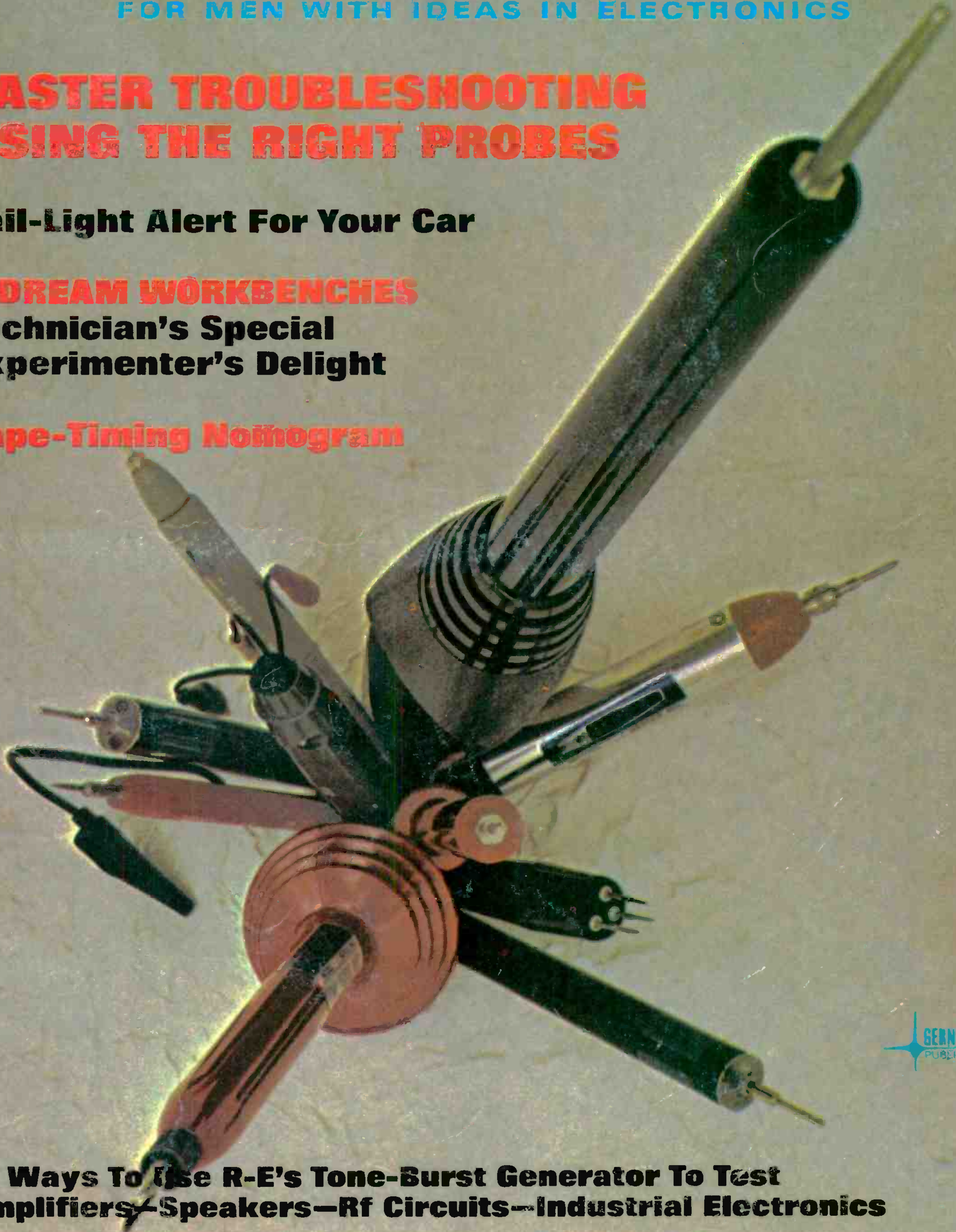
60c ■ AUG. 1971

Radio-Electronics

IND

FOR MEN WITH IDEAS IN ELECTRONICS



FASTER TROUBLESHOOTING USING THE RIGHT PROBES

Tail-Light Alert For Your Car

2 DREAM WORKBENCHES
Technician's Special
Experimenter's Delight

Tape-Timing Nomogram

A GERNSBACK PUBLICATION

14 Ways To Use R-E's Tone-Burst Generator To Test Amplifiers—Speakers—Rf Circuits—Industrial Electronics

GTE Sylvania has the lines that lay it on the line.

Only GTE Sylvania gives you a choice of three different price lines in color picture tubes.

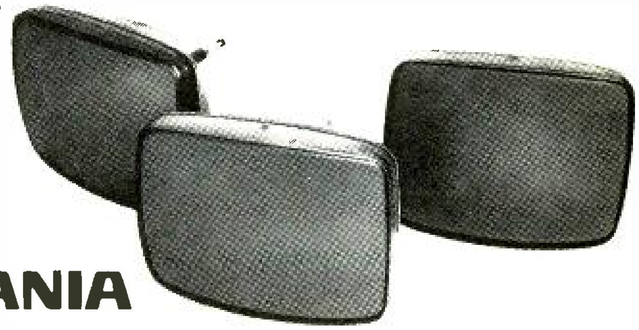
And GTE Sylvania tells you and your customer exactly what you are getting in each line.

That makes Sylvania tubes easier to sell.

You can tell your customers the advantages of the top-line *color bright* 85® XR. You can show them where the savings come from in the economy *color screen* 85 line. And you can tell them exactly what they're getting for their money in the middle-line *color bright* 85® RE.

The way we see it, if we lay it on the line with you, you can lay it on the line with your customers.

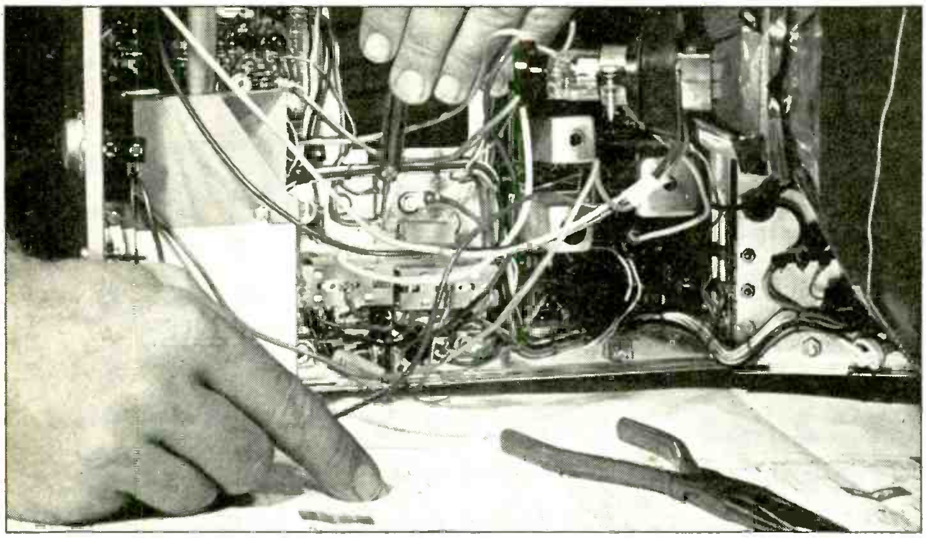
Instead of just handing them a line.



GTE SYLVANIA

	color bright 85® XR	color bright 85® RE	color screen 85
Sylvania rare earth red phosphors	yes	yes	yes
Other manufactured rare earth phosphors	no	no	yes
All sulfide phosphors	no	no	no
X-ray inhibiting glass	yes	no	no
New glass	yes	some	some
Reused glass	no	some	some
Regunned	no	no	some
Screen blemish specs	OEM	OEM	slightly wider than OEM
White field uniformity	OEM	slightly wider than OEM	slightly wider than "RE"
Cut off; purity currents; beam shield leakage	OEM	OEM	slightly wider than OEM

There is no substitute for training on real electronic equipment.



It's just as easy to train on the type of equipment technicians actually use and service.

And it's a lot more practical. Take TV Servicing, for instance.

You'll have it all over the man whose only experience has been on a TV receiver designed strictly for training purposes.

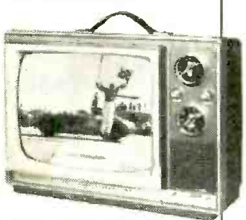
NTS Project-Method courses in Electronics combine the latest, professional equipment with easy-to-grasp lessons, texts and manuals. You build your equipment a stage at a time, and then use the equipment on projects that duplicate actual servicing problems.

It's like getting on-the-job experience at home.

Here's just some of the equipment you get to keep, and what you will learn. You'll get all the details when you receive the NTS full-color catalog.

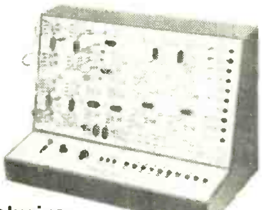
NTS COLOR AND B&W T.V. SERVICING

You receive a color TV with many unique features, including built-in self-servicing equipment so you can make all normal test operations. You also build an AM-SW radio, solid-state radio, F.E.T. Volt-Ohmmeter, and electronic tube tester. You learn trouble-shooting, hi-fi, multiplex systems, stereo and color TV servicing.



Solid-state B&W TV 74 sq. in. picture (cabinet included)

The B&W TV receiver features the latest in solid-state circuitry, making your TV training the most modern, most advanced available.



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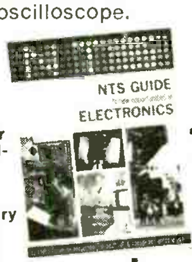

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5 watt AM transmitter receiver

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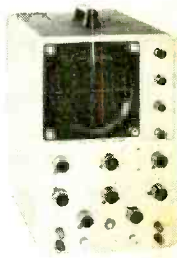
5" Oscilloscope



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Let NTS put you into the age of electronic controls. Systems automation is rapidly becoming the emphasis of modern industry. NTS training equipment includes a 5" wide band oscilloscope. You also get the new exclusive NTS Electro-Lab—a complete workshop. Build five industrial controls to regulate motor speed temperatures, pressure, liquid level and much more.

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- ☐ Master Course in B&W TV & Radio Servicing
- ☐ Master Course in Electronics Communications
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- ☐ Industrial and Automation Electronics
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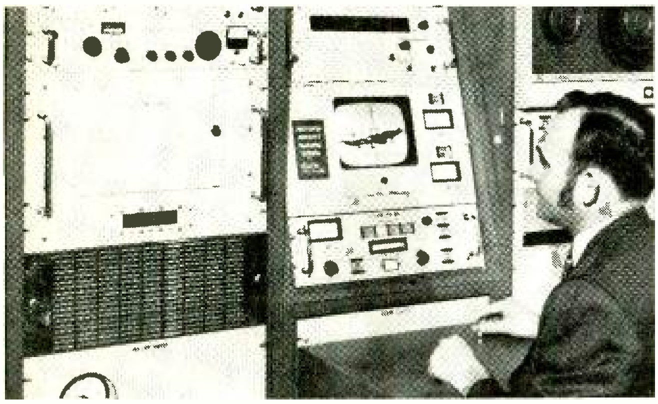
NEW & TIMELY

Volume 42 Number 8 RADIO-ELECTRONICS . . . FOR MEN WITH IDEAS IN ELECTRONICS August 1971

LASER TRACKING SYSTEM



MOUNTAIN VIEW, CALIF.—GTE Sylvania announced the delivery of an aircraft tracking system that uses an invisible laser beam to help assess the inflight performance of the new DC-10 jet transport. The system will assist engineers in evaluating avionic, aerodynamic, and acoustic functions of the aircraft during Federal Aviation Agency certification tests by providing precise data on the aircraft's location up to 60,000 feet.

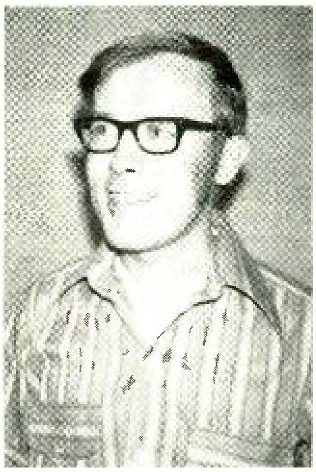
Completely self-contained in a transportable van near the runway, the system is controlled by a single operator from the control console. A low-powered infrared laser beam, originating from the van, illuminates a reflector mounted on the flying aircraft. The reflected beam is returned to detectors in the van that determine automatically azimuth, elevation, and range at rates of up to 100 measurements per second. This data is recorded on magnetic tape for computer analysis. The new system will dramatically reduce the data analysis time and cost required in other tracking systems, states Kenneth L. Brinkman, GTE Sylvania's director of the Electro-Optics Organization. ★

Hugo Gernsback Award Winners Announced

MILWAUKEE, WISC.—Vernon W. Greunke of Cedar Bluffs, Nebraska, has been chosen by Career Academy for the 1971 Hugo Gernsback Scholarship Award of $125.00. This award is given annually to worthy students in the electronics field from several home study schools.

Mr. Greunke is a printer on his home town newspaper, the *Fremont Tribune*. He says he sees the need for increased electronics training for anyone in his trade.

A Viet Nam veteran, Vernon's hobby is stereo and multi-track recording. His



courses will enhance his leisure time enjoyments while adding useful skills to his repertoire. ★

WASHINGTON, D.C.—CREI has announced its 1971 Hugo Gernsback Scholarship Award winner, Terrence A. Gregg of Phoenix, Arizona. Mr. Gregg is twenty-six years old, married, with three children, and is a former member of the USAF.

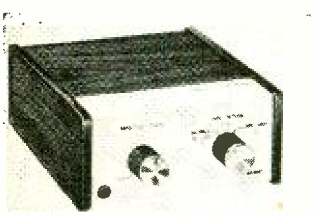
Along with his studies in electronics, Terrence works for Goodyear as a maintenance and calibration technician, and is enrolled at Phoenix

College in a program leading to a degree in Electronic Engineering. His hobbies are photography, astronomy, and of course, electronics. ★

ALL ABOUT PROBES

Must reading cover story starts on page 23. You'll be surprised at what you didn't know.

4-CHANNEL DECODING KIT



BENTON HARBOR, MICH.—The Heath Company has announced a one-evening assembly, kit version of the Electro-Voice Stereo-4 Decoding System.

The decoder is used in conjunction with an existing stereo system and a second stereo amplifier and speaker system, to provide four-channel stereo listening for any tape, record, or FM-stereo broadcast that has been encoded using the Electro-Voice matrixing process. ★

TWO DREAM WORKBENCHES

What would you put into your dream workshop? We're assuming an unlimited budget and all the space you might want. We offered this proposal to two of our top authors; and they've come back with two detailed articles. Jack Darr has drawn up his image of a Technician's Special starting on page 36, while Peter Sutheim has looked into an Experimenter's Delight starting on page 41. Compare your dreams with their dreams.

Electronic Airport Horizontal Elevator

TAMPA, FLA.—An electronically controlled automatic passenger transfer system, a type of "horizontal elevator,"

is operating at the recently opened Tampa International Airport. The shuttle system, built by the Westinghouse Electric Corporation, is said to be the first of its kind anywhere in the world.

Electronic equipment on the cars and along the wayside provide automatic controls that operate the system. Two-way audio-frequency

(continued on page 6)

Radio-Electronics

FOR MEN WITH IDEAS IN ELECTRONICS

August 1971 • Over 60 Years of Electronics Publishing

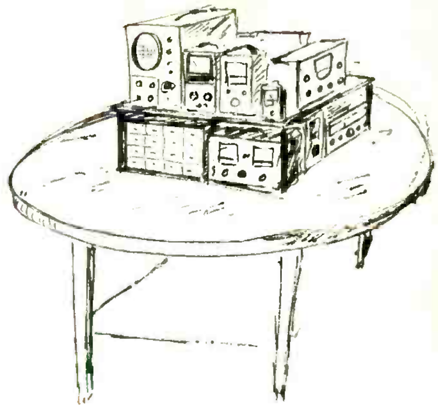
2 DREAM WORKBENCHES

AUDIO—STEREO—HI-FI

GENERAL ELECTRONICS

BUILD ONE OF THESE

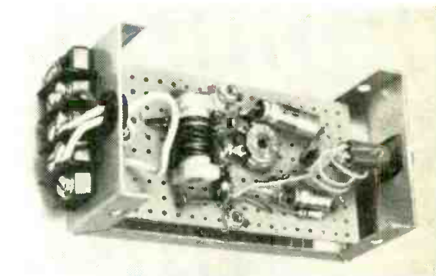
TELEVISION



If you could build your ideal workbench what would it look like? Compare your choices with those of two popular authors.

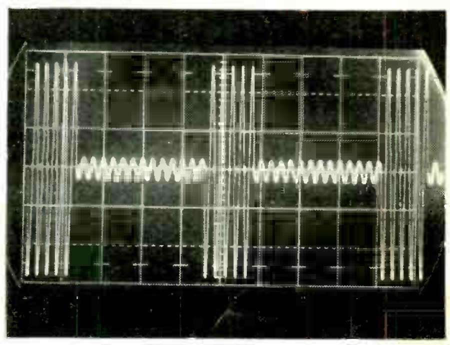
. . . see technicians bench on page 36

. . . see experimenters bench on page 41



Tail-light monitor tells you when a brake light has failed to operate. It could keep you out of a nasty accident.

. . . see page 60



Know what a tone-burst generator is? See how they can be used to do all kinds of electronic troubleshooting.

. . . see page 32

DEPARTMENTS

RADIO-ELECTRONICS, August 1971, Vol. 42, No. 8
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LOOKING AHEAD

Volume 42 Number 8 RADIO-ELECTRONICS . . . FOR MEN WITH IDEAS IN ELECTRONICS August 1971

by **DAVID LACHENBRUCH**
CONTRIBUTING EDITOR

The new TV sets

The 1972 model year will be a year of evolution—not revolution—in television receivers. The trends which started in the 1971 models will be consolidated. These include: (1) The substitution of square-cornered 19-, 21- and 25-inch color picture tubes for the older type 18-, 20- and 23-inch ones. (2) Continued momentum of solid-state, and generally modular, circuitry. (3) The proliferation of various automatic and pre-set tint controls. (4) Further moves into electronic varactor-diode tuning in high-priced sets. Prices of color sets are generally higher across-the-board as the result of increased costs of everything from components to shipping.

One color tube size has virtually disappeared—the 20-incher, now almost universally replaced by the 21-inch. And in all sizes from 19 inches up, the black matrix tube strongly predominates. Panasonic has introduced the first 19-inch color tube with 110-degree deflection in this country, making possible a shallower set. Sony is adding a 17-inch Trinitron color set to its line of 12-inch and 9-inch versions. In the solid-state sweepstakes, RCA has taken a strong lead, with 37 color models—about 65 percent of its line—containing no tubes except the picture tube. RCA says that every new color set it introduces from now on will be all-solid-state, with tube-type sets eliminated in the next couple of years. Most other domestic manufacturers are gradually increasing the solid-state content of their color sets, and both Sony and Hitachi are all-solid-state in color. Motorola has introduced a new version of its all-solid-state Quasar color chassis which uses eight circuit panels in place of the former 10, but with only two new ones. One of these is a transformerless power-supply module, used interchangeably on 19-inch and 25-inch sets.

Tuning ease continues to be a highly promoted feature—from Magnavox's TAC to RCA's AccuColor to Motorola's Instamatic. Philco-Ford has coined the word "Philcomatic" to cover all of its automatic-tuning features and added a light to indicate when the channel is tuned closely enough for AFC to take over. Wireless remote control is getting increased emphasis in both color and monochrome sets. RCA has a completely new remote-control system using a 20-channel varactor tuner, which changes vhf and uhf channels in complete silence. Other varactor remotes, generally using only one motor, are featured on Panasonic, Sylvania and Motorola sets. Seeking to make remote tuning as popular a feature on TV as automatic transmission is on automobiles, Motorola is using a simple remote control which adds only $50 to the retail cost of a color set, as compared to the normal $100 or $120 for the traditional full-feature remote. Motorola's unit controls only channel-change, on-off and volume, the company claiming that its Instamatic takes care of all picture adjustments automatically. RCA has the distinction of offering the lowest priced remote-control set in history—a 15-inch black-and-white with wireless remote on-off and channel change at a suggested list price of only $129.95. (We'll report next month on any other newsworthy new sets introduced after press time.)

Color VTR standards

A set of standards for half-inch open-reel color video tape recorders has been recommended by the Electronic Industries Association of Japan and quickly adopted by most Japanese VTR manufacturers. The EIAJ standard for monochrome VTR's has already been widely accepted (**Radio-Electronics,** May 1970), and the color version, which is compatible with it, is certain to gain the same acceptance. The new specs are designed for industrial-educational-institutional VTRs, but could also influence future home videocassettes. Ampex announced that its Instavideo cartridge VTR—already compatible with EIAJ's monochrome standards—would also embrace the color specifications, to make possible interchangeability of tapes when removed from the cartridge. The new color standards are expected to give a big lift to the color VTR market.

Videocassettes stalled

More has probably been written in the consumer magazines and newspapers about the home videoplayer than any other non-product in years. The articles all told about the coming "revolution" in television which would make possible the viewing of uninterrupted first-run movies, how-to-do-it lessons, sports events and so forth. Most of the articles enthusiastically reported that these home videocassette units would be on the market in 1972. Now we're almost into 1972 but that big revolution doesn't seem to be in sight. One home VTR—Cartridge Television Inc.'s Cartrivision system—is still scheduled for 1972 in very limited production, but all the others have been postponed or shelved. Some were plagued with technical problems, but the biggest problem of all seems to be uncertainty. In spite of all the optimistic statements about the huge home videocassette market, few manufacturers have convinced themselves that the time has come to take the multi-million-dollar plunge into production.

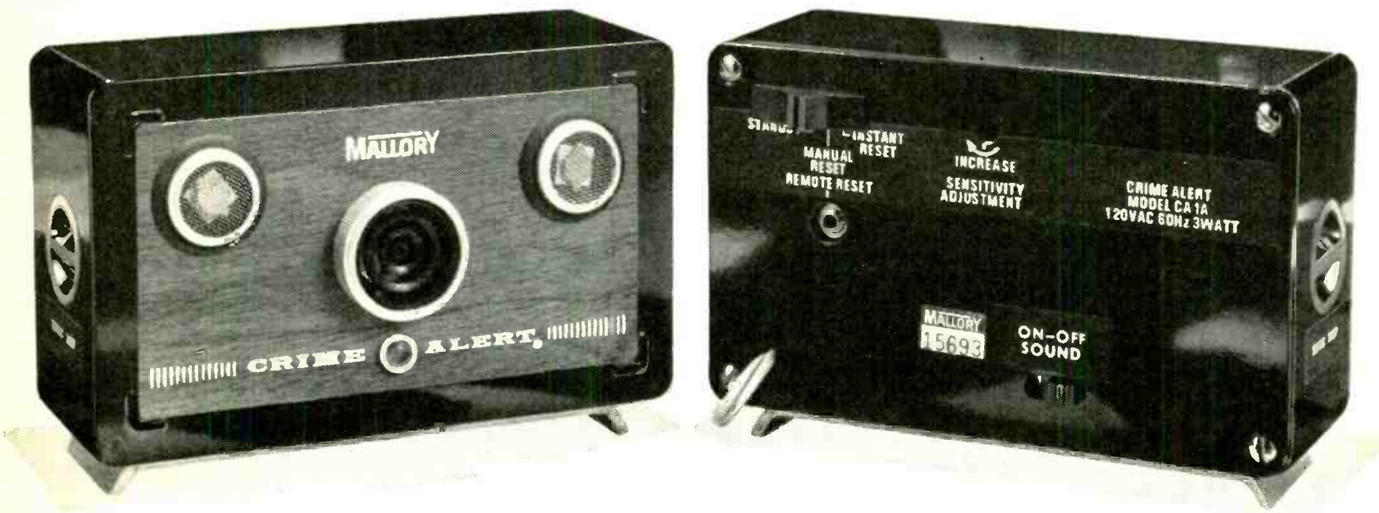
Too many uncertainties still remain. The biggest ones: (1) Given the high costs of materials such as magnetic tape or film plus the costs of program production, royalties, etc., will the public be willing to pay the necessary price to buy or rent videocassettes—particularly when everyone is used to receiving television programs free? (2) Which of the more than 20 mutually incompatible home videoplayer systems will become the "standard"—and what will happen to the non-standard systems? These nagging questions have served to delay the mass introduction of the home videoplayer.

