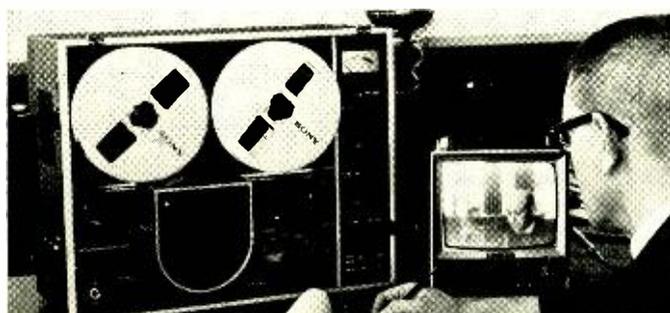
## FIRE DETECTION

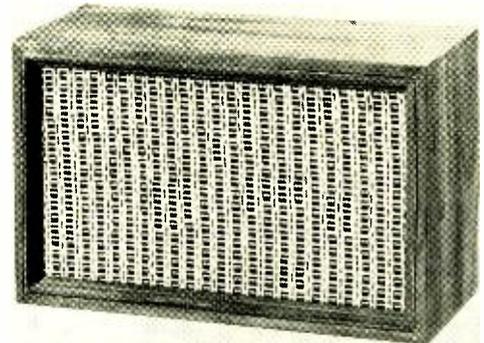
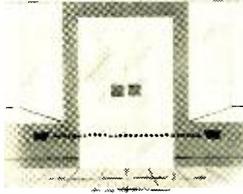
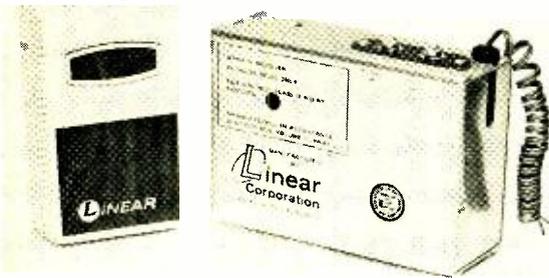
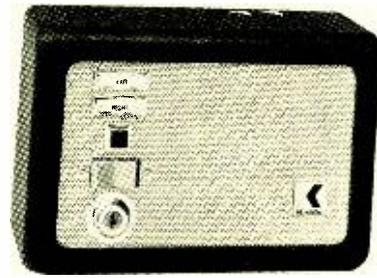
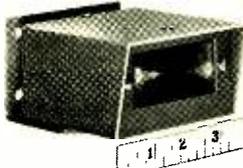
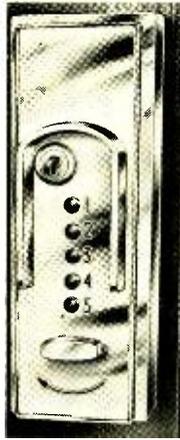


Protection against fire can be tied into any kind of alarm system. All it takes is the proper transducer. The most common type is a thermostatic unit that triggers the alarm when the temperature reaches a critical level. Obviously, the location of such units is critical. For they must not only be located where heat from a fire is likely to become noticed, but they must not be placed in a location that gets hot enough to set off the alarm under normal conditions.

An even more desirable detector is the smoke detector. It does not rely upon heat to set off the alarm. Instead it determines if there is any smoke in the air and if so triggers the warning system. This is a much more sensitive device than the heat detector, but again only an expert can position it correctly for maximum effectiveness. And of course it cannot be used in industrial sites that have normally smoke ridden air.

Several small fire alarms have been made and are available. This family of device is usually self-contained and is a heat sensitive unit. When temperature reaches the critical point the alarm goes off. The disadvantage common to these low-cost units is that the alarm itself is rather limited in output volume. As a result you could sleep right through it unless you hooked on some additional loud alarm bell, siren or what have you.





# INTRUDER ALARMS

## MISCELLANEOUS

There are many other types of accessory items that complete the home protection area. One handy item is in photo A above. It's a special combination lock. Handy for when you want to run across the street, may not take a key with you, but still want to leave the door locked. This is an additional lock and is not intended to be used by itself under any circumstances.

An apartment entrance security system is shown in photo B. With this system the apartment occupant dials a single digit on his standard phone to unlock the lobby door. Called enterphone, the system is made by General Telephone and is currently being installed in apartment houses and condominiums in the United States and Canada. To enter the building the visitor picks up the telephone handset and presses the button for the appropriate apartment. This activates a two-ring signal over the resident's phone.

Remote control transmitter shown in photo C is a handy panic and remote alarm. It is used in conjunction with whatever alarm system you already have. Keep the remote unit by your bedside. If you hear an intruder downstairs don't run for a baseball bat, push the button instead. It activates your alarm system and the resulting noise should scare the intruder off at no risk to yourself.

Typical photoelectric system is made by Arrowhead and shown in photo D. Here you can see how such a system is effectively used to monitor and detect the use of a pair of swing doors. If the doors are opened the alarm goes off. In a similar fashion this same system can be

used to protect any means of access to your home or business.

Looks like a decorated speaker cabinet in photo F, doesn't it? But it isn't. That's an ultrasonic alarm system made by Walter Kidde for home use. With it turned on it is almost impossible for anyone to walk through the protected area without setting off the alarm. And since the unit does look like a fine high-fidelity speaker system, the intruder won't know where to find the alarm.

In photo E is another Kidde residential alarm system. This is the master control box. Key operation permits entry by authorized persons, yet makes it difficult for an intruder to turn off the alarm before the built-in time delay turns it on, and once the alarm goes off most burglars will depart.

All in all, there is some kind of alarm for just about any specific application you can describe. The best alarm in any specific instance is a mixture of cost, efficiency, value of the property to be protected and remoteness of the house to be protected.

If your home is really remote, an automatic telephone dialer may be a must. It will telephone the police, plus one or two other preprogrammed numbers. Then it plays back a prerecorded message telling the party who answers the phone what's happening. A typical recording might go like this. "This is a recorded message. There is a burglary in progress at 17 Grand Street." The equipment then hangs up and dials the next preprogrammed number. **(A list of manufacturers is on page 70.)**

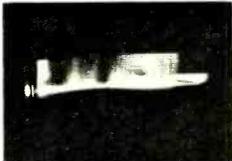
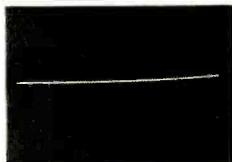
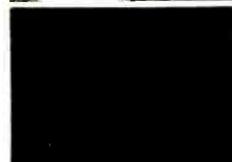
NEW R-E EXCLUSIVE

vertical  
multivibrator/output  
triode-triode

# Kwik-Fix™ picture and waveform charts

by Forest H. Belt & Associates\*

## SCREEN SYMPTOMS AS GUIDES

SYMPTOM PIC	DESCRIPTION	WHERE TO CHECK FIRST		PART
		VOLTAGE	WAVEFORM	
	Rolling can't be stopped. Off end of Hold control.	plate-pin-6 grid-pin-7	not much help	R1 R4 R9 C4 C5 PC1
	Only slight sweep. May roll drastically. Very nonlinear.	plate-pin-6 cathode-pin-9	WF2 WF3 WF5	R6
	Pic short. Sweeps only few inches. Locks okay.	plate-pin-6 grid-pin-7	All low	R5 C3
	Top stretched. Sync poor, or won't lock.	plate-pin-6	WF2 WF3 WF4	R10
	Thin white line.	plate-pin-6 plate-pin-1	All missing. Use 6.3-Vac test.	See "V p p zero" in Waveform Guides
	Stretched 'way out. Bunched at top.	not much help	WF1	C1
	Rolling lazily. Hold rolls either way. (May be outside stage.)	plate-pin-6	WF2	R7 R10
	Top stretched. Bottom slightly compressed.	grid-pin-7 cathode-pin-9	not much help	R8 R10 C2
	(NO PIC) Jitters.	not much help	not much help	C4 PC1

\*an Easy-Read™ feature by FOREST H. BELT & Associates © 1969

Use this guide to help you find which key voltage or waveform to check first.  
Study the screen and the action of the Hold control.  
Most helpful clues to fault are found at key test points indicated.  
Make voltage or waveform checks as indicated for screen

symptoms.  
Use VOLTAGE GUIDE and WAVEFORM GUIDE to analyze results of tests.  
For quick check, test or substitute parts shown as most likely cause of symptom.

### The Circuits

THIS IS ONE OF THE TWO MOST POPULAR VERTICAL SWEEP stages. The other is a triode-pentode. Multivibrator is cross-coupled type. Free-run frequency is near 60 Hz, determined mainly by feedback network and V1-a grid-load components. Station vertical-sync pulses pull cycles into precise phase with video frames. Vertical-sweep energy is coupled to the yoke from power-tube V1-b by impedance-matcher T1. Voltage at V1-a plate sets amplitude of signal sawtooth fed to V1-b, and thus controls size. R10, R8, R3, and C6 determine linearity of output waveform.

### Signal Behavior

Station sync comes through C1. It's applied to grid of V1-b through C2. Negative-oriented sync pulse cuts off V1-b momentarily, creating high positive voltage spike at plate (WF3).

Spike collapses just as suddenly into windings of T1. Before voltage reaches "zero," natural sawtooth of the multivibrator takes over. Spike and sawtooth together make a trapezoid. One frame or 1/60 second after spike, along comes another sync pulse. It starts grid sharply negative again, and sharp positive spike in plate waveform repeats.

Not all energy from decay cycle of WF3 goes into yoke (WF4). Some goes back through network C5-R9-PC1-C4 to grid of V1-a. Those feedback components and input load resistors R1 and R4 control natural frequency of multivibrator. They shape waveform into characteristic sawtooth, too; spike is almost nonexistent in WF1. V1-a amplifies sawtooth.

You can't see the sync pulse that mixes with sawtooth at plate of V1-a. It's just there, timing front edge of each trapezoid. If sync is missing, you can tell by inability of Hold control to lock picture in. Some faults *inside* this stage can swamp out sync signal.

### Dc Distribution

Plate-supply path for V1-a is through R5 and R2. The source of dc voltage is boost; short in C3 could kill raster, if R2 is set near zero ohms. R2 and R5 are both

large, so quite a bit of voltage is dropped, even though plate current in V1-a isn't large—less than 1 mA, usually. Grid of V1-a has contact bias, developed across R4 and R1. Cathode is grounded.

V1-b connects to 260 volts of plate supply through primary winding of T1. Winding has such low resistance, there's little change in plate voltage no matter how current varies. Bias is developed mainly in cathode dc circuit, by current through R8 and R3. Tiny positive voltage on grid is due to gas or to ion bombardment of grid; some tubes don't have it.

Schematic shows 50 volts dc on line coming from integrator. This voltage has almost no effect on bias at cathode-pin-9.

### Signal and Control Effects

Tuning away from station doesn't change stage operation. Sync is missing, but without video on screen you can't tell it.

With or without signal, dc voltages are drastically affected by settings of R1, R2, and—to some extent—R3. At grid-pin-7, for example, normal -48 volts can be turned down (with Hold control) to about -30 volts or up to about -65. Plate voltage also swings widely when Hold is changed.

Setting of R2, Size control, has heavy bearing on voltage at plate-pin-6. Can be varied from low of 35 to high of 140. There is some change in grid voltage when Size control is turned.

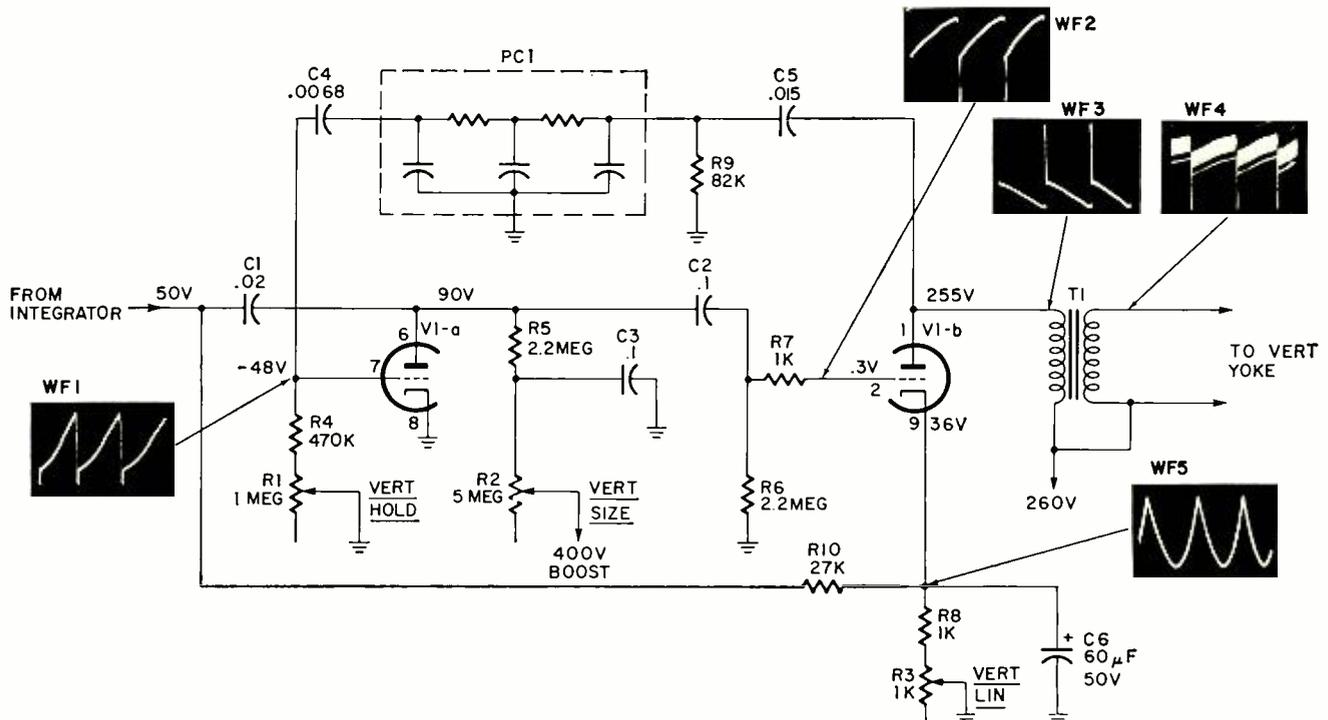
Changing setting of R3 hardly affects cathode bias. Variation is less than 10%—little help in troubleshooting.

### Quick Troubleshooting

Be sure fault is in multivibrator/output stages. Disconnect sync coming from integrator. Hold control should roll picture loosely either way, but without lock. If it does, trouble may be outside stage.

Two ways to troubleshoot quickly. First is by symptom, waveform, and dc analysis—as you do with *speedi-guide*. No matter what the symptom, adjust Hold, Size, and Linearity controls for as nearly normal picture as you

*continued on page 40*



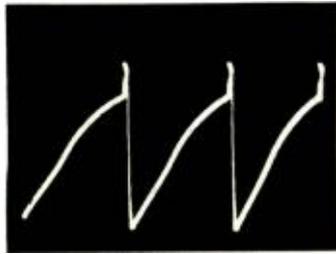
**DC VOLTAGES AS GUIDES**

Voltage change	to zero	very low	low	slightly low	slightly high	high
<b>Plate-pin-1</b> Normal is about 250 volts. Almost nothing affects it, since T1 primary is such low dc resistance. Not much help as a clue. T1 open						
<b>Grid-pin-2</b> Normal is zero or few tenths positive. Gas or ion bombardment is cause of positive reading. Not reliable for a clue.	R2 open R5 open R6 V. low R6 short R9 short C1 short C2 open C3 short C4 open C5 open T1 open	R5 high	R5 high R6 low R9 low C1 leaky	C3 leaky		C1 open C2 leaky C2 short
<b>Plate-pin-6</b> Normal 90 volts. Is affected by Size and Hold Controls. Moves from 35 to 135, but is good clue. Set Hold and Size for as normal picture as possible.	R2 open R2 short R5 open R9 short C3 short	R3 open R5 high R6 short R7 open R8 open R9 high C2 open C3 V. leaky C4 open C5 open T1 open	R1 short R5 high R6 v. low R7 open R10 low C1 lky, short C2 lky, short C3 leaky	C3 leaky	R6 low R8 high	R1 open R4 open R2 short C1 open
<b>Grid-pin-7</b> Normal is -50 volts, when set is in sync. Varies from -30 to -65 with Hold control. Good clue. Set Hold for as normal picture as possible.	R2 open R2 short R3 open R5 open R6 short R8 open R9 short C2 open C3 short C4 open C5 open	R6 V. low R7 open C2 open C4 open C5 open T1 open	R1 short R5 high R9 low R10 low C1 short	R6 low C3 leaky	R8 high	R1 open R4 open C1 open C2 leaky
<b>Cathode-pin-9</b> Normal is 35 volts. Is quite stable, and varies only slightly with faults in other circuits. Fair clue.	T1 open			R1 short R2 open R5 hi, open R6 V. low R6 short R9 short C1 leaky C2 open C3 short	R8 high	R3 open R7 open R8 open C1 open C2 lky, short

Use this guide to help you pinpoint the faulty part. Measure each of the five key voltages with a vtvm. For each, move across to the column that describes the change you find. Notice which parts might cause that change.

Finally, notice which parts are repeated in the combination of changes you found. Test those parts individually for the fault described. NOTE: For more guides to narrow down the faulty part further, see waveform guide.

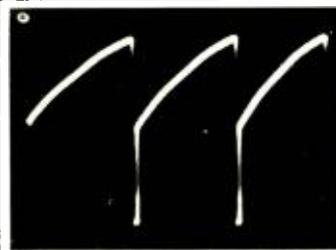
## WAVEFORMS AS GUIDES



**WF1 Normal 100 V p-p**

Taken at grid-pin-7, WF1 is close to natural waveshape generated by this multivibrator. Pip at top is residual from feedback circuit; is caused by spike in sweep voltage waveform. Curve of sawtooth rise depends on linearity of output trapezoid. Ideal would be straight, but actual WF1 seldom is. **SPECIAL:** This is best checkpoint to evaluate feedback circuit when 6.3-Vac sine wave is fed into loose end of C5 (see Quick Troubleshooting); waveform at far right is what signal should look like at WF1.

<p><b>V p-p low</b></p> <p>R6 low R9 low PC1 faulty</p>	<p><b>V p-p high</b></p>	<p><b>V p-p zero</b></p> <p>R1 open R4 open R2 open R3 open R5 open R6 short R7 open R8 open, hi R9 short C2 open C3 short C4 open C5 open T1 pri open PC1 open</p>	<p>R6 low</p>	<p>R9 low</p>	<p>C5 leaky</p>	<p>C4 leaky</p>	<p>Normal under 6.3 Vac test</p>
			<p>C1 faulty</p>				



**WF2 Normal 120 V p-p**

Taken at grid-pin-2. This is same as plate waveform of V1A; C2 and R6-R7 hardly change the shape at all. Downward spike is timed by sync pulse. Spike drives V1B into cutoff and creates high positive spike in WF3. When you measure any of these waveforms, be sure to include the spike; it's barely visible on some scopes unless you turn up Intensity. **SPECIAL:** Waveform at far right is normal WF2 with 6.3-Vac signal applied to loose end of C5 (Quick Troubleshooting). Amplitude indicates x10 gain in V1A. Weak signal might indicate open C2.

<p><b>V p-p low</b></p> <p>R5 high C2 lky, short C3 leaky</p>	<p><b>V p-p high</b></p> <p>R10 high</p>	<p><b>V p-p zero</b></p> <p>Same as in WF1 above.</p>	<p>R10 high</p>	<p>R10 low</p>	<p>R10 V. low</p>	<p>R7 high</p>	<p>Normal under 6.3-Vac test</p>
			<p>R6 low</p>	<p>R6 v. low</p>			

*continued from page 38*

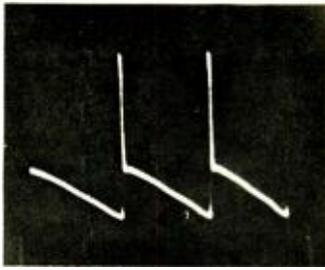
can get. Set scope controls for three locked cycles of waveform, even if different from normal setting. Then go ahead with usual *speedi-guide* procedures. So many parts can kill stage completely, rely on voltage guides for "thin white line" symptom.

Another troubleshooting method: Disconnect capacitor C5 from plate of V1-b. That opens feedback circuit, so stage can't oscillate. Then feed 60-Hz signal from 6.3-volt tube-heater line directly to loose end of C5. Picture will look as in these photos, and blanking bar may creep.

You can trace signal with scope and find faulty circuits. You're treating stage like two amplifiers. Waveform Guide shows what WF1 through WF5 look like under 6.3-Vac testing. If set has series heater string, just couple line voltage to C5 through .001- $\mu$ F capacitor.

You may prefer cut-and-try, going by symptoms. For off-frequency operation (rolling) try C5, R9, PC1, C4, R4, R1. For size problems, where linearity isn't bad, try R5, C3, R2, R6. If top is compressed, try R3, R8, C2, C6. If stretched, try R10, R8, C2. If bottom is compressed, try R6, C1, C2, C6.

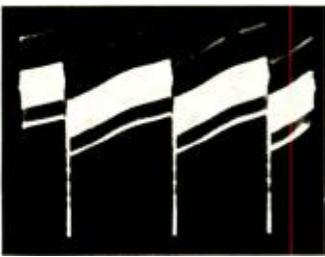
**R-E**



### WF3 Normal 500 V p-p

Taken at plate-pin-1. This is output waveform fed into transformer T1 and to yoke. Trapezoidal voltage waveform into inductive load (yoke) creates sawtooth current. Sawtooth magnetic field sweeps CRT beam linearly from top to bottom of screen. Some of this signal goes into feedback network through C5. Integrator PC1 makes sawtooth dominate SPECIAL: Waveform at far right is output signal when you test stages with 6.3-Vac signal fed to open end of C5. Voltage gain of output stage is about 7x; power gain is more.

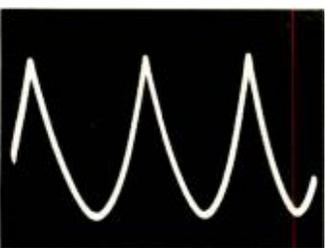
<p><b>V p-p low</b> R5 high R10 low</p>	<p><b>V p-p high</b> R10 high C2 leaky</p>	<p><b>V p-p zero</b> Same as in WF1 above.</p>	<p><b>R10 low</b></p>	<p><b>R6 low</b></p>	<p><b>R6 V. low</b></p>	<p><b>R7 open</b></p>	<p><b>Normal under 6.3-Vac test</b></p>
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### WF4 Normal 80 V p-p

Taken at yoke hot lead, top of T1 secondary. Thick bar at top, with shadows above, caused by horizontal-sweep energy coupled back by deflection coils. (You can see some of it in WF3 if oscillator has stopped. Notice "R7 open" above.) Shape depends on condition of yoke; easy to test by substituting or merely by opening yoke lead (amplitude goes up without load). SPECIAL: Waveform at far right is sawtooth shape developed when 6.3-Vac signal is fed to open end of C5 (see Quick Troubleshooting). Horizontal-sweep hash is hardly visible.

<p><b>V p-p low</b> R5 high C2 short, lky C3 leaky T1 sec open</p>	<p><b>V p-p high</b> R10 high</p>	<p><b>V p-p zero</b> Same as in WF1 above. T1 faulty</p>	<p><b>R10 high</b></p>	<p><b>R10 low</b></p>	<p><b>R6 low</b></p>	<p><b>R6 v. low</b></p>	<p><b>Normal under 6.3-Vac test</b></p>
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### WF5 Normal 2 V p-p

Taken at cathode-pin-9. Round-bottom sawtooth is typical of waveshape across filter or bypass capacitor. Cathode is bypassed by large C6, which accounts for low amplitude. When the capacitor develops a power factor or becomes open, waveform changes some, but major clue is higher amplitude (notice symptoms below). SPECIAL: High-amplitude clue is good with 6.3-Vac test of stages, too (see Quick Troubleshooting). Normal waveform then is sine wave at cathode-pin-9, about 2 V p-p.

<p><b>V p-p low</b> R5 high R6 low</p>	<p><b>V p-p high</b> C2 leaky R6 faulty</p>	<p><b>V p-p zero</b> Same as in WF1 above.</p>	<p><b>R8 high</b></p>	<p><b>C6 poor</b></p>	<p><b>C6 open</b></p>		
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Use this guide and the voltages guide to help pin down the fault possibilities.

With direct probe or scope, check the five key waveforms. Set the scope at V or at about 2 Hz.

Note amplitude. If it's low or high, check parts under

those columns.

Note waveshape. If there's a change, check those parts.

NOTE: Only waveforms that help most with diagnosis are included in this guide.

PERCUSSION INSTRUMENTS AND sounds such as bongos, drums, wood blocks, gongs are probably the oldest known to man. Yet they are a very desirable and almost necessary adjunct to most modern music.

The richness, depth, and rhythm that these sounds add to almost any type of music must truly be heard to be appreciated. In the past it required several costly and bulky instruments to produce the sounds that can be generated by this one small portable unit. At present there are no commercial counterparts, so the builder is assured he has something novel and quite unique in electronic sound.

This project makes an ideal addition to the HEP Guitar Amplifier presented in the November 1968 issue of RADIO-ELECTRONICS or to any existing amplifier system. Each of the five

distinct tones produced by this unit is generated by individual twin-tee ringing oscillator circuits. (A ringing oscillator is not free-running, but can be triggered or shocked into a short burst of oscillation by any sort of transient.) Since the human body accumulates a definite electric charge, the oscillators are triggered by merely touching the touch-plates with your fingers. Thus the instrument can be played in a manner very similar to actual bongos.

Construction of the HEP Electronic Bongo is fairly simple and straightforward. Cut a piece of 1/8 inch Masonite 10 x 5 inches and drill as shown in Fig. 1. (The large holes for the touch-plates can be easily cut with a 1 3/16-inch chassis punch.) Cut the circuit board 8 3/4 x 2 1/2 inches and drill a mounting hole in each corner.

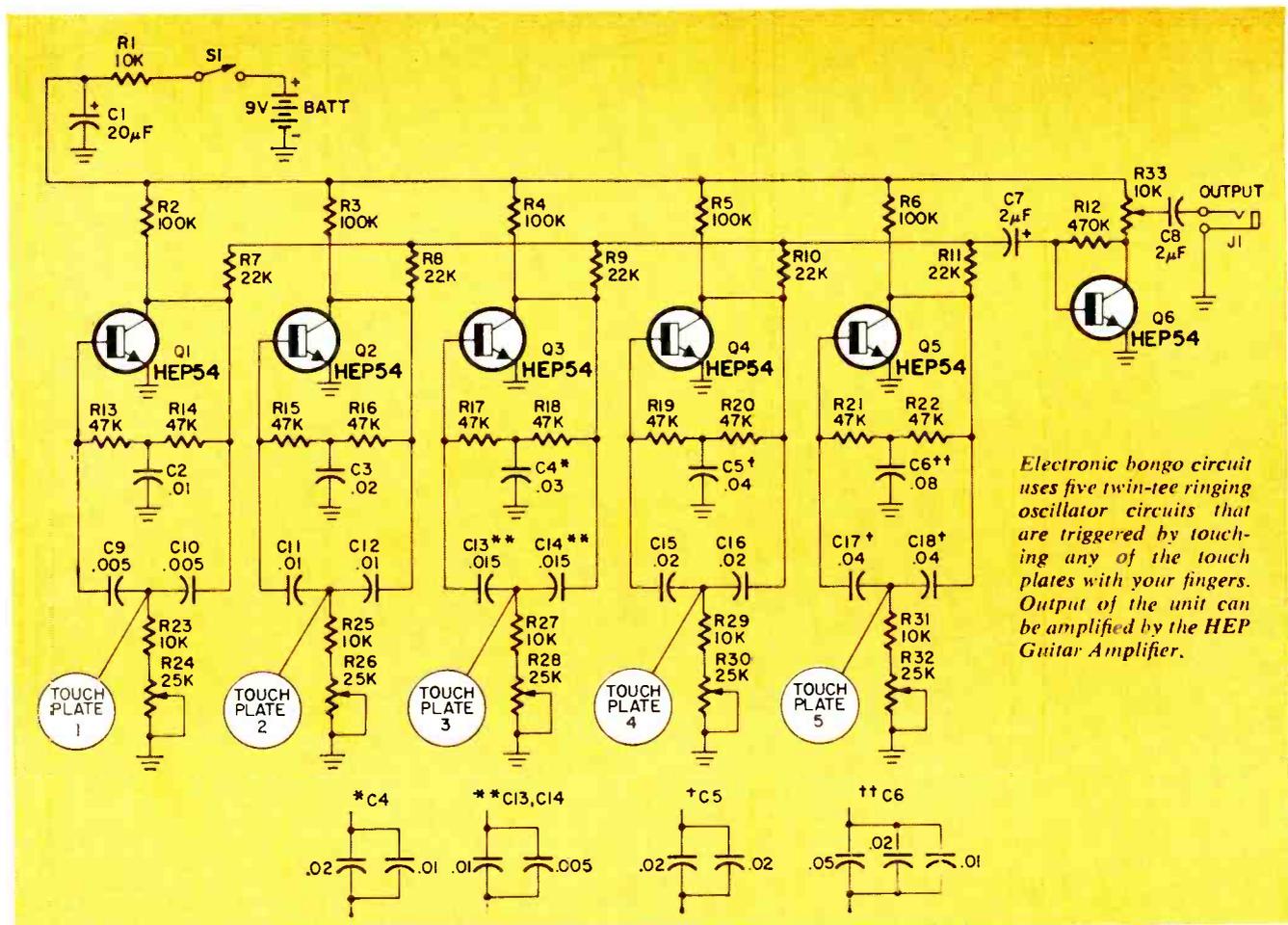
Now carefully mount R24, R26, R28, R30, and R32 so the adjusting slots are directly beneath the holes drilled in the Masonite for adjusting procedures. Refer to Fig. 2 and insert the push-in terminals and mount the transistor sockets. Proceed with the point-to-point wiring as in Fig. 3 and 4. Clip the touch-plates into the holes in the Masonite and mount the other components as in Fig. 5.