It may be just as well. The battle between the 33 and 45 rpm records and between the various audio tape cartridges were penny-ante stuff compared to the potential compatibility battle between a number of non-compatible and expensive home videoplayers, and the portion of the public buying systems which turned out to be orphans would be substantial losers. With manufacturers now exercising extreme caution about plunging into this field, it's possible that the standards problem will be worked out before there is wide-scale production. Some videocassette systems are coming on the market—the CBS EVR system is being produced by Motorola in the U.S. and is scheduled to be manufactured by about 10 more firms outside the U.S. Sony is getting into production of its cassette-type magnetic tape system. Ampex still has its cartridge Instavideo tape recorder-player targeted for early 1972. But these are no longer described as home systems—rather

(continued on page 12)

NEW CRIME ALERT®

features greater protection range, many new options for security systems.



New CA1A CRIME ALERT®

Even 22 feet away, this new ultrasonic intrusion alarm can detect a burglar and take appropriate action. Like letting out a high-pitched scream or turning on a lamp floodlight, horn or bell. The built-in audible signal may be switched off and the accessory outlet used to give warning at some remote location without alerting the intruder.

Increased detection sensitivity isn't all that's new about the CA1A. It's got four different operating options that give it greater flexibility and allow it to make use of more accessories for a variety of security systems.

Option REMOTE RESET, lets you activate and deactivate the alarm from a remote location. Lockswitch RS1 is recommended.

Option AUTOMATIC RESET, alarm automatically stops after two minutes of operation. Accessory timer CAT 100 must be used.

Option INSTANT RESET, lets alarm trip only when intruder moves. When movement stops, the alarm stops and is instantly and automatically reset, ready to signal the next movement. Accessories like the weatherproof horn 87600, bell 60006 and rotating red light RRL1 are ideal for use with this option.

Option MANUAL RESET, after the intruder has been detected the alarm remains on until manually turned off and reset.

A variety of remote alarms which plug into any 120 VAC outlet without additional wiring are available for use with the CA1A.

New CA1DC CRIME ALERT®

This model operates on both 120 VAC and 12 to 18 VDC. Automatically switches to batteries if AC power fails. Has remote reset, automatic reset and manual reset described above. Audible alarm may be switched off. Normally open isolated relay contacts may be used for accessories such as DC bell 60007. Three Mallory M915 batteries are recommended for standby power. AC accessories not recommended for use with CA1DC.

Price for either CA1A or CA1DC $99.95.
Accessories at additional cost.

Write for bulletin 9-616 which describes the Mallory full line of security systems.

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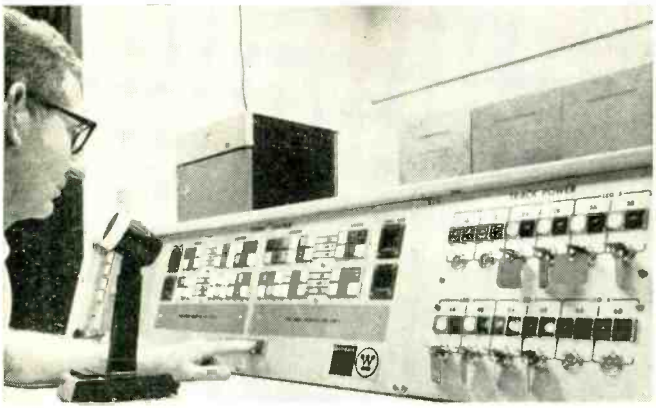
Circle 1 on reader service card

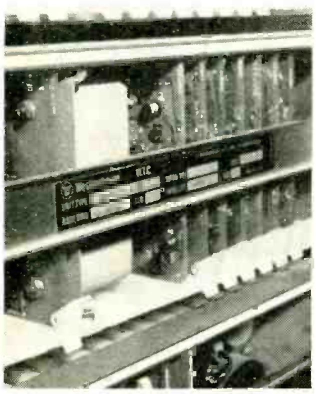
(continued from page 2)

communications link wayside controls to the vehicles on each system leg. The wayside



equipment initiates commands that signal the car to go, stop, make an emergency stop, open doors, reverse power and close doors.

Failure safety is provided by a combination of conventional railroad-type fail-safe relays and modern solid-



state electronic devices. The signal that activates the emergency brake comes from an electronic timing circuit using magnetic sensors mounted on the cars that sense small vertical interruptor plates mounted at specific points along the roadway. Passing each point where a plate is mounted causes an interruption which triggers a down-counter and a cascaded series of failsafe latches (solid-state relays that require ac signals to be activated) operating in conjunction with the down-counter.

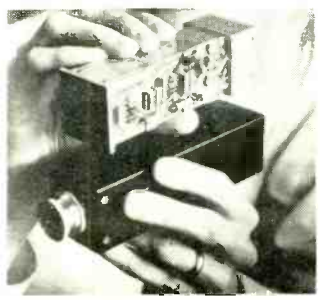
If the sensors pick up the next vertical plate before the timer has finished its count, the vehicle is going too fast at that point and a signal goes to the railroad relay to release the spring-loaded emergency brake.

A special-purpose sub-minicomputer carried on each car as part of the normal stopping control recalculates the required deceleration rate every six inches. ★

IN THIS ISSUE

If you built the tone-burst generator we described last month, you're looking for ways to use it by now. Turn to page 32 for an article that shows you 14 ways to use your new equipment.

SMALLEST TV CAMERA ever built was described by its chief designer, James H. Meacham of the Westinghouse Defense & Space Center in Baltimore, in a paper presented at the Nat'l. Aerospace Electronics Conference. Performance of the pocket size 9 oz. camera meets that of conventional cameras. Meacham said "Camera systems built recently have not fully utilized the expanding integrated circuit technology to achieve the size and reliability advantages inherent in this



approach. To mate the latest technologies in the image sensors and packaging ideas, we developed a subminiature TV camera for testing as a feasibility prototype."

Experimental Ignition Interlock System

MILWAUKEE, WISC.—For nearly two years Delco Electronics, a division of General Motors, has been developing the Phystester(TM) Ignition Interlock System, a device that may someday help keep drunk or impaired motorists from operating their vehicles. Students at the Medical College of Wisconsin took part in a scientific evaluation of the system which is aimed at the largest single cause of automotive fatalities and disabling injuries, crashes involving drivers who have significant levels of alcohol in their blood.

The Phystester(TM) works by displaying a random 5-digit number on a miniature scoreboard when the driver turns on the ignition key in his car. The driver then has a short time to punch into the keyboard the exact number which was displayed. If he does this in the time allowed, the car will start. If he fails the "test", the driver has two more chances to start the vehicle, al-

(continued on page 12)

Radio-Electronics

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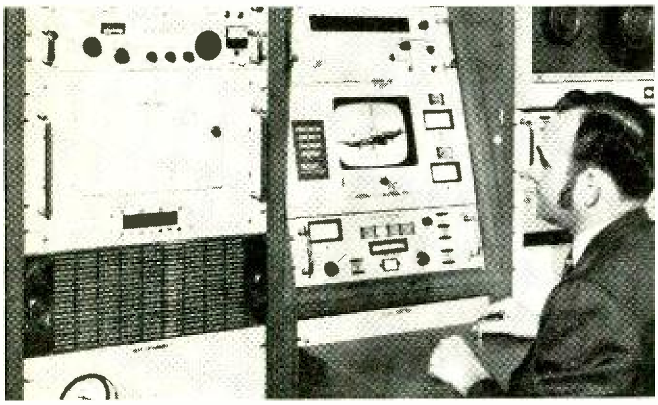
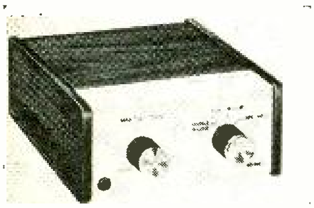
LASER TRACKING SYSTEM



MOUNTAIN VIEW, CALIF.—GTE Sylvania announced the delivery of an aircraft tracking system that uses an invisible laser beam to help assess the inflight performance of the new DC-10 jet transport. The system will assist engineers in evaluating avionic, aerodynamic, and acoustic functions of the aircraft during Federal Aviation Agency certification tests by providing precise data on the aircraft's location up to 60,000 feet.

Completely self-contained in a transportable van near the runway, the system is controlled by a single operator from the control console. A low-powered infrared laser beam, originating from the van, illuminates a reflector mounted on the flying aircraft. The reflected beam is returned to detectors in the van that determine automatically azimuth, elevation, and range at rates of up to 100 measurements per second. This data is recorded on magnetic tape for computer analysis. The new system will dramatically reduce the data analysis time and cost required in other tracking systems, states Kenneth L. Brinkman, GTE Sylvania's director of the Electro-Optics Organization. ★

4-CHANNEL DECODING KIT



BENTON HARBOR, MICH.—The Heath Company has announced a one-evening assembly, kit version of the Electro-Voice Stereo-4 Decoding System.

The decoder is used in conjunction with an existing stereo system and a second stereo amplifier and speaker system, to provide four-channel stereo listening for any tape, record, or FM-stereo broadcast that has been encoded using the Electro-Voice matrixing process. ★

TWO DREAM WORKBENCHES

What would you put into your dream workshop? We're assuming an unlimited budget and all the space you might want. We offered this proposal to two of our top authors; and they've come back with two detailed articles. Jack Darr has drawn up his image of a Technician's Special starting on page 36, while Peter Sutheim has looked into an Experimenter's Delight starting on page 41. Compare your dreams with their dreams.

Hugo Gernsback Award Winners Announced

MILWAUKEE, WISC.—Vernon W. Greunke of Cedar Bluffs, Nebraska, has been chosen by Career Academy for the 1971 Hugo Gernsback Scholarship Award of $125.00. This award is given annually to worthy students in the electronics field from several home study schools.

Mr. Greunke is a printer on his home town newspaper, the *Fremont Tribune*. He says he sees the need for increased electronics training for anyone in his trade.

A Viet Nam veteran, Vernon's hobby is stereo and multi-track recording. His

courses will enhance his leisure time enjoyments while adding useful skills to his repertoire. ★

WASHINGTON, D.C.—CREI has announced its 1971 Hugo Gernsback Scholarship Award winner, Terrence A. Gregg of Phoenix, Arizona. Mr. Gregg is twenty-six years old, married, with three children, and is a former member of the USAF.

Along with his studies in electronics, Terrence works for Goodyear as a maintenance and calibration technician, and is enrolled at Phoenix

College in a program leading to a degree in Electronic Engineering. His hobbies are photography, astronomy, and of course, electronics. ★

ALL ABOUT PROBES

Must reading cover story starts on page 23. You'll be surprised at what you didn't know.

Electronic Airport Horizontal Elevator

TAMPA, FLA.—An electronically controlled automatic passenger transfer system, a type of "horizontal elevator," is operating at the recently opened Tampa International Airport. The shuttle system, built by the Westinghouse Electric Corporation, is said to be the first of its kind anywhere in the world.

Electronic equipment on the cars and along the wayside provide automatic controls that operate the system. Two-way audio-frequency

(continued on page 6)

Radio-Electronics

FOR MEN WITH IDEAS IN ELECTRONICS

August 1971 • Over 60 Years of Electronics Publishing

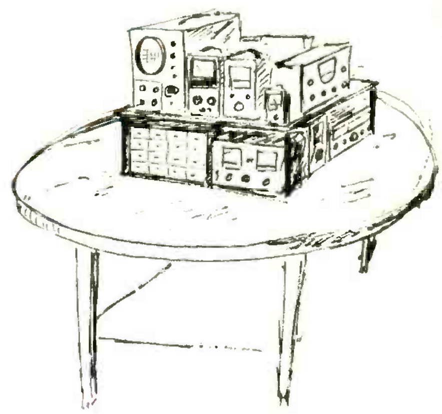
2 DREAM WORKBENCHES

AUDIO—STEREO—HI-FI

GENERAL ELECTRONICS

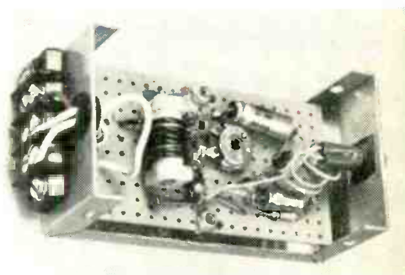
BUILD ONE OF THESE

TELEVISION



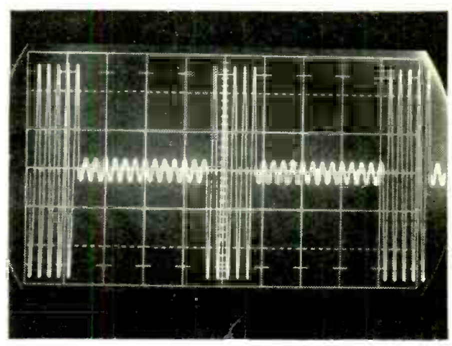
If you could build your ideal workbench what would it look like? Compare your choices with those of two popular authors.

. . . see technicians bench on page 36
. . . see experimenters bench on page 41



Tail-light monitor tells you when a brake light has failed to operate. It could keep you out of a nasty accident.

. . . see page 60



Know what a tone-burst generator is? See how they can be used to do all kinds of electronic troubleshooting.

. . . see page 32

DEPARTMENTS

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LOOKING AHEAD

Volume 42 Number 8 RADIO-ELECTRONICS . . . FOR MEN WITH IDEAS IN ELECTRONICS August 1971

by **DAVID LACHENBRUCH**
CONTRIBUTING EDITOR

The new TV sets

The 1972 model year will be a year of evolution—not revolution—in television receivers. The trends which started in the 1971 models will be consolidated. These include: (1) The substitution of square-cornered 19-, 21- and 25-inch color picture tubes for the older type 18-, 20- and 23-inch ones. (2) Continued momentum of solid-state, and generally modular, circuitry. (3) The proliferation of various automatic and pre-set tint controls. (4) Further moves into electronic varactor-diode tuning in high-priced sets. Prices of color sets are generally higher across-the-board as the result of increased costs of everything from components to shipping.

One color tube size has virtually disappeared—the 20-incher, now almost universally replaced by the 21-inch. And in all sizes from 19 inches up, the black matrix tube strongly predominates. Panasonic has introduced the first 19-inch color tube with 110-degree deflection in this country, making possible a shallower set. Sony is adding a 17-inch Trinitron color set to its line of 12-inch and 9-inch versions. In the solid-state sweepstakes, RCA has taken a strong lead, with 37 color models—about 65 percent of its line—containing no tubes except the picture tube. RCA says that every new color set it introduces from now on will be all-solid-state, with tube-type sets eliminated in the next couple of years. Most other domestic manufacturers are gradually increasing the solid-state content of their color sets, and both Sony and Hitachi are all-solid-state in color. Motorola has introduced a new version of its all-solid-state Quasar color chassis which uses eight circuit panels in place of the former 10, but with only two new ones. One of these is a transformerless power-supply module, used interchangeably on 19-inch and 25-inch sets.

Tuning ease continues to be a highly promoted feature—from Magnavox's TAC to RCA's AccuColor to Motorola's Instamatic. Philco-Ford has coined the word "Philcomatic" to cover all of its automatic-tuning features and added a light to indicate when the channel is tuned closely enough for AFC to take over. Wireless remote control is getting increased emphasis in both color and monochrome sets. RCA has a completely new remote-control system using a 20-channel varactor tuner, which changes vhf and uhf channels in complete silence. Other varactor remotes, generally using only one motor, are featured on Panasonic, Sylvania and Motorola sets. Seeking to make remote tuning as popular a feature on TV as automatic transmission is on automobiles, Motorola is using a simple remote control which adds only $50 to the retail cost of a color set, as compared to the normal $100 or $120 for the traditional full-feature remote. Motorola's unit controls only channel-change, on-off and volume, the company claiming that its Instamatic takes care of all picture adjustments automatically. RCA has the distinction of offering the lowest priced remote-control set in history—a 15-inch black-and-white with wireless remote on-off and channel change at a suggested list price of only $129.95. (We'll report next month on any other newsworthy new sets introduced after press time.)

Color VTR standards

A set of standards for half-inch open-reel color video tape recorders has been recommended by the Electronic Industries Association of Japan and quickly adopted by most Japanese VTR manufacturers. The EIAJ standard for monochrome VTR's has already been widely accepted (**Radio-Electronics,** May 1970), and the color version, which is compatible with it, is certain to gain the same acceptance. The new specs are designed for industrial-educational-institutional VTRs, but could also influence future home videocassettes. Ampex announced that its Instavideo cartridge VTR—already compatible with EIAJ's monochrome standards—would also embrace the color specifications, to make possible interchangeability of tapes when removed from the cartridge. The new color standards are expected to give a big lift to the color VTR market.

Videocassettes stalled

More has probably been written in the consumer magazines and newspapers about the home videoplayer than any other non-product in years. The articles all told about the coming "revolution" in television which would make possible the viewing of uninterrupted first-run movies, how-to-do-it lessons, sports events and so forth. Most of the articles enthusiastically reported that these home videocassette units would be on the market in 1972. Now we're almost into 1972 but that big revolution doesn't seem to be in sight. One home VTR—Cartridge Television Inc.'s Cartrivision system—is still scheduled for 1972 in very limited production, but all the others have been postponed or shelved. Some were plagued with technical problems, but the biggest problem of all seems to be uncertainty. In spite of all the optimistic statements about the huge home videocassette market, few manufacturers have convinced themselves that the time has come to take the multi-million-dollar plunge into production.

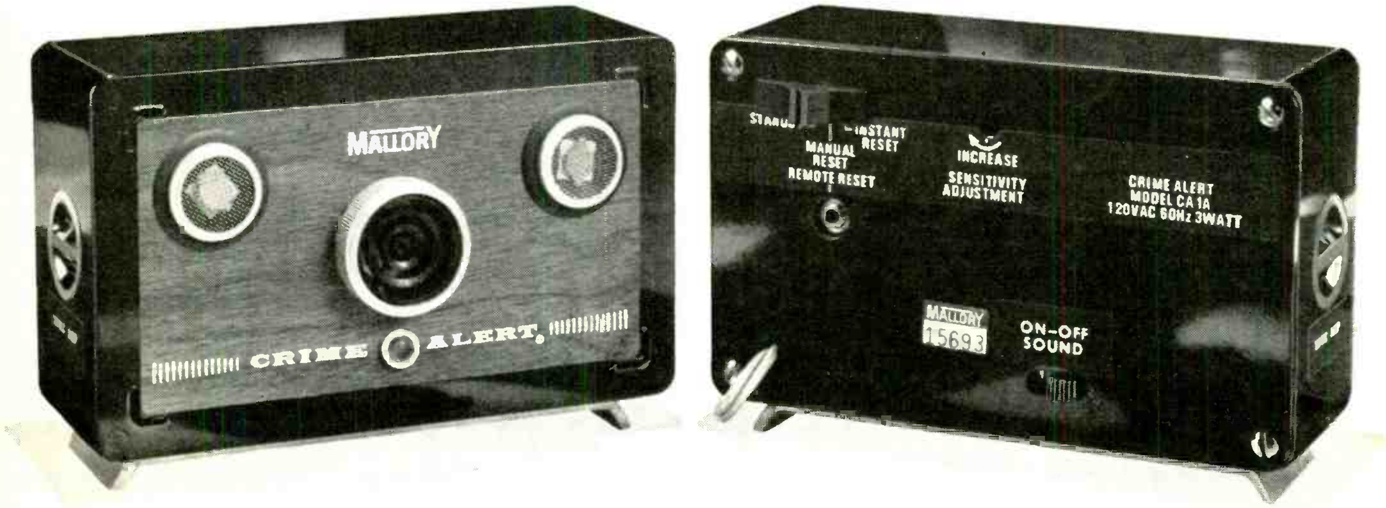
Too many uncertainties still remain. The biggest ones: (1) Given the high costs of materials such as magnetic tape or film plus the costs of program production, royalties, etc., will the public be willing to pay the necessary price to buy or rent videocassettes—particularly when everyone is used to receiving television programs free? (2) Which of the more than 20 mutually incompatible home videoplayer systems will become the "standard"—and what will happen to the non-standard systems? These nagging questions have served to delay the mass introduction of the home videoplayer.

It may be just as well. The battle between the 33 and 45 rpm records and between the various audio tape cartridges were penny-ante stuff compared to the potential compatibility battle between a number of non-compatible and expensive home videoplayers, and the portion of the public buying systems which turned out to be orphans would be substantial losers. With manufacturers now exercising extreme caution about plunging into this field, it's possible that the standards problem will be worked out before there is wide-scale production. Some videocassette systems are coming on the market—the CBS EVR system is being produced by Motorola in the U.S. and is scheduled to be manufactured by about 10 more firms outside the U.S. Sony is getting into production of its cassette-type magnetic tape system. Ampex still has its cartridge Instavideo tape recorder-player targeted for early 1972. But these are no longer described as home systems—rather

(continued on page 12)

NEW CRIME ALERT®

features greater protection range, many new options for security systems.



New CA1A CRIME ALERT®
Even 22 feet away, this new ultrasonic intrusion alarm can detect a burglar and take appropriate action. Like letting out a high-pitched scream or turning on a lamp floodlight, horn or bell. The built-in audible signal may be switched off and the accessory outlet used to give warning at some remote location without alerting the intruder.

Increased detection sensitivity isn't all that's new about the CA1A. It's got four different operating options that give it greater flexibility and allow it to make use of more accessories for a variety of security systems.

Option REMOTE RESET, lets you activate and deactivate the alarm from a remote location. Lockswitch RS1 is recommended.

Option AUTOMATIC RESET, alarm automatically stops after two minutes of operation. Accessory timer CAT 100 must be used.

Option INSTANT RESET, lets alarm trip only when intruder moves. When movement stops, the alarm stops and is instantly and automatically reset, ready to signal the next movement. Accessories like the weatherproof horn 87600, bell 60006 and rotating red light RRL1 are ideal for use with this option.

Option MANUAL RESET, after the intruder has been detected the alarm remains on until manually turned off and reset.

A variety of remote alarms which plug into any 120 VAC outlet without additional wiring are available for use with the CA1A.

New CA1DC CRIME ALERT®
This model operates on both 120 VAC and 12 to 18 VDC. Automatically switches to batteries if AC power fails. Has remote reset, automatic reset and manual reset described above. Audible alarm may be switched off. Normally open isolated relay contacts may be used for accessories such as DC bell 60007. Three Mallory M915 batteries are recommended for standby power. AC accessories not recommended for use with CA1DC.

Price for either CA1A or CA1DC $99.95.
Accessories at additional cost.

Write for bulletin 9-616 which describes the Mallory full line of security systems.

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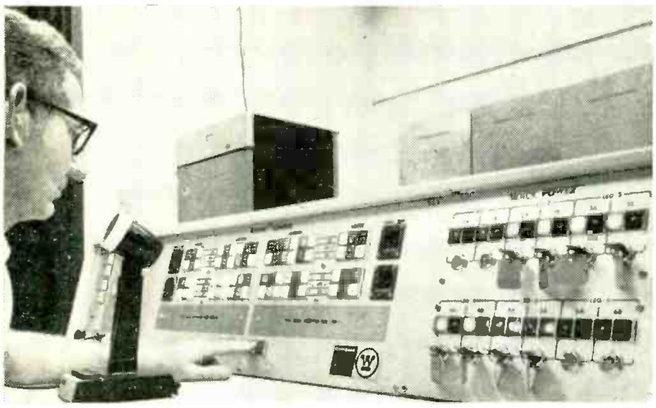
Circle 1 on reader service card

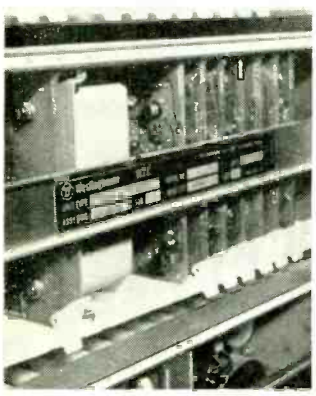
(continued from page 2)

communications link wayside controls to the vehicles on each system leg. The wayside



equipment initiates commands that signal the car to go, stop, make an emergency stop, open doors, reverse power and close doors.

Failure safety is provided by a combination of conventional railroad-type fail-safe relays and modern solid-



state electronic devices. The signal that activates the emergency brake comes from an electronic timing circuit using magnetic sensors mounted on the cars that sense small vertical interruptor plates mounted at specific points along the roadway. Passing each point where a plate is mounted causes an interruption which triggers a down-counter and a cascaded series of failsafe latches (solid-state relays that require ac signals to be activated) operating in conjunction with the down-counter.

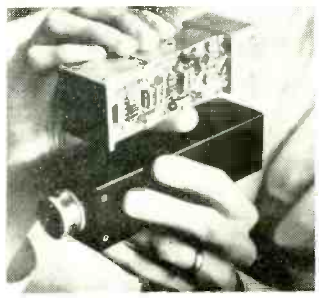
If the sensors pick up the next vertical plate before the timer has finished its count, the vehicle is going too fast at that point and a signal goes to the railroad relay to release the spring-loaded emergency brake.

A special-purpose sub-minicomputer carried on each car as part of the normal stopping control recalculates the required deceleration rate every six inches. ★

IN THIS ISSUE

If you built the tone-burst generator we described last month, you're looking for ways to use it by now. Turn to page 32 for an article that shows you 14 ways to use your new equipment.

SMALLEST TV CAMERA ever built was described by its chief designer, James H. Meacham of the Westinghouse Defense & Space Center in Baltimore, in a paper presented at the Nat'l. Aerospace Electronics Conference. Performance of the pocket size 9 oz. camera meets that of conventional cameras. Meacham said "Camera systems built recently have not fully utilized the expanding integrated circuit technology to achieve the size and reliability advantages inherent in this



approach. To mate the latest technologies in the image sensors and packaging ideas, we developed a subminiature TV camera for testing as a feasibility prototype."

Experimental Ignition Interlock System

MILWAUKEE, WISC.—For nearly two years Delco Electronics, a division of General Motors, has been developing the Phystester(TM) Ignition Interlock System, a device that may someday help keep drunk or impaired motorists from operating their vehicles. Students at the Medical College of Wisconsin took part in a scientific evaluation of the system which is aimed at the largest single cause of automotive fatalities and disabling injuries, crashes involving drivers who have significant levels of alcohol in their blood.

The Phystester(TM) works by displaying a random 5-digit number on a miniature scoreboard when the driver turns on the ignition key in his car. The driver then has a short time to punch into the keyboard the exact number which was displayed. If he does this in the time allowed, the car will start. If he fails the "test", the driver has two more chances to start the vehicle, al-

(continued on page 12)

Radio-Electronics

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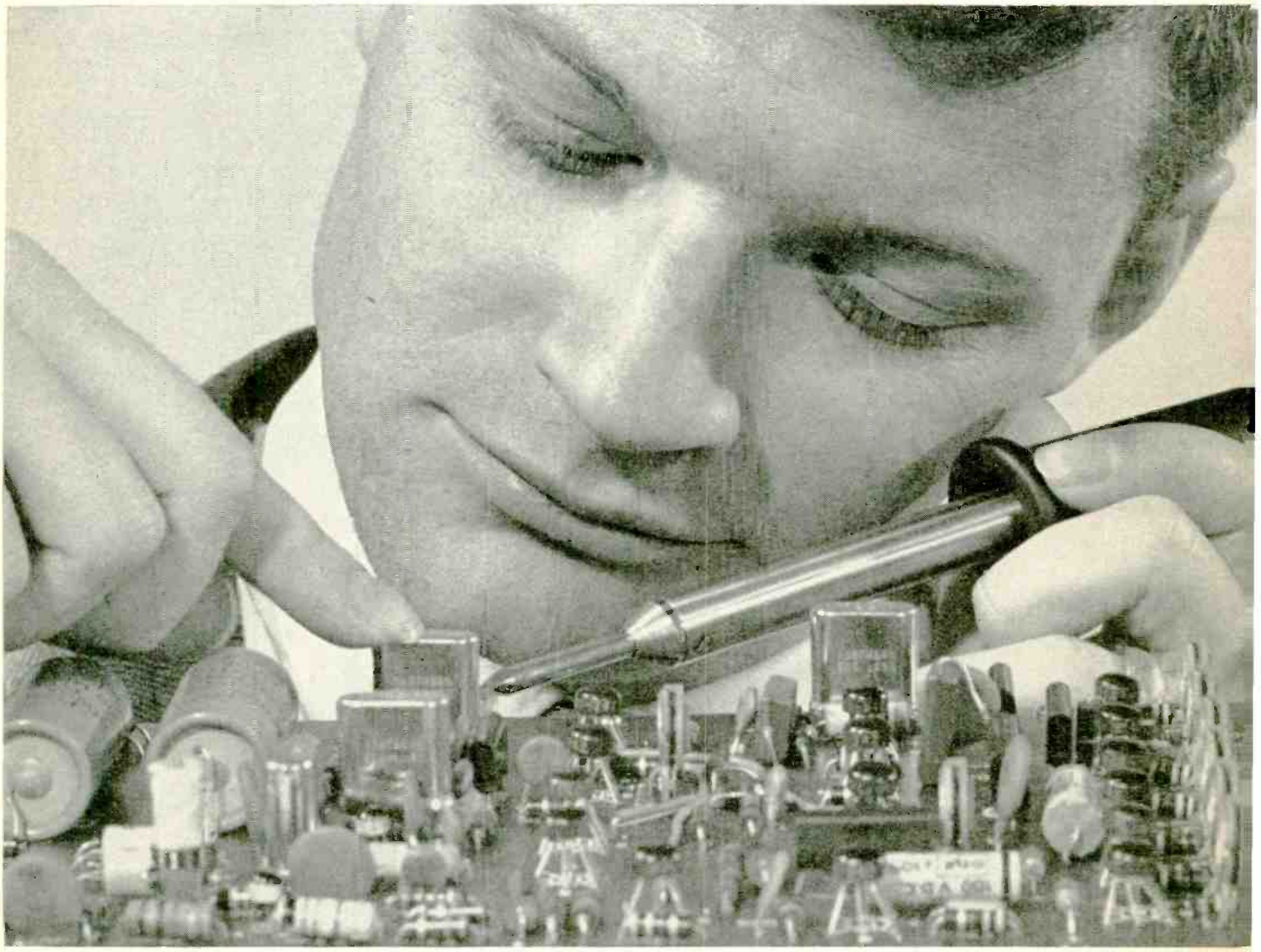

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HOME APPLIANCE ELECTRONICS

by JACK DARR
SERVICE EDITOR

SCR's AND POWER TRANSFORMERS

"WILL AN SCR WORK WITH A POWER transformer?" Meaning, can it be used to cut down the voltage, control the output, etc; as it is with electric drills and similar things? This is a question I get with some regularity (and one which I blushingly admit that I blew, the first time!) The right answer is pretty simple, and based, as usual, on one of the fundamentals of electronics. To start with, a short story.

Long, long ago, like about 1927, I traveled through the Midwest, specifically around Keokuk, Iowa and environs. At that time, there was a big power plant, on the Mississippi. This generated ac power for quite a large area; however, it was at a frequency of *25 cycles per second!*

This was a sort of island of 25-cycle power, surrounded by the present standard 60-cycle power. Special radio sets, synchronous motors, clocks, etc. were built for use in the 25-cps zone. If one of the radios was moved into the 60-cps zone, it worked nicely. (Not the clocks, etc. of course.) However, this was a one-way street! If you took a 60-cycle radio, using a power transformer, into the 25-cycle zone, it worked fine for about 20 minutes. Then the power transformer blew up!

People wanted to know *why?* So did I, since I was in the middle of my course at radio school, and none of our textbooks had the answer! Eventually, I found out. The power transformers designed for the 25-cps zone had large heavy iron cores: those used on 60-cps had much smaller cores. Put a 25-cps transformer on 60-cps, and it ran very cool. Put the smaller 60-cps transformer on 25-cps, and it promptly overheated.

This was caused by the design of the transformer windings. The lower frequency transformers had to have high-inductance windings, and lots of iron. When the lower-inductance 60-cps transformers were used on the 25-cps current, there simply wasn't enough impedance across the line to hold the current within safe limits. The smaller cores saturated, up went the current and the temperature and away we went.

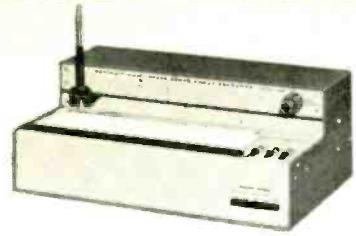
Finally I get to the point! What *is* an SCR? A half-wave rectifier, with a gate, to control its conduction. So, if we connect the thing in series with a "Universal-wound" motor, able to run on either ac or dc, we *can* use it as a simple speed control. With a single SCR, the motor will not run up to full speed, unless the switch is arranged so that the SCR can be shorted out in the "High" position. If the SCR is in the circuit at all, the motor runs on half-wave *dc* pulses.

Now, if we try to use an SCR as a voltage control, in the primary of a power transformer designed for 60-Hz operation (now we're back to the present, so I have to go back to saying "Hz") **What** are we feeding the primary of this transformer? *30-Hz current!* One "set" of half-waves does not pass through the SCR at all. So, the 60-Hz sinewave becomes a series of pulses at a basic frequency of 30 per second. If we vary its firing point, we get more or less of each half-cycle, but the frequency remains the same—30 Hz.

So! We're back in Keokuk in the 1920's, the transformer overheats, and out it goes, if left on long enough to break down. So, the answer to the first part of the question is **"Definitely NO!"** You can **NOT** use a single SCR with a power transformer.

However, there's a second half; now, "What *can* we use to control transformers?" The answer is simple. Use **TWO SCR's,** in parallel, one reversed. You'll find a circuit for this in the General Electric *SCR Manual* p. 104, 3d Edition. Now, we're clipping off a part of each half-cycle, but both of them get through, so that our basic frequency is 60 Hz.

The G-E *Hobby Manual* has circuits and full explanations on a simpler device, which is actually the same thing. This is called a "Triac" and is, in effect, two SCR's back to back, with a single common gate. These can be controlled by a device called a "Diac", which is a 'two-way SCR with no gate", and which can be controlled by pulses, etc. There are even light-operated Triacs, called "LASCR's". Circuits for the use of these are included in the *Hobby Manual.* **R-E**



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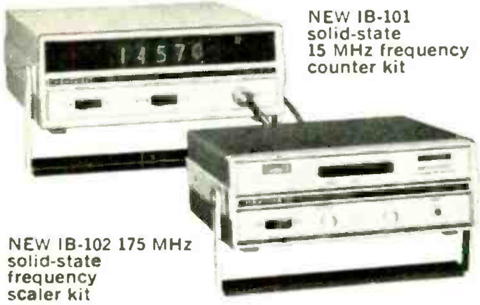
NEW GR-371MX 25" square-corner solid-state color TV kit

NEW GD-29 microwave oven kit



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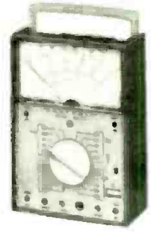

NEW IM-105 solid-state VOM kit

Seven new Heathkit® improvement ideas for home or shop

NEW! **Heathkit IR-18M 10" chart recorder kit** provides 12 different chart speeds...instant pushbutton selection from 5 sec/in. to 200 min/in. Digital logic delivers accuracy unobtainable with ordinary gear trains. Two input ranges permit accurate measurements from 0-1 & 0-10 mV full scale. Hi-Z input minimizes loading. 3-terminal floating input. Light-operated modulator eliminates problems of a mechanical chopper...operates at 240 Hz to reduce 60 Hz noise. Internal temperature-stabilized reference voltage eliminates troublesome reference battery. Coarse & Fine zero controls allow fast, accurate pen positioning. Other features: versatile pen holder that accepts virtually any writing instrument & hinged top for easy paper loading. For the best value going in a chart recorder, order your IR-18M now. Kit IR-18M, 15 lbs., **149.95***

NEW! **GR-371MX 25" solid-state ultra-rectangular color TV.** Check out the competition for standard features like these: 25" square corner Matrix picture tube for the biggest, brightest, sharpest color picture ever...high resolution circuitry plus adjustable video peaking ...Automatic Fine Tuning...pushbutton channel advance..."Instant-On"...Automatic Chroma Control...factory assembled 3-stage solid-state IF and VHF & UHF tuners for superior reception, even under marginal conditions...adjustable noise limiting & gated AGC...adjustable tone control...hi-fi sound output to internal speaker or your hi-fi system. Plus your choice of installation in one of the three beautiful Heath cabinets or custom wall mounting capability. And the exclusive Heath self-service features let you do all normal adjustment & servicing, saving hundreds of dollars in service costs. If you want the finest, this is it...order your 371MX now. **Kit GR-371MX,** 125 lbs. **579.95***

NEW! **GD-29 microwave oven**...the most modern way to prepare food. Cooks up to 70% faster with better vitamin retention. Cooks on glass, ceramics, even paper plates. low profile design fits under cupboards easily, yet has one of the largest oven capacities in the industry. Operates anywhere on standard 120 VAC current. Kit includes specially prepared cookbook. **Kit GD-29,** 97 lbs. **379.95***
Roll-around cart gives oven easy mobility, **Model GDA-29-1, 24.95***

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Kit IB-102, 7 lbs. **99.95***

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NOT SATISFIED with your present income? The most practical thing you can do about it is "bone up" on your electronics, pass the FCC exam, and get your Government license.

The demand for licensed men is enormous. Ten years ago there were about 100,000 licensed communications stations, including those for police and fire departments, airlines, the merchant marine, pipelines, telephone companies, taxicabs, railroads, trucking firms, delivery services, and so on.

Today there are over a million such stations on the air, and the number is growing constantly. And according to Federal law, no one is permitted to operate or service such equipment without a Commercial FCC License or without being under the direct supervision of a licensed operator.

This has resulted in a gold mine of new business for licensed service technicians. A typical mobile radio service contract pays an average of about $100 a month. It's possible for one trained technician to maintain eight to ten such mobile systems. Some men cover as many as fifteen systems, each with perhaps a dozen units.

Coming Impact of UHF

This demand for licensed operators and service technicians will be boosted again in the next 5 years by the mushrooming of UHF television. To the 500 or so VHF television stations now in operation, several times that many UHF stations may be added by the licensing of UHF channels and the sale of 10 million all-channel sets per year.

Opportunities in Plants

And there are other exciting opportunities in aerospace industries, electronics manufacturers, telephone companies, and plants operated by electronic automation. Inside industrial plants like these, it's the licensed technician who is always considered first for promotion and in-plant training programs. The reason is simple. Passing the Federal government's FCC exam and getting your license is widely accepted proof that you know the fundamentals of electronics.

So why doesn't everybody who "tinkers" with electronic components get an FCC License and start cleaning up?

The answer: it's not that simple. The government's licensing exam is tough. In fact, an average of two out of every three men who take the FCC exam fail.

There is one way, however, of being pretty certain that you will pass the FCC exam. And that is to take one of the FCC home study courses offered by the Cleveland Institute of Electronics.

CIE courses are so effective that better than 9 out of every 10 CIE-trained graduates who take the exam pass it. That's why we can afford to back our courses with the iron-clad Warranty shown on the facing page: you get your FCC License or your money back.

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Correspondence

AMATEUR ELECTRONICS CLUB NEWS

You may be interested to hear that the subscription to our British Amateur Electronics Club Newsletter has not been raised since we started in May 1966—it is still only $2.00 per year for overseas members. I will be pleased to send further details to your readers regarding our Club. Just write to me at the address below. Thanks for your interest and help in the past.

CYRIL BOGOD
"Dickens",
26 Forrest Road,
Penarth, Glam,
Great Britain

CALL BUTTON SAFETY DEFENDED

In the April 1971 issue of *Radio-Electronics* there is a New & Timely item (page 14) about elevator touch buttons which is untrue and misleading. I have been in the elevator business for over sixteen years and I know how these buttons work—and it's not from heat.

The February 1971 issue of *Elevator World Magazine* explains the operations of these touch buttons and the degree of safety to be expected from them. The magazine states, that "there is no such animal as a 'heat actuated call button'. . . . All call buttons in use in skyscrapers (or elsewhere) can be destroyed at some high degree of heat, and can, at the time of disintegration, create a call within the system. 'Electronic' or other types of 'touch' buttons are not activated by any amount of heat until the fixture parts collapse. It is inconceivable that any button of current design can be activated by the 'heat of a finger'. How do 'touch' buttons work if not by heat? They contain a vacuum tube wherein a person placing a finger on the button surface, provides a ground potential, completing a firing circuit, or, the button surface may have minimal movement wherein a 'touch' does constitute operational pressure."

Although elevators should not be used in a building where there is a fire, several other safety factors are involved in this dictum.

DAVID N. AMIDON
Pasadena, Calif.

GRATEFUL AWARD WINNER

I would like to take this opportunity to express my gratitude to you for making the Hugo Gernsback Scholarship possible.

It is deeply appreciated and will be put to good use toward my tuition at Bell & Howell Schools.

ROBERT E. RICHARDSON
Janesville, Wisc.

SERVICE MANUAL NEEDED

I have been searching for a service manual for a Model MX-2930/USM105 dual-trace oscilloscope preamplifier. This is a Navy surplus unit made by Hickok and I understand the model number of the oscilloscope it was used with is AN/USM105.

Hickok does not have a manual nor does Navy Publications. I hope your fellow readers can help me locate one.

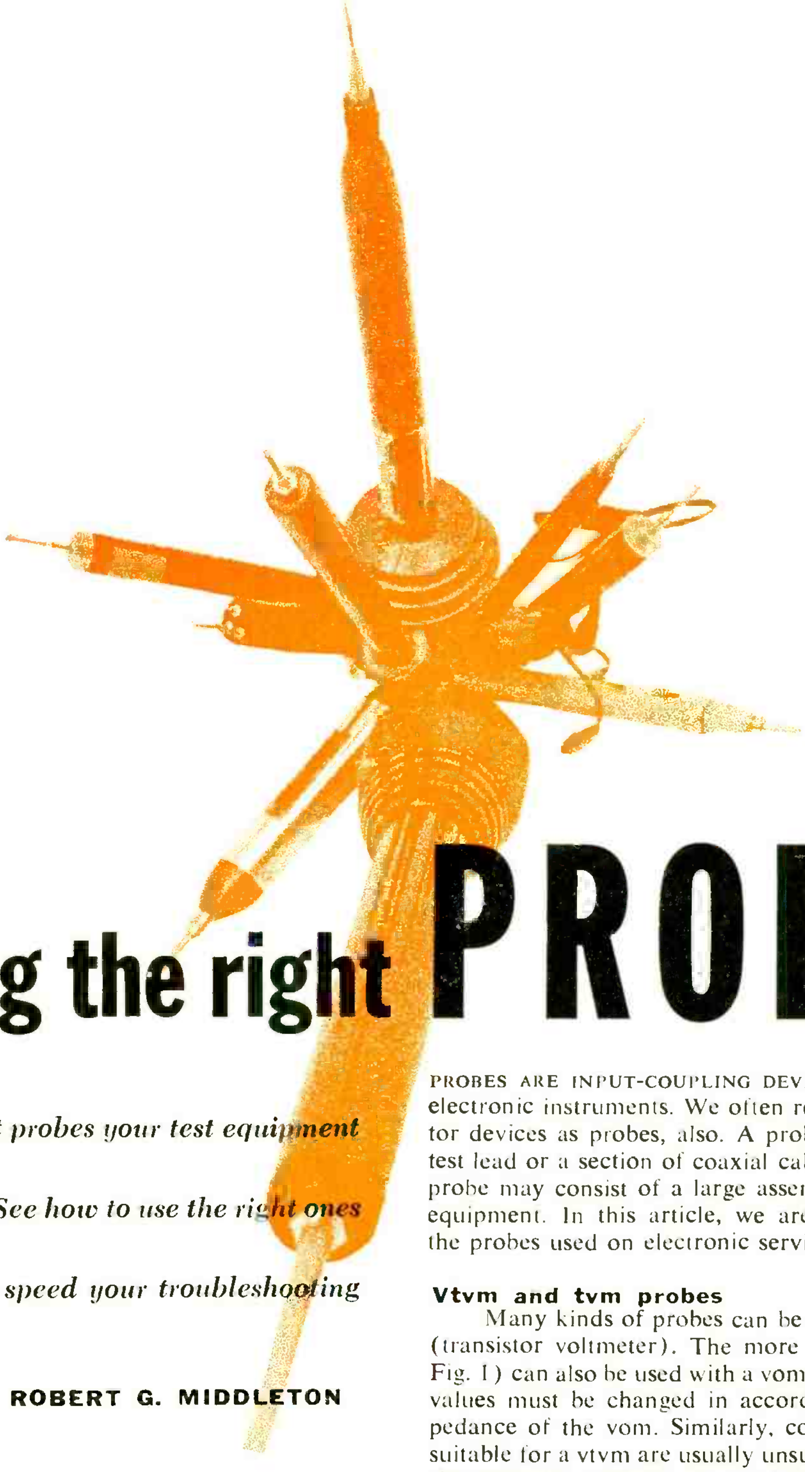
Thanks for the twenty-five years of help and enjoyment I have received from your magazine.

LEE TATE
2812 Stratford Drive
Greensboro, N. C.

CRT CHANGE NOTE

Tom Richmond wrote an interesting and informative article, "Change Color Pix Tubes Faster," in the May

(continued on page 26)



using the right PROBES

Without the right probes your test equipment is worthless. See how to use the right ones and speed your troubleshooting

by **ROBERT G. MIDDLETON**

PROBES ARE INPUT-COUPLING DEVICES FOR ELECTRICAL OR electronic instruments. We often refer to small signal-injector devices as probes, also. A probe may consist only of a test lead or a section of coaxial cable. On the other hand, a probe may consist of a large assembly of signal-processing equipment. In this article, we are chiefly concerned with the probes used on electronic service benches.

Vtvm and tvm probes

Many kinds of probes can be used with a vtvm or tvm (transistor voltmeter). The more basic types (depicted in Fig. 1) can also be used with a vom, although the component values must be changed in accordance with the input impedance of the vom. Similarly, component values that are suitable for a vtvm are usually unsuitable for a tvm. A probe that operates properly with one brand vtvm may operate improperly with one of another brand. Again, it is the input impedance of the instrument that is of basic concern.

The simplest type of "probe" is a pair of *open test leads*, as shown in Fig. 1-a. Open leads can be used with a vom, vtvm, or tvm. However, we will find that direct leads *may* give an abnormally high dc voltage reading when used with vtvm or tvm. This possibility is explained at a later point. Open test leads are suitable for measuring dc voltages in low-impedance circuits, as in power supplies. Open leads are usually satisfactory for measuring resistance values, although there are some exceptions, as will be explained. They are also suitable for measuring low-impedance circuits, as in 60-Hz heater and power-supply circuits.