Interconnect the circuit board and the panel and attach the circuit board to the panel with the indicated hardware. Insert the completed unit into the metal chassis box, connect J1 to the high-impedance input of your sound system and you are ready to play the electronic bongos. The correct pitch for any one of the oscillator circuits can be easily adjusted by means of the adjustment holes. **R-E**

# Make Electronic Bongos

by JACK JAQUES

*Portable instrument works with 'charges' on your fingers*



*Electronic bongo circuit uses five twin-tee ringing oscillator circuits that are triggered by touching any of the touch plates with your fingers. Output of the unit can be amplified by the HEP Guitar Amplifier.*

## PARTS LIST

**Resistors**—all 1/4-watt 10% unless noted

R1, R23, R25, R27, R29, R31—10,000 ohms

R2, R3, R4, R5, R6—100,000 ohms

R7, R8, R9, R10, R11—22,000 ohms

R12—470,000 ohms

R13, R14, R15, R16, R17, R18, R19, R20, R21, R22—47,000 ohms

R24, R26, R28, R30, R32—25,000 ohms, miniature potentiometer (Mallory MTC253L4 or equiv.)

R33—10,000 ohms, linear potentiometer

**Capacitors**—all ceramic unless noted

C1—20  $\mu$ F, 12V, electrolytic

C2, C11, C12—0.01  $\mu$ F, 100V

C3, C15, C16—0.02  $\mu$ F, 100V

C4—0.03  $\mu$ F, 100V (see schematic note)

C5, C17, C18—0.04  $\mu$ F, 1000 V (see schematic note)

C6—0.08  $\mu$ F, 100V (see schematic note)

C7—2  $\mu$ F, 10V, electrolytic

C8—2  $\mu$ F, 100V, mylar

C9, C10—0.005  $\mu$ F, 100V

C13, C14—0.015  $\mu$ F, 1000V (see schematic note)

**Semiconductors**

Q1, Q2, Q3, Q4, Q5, Q6—HEP54

**Miscellaneous electronic parts**

BATT—9V mercury (Mallory TR146X or equiv.)

J1—Phono jack

**Miscellaneous hardware**

Chassis Box—10" x 5" x 3"

Touch-Plates (5)—1-7/16" dia. (Walsco 7320)

Transistor Sockets (6)

Circuit Board—2 1/2" x 8 3/4"

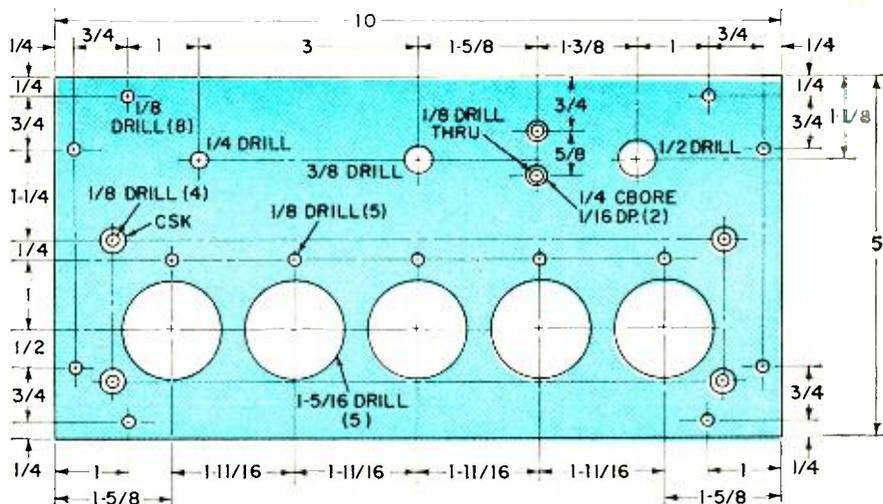
Push-in Terminals (37)

Battery Holder—(Keystone 79)

Battery Clip—(Keystone 72)

Panel—10" x 5" x 1/8" Masonite

Mounting screws, spacers, nuts, hook-up wire, knob



NOTE: ALL DIMENSIONS IN INCHES.

Fig. 1—Use dimensions here to cut the mounting holes for the touchplates and other components. Use 1/8" Masonite.

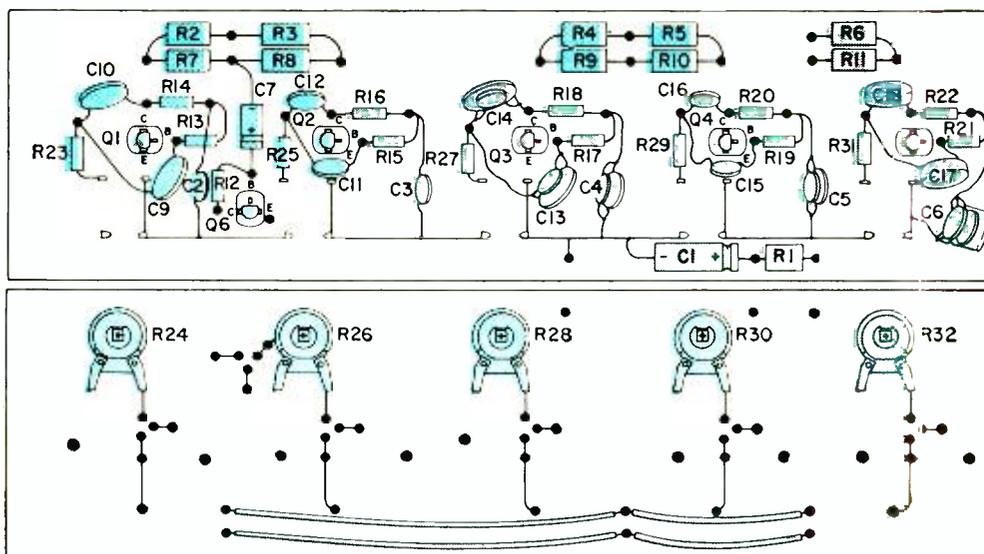
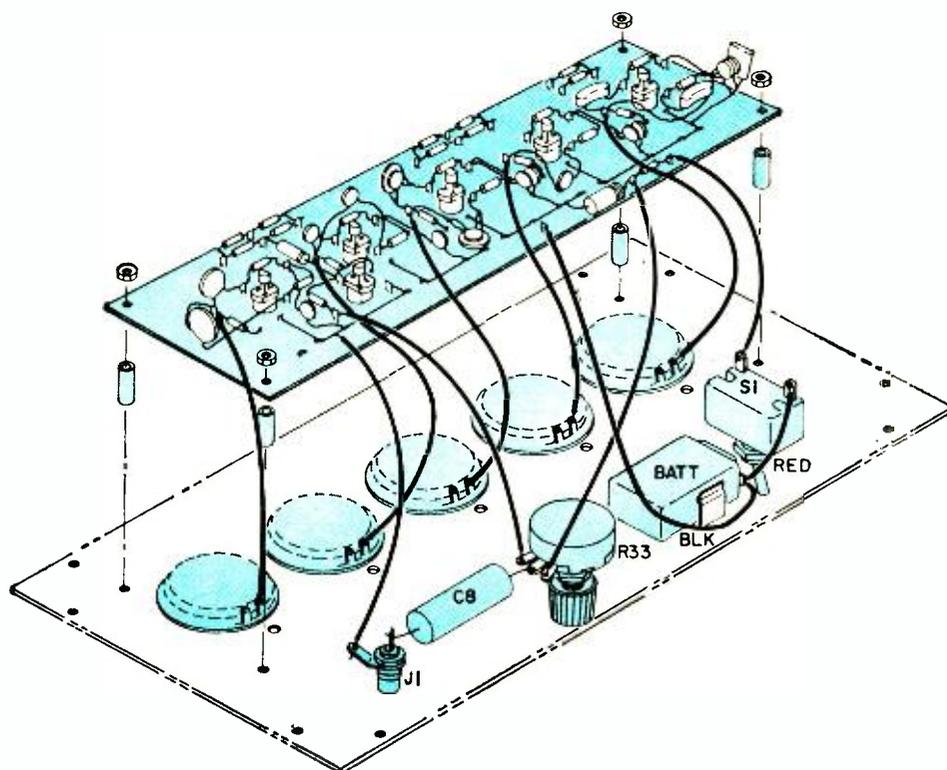
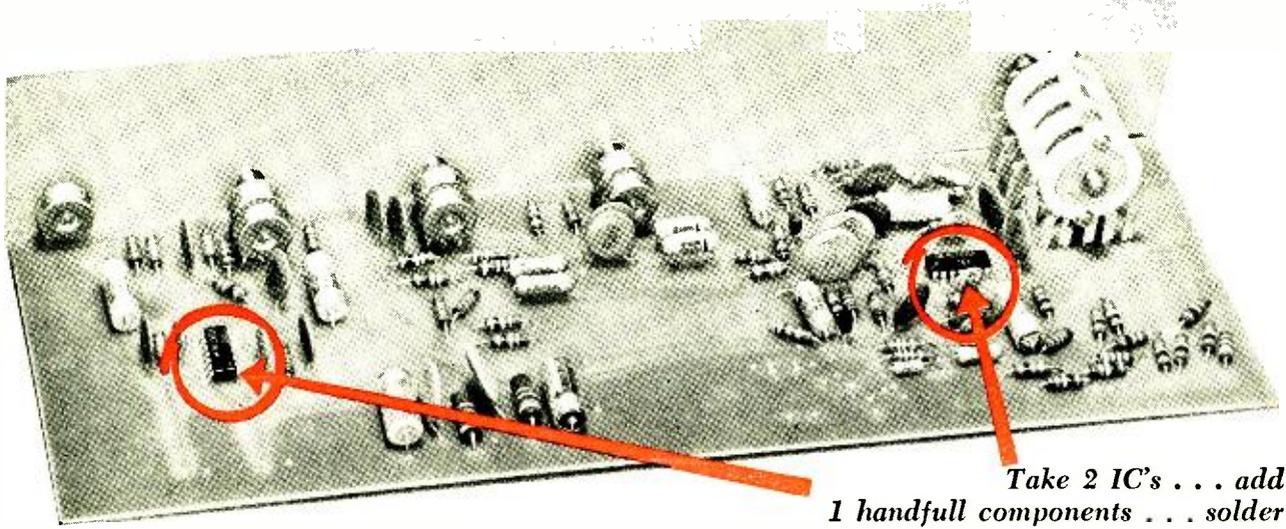


Fig. 2 (above)—Mount components on a 8 3/4 x 2 1/2" board. Wire the component board to the touch panel as shown below.





Take 2 IC's . . . add  
1 handful components . . . solder  
well . . . enjoy. . .

# Recipe For An IC Preamp

By JOHN TEELING\*

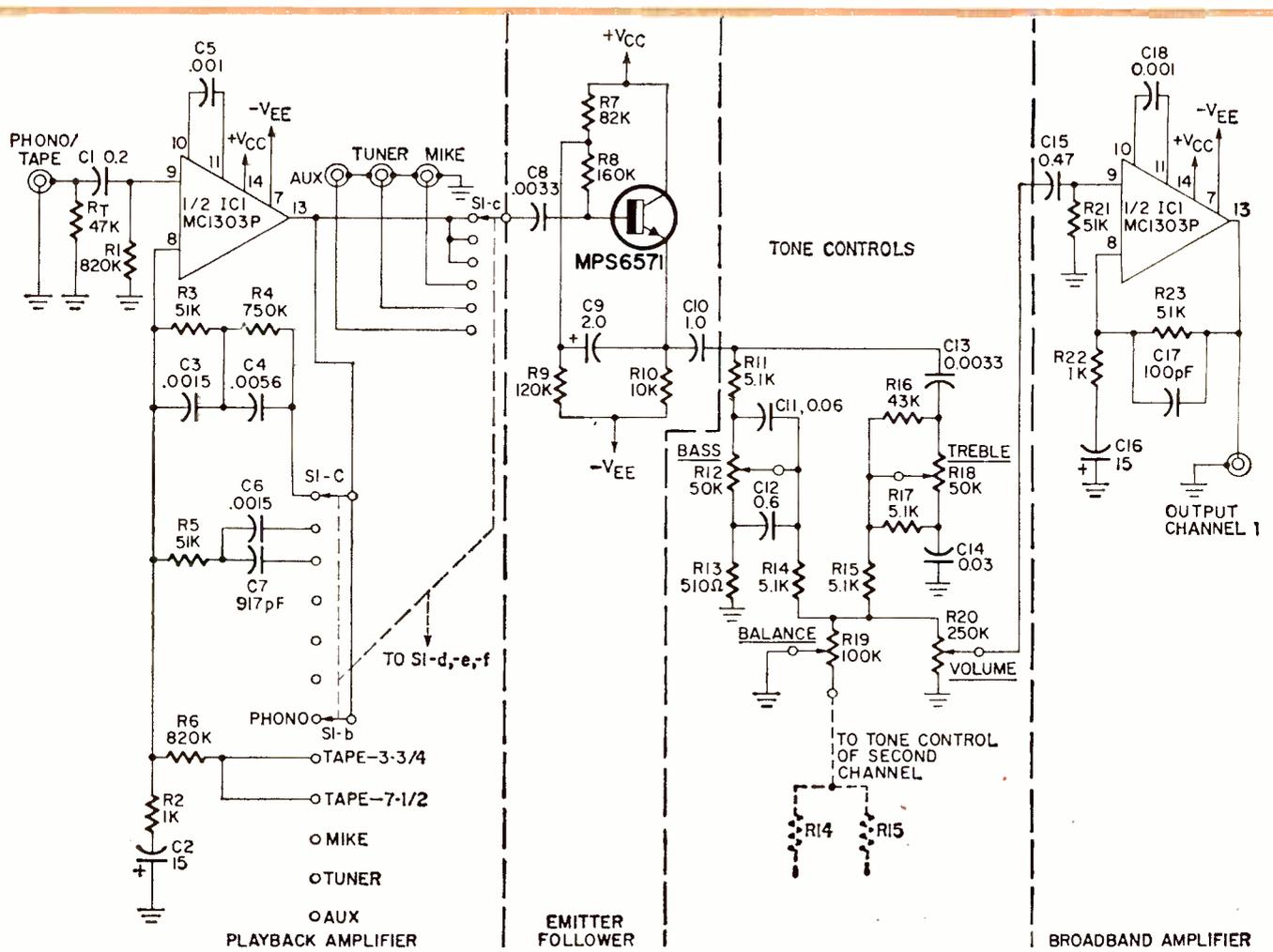


Fig. 1—One channel of the IC preamp is shown with dotted lines separating the four "recipe" parts that will be described.

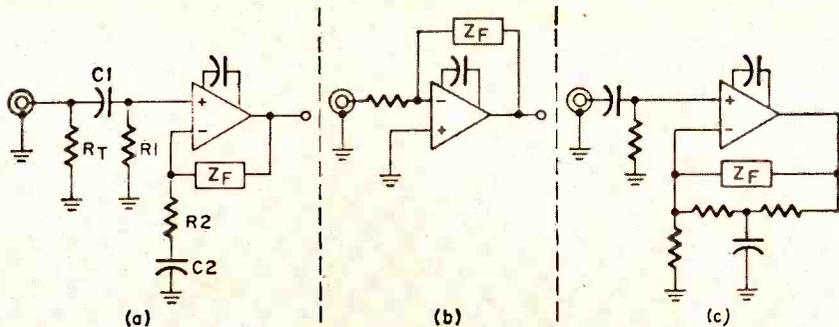


Fig. 2-a—Basic amplifier design selected for best characteristics. b—High noise version. c—Unstable circuit.

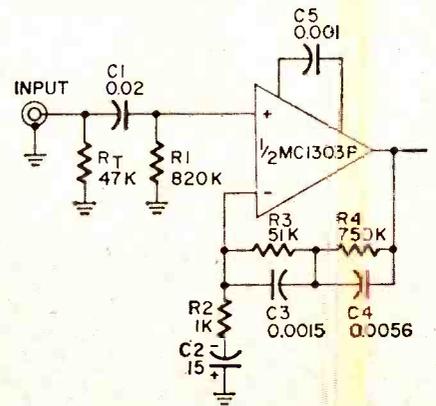


Fig. 3 (upper right)—Components used for input impedance matching, input lag (C5) and for RIAA equalization.

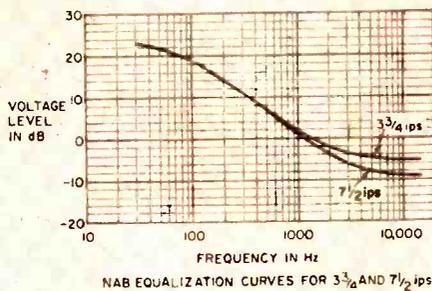


Fig. 4 (above)—NAB tape playback equalization curves for 3 3/4 and 7 1/2 ips. Fig. 5 (right)—Switch-selected RC network for the amplifier in tape mode.

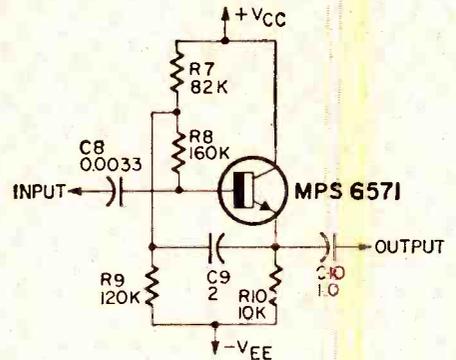
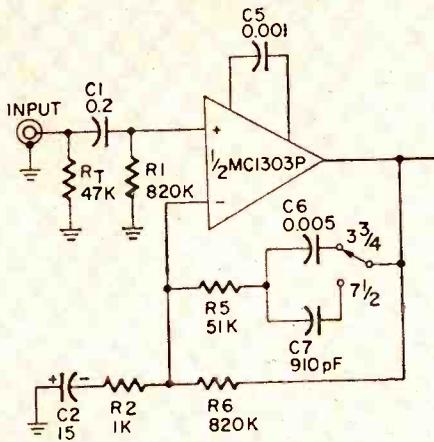


Fig. 6—Bootstrapped emitter follower stage has high input impedance, and cuts "flicker" noise sharply below 20 Hz.

SOLID-STATE AUDIO PREAMP AND CONTROL units are becoming increasingly rare—both as commercially available prewired units or kits. On the other hand, construction details for solid-state audio power amplifiers appear regularly in magazines, semiconductor application notes and manuals. If you decide to build one of these amplifiers, you'll probably need a preamp to go with it. If so, why not consider using IC's (integrated circuits) and design your own along the lines of the one described here.

One channel of the stereo preamp is shown in Fig. 1. It is designed around the Motorola MC1303P IC.

(The Motorola MC1302P and HEP592 IC stereo preamps are similar and can be used. The supply voltage should be reduced to +12V and -12V for the HEP592 and +6V and -6V for the MC130ZP.)

The MC1303P is a dual preamp on a single semiconductor die and is intended for use as a stereo audio pre-amplifier. Each channel of the preamp has a differential-input amplifier, followed by a second differential stage with single-ended output, and two emitter-follower stages.

The emitters of each input differential amplifier are fed from a transistor constant-current source which is biased from a voltage divider in the

emitter circuit of the second-stage differential amplifier. This arrangement provides common-mode negative feedback to increase rejection of the common-mode signal. The input transistors are biased at approximately 250  $\mu$ A to provide low-noise operation. By cascading the two differential amplifiers in the manner described, low drift, dc bias stability, and temperature stability are obtained.

The second stage differential amplifier drives an emitter follower which in turn drives a complete pnp output stage a pnp-npn combination used to get both voltage gain and impedance transformation. If a single npn device were used, an emitter follower configuration would be needed. It provides no voltage gain, and in view of the emitter follower stage, would be redundant.

We could get both voltage gain and impedance transformation with a single pnp transistor in the output, assuming such a transistor could be designed to have normal beta. Unfortunately, in conventional integrated circuits, the beta of pnp transistors is very low, resulting in a very low output current capability.

In the composite pnp stage, the voltage at the base and the resistor in the emitter circuit of the pnp transistor control the current in both the pnp and the npn devices. Thus, the two transistors operate as a single

pnp unit. This combination yields the required current gain and voltage gain. Level translation is achieved by setting the voltage across the 4,000-ohm npn emitter resistor to equal the -V<sub>BE</sub> supply voltage.

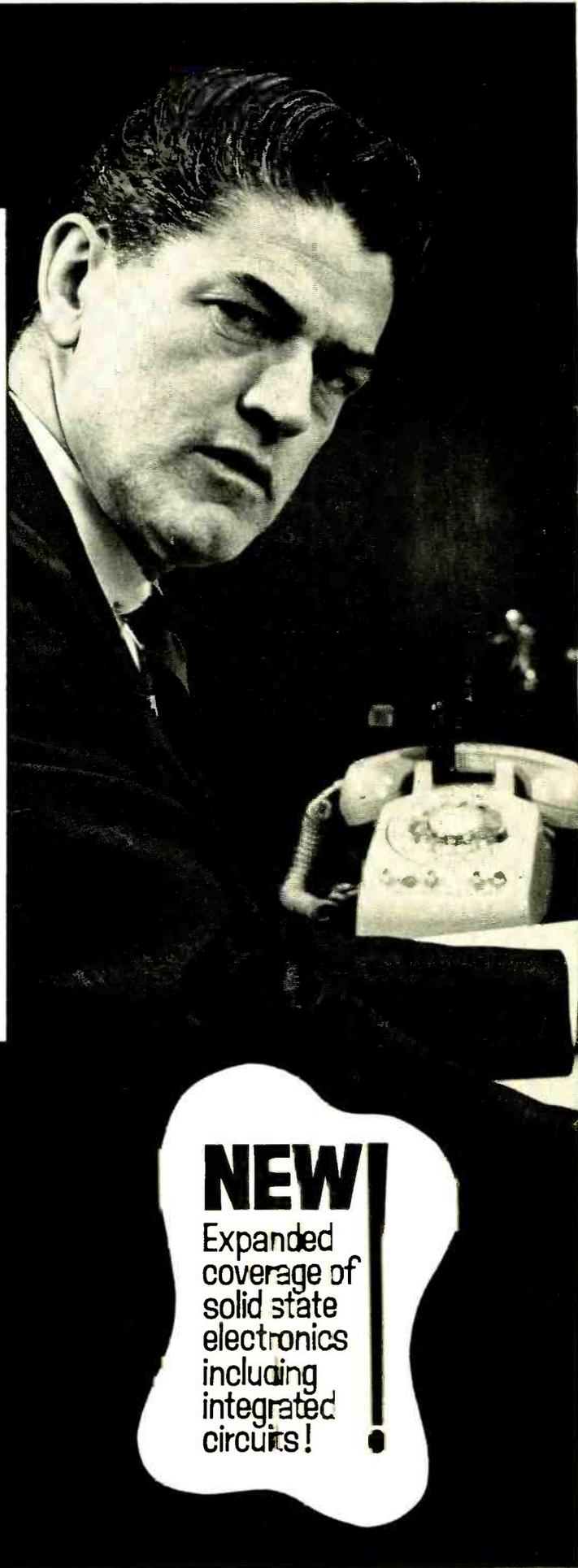
### Basic amplifier selection

Three basic amplifier circuits, shown in Fig. 2 was chosen as terms of performance and cost. The circuit shown in 2-a was chosen as having the best combination of low noise, low distortion, and low component count. The circuit of Fig. 2-b had the highest noise figure and had an additional disadvantage of a large dc offset voltage at the output. The circuit in 2-c used an excessive number of parts and was unstable at low frequencies. All further discussion will be confined to the circuit of Fig. 2-a.

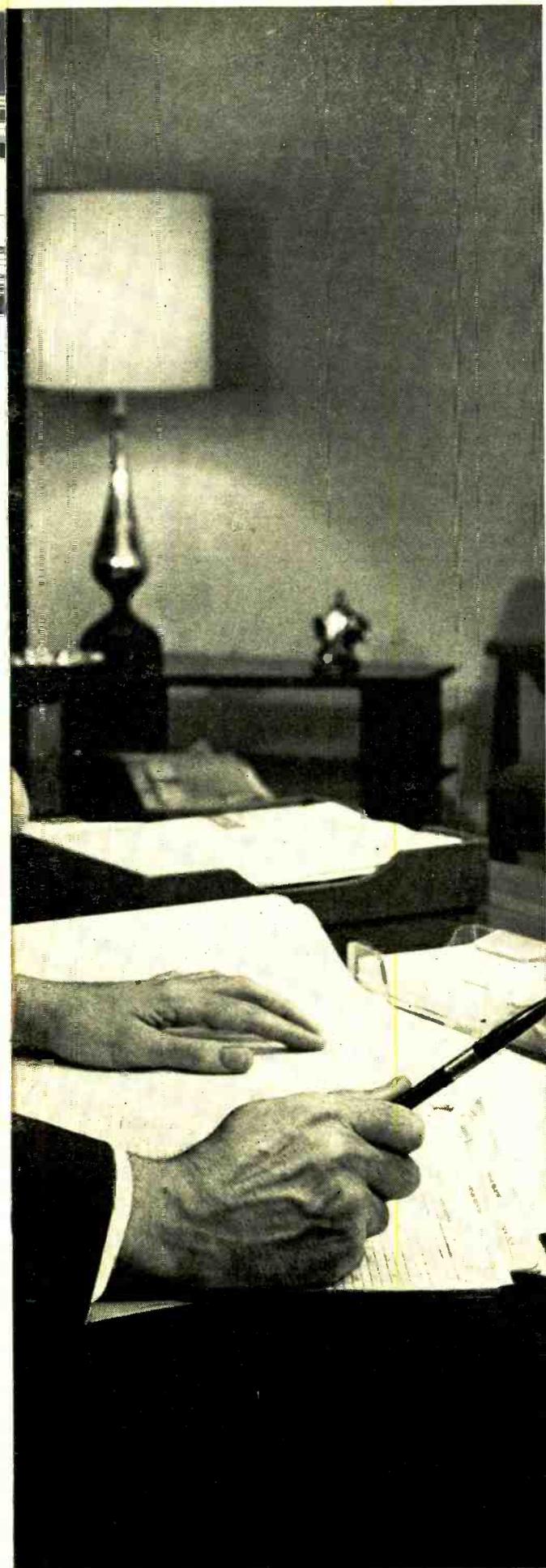
The closed loop voltage gain is set by the ratio of the compensating feedback network (Z<sub>F</sub>) to resistor R<sub>2</sub>. Resistor R<sub>1</sub> is made approximately equal to the dc resistance of the compensation network. The reason for this arrangement is that the dc input currents for the input transistors must flow through R<sub>1</sub> and the compensation network. If R<sub>1</sub> is smaller than the dc resistance of the compensation network, the subsequent dc drops will appear as an offset voltage at the input. This offset will be amplified by the circuit, causing a considerable off-

\*Applications Engineering, Motorola Semiconductor Products, Inc.