Next, the *direct cable* (coaxial cable) arrangment in Fig. 1-b is similar to open test leads, with one important exception. Since the "high" conductor is shielded, a direct cable does not pick up stray fields. This fact can be important in measuring high-resistance values of semiconductor junctions. For example, Fig. 2 shows a resistance measurement being made with a pair of open test leads on a semiconductor diode. When the vtvm is operated on its R×1-meg range, the reading error is very obvious—as the technician's hands are moved, or as the leads are moved on the bench, the ohms reading changes considerably, due to stray-field pickup. A shielded cable eliminates this error.

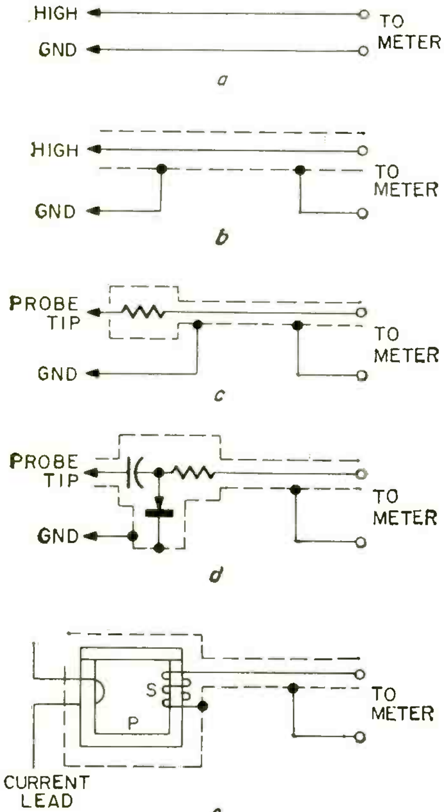


FIG. 1—BASIC PROBES for vtvm and tvm. Open test leads—commonly called prods (a)—are used to measure dc voltages in low-impedance circuits. The direct cable probe (b) is not affected by stray fields. Isolating and high-voltage probes (c) have a series resistor in the "high" input lead. A 1-meg resistor—in vtvm isolating probes—provides a high input impedance and greatly reduces the effective capacitance of the cable. In a high-voltage probe the resistor may be 1000 megs or more. Rf probe (d) is for high-frequency, high-impedance circuits. Series resistor must be a part of the calibrating circuit. Clamp-on current probe (e) permits measuring current without opening the circuit. The current-carrying lead acts as a one-turn primary for the current transformer.

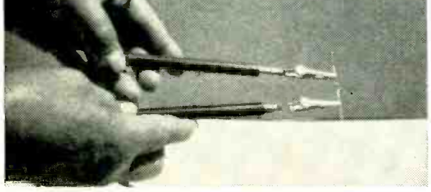


FIG. 2—ERRONEOUS READINGS may develop when open test leads are used to measure resistance with a vtvm or a tvm.

Now, let us consider the arrangement depicted in Fig. 1-c. This is a shielded cable with a series resistor at the input end. An *isolating probe* employs a 1-meg series resistor, and is commonly used with a vtvm for dc voltage measurements. The series resistor provides high input impedance, so that circuit disturbance is minimized. For example, if we use open test leads or a direct cable to check the grid-bias voltage in a high-frequency oscillator circuit, the reading is likely to be badly in error. On the other hand, if we use an isolating probe, the reading is almost certain to be very accurate. The isolating resistor cuts down the input capacitance of a direct cable from a typical value of 75 pF to 1.5 pF.

Many vtvm probes consist of a combination direct and isolating probe, with a slide switch to short out the series resistor when measuring resistance values. Note that if we forget to set the switch on its DC position when measuring dc voltages, the readings will be incorrect, even in low-impedance circuits. For example, a true value of 5 volts will be indicated as 5.5 volts under this condition, using a typical vtvm. Most vtvm's have a 1-meg resistor in the isolating probe, although a few instruments use other values. Therefore, an isolating probe from one vtvm will not necessarily match another vtvm. This precaution holds true also for tvm's that are designed for use with an isolating probe.

A high-voltage dc probe is similar to an isolating probe, except that the series resistor has a very high value. This resistance value must provide correct voltage division in combination with the internal multiplier of the voltmeter. Therefore, a high-voltage dc probe for one vtvm or tvm will not necessarily match another similar instrument. Note also that high-voltage dc probes designed for use with vom's cannot be used with either a vtvm or tvm, because the series resistor has too low a value.

Next, let us consider the measurement of ac voltages. Although vtvm's and tvm's are used with direct cables for measuring ac voltages in low-impedance circuits and at low frequencies, an *rf probe* is generally needed for tests in high-frequency and high-impedance circuits. As we saw previously, a direct cable has substantial input capacitance. This capacitance tends to load high-impedance circuits, and to bypass high frequencies to ground. Accordingly, rf probes such as depicted in Fig. 1-d are widely used in these applications. This probe is basically a half-wave detector, with a series resistor feeding into the cable. In turn, the input capacitance of the probe is only a few picofarads.

The series resistor in an rf probe not only isolates the detector from the cable capacitance, but also serves a calibrating function. The series resistor must have a value with respect to the internal multiplier of the voltmeter such that correct voltage division occurs. Accordingly, an rf probe for one voltmeter may not match another voltmeter. Figure 3 shows the voltage division that is involved. A half-wave rectifier is a peak rectifier, and a dc vtvm or tvm would read the peak voltage value, if it were not for the series resistor in the rf probe. This type of probe always *indicates rms values* of sine waves. Therefore, the series resistor must have a value with respect to the voltmeter multiplier such that 70.7% of the rectified output voltage is fed to the dc vtvm.

Note also that a semiconductor type of rf probe has limited low-frequency response. The reason for this limitation is that the series coupling capacitor cannot have a value much greater than 0.05μF. Otherwise, surges that occur when contacting B-plus

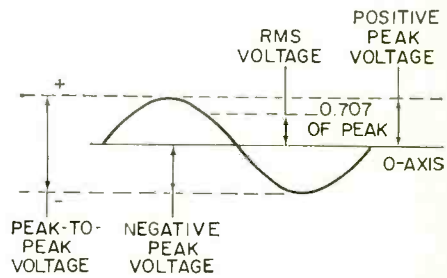


FIG. 3—A SINE WAVE. Output of a half-wave rectifier equals the peak voltage. Resistor in rf probe reduces this value to 70.7% so meter indicates rms.

FIG. 4—VACUUM-TUBE DIODE in rf probe provides better low-frequency performance than does a solid-state diode.

FIG. 5—A CURRENT PROBE for ac measurements. Current-carrying lead slips through slop into hole in probe tip.

lines with the probe will damage the semiconductor diode. Since the reactance of a capacitor increases as the frequency decreases, an rf probe is not suitable for use in power and audio circuits. This disadvantage is overcome by use of an rf probe with a vacuum tube diode, instead of a semiconductor diode. Figure 4 shows the arrangement of this type of rf probe. Since a vacuum diode is rugged, a large value of series capacitance can be used, with resulting good low-frequency response.

Alternating currents at frequencies through the video range can be measured without opening the circuit under test, if a clamp-around *current probe* is used. One of the simpler types (Fig. 5) uses the basic circuit depicted in Fig. 1-e. The probe utilizes a ferrite core which can be opened to clamp around a wire carrying alternating current. This wire serves as a *one-turn* primary, and the output from the secondary winding in the probe is fed to the ac voltmeter. Electricians generally use this basic arrangement. However, electronic technicians are concerned with smaller current values, and usually require a probe amplifier.

A current-probe amplifier is merely a stable class-A transistor amplifier. The amplifier is calibrated in this example to provide 1 millivolt output for each milliampere of current in the wire under test. Therefore, when measuring small alternating-currents with this type of probe, it is advisable to use an audio vtvm or tvm. That is, an audio voltmeter has much higher sensitivity than a conventional service-type ac voltmeter.

Oscilloscope probes

An oscilloscope is a voltmeter that shows the rise and fall of a voltage in time. Since a scope is a voltmeter, we can use the same open leads or direct cable as previously described for vom's, vtvm's, or tvm's. Open test leads have the disadvantage of stray-field pickup, which distorts screen patterns. A direct cable avoids stray-field pickup, but has the disadvantage of high input capacitance, which loads or detunes resonant circuits and loads high-impedance circuits in TV receivers and other devices.

Therefore, a scope employs a *low-capacitance* probe as standard equipment. This is a probe that exploits a trade-off between input capacitance and signal amplitude. The appearance of a low-capacitance probe is the same as that of an rf probe used with vtvm. However, the probe circuitry is quite different. To understand the operation of a low-capacitance probe, let us consider the two voltage dividers in Fig. 6. A resistive voltage divider operates well at low frequencies, but its stray capacitance and the input capacitance of the scope cable distorts high-frequency waveforms. Again, a capacitive voltage divider operates well at high frequencies, but distorts low-frequency waveforms (due to the increasing capacitive reactance at low frequencies).

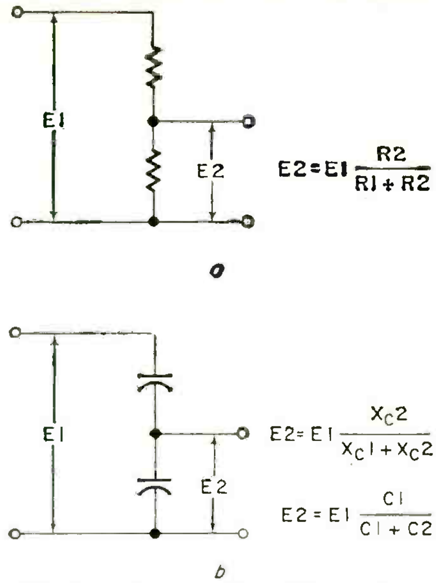


FIG. 6—VOLTAGE DIVIDERS. Resistive type (a) is good for dc and at low frequencies. Stray and cable capacitances cause distortion at high frequencies. Capacitive voltage divider (b) uses reactance of series capacitors to drop voltage at high frequences. Waveform distortion increases at low frequencies.

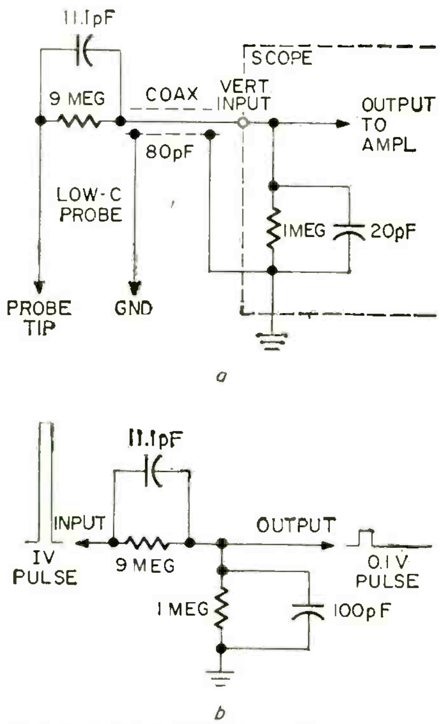


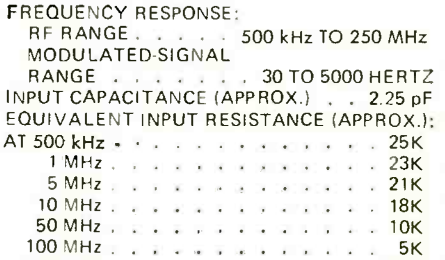
FIG. 7—LOW-C PROBE combines the best features of resistive and capacitive voltage dividers. Cable and scope input capacitances (a) are reduced by a factor of 10 as is the amplitude of the signal fed to scope. In equivalent circuit (b) probe and scope time constants are equal.

In view of the characteristics of resistive and capacitive voltage dividers, it is not surprising that a combination of the two basic divider circuits provides distortionless voltage division at both high and low frequencies. The arrangement used in a low-capacitance probe is shown in Fig. 7. Let us consider the trade-off that is involved in this example. An input capacitance of 80 pF plus 20 pF (total of 100 pF) is changed to an input capacitance of 11 pF. At the same time, the signal amplitude is reduced to 0.1. In other words, the input capacitance has been reduced by a factor of 10 (practically), while the signal amplitude has also been reduced by a factor of 10.

The basic requirement for distortionless reproduction of waveforms is that the two time constants in the low-capacitance probe must be equal. We observe that 9 times 11.1 is the same (practically) as 1 times 100. Note that since the 1-meg resistor is inside the scope (Fig. 7), the external low-capacitance probe must use a 9-meg resistor to obtain 10-to-1 signal ratio. If this same low-C probe were used with another scope that has some other value of input resistance, the signal ratio would not be 10-to-1. It is important to use a decimal (10-to-1) low-C probe to simplify calibration.

Another "standard equipment" type of scope probe is the demodulator variety. A circuit of a typical *demodulator probe* is in Fig. 8. Although a demodulator probe is somewhat similar to an rf probe, its circuit is designed to operate as a detector, so

(continued on page 78)



FREQUENCY RESPONSE:
RF RANGE . . . . . 500 kHz TO 250 MHz
MODULATED-SIGNAL RANGE . . . . 30 TO 5000 HERTZ
INPUT CAPACITANCE (APPROX.) . . 2.25 pF
EQUIVALENT INPUT RESISTANCE (APPROX.):

AT 500 kHz	25K
1 MHz	23K
5 MHz	21K
10 MHz	18K
50 MHz	10K
100 MHz	5K
150 MHz	4.5K
200 MHz	2.5K

MAXIMUM INPUT:
AC VOLTAGE. . . . . 20V RMS, 28V PEAK

FIG. 8—DEMODULATOR PROBE has a very low input capacitance to avoid detuning resonant circuits. Its short time constant insures that the scope waveform presentation is accurate.

CORRESPONDENCE
(continued from page 22)

1971 issue. It could be very helpful and timesaving to the hobbyist and beginning TV technician. I'd like to make one suggestion to your readers, though. Do *not* draw a grease pencil circle around the dots in the center of the screen for convergence. The grease could become embedded in the microscopic pores and valleys of the antiglare etching on the face of some new tubes, resulting in a permanent smudge. Instead, I find it convenient to stick a piece of masking tape on my dot-bar generator to use to mark the center of the screen.
G. A. CARROLL
Culver City, Calif.

MORE ON CAPACITOR LEAKAGE

Reading your article on the door-opener gadget and the capacitor leakage, I recalled that about 15 years ago I came across the same type of problem in the twin noise squelch circuit where there was 1.5 megs involved. After trying a few paper capacitors I tried oil-impregnated capacitors. That was the end of the problem. Now, when I work on something with more than 1 meg, I put in an oil-impregnated capacitor. I will have to try Mylar next.
HIRAM BROWN
New York, N.Y.

Thanks for the comments. Working on the old battery-powered radios, a long time ago, I became very "sensitive" to problems of capacitor leakage. Especially true in coupling capacitors feeding the audio output stage. In those, I didn't have to resort to oil-filled types, since the originals were 200 or 400 working volt papers. The 600-V paper type usually had practically no leakage. Later, we used Mylar for the same reason.

You might be amused by one that happened to me not too long ago. When I started, mica capacitors were considered as the absolute last word; never leaked, etc. So, I developed a habit of not checking them. I also developed a peculiar distortion in my old faithful audio generator. For two years at odd intervals I checked its circuits, without results. Then, I noted a mica capacitor connected across the bias resistor. (Since this was a phase-shift oscillator, this did have quite an effect.) Yep. Disconnecting this capacitor showed that it was regrettably very leaky! When replaced, the sine-waves were perfect as before. Now I suspect all capacitors until proven innocent!

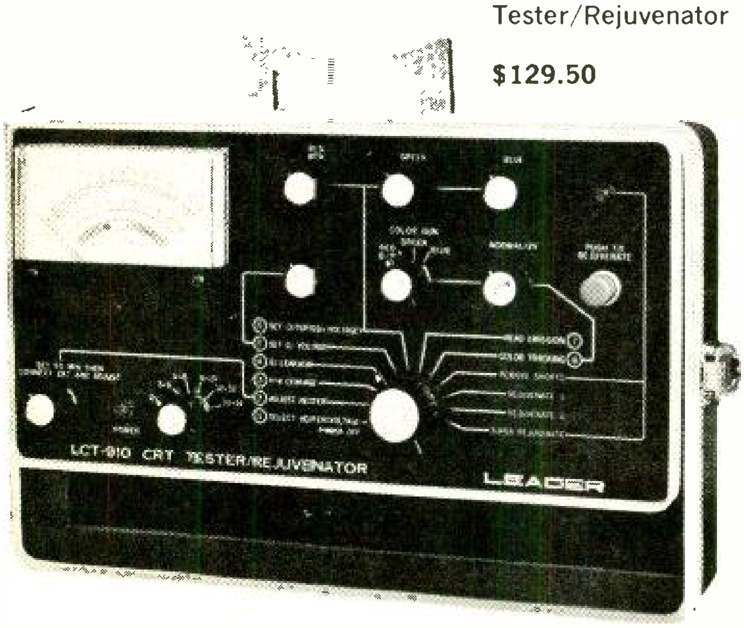
Thanks again!
JACK DARR
Service Editor

THE NEWER LEADER

LCT-910

Cathode Ray Tube Tester/Rejuvenator

$129.50



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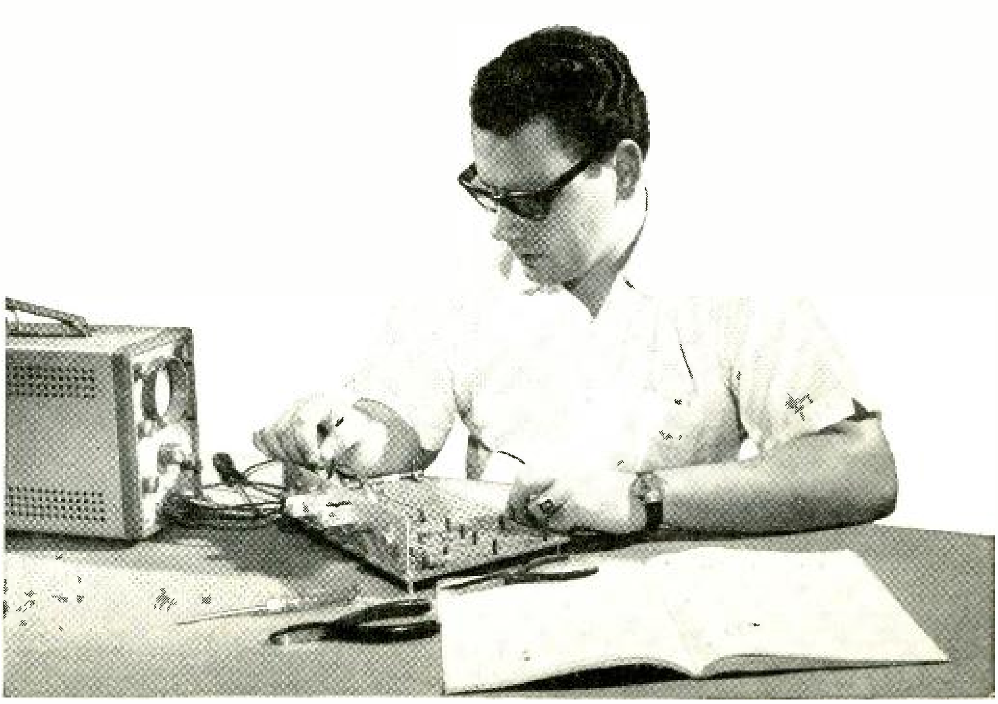

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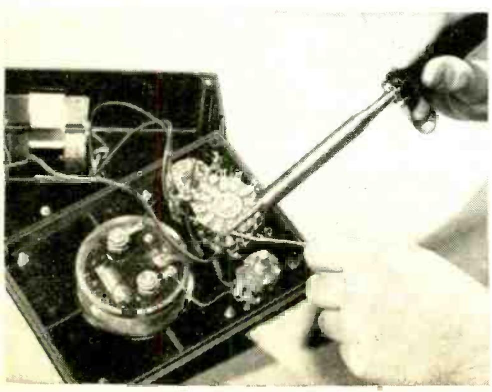
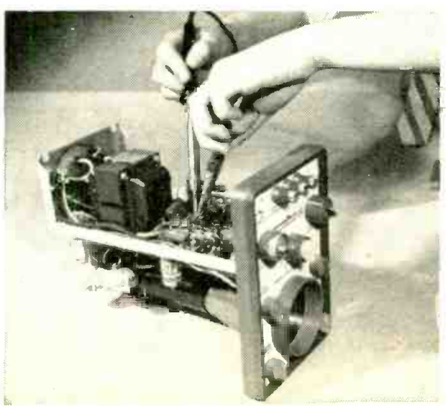
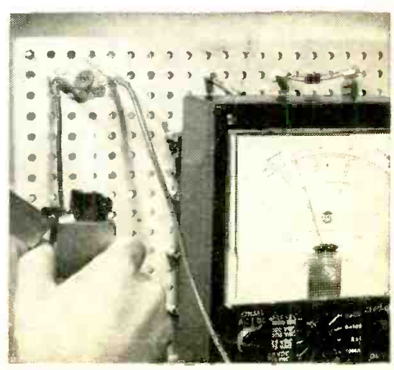




Construction of Oscilloscope.

Temperature experiment with transistors.



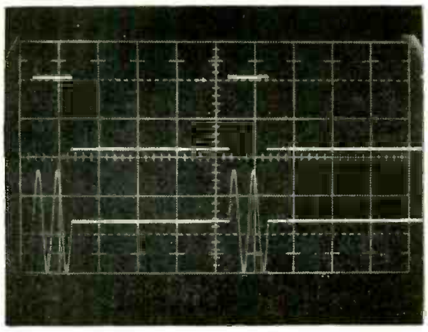


Fig. 2

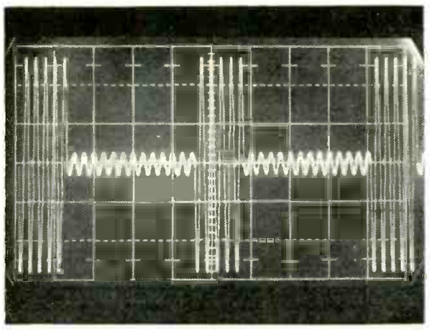


Fig. 4-a

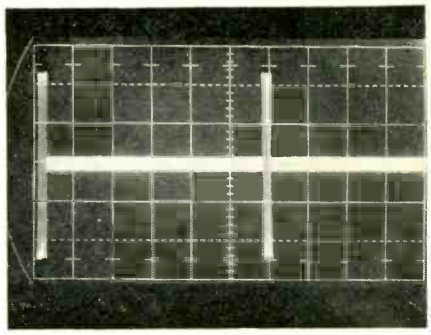


Fig. 4-b

FIG. 2—TONE BURST AND SYNC PULSES, lower and upper traces, respectively. The leading (positive-going) edge of sync pulse is usually used to sync scope.

FIG. 4-a—TONE BURST switched between two levels without reaching zero. (b)—TEST SIGNAL for an audio compressor. (c)—COMPRESSOR OUTPUT when fed with a tone burst like that in Fig. 4-b.

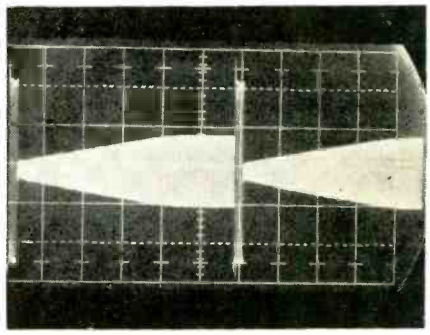


Fig. 4-c

14 Ways To Use R-E's Tone-Burst Generator

Here's a new way to test all kinds of electronic equipment with a new kind of test instrument

by TOM ANNES

TESTING WITH TONE BURSTS IS A TECHnique that is starting to come into use. This technique consists of subjecting a piece of equipment to an ac transient or tone burst and observing the results on an oscilloscope.

There are two basic methods of generating tone bursts. The first method is to use a voltage-controlled oscillator. Turning the control voltage on and off causes the oscillator to turn on and off to create a tone burst. This technique is used to give tone burst capability to some models of commercially available function generators.

The second method is to use a gate to control the output of existing oscillators and waveform generators. This technique was chosen for a future construction article in this magazine. The reasons for this choice are: (1) it can be used to gate any type of waveform generator that you may have on hand, even a noise generator; and (2) it is a more versatile unit yet lower in cost.

Controls and their uses

Let us now learn the controls and their uses. Fig. 1 shows the front panel of the instrument we built last month. **(Radio-Electronics,** July 1971, page 22.) The center knob selects the voltage level on the input waveform where gate open-

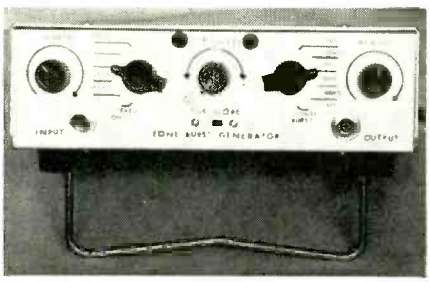


FIG. 1—TONE-BURST GENERATOR you studied and built last month. Now, you are ready to try its multitude of uses.

ing and closing takes place. It also serves as the power switch. Below this is the TRIGGER SLOPE switch. This little slide switch selects which slope (positive or negative going) is used for gate switching. The two knobs on the right control the period between the start of successive bursts. The one on the far right is the vernier. The bar knob selects the range. This control also has a SINGLE-BURST position. In this mode of operation, the generator produces only one burst and then stays off until reset. Resetting is done by applying a ground or a positive pulse to a BNC jack on the rear panel.

The two controls on the left control burst width. They are set in the same manner as the period control. The STEADY ON position overrides all other controls and close circuits (closes) the gate. If the PERIOD switch is set to SINGLE BURST, the output will be turned off if the WIDTH switch is in any position other than STEADY ON. This gives good on-off control for setting levels.

The status of the gate is indicated by the red and green traffic lights on the front panel. In actual operation, the intensity of these lamps give an indication of the time on, time off ratio of the gate.

Figure 2 shows the time relationship of the sync pulse and the tone burst.This pulse is available at the back panel for oscilloscope triggering. Setting the oscilloscope to trigger on the positive slope will start the sweep at the start of the tone burst.

The other controls on the rear panel are an INTERNAL-EXTERNAL SYNC selector switch, a SYNC INPUT jack, and a PEDESTAL NULL control. This PEDESTAL NULL control is used to balance out any change of dc output voltage between gate open and gate closed condition.

1. Compression amplifiers

Compression amplifiers, also known as regulated-output amplifiers, have several characteristics that are very easily checked with tone bursts. They are:

1. **Attack Time:** The time required for the compression circuits to take hold and reduce the gain.

2. **Overshoot:** The amount the amplifier output momentarily exceeds the reference or regulation level.

3. **Settling Time:** The time required for the output to stabilize after the amplifier is subjected to signal that exceeds the regulation level by some specified amount.

4. **Recovery Time:** The time required for the amplifier gain to recover after removal of a signal that exceeds the regulation level by some specified amount.

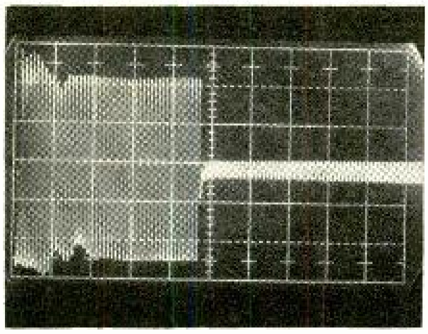


Fig. 4-d

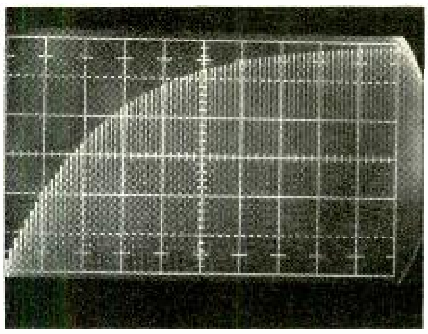


Fig. 6-a

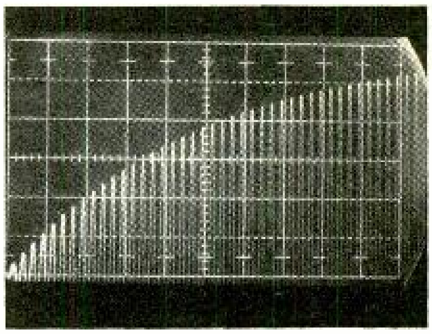


Fig. 6-b

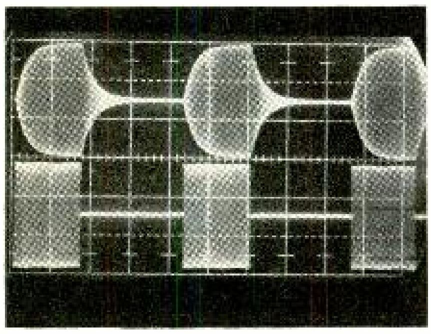


Fig. 5

FIG. 4-d—EXPANDED TRACE simplifies measuring the overshoot and settling time.

FIG. 5—DUAL-TRACE DISPLAY shows output of burst generator at the bottom and the output of a tuned filter at the top. Sweep speed is 20 msec/cm.

FIG. 6-a—RISETIME of compressor amplifier can be read on expanded trace. (b)—FURTHER EXPANSION of filter output trace simplifies Q measurements.

To make these tests, the amplifier must be subjected to a tone burst that is switched between two levels rather than on and off. To produce a tone burst that switches between two levels, use the hookup in Fig. 3. The potentiometer bridged between the input and output may be any value from about 1000 ohms and 1 meg. Output is taken between the wiper arm and ground. The output level between bursts is adjusted by the wiper position: however, it doesn't appreciably change the burst amplitude. If a fixed resistor is added at the point marked "X", the maximum output between bursts will be reduced. This makes adjustment of the potentiometer easier for lower levels. The output at the wiper arm should work into a reasonably high impedance. (A 50-ohm load would look like a short circuit to a 1-meg potentiometer.) Keep the leads between the potentiometer and the tone burst generator short.

The waveform in Fig. 4-a is of a

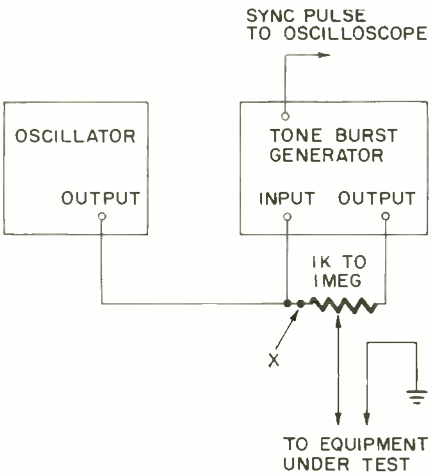


FIG. 3—GENERATOR HOOKUP for developing a burst that switches between two levels. Output is from arm of pot.

tone burst that switches between two levels rather than going to zero between bursts. This type of waveform is needed when checking amplifier recovery characteristics. It can only be generated by gating-type tone-burst generators. Fig. 4-b is a 1-kHz input signal to a compression amplifier under test. There is a 20-dB signal reduction between bursts. Sweep speed is 0.2 sec/cm.

The output of the compression amplifier is shown in Fig. 4-c. The voltage between bursts increases 12 dB over the level directly following the burst. The recovery time is about 0.7 second for full recovery of gain. Quite often, recovery time is considered as the time required for the amplifier to recover 63% of the gain it lost. The trace in Fig. 4-d is the waveform in Fig. 4-c expanded to 10 msec/cm to show the burst. Overshoot and settling time are easily measured. The attack-time was so fast that even the first cycle was held down in amplitude.

2 & 3. Bandwidth and Q

Tone-burst testing is a very rapid and accurate method of measuring the bandwidths of tuned filters and amplifiers. Since the results are displayed on an oscilloscope, the effects of adjustments are immediately apparent. This permits more rapid and accurate adjustments to equipment.

The basic concept used in this technique is the relationship between the risetime and the upper 3-dB point of a pulse amplifier. This is expressed by the relationship: Frequency $= 0.35/T_r$, where T_r (risetime) is the time required for the amplitude of a pulse to rise from 10% to 90% of its final value.

If we look at a tone burst as a pulse-modulated carrier, then we can measure the risetime of the burst after passing through an amplifier and compute the bandwidth. Remember that we are talking of a modulated carrier. This means that the calculated value is the bandwidth each side of center or carrier frequency. This value has to be doubled to get amplifier bandwidth.

The lower trace of Fig. 5 shows the input to a tuned filter resonant at 4 kHz. The upper trace shows the output.

Figure 6-a is the upper trace of Fig. 5 greatly expanded. This permits an accurate measurement of the risetime of the output, which is 11 milliseconds. Dividing this into 0.35 (a rounded-off approximation) gives us 31.8 cycles as the bandwidth each side of center frequency. Doubling this gives us a bandwidth of 63.6 cycles.

To measure the Q of a tank circuit, connect the tank circuit across the vertical input of the oscilloscope. Couple the tone burst output to the tank circuit with a 1 or 2 turn loop and a current limiting resistor per Fig. 7. Use the largest value resistor you can and still get adequate vertical deflection on the oscilloscope. This minimizes loading.

Tune the oscillator frequency to give maximum amplitude. Adjust the burst width to a value great enough to permit the amplitude of the burst to reach a steady value. Make the period long enough to let the voltage decay to zero between bursts. Count the number of cycles and estimate the fractional part of a cycle to reach the 63.2% point. Multiply this number by π (3.1416) to find the Q.

The 63.2% point doesn't fall on a graticule line, this alternate method is more convenient: Count the number of cycles to the 50% point and multiply by 1.45 to find the equivalent number at the 63.2% point. Then multiply by π to find the Q.

Figure 6-b is Fig. 6-a expanded for this Q measurement. The 14th positive peak falls exactly on the horizontal center line or 50% point. However, there is only ¾ cycles to the first positive peak.

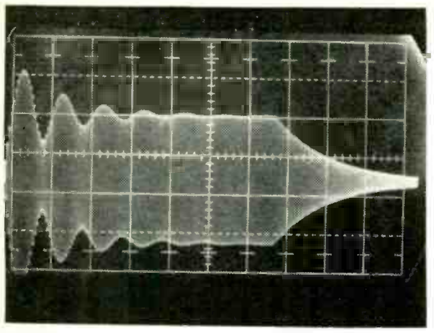


Fig. 8

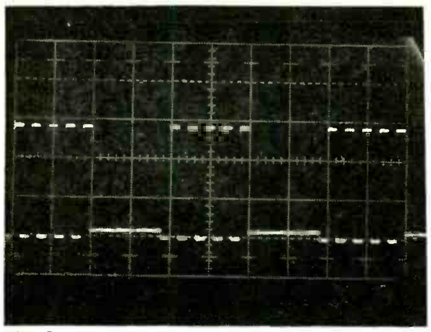


Fig. 9-a

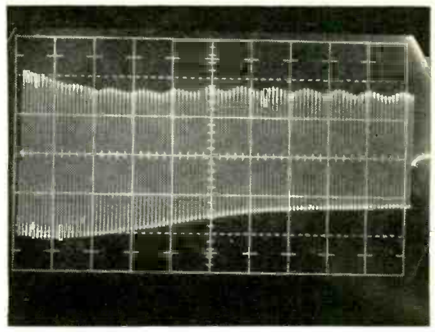


Fig. 9-b

FIG. 8—OFF-RESONANCE WAVEFORM resulting from feeding 4.2-kHz burst into a 4-kHz tank. Ringing on burst has a period of 5 msec whose frequency equals the difference between the tone burst and the excitation frequencies.

FIG. 9-a—BURST INPUT LEVEL raised just to clipping point. (b)—**LENGTHENED BURST** causes amplitude distortion as the B+ drops under sustained signal.

FIG. 10—PULSE GENERATOR OUTPUT gated into pulse pairs by the tone-burst generator. Pulses are 10 nsec wide.

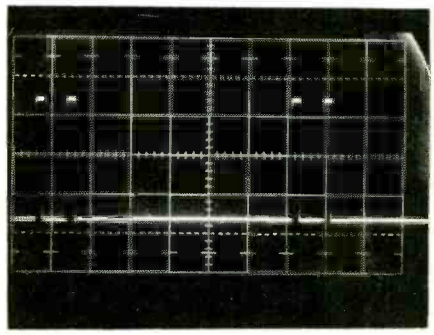


Fig. 10

Tone-Burst Generator

Thus 13¾ cycles to the 50% point. Q = 13.75 x 1.45 x π = 62.6.

The bandwidth measurements of the resonant filter and the Q of the resonant circuit should jibe because they are the same circuit and components. The bandwidth of a resonant circuit equals Frequency/Q. At 4 kHz center frequency, the bandwidth figures out to be 63.8 cycles for a Q of 62.6. This is less than 1% off from 63.6 cycles, the bandwidth calculated from risetime measurements. Close enough to prove the validity of these techniques.

Whenever a tuned circuit is excited by a tone burst that is not at its resonant frequency, the results will be something like Fig. 8. The damped ringing has a period that corresponds to the frequency difference between the tone burst and the resonant frequencies. In most cases, this method of measuring how far you are off resonance is easier and more accurate than trying to read the oscillator dial.

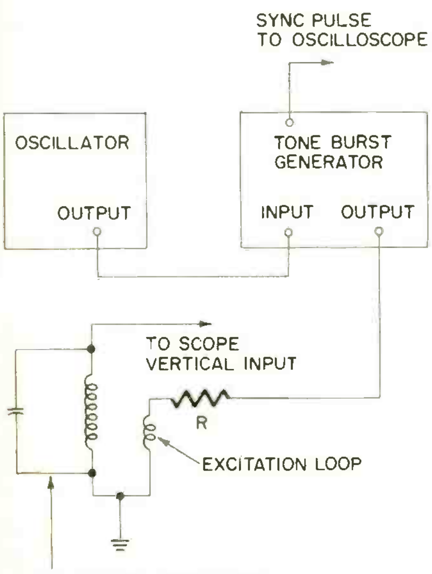


FIG. 7—L-C TANK CIRCUIT as set up for Q measurement. R should be as high as practical to reduce circuit loading.

Quite often, an oscilloscope with triggered sweep and calibrated sweep speeds may not be available. These measurements may still be made with the lower-cost service scopes by making use of the following points. All time measurements may be made by counting the number of cycles between the points of interest (e.g. 10–90% points for risetime measurements) and multiplying by the period of 1 cycle.

Period equals 1/frequency.

If the scope sweep cannot be synchronized to start with the tone burst, measure the fall time rather than the risetime of the burst. With Q measurements, count the number of cycles to decay to 36.8% amplitude rather than rise to 63.2%.

4. Music power rating

There are several methods of rating the power output of audio amplifiers. The oldest and most common is to list the maximum rms power delivered to a load, without distortion exceeding a specified amount. Some manufacturers, in order to make their products look better, started using the *peak power* method. This method computed power from the *peak* rather than the *rms* voltage of a sine wave, thus giving the amplifier a power rating twice that of the true rms power rating.

Another power rating system has now come into use. This is the *music power* rating. This power rating system is based on the fact that many amplifiers can deliver more power than the rms power rating. However, they cannot sustain this power output level; the power-supply voltage sags off under the heavy drain of full output. This power is usually about 20% to 50% greater than the rms power rating.

To measure this power rating, inject into the amplifier a short duration tone burst. (3 to 5 cycles of 1 kHz every 20 msec) While observing the amplifier output on an oscilloscope, increase the amplitude until 5% distortion is indicated. Measure this voltage with the oscilloscope and compute the rms power as if the amplifier were able to maintain this power.

In practice, distortion at maximum power levels is usually caused by peak clipping. Since distortion increases very rapidly after clipping starts, the point of discernible clipping can be called the maximum power point.

Figure 9 shows the results of tests run on an amplifier rated at 25 watts rms or 35 watts music power. The 25-volt output was terminated in a proper load of 25 ohms. A short 1-kHz burst (Fig. 9-a) was used to adjust the output level to 35 watts where clipping was just discernible. The tone burst was then lengthened to 100 msec once every second. The oscilloscope trace in Fig. 9-b shows how the output goes to pot. This amplifier is normal. It just requires a tone burst to check it out. Vertical scale is 20 volts/cm; horizontal scale is 10 msec/cm.

Pulse bursts and pairs

This tone-burst generator, though designed for home construction, has a very good transient response. The rise and fall time is about 170 nanoseconds, without any overshoot or ringing. This makes it well suited for gating pulse generators.

The gating of a pulse generator produces pulse bursts, a signal form needed for testing some types of pulse equipment. However, if the number of pulses in a burst are reduced to two, you have a pulse pair generator (Fig. 10). This is a *must have* type of signal when working with pulse-spacing decoders.

The spacing between pulse pairs is adjusted by the tone-burst generator period controls. But, the pulse generator period control adjusts the spacing of the

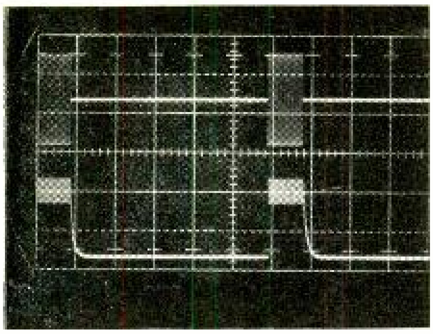


Fig. 11

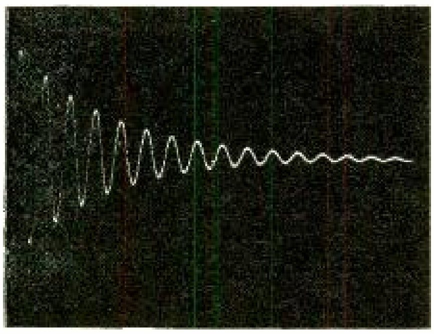


Fig. 12

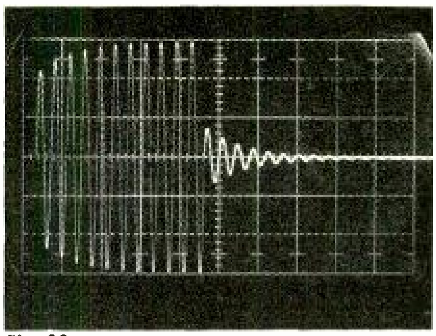


Fig. 13

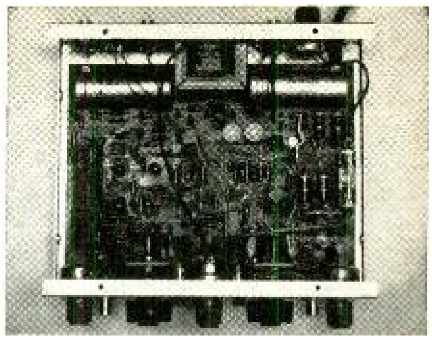


FIG. 11—UPPER TRACE is 50-kHz input to a detector; lower trace is output.

FIG. 12—SINEWAVE decaying at an exponential rate is used to determine writing rates of scope and photo films.

FIG. 13—VOICE-COIL VOLTAGE of a 4-inch loudspeaker showing room/speaker resonance at approximately 255 hertz.

INSIDE VIEW OF BURST GENERATOR (top right) shows how instrument will look if you followed the construction details and layout given last month.

pulses in the pair. **NOTE:** If the spacing of the pulses in the pair must be varied over a large range, the tone-burst generator width control may have to be adjusted to maintain two pulses. Triggering slope should be set to trigger when the pulse voltage is returning to zero volts. For example, on a positive pulse, trigger on the negative-going or trailing edge. If you trigger on the positive or leading edge, the last pulse in the burst would end the burst and make a spike of itself.

5. Detector circuits

Another use for this versatile instrument, is checking detector circuits. Figure 11 shows the performance of a detector circuit under test. The upper trace shows the tone burst fed to the detector. The lower trace shows the detector output. Frequency response can easily be determined by measuring the falltime of the recovered signal and computing bandwidth. Falltime is used rather than risetime because it is longer.

6. Frequency division

On occasion, there is the need for a frequency divider. The timing circuits in this tone burst generator are very stable. This feature permits frequency division of at least 100. Whenever an input signal is being gated, the burst-repetition frequency is a subharmonic of the frequency in the burst. The sync pulse available on the back panel is at the burst-repetition frequency.

In actual practice, the input frequency may be anything up to 5 MHz or higher. The divided output frequency is controlled by the period controls. They can be set to anything between 1 Hz and 100 kHz. The width controls may be set to anything less than the period controls.

7. Photographic writing speed

When photographing single-sweep displays on an oscilloscope, it is necessary to know the writing speed of your oscilloscope, camera and film combined. *Writing speed* is defined as the fastest spot velocity that can be recorded on film on one trace. This is usually given in centimeters per microsecond.

One way that this can be measured is to photograph a decaying sine wave, the frequency and amplitude of which is high enough that only the peaks of the first few cycles show up on the film. Inspect the photograph to determine the first two peaks that have a discernible line between them. Measure the vertical distance between these peaks and compute the writing speed. Writing speed equals π DF. Distance (D) is in *centimeters* and frequency (F) is in *megahertz*.

This decaying waveform is produced across a resonant tank at the end of a tone burst (Fig. 12), and displayed by triggering the scope on the negative or trailing edge of the sync pulse out of the tone burst generator.

8. Loudspeaker testing

Whenever a steady audio tone is fed to a loudspeaker or any other transducer, resonances enter the picture. These resonances are caused by reflections in the room or baffle. When a loudspeaker is excited by a tone burst, the first cycle will be unaltered by reflections. As the burst progresses in time, the effects of reflections will show up. This permits the identification of resonance conditions and enables you to do something about them.

In actual practice, the tone-burst generator itself is used to drive the speaker. A resistive matching pad must be used between the speaker and the tone-burst generator output. The voltage directly across the voice coil is fed to the oscilloscope. **NOTE:** Do not try to feed the speaker from an amplifier directly. The very low output impedance of the amplifier will swamp out these resonance conditions you are seeking to locate.

9. Speaker impedance

It is possible to measure the free-space impedance of a speaker or other transducer in the presence of reflections. This is done as follows: Feed the tone burst through an attenuator pad to the speaker under test. This pad must have 20 dB or more loss. (With this much loss, the speaker will think it is being fed from a source that has an impedance very close to the impedance of the pad.) Make two voltage measurements. First, measure the voltage out of the pad without the speaker connected. Next, connect the speaker to the pad and measure the voltage of the first cycle of the burst. Now, take these voltages, along with the pad impedance, and plug them into the formula

$$Z_s = \frac{E_s \times Z_p}{E_o - E_s}$$

Z_s = Speaker impedance
Z_p = Pad impedance
E_o = Open-circuit voltage
E_s = Voltage across the speaker

Note that the voltages end up as ratios. This means that you don't have to have an accurately calibrated scope for this measurement. However, the impedance of the pad must be known. It should also be close to the impedance of the speaker under test.