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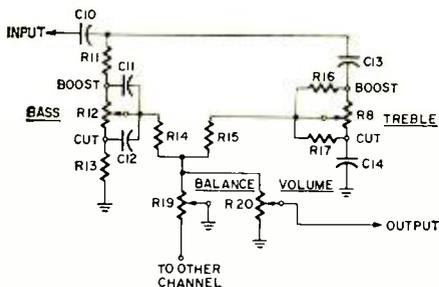
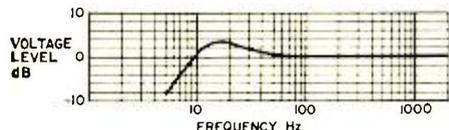


Fig. 7 (top)—Response curve of the emitter follower stage shows the 12-dB-per-octave slope. Values selected for C8 and C9 (see text) determine the response of this preamplifier stage.

Fig. 8 (above)—Passive tone-control circuit for the preamp provides flat response from 50 Hz to 20 kHz with 20-dB loss.

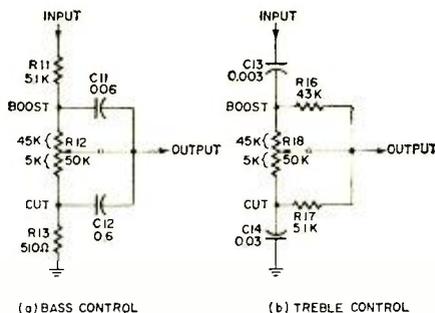


Fig. 9 (above)—Simplified bass and circuits control are shown in parts a & b. Fig. 10 (top right)—Taper rotation.

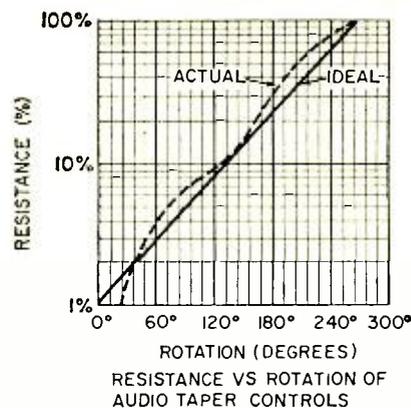


TABLE I PLAYBACK AMPLIFIER TYPICAL PERFORMANCE CHARACTERISTICS	
VOLTAGE GAIN @ 1 kHz	34 dB (50 TIMES)
INPUT OVERLOAD POINT	100mV rms @ 1 kHz
OUTPUT VOLTAGE SWING	5Vrms @ 1 kHz AND 0.1% TOTAL HARMONIC DISTORTION

set voltage at the output.

For example, if the base current were 1  $\mu$ A, R1 were 100,000 ohms and the dc resistance of the feedback loop were 1 megohm, then the offset voltage would be: 1  $\mu$ A times 1 megohm = 1  $\mu$ A times 100,000 ohms = 0.9 V. This would be amplified by the circuit. If the closed loop voltage gain were 50, then the output offset voltage would be 50 times 0.9 = 45 volts! This is a bit beyond the capability of the integrated circuit, but it does illustrate that some care is required in choosing the values of R1 and the compensation network.

The offset voltage catastrophe can be prevented by adding C2 in series with R2. The time constant of C2-R2 is selected to give a 3-dB roll off at the lowest frequency to be considered. The time constant of C1 and the input impedance should also be selected for a 3-dB roll off at this frequency.

The amplifier's input impedance will be approximately equal to R1. If the amplifier is used with a magnetic phono cartridge, R1 will probably be an order of magnitude greater than the nominal 50,000-ohm impedance required. To overcome this problem, R<sub>T</sub> is added to properly terminate the cartridge impedance.

Input lag is compensated by C5 (see Fig. 3). Its value could range from 680 pF to about 0.002  $\mu$ F. The slow rate (maximum rate of change of output voltage) and consequently the high-frequency response are partly governed by the size of this capacitor. A 0.001- $\mu$ F capacitor was selected as a nominal value.

### RIAA playback equalization

The feedback network could

range from a simple resistor to a quite complex network for shaping the frequency response of the amplifier. In all cases, it must provide a return path for dc bias current. The RIAA playback equalization curve requires a compensation network.

The selected method of reproducing the playback equalization curve is shown in Fig. 3. At low frequencies, the predominant impedance of the compensation feedback network is that of R4. As frequency increases from about 50 Hz, the reactance of capacitor C4 in parallel with R4 begins to decrease the impedance of the C4-R4 leg. At about 1 kHz the net impedance of C4-R4 is low compared to R3, and R3 sets the mid-band gain. As frequency increases to about 2 kHz, the parallel reactance of C3 begins to shunt R3, decreasing the impedance of the C3-R3 leg. If desired, a small stop resistor may be inserted in series with C3 to set a minimum gain.

The compensated voltage gain, A<sub>VF</sub>, of the circuit is then approximately equal to Z<sub>F</sub>/R1, where Z<sub>F</sub> is the impedance of the compensating network. Thus, by applying frequency-selective feedback, we may easily obtain the A<sub>VF</sub> versus frequency characteristic desired. A sample calculation for a complete playback preamplifier is:

- Required: Z<sub>in</sub>: 47K
- A<sub>VF</sub> @ 50 Hz: 500
- A<sub>VF</sub> @ 1 kHz: 50
- A<sub>VF</sub> @ 20 kHz: 5
- E<sub>rms out</sub>: 5 V

Band pass: 20 Hz to 25 kHz min.

The 5-volt rms output requires that a  $\pm$ 13-volt V<sub>cc</sub> supply be used. The compensation network impedance is set at 50,000 ohms at the mid-band position for minimal loading. Resistor

R3 is then set at 51,000 ohms (the nearest standard value to 50,000) and R2 becomes 51,000 $\Omega$ /50  $\approx$  1,000 ohms.

Rolloff at the lower frequencies is affected by the selection of C2. To obtain a 3-dB point at 10 Hz, C2 should have a reactance at 10 Hz equal to R2, or 1,000 ohms. This is calculated from the formula:

$$C = \frac{1}{2\pi f X_c} \text{ farads, or,}$$

$$C = \frac{159,000}{f \times X_c} \text{ where F is in cycles and C in } \mu\text{F} \quad (1)$$

$$\text{Thus, } C = \frac{159,000}{(10)(1,000)} = 15.9 \mu\text{F}$$

The nearest standard value is 15  $\mu$ F and a 3-volt rating is adequate.

For the RIAA compensation network, since R3 is 51,000 ohms, the reactance of C3 is set equal to R3 at 2.1 kHz, the high-frequency rolloff point. Equation (1) is used with the nearest standard value for C3 being 0.0015  $\mu$ F. In like manner, the reactance of C4 is set equal to R3 at 530 Hz. The nearest standard value is 0.0056  $\mu$ F. The resistance of R4 should be about ten times that of R3; however, the shunting effect of C4 cannot really be ignored. For this reason, R4 should be about 15 times the value of R3 to attain the full bass boost. The value of R4 then becomes (15) (51,000) or approximately 750,000 ohms. The value of R1 is made equal to R3 and R4 = 750,000 + 51,000 = 811,000 ohms. The nearest standard value is 820,000 ohms.

The reactance of C1 is made equal to the input impedance of the amplifier plus the parallel combination of the impedance of the cartridge (47,000 ohms) and the 47,000-ohm terminating resistor (R<sub>T</sub>) at 1 Hz. Again using equation (1):

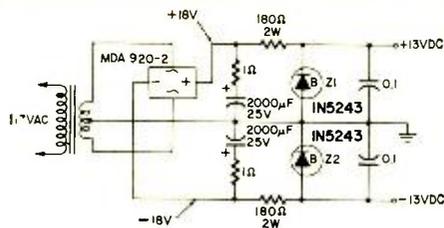


Fig. 11—Split power supply uses center-tapped transformer with full-wave bridge. Zener diodes provide ripple filtering.

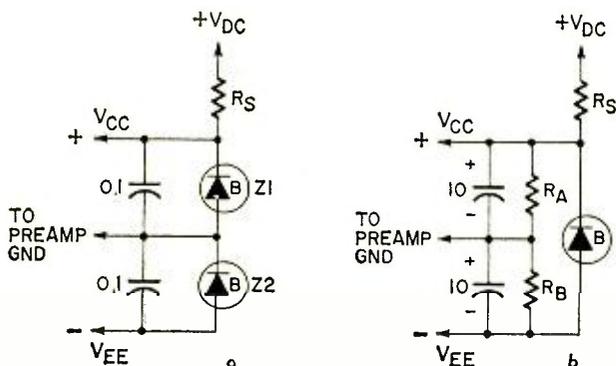
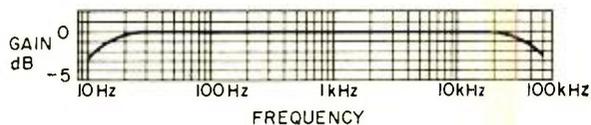


TABLE 2  
BROADBAND AMPLIFIER TYPICAL PERFORMANCE CHARACTERISTICS

VOLTAGE GAIN @ 1 kHz ..... 40 dB (100 TIMES)  
OUTPUT VOLTAGE SWING ..... 5 V rms



THE OUTPUT NOISE OF THE PREAMPLIFIER AS SHOWN IN FIGURE 1 IS -70 dB OR GREATER.

Fig. 12 (left)—Two approaches to a single rather than a split power supply. Grounding the junctions of the Zeners (left circuit) and resistors R<sub>A</sub> and R<sub>B</sub> (right) provides a dc output voltage of 1/2 V<sub>CC</sub>, effectively similar to the split supply.

$$C1 = \frac{159,000}{(1) \left( \frac{47,000}{2} + 820,000 \right)}$$

$$= 0.18 \mu\text{F}$$

A 0.2-μF, 3-volt capacitor is sufficient. The input lag compensation capacitor, C5, as was previously mentioned, is 0.001 μF, a nominal value.

### NAB playback equalization

If the preamplifier is to be used for tape deck amplification, NAB playback equalization is required. Figure 4 shows the 3/4- and 7/2-ips equalization and curves and the NAB playback amplifier is shown in Fig. 5. Since there is only one breakpoint in the curve, a simple RC series network is all that is required.

The break point for 3/4 ips occurs at 1.85 kHz. The midband frequency A<sub>v</sub> is still 50 so the value of R2 remains at 1,000 ohms and R5 is set equal to R3, or 51,000 ohms. The proper frequency response can be obtained if the reactance of C6 is equal to R5 (51,000 ohms) at 1.85 kHz. Again, equation (1) is used to solve for C6. The calculation yields a capacitance of 0.00169 μF with the nearest standard value of 0.0015 μF.

The break point for 7/2 ips is at 3.2 kHz so that C7 must have a reactance of 51,000 ohms at this frequency. The calculation is again the same with 0.000945 μF, the capacitive value, and 910 pF, the nearest standard value.

Input dc base current is supplied to the preamp by R6, an 820,000-ohm resistor. Using this resistor prevents the realization of a full 20-dB bass boost because of its shunting action across the NAB compensation

network. It does provide about 15 dB of boost, which is generally satisfactory. The emitter-follower stage (see Fig. 1) does allow the full 20 dB of bass boost to be realized.

The accuracy of both the RIAA and NAB compensation networks will be only as good as the components used in the circuits. So we recommend using 5% tolerance resistors and capacitors. Typical performance characteristics of both the RIAA and NAB versions of the preamplifier are shown in Table 1.

### The emitter-follower stage

The passive tone control selected for this preamplifier gives a constant slope, variable turnover characteristic. Since the tone control establishes the driving impedance for the second preamplifier stage, its impedance should be low. This low impedance would load the output of the first stage, so an emitter-follower stage is sandwiched between the first stage and tone control.

The emitter-follower stage (Fig. 6) is bootstrapped to provide a higher input impedance and will also allow some low-frequency compensation. Proper selection of the coupling and bootstrap capacitors produces a 12-dB per octave rolloff at the low cutoff frequency. This greatly reduces the effects of excess noise which occurs at very low frequencies in semiconductor devices. This noise is known as the 1/F noise or "flicker" noise. Since flicker noise occurs more noticeably at frequencies below 10 Hz, the 12-dB rolloff can attenuate this noise by 24 dB or more. Using this arrangement also gives about 5 dB of bass boost due to the "resonant rise" of

the output voltage, thus realizing a full 20 dB of bass boost in both the RIAA and NAB positions of the preamp.

Referring to the schematic in Fig. 6, at frequencies where C9 is a low impedance, the input impedance of the circuit is approximately R10 (h<sub>ie</sub> + 1). However, at low frequencies, when the reactance of C9 becomes appreciable, less signal voltage is developed across R8. As frequency decreases further, the input impedance decreases at a rate corresponding to a 6-dB per octave slope. If C8 is chosen to establish a break point at this same frequency, the net effect is a 12-dB per octave rolloff at the low frequency cutoff point.

The reactance of C9 at the low frequency cutoff point is made equal to 10% of the parallel combination of R7 and R9.

The reactance of C9 (X<sub>c9</sub>) is found as follows:

$$X_{c9} = 0.1 \left( \frac{R7 \times R9}{R7 + R9} \right)$$

$$= 0.1 \left( \frac{9,840,000,000}{202,000} \right)$$

$$= 4,871 \text{ ohms}$$

Using equation (1) and a cutoff frequency of 20 Hz and rounding off the reactance of C9 to 5,000 ohms.

$$C9 = \frac{159,000}{(5,000) (20)} = 1.59 \mu\text{F}$$

A 1.5- or 2.0-μF capacitor could be used. C8 is selected in a similar manner. For a typical input impedance of 2.5 megohms and a cutoff point of 20 Hz,

$$C8 = \frac{159,000}{(2,500,000) (20)} = 0.0032 \mu\text{F}$$

The nearest standard value is  
(continued on page 90)

# POWER IC'S FOR HI-FI

Miniature package delivers audio power and performance

by D. V. JONES\*

AMONG THE GRADUAL IMPROVEMENTS IN MONOLITHIC linear integrated circuits is their ability to handle more power. Today, low-cost, off-the-shelf power IC's are finding a wide range of new commercial and hobby applications. A monolithic IC amplifier in the 1-2 watt range, for example, will drive a speaker or earphones for phono, tape, AM, FM and TV audio, as well as intercoms, dictating equipment, movie projectors, language labs and other teaching equipment.

Heading the list of monolithic IC advantages over discrete components is sharply reduced circuit size. Next come increased reliability and lower costs. Another advantage to IC amplifier design is that thermal feedback can be used to stabilize voltage and current quiescent bias conditions. The small size of an IC chip (typically 0.060 x 0.064 inch) offers close thermal coupling between chip components that could not be duplicated with discrete components on a common heat sink.

A monolithic power amplifier such as General Electric's PA237 must provide a means for transferring internally generated heat. GE uses a low-cost plastic package with a copper tab at one end to allow heat to flow from the IC chip to a copper area on the PC board. The package, as shown in Fig. 1, is connected by first bending the tab and leads at right angles for soldering. The tab is connected to the substrate at the bottom of the monolithic chip, and should be connected to lead 8 (circuit ground for the PA237).

## Quasi-complementary push-pull output

Let's look at how the PA237 is used in audio circuits. The circuit of the IC is shown inside the dashed line in Fig. 2 along with external test-circuit components. Distortion curves for both frequency and power output are shown in Fig. 3. These curves indicate good performance up to 2 watts, with peak clipping occurring at 2½ watts. The open loop gain is about 55 dB. With 21 dB of negative feedback, the 2-watt sensitivity is 120 mV.

\*General Electric Co., Syracuse, N.Y.

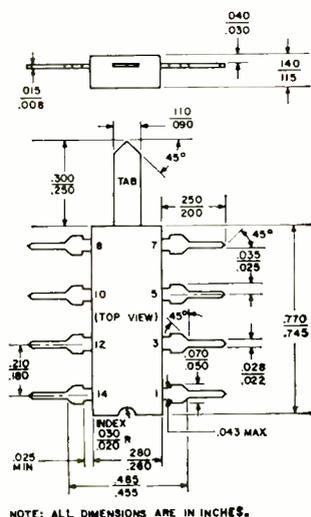


Fig. 1—Plastic packaged PA-237 can dissipate 2½ watts of power. Fig. 2 (right)—Test circuit for PA237. Chip circuit is inside dashed line. Setup gives Fig. 3 response.

Transistors Q4-Q8 in Fig. 2 comprise a quasi-complementary push-pull output circuit.† Because the emitter current gain ( $h_{fe}$ ) of Q6 is only 1-10 at 1 mA collector current, three transistors are required for the composite pnp output transistor (Q4-Q6). Transistors Q1 and Q2 form a differential amplifier, with Q1 operating as an emitter follower to drive Q2 as a quasi-common-base stage. When R6 is zero (feedback removed from Q2's base), Q2 operates common-base. The circuit has no phase inversion of the signal from input to output—except within composite pnp transistor Q4-Q6. The arrangement of push-pull composite transistors provides a high current amplification so Q2 can operate at low current (about 0.5 mA). This also enables R3 to be relatively large (18,000 ohms), to enhance voltage amplification.

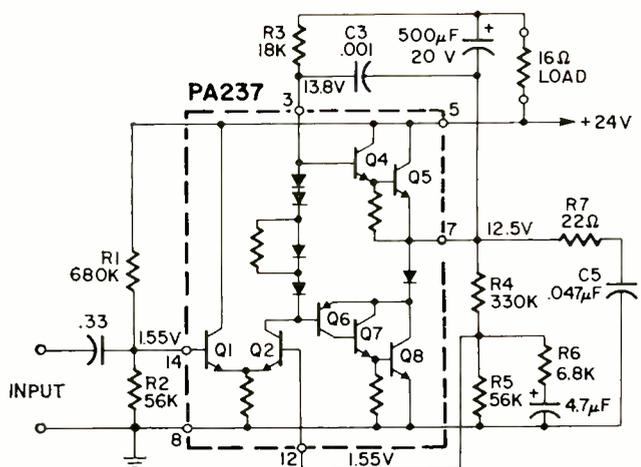
The differential amplifier configuration of Fig. 2 is often used in IC's to utilize the matching of  $V_{BE}$  and  $h_{fe}$  on similar and adjacent transistors of a chip. Since a differential amplifier amplifies the difference between two signals applied to the base of each transistor, an in-phase feedback signal is often applied to one side of the differential. In Fig. 2, feedback is applied to the base of Q2.

Voltage-source base bias provides good bias stability against variation in  $h_{fe}$  for Q1 and Q2 (also against temperature variations). Dc bias voltage on lead 7 must be stable if maximum power output at low distortion is to be maintained. The differential amplifier with dc feedback to Q2's base provides this stability.

A diode string between the bases of Q4 and Q6 provides the needed dc bias voltage for the quasi-complementary push-pull output to minimize distortion at low signal levels. The value of R3 can be reduced to maintain 0.5 mA through the series diodes at lower supply voltage. The power-output diode in series with Q5 and Q8 assists in the bias stabilization of this direct-coupled circuit, and also provides local ac feedback in the effective emitter of the composite pnp transistor.

The 16-ohm load is returned to the power supply, an ac ground, so the 500- $\mu$ F load-coupling capacitor can

†For additional information on quasi-complementary outputs see D. V. Jones and R. F. Shea, *Transistor Audio Amplifiers*. New York: John Wiley & Sons, 1968.



also serve to bootstrap resistor R3. This eliminates the need for a separate capacitor and resistor. The positive feedback increases the effective resistance of R3 and thus increases the open-loop (with R6 = 0) voltage amplification by 14 dB. Negative feedback with R6 = 6800 ohms is 24 dB.

Capacitor C3 decreases the open-loop gain at extreme high frequencies by decreasing the effective bootstrapping of R3. This capacitor rolls off the high-end frequency response of the circuit by 100 kHz (-3 dB). Without feedback (R6 = 0), the frequency response is down 3 dB at 30 kHz. Capacitor C3 also provides high-frequency stabilization when the amplifier is operating from a high-impedance signal source, or with various output load conditions. An RC network (R7-C5), similar to that used with discrete amplifiers, is in parallel with the load and limits the increase of inductive load impedance with its accompanying phase shift as frequency increases.

The PA237 can be biased to operate with supply voltages from 9 to 27 volts, and sensitivity can be increased or decreased by changing feedback resistor R6. Many combinations of supply voltage and load impedance are possible.

Sensitivity and input impedance are suitable for driving the IC with an FM or TV ratio detector. By using a resistor in series with the input to trade sensitivity for

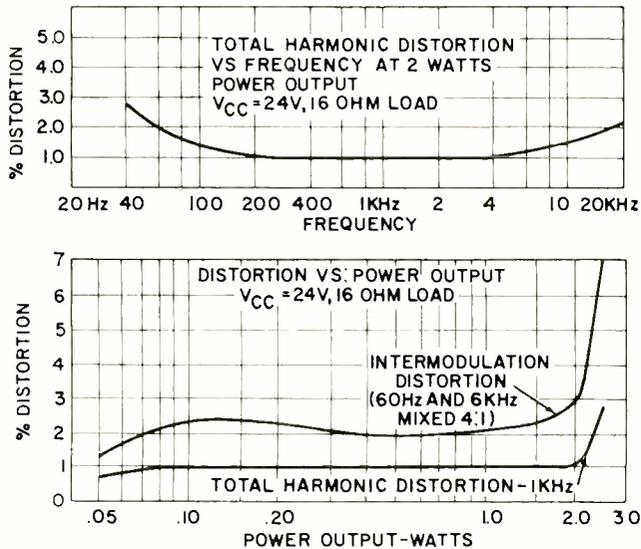
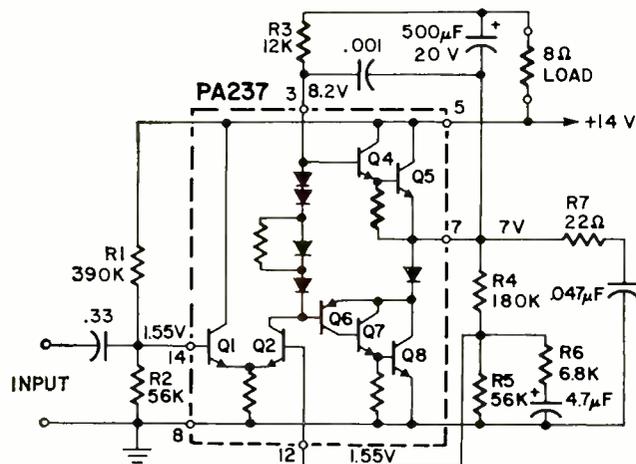


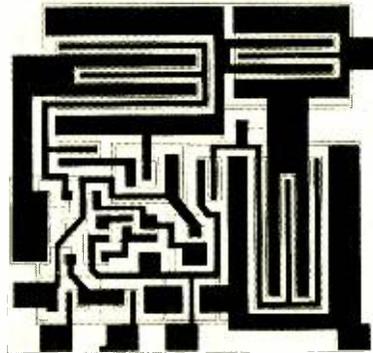
Fig. 3—Total harmonic distortion vs. frequency for the IC circuit in Fig. 2 (top), and power vs. distortion (bottom curve).

Fig. 4—This PA237 circuit can deliver 1 watt into an 8-ohm load with a 14-volt power supply. By changing 3 resistors (see text), circuit can be used with an 18-volt power supply.



## WHAT'S INSIDE THE PA237?

MONOLITHIC INTEGRATED CIRCUITS ARE COMPLETE WITHIN a single chip structure. Transistors and diodes are fabricated on and within a *single* semiconductor substrate together with resistors and capacitors. In contrast, hybrid integrated circuits are usually discrete components such as transistors joined with thick- or thin-film resistors and capacitors on a passive ceramic substrate. Hybrids can also be other combinations such as monolithic IC's combined in a single package. For monolithic IC fabrication,

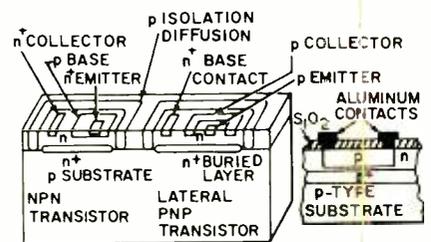


circuit elements are usually diffused into a p-type silicon substrate (see drawings below). Interconnections between elements are made with aluminum metalization on the IC chip surface. The resulting pattern is shown in the

greatly enlarged photo. The two output transistors of the PA237, Q5 and Q8 in Fig. 2, together with the series-connected output diode, occupy about 60% of the chip area. The output diode is located in the upper right-hand corner of the chip. The differential amplifier transistors, Q1 and Q2, are located at the lower left corner of the chip.

The drawing on the left below shows formation of common-substrate npn and pnp transistors. A reverse-biased pn junction surrounding each element or group of elements provides electrical isolation. The p-type region of the isolating junction is common with the p substrate of the IC.

Common substrate for both npn and pnp transistors (left), and the cross section of an IC resistor (right).



In the npn silicon transistor, emitter current flows vertically down across the base region and is collected at the n+ region directly below. Since all connections are made on the top surface with the metallization pattern, collector current flows laterally through the low-impedance n+ buried layer until it reaches a point of shortest path in the vertical direction to the collector contact area.

The lateral pnp gets its name from the lateral flow of transistor current from emitter to collector. Because of its wider base region, the current gain ( $h_{fe}$ ) of the lateral pnp is low.

A cross section of a monolithic IC resistor is shown on the right above. Most monolithic resistors are formed during the p-type (transistor base) diffusion cycle. Their resistance is proportional to their physical length and width, making large resistor values expensive because of the large silicon area needed. When diodes are required in a monolithic circuit, a collector-base shorted transistor connection is usually used since it has a low dynamic resistance, reduces current flow to the substrate and also reduces stored charge in the collector region.

higher input impedance, the IC can be driven with a phono cartridge. With a 330,000-ohm series resistor, for example, 2-watt sensitivity is 1 volt. Volume, tone and balance controls can be incorporated between the cartridge output and the amplifier input.

To deliver 1 watt into an 8-ohm load with a 14-volt power supply, use the circuit in Fig. 4. Sensitivity of this circuit is 110 mV for 1 watt output, and total harmonic distortion is 1% at 1 kHz. The same circuit can be used with an 18-volt supply by changing R1 to 470,000 ohms, R3 to 15,000 ohms and R4 to 220,000 ohms. With an 18-volt supply, the load can be 8 or 16 ohms for about 1.5 watts output.

Some applications may require one side of the load to be connected to ground potential. The circuit in Fig. 5 meets this requirement with the addition of R8 and C6 for the bootstrap (positive-feedback) network. Performance of this circuit is the same as that of Fig. 2. When an input impedance of 2 or 3 megohms is required, a single transistor can be added as shown in Fig. 6.

A tape playback system using a two-transistor preamp to drive the PA237 is shown in Fig. 7. The preamp is equalized for 1 $\frac{7}{8}$ - or 3 $\frac{3}{4}$ -ips tape speed with R15 set at about 15,000 ohms. TREBLE EQUALIZATION control R15 can be adjusted to compensate for variations in program material, tape head or speaker, and function as a normal treble-cut control. Overall voltage amplification vs frequency for this circuit is shown in Fig. 8.

Sensitivity of the tape system can be adjusted by varying the value of R18. The value shown will give 2 watts output with 0.7 mV input signal from the tape head, adequate for an 8-track cartridge stereo tape system. The output noise (weighted) is more than 50 dB below the 2-watt signal level. The preamp will accept input levels of 8 mV before clipping—20 dB above the input signal for 2 watts output.