10. Echos

The tone-burst generator is an ideal source of pulses in any type of echo research or experiment. Because these pulses or bursts are phase coherent, very accurate reflection times may be measured. This is done by cycle matching (comparing the phase of the cycles in the returned pulse to the outgoing pulse). Typical applications would include things like ultrasonics, sonar, acoustical radar and round-trip time and return-loss measurements in communication land lines.

(continued on page 85)

Leader LBO-31M scope


Sencore SM158 speed aligner


Lectrotech SMG-39 sweep-marker-gen

2 DREAM WORKBENCHES
1. Technician's Special

I DIDN'T EVEN KNOW THAT THE EDITOR was in the room until he kicked my feet off the desk. *"DARR!"* he said in his usual quiet voice. *"WAKE UP!* Get up and get that silly wastebasket off your foot!"

"Yes, sir! Yes Sir!" I said, snapping to attention, and trying to kick my foot loose from the wastebasket, where it had wedged.

He glared at me. "Sleeping again, eh?"

"Oh, no, Sir!" I assured him. "I just think better with my eyes shut."

"Do you also think better when you *snore?*" he snarled. "Attend me! I have something right in your line, since you like to dream on the job."

"What is it, Sir?" I asked humbly.

"We want an article on your Dream Workshop! What would you want if you could have everything you could desire? If you had carte blanche to get anything?"

"Oh, Sir!" I gasped, overwhelmed. "Anything?"

"ANYTHING!" he roared quietly. "We want to tell our readers what an absolutely perfect shop would be like. One that will do everything, in the least possible time. Think you can do it?"

"Oh, yes, sir! Indeed I can! When do you want it, Sir?"

"YESTERDAY!" he said. "Now *GET TO WORK!"* and he left, closing the door behind him, quietly as usual. I picked up the pieces of broken glass and threw them into the wastebasket after I got my foot loose. It was only a small pane of glass anyhow and it never took me long to put in a new one after his visits. After all, in my office, three levels below the street, I don't need much outside light.

Peeping through the hole in the door to be sure he was really gone, I assumed the thinking-position again, closed my eyes, and meditated. Oh, boy! After all these years they were going to give me all of the test equipment I'd wanted. Wonderful! As I began to choose the equipment, in my mind, things got quieter and quieter. There never was much noise this far below ground anyhow, but today it seemed quieter than usual. My mind drifted off into a sort of rosy haze, and—— ZZZZZZZZZZ!

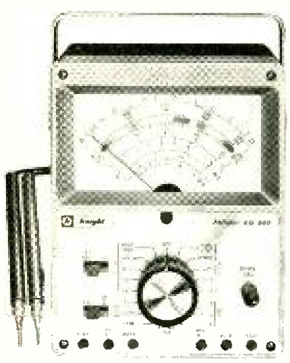
What would I want in a Dream Workshop? First, test equipment that would measure *everything* I wanted to read, and do it quickly and easily. Let's see. The first category would be . . .


Eico HVP-5 hi-voltage probe

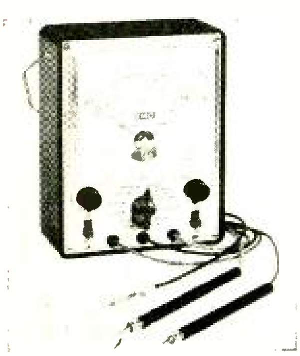
Quantity instruments

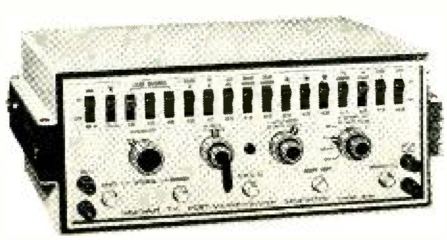
This means test instruments that will read the basic quantities we must check. Voltage, current, resistance, and power. The first one would be a high-impedance ac/dc volt-ohmmeter, either a vtvm or tvm (*T*ransistorized *V*olt-meter. Probably referred to from now on as simply tvm).

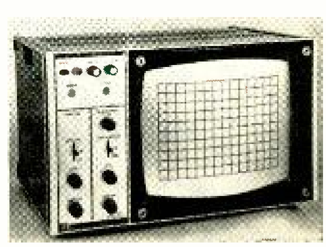
These must be able to read dc voltages from very small values, for transistor work, up to very high values, for tube sets, color TV, and so on. They should also be able to read currents (dc) for the all-important tests for correct cathode current in color TV horizontal output tubes, power transistors, auto-radios, etc. Incidentally, I'd like to have a separate 0–500 dc milliammeter, in a box, for the output-tube testing. This would free the tvm for taking other readings that I'd like to make at the same time. Also very handy for monitoring TV sets after repairs in that circuit.


Knight KG-640 multimeter

For the important high-voltage tests on color TV I'd like to have a high-voltage probe to work with the tvm. This would be a straight "multiplier" type, so that I could also read the focus voltage


EMC 116 solid-state vom


Heathkit IG-57A post-marker sweep gen


Kikusui 5121 scope

RCA WR-508A chro-bar gen

Pomona crt adapters

B&K 1246 color gen

R-E's service editor knows what his dream workbench would look like. How does it compare with yours?

by **JACK DARR**
SERVICE EDITOR

on a lower range. Alternate: one of the special "high-voltage-probe" type meters, for just this job.

Before I get out of this category, I'd also want a good vom. 20,000 ohms per volt or more, for portable work, car radios, on the bench and outside.

The Wattmeter, with variations

I want a permanently-installed bench wattmeter. This is a true dynamometer-type wattmeter and very accurate. It should be connected through its own isolation transformer, rated at least 300 watts, to a special outlet on the bench. When I start an analysis on anything powered by ac, the first thing I want to know is "Is it drawing **too much** power? (Short or high leakage); or is it drawing **too little** power?" (open-circuit somewhere) or is it **just right?** (Dc power supply ok; go and look for trouble somewhere in the signal-circuits!)

A portable unit is also handy; for house calls, or any kind of field work. Also handy for cooking suspected intermittents on the bench.

For wiring tests, heavy appliance testing, industrial electronics work, and that sort of thing, the "mini-vom" with a clamp-on ammeter is very useful indeed.

For the final instrument in this class, an 0–5 ac ammeter, in a box, is a must for checking circuit breakers for proper trip and hold current, and so on. This too, can be connected in series with the input ac line, and used to monitor sets suspected of intermittent power supply trouble.

The "Most Important Quantity"

Before we leave "quantities" that we must be able to read, I'd want the most important instrument of all, for reading the most important quantity of all—the signal. This, of course, means a good oscilloscope. I'd like one with a really wide bandwidth, so that I could see the burst, color-bar pattern, horizontal and vertical sync, and all of the things that *no other* piece of test equipment will read.

I'd like one with the calibrated attenuators; one step, one variable, so that I could read p–p signal voltages on any kind of waveform, as quickly as possible. This will let me check every kind of stage for gain, distortion, signal input vs signal output, and in general tell me whether there really *is* any trouble in this stage, or shall I go on to another.

This scope should have a full set of probes; direct, low-capacitance, and crystal-detector, so that I can get the exact waveform in any type of circuit, without disturbing it too much. The triggered-sweep types are very nice, since they're able to lock in the waveform you want much faster, but a *good* scope, properly used, will give you good results in any case.

"Parts testers"

Now that I can read all of the quantities, I want things that will test the parts that make these "go off-value"; resistors, capacitors, tubes, transistors, etc. Resistors will be taken care of very nicely by the ohmmeter function of the tvm/vom. For the rest, I'll want a really good capacitor tester.

I want one that will read capacitance from a few picofarads up to at least 5,000 microfarads (for those monstrous filter capacitors in transistor power supplies). Surprisingly enough, electrolytics are the only capacitors that really *need* a "value" or size reading! They're the only ones that can *change value*. All you need to know about a paper or ceramic capacitor is "Is the thing open or not?" These can't change *value*.

However, they can *leak*; they all can. So I want a really sensitive "insulation-resistance" test, which will catch leakage of several megohms minimum. Also, I want a dc leakage test for electrolytics, under the full working voltage, as well as a power-factor test. The last is often the cause of those "obscure faults" that plague us so much; so, I want to be able to catch these too.

The coil-checker

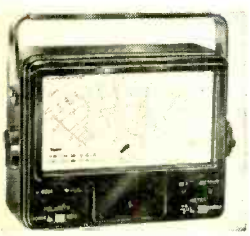
Coils aren't often "checked" in the service shop, in the sense of reading their actual inductance value, etc. About all we need to know are the simple things; is the coil open, or shorted, or (in two-winding transformers) is it leaking from primary to seconnary? Most of these can be checked very accurately with the ohmmeter. A signal-test for tuned coils will catch the rest of the defective units.

The one very important "coil" that we need to check is the flyback transformer! For a reliable test on this, I'll want one of the "resonant" flyback-testers. These things operate something like a grid-dip meter, and can actually read as little as *one* shorted turn in a flyback!

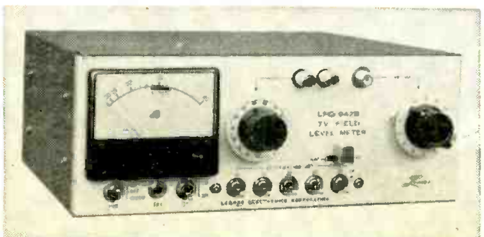
Used with the proper technique, these can also check yokes for shorts. The low-Z yokes are harder, but even these can be checked for *balance*. (I wish someone would build a really good "yoke-checker" substitute; a variable inductance that we could hang in there as a substitute for suspected yokes!)

Oddly enough, an actual inductance-meter is seldom needed in the *service* shop. When we need a 180-μH choke, for instance, we go and buy one! As I said, defective ones are usually easy to find.

The other important "coils"—power and audio transformers, are easily checked with the wattmeter or ohmmeter.



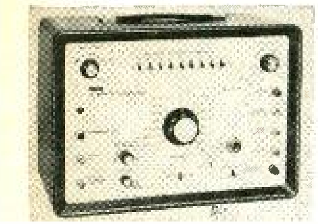
Lafayette 99-5076 vom



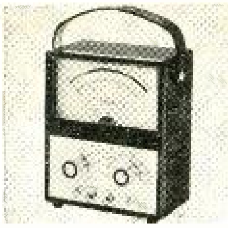
Leader LFC-924B field level meter

Triplett 6028 digital vom

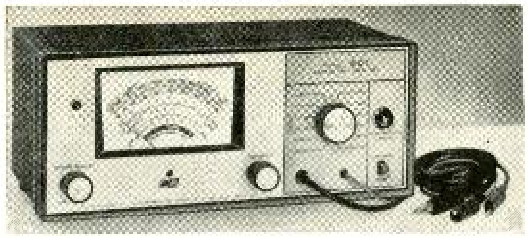
Sencore BE156 dc bias supply



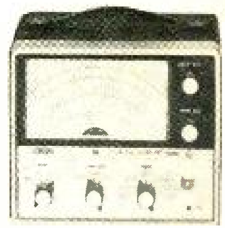
RCA WR-514A sweep chanalyst



Delta 3000 fet-vom



B&K 801 capacitor analyst



Eico 242 FET tvom

Other important parts

Tubes and transistors are very important "parts". So, we need good checkers for both. A tube-tester should be able to check all of the different types of tubes. It must read "quality", mutual conductance or emission (or both). Possibly more important, it must have a good, accurate test for gas, leakage, and grid-emission. (The last causes some strange and wonderfully obscure symptoms if we don't know it's there!)

It should also have provisions for up-dating the socket-panel, to take care of new types. (Although, for the life of me I don't know where they'll go from here, unless they start putting bases on both ends of the things!)

The CRT tester

A good picture-tube tester, able to check and, if needed, rejuvenate either b/w or color picture tubes, is a necessity. I'd want one that would help me to match emission of all three guns by shooting only the weak gun(s) until they all read within tolerance, so that I know that this tube can make a good b/w picture.

It should have provisions for socket adapters, so that you can check the oddballs that are coming along: the Trinitron one-gun tube, the 3-in-line types such as 15SP22, and any other new base arrangement. You need one with a variable heater voltage, too. Some of the new color CRT's have 12-volt heaters; some of the older b/w tubes have 2.5 volt heaters, and so on.

The transistor tester

I want a good transistor tester, too. It should be able to check transistors both in-circuit and out. The in-circuit test is very handy for quick-checking through unknown sets. I've found one thing with all of the in-circuit testers so far; if they say GOOD!" in-circuit, it usually *is*. If they say "BAD" in-circuit, you're going to have to take it out anyhow; so recheck it after it's out. It may not be bad after all. But the out-of-circuit tests are reliable.

It should be able to read the beta of all types of transistors, from the tiny rf specials up to the big power-output types. Also, I want to check FET's, one and two-gate, UJT's, Diacs, Triacs, SCR's and all types of diodes from signal types up to power rectifiers. (For another impossible request, I wish they'd make one that would light up a light saying "Silicon" or "Germanium!")

It *must* provide an accurate test for what I think is the most important of all—*leakage*. (Usually I_{cbo}, but others as well.) In actual service, I have found more obscure problems due to very minute leakage than any other single defect. Sometimes as little as 10 μA is enough to cause big troubles. Shorted transistors can be caught with the ohmmeter; no problem.

It would also be very nice if we had a reliable "balance" test, for transistors and diodes too, for those applications where matched-pairs of either are needed.

Signal sources

Now that I've got all of that fine equipment for measuring signals and things, I want some good standard sources of test signals. I'd like to have signal generators that would give me test signals of every possible kind, audio, rf, TV, i.f., color-bar, etc. With these I can make the most useful test of any, on electronic equipment; feeding in a duplicate of its actual signal, then measuring its output to see if it's working or not!

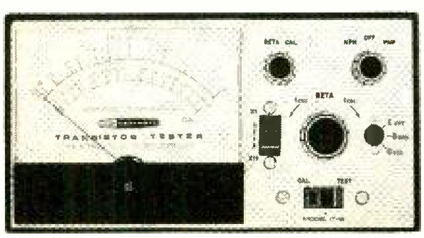
The oldest of these, and still the best "all-around" item, is a standard rf signal generator. This should start at about 100 kHz, and go on up to at least the TV i.f.'s, and higher on harmonics. Modulated and unmodulated signals, of course, and the audio modulation should be available alone, for audio testing. If the rf output can be swept, it will be very handy for aligning AM and FM.

For audio work, I'll need a good audio signal generator; one with a good clean sinewave output, at about 5 volts or more. Frequency range should be from say 25 up to 25,000 Hz. It should also have a good square-wave output, for making easy frequency-response tests on both audio and video amplifier circuits. The output should be through an attenuator able to bring the signal down to 50-mV rms, or a little less, for testing sensitive audio amplifier circuits, preamps, etc.

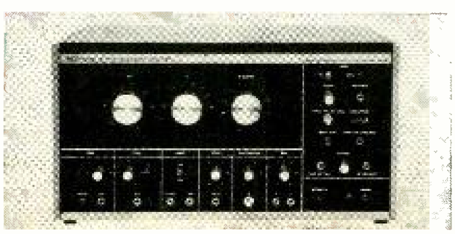
Incidentally, wouldn't it be nice, for rf work, if we had some kind of black-box attenuator, with an IC or two in it, and a voltmeter, which could take the output of an rf signal generator, and attenuate it down to about 1.0 μV? This should be accurate to within about 5%, and cost about $9.95. (Remember, I'm dreaming this!)

For TV testing, I want a signal generator that I can connect right to the antenna input of a color set and get a test signal that will duplicate the normal TV signal. The stable patterns will help us to signal-trace the location of the trouble in the set. This is no dream, of course: I'm talking about a color-bar generator. Incidentally, you'd be surprised how quickly you can find trouble in a *black-and-white* set with these easily recognizable signal patterns! Video, sync, and several other problems are much easier.

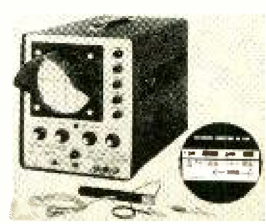
Another handy item, in this area, is the "pattern generator". By this, I mean the "flying-spot scanner" type of signal-generator. It reproduces whatever pattern is on the slide in front of the scanner tube: Indian-head test pattern, crosshatch, bars, dots, and even color-bars. One very handy use for these is the isolation of tuner troubles; they have both rf, i.f. and video output signals. If the test i.f. signal goes booming through from the i.f. input, but won't get through from the antenna terminals at rf, you have tuner trouble!



Heathkit IT-18 transistor tester

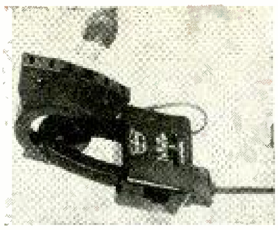


B&K 1077-B tv analyst

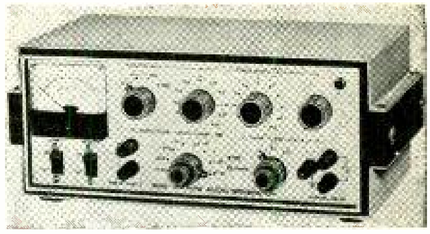


Sencore PS 148 scope/vectorscope

Lectrotech V6-B color bar gen



Triplett 10 clamp-on ammeter



Heathkit IG-18 audio gen

The field-strength meter

For the final instrument in the rf signals group, I want a good field strength meter. It must be able to read vhf and uhf signals with reasonably good accuracy. This is useful for several things besides positioning antennas. You can check signal levels in MATV and CATV systems, or make sure that the FM antenna is delivering enough signal for good FM stereo reproduction. Last, but certainly not least, you can use the FS meter as a darn good *signal-tracer* for checking your way through a TV tuner!

The sweep generator

Now that we've tested everything in the set, and gotten it working, the last-but-not-least step is checking its alignment. Especially in color TV, a sweep-generator is essential! You can *see* the i.f. curve, bandpass transformer response, etc. and tell whether your circuits are delivering the right amount of signal at the right places!

Of course, I want one of the new models; crystal-controlled markers for all i.f.'s, all trap frequencies, and at least one high and one low channel signal frequency. Sweep variable from practically nothing up to 10.0 MHz, a SWEEP-CENTER or "fine-tuning" control to center the curve, both 4.5 MHz and 10.7-MHz crystal markers for TV/FM sound i.f.'s and sound-detectors, and, above all, a "post-marker-adder" system.

This last is very important. With it, the sweep signal goes through the i.f.'s, but the markers do *not*. So, you get no marker distortion, and markers so sharp that they're actually hard to photograph! (I know!) All of this, plus at least a dual-voltage variable bias supply should be in one box! This gets rid of all that mess of cables, grounds, metal plates and so on, that we used to use with the original system. The multiple, simultaneous markers make alignment work a breeze.

Analyzers

Now, I've about gone through all of the standard test equipment. Here are a few specialized units that can be real time-savers on the tough-dog jobs that we all love so well! These could be called "analyzers", since they can be used to make a complete check of the characteristics of their circuit, with the set in operation.

One of these is a *"Horizontal sweep* analyzer". It can be plugged into the horizontal output stage, and read all of the important currents, voltages, etc. you need. Also very handy for monitoring the sweep stage after repairs have been finished.

Next is a *"CRT analyzer"* for color TV picture tubes. This is not a picture-tube tester. It is plugged into the circuit, by taking off the CRT socket and inserting the Analyzer between it and the tube. By switching, everything but the high voltage can be measured under actual operating conditions! You can even read the focus voltage. Most important, by pushing a button, the *current* in any circuit can be read.

This is useful; by reading all three cathode currents, you can tell whether the tube is being driven hard enough. Or, in rare cases, being over-driven; about 500 microamperes per gun should be the maximum current! It will also check for "current where there shouldn't be any": screens, and most of all, the focus. Any current here indicates a gassy tube, usually.

The Vectorscope

The "Vectorscope" is another one of the instruments that will do something the rest can't. It will show you the actual phase-angle of the demodulators, and help you set up these tricky circuits for best performance. Very handy for checking out the popular automatic chroma control circuits we're seeing in the later sets.

Actually, this instrument is a color-bar generator with its own scope. The color-bar generator can also be used to do convergence, signal-tracing and all of the other tests as well.

Service data

There's one "test instrument" that I want, and that every service shop MUST have, nowadays. This is a complete set of SERVICE DATA! A complete set of Sams Photofact folders, and the specialized manuals, plus as much factory service data as I can get. (On many occasions, you need both, for one reason or another.) This may not fill up the 16 filing cabinets that it does in **Radio-Electronics'** Service Test Lab, (Even this is incomplete!) but it will be invaluable in today's mysterious PC-board chassis, with their multiple connecting cables, transistors and so on. You've got to know *where* things are before you can find and check them!

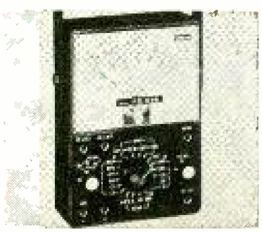
To go with this, a full set of Reference Guides; Tube, Transistor Characteristics books, Transistor Replacement Guides, transformer and capacitor catalogs (You'd be surprised how handy these can be at times!) and a couple of catalogs from the bigger mail-order houses. These can do double duty, as a source of unusual parts, and as reference books!

The little things

Next, there's a category of little things; physically small, and inexpensive, but very, very useful. These could be called "time-savers". Each of them is used to make some particular job a heck of a lot easier, meaning faster. Figure it out; a gadget that costs $3.00, and saves you 10 minutes on each job, will pay for itself in two jobs, if you're getting the 15 cents a minute for bench time that you should be! There are so many of these that I'll just have to list them, to save space.

1. Hand-tools; pliers, cutters, screwdrivers, etc. of all kinds, sizes and

Simpson 150 amp-clamp

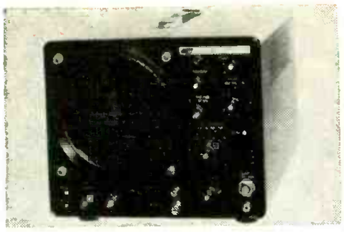


Olson TE-216 multimeter

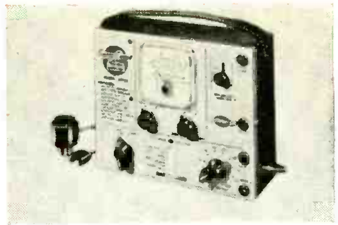
Pomona adapters & rack

G-C H3-358 multitester

Eico 330 rf gen



B&K 1460 triggered sweep scope



Sencore SS105 sweep ckt checker

shapes. You need the *right* tool for each job.

2. Soldering irons. At least three. One tiny-pointed-tip 30-watt for PC board work, one heavy-duty, like the 100-watt solder-gun, for the big jobs, and most useful of all, an "unsoldering iron", or "solder-sucker", for taking out multiple-joint things like transistors, transformers etc.

3. The "specials"; nut-holding nut-drivers; screw-holding screwdrivers; extra-long nut-drivers for going deep into cabinets to get tuners out, and so on. Locking pliers, also handy hemostats, etc.

4. Extension cables. CRT extension cables for all tubes; yoke extensions deflection and convergence, HV extensions, tuner cables, and a full set of the Molex multi-contact cables used so often now in the popular "Stereo-Theater-TV" combinations.

6. Test socket adapters. Plug into tube sockets, for taking readings without pulling the chassis. Good time-saver for diagnosis. Cathode-break adapters, for all types of horizontal output tubes. You can read the cathode current without pulling the chassis. Very handy for house calls! Saves pulling the chassis.

7. Resistor and capacitor sub-boxes. All sizes of R and C, with selector switches. An "Electrolytic Substituter" is very useful, for bridging good capacitors across suspected filters.

8. Bias-box. Ac-powered variable dc source, for alignment work, clamping agc lines, etc. Tube or transistor TV sets.

9. A group of testleads, short and long, with an alligator clip on each end. Should be in as many different colors as possible. These are invaluable for making temporary connections, jumpering things, clipping in small parts for tests, and on and on.

10. A good test-speaker. Put it in a box of some kind, with long leads and alligator clips. 16-ohm type best "all around", but can be of any impedance as long as you're careful.

11. A BIG resistor, preferably 100-watt. (Lots of these in surplus stores.) Used for load-checking on powerful amplifiers, power-output tests, distortion tests, etc. Must have slider, so you can set it to match the output load-impedance of transistor amplifiers.

12. Power supplies. A dc power supply, well-filtered, with adjustable output, and metered for output voltage and current. Up to 16 volts dc at about 2–3 amperes. For auto-radio and tape-players. Can be used to power any kind of transistor radio.

13. Variable ac transformer, or Variac. (With this, the adjustable-output feature of the dc power supply can be left out, saving money. Plug the dc power supply into the variable transformer, and adjust the line voltage until the dc output is exactly what you want.

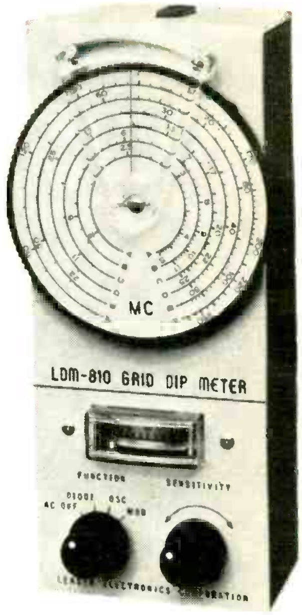
This device is absolutely essential for initial testing of big transistor power amplifiers. Bring the ac line voltage up very slowly, monitoring the collector current, to be *sure* that the replaced transistors are going to stay inside their safe ratings. It can also be used with ac ammeter for checking hold and break currents of circuit-breakers.

14. The Test Jig, for color TV. This isn't a "little item", of course, but it's a time and money saver! Picture tube, deflection and convergence yokes, and cabinet. Leave the big cabinet at the home, and bring in only the chassis. Many of these have built-in hv voltmeters for continuously monitoring the high-voltage during test. With adapter cables, any make or model of color TV can be tested on the same jig.

15. Chemicals. Spray-cleaners, coolants, cements, insulation-varnishes, corona dopes, oils, greases, tape-headcleaners, and so on.

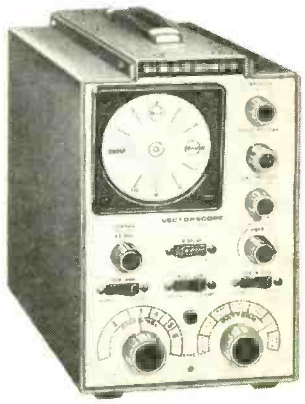
16. Small parts. A set of racks or bins, cabinets, etc., for keeping those very small parts is very handy. Nuts,

(continued on page 88)

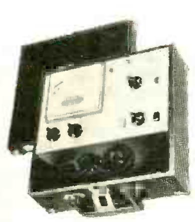


Leader LDM-810 grid dip meter

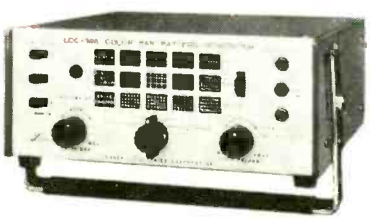
Knight KG-646 multimeter



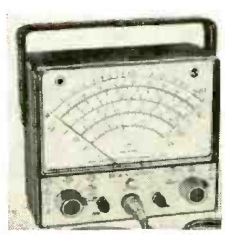
Heath IO-101 vectorscope



Lectrotech CRT analyzer



Leader LCG-388 color bar gen



RCA Senior VoltOhmyst

2 DREAM WORKBENCHES

2. Experimenter's Delight

One man's idea of how he would build his dream shop—if the dollars were unlimited

by **PETER SUTHEIM**

MAYBE IT'S JUST A RESULT OF HAVING lived with them for the past 10 years, but I prefer small workshops and small kitchens. By all means choose a room as large as you like for yours, but keep the workbench, the active work area and most of the commonly used tools, instruments and parts in one corner. Use the rest of the room for storage, think-space, calisthenics or whatever, but don't spread your shop all over the place so you have to keep walking around.

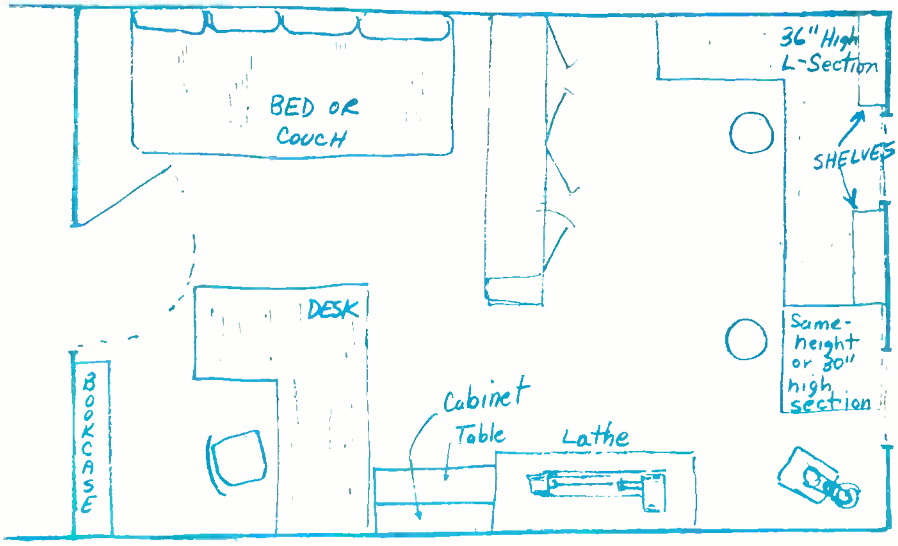
As a writer, I like to have my desk and office-type facilities in the same room as the workbench. But I haven't often been able to do that. Once I had a whole room with space for a small lab/shop, a desk, and a *bed*. Since I sometimes think best horizontally, that was a great asset. And when company came, people could crash there for the night. So you, too, may want to have space for a bed or couch, or at least a good comfortable reading/relaxing chair, maybe something old and leathery. A couple of extra tables, possibly a drafting table, lots of shelves and cabinets, too.

And as long as we're talking about a dream workshop, I'd like to include a wood-burning fireplace and direct access to a small garden. In any case, the space ought to have the possibility for good ventilation, since you'll sometimes be using solvents, spray paints and other toxic chemicals. Make good use of windows for the natural light they provide. Put your bench near a window—it's much more pleasant that way—but avoid seating yourself where you cast a shadow on your work.

The facilities

The heart of the operation, clearly, is going to be a workbench. I prefer a 36-inch-high surface (waist height on an average man), which is right for working standing up. For working seated, a 24-inch-high stool, with or without back, as you prefer. Some people prefer a desk-height bench (29 to 30 inches) and conventional (18-inch) chairs, but I find that inconvenient for standing. You may want to design a bench with sections at both levels.

I like L- or U-shaped benches. They are more versatile and convenient than a single, long, straight bench. Sitting or standing at a corner, you can reach an amazing number of things without stepping. When you plan your work area, you might consider whether you'll ever want to have your son or daughter or an assistant working with you, and allow space enough for two or more to work if you do.



ROOM FOR SLEEPING is included in this experimenter's shop. Also note the power tools, important where prototypes are made.

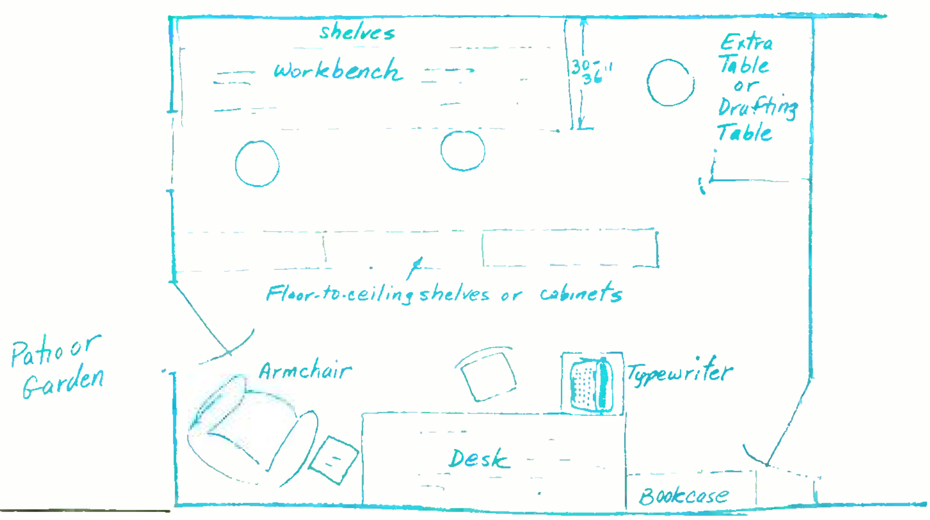
A workbench can be made of anything that's sturdy. A quick and dirty one is a slab of ¾-inch (good-one-side) fir plywood laid on stacked concrete blocks, sawhorses, crates or large cardboard cartons.

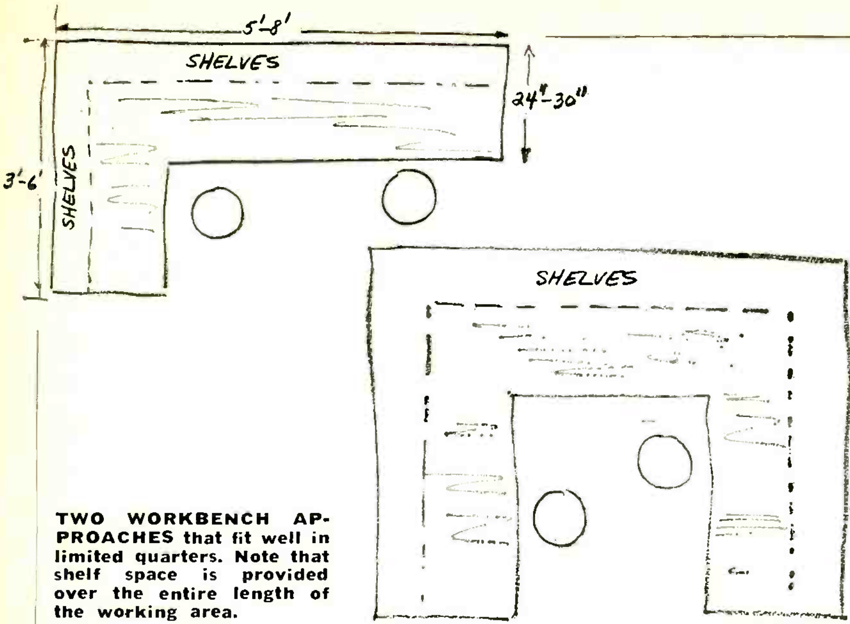
Tempered (or even untempered) Masonite makes an excellent surface for the bench. It isn't gorgeous, but it's durable and cheap enough so you can replace it when you get tired of the gouges, drill holes and stains of grease and battery acid. Best way to apply it is to screw it down along the edges every 18 inches or so, using No. 6 x ½-inch flathead woodscrews, countersunk. Nails tend to lift out, and glue or contact cement makes the Masonite hard to replace. Of course, you could always glue a new piece right on top of the old. Bevel the exposed edges of the Masonite slightly to reduce chipping.

Electrics

One of the most important facilities is, of course, electric power. Your shop deserves to have at least one 20-amp line all to itself. If you plan to include a room air conditioner in your shop, it should come off a different line, otherwise your meters and scope traces will go crazy every time the compressor starts. You should have easy access to the fuse or breaker box for when you

FLOOR-TO-CEILING SHELVES divide this workshop into two distinct areas. Cabinets can be arranged to provide access from either side.





TWO WORKBENCH APPROACHES that fit well in limited quarters. Note that shelf space is provided over the entire length of the working area.

goof. If that's impractical because the box is in a locked basement, you might consider running your workbench power through a fuse or breaker one size smaller than the protection that comes earlier in the line. Put the new protection near your bench. If you short the powerline, the fuse or breaker near your bench will go first and you'll never have to worry about the one that's hard to get at.

Have lots of outlets. A strip of them running along the back or front edge of the bench, or both, is handy; otherwise several four-receptacle boxes. Another interesting possibility is to fasten a strip of outlets along the front edge of a shelf over your bench (Fig. 1). This is convenient for instruments

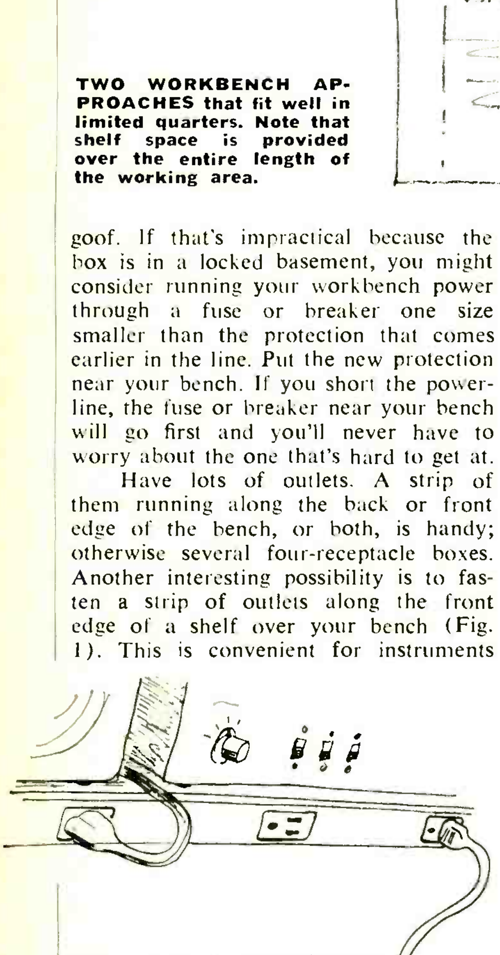


FIG. 1—RUN ELECTRICAL OUTLETS across the front strip of shelves for easy access.

standing on or under the shelf, and also for tools like drill and soldering iron. But whatever way you arrange it, it's nice to have at least a couple of outlets at the front of the bench so the cord for your soldering iron or gun doesn't need to cross over everything else; ditto the drill.

I like to provide a master switch for all the bench outlets. It's convenient and a safety matter besides. The switch is mounted in a box with a bright red light, and everybody in the household knows where it is. There could be times when all power to the bench needs to be shut off fast—for example when someone puts himself across the power line and can't let go. A lock switch would prevent unwanted people from using your bench. I've thought of providing a separate, unswitched outlet for a soldering iron or drill only, which would make it unnecessary to switch on the whole bench and all the instruments for a simple repair job.

Bring a good ground to your bench and make it available on a binding post or metal strip. If your house has good, relatively recent wiring, the ground wire or BX armor or conduit is about as good a ground as you'll find, except for rf. If the wiring is old, run a heavy wire from the nearest cold-water line or from a copper pipe driven into moist ground.

Good lighting is extremely important. You can get very discouraged working at a poorly lighted bench, sometimes without knowing exactly why. An industrial-type dual-40-watt fluorescent fixture (about 50 inches long) hung 4 to 5 feet above the bench is a marvelous light source—bright but even and diffused. It will nicely cover a 6-foot by 3-foot work surface. One or two high-intensity lamps or gooseneck desk lamps are useful for lighting insides and undersides of things you're working on. Paint walls and ceilings a light color, preferably white, or light yellow if you're using fluorescent lamps.

Storage

It's good to have two fairly wide (10 to 12-inch) shelves running the length of your bench along the wall, the lower one 12 inches above the bench, the next one 12 inches above the first. On the bench itself and on the first shelf, you can put instruments. The upper shelf is good for less-often-used instruments or other kinds of storage. The lower shelf puts a lot of things at about eye level.

You will never have enough cabinets, shelves and drawers. Equip yourself with enough plastic-drawer cabinets to keep well sorted all the hardware, resistors, capacitors, semiconductors and other small parts you will accumulate. These should not be on the workbench, because bench space is better used for other things. You can always pull out individual drawers and lay them on the bench as you need them. I've found an ideal arrangement is to have all the small parts cabinets *behind* me within easy arm's reach—things like ½-watt resistors and small ceramic and electrolytic capacitors being nearest and easiest to get at. That is why the floor-plan drawings show shelves generally within arm's length of the workbench.

An experimental concept with interesting possibilities is the circular workbench shown in Fig. 2. The instruments and other things you want in front of you are clustered in the center in a one- or two-layer rectangular array, providing the possibility of up to four "workstations"—especially nice if you're into teaching electronics to neighborhood youngsters, for instance. Instruments that are likely to be used together should, of course, be grouped on one side of the central square. The main difference of this arrangement is that it opens possibilities for a very different floor layout, in which you are not always working against a wall or window. Some of you might prefer being able to walk around the bench. Fig. 3 shows a possible floor plan for this type of bench.

Tools can be hung on pegboard mounted on the wall, or stored in cabinets. Hanging tools in definite places, whether enclosed by a cabinet or open on the wall, seems to be the most orderly way to store them. Another good idea is a tool caddy—a single portable thing with a lot of holes, trays and recesses, even a couple of drawers, that keeps everything easily accessible but neat and carryable. Many experimenters, incidentally (including me) refer to keep a fairly complete set of hand tools ready to go in a tool box, for those away games that all electronics people seem to get called on for.

Instrumentation

Certainly one of the most useful all-around instruments is the volt-ohm-milliammeter, or vom. There used to be kind of a tough choice between the portable, passive vom, which needed only a small internal battery for the resistance-measuring function, and the vacuum-tube voltmeter (vtvm), which needed to be plugged into the power line but had a far greater input resistance. Today that choice is eliminated by a type of instrument that combines the best features of both: the "fetvom"—a vom that uses field-effect transistors in its input stage, often in combination with ordinary bipolar transistors as well.

Typical of such instruments is the Heathkit IM-16. At $46.95 (kit), it is not terribly much more expensive than the old vtvm, yet offers all the advantages of transistor operation. The unit can be powered from a 9-volt battery or from the power line. It has a low ac and dc range of 0.5 volt, but has no current (milliampere) ranges. A more elaborate instrument, Heath's IM-25 (kit, $85), offers current ranges, ac and dc voltage ranges down to 0.15 volt full-scale, and a 10-megohm input resistance even on ac volts (the IM-16 has 1-megohm ac input). The more expensive instrument can do a number of audio measurements that would otherwise require a separate ac vtvm.

Allied/Radio Shack "Knight-Kit" offers two similar instrument kits at approximately similar prices. The Knight deluxe unit has a mirror-scale meter movement.

Sencore offers three such instruments, at $69.95, $84.50 and $169.50 (all factory-wired). The most expensive unit has a 7-inch mirror-scale meter, pushbutton range selection, and can be battery- or powerline-operated. The cheaper meters are battery only.

B & K, EICO, RCA, Simpson, Triplett and Weston each make one or more similar instruments at prices ranging from $59.95 (kit) to $230 (wired). The most elaborate is probably the $230 Simpson 2795, which includes capacitance-measuring ranges and *temperature* ranges (with optional accessory probe).

All these instruments are relatively expensive, somewhat delicate, comparatively bulky, and some of them will give misleading readings in the presence of a strong rf field. For these reasons, you may also want to equip yourself with an inexpensive vom, one of the myriad Japanese-made instruments at prices ranging from under $10 to about $30. Many of these are sensitive, accurate, ruggedly built and yet small and light enough to be carried around in a pocket or toolbox. An experimenter will find many occasions for using more than one meter at the bench—for example, monitoring voltage and current in a circuit simultaneously.

If you're willing to go down the specialization trail a little further, you'll certainly get good use from limited-range lab-type meters, of which Weston is probably the best-known maker. They're expensive ($45 to over $200), but supremely accurate (some to within ¼%). One such meter can serve as a calibration standard. For example, the Weston 901 series dc milliameter has seven ranges from 10 mA to 1 A full scale, with ¼% accuracy. With a few multiplier resistors of the same order of precision, (costing a few dollars each), you have a highly accurate voltmeter as well.

Perhaps more generally useful, Weston makes a number of bench-type multi-range meters in cases with binding posts on top for the various ranges. These can be quickly wired into a power-supply line to monitor current or voltage in an experimental circuit. For example, the 2931 "Bench Tester" dc voltmeter can be obtained with ranges of zero to 1.5, 15 and 150 volts, with a 1,000-ohm/volt sensitivity, for $45. These have 2% accuracy. Ac voltmeters, dc ammeters and milliameters, dc galvanometers and null indicators are also available in this series.

If you are willing to settle for about 5% accuracy, you can make such meters yourself by starting with a few inexpensive dc milli- or microammeters and adding appropriate shunts or multipliers to give you whatever you want in the way of current- or voltage-measuring devices. Such meters are generally available for a few dollars each; for another few cents you can set them up to cover the desired voltage or current range very quickly according to formulas in, say, the *Radio Amateur's Handbook* (1971 edition, pp 527-529). You can make up 3 or 4 such meters for the cost of one moderately priced vom, and thus monitor simultaneously a number of currents and voltages.

Another type of meter (for which you'll probably not find a *great* deal of use) is the clamp-type ammeter. It measures ac amperes by induction—a pincers-like pair of claws opens and then closes around a conductor carrying the alternating current you want to measure. The claws are actually part of the core of a current transformer. The huge advantage of this type of meter is, of course, that you don't have to interrupt a circuit to measure the current flowing in it. Needless to say, it works only with ac, since the transformer effect doesn't happen with direct current.

If you plan to do a lot of high-quality audio work, you will definitely want an audio vtvm. This kind of instrument measures only ac volts, but does so over a very wide range of frequencies and amplitudes. Frequency response of one typical unit (the Heathkit IM-38, kit, $41.95; IMW-38, wired, $57.95) is within 1 dB from 10 Hz to 500 kHz. Its lowest full-scale range is 10 mV (0.01 volt) rms, and its highest is 300 volts. The low range is low enough to measure directly the outputs of many microphones, tape heads and phono car-

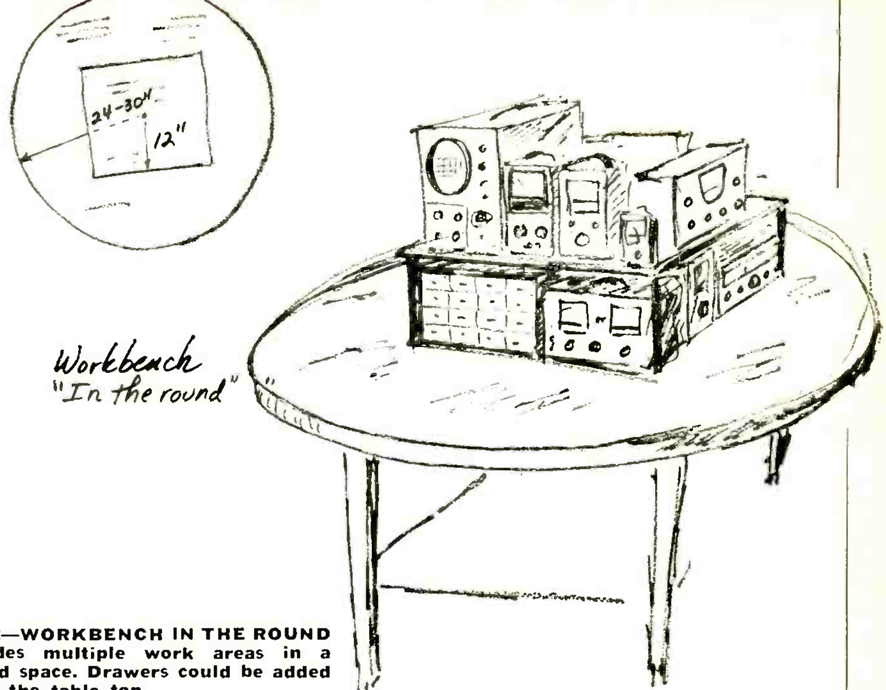


FIG. 2—WORKBENCH IN THE ROUND provides multiple work areas in a limited space. Drawers could be added below the table top.