R-E

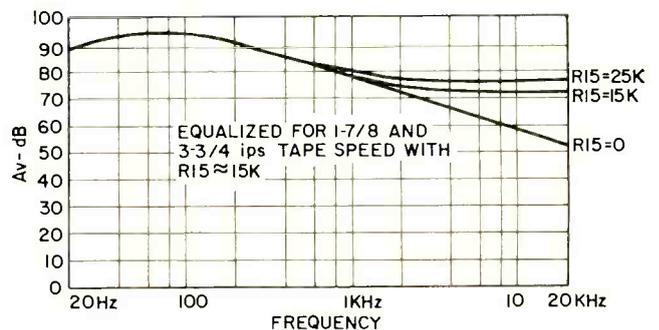
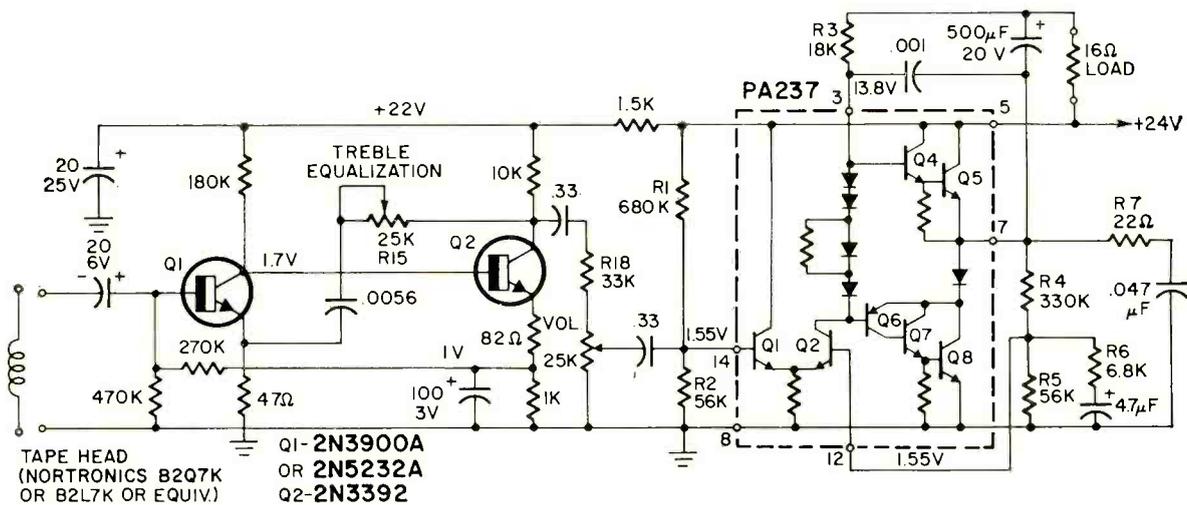
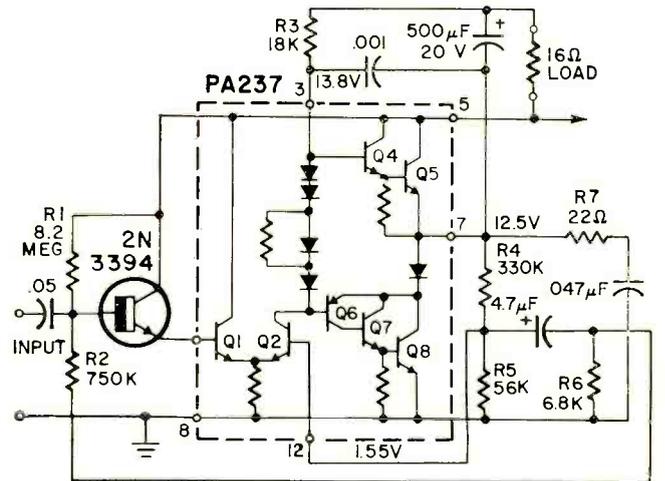
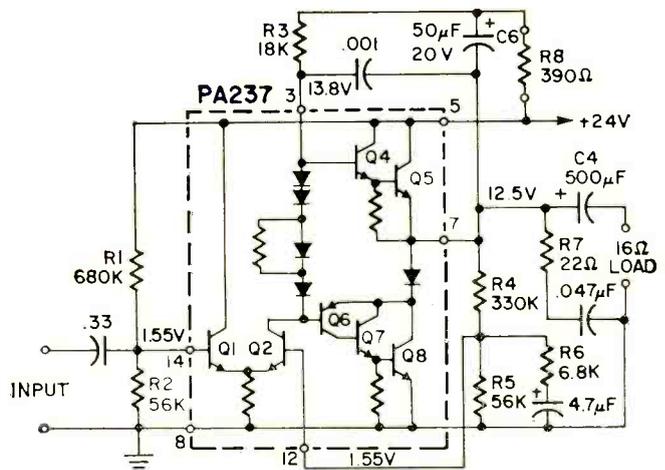


Fig. 5 (top)—A 2-watt hookup with load at ground potential.

Fig. 6 (middle)—Addition of transistor boosts input impedance.

Fig. 7 (above)—One 2-watt channel of cartridge tape system delivers full output with 0.7-mV input from tape head. Treble equalization R15 also compensates for various inputs and loads.

Fig. 8 (right)—Voltage amplification vs. frequency for Fig. 7.

# 20 SCR CIRCUITS YOU CAN MAKE

Part 2—Put silicon controlled rectifiers to work in your home. Build dozens of useful circuits

by R. M. MARSTON

LAST MONTH, IN THE FIRST PART OF this series, we looked at the operating theory of silicon controlled rectifiers (SCR's) and learned how they are gated to control high power levels. With this background and the practical circuits described, you should be ready to tackle these more complex SCR applications.

## Delayed-turn-on lamp driver

Fig. 1 shows a delayed-turn-on lamp driver circuit. Lamp LM1 goes on some time after START switch S1 is closed. Normally, SCR1 and the lamp are off. S1 is open and no power is applied to the unijunction transistor (UJT) circuit. When S1 is first closed, therefore, the SCR anode is at +12 volts, and power is applied to the UJT timer to initiate the timing cycle. At the end of this cycle, the UJT fires and turns on the SCR and lamp via a gate pulse. As the SCR conducts, its anode falls to near-ground potential, making the UJT circuit inoperative. The SCR is self-latching, so the lamp stays on until the supply-line connections are broken.

The turn-on delay of the circuit can be varied from approximately 8–80 sec by R4. Longer delays can be obtained by increasing the value of capacitor C1.

Notice in this and other dc circuits described earlier that a 12-volt, 500-mA lamp load has been specified, but any load with a current rating of about 50 mA to 3 amps can be used. Similarly, alternative supply voltages may be used if preferred, but in this case some component values may have to be changed.

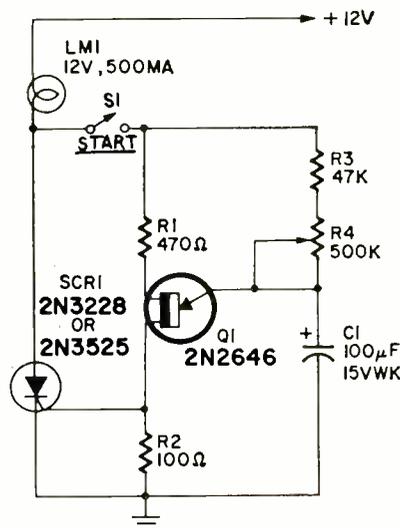


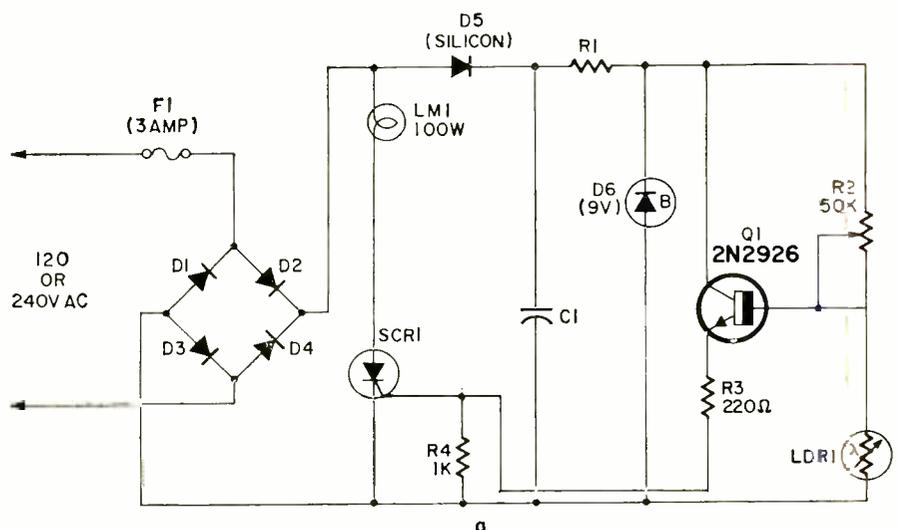
Fig. 1 (above)—Unijunction transistor Q1 applies a gate pulse to the SCR after timing delay. Circuit is self-latching. Fig. 2-a (below)—SCR conducts, operating LM1, when LDR1 turns Q1 on.

## Light-operated line switches

A simple light-operated ac line-switch circuit, driving a 100-watt lamp load, is in Fig. 2-a. The lamp turns on automatically when the light level falls below a predetermined value and switches off when the light level rises.

The ac line voltage is converted to rough dc via bridge rectifier D1–D4, and this rough dc is then applied across the LM1–SCR1 series network. Part of this dc is also tapped off and smoothed by D5 and C1, and is used to provide a stable 9-volt supply through R1 and Zener diode D6. This 9-volt supply is then used to power Q1, which controls SCR1.

Transistor Q1 is wired as a simple emitter follower, with base bias supplied by the R2–LDR1 divider network. Emitter current is fed to SCR1's gate via limiting resistor R3. Photocell LDR1 can be any cadmium-sulphide unit, and presents a high resistance under dark conditions



and low resistance under bright conditions. Thus under bright conditions a low voltage appears on Q1's base through the voltage divider action of R2-LDR1. Since insufficient current flows in Q1 to trigger the SCR, both the SCR and lamp are off. Under dark conditions, on the other hand, a large voltage appears on Q1's base, so the SCR is triggered on via Q1's emitter current, and SCR1 and the lamp go on. The circuit is not self-latching.

The circuit can be modified to give self-latching operation (Fig. 2-b). In this case part of the smoothed dc high-voltage supply is tapped off and fed to the SCR anode through S1 and R5. The SCR is therefore supplied with both ac (via LM1) and

dc (via R5) anode currents once it has been initially turned on by Q1. Since the direct current is above the SCR's minimum holding requirement, the circuit is self-latching. Once the circuit has latched on, it can be unlatched again by momentarily opening switch S1.

Fig. 3 shows a more complex version of the light-operated line switch. Transistor Q1 is again wired as an emitter follower supplying gate bias to the SCR, but in this case a high-input-impedance Schmitt trigger (Q2-Q3-Q4) is connected between Q1's base and the R2-LDR1 junction. This enables the switching light level of the circuit to be precisely set. In addition, R5 and C2 act as a long-

time-constant smoothing network at the R2-LDR1 junction, insuring the SCR is not triggered by brief changes in light level (lightning flashes or passing lights).

Under bright conditions, the Schmitt trigger is off, with Q3-Q4 cut off and Q2 saturated. A very low voltage is applied to Q1's base, and the SCR and lamp are off. Under dark conditions, the Schmitt trigger is on, and Q3-Q4 saturate and Q2 goes off, applying a large voltage to Q1's base, and the SCR and lamp are driven on. This circuit is also not a self-latching type.

Note that when the trigger light levels of this circuit are being set initially (via R2), C2 should be temporarily disconnected, to eliminate the time-delay effects.

### Isolated-input line switches

The line-switch circuits of Figs. 2 and 3 can be readily adapted for inputs other than light by simply using alternative types of transistor sensing circuits. They can, for example, be operated by sound, by audio tones, by radio signals or by proximity of the human body, etc. Similarly, they can be used as lamp flashers, as delayed-turn-on or delayed-turnoff line switches if suitable timing circuits are used.

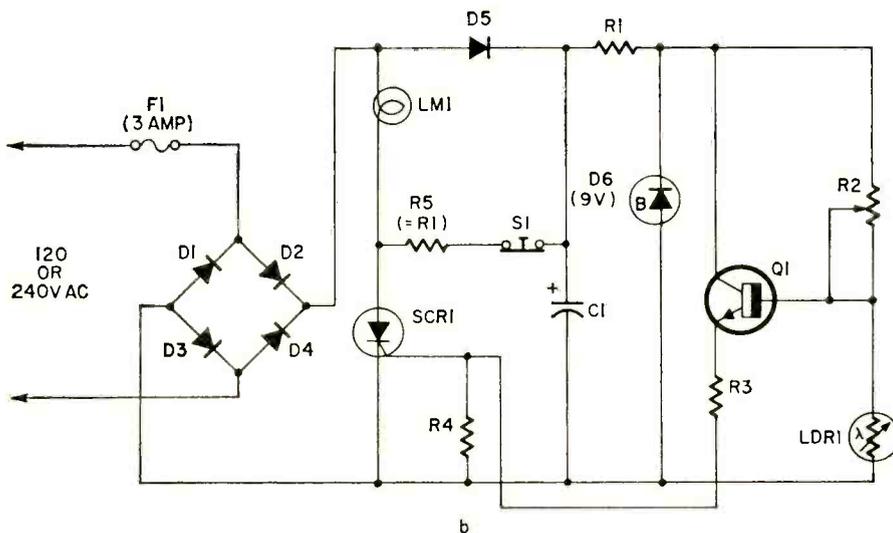
Remember that in these circuits the transistor sensing circuits are "hot" since they are connected to one side of the ac line supply. For some applications, such as water-operated or touch-operated line switches, this is too dangerous, and the input to the sensing circuitry must be electrically isolated from the gate of the SCR.

One way of obtaining an isolated input is to replace S1 of Fig. 7 or 8 (Part 1) with a low-current relay contact, the relay itself being operated by the sensing circuitry, which in turn is powered from an isolated supply. Or can be replaced with a shielded LDR and switched light source, as shown in Fig. 4.

In this case, the LDR is mounted in a lightproof tube, together with low-voltage lamp LM2, so that the LDR presents either a very high resistance (with LM2 off) or a very low resistance (with LM2 on). Thus, the SCR goes on when LM2 is on and off when LM2 is off, but LM2 is fully isolated from the SCR. In practical circuits, LM2 can be powered directly by transistor sensing circuitry. The LDR can be almost any low- to medium-power type, but must be capable of withstanding the full ac line voltage.

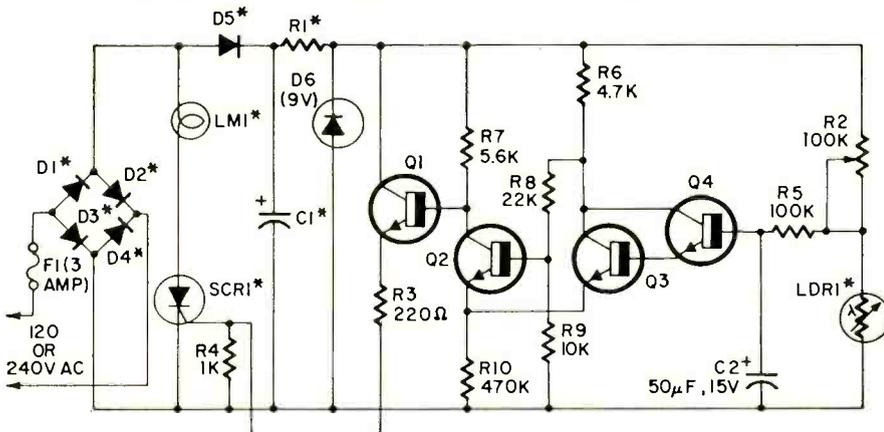
### Phase triggering

The ac circuits shown so far give



SCR1 = 2N322B ON 120V AC LINE, OR 2N3525 ON 240V AC LINE.  
 DI-D4 = 200 P.I.V., 3AMP ON 120V AC LINE, OR 400 P.I.V., 3AMP ON 240V AC LINE.  
 D5 = 200 P.I.V., 100MA ON 120V AC LINE, OR 400 P.I.V., 100MA ON 240V AC LINE.  
 C1 = 1 $\mu$ F, 250VWK ON 120V AC LINE, OR 1 $\mu$ F, 500VWK ON 240V AC LINE.  
 R1 = 10K, 5 WATT ON 120V AC LINE, OR 22K, 10 WATT ON 240V AC LINE.  
 LDR1 = ANY CADMIUM SULPHIDE PHOTOCELL WITH FACE DIAMETER GREATER THAN APPROX. 1/4".

Fig. 2-b—Lamp stays on until SCR anode current is reduced by opening S1. Self-latching occurs because of dc applied to SCR.



\* = AS IN FIG. 2  
 Q1-Q4 = 2N2926

Fig. 3—Adding a Schmitt trigger circuit lets you accurately set the light level that turns on lamp LM1. Disconnect C2 before setting light-level control R2.

a simple on/off form of power control in which either full power or zero power is applied to the load. The SCR can also be used to give very efficient variable power control in ac circuits with phase triggering. This principle can be understood with the aid of Figs. 5 and 6.

A basic full-wave, phase-triggered, variable-power-control circuit is shown in Fig. 5. The SCR and lamp are fed from a full-wave rectified power source, and the SCR's gate trigger signal is derived from the SCR anode via a variable phase-delay network. Thus, with a short phase delay the SCR can be triggered just after the start of each half-cycle. With a long phase delay it can be triggered near the end of each half-cycle or, with a medium phase delay, at say, halfway through each half-cycle. Fig. 6 shows the circuit waveforms that result.

Remembering that each half-cycle of ac covers a 180° phase angle, look first at the waveforms that result if the gate signal is given a 5° phase delay. In this case the SCR is triggered 5° after the start of each half-cycle. Consequently, the available line voltage is applied to the lamp for the remaining 175°, and the lamp operates at virtually full power. But suppose the gate signal is given a 90° phase delay. In this case the SCR does not trigger until halfway through each half-cycle. The line voltage is applied to the lamp for only the final 90° of each half-cycle, and the lamp lights at half power. Finally, look at the case where the gate signal is delayed by 170°. Power is applied to the lamp for only the final 10° of each half-cycle, and the lamp operates at near-zero power.

In practical circuits the phase delay of the gate trigger signal is usually fully variable from 5° to 170°, enabling the load power to be smoothly varied from near zero to maximum. Note, however, that since the SCR is either full on or full off at all times, very little power is "lost" in the SCR, making the power-control system highly efficient. Since the brightness of a lamp, or the speed of an electric motor, is proportional to the power fed into the device, phase-triggered SCR circuits of this type operate as very efficient lamp dimmers, drill-speed controllers, etc.

### Phase-triggered lamp dimmer

Fig. 7 shows the circuit of an SCR lamp dimmer using the phase-triggered principle of operation. The line voltage is converted to rough dc via bridge rectifier D1-D4. This voltage is applied to the SCR and to the UJT timer circuit. Thus, an energizing

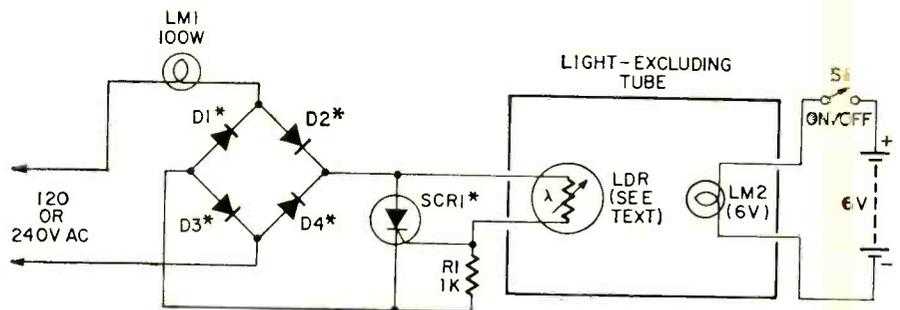
voltage is applied to the UJT during each half-cycle of ac line voltage. As soon as this voltage is applied, the UJT starts a timing cycle, at the end of which Q1 fires and triggers the SCR on. As the SCR conducts, it applies power to the lamp, and the voltage at SCR1's anode and across the UJT circuit falls to near zero, turning off the UJT for the rest of the half-cycle. The UJT timer is thus synchronized to operate with the 60-Hz ac line frequency.

The timing period of the UJT can be varied over a wide range by R3, so the SCR can be triggered just after the start or near the end at any intermediate point of each half-cycle. The lamp power can be smoothly varied from near zero to maximum via resistor R3.

The SCR switches from the off to the on state in a few microseconds. This generates a large number of harmonics, which may be injected into

be used to control efficiently the operating speeds of electric drills and other devices powered by universal (ac/dc) motors. These controllers can work on either the full-wave or half-wave principle, and can give either regulated or unregulated speed control. Half-wave controllers enable the motor speed to be varied from zero to about 75% of maximum, while full-wave units permit variation all the way from zero to maximum. Regulated units hold motor speed constant under all load conditions, but unregulated units do not.

Fig. 8 shows the circuit of a half-wave unregulated speed controller. Network D1-R1-R2 and C1 form a simple phase-shifting circuit that works on positive half-cycles only. This provides a phase shift that can be varied from about 5° to 170° by R1. The Q1-Q2-R3-R4-R5 circuit acts as a self-latching, voltage-triggered  
(continued on page 86)



\* = AS IN FIG. 3

Fig. 4—A light-excluding tube containing a photocell and lamp isolates sensing circuits from ac line. LM2 controls SCR by changing LDR resistance.

the ac power line and cause interference on AM radios. This problem is particularly acute if the SCR is triggered more than about 10° after the start of each half-cycle (as in this case). To help overcome this problem, L1 and C1 are wired in the circuit as shown and act as an rf filter to attenuate the high-order harmonics. Coil L1 must be capable of carrying the full load current of LM1.

### Drill-speed controllers

Phase-triggered SCR circuits can

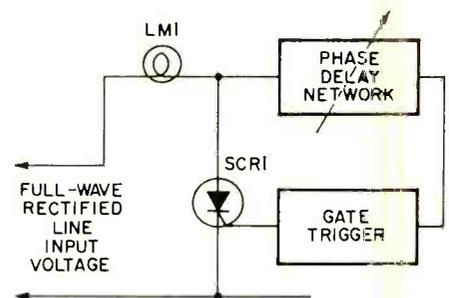


Fig. 5—Phase delay of SCR gate signal permits full range of power to lamp.

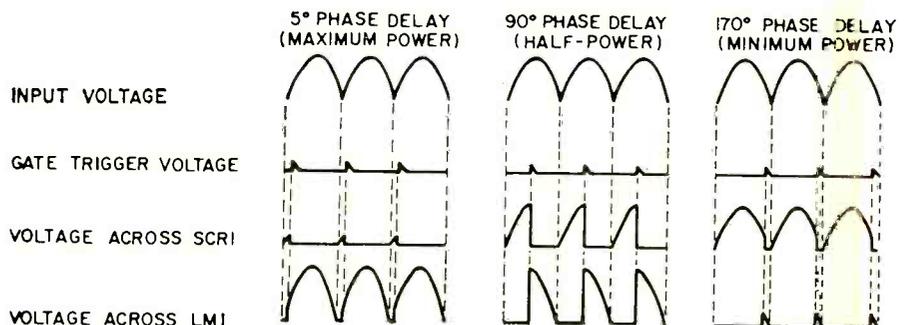


Fig. 6—Waveforms show effect of various phase delays on SCR and LM1 (Fig. 5). With a 5° gate-phase delay, most of the 180° phase angle appears across LM1.

## ALL ABOUT IC'S

# Making Circuit Components

by **BOB HIBBERD**

TEXAS INSTRUMENTS, DALLAS, TEXAS

How to squeeze diodes, transistors, capacitors, resistors into thousandths of an inch—Part 2

THE TRANSISTOR REVOLUTIONIZED ELECTRONICS. It made possible smaller, lighter, more versatile, more reliable, less costly electronic gear which required less operating power. But the transistor was only a prelude to a much greater revolution—the *monolithic integrated circuit*. These devices perform complete circuit functions in a space the size of a single transistor. As a result IC's (integrated circuits) are becoming the basic component of electronic equipment. They are rapidly replacing assemblies of discrete transistors, diodes, resistors and capacitors.

In this article we will see how silicon monolithic integrated circuits are made. The method of forming the electronic circuit elements within a single silicon wafer and interconnecting them to give a complete electronic circuit is detailed.

### Microelectronics

The terms "microelectronics" and "integrated circuits" are sometimes used interchangeably, but this is not correct. Microelectronics is a name for extremely small electronic components and circuit assemblies, made by thin-film, thick-film or semiconductor techniques. An *integrated circuit* (IC) is a special kind of microelectronics. It is a circuit that has been fabricated as an inseparable assembly of electronic elements in a single structure. It cannot be divided without destroying its intended electronic function. Thus, IC's come under the general category of microelectronics, but all microelectronic units are not necessarily IC's.

There are two basic approaches to modern microelectronics—monolithic integrated circuits and film circuits. In *monolithic integrated circuits*, all circuit elements, active and passive, are simultaneously formed in a single small wafer of silicon. The elements are interconnected by metallic stripes deposited onto the oxidized surface of the silicon wafer.

*Film circuits* are made by forming the passive electronic components and metallic interconnections on the surface of an insulation substrate. Then the active semiconductor devices are added, usually in discrete wafer form. There are two types of film circuits, thin film and thick film.

In *thin-film circuits* the passive components and interconnection wiring are formed on glass or ceramic substrates, using evaporation techniques. The active components (transistors and diodes) are fabricated as separate semiconductor wafers and assembled into the circuit.

*Thick-film circuits* are prepared in a similar manner except that the passive components and wiring pattern are formed by silk-screen techniques on ceramic substrates.

Other integrated circuits are produced using a combination of techniques. In *multichip circuits*, the electronic components for a circuit are formed in two or more silicon wafers (chips). The chips are mounted side by side on a common header. Some interconnections are included on each chip, and the circuit is completed by wiring the chips together with small-diameter gold wire.

*Hybrid integrated circuits* are combinations of monolithic and film techniques. Active components are formed in a wafer of silicon using the planar process, and the passive components and interconnection wiring pattern formed on the surface of the silicon oxide, which covers the wafer, using evaporation techniques.

### Monolithic IC's

The monolithic IC is often considered a single electronic component since it is made and installed as single entity. The circuit components, as they were called in discrete assemblies, are referred to as circuit elements of integrated circuits. From now on we use the word "element" for this purpose.

Monolithic IC technology is an ex-

tension of the diffused planar process. Active elements (transistors and diodes) and passive elements (resistors and capacitors) are formed in the silicon slice by diffusing impurities into selected regions to modify electrical characteristics, and where necessary to form pn junctions. The various elements are designed so all can be formed simultaneously by the same sequence of diffusions.

In practice, the details of the diffusion processes are decided by the requirements of the transistors. The geometry of the other elements is designed so desired values are obtained with the transistor diffusion schedules. All process operations are carried out on the top surface of the silicon slice and all element contact regions are formed on this same surface. They are interconnected to form the complete electronic circuit by evaporating a metallic wiring pattern atop the silicon oxide which covers the surface between the contact areas.

As with planar transistors, selective oxide removal, diffusion and metallization are carried out on whole silicon slices. On each slice, the same circuit pattern is repeated a large number of times. For example, with an IC wafer 50 mils square (1 mil equals 0.001 inch) a single slice of silicon, 1.5 inches in diameter, contains about 500 circuits, which are all processed at the same time (see Fig. 1).

The general sequence of monolithic integrated circuit fabrication is shown in Fig. 2. The first step is the "bread-board" design of the electronic circuit using discrete components. The circuit is designed to perform the required function and to insure that the values of the circuit elements are compatible with the diffusion processes. Next, the circuit elements are designed dimensionally and the complete circuit laid out in a geometric pattern. This is usually done by drawing the layout about 500 times full size—a 50-mil square wafer is drawn about 2 feet square.

From this drawing, a series of related drawings are prepared, one for each of the oxide removal steps. Each drawing is reduced to actual size by a series of photographic processes. At the same time as the final reduction to life size, the pattern is repeated by indexing the photographic plate under the image in a "step and repeat" sequence.

For each oxide removal step, a "master" photographic mask is made. It contains a matrix of the circuit patterns in precise location over an area greater than the slices to be processed. Copies are made from the master, and are used to expose the photoresist selectively during the oxide removal steps.

To understand IC fabrication, we must know how each type of circuit ele-

ment is formed. The elements used are the same as those in discrete circuits—transistors, diodes, resistors and capacitors. A requirement common to all elements in IC's is that each one must be electrically isolated from the main part of the silicon wafer so that unwanted coupling between elements is minimized. Then the only connections between the elements will be the metallized pattern on the surface.

### Isolation techniques

Several isolation methods have been developed. The most common are diode isolation and oxide isolation. *Diode isolation* uses the very high resistance of a reverse-biased pn junction. In this process (Fig. 3), an n-type epitaxial layer is

grown on a p-type substrate slice of silicon. The surface of the epitaxial layer is oxidized (Fig. 3-a) and the oxide selectively removed from everywhere but the regions in which the elements will be formed (Fig. 3-b).

A p-type diffusion is then carried out and the p-type regions formed extend down through the epitaxial layer and join up with the p-type substrate (Fig. 3-c). This leaves n-type regions, each separated from the substrate by a pn junction (Fig. 3-d). When the final IC is operated, the pn junctions are all biased in the reverse direction by connecting the p-type substrate to a potential more negative than any part of the circuit. Then each junction presents a very high resistance which isolates the element formed in the

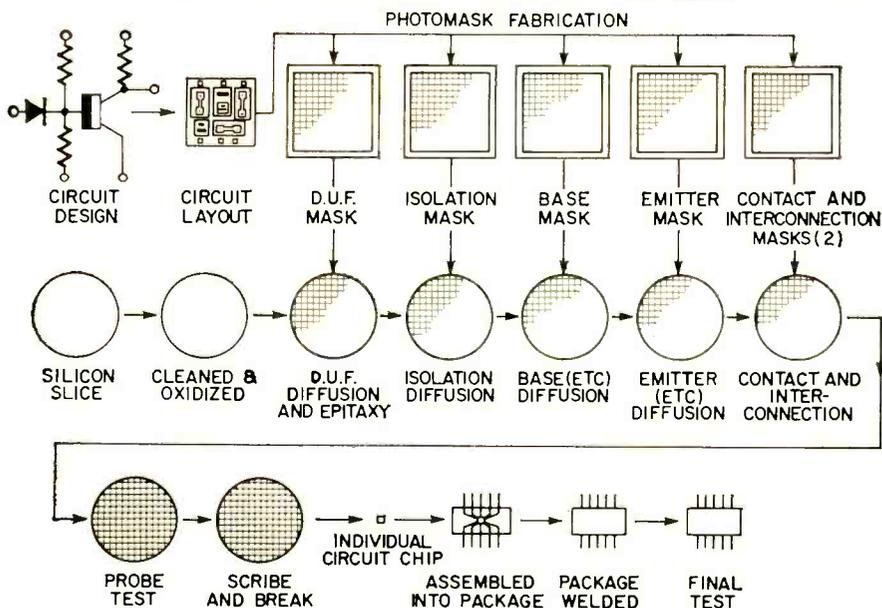
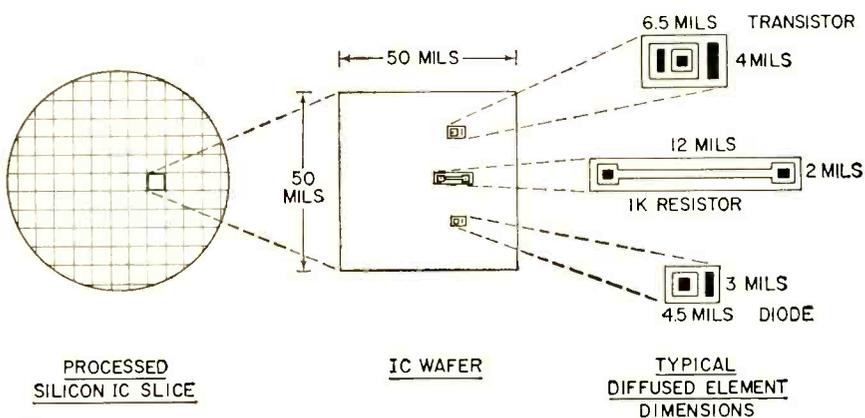
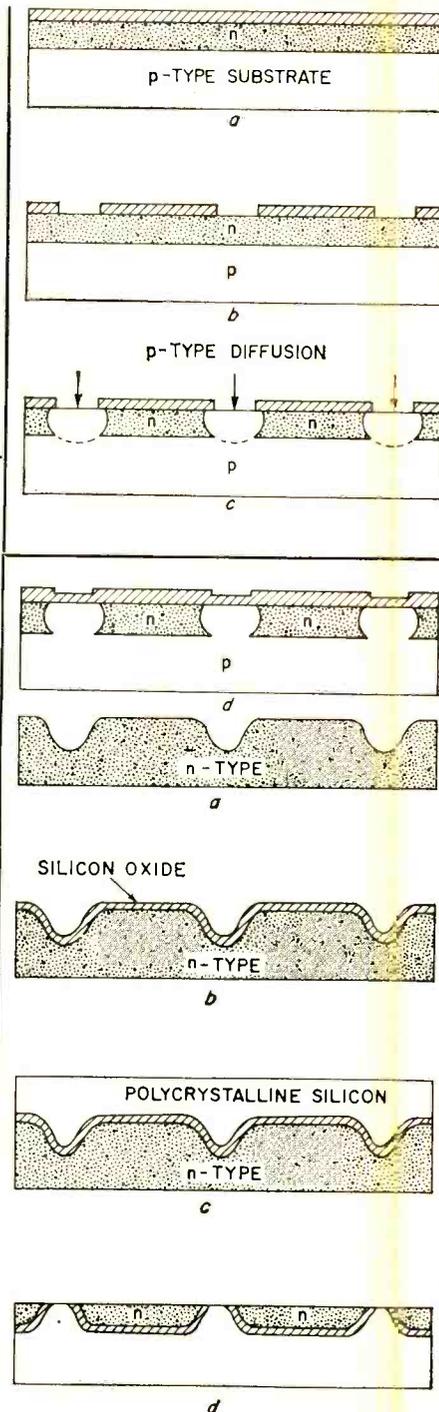


Fig. 1 (top)—A 1.5-inch silicon slice can contain 500 IC wafers. Within a 50-mil wafer, resistors and transistors need the most area. Typical component sizes are shown.

Fig. 2 (above)—To make an IC, greatly enlarged drawings are photographically reduced to about 50-mil square. Separate masks are needed for each oxide removal step.

Fig. 3 (top right)—Pn junction formation as oxidized n-type layer (a) has areas opened (b), and p-type diffusion isolates n areas. Surface is reoxidized (d).

Fig. 4 (right)—Oxide isolation starts with etched channels between surface-oxidized elements (a & b); silicon deposit (c) is then lapped on inverted slice (d).



n-type region of the junction.

With *oxide isolation*, a layer of silicon oxide is formed around each element as in Fig. 4. On a slice of n-type single crystal silicon (Fig. 4-a) channels are etched in the surface between the locations planned for each element. Then the surface of the slice, including the channels, is oxidized to form a continuous layer of silicon oxide Fig. 4-b. Polycrystalline silicon is deposited on top of the oxide in an epitaxial reactor (Fig. 4-c). Finally the slice is inverted and the original silicon is lapped down so only the regions between the channels are left (Fig. 4-d). Each of these is a region of single crystal silicon isolated by the layer of silicon oxide and supported on the substrate of polycrystalline silicon.

A third system of isolation used for special applications is called *beam lead isolation*. The circuit elements are formed in a wafer of silicon in the regular manner. The interconnecting metallization is made thicker than usual. Then the silicon between each element is completely removed by etching from the back side. The etchant does not attack the metallization, so each element is completely separate and is supported from the top by the metallic connections. A thermo-setting plastic can be applied to fill the spaces between the elements for added mechanical support.

### Forming an IC transistor

The techniques for making bipolar transistors for integrated circuits are similar to those for discrete planar transistors. A typical arrangement using diode isolation is shown in Fig. 5-a. After the isolation process, boron is diffused in to form the p-type base region. Then phosphorus is diffused in to form the high-concentration n<sup>+</sup>-type emitter region. At the same time, another n<sup>+</sup> region is diffused into the n-type collector region so a low-resistance contact to the collector region can be made.

There is one significant difference from the discrete planar transistor. The collector contact is made at the top surface, alongside the base and emitter contacts. This is a problem because collector current must flow laterally along the narrow n-type collector region to reach the contact. There is additional series-collector resistance compared with the discrete transistor, in which the collector contact is made to the bottom surface.

### Using D.U.F.

To minimize this series resistance, a low-resistance n<sup>+</sup>-type region is selectively diffused into the substrate slice before the epitaxial growth of the n-type layer. This gives the structure in Fig. 5-b. Collector current can now flow straight down into the low-resistance n<sup>+</sup> region and then sideways along it to the vicinity

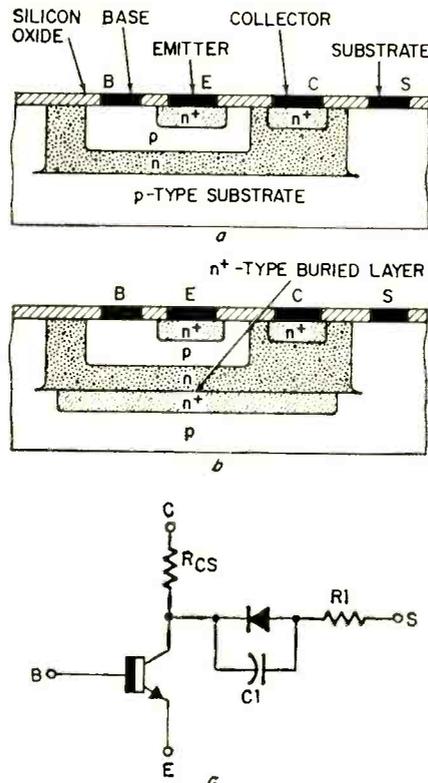


Fig. 5—An IC transistor, showing basic structure (a), preferred structure (b) and the device's equivalent circuit (c).

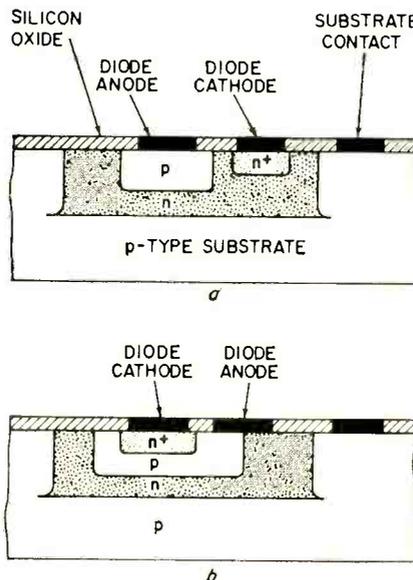


Fig. 6-a—A collector-base IC diode used in general-purpose circuits. b—The faster-switching emitter-based diode.

## NEXT MONTH

In the August article of this series, we'll look at how other elements are formed in IC's. The upcoming section describes how resistor values are determined by p-type material dimensions and concentration. Also covered are junction and MOS-type capacitors, IC testing and assembly processes.

of the contact, resulting in a lower series-collector resistance ( $R_{CS}$ ). This arrangement is called D.U.F. (Diffusion Under the Epitaxial Film).

The equivalent circuit of the transistor, including the isolation junction, is shown in Fig. 5-c. The isolation junction has capacitance  $C_I$  in parallel and series resistance  $R_I$  due to the resistance of the substrate between the active transistor region and the substrate contact. At high frequencies and fast switching speeds, the effect of the isolation diode capacitance must be carefully evaluated, as it may be high enough to allow some stray coupling to the substrate and other elements of the circuit.

### MOS transistors

Because of its construction, the MOS (Metal Oxide Semiconductor) transistor is self-isolating. Both source and drain are isolated by their own pn junctions. The gate is isolated by the thin layer of silicon oxide. The channel formed under the gate is also isolated by a pn junction which forms with it. This means that MOS transistors can be fabricated in a smaller area than bipolar transistors, allowing a higher element density.

The MOS transistor can be used as a resistor between source and drain. Its value is dependent on the gate potential and the transconductance of the structure. Resistors with values compatible with switching circuits can be obtained by designing the MOS structure to have a low transconductance (wide source to drain spacing) and connecting the gate to the drain, so that the structure is biased on. Such resistors can be made in a much smaller area than that required for diffused resistors, allowing a further increase in element density. One disadvantage is that the MOS circuit has a considerably slower switching speed than the bipolar circuit.

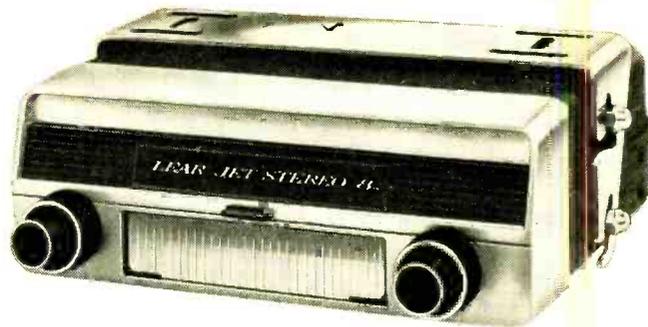
### Integrated circuit diodes

Integrated circuit diodes are prepared by forming pn junctions at the same time as one of the transistor junctions. A diode in which the cathode is the original n-type region and the p-type anode is formed during the transistor base diffusion is in Fig. 6-a. This diode has the same reverse-voltage capability as the transistor collector junction, and is widely used for general-purpose circuit applications.

Where fast switching speeds are required, emitter-base diodes are used (Fig. 6-b). The diode anode is formed at the same time as the transistor base, and the cathode with the emitter. This gives a low-voltage diode with fast response time. To avoid unwanted effects caused by transistor action this type diode is arranged so the anode contact shorts the p-type anode region to the n-type region in which the diode is formed. **R-E**

# Programmed

## HOW CAR STEREOS WORK



**2** Certainly not. In the first place, the car's battery should absorb variations of voltage caused by an intermittent generator. In the second place, the regulator in the player should hold tape speed fairly constant. You should hear little or no wow. **Go back to Frame 22.**

by LARRY ALLEN, cet

THESE CAPSULES TEACH YOU THE BASICS OF CAR-tridge-tape players for automobiles. Study each easily digested frame of information, then test your grasp of it by answering a multiple-choice question. If you choose correctly, you're guided automatically to the next programmed capsule. If you miss, don't worry; programmed extra information helps you learn the correct answer. **Start with Frame 1.**

**3** Not these. Tape travel in the Orrtronic is backward, so the motor would have to be reversible. The Orrtronic needs a horizontal pressure roller and capstan; the Lear-Jet tape is in a vertical position, and switching the drive is mechanically difficult. The 8-track head can be made to play 4-track by tying some wires together, but the other problems preclude easy interchangeability. **Study the diagrams in Frame 1 and try again.**

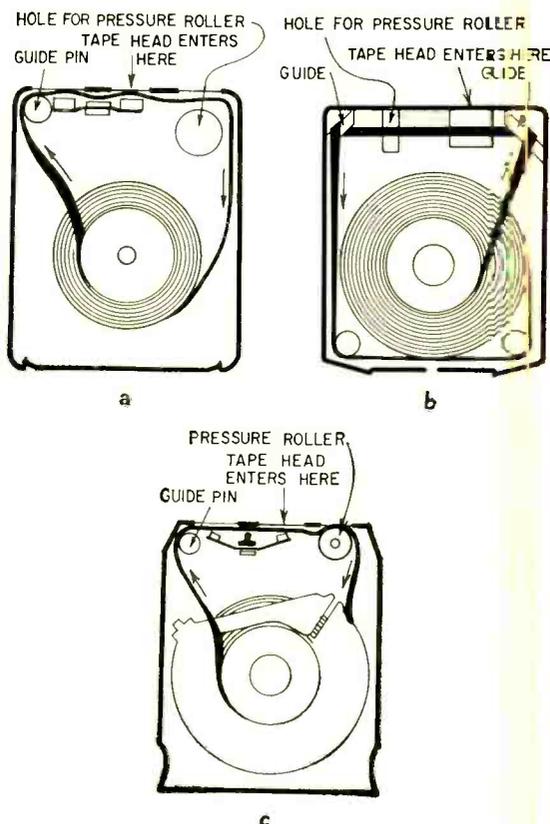
Most car tape players are stereo, and play prerecorded cartridge tapes. Few can record blank tapes. Tape in the cartridge is an endless loop that unwinds from the hub and returns to the outer perimeter of the tape roll in the cartridge.

**1** There are three cartridge types. Tape in the *Fidelipac* cartridge (a) has two 2-channel tracks of stereo program; it's called a 4-track system. The machine's pressure roller and capstan, which extend into the cartridge from the bottom, grip the tape and pull it past the playback head. The *Orrtronic* cartridge (b) is also 4-track, but guides its tape differently. Tape is pulled past the playing head horizontally; direction of tape travel is opposite that in the *Fidelipac* cartridge.

The *Lear-Jet* cartridge (c) has fancier guides for the tape, and the pressure roller is part of the cartridge. Chief difference is that the Lear-Jet system is 8-track; the tape holds four complete stereo-program tracks. This is the system most popular in autos.

*Question: Which two of the above cartridges can be interchanged by minor adaptations?*

- Lear-Jet and Fidelipac. **Go to Frame 24.**
- Orrtronic and Lear-Jet. **Go to Frame 3.**
- Fidelipac and Orrtronic. **Go to Frame 31.**



4 **You forgot to count both stereo channels.** There's a left *and* a right, remember. **Go back to Frame 21 and pick another answer** (maybe count the stages named?).

5 **You didn't get it.** Use the diagram and the last paragraph to trace each regular action. Then, if you understand the sequence, you can trace out the right answer. Have another go at it—**Frame 27.**

6 **That's right.** A button or a metallic strip trips the solenoid, which turns the ratchet, which positions the head for the next stereo-program track. **Move to Frame 26 now.**

7 **Nope.** If the voltage there stayed the same, there would be no change in voltage across the motor to correct the speed. **Reread the last paragraph of Frame 27.** It describes the action of the regulator.

8 **You missed.** Any of these troubles will stop the tape altogether. With a broken drive belt, the motor can't turn the flywheel capstan. A busted flywheel can't be driven normally, and broken pieces might jam other mechanisms. Of course, with a dead car battery, the tape machine can't run. **Read Frame 17 more carefully and pick another answer.**

9 **Of course it goes downward.** Action of the regulator with a decrease in speed is just the opposite of that with an increase. For a decrease, the switch stays closed longer during each motor revolution. That puts more average bias on Q11, increasing conduction, and reducing voltage at the collector. Thus more voltage is applied across the motor, because the motor gets the difference between the Q11 collector voltage and the supply voltage.

*Question: What happens to voltage across the motor when the car's battery voltage rises because of an overactive generator?*

- It remains constant. **See Frame 28.**
- It goes upward. **See Frame 12.**
- It goes downward. **See Frame 19.**

10 **Not exactly.** A manual button or a metallic strip on the tape activates the solenoid. The solenoid affects the ratchet, not the playing head. **Have another look at Frame 14 and try another answer.**

11 **Sorry, that's wrong.** You're forgetting the basic principles of the regulator. The motor voltage stays constant only if the regulator is operating properly. That makes motor voltage one test of how well a regulator is working. **Go back to Frame 16 and try again.** It'll help if you trace the changes, beginning at the collector of Q15.

12 **No, that's not it. Reread Frame 27** and then try **Frame 9 again**, remembering what the regulator is for.

13 **Very wrong.** The battery in the car would quite easily keep the tape machine running until its charge is exhausted. **Better go back to Frame 22 and think some more about the answers.**

In 4- or 8-track cartridge players, the tape is a continuous loop, you remember. Yet, with two and four stereo-program tracks, respectively, they need a way to change tracks. That's done electromechanically, by a solenoid-and-ratchet mechanism. It moves the head up or down to align with the track you want.

14 Most players have a button so you can move the head up or down at will. It's done automatically at the end of each program track when a metallic strip shorts two contacts and trips the solenoid; the ratchet moves the head down one track. When the bottom track is finished, some machines shut off automatically and eject the cartridge, some just shut off, some repeat the last track till you reset for the top track, and so on. There are other combinations.

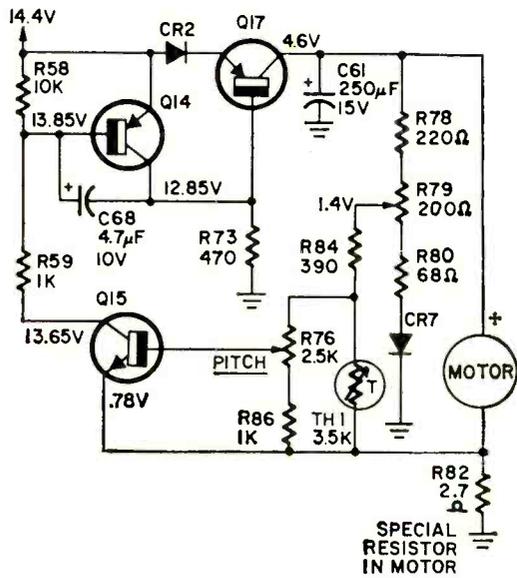
*Question: How does the ratchet change tracks?*

- By a knob on the front or top of the unit. **See Frame 23.**
- It doesn't. That's the job of the solenoid. **See Frame 10.**
- By pushing the playback head up or down to fit the gaps at exactly the right spot on the tape. **See Frame 6.**

15

Guess you counted them; you're right. You count both channels. Move on quickly to Frame 14.

Speed in one model of Lear-Jet player is controlled by the three-transistor voltage regulator. Current path for the motor is through CR2, Q17, the motor, and special resistor R82 (part of the motor). Q17 is a series regulator; its conduction determines what voltage is applied to the motor. The bias on Q17 comes mainly from the voltage drop across Q14 and R73. And conduction through those two components depends in turn on bias (for Q14) developed by Q15 and resistors R58 and R59. And Q15 is biased mainly from a sensing network (R78-R79-R80-CR7) across the motor.



16

Tracing the action, suppose voltage across the motor lowers (which would slow it down). Less than the normal positive voltage reaches the base of npn Q15, which reduces conduction. That makes Q15's collector—and thus Q14's base—more positive. Q14 is pnp, so a positive change on its base cuts down collector current, letting collector voltage go more negative. That change is applied to the base of Q17, another pnp, and raises its conduction. More voltage reaches the motor through Q17, restoring speed to normal.

The other circuit components are mostly for stabilization. Motor speed can be adjusted by R79 and R76. R79 is the main control, with R76 mounted out front (labeled Pitch) to let the listener "fine tune" motor speed.

Question: What happens to voltage across the motor if Q15 opens?

- Remains constant. See Frame 11.
- Goes upward. See Frame 32.
- Goes downward. See Frame 20.

The cartridge is part of the tape-handling machinery of an auto stereo player. Another important part is the motor that drives the capstan. It must run at constant speed even when fed voltages that vary between 11 and 15 volts. A husky flywheel uses inertia to help keep speed steady. Another aid in most players is a speed-regulating transistor circuit.

The capstan is usually part of the flywheel. The motor is separate, with a belt-drive. In Lear-Jet machines, the flywheel—and capstan—is part of the motor; brushes and windings fit inside the flywheel. The motor is dc.

17

Many problems in auto stereo tape players are traced to the motor and associated components. Common complaints are: erratic speed, causing "wow"; nonmovement of tape; or tape speed varying with the speed of the car engine.

Question: In an auto stereo tape machine, a too-slow tape could be caused by:

- Broken drive belt, busted flywheel, or dead car battery. See Frame 8.
- Faulty regulator, slipping drive belt, or dirty motor. See Frame 22.
- Slipping capstan, open winding, or open brushes. See Frame 30.

18

Yes, the mechanical part of an auto cartridge-tape machine is the most troublesome. In the electronic portion, the regulator is probably more trouble-prone than any other stage—or perhaps you notice it more quickly. But experience shows that mechanical troubles outnumber electronic complaints by two or three times. That's probably to be expected, considering the dust, vibration, shaking, and battering the unit often gets.

Here you are, right in the middle of this quickie course, but relax—you just graduated!

19

Wrong. You're being fooled by those sequence descriptions. Think about the purpose of a regulator, and then try answering the question in Frame 9 again.

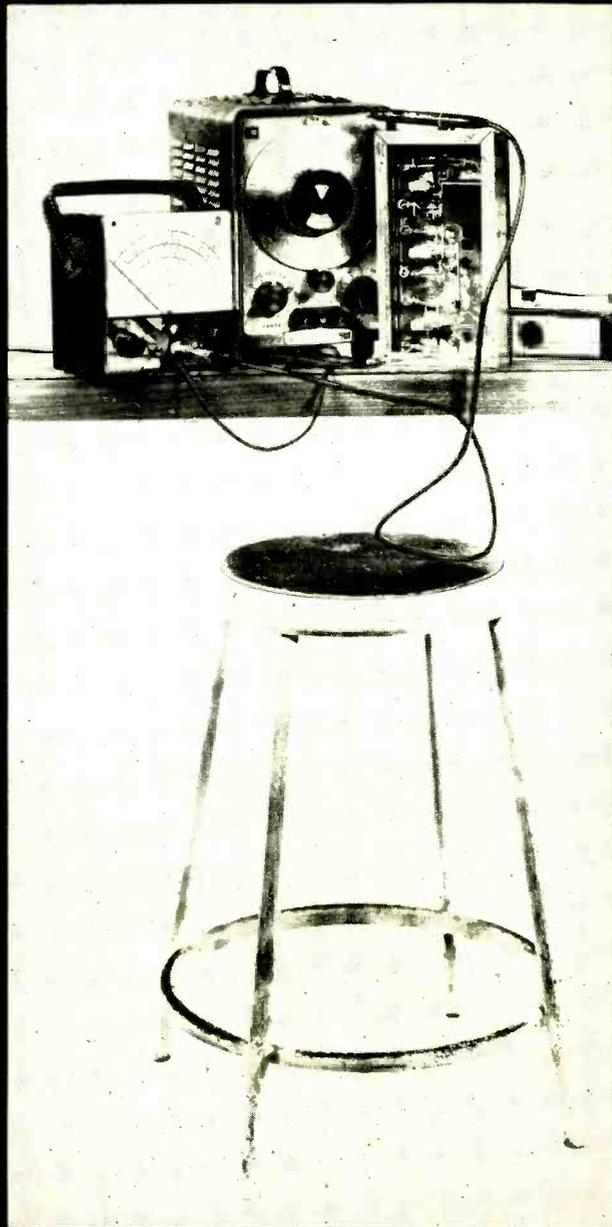
20

Not this time. The sequence of changes in this regulator take some tracing to understand. Imagine all connections to Q15 severed. Decide which direction each voltage would change, and that'll eventually tell you what happens to motor voltage. Go back to Frame 16.

This article continues on page 58

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**RCA**

The electronic portion of auto stereo is familiar. It's like stereo amplification in any tape player. For example, in one Motorola model, one stereo channel has a pair of preamps, a tone-control emitter follower, a predriver, a driver, and a power amp; the other channel has the same lineup. This complement is typical.

In machines that play both 4- and 8-track cartridges, a switch is included to tie certain tracks of the 8-track playing head together for playing 4-track tapes. That wiring is easy to trace in the service schematic for the model.

21

*Question: How many stages in an auto stereo unit with single-ended audio output stages?*

- Twelve, not counting a regulator. See **Frame 15**.
- Six, not counting a regulator. See **Frame 4**.
- Fourteen, not counting a regulator. See **Frame 29**.

**Sure!** (1) A bad regulator can let the motor slow down. (2) A slipping drive belt won't turn the flywheel as steadily as it should; the tape may alternate between normal and slow, as the belt sometimes holds and sometimes slips. (3) Autos are dirt- and dust-catchers. If anyone oils the motor improperly, it can become a muddy mess in a week or two. Even dry dust and dirt can bind the motor and slow it down.

Other problems can slow a tape down, and most of them can also cause wow. A loose pressure roller, or one that's hard and slick, is an example. Oxide from tape can collect on the capstan and pressure roller (sometimes called *pinch* roller) and glaze them enough to cause slippage.

If the car battery is low, and the tape player runs slow when the car engine is off, the transistor regulator may be at fault.

It is possible for a cartridge to feed tape slowly. The rollers or guide posts in the cartridge may hold it back. Try a cartridge you *know* is okay. (There's not much you can do to fix a faulty cartridge.)

22

*Question: If the generator in a car cuts in and out, what is the effect on the cartridge tape player?*

- None; the player operates normally. **Go to Frame 27**.
- The player goes dead every time the generator cuts out. **Go to Frame 13**.
- The tape speed varies up and down as the generator cuts in and out. **Go to Frame 2**.

**Oh no!** There's no mechanical knob to bother with; the job is done electromechanically, remember? **Try another answer for Frame 14.**

23

**Right you are.** An adapter in the hole of a Fidelipac cartridge supplies a pressure roller. Or, the machine's pressure roller can be moved out of the way when playing a Lear-Jet cartridge. An 8-track playback head is easy to wire up so it plays 4-track tapes. So, minor modifications make it possible to play both cartridges on one machine. Good work. **Now move to Frame 17.**

24

**'Tisn't this part,** so it must be the other. **Look at Frame 18.**

25

Here are some points to consider when you service a cartridge-tape player from an automobile.

1) Think of electronic and mechanical troubles separately. Work on one at a time.

2) If tape won't move smoothly, try another cartridge. Clean the capstan, pressure (pinch) roller, drive belts, motor shaft, pulleys, and idlers with isopropyl alcohol or a commercial cleaner. Keep lubricants out.

3) If tape stops, check the cartridge. Make sure it's pushed in far enough to trip the switch. If the motor heats, it's binding. If not, it might have an open winding or brush. The regulator circuit or motor ground might be open.

4) For noise, check loose parts and other possible vibrations. Then check for moving parts that rub adjacent parts. Don't discount electrical noise, even if the noise sounds mechanical. Clean the heads regularly (alcohol is okay). Try another cartridge.

26

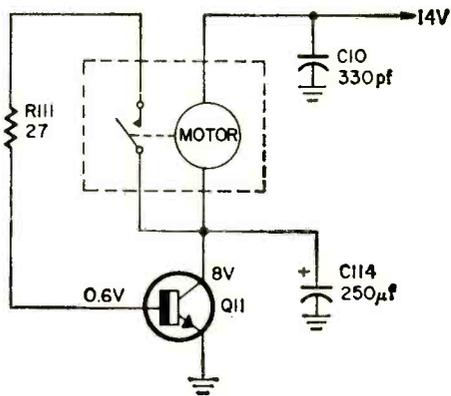
5) Wow can be caused by a cartridge, by the regulator, by a draggy motor, or by slipping pulleys, belts, or drives. If the wow sound is regular, check circular moving parts. If it's irregular, check voltages or possible bind spots.

6) A good cleanup and adjustment every 6 months does a lot for dependable operation.

*Question: Which portion of an automobile stereo-tape machine is most likely to cause trouble?*

- The electronic part. **See Frame 25**.
- The mechanical part. **See Frame 18**.

**That's right.** The car's battery should absorb most of any wide variation in voltage from the faulty generator, and the transistor regulator inside the player should handle any remaining variation.



Regulators divide into two main types: true speed governors and voltage-only regulators. An example of the governor type, used in a Delco tape player, is diagramed above. Operation is not complicated.

A transistor, a capacitor, and a centrifugal switch in the motor are the chief components. When voltage is first applied to the motor, C114 acts as a direct ground while charging. The motor starts turning. The switch inside the motor, being normally closed, also applies the charging voltage to the base of Q11. Being positive, that voltage forward-biases Q11, and the conducting transistor takes over as ground return for the motor as the capacitor charge builds up.

As the motor approaches normal speed, the internal switch starts opening up as the motor whirls. The speed determines how often it opens, and that sets average bias for Q11. Conduction of Q11 determines how the voltage divides between the transistor and the motor. The motor in the diagram stabilizes at about 5 volts—with 13 volts on the battery line, 8 volts is dropped across the transistor.

If speed increases, the switch opens more often, lowering bias; the transistor conducts less, and drops more of the voltage; less voltage is left for the motor and it slows down to normal. Capacitor C114 becomes a smoothing filter to keep the voltage constant, and prevent speed "hunting." This kind of governor is effective whether the speed variation comes from slight tape drag in a cartridge or from changes in battery voltage.

*Question: If tape speed decreases, the dc voltage at the collector of Q11 . . .*

- remains constant. See Frame 7.
- goes upward. See Frame 5.
- goes downward. See Frame 9.

**Yes, that's right.** It remains constant if the regulator is working. A higher car voltage turns the motor faster, which opens the switch more often, which biases the transistor less, which raises collector voltage just enough to equalize the voltage across the motor—returning it to the normal 5 volts that produces correct speed. **Now move to Frame 16 and study another regulator.**

**Careful, there.** You're on the right track but you picked the *wrong answer*. You probably thought about push-pull outputs and counted them as two stages per channel. **Go back to Frame 21 and notice that the question specifies single-ended.**

**Guess again.** A more careful reading of Frame 17 will remind you that the capstan is part of the flywheel and can't slip. Information following the correct answer tells you what capstan defects might cause slow tape feed.

Either of the other two faults in this answer stops the motor completely; tape doesn't move at all. **Try another answer for Frame 17.**

**Wrong.** The chief stumbling block is the opposite direction of tape travel and the different drive planes. The Orrtronic tape travels from right to left, and is flat or horizontal. In the Lear-Jet cartridge, tape goes from left to right, and is held vertically. Both are 4-track, but that isn't enough. **Study the illustrations in Frame 1 again and try another answer.**

**Yes, it does.** With Q15 open, voltage at the base of Q14 rises almost to 14.4 volts. With conduction in Q14 almost cut off, Q14's collector voltage drops low, making bias on Q17 heavy in the forward direction. Result: heavy conduction and a fast-running motor.

**If you don't understand regulators now, go back and review them, beginning at Frame 27. When you get to here again, move on to Frame 21.**

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Los Angeles, Calif. 90025

Fairchild Space and Defense Systems  
30 Park Place  
Paramus, N. J. 07652

Sony Corporation of America  
VTR Division  
47-47 Van Dam Street  
Long Island City, N. Y. 11101

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P.O. Box 191  
Bethel, Conn. 06801

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Long Island City, N. Y. 11101

Continental Instruments Corp.  
110 Atlantic Ave.  
Lynbrook, N. Y. 11563

Security Electronics Inc.  
Box 14224  
Omaha, Neb. 68114

## OTHER SECURITY DEVICES

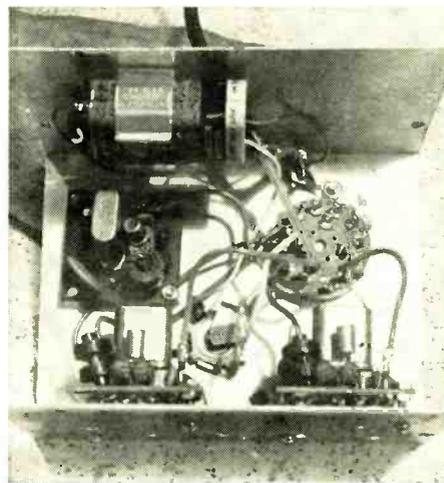
General Telephone & Electronics Corp.  
(APARTMENT ENTRANCE SECURITY)  
730 Third Ave.,  
New York, N. Y. 10017

On-Guard Corp. of America  
(AUTOMOBILE ALARMS)  
343 West 37 St.  
New York, N. Y. 10018

Squires Sanders  
(VIDEO MOTION DETECTOR)  
Martinsville, Road  
Liberty Corner, N. J. 07938

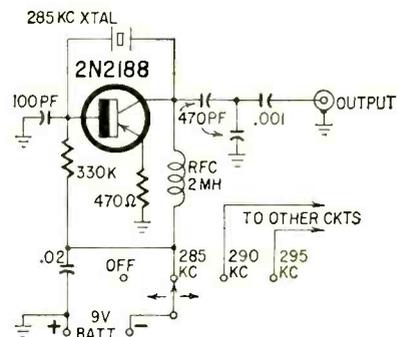
## SIGNAL GENERATOR FOR 2-WAY RADIO

Precision equipment is needed to align the i.f. circuits in two-way radios using dual-conversion receivers with crystal-controlled oscillators. Here is a simple transistor signal generator that I built for aligning the 290-kc second i.f. circuits in the G-E two-way radios of the local power company.



The generator uses three identical crystal-controlled oscillators operating on 285, 290 and 295 kc. The diagram shows the circuit of one of the oscillators. The three oscillators are connected to a 9-volt battery through a three-position selector switch.

To align the low i.f., feed the 290-kc signal into the circuit and tune the discriminator transformer secondary for zero on a meter connected to the dis-



criminator test point. Switch between the 285- and 295-kc oscillators and note the meter readings. Tune the discriminator transformer primary for equal positive and negative voltage readings.

Now, switch back to the 290-kc oscillator and tune each low i.f. transformer for maximum reading on the meter inserted in the grid circuit of the second limiter. This completes the low-frequency alignment.—Larry Loper

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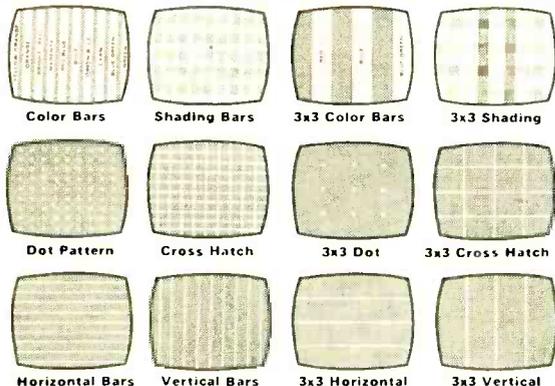
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# 9 Exciting New Kits



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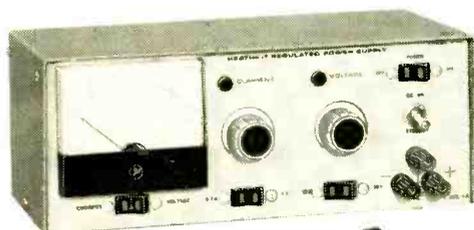


## NEW Heathkit Color Bar-Dot Generator ... Advanced Integrated Circuitry Produces 12 Patterns Plus Clear Raster, Eliminates Divider Chain Instability Forever

The new IG-28 is the signal source for all color and B&W TV servicing. No other instrument at any price will give as much stable, versatile TV servicing capability. Its solid-state circuitry produces dots, cross hatch, vertical and horizontal bars, color bars, and shading bars in the familiar 9x9 display ... plus exclusive Heath 3x3 display of all these patterns ... plus a clear raster that lets you adjust purity without upsetting AGC adjustment. Fifteen J-K Flip-Flops and associated gates count down from a crystal controlled oscillator, eliminating divider chain instability and adjustments. And for time-saving convenience the IG-28 has variable front panel tuning for channels 2 through 6. Plus & minus going video signals at the turn of a front panel control ... for sync, in-circuit video or chroma problems, use the front panel sync output. Two front panel AC outlets for test gear, TV set, etc. Built-in gun shorting circuits and grid jacks too. Add any service-type scope with horizontal input and you have vectorscope display capability as well. Fast, enjoyable circuit board-wiring harness construction. You can't beat the Heathkit IG-28 for versatility or value ... put it on your bench now. 8 lbs.

## NEW Heathkit 1-30 VDC Solid-State Regulated Power Supply

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**NEW**  
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# From The Leader



## NEW Heathkit Ultra-Deluxe "681" Color TV With AFT ... Power Channel Selection & Built-In Cable-Type Remote Control

The new Heathkit GR-681 is the world's most advanced Color TV with more built-in features than any other set on the market. Automatic Fine Tuning on all 83 channels ... eliminates touchy fine tuning forever, power push button VHF channel selection, built-in cable-type remote control ... or you can add the optional GRA-681-6 Wireless Remote Control any time you wish ... plus the built-in self-servicing aids that are standard on all Heathkit color TV's but can't be bought on any other set at any price. Other features include a bridge-type low voltage power supply for superior regulation; high & low AC taps to insure that the picture transmitted exactly fits the "681" screen. Automatic degaussing, 2-speed transistor UHF tuner, hi-fi sound output, two VHF antenna inputs, top quality American brand color tube with 2-year warranty.

**GRA-295-4, Mediterranean Cabinet shown** ..... \$119.50\*

## Heathkit "295" Color TV

Big, Bold, Beautiful ... with the same high performance features and built-in servicing facilities as the GR-681 above ... but less the Automatic Fine Tuning, push button VHF power tuning and built-in cable-type remote control. You can add the optional GRA-295-6 Wireless Remote Control at any time.

**GRA-295-1, Contemporary Walnut Cabinet shown** ..... \$62.95\*

Both the GR-681 and GR-295 fit into the same Heath factory assembled cabinets; not shown, Early American style at \$99.95.\*

## NEW Deluxe Heathkit "581" Color TV With AFT

The new Heathkit GR-581 will add a new dimension to your TV viewing. Brings you color pictures so beautiful, so natural, so real ... puts professional motion picture quality right into your living room. Has the same high performance features and exclusive self-servicing facilities as the GR-681, except with 227 sq. inch viewing area, and without power VHF tuning or built-in cable-type remote control. The optional GRA-227-6 Wireless Remote Control can be added any time you wish. And like all Heathkit Color TV's you have a choice of different installations ... mount it in a wall, your own custom cabinet, your favorite B&W TV cabinet, or any one of the Heath factory assembled cabinets.

**GRA-227-2, Mediterranean Oak Cabinet shown** ..... \$99.50\*

## Heathkit "227" Color TV

Same as the GR-581 above, but without Automatic Fine Tuning ... same superlative performance, same remarkable color picture quality, same built-in servicing aids. Like all Heathkit Color TV's you can add optional Wireless Remote Control at any time (GRA-227-6). And the new Table Model TV Cabinet and roll around Cart is an economical way to house your "227" ... just roll it anywhere, its rich appearance will enhance any room decor.

**GRS-227-6, New Cart and Cabinet combo shown** ..... \$49.95\*

Both the GR-581 and GR-227 fit into the same Heath factory assembled cabinets; not shown, Contemporary cabinet \$59.95.\*

## NEW Heathkit Deluxe "481" Color TV With AFT

The new Heathkit GR-481 has all the same high performance features and exclusive self-servicing aids as the new GR-581, but with a smaller tube size ... 180 sq. inches. And like all Heathkit Color TV's it's easy to assemble ... no experience needed. The famous Heathkit Color TV Manual guides you every step of the way with simple to understand instructions, giant fold-out pictorials ... even lets you do your own servicing for savings of over \$200 throughout the life of your set. If you want a deluxe color TV at a budget price the new Heathkit GR-481 is for you.

**GRA-180-1, Contemporary Walnut Cabinet shown** ..... \$49.95\*

## Heathkit "180" Color TV

Feature for feature the Heathkit "180" is your best buy in color TV viewing ... has all the superlative performance characteristics of the GR-481, but less Automatic Fine Tuning. For extra savings, extra beauty and convenience, add the table model cabinet and mobile cart. Get the value-packed GR-180 today.

**GRS-180-5, Table Model Cabinet & Cart combo** ..... \$39.95\*

Both the GR-481 and GR-180 fit the same Heath factory assembled cabinets; GRA-180-2, Early American Cabinet \$75.00.\*

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**Kit GRA-295-6, for Heathkit GR-295 & GR-25 TV's** ..... \$69.95\*

**Kit GRA-227-6, for Heathkit GR-581; GR-481 & GR-180 Color TV's** ..... \$69.95\*

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Kit GR-295  
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### 2 Models In 227 Sq. Inch Size

**NEW**  
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Kit GR-227  
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**\$379.95\***  
(less cabinet  
& cart)

### 2 Models In 180 Sq. Inch Size

**NEW**  
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CL-357



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## BASS BOOST

*I want more bass response in a stereo amplifier. I added a 12-inch speaker in place of the original 5 x 7, but it didn't help much. What more can I do?—G. M., Flushing, N. Y.*

Notice that your stereo amp uses 35C5 tubes in the audio output. (one per channel) with only 150 volts on the plates? So, your actual power output can't be more than about 1.5 watts each. In a composite tone, such as music, almost all of the power is in the lower frequencies. So, with so little actual power available, you're not going to break any windows with the bass!

Suggestion: Since bass is mostly nondirectional, get hold of an old PA or juke-box amplifier, and rig up a center channel for the bass only. Use your present stereo signals for the mid-range and highs, and put the woofer in the center. This is done intentionally in some high-priced outfits, and gives good results.

Old juke-box amplifiers can be bought for a small price, and some of them have 12- or even 15-inch speakers with them. They're noted, sometimes disdainfully, among hi-fi fans for their walloping bass. That ought to give you enough low-frequency response for anyone! **R-E**

## SPACE ALARM DIRECTORY

Each listing is identified as to type.  
1. Microwave. 2. Ultrasonic.

Artronix Surveillance  
716 Hanley Industrial Ct.  
St. Louis, Mo. 63144

Advanced Devices Laboratory 1  
701 Kings Row  
San Jose, Calif. 95122

Euphonics Marketing 2  
202 Park Street  
Miami Springs, Fla. 33166

Holmes Electric Protection 2  
370 Seventh Ave.  
New York, N. Y. 10001

Radar Devices Mfg. Corp. 1  
22003 Harper Ave.  
St. Clair Shores, Mich. 48080

Radar Detection Systems Inc. 1  
6300 Northern Blvd.  
East Norwich, N. Y. 11732

Sonaguard 2  
119 Dover St.  
Sommerville, Mass. 02144

Walter Kidde & Co. Inc. 2  
675 Main St.  
Belleville, N. J. 07109

## ALARM SYSTEM DIRECTORY

Each listing in this column is followed by a key number that identifies the type of alarm system. Here's the code: 1. Sound Pickup; 2. Telephone Dialer; 3. Capacitance; 4. Pressure; 5. Exit; 6. Fire; 7. Identification; 8. Magnetic; 9. Door Lock; 10. Radio Control Remote.

Alarm Lock Corp. 9  
33 Powerhouse Rd.  
Roslyn Hts., N. Y. 11577

Alarm Systems Co. 1, 2  
31807 Utica Road  
Fraser, Mich. 48026

Alarmtronics Engineering Inc. 1  
154 California Street  
Newton, Mass. 02195

American District Telegraph Co. 6  
155 Sixth Ave.  
New York, N. Y. 10013

Ballistics Control Corp. 2, 6, 10  
39-50 Crescent St.  
Long Island City, N. Y. 11101

Card Key Systems Inc. 7  
P.O. Box 589  
Burbank, Calif. 91503

Chicago Fire & Burglar Detection Inc. 2  
646 Roosevelt Rd.  
Glen Ellyn, Ill. 60137

Detex Corp. 7, 9  
53 Park Place  
New York, N. Y. 10007

Door Alarm Devices Corp. 5  
P.O. Box 112, Hillside Manor Br.  
New Hyde Park, N. Y. 11040

Electro-Guard 2  
31st & N. Church St.  
Hazleton, Pa.

Electronic Systems Div. 3  
Mosler Safe Company  
9 South Street  
Danbury, Conn. 06810

Heath Co. 3, 4, 6  
Benton Harbor, Mich.

Holmes Electric Protective Co. 4, 5  
370 Seventh Avenue  
New York, N. Y. 10001

Interstate Alarm Systems Inc. 6  
1428 N. Cass Lake Rd.  
Pontiac, Mich. 48054

International Alarm Research Co. 1  
1428 N. Cass Lake Rd.  
Pontiac, Mich. 48054

Linear Corp. 10  
347 South Glasgow Ave.  
Inglewood, Calif. 90301

Multi-Elmac Co. 10  
21470 Coolidge Hwy.  
Oak Park, Mich. 48237

P & F Corbin Div. 6  
New Britain, Conn.

Prestodial Inc. 2  
265 W. 40 Street  
New York, N. Y. 10018

Pyrotronics Inc. 6  
2343 Morris Ave.  
Union, N. J. 07083

R. D. Products Inc. 7  
220 N. Washington  
East Rochester, N. Y. 14445

Radar Detection Systems Inc. 2  
6300 Northern Blvd.  
East Norwich, N. Y. 11732

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Your personal friends at Perma-Power keep pace with the TV market. It's hard to find replacement picture tubes for personal portable TV sets but it's easy to extend the useful life of the old ones with this new Vu-Brite. Model C-414 restores like-new clarity to 4.5 and 6.3 volt CRT's on AC operated sets. (Briteners aren't effective on sets equipped for battery operation). Now available at your distributor \$2.00 dealer net.

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12BFP4	12CFP4	16CFP4
12BMP4	12CMP4	16CQP4

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Circle 32 on reader service card

# If you think all watts are alike, you may get apples the next time you buy oranges.

Which is our way of saying that all amplifiers and receivers aren't rated the same way.

The several different methods of rating an amplifier's power capacity are so far apart that an amplifier rated at 250 watts by one system actually puts out only 50 watts by another.



Look for our dealer members' window decal and our manufacturer members' identifying product tag.

## It's not a Question of "Right" and "Wrong"

We don't mean that some power rating systems are "wrong" and others are "right." What we are saying is that one component may appear to be more "powerful" (i.e. deliver more watts) than another, when the real difference may be in the methods used to measure their respective outputs.

Let's end the confusion by defining the three main rating methods:

**"RMS" Rating**—The standard laboratory method. The output of an amplifier is measured at a single given frequency. Not especially useful in measuring a component's capacity to

reproduce a complicated signal like music.

**EIA Rating**—Derived by measuring output at a single frequency. But permits a higher distortion factor (5%), and thus results in a much higher wattage number than the comparable IHF rating (at 1%).

**IHF Rating**—Arrived at in accordance with the published Institute of High Fidelity Standard, which sets forth two methods of power measurement: "continuous power" method (same as RMS method above) and "dynamic or music power" method. Additionally, it specifies that measurements are to be made with all amplifier channels driven. These two methods, as set forth in the publication IHF-A-201, are accepted as the industry standard by quality manufacturers.

## The IHF Method is More Musically Inclined

Clearly, the IHF rating of an amplifier or receiver is more meaningful to anyone buying high fidelity equipment. Because it uses conditions that the listener encounters, while still maintaining strict limits where distortion is concerned.

So it makes sense to check the IHF power rating when you're looking for an amplifier or receiver. The specification sheets of our member manufacturers carry this rating. As the common yardstick of the industry, it best reflects the concerns of those who developed the concept and craft of high fidelity.



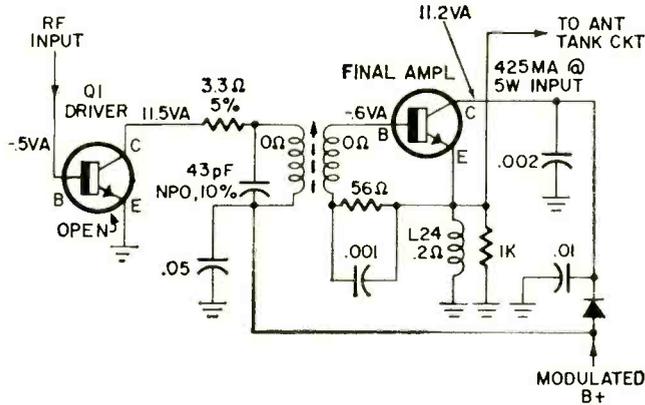
*The organization of the quality sound equipment makers and dealers. Specifications stated in terms such as "100 watt IHF  $\pm 1$  db" are not true ratings.*

# CB Troubleshooter's Casebook

Compiled by Andrew J. Mueller\*

**Case 1:** No transmit function. Receive function is OK.

**Common to:** B&K Cobra 23

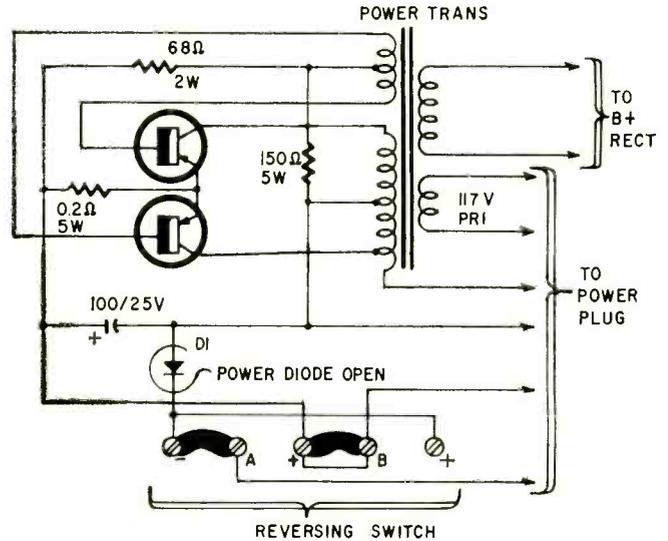


**Remedy:** Replace transmit driver transistor Q1.

**Reasoning:** The driver transistor became overheated during a long transmission. This caused thermal runaway, and consequently the collector-base junction opened. When replacing Q1, be sure to use a good heat-sink compound to protect the transistor against future failures.

**Case 2:** Inoperative on 12 volts. Unit is OK on 117 volts ac.

**Common to:** U.S.L. Contact 8



**Remedy:** Replace power diode, D1.

**Reasoning:** On 12-volt operation, D1 is in series with the -12-volt line. This protects the power transistors against accidental polarity reversal. In this instance, it has "opened up". Now the dc primary circuit is not complete. Replacing D1 will cure the trouble. Since the diode is only used on 12-volt operation, it has no effect when the radio is used on 117 volts ac.

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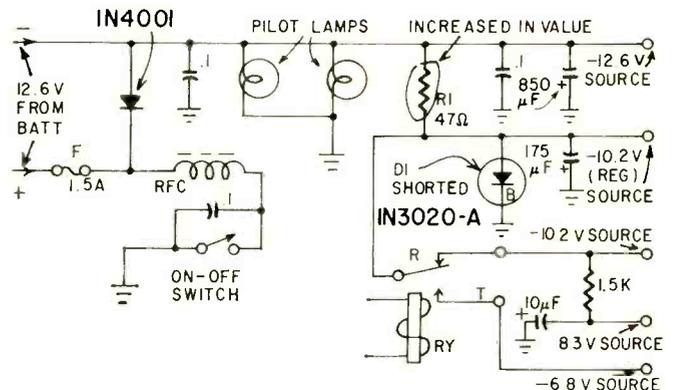
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Circle 34 on reader service card

**Case 3:** Unit does not transmit or receive even though it lights up.

**Common to:** Hallicrafter CB-14



**Remedy:** Replace D1 and R1.

**Reasoning:** Zener diode D1 has shorted to ground. This removes the regulated 10 volts from the 10-volt line. Therefore no voltage gets to the frequency synthesizer. This in turn makes the radio inoperative. Replace R1 along with D1 as it may have changed value due to the short-circuit current through it. **R-E**

\*Service Manager, Tel-Air Communications, Inc., Pewaukee, Wis.

# TECHNOTES

## G-E S AND V MONOCHROME CHASSIS

Occasional reports have been received indicating horizontal oscillator startup problems on these b-w chassis using an 8LT8 horizontal oscillator.

The problem appears as a "no raster" symptom when the set is turned on. Sometimes switching the set on and off will cause the oscillator to start. Then the set may operate normally for a few days or even weeks before the problem returns. Because the problem is random and intermittent, it is difficult to pin down. Normal troubleshooting procedures do not provide any answers.

First, check the receiver out thoroughly. Change the 8LT8 tube and check all associated circuitry to determine that the components are of the correct value and are not defective. Use a Variac or other variable-voltage transformer to reduce the line voltage to 100 and check oscillator operation. Sometimes a borderline no-start will show up under reduced line voltage.

If a chronic startup problem exists, increase grid resistor R254 to 10 megohms. Original values for R254 in the S and V chassis are 4.7, 5.6 and 6.8 megohms. Increasing R254 will reduce grid current at startup and increase the grid input impedance. This permits a lower level of circuit noise to start the oscillator.

An increase in the value of C254 from 390 pF to 470 pF will also aid oscillator startup. However, changing this capacitor can be extremely touchy, because C254 is part of the horizontal oscillator temperature compensation. The replacement part must be a 470-pF, N750 5%, 500-volt unit.

After changing capacitors, check the receiver for horizontal drift and hold-in range. Using a strong channel (preferably channel 6) set the fine-tuning control for best picture and set all other controls to their normal operating positions.

Turn the horizontal hold control two full turns counterclockwise. Switch to the next highest channel and then return to the original channel. Now, slowly turn the horizontal hold control clockwise until the picture just barely "hangs on" out of sync. You should count three or four bars just before the picture snaps into sync. Repeat this same procedure in the opposite direction.

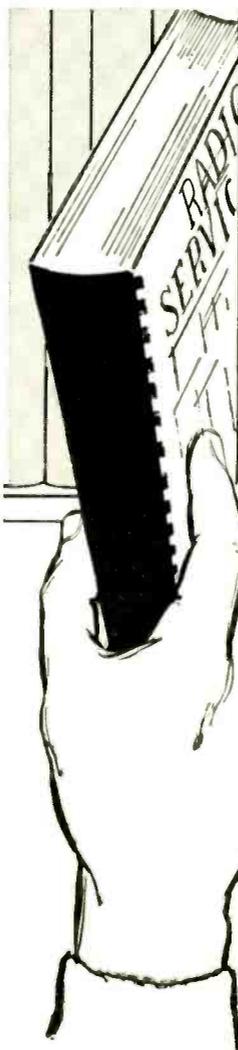
After completing this test, the control must be returned to its proper setting. This can be approximated by fine-tuning into audio and adjusting the horizontal hold for a floating picture. Exact horizontal frequency adjustment procedure can be found in the specific chassis service manual.

These repairs are applicable only to individual oscillator startup problems which do not respond to normal troubleshooting and repair procedures. The change in R254 value is much preferred over the capacitance change when dealing with this problem.—G-E Portafax **R-E**

### WANTED: TECHNOTES

Have you solved a particularly difficult servicing problem on a receiver, amplifier, recorder or other electronic gear? If so, the chances are good that some of your fellow readers will run across the same problem. Here is your chance to make life easier for them.

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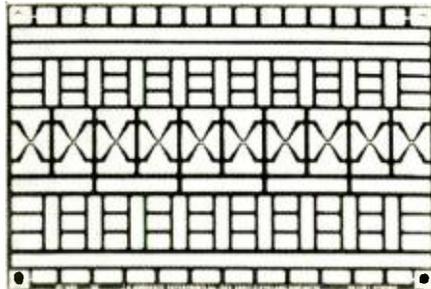
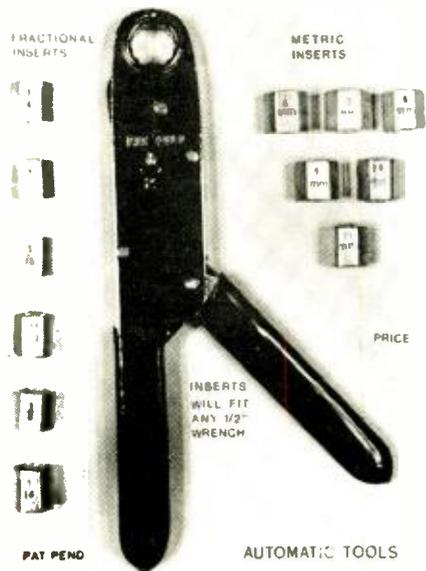
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# NEW PRODUCTS

More information on new products is available from the manufacturers of items identified by a Reader Service number. Use the Reader Service Card at the left and circle the numbers of the new products on which you would like further information. Detach and mail the postage-paid card.

**RATCHET WRENCH**, complete with a  $\frac{1}{2}$ " box socket and 12 hex inserts ranging from  $\frac{1}{16}$ " and 6 mm-11 mm, is designed to reach tight places. Turning



is for a variety of components and consists of 17 pads for exterior connection; 10 transistor configurations and 60 pads for miscellaneous components. Size:  $3\frac{3}{32}$ " x  $8\text{-}5/8$ " x  $5\text{-}49/64$ ". Under \$6.—**AEI Instrument Co.**, Div. of **Andresen Enterprises Inc.**, Cleveland, Ohio

Circle 48 on reader service card

**FM/AM RADIO RECEIVER, Model A124W**, is top-mounted with a  $6\frac{1}{2}$ " high inverted-cone-shaped speaker which disperses sound in a full  $360^\circ$  circle. Other features include 16 tuned circuits; auto



frequency control; automatic bass-boost circuitry; 1000 mW of undistorted audio output; 2 illuminated horizontal slide-rule dials; one line-cord antenna for FM and a Wavemagnet antenna for AM. \$49.95.—**Zenith Radio Corp.**, Chicago, Ill.

Circle 49 on reader service card

**READOUT INDICATOR, Model MS-4000B**, 7-segment, displays 0-9 numerals and alpha that look like neon by utilizing



is accomplished by merely squeezing spring-loaded scissor-type handle. Rubber friction lock keeps insert firmly in position. \$12.95.—**Jay-Thomas Co.**, Chula Vista, Calif.

Circle 46 on reader service card

**FM/AM STEREO RECEIVER, Model KR-100**, solid-state, provides 140 watts music power at 4 ohms and 110 watts at 8 ohms. Unit features 4 IC's, 2 FET's, front-panel dubbing tape recording jack



and headphone jack, inputs for 2 record players and 300/75-ohm antenna. Distortion rate: 0.5%. Frequency response: 13-70,000 Hz. \$299.95.—**Kenwood Electronic Inc.**, Los Angeles, Calif.

Circle 47 on reader service card

**CIRCUIT BREADBOARDS** on  $3/32$  phenolic base 2-oz copper-clad 60/40 solder plated can be used repeatedly. **Model MC-2** provides pads for mounting 15 dual in-line IC circuits—3 pads for 16-pin units and 12 for 14 pins. Size:  $3/32$ " x  $8\text{-}5/8$ " x  $5\text{-}49/64$ ". **Model DC-2**

T-1 incandescent lamps #683, 5V @ 60 ma, with a life expectancy to 100,000 hr. Character size:  $0.325$ " x  $0.600$ ". Overall case size:  $0.552$ " x  $1.18$ ". Weight: 15 grams. Power consumption: 0.6 watts min., 2.1 watts max. Load resistance: 83.33 ohms. Vibration test: 2000 c/s per min. Insulating resistance: more than 100 megohms, \$6.45. Discount for quantities over 100.—**Alco Electronic Products Inc.**, Lawrence, Mass.

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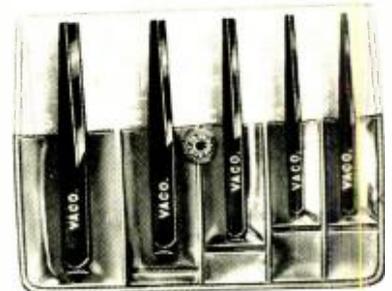
**ULTRASONIC CLEANER** utilizes a generator to produce high-frequency electrical impulses which a transducer converts into ultrasonic waves in a water-filled tank. Cavitation thus cleans dirty objects in a minute. Rate of elec-



trical impulses: 45,000/sec. Special solvents common household cleaning solutions can be employed. Standard model, \$39.95; deluxe model, \$49.94 complete with 2 insertable cleaning tanks and 2 bottles of cleaning solutions.—**Branson Instruments Co.**, Stamford, Conn.

Circle 51 on reader service card

**SCREW EXTRACTOR KIT 70007** contains 5 units sizes  $\frac{1}{8}$ "- $\frac{3}{8}$ ". A hole is drilled in the broken or buried stud of screw or bolt. Use a plier/wrench on the

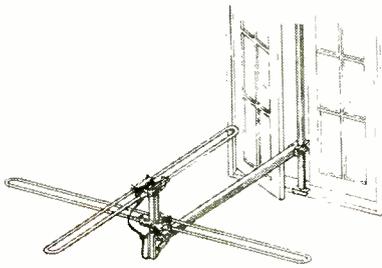


correct-size extractor, which has ground flutes, to firm grip and unscrew the broken stud without damage to the surrounding material. \$6.50.—**Vaco Products Co.**, Chicago, Ill.

Circle 52 on reader service card

**FM WINDOW ANTENNA, Model FM-WT**, solves reception problems in build-

ings where rooftop antenna is impossible. Omnidirectional unit covers FM band from 88-108 MHz. Can be mounted horizontally or vertically on a window-



frame mount of up to 42" span. 2 folded dipoles with a special quarter-wave phasing stub are for optimum gain and approximate circular, omnidirectional radiation pickup pattern. \$16.95.—Finney Co., Bedford, Ohio

Circle 53 on reader service card

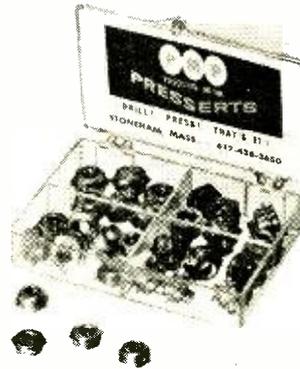
CB 2-WAY RADIO, Model A-2569, 23-channel, can be used as a base station or



a built-in 3½-watt PA system. Sensitivity: 0.2 µV for 10 dB S/N ratio. Selectivity: 7 kHz at 6 dB down. dual conversion, 10.7 MHz and 455 kHz, tuned LC filter. Squelch sensitivity: 0.5 µV–50 µV. Audio output: 3.5 watts. Input power: 5 watts. Rf output power: 3 watts nominal. Modulation capability: 100% with speech compressor. \$149.95.—Allied Radio Corp., Chicago, Ill. 60680

Circle 54 on reader service card

FLOATING NUTS KIT, Type FN Presert, made of #303 stainless steel, makes hole misalignment adjustments possible

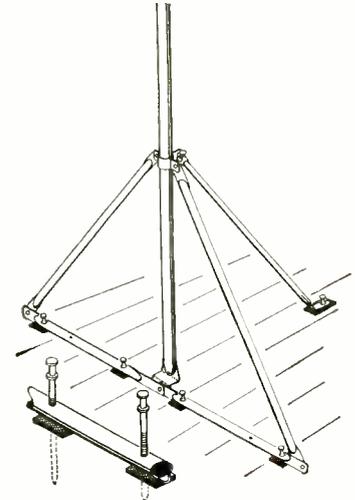


with a free-floating threaded insert movable 0.015" in any direction through

360°. Press unit into punched or drilled holes; hexagonal head displaces metal by cold flow into a special recess ringing the insert and thus creates a permanent lock.—Precision Metal Products Co., Stoneham, Mass.

Circle 55 on reader service card

ANTENNA MOUNTING opens like an umbrella with no loose parts to assemble. The 5' x 1½" OD mast is made of rust-proof, hot-dip galvanized steel tubing and can be fixed with a single wing nut.



Model TRM 520, 20 gage (\$7.98); Model TRM 518, 18 gage (\$8.54). Complete with 5 ring nails and 5 pitch patches. —South River Metal Products Co., South River, N.J. 08882

Circle 56 on reader service card

EXPERIMENTER'S IC KIT, Model KD2117, contains 5 monolithic IC's, 4 transistor arrays (2 each Models KD2114 and KD2116) and 1 audio amplifier. All feature matched electrical and

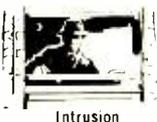


thermal characteristics as well as compactness and can be used as electronic building blocks in a variety of applications. \$4.40.—RCA Electronic Components, Harrison, N.J.

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Circle 106 on reader service card

Series: 2 provide boathook-type clamp grip, 1 with a forked-tongue gripper, 1 with a 3-segment auto collet and 1 with meshing claws. Size: 4½"-77". Prices:

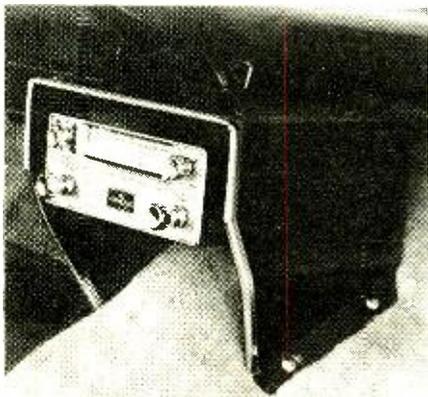


Kleps 10-20      Kleps 30      Kleps 40

\$0.99-\$2.39. Model Prof 10, 5½" long, molded phenolic, includes solder connection, phone tip and a "bunch" pin that fits banana jack. \$0.79.—Rye Industries, Mamaroneck, N.Y.

Circle 58 on reader service card

**AUTO CARTRIDGE STEREO MOUNT** designed to fit all tape cartridge units, for center mounting on the auto transmission hump or for cars with console. Unit can be installed with 4 screws and



fits most models of automobiles without built-in dash stereo space. Available in chrome or black paint with chrome trim. —K & R Enterprises, Van Nuys, Calif.

Circle 59 on reader service card

**TURNTABLE, Model 600,** features Decormatic base with an illuminated power switch that permits automatic shut-off after last record has been played.



Unit has a micrometer stylus-pressure adjustment which allows ½-gram settings from 0-6 grams and a stereo muting switch for complete silence during

record-change cycle. Cuing and pause control lever enables listeners to raise or lower pickup arm and return it to the same groove.—BSR (USA) Ltd., Blauvelt, N.Y.

Circle 60 on reader service card

11-to-1 CUTTER, Model 447-4, reduces

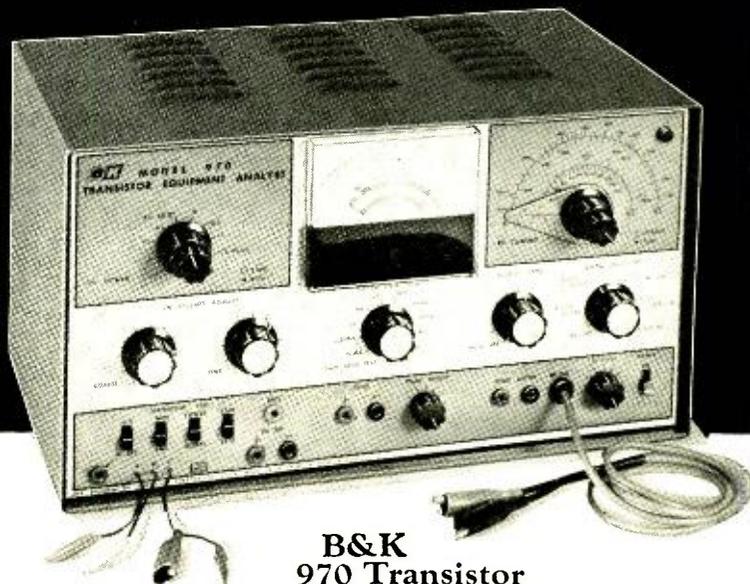


user fatigue and provides greater edge life and better cuts. 5-lb pressure on the grips yields 55-lb pressure at cutting surface. Cutting jaws are replaceable and interchangeable. Tool is ideal for work with high-strength wiring.—Utica Tool Co., Orangeburg, S.C. 29115

Circle 61 on reader service card

**AM/FM RADIO CASSETTE RECORDER, Model RK-150,** operates on battery/electricity and can play back and record up to 2 hr on a single cassette cartridge. Circuitry: 12 transistors, 8 diodes, 1 thermistor. Power output: 1.8 watts. Other features include a built-in 5" speaker, built-in telescoping FM and ferrite-core AM antennas. \$89.95 complete with remote control mike, car phone, batteries and a blank 60-minute

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Service engineers everywhere have acclaimed the 970 as the leader in the

field. And that's understandable, when you stop to think what a precision instrument it really is. The all solid-state circuits assure minimum down time and maximum reliability. It's capable of in-circuit and out-of-circuit testing and requires no unsoldering of transistors or other components. It even has its own built-in power supply with a 5 amp output and low ripple. And the rugged, burn-out-proof DC Volt-Ohm-Millimeter features 11 ranges for your convenience.

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**B&K Transistor Analyst  
Model 970. Net: \$209.95**

B&K Division of Dynascan Corporation  
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Chicago, Illinois 60613

**B&K puts an end to test equipment.  
We've developed Silent Partners.**



Circle 107 on reader service card



cassette tape.—Lafayette Radio Electronics Corp., Syosset, N.Y.

Circle 62 on reader service card

STROBE LIGHT FLASHER, Model BHR, solid-state, includes a replaceable



flash tube separated from the other circuitry by a 23" cord; and a small cylinder

containing the major electronic components with a 9' cord for a standard 117V outlet. Power output: less than 5 watts. Flash rate: 40-50 per minute. Life expectancy: 10,000,000 flashes. Weight: 6 oz. \$24.95—Zipcom Corp., Little Rock, Ark.

Circle 63 on reader service card

AUTO TURNTABLE, Model PE-2018, for single and multiple record playing, has a BV-18 standard base with three speeds, 78, 45 and 33-1/3 rpm. Features include 15° vertical tracking-angle ad-



justment; automatic selection of record size and gentle lowering action of tone arm when a record is on the platter. \$99.50.—Elpa Marketing Industries Inc., New Hyde Park, N.Y.

Circle 64 on reader service card

HORN TWEETER, Model 1000-12, provides a high-frequency response of 700-13000 Hz and a power rating of 30 watt rms which permits safe operation with amplifiers up to 100 watts. Imped-



ance: 8 ohms. Flare cutoff: 1000 Hz. Magnet wt: 12-oz oriented ceramic. Size: 8 7/8" depth overall, 3 1/2" x 8" mouth. Weight: 2 1/2 lb.—Cleveland Electronics Inc., Cleveland, Ohio

Circle 65 on reader service card

TV TUBE BRIGHTENER, Model vubrite C-4161, for ac only, can be used to



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**HAND TOOLS** such as pliers, wrenches, punches and chisels, automotive tools etc. are illustrated with photos and full specs in *Catalog K-165-1*, 20 pages. Supplement to this is *Catalog 9931058*, 14 pages. Separate price list with size description for this product line is available.—**Kraemer Tools**, Chicago, Ill.

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**TV CAPACITOR REPLACEMENT GUIDE**, 23 pages, provides listing of 7,000 twist mount and tubular electrolytic replacements for domestic and imported color or b/w TV by major manufacturers. Products include manufacture from 1958 to January 1969.—**Loral Distributor Products, Div. of Loral Corp.**, Great Neck, N.Y.

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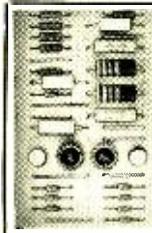
**FAIRCHILD HYBRID MICROCIRCUITS** is the title of an illustrated reference guide, 24 pages, which shows how hybrid technology can achieve design functions. Included also are step-by-step explanation by hybrid manufacture, Fairchild's testing and quality assurance programs, a listing of 16 standard hybrid products, complete with electrical specs, logic diagrams and packaging information. Write to **Distribution Services, Fairchild Semiconductor**, 313 Fairchild Dr., Mountain View, Calif. 94040

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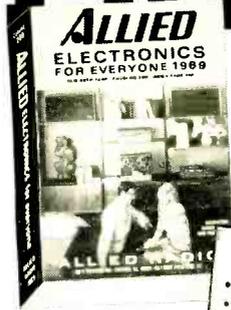
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**20 SCR Circuits**  
(continued from page 57)

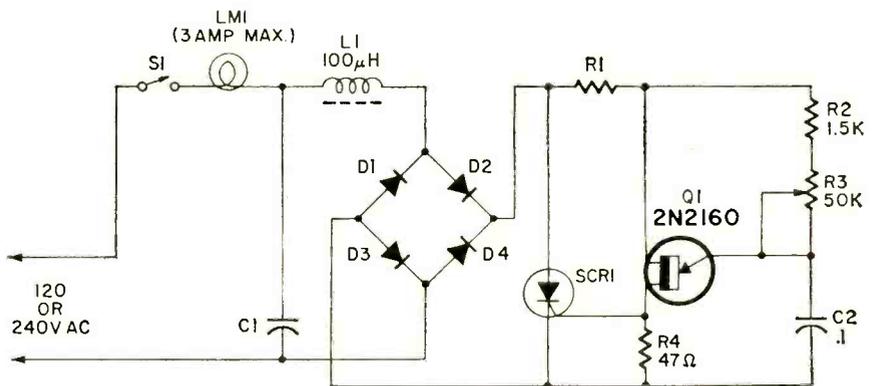
switch with a firing potential of about 8 volts. At low voltages, both Q1 and Q2 are off, so the Q1-emitter/Q2-emitter path presents a fairly high impedance (about 6000 ohms—the series value of R3 and R4). When the potential across the circuit rises to about 8 volts, Q2 becomes forward-biased via the R3-R4 voltage divider, so Q2 starts to turn on. Q2's collector current is fed directly into Q1's base, and Q1's collector current is fed directly into Q2's base. Therefore, as soon as Q2 starts to turn on, the circuit regenerates and both transistors saturate. Under this condition, the Q1-emitter/Q2-emitter path presents an impedance of only a few ohms.

Thus, on each positive half-cycle of supply line voltage, C1 starts to charge via the D1-R1-R2 network, but the C1 voltage is effectively isolated from the SCR gate via Q1 and Q2 until the C1 charge reaches about 8

volts. Then the Q1-Q2 circuit regenerates into the low-impedance state and causes C1 to discharge through R6. The resulting positive pulse across R6 triggers the SCR on. As the SCR goes on, its anode voltage falls to near zero, and disables the phase-shift and trigger networks for the rest of the half-cycle. This process repeats over on all positive half-cycles of supply line voltage. The triggering delay can be varied via R1, so efficient half-wave speed control is obtained.

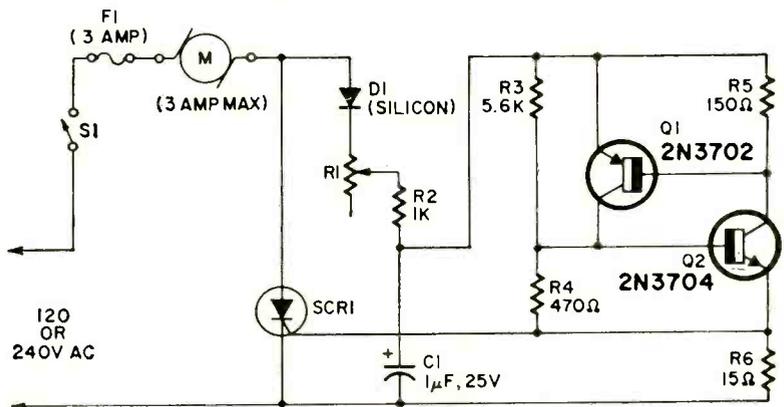
Universal motors draw an operating current proportional to the motor load. When they are lightly loaded they draw a low current, and when they are heavily loaded they draw a high current. This characteristic makes it possible to devise SCR control circuits that will hold the motor speed fairly constant under different loading conditions. Fig. 9 shows how Fig. 8 can be modified to give regulated speed control.

The circuit operates similarly to Fig. 8, but in addition uses R7-D2-



SCR1 = 2N3228 ON 120V AC LINE, OR 2N3525 ON 240V AC LINE.  
D1-D4 = 200P.I.V., 3AMP ON 120V AC LINE, OR 400P.I.V., 3AMP ON 240V AC LINE.  
C1 = 0.1µF, 200VWV ON 120V AC LINE, OR 0.1µF, 400VWV ON 240V AC LINE.  
R1 = 18K, 2WATT ON 120V AC LINE, OR 33K, 3WATT ON 240V AC LINE.

Fig. 7—A phase-triggered lamp dimmer uses a UJT timer synchronized to the 60-Hz line frequency. Potentiometer R3 sets the UJT's timing period, which determines half-cycle SCR trigger point. L1 and C1 are rf filters.



SCR1 = 2N3228 ON 120V AC LINE, OR 2N3525 ON 240V AC LINE.  
D1 = 200P.I.V., 100MA ON 120V AC LINE, OR 400P.I.V., 100MA ON 240V AC LINE.  
R1 = 75K, 1/2 WATT ON 120V AC LINE, OR 150K, 1/2 WATT ON 240V AC LINE.

Fig. 8—A diode-resistor-capacitor network forms a phase-shift circuit to regulate motor speeds. Circuit operates on positive half-cycles of the line voltage.



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Circle 113 on reader service card

# In the Shop . . . With Jack

by **JACK DARR**  
SERVICE EDITOR

## THE CUSTOMER'S CATASTROPHE

HEATER-CATHODE SHORTS IN COLOR picture tubes are the customer's pet catastrophe. With the price of CRT's today, you can see why. The typical symptom of this disease is a raster obviously and uncontrollably all one color: red, green, blue. The shorted gun has lost its bias and usually runs wide open, to full conduction.

However, there's an easy cure: same old principle we've used in b-w tubes for years. Just clear the short by isolating the heater winding from ground. We used to do this with "brighteners" in b-w sets; however, heavy-duty types to handle the higher heater current of color tubes weren't available until lately. Now they are, from Perma-Power and others.

Figure 1 shows what happens. The heater of the color CRT is "de-biased" to reduce the voltage stress between cathode and heater. Color CRT cathodes run at about 150-200 volts above ground. So set makers connect a voltage divider between

extremely complicated (Fig. 2)! It's a plain 1:1 transformer: 6 volts in, 6 volts out. This is not a brightener, though it looks like one on the out-

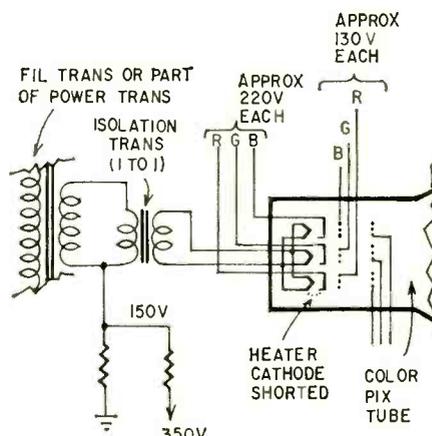


Fig. 2

side. There is no increase in the heater voltage. All the transformer does is isolate ground from heater supply.

Even though this "ground" may be through the B+ supply lines, it will still be at a low impedance for the high-frequency video signal (through filter capacitors, etc.). It will also have the inevitable effect on the dc bias of the CRT, also a problem.

Like the brighteners, the transformers are plug-in. Though the transformers are the same, you'll need two types: one for the older round-tube bases, and one for the rectangular types with the small base.

All you need on this job is a good CRT tester to confirm your diagnosis of a shorted CRT, and a pair of these isolation transformers.

We've seen tubes equipped with similar devices last for several years. Before the introduction of these, we had to use separate filament transformers mounted in the cabinet. The modern method is a lot simpler and easier. **R-E**

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.

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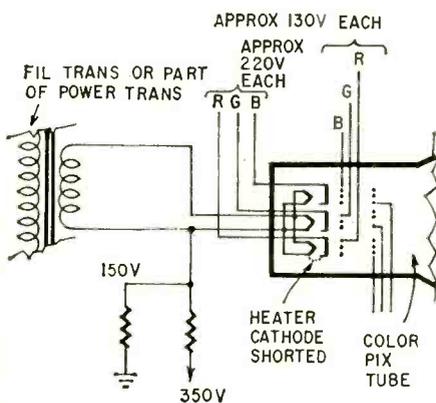


Fig. 1

B+ and ground, and apply about 150 volts dc to the heater. This winding is not grounded like the others, of course. (This same biased winding normally supplies the damper and/or high-voltage regulator tubes, for the same reason, and, in one well-known chassis, the second i.f. tube!)

A heater-cathode short in the CRT usually kills the dc bias, letting that gun go wide open, or kills the video (Y) signal, or both. DON'T try to blow this type of short out with your CRT tester rejuvenator; you'll usually blow the heater itself. The easiest way to get rid of it is to "lift" the heater from ground—isolate it.

The equipment needed for this is

# Service Clinic

By JACK DARR  
SERVICE EDITOR

## Sweep generators: kit or ready-built?

*I'm going into TV servicing and want good equipment that will enable me to align rf and i.f. stages. I'll need a sweep generator, plus crystal-controlled marker pips.*

*I've been told not to buy kits, but a factory-assembled sweep generator. They also tell me the marker generator must be capable of producing calibrating beats every 250 kHz through the rf and i.f. ranges. Correct? Also, how about a marker adder?—J. H., Houston, Tex.*

Someone is misleading you. Kit instruments will give you about what you put into them. If you do a careful assembly job and follow the instruction book, you'll have a useful piece of equipment with any of the first-line kit sweep generators. I know the chief engineer of a CATV system who has been using a kit sweep generator for years to align his line amplifiers.

Your marker generator must be accurate, but the sweep generator dial can be somewhat off since the markers determine alignment accuracy. Most instruments have provisions for crystal control of intermediate frequencies. For rf, I prefer TV station carriers, which are always accurate.

A marker adder will give better results since it eliminates marker distortion, the result of accidentally setting marker signal levels too high. Many generators have built-in marker adders.

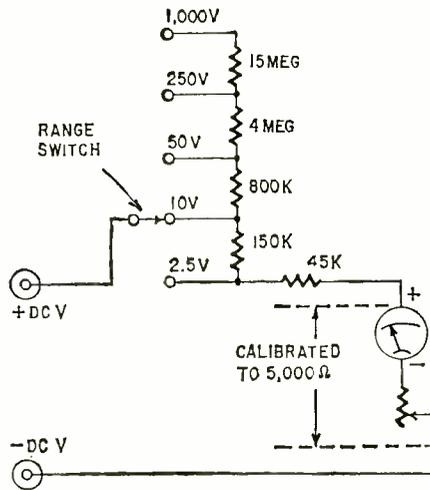
## Vom problems

*I have a Simpson 260 vom with a problem. It works all right on the ohm scales, but it isn't right on voltages. They're all low.—G. C., Catskill, N. Y.*

Well, if your ohmmeter is ok, this means that the meter itself is ok. This is a 20,000-ohms-per-volt type. The resistance of the vom, read right across the dc-volts jacks, should be full-scale reading times 20,000 (on the 10-volt scale, 200,000 ohms, and so on).

The schematic of a typical vom is shown below. On the 1000-volt scale, you should read 15

meg + 4 meg + 800K + 150K + 45K + 5000 ohms (the resistance of the meter movement and its calibrating resistor). Total, 20 megohms. You can read the individual resistors "from outside" by changing the position of the range switch. For example, on the 2.5-volt position, all you have in the circuit is the 45,000 ohms and the meter, or 50,000 ohms; on the 10-volt position, you'll have this re-



sistance, plus the 150,000-ohm resistor, or 200,000 ohms total, and so on.

Incidentally, I ran into a very odd thing on a similar vom. Checks

showed everything ok up to the meter itself, which had continuity, etc. Turned out to be a bit of varnish under the terminal bolts of the meter! Loosening these and retightening made the lockwashers cut through the varnish, and this cured the problem. Try it.

## Blown tube-tester meter

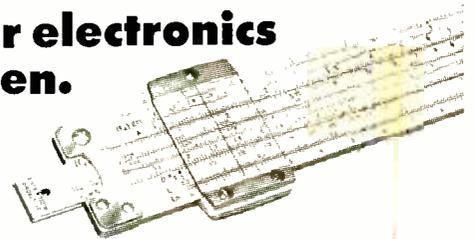
*About three months ago I blew the meter on my Radio Shack tube tester. I can't get any information about it. What kind of meter does it use?—L. G. L., Grand Junction, Colo.*

I'm not broken out with information about tube-tester meters, either! However, I did find a few of them which specified an 0-1-mA dc meter (instead of just showing a circle and the letter M!). From what I can find, most tube testers should be similar.

Try this: Hook up the dc milliammeter of your vom in place of the damaged meter. Set it on at least a 100-mA scale on general principles. Put a known-good tube in the tester, and turn it on. (Now, turn it off, and reverse the meter connections, if you're like I am. I never hooked a current meter up right in my life!)

Seriously again, turn the range

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down on the vom until you can see a reading on the meter, with all tube-tester controls set for this particular type. For a good tube, you should have a "quality" reading of about half-scale on the "good" sector; with the average meter, this would mean something like  $\frac{3}{4}$  of full scale. Check the dial scale of the old meter to find out exactly how much this should be.

Now, you can tell by the vom range switch what meter movement was used: 0-1 mA, 0-10 mA or whatever. You can get a replacement meter from Triplett, Simpson and others, with the same size case, and mount the new meter on the panel. If you want to, you can draw the GOOD-BAD calibration on the face. If you don't want to take the new meter apart, draw calibrations on paper and paste it on the glass of the face, above the scale!

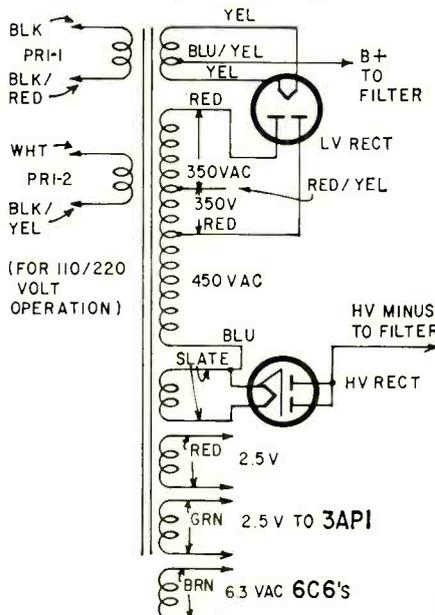
### Scope power transformer

The power transformer on my DuMont 164 scope burned out. Do you know where I can get an exact replacement? Also, a schematic of the scope?—P. G. S., San Gabriel, Calif.

A schematic of this scope is on pages 856-57 of Rider's *Encyclope-*

*dia on Cathode-Ray Oscilloscopes* (1st Edition). I doubt if you can get a duplicate power transformer since DuMont Co is no longer making test equipment.

However, you might try to locate



two that will do. The drawing (left) shows the original and a possible modification is shown below.

Use two small power transform-  
(continued on page 98)

### RECIPE FOR IC PREAMP (continued from page 51)

0.0033  $\mu$ F. The resultant response curve of the emitter-follower stage is shown in Fig. 7.

### Tone controls

The complete tone control schematic is shown in Fig. 8, and a simplified version is shown in Fig. 9. The bass and treble controls are standard audio-taper potentiometers. At 50% rotation of the control the resistance is split—90% on one side of the wiper and 10% on the other side. The relationship between wiper position and resistance is shown in Fig. 10.

In the bass control circuit (Fig. 9-a), when the control is in the center position, the frequency response is flat from about 50 Hz to 20 kHz. The reactance of C11 is made equal to the 45,000-ohm portion of R12 and the reactance of C12 is made equal to the 5,000-ohm section, both at 50 Hz. As frequency increases above 50 Hz, C11 couples more signal to the output while C12 shunts more signal to ground through R13. The net effect is a flat response from 50 Hz to 20 kHz with a 20-dB insertion loss.

When the wiper is in the boost position, C12, with a reactance  $\frac{1}{10}$  the resistance of R12 at 50 Hz, effectively shunts R12 out of the circuit, making R11 and C12 the dominant frequency response shaping components. Ideally, the full bass-boost position will supply an output voltage (at 50 Hz) that is 20 dB greater than the center position (flat response). The full boost position represents zero attenuation in the tone control of the bass frequencies. The amplitude of the output decreases at a 6-dB per octave rate to the frequency where the reactance of C12 is negligible.

The output amplitude will then be determined by the ratio of R11 to R13. When the wiper is in the full "cut" position, the output amplitude at 50 Hz is determined by the ratio of  $X_c(C11)$  to R13 and is 40 dB below the input voltage. As the frequency is increased, the reactance of C11 decreases until it is equal to the resistance of R13, again making the output amplitude dependent on the ratio of R11 to R13.

When the control is in an intermediate position, the frequency at which rolloff begins ( $\pm 3$  dB from the flat response curve) will vary, but the slope of the rolloff will change only slightly.

The treble control in Fig. 9-b is

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shown in the center or flat position. For frequencies below 2.1 kHz the reactances of C13 and C14 form a 10 to 1 divider or 20-dB insertion loss. Above 2.1 kHz, the reactances of C13 and C14 become small when compared to the parallel divider combination of the control (R18) and R16 and R17. The resistive divider then provides the 10 to 1 voltage division to maintain the 20-dB insertion loss for the high frequencies. The net result is a 20-dB loss that is flat from 20 Hz to 20 kHz.

When the control is moved to the full boost position, C13 has a reactance at 2.1 kHz approximately equal to the total resistance of the potentiometer. This means that one half the input voltage appears at the control output, or, is 6 dB below the input voltage. This is, in effect, a 14-dB treble boost at 2.1 kHz where it should be only 3 dB. By placing a resistor (R17) from the wiper of the potentiometer to the ground end of the pot with a value equal to the flat-gain position resistance (5,000 ohms), the ratio of the capacitive reactance to this additional resistor will insure treble boost action starting at 2.1 kHz.

Resistor R16 is then necessary to achieve a smooth boost action. Without R16, all of the boost action would occur at the end point of the potentiometer. In the cut position, C13 and resistors R16 and R18 in parallel are the response shaping components. As frequency increases from 2.1 kHz, the reactance of C14 decreases until, at 20 kHz, there is a 20-dB reduction in output amplitude.

#### Broad-band amplifier

The broadband stage is designed exactly like the playback amplifier except that the compensation network is replaced with a 51,000-ohm resistor (R23) in parallel with 100-pF capacitor C17. The capacitor reduces mid- and high-frequency noise of the amplifier. Input resistor R21 is also 51,000 ohms.

#### Power supplies

**Split Supply**—The requirements for the power supply are not too critical. A suitable supply using a center-tapped transformer is shown in Fig. 11. Each IC draws about 15 mA. The simple shunt Zener regulator uses the 1N5243 which has a dynamic impedance of about 7 ohms at 10 mA. Any ripple which may be present on the filter capacitor will be reduced by a factor of about 15 which corresponds to about 35 dB. The MC1303P is re-

latively insensitive to hum and the few hundred microvolts present with this supply is not objectionable. The 1-ohm resistors limit surge current due to the initial charging of the 2,000- $\mu$ F electrolytics.

The Zener tolerance is  $\pm 10\%$  which is sufficient since the integrated circuit is also tolerant of supply voltage variations.

**Single Supply**—Operation from a single rather than a split power supply may be desired. In this event, either of the two methods shown in Fig. 12 may be used. Note that the preamp ground is connected, in one, to the junction of the two Zeners, and, in the other, to the junction of the divider resistors  $R_A$  and  $R_B$ . This allows the output dc voltage to be at  $\frac{1}{2}V_{CC}$ , which gives the effect of having a split supply.

The method shown in Fig. 12-a is self-explanatory. Use of 10% or 5% tolerance Zeners is recommended to prevent variations in the equivalent positive and negative supplies.

The resistor  $R_s$  is computed using;

$$R_s = \frac{V_{z1} + V_{z2} - V_{in}}{N(15mA) + I_z}$$

where  $V_m$  is filtered dc from power supply; where "N" is the number of integrated

circuits and  $I_z$  is the bias current through the Zeners.

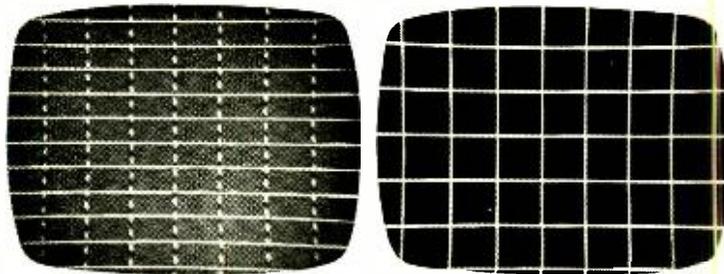
The Zener bias current,  $I_z$ , should be chosen to ensure operation of the Zeners in their lowest dynamic impedance region.

The method shown on the right is similar to that on the left. The divider resistors are required to supply input bias current to the integrated circuit. The maximum (signal) input current is 10  $\mu$ A per integrated circuit, so the current through the divider should be at least ten times the total input bias current drawn by all the integrated circuits in the preamplifier. The bypass capacitors should then be selected to have a reactance which is at least one-tenth of the resistance of the divider resistors at the lowest frequency of operation of the preamplifier.  $R_s$  is then computed as before.

Either method requires the use of a Zener whose voltage plus the maximum voltage due to tolerance variations does not exceed 30 volts. Thus, for a 20% tolerance Zener, a 24-volt unit would be required. For a 5% tolerance Zener, a 28-volt unit would be satisfactory.

In Fig. 12-b the Zener and  $R_s$  could be eliminated with small loss in performance. **R-E**

## Make the wiggly test.



On the left, a pattern\* produced by an ordinary color bar generator. On the right, the equivalent pattern\* produced by Leader's LCG-388. Perfectly stable, the instant you turn the power on.

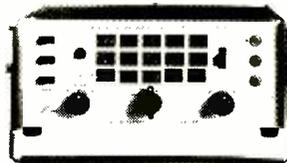
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\*As photographed.

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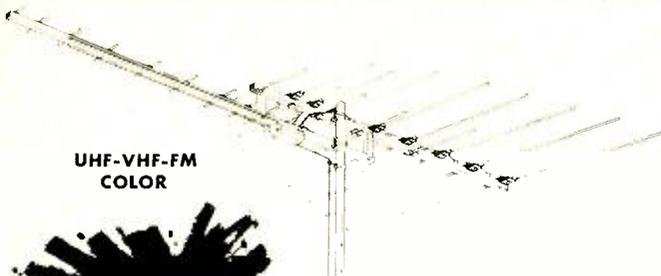


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(continued from page 26)

and the vertical sawtooth amplitude will not be enough. It should be possible to substitute with GE Universal replacement transistor GE17. The SA599 can be replaced by a GE2, 2N404, 2N217 or a 2N109.

It is a good idea to build up each section of the camera, connect it to a power supply, and test each circuit for correct waveforms before final installation. Remember to use the filament transformer for the vertical input signal. The video amplifier and rf oscillator can be tested by touching the body of C1 with your finger. This should induce hum and rf pickup through the video amplifier system, and in turn through the rf oscillator. Connect the oscillator to the antenna terminals of your TV set. This test will indicate whether the video amplifier is capable of amplifying.

After assembly is complete, by adjusting R20 you should be able to lock a synchronized raster on the TV set. Adjust height and width controls to maximum waveform amplitude. This will throw the camera in over-scan when the vidicon is connected. Adjust FOCUS CURRENT control R8 for a 10-volt voltage drop across the focus coil. The high voltage dc in the power supply can be checked for 300 volts at C33. The BEAM control should be adjusted for approximately 90 volts on R58. However, the beam, target, and electrostatic focus control settings will vary from vidicon to vidicon.

After all waveforms are checked, including blanking, and the video amplifier is operating, test for correct vidicon voltages at the vidicon socket. At this point insert the vidicon in the camera, being careful not to short the vidicon target ring connector. Do not expect to see a picture immediately, but by raising the target voltage (about 1/3 rotation) and bringing up the beam control, the raster should flash. At this time by adjusting the electrostatic focus control R1, you should see a gray area inside a black oval.

At this point you may remove the lens cap. You should see blobs of light and dark areas comprising a rough scene. By adjusting the optical focus, electrostatic focus, target, and beam, a picture should appear compressed in the black over-scan oval. It may be necessary to reverse horizontal or vertical yoke windings for image reversal, or it is possible the yokes may be magnetized if the picture appears off-center. The yokes can be demagnetized by discharging a capacitor (around 0.5 MF) through the yoke or applying a 6-volt battery momentarily to reverse its magnetism. If you try the battery polarity one direction and it does not respond, reverse it.

Finally, adjust the width and height controls so that only the edges of the black oval are just outside the picture area. This will maintain the best resolution from the vidicon tube. Never reduce the amplitude to under-scan because it is possible to burn a raster scanning area on the target which would be visible when full scanning is returned.

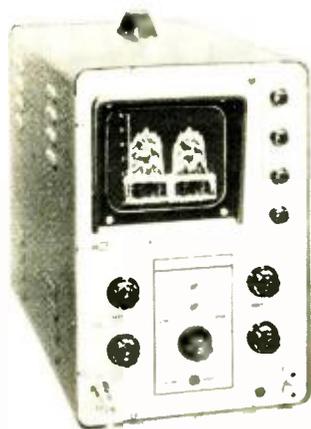
The deflection circuits were designed to provide adequate over-scan with 26 mA flowing through the focus coil. As focus coil current increases, so will the deflection current necessary to move the electron beam a given distance. For this reason R8 should be used to set magnetic focus current only. While using various makes of focus coils, it may be possible that R51, the electrostatic focus control, will come into range only near extreme ends of rotation. Do not attempt to compensate by re-adjusting R8. Instead, a separate voltage divider network has been provided for electrostatic focus, consisting of R52, R51 and R50, thereby allowing the value of R52 or R50 to be changed in order that optimum electrostatic focus will occur near the center rotation of R51.

**R-E**

# EQUIPMENT REPORT

B&K 1450 Diagnostic Oscilloscope

For manufacturer's literature, circle No. 88 on Reader Service Card.



A TEST INSTRUMENT IS VALUABLE ONLY if it saves your time by making tests faster and easier, or by making tests other instruments can't. The B&K Model 1450 Diagnostic Oscilloscope fits into this class. In fact, it's smart enough to make certain tests by itself without you!

The 1450 is a wide-band 5-inch scope with a frequency response from 5 Hz to 4.5 MHz  $\pm$  1.0 dB, and 3 dB down at 5.5 MHz. The 12-nsec rise time is fine for displaying such hard-to-see waveforms as the output of the burst amplifier. Input impedance is 3 meg-ohms and 47 pF in DIRECT, and 10 meg-ohms at 15 pF in the LOW-CAPACITY position.

The switch, intensity, focus and calibrate controls are in a vertical row to the right of the screen, making them handy. Vertical amplifier sensitivity is 25 mV rms/inch, controlled by a seven-step frequency-compensated attenuator. The horizontal amplifier has a sensitivity of 0.5 mV/inch, with a horizontal sweep range from 4 Hz up to 500 kHz in five ranges.

There is a phased 60-Hz sine-wave sweep for alignment work, and two special positions, TV-V and TV-H, for quickly checking video signals at either vertical (30 Hz) or horizontal (7875 Hz) sweep.

The 1450's vertical attenuator is calibrated in units of either "2" or "6." Peak-to-peak voltage ranges are 0.2V, 0.6V, 2.0V, 6.0V, 20V, 60V and 200V. The plastic graticule has a scale on each edge—0-2 and 0-6. To read p-p voltage, you simply turn the vertical attenuator to the VERTICAL position, turn off the horizontal gain, and adjust the CALIBRATE knob until the vertical line is the same height as either scale.

Once this calibration is done, a signal can be read for p-p value by adjusting the vertical attenuator switch until the whole waveform is visible, then noting the multiplier. The direct p-p voltage reading feature is useful for making quick tests of gain through several stages and checking p-p voltages against the schematic.

The 1450 can be used as a vector-scope—very handy in checking out color demodulator circuits. A color bar generator is connected to the set and tuned in with the set's hue and color controls at midrange. Now, the 1450's VERTICAL-RANGE switch is set to '60', the CAL control to minimum and the HORIZONTAL SWEEP control set to 'FX1'. A test lead is connected to the horizontal input.

Next the probe and the horizontal lead are both hooked to the red CRT grid terminal, and the horizontal gain control is adjusted. Move the horizontal clip to the blue grid terminal, and the vector pattern will appear, looking like a green chrysanthemum. Demodulator action can be checked by noting the amplitude and angles of the "petals," and hue control action checked by noting how far a given petal rotates when this control is moved, and so on. This pattern will also tell you whether the set uses 90° or 105° demodulation angles, and help set this correctly.

The most unusual and useful feature of this instrument is a built-in "Intermittent Analyzer." Briefly, this is how it works: If a signal is suspected of changing at any point in the circuit (up or down), the 1450's probe is hooked to that point and a constant test signal is fed in. The waveform pattern of the signal is set by adjusting the vertical gain.

In the scope, a comparator circuit is fed by a sample of the signal p-p voltage, and a comparison voltage set by the control knob. If the signal changes in amplitude, the comparator circuit fires an "up" or "down" neon lamp and closes a locking relay. This lights a front-panel pilot lamp, and applies 117 Vac to a receptacle on the back of the cabinet. This can be used to light a remote indicator lamp, a bell or an optional lighted sign which says 'INTERMITTENT.' The relay stays locked until the control is reset, but the neon lamps go off and on as the signal changes.

The Intermittent Analyzer can be very useful if used with an audible alarm. When hunting for an intermittent connection, part, etc., you can poke, pry, hammer and bend things until you "hit a nerve."

The sensitivity of the Intermittent Analyzer can be varied by adjusting pattern height on the screen. With the waveform set to cover most of the screen, the alarm will fire on a 10-15% variation in amplitude. Set to cover about half the screen, it will fire on a change of about 25%.

A crystal demodulator probe is available, for signal-tracing rf, tuner and i.f. stages.

All in all, this is a very useful piece of test equipment, and one that can make your work on today's complex electronic apparatus quite a bit easier than before.—*Jack Darr* **R-E**

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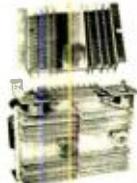
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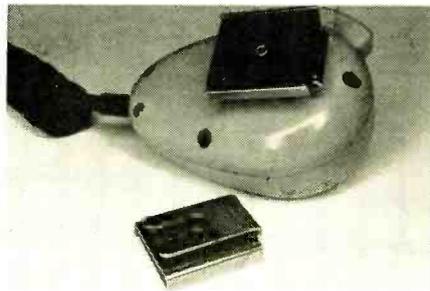
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EVERY MOBILE INSTALLATION MUST have a place for the microphone when it is not in use. Normally this is a sheet-metal bracket, or a hanger used with a button on the back of the microphone. The hanger must be screwed either to the car dashboard or to the transceiver case.

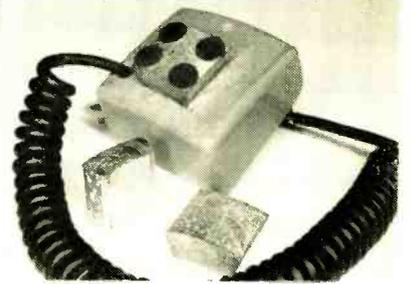
However, GC Electronics recently made available a *magnetic* mike holder, catalog number 65-525. This is for use only with microphones having the hanger button on the back. It can be



used two ways. Either place it on the dashboard or transceiver case, where the strong magnet will hold it in position, and drop the mike into the slot, or squeeze the holder a bit and force it on the back of the mike permanently. The second way, mike and magnet act as

one, and there is no searching for the slot of the holder in the dark or in traffic—the mike will stick almost anywhere.

But what if your mike doesn't have a hanger button? The answer, of course, is to attach a strong magnet to the back of the mike case. Strong magnets are not easy to find, but John Meshna Jr., 19 Allerton St., Lynn, Mass., will send



you six powerful magnets, like the ones in the photo, for \$1. Just ask for catalog item ALNICO. Include postage. [You can salvage similar magnets from small PM speakers.—*Editor*] Simply cement one or two of these magnets to the back of your carbon, crystal or ceramic microphone (dynamic mikes might be affected by the strong field of the magnet). Use Pliobond or epoxy cement. Small felt dots (you can get them at a 5 and 10) should be cemented to the magnet corners to prevent scratching the dashboard or transceiver case. Alternatively, you can spray or brush on some varnish or plastic. A thin coat will do.

This idea is not limited to mobile operation. Since most transceivers are in steel cases, the magnetically mounted hand mike is just as convenient in the base station.—*Fred Blechman, K6UGT*

## SLIPPING DIAL CORDS REPAIRED WITH PHONO-DRIVE ANTI-SLIP COMPOUND

Most of us have had maddening sessions with slipping radio dial cords. Common remedies, such as tightening the cord or taking additional turns around the tuning shaft, all too often do not work or, even worse, result in binding. However, here is a solution that I have found to work in the majority of cases. I use a liquid phono-drive anti-slip compound such as GC No. 86-2. A light application directly to the portion of the tuning shaft around which the dial cord is looped normally provides ample friction to prevent further slippage. In situations where the cord passes over idler pulleys the cord may even be left in place during application of the compound. Where the cord passes over friction-type guides, however, it should be removed and left off until the compound dries, to prevent binding later, as the compound-impregnated cord tries to slide over the guides.—*Klaus Halm* **R-E**

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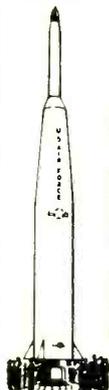
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# NOTEWORTHY CIRCUITS

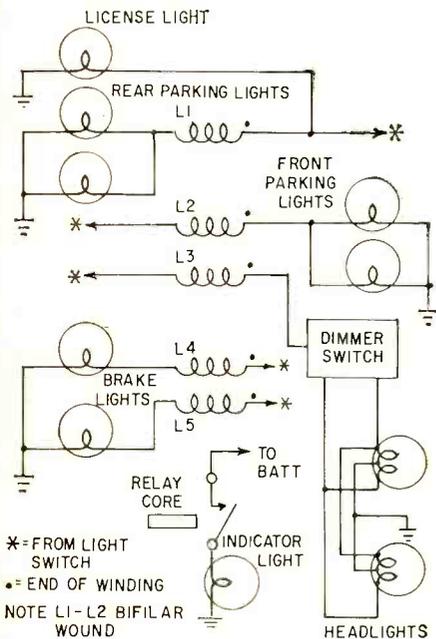
## AUTO BURNED-OUT LIGHT DETECTOR

Often a light on a car burns out and goes undetected for a long time. Also brake light switches and wiring fail occasionally.

This simple device to alert the driver is basically a differential relay. I chose a long coil relay (the coil itself is 3" x 1" in diameter) to accommodate the windings. The principle of the system is cancellation of magnetic fields of opposing coils feeding pairs of lights.

The brake-light coils are additionally connected so that the indicator shows when your brake lights go on. The indicator doesn't light if either brake light fails or if the indicator fails. This keeps a constant check on the indicator.

Since the taillights are always on with either parking or headlights, I chose to balance them against the



headlights or the parking lights (since front parking lights on my car do not operate with the headlights), whichever were on.

Having a 4-pole double-throw plate relay on hand, I drilled off the old winding with an electric drill. Then, to make the relay more sensitive, I bent the unused contacts away so that pull-in energy could be kept to a minimum.

I wound the front and rear parking-light windings (L1 and L2) as

a bifilar pair to insure their balance. The first layers wound were L1 and L2 (each consists of about 60 feet of No. 22 wire). The next winding is L3, the headlight coil, 28 turns of No. 18 wire evenly spaced. After finishing these coils, brake-light coils L4 and L5 are added. They consist of 15-20 turns of No. 22 wire. It is best to check operation before finishing completely in case pruning or adding is necessary.

The license-plate light is bypassed in the taillight circuit to achieve balance. Neither it nor the front signal lights are covered, except by failure of the turn-signal flasher to operate properly.

My car is a 1966 Plymouth Valiant with two GE-1034 lights in front and two in back. Headlights are two GE-6012's.

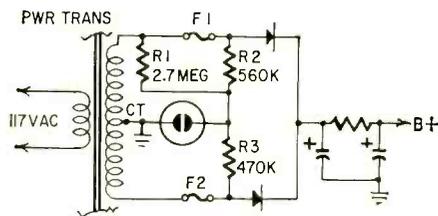
Any number of combinations are possible if you experiment with balancing. Coil size seems to be the only limiting factor. When experimenting, bear in mind that turn-signal filaments draw much more current than parking-light filaments.

Any iron core might be used with a reed switch in glass and the whole thing potted. But I believe it would require considerable more turns to obtain the necessary flux.—H. P. Neylon

## BLOWN-FUSE INDICATOR

Several methods have been developed to indicate a blown fuse in the primary circuit of a power supply. This circuit, taken from *Signalite Application News*, tells when either or both fuses in a secondary circuit are blown.

The circuit is inherently a balanced bridge with a neon lamp as the detector



or indicator. Two legs of the bridge are formed by the center-tapped transformer winding. One resistive leg is R3 and the other consists of R1 and R2 in parallel. If either fuse blows, the bridge is unbalanced and the neon lamp lights. Signalite recommends a high-brightness lamp such as the LT2-24.

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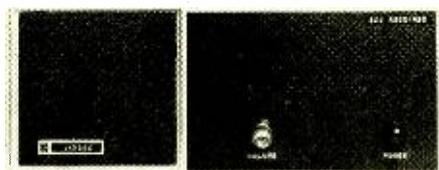
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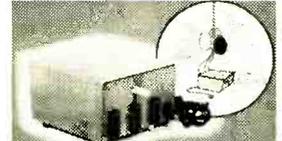
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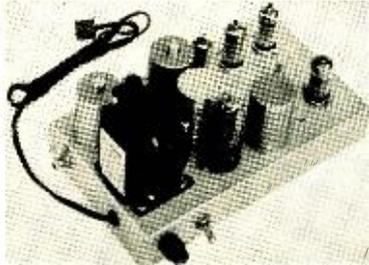
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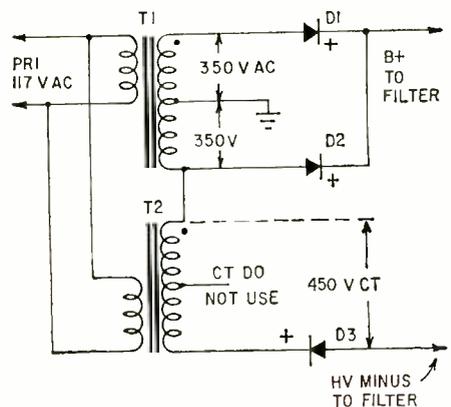
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## SERVICE CLINIC (continued from page 90)

ers (T1 and T2) to replace the original. Hook the high-voltage secondaries in phase (the voltages will add). D1-



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400	.12
600	.18
800	.22
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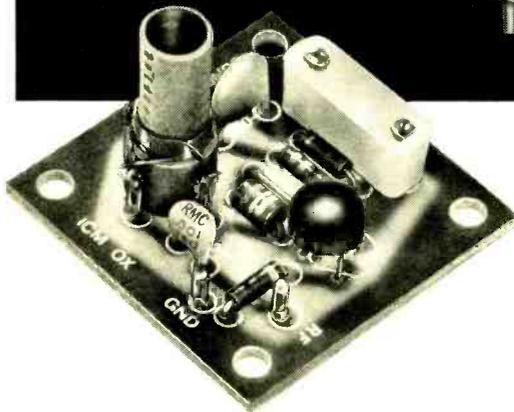
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### Type EX Crystal

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Crystal controlled transistor type.  
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