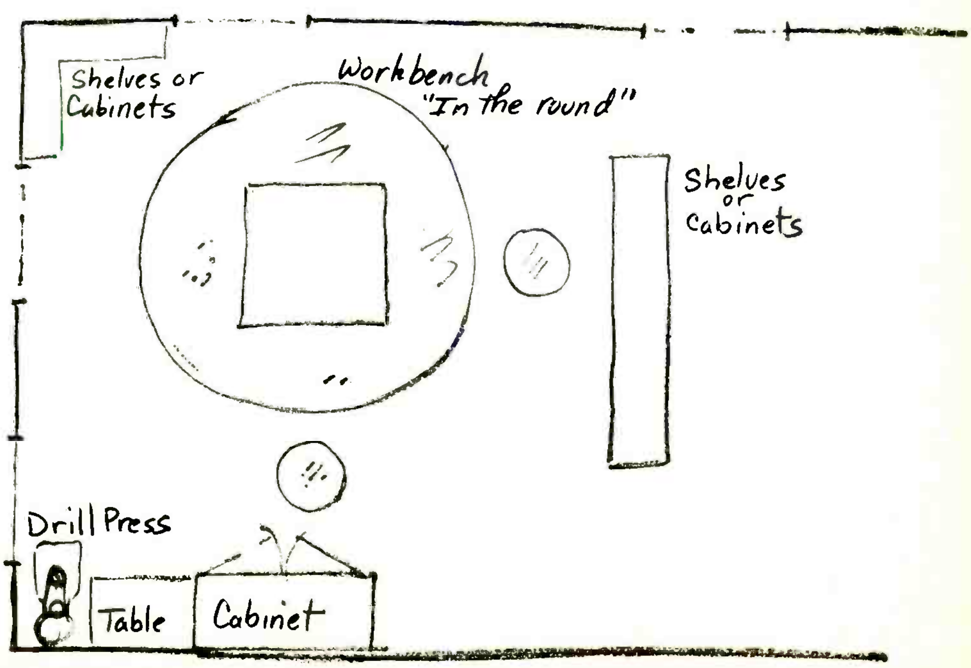


FIG. 3—WORKSHOP BUILT AROUND a "Workbench in the round. Tools can be hung on pegboards on the walls.

tridges. Furthermore, the ranges are set up in standard, convenient "root decade" manner, in 10-dB steps. Zero db is the standard 1 mW in 600 ohms, or 0.775 volt, which correlates exactly with the standard VU meters used throughout the American professional audio industry. A similar unit, with the additional advantage that it can be used as a 38-dB scope preamp, is the RCA ac vtvm WV-76A, $99.

Considerably more expensive units are available, such as the H-P 400E, which offers slightly greater accuracy, full-scale ranges down to 1 mV (.001 volt) and generally more rugged construction. The famous Ballantine log-scale meter is unusual in that its scale is linear in dB, thanks to a special logarithmic meter movement, which reduces range switching and improves accuracy. There's also the Simpson 715.

Other meters you'll want: a line-voltage monitor (RCA WV-120A, $19.50, or the WV-503A for 240-volt lines, same price). This is simply a moving-vane ac voltmeter with a suppressed zero. It plugs into a wall outlet and without further ado keeps indicating the line voltage, to 2% accuracy. How about a wattmeter to indicate the power taken by various devices? The Simpson 390 ($70) is accurate to within 3%, has 4 ranges indicating up to 3,000 watts (ac only). If you want ½% accuracy (and I can't imagine why you would), and the ability to use the instrument on both ac and dc, Weston makes a 905 for $327.

Should you want to make a permanent record of line voltage, Amprobe offers a line of recording ac voltmeters and ammeters, which have a primitive but effective moving-paper recording arrangement. Prices start at $135. All can be used as ordinary indicating meters also, though not at the same time.

Digital meters

One of the most exciting advances in instrumentation in recent years has been the digital meter, which indicates (or, in the jargon of the field, "provides a readout") quantities in illuminated digits rather than in terms of the position of a pointer along a scale. One obvious advantage of this is ease of reading—the quantity appears before you, 28.35 volts, decimal point and all, without parallax or the possibility of reading the wrong scale. Digital readouts appear, in most cases, instantaneously, without pointer swing or bounce. In digital vom's, less range-switching is required than with conventional instruments. Accuracies of 0.1% on dc are typical. Input impedance is 10 megohms on moderate dc ranges, can be 100 megohms on low (0.1-volt) ranges.

A particularly attractive device is Heath's EU-805A "Universal Digital Instrument"—which is exactly what it says. It can be a digital voltmeter, an events counter, a frequency meter (out to 12.5 MHz!), a ratio meter, a time-interval meter, and a few other things. Its price is a rather staggering $1250 (assembled only), but that is probably considerably less than you'd have to lay out for separate instruments to perform all those operations. For example, a Simpson 2726 6-digit frequency counter alone costs $575 (good to 32 MHz).

If you think you can make do with just a digital vom (which does everything done by a conventional vom plus a vtvm or fetvom), you have quite a wide range of features and prices to choose from. One of the most compact and least expensive, surprisingly, is made by Weston—the model 1241, $289, but it is for dc volts and resistance measurements only. The model 1240, $394.50, also measures ac volts and amps. The cheapest all around digital multimeter as of this writing seems to be produced by United Systems Corp., 918 Woodley Rd., Dayton, Ohio 45403. It is called Digi-ec model 262 digital multimeter and costs $375. It measures ohms, dc and ac volts, and dc amps (including of course microamps).

Two newer Heath instruments are the IB-101 frequency counter, which gives direct *eight-digit* frequency readout up to 15 MHz and higher (kit, $199.95), and a companion piece, the IB-102 frequency scaler, which extends the range of the counter to 175 MHz (kit, $99.95).

The digital-instrument field is growing and changing so rapidly that information is out of date almost as fast as it is printed. For most experimenters, a digital counter or multimeter is definitely a luxury, but it is not completely frivolous, any more than a drill press is when compared to an electric hand drill. The enormous improvement in accuracy, repeatability and speed may justify the greater cost to you.

Briefly, other types of meters you'll find useful: some sort of transistor checker. There are many. In kit form, Heath's IT-18 at $24.95 represents an excellent value—probably the most convenient for rapid sorting of "bargain" transistors by dc beta. It can also check current-gain in-circuit, test diodes in- or out-of-circuit. A more elaborate unit is the Heathkit IM-36 ($61.95, kit; IMW-36, wired, $92.50). It uses a bridge-type circuit and is probably more accurate, but its top-scale beta figure of 400 is outreached by some transistors. Both units suffer from the defect of treating transistors only as dc amplifiers. AC signal characteristics can differ substantially.

A more versatile unit, which applies ac as well as dc tests and also checks FET's, unijunctions, SCR's etc, is the Eico model 685 ($59.75, kit; $139.95 wired). Also check out the Sencore model TF17, $109.95, and the B & K model 162, $99.95. These three instruments are all similar, but differ slightly in size, shape, features, etc., as well as price.

If you do any rf work at all, a grid-dip meter is a wonderful device. You can choose from the Eico model 710 ($34.95 kit), whose greatest feature is that it works down to 400 kHz. This is rare among grid-dippers, but useful if you want to apply it to i.f. strips or the AM broadcast band. Allied Radio Shack's G-30 kit costs $29.95. Heath makes the "Tunnel Dipper"—which works just like a grid-dip meter but uses a tunnel-diode oscillator and works from a single 1.5-volt AA cell.

As a ham or CB'er, you'll want to have an SWR meter handy, and possibly also a relative power or signal strength meter. Both are available from Heath or Allied Radio Shack in kit form.

Serious audio work usually demands a harmonic distortion meter. The Healthkit IM-58 ($65) is quite a bargain. While not as refined as more expensive units, and not very useful below about 0.2% distortion, it will fill many needs on an audio bench. There is little if anything that could be called "moderately priced" in harmonic distortion meters. If price is no object, General Radio makes one for around $900, and Hewlett-Packard has a couple in a similar range.

If you feel intermodulation measurements are important, there are meters for that too. Again, the only other instruments are very much more expensive, and don't offer much more to the experimenter/hobbyist.

You may want an audio sweep generator, to run frequency response curves with a minimum of effort and a maximum of repeatability. A chart recorder, of course, is a must for making graphic records of frequency response, distortion and other amplifier characteristics.

Another exceedingly useful instrument is an impedance bridge, which can be used to measure or matching resistance, capacitance and inductance. One of the best buys in the field is still the old Heathkit IB-28 (kit, $89). A more precise instrument with a wider range is the Simpson 2785, $350.

We might mention a few important

Tools For The

6 to 8 ordinary screwdrivers of various tip sizes and lengths (some of those might be the screw-gripping type)
3 or 4 assorted Phillips drivers
Slip-joint pliers (2 sizes)
Diagonal cutters
End cutters
Grippers (hemostats), straight and curved tips
5" needlenose pliers
5" curved needlenose pliers
Tip-cutters or fingernail clippers
K. Miller wire-cutter/stripper ("yellow-handled stripper-nippers")
Crimping and bolt-cutting tool
Assorted nutdrivers
Ratchet wrench with sockets from 3/16" to ½" or bigger
Dual-heat (100/250W) soldering gun
Soldering pencil with 37½W element and chisel-tip (iron-plated)
Solder-aid tool
De-soldering "solder sucker"
Constant-temperature (controlled-heat) iron
2 or 3 adjustable wrenches
Variable-speed electric hand drill with

accessories to meters: some sort of calibrator, which need be nothing more than a new mercury cell, or a simple device made with a 1% or 2% tolerance Zener diode. A dummy load for audio amplifier power measurements, consisting of a set of four 8-ohm (preferably noninductive) 50-watt resistors, which can be used singly or connected in parallel to give 4-, 8- or 16-ohm loads. An rf probe for your vtvm or fetvm (something you can easily make yourself, otherwise buy inexpensively from almost all makers of those instruments).

You may also want an rf dummy load—which can be as simple as a Sprague 10-watt 50- or 75-ohm noninductive wirewound resistor (or some series or parallel combination to give the right resistance with a higher dissipation rating). A ready-made unit in kit form which will dissipate up to 1 kW for short periods is the Heath "Cantenna", model HN-31, $10.95. It consists of a noninductive load resistor immersed in a gallon of oil.

Resistance and capacitance substitution boxes are useful in many ways when you breadboard a circuit. Eico makes the 1140 (kit, $17.95; wired, $27.95), which gives you various values of C or R alone, or series or parallel combinations of R and C, at a single pair of terminals. You might prefer to have a number of simpler, cheaper boxes. Lafayette offers a capacitor box with 9 values, each 600 volts, for $2.25, complete with clip leads. A similar unit offers 24 resistance values for $3.49. A third unit offers R or C for $4.95. Heathkit also produces sub-box kits. Sencore makes two ingenious units: models 36 and 75 "Component Substitutors". At $19.95 and $69.95 respectively they put a variety of components across a pair of clipleads—capacitors (including electrolytics), resistors, a rectifier, etc.

Signal generators

Another extremely valuable category of instrument is the signal generator—or, more recently, the function generator. Every experimenter's shop ought to be equipped with at least an audio generator and a simple rf generator. If you expect to do a considerable amount of work with high-quality audio, you will want an audio oscillator, or generator, that offers low harmonic distortion, low hum, high stability and flatness of output, and is, preferably, metered, so that you can monitor the output level. Several modestly priced units are available now in kit form, with distortion as low as 0.1%. The type in which frequencies are selected by switching offers some convenience and easy resettability, but there are many applications where you'll find the more usual continuous-dial-plus-range-switch easier to use. Square-wave output is a convenience for some kinds of audio testing and other work, but not absolutely necessary. There are accessory square-wave shapers that can convert sine waves to square wave and can be used with any sine generator.

Oscilloscopes

A good, calibrated scope is perhaps the most useful single instrument an experimenter can have. One of the best scope bargains is still the Heathkit IO-21 (kit, $61.95). It is light and compact, but not calibrated; with the help of an ac vtvm, the single continuously-variable vertical gain control can be voltage-calibrated to within about 10% resettability. The scope is reasonably flat from 2 Hz to 200 kHz. Vertical and horizontal deflection amplifiers are identical, which makes the scope unusually useful for phase measurements. It is one of the easiest scopes for a young beginner to use because it has so few controls and "extras". Its price is so low that you might consider purchasing one even if you have a more elaborate scope. It can serve you well in less demanding applications, or carried along on "away games".

Somewhat more versatile are the Eico 435 (kit, $119.95) and the Heathkit IO-10 ($99.95). Both work down to dc; the Eico goes to 4.5 MHz while the Heath goes to 200 kHz (again with identical vertical and horizontal amplifiers). Both have 3-inch screens and are similar in size to the "minimum" scope described above.

At this level the field blossoms into a fantastic profusion of makes and models. There are more 5-inch-screen scopes with free-running sweep priced between about $90 and $200-$270 than we can possibly enumerate here. Check the catalogs. Scopes in this category are made by Sencore, B&K, Heath, Lectrotech, Eico, Knight (Allied Radio Shack), RCA, Leader, Kikusui and others.

The triggered-sweep scope, once a laboratory luxury, has now come low enough in price to bring itself into the serious experimenter's range. If you're unfamiliar with it, the principal advantages of such a scope come from a more sophisticated horizontal sweep circuit, in which the sweep is calibrated in terms of the time required to move once across the screen. Furthermore, the sweep can be triggered by the event you want to observe, which makes it much easier to observe transient phenomena. It also becomes unnecessary to resynchronize the sweep manually every time you change the frequency of the waveform you are observing—something that saves a lot of time and annoyance in certain audio work. The accurate time and amplitude calibrations make possible many kinds of voltage and time or frequency measurements.

Surely one of the best buys in the field is the Heathkit IO-14 (kit, $275). It's no beginner's kit, but if you are sufficiently far advanced to require such a scope, you presumably know enough not to be snowed under in building it. A wired version (IOW-14) is available for $399. A relative newcomer in low-priced triggered-sweep scopes is Leader: the Model LBO-501 costs $339 factory-wired. The Heath and Leader are close competitors in terms of price and features, but there are significant differences—you'll have to check out the manufacturer's literature. There is also a Leader LBO-301, a very compact portable with a 3-inch screen, all solid-state circuitry, and with about the same features as the 501. Its price is in the same bracket.

Moving higher in price brings you into the realm of lab scopes, among which there is a vast choice including such delectable features as dual-trace or dual-beam displays, plug-in deflection and sweep units with different purposes and features, vertical-channel frequency response to 10 or 15 MHz and beyond, storage facilities, etc. Analyzing and comparing all these elegant capabilities is beyond the "scope" of this article: send for catalogs from Hewlett-Packard, Tektronix, Dumont, Hickok and others.

My inclination would be to splurge on an oscilloscope (possibly even *two* oscilloscopes, a fancy one and a little one) and, if necessary, get more modest instruments of other kinds, upgrading later as desired. Even for just audio work, response to 5 MHz and triggered sweep are useful, most especially if you do any tone-burst testing. If you expect to work a lot with speakers, comparing their audio input with their acoustic output via a microphone, a dual-trace scope is a tremendous help. (An electronic switch is useful with a conventional single-trace scope, but imposes its own bandwidth limitations on the scope.) Incidentally, several instrument companies make dual-trace scopes, but they are usually costly.

Power supplies

No experimenter's workbench is complete with several kinds of variable, and preferably regulated, power supplies. First in line is a variable trans-

(continued on page 77)

Dream Bench

⅜" chuck capacity
- High-speed drill bits in 64ths from 1/64" to ½" (with ⅜" shank), and/or numbered drill sizes
- Center punch
- 12- or 16-oz hammer
- Countersink bit
- Hand reamer
- Hole saws in various sizes
- Assorted chassis punches
- Bench vise
- Several 2", 3" and 4" C-clamps
- "Nibbler"
- Drill press
- Sheet-metal brake
- Tinsnips
- Small lathe & accessories
- Leather, plastic or rubber mallet
- Riveting tool & rivets
- Hacksaw
- Jeweler's (coping) saw
- Various files, especially ¼" & ⅜" rat-tails
- Calipers
- Tap wrench & taps, esp. 4-40, 6-32, 8-32, 10-32 threads
- Dies for 4-40, 6-32, 8-32, 10-32 threads

24 easy-to-build burglar alarms

Six more alarm circuits. One is steam operated, the rest are light activated

by R. M. MARSTON

And the alarm circuits continue. Here are six more to try, use and enjoy. There's one more water-triggered alarm, and five light-operated alarms. The more advanced versions of the light-operated alarm can be used as smoke detectors in a fire protection system. You'll find the details further on.

Water and many other liquids are reasonably conductive, and act as moderately low-value resistances. These liquids thus cause the alarm to operate if they come into contact with both of the metal probes simultaneously.

A simple development of the water-operated alarm is the steam-operated alarm of Fig. 14. This circuit is similar to that of Fig. 13 (July issue). The common-emitter amplifier is made up of super-alpha-connected transistors Q1 and Q2. The circuit is thus far more sensitive than the water-operated alarm, and will in fact operate with a resistance of less than 10 megohms connected between its probes. This sensitivity is sufficient to enable the alarm to be operated by a jet of steam directed across a pair of closely spaced probes.

In both of these circuits, C1 is used to suppress any ac pick-up from long connecting leads, which might otherwise cause the circuits to operate erratically. Both circuits draw typical standby currents of only 1 μA when the probes are open circuit. The sensitivity of the circuits can be reduced, if required, by wiring a preset resistor across C1, as shows dotted in Fig. 14.

Both of these circuits have a number of uses in the home and in industry. They can be used to sound an alarm when water reaches a preset level in baths, reservoirs, tanks, or other containers, by placing one probe at the bottom of the container and the other at the preset level. They can be used to indicate the start of flooding in cellers, etc., by etching two parallel strips on a printed circuit and using these as the probes; this printed circuit is then placed face upwards on the cellar floor, so that flood water shorts the two probes as soon as its depth exceeds the thickness of the printed panel.

Similar printed probes can be used to indicate the onset of rain by placing them face upwards out of doors, so that the first few drops of rain short out the probes and sound the alarm. These probes can also be used to indicate the presence of steam, since steam will condense on the printed panel and will consequently short out the probes.

In all of the above applications, several sets of probes can be wired in parallel and used with a single alarm unit, so that one alarm can be used to monitor several different points simultaneously.

Light-operated alarms

Light-operated alarm systems have a number of important applications in the home and industry. They can be used to sound an alarm when light enters a normally-dark area, such as the inside of a store-room or a wall safe, or they can be used to sound an alarm when an intruder or object enters a prohibited area and breaks a projected light-beam. They can also be used as smoke-sensitive alarms.

Seven light-operated alarm systems are described on the following pages. All of these circuits use an LDR (light-dependent resistor) as a light-sensing element. This LDR is a cadmium sulphide photocell, and acts as a variable resistor that presents a high resistance (typically hundreds of thousands of ohms) under dark conditions, and a low resistance (typically a few hundred ohms or less) when brightly illuminated. All the light-operated circuits given here are highly versatile types, and will work well with almost any general-purpose cadmium sulphide photocells with face diameters in the range ⅛ to ½"; no precise LDR types are thus specified in these circuits. Notes on LDR selection are, however, given where applicable.

One of the simplest types of light-activated alarm circuits is that shown in Fig. 15. Here, the SCR is wired in the self-latching mode, and has its gate current derived from the voltage divider formed by LDR and R1–R2. In this circuit the LDR is mounted in a normally-dark area, such as a store room or a wall safe, so that the LDR normally presents a very high resistance. Under this condition negligible current flows into the SCR gate and the SCR and alarm are off.

When light falls on the LDR its resistance falls to a fairly low value. If the resistance falls to less than 10,000 ohms or so, enough current flows into the SCR gate to turn the SCR on, and the alarm then goes on and self-latches. Most LDR's have a resistance of less than 10,000 ohms when exposed to low-intensity room lighting or to the light of a torch, so this circuit will operate and lock-in as soon as the LDR is exposed to a moderate degree of illumination.

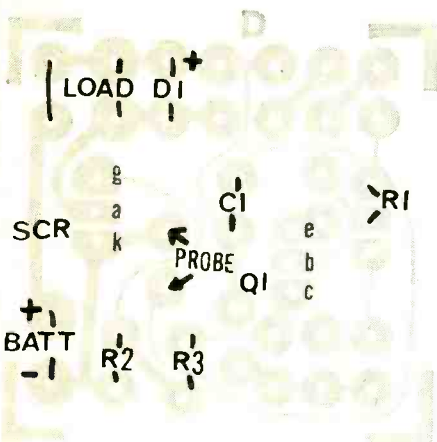
Figure 16 shows how the sensitivity of the circuit can be increased so that the alarm turns on when only a very small amount of light falls on the LDR face. Here, the SCR is again wired in the self-latching mode, but in this case the SCR gate current is derived from the LDR-R1 potential divider via emitter-follower Q1. This emitter-follower enables the SCR to be driven on when the LDR resistance falls to a value as high as 200,000 ohms, as when the LDR is exposed to only very small amounts of light. Potentiometer R1 enables the sensitivity of the circuit to be varied over a wide range. This circuit, and that of Fig. 15, draws a typical standby current of only a few microamps when the LDR is under the 'dark' condition.

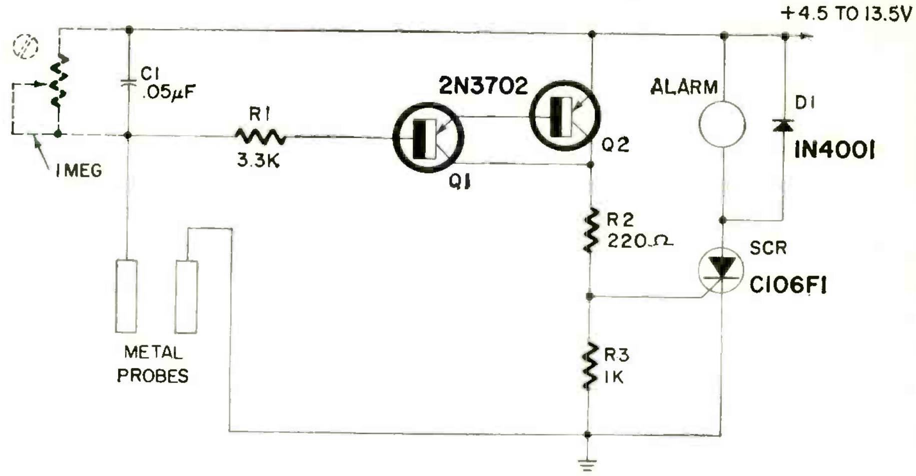
Another simple type of light-activated alarm is the interrupted-light-beam alarm circuit shown in Fig. 17. Here, the SCR is wired in the self-latching mode and has its gate current taken from the voltage divider formed by R1 and the LDR. Normally, the LDR is brightly illuminated via a light-beam formed by a remotely placed lamp and lens system. The LDR acts as a low resistance under this condition, and insufficient voltage is developed at the R1–LDR junction to turn the SCR on. The alarm is off.

When a person or object interrupts the light beam, the resistance of the LDR rises to a fairly high value and enough voltage is developed at the R1–LDR junction to turn the SCR on, so the alarm goes on and self-latches.

This simple interrupted-light-beam circuit draws a typical standby current of only 340 μA when operated from a 4.5-volt supply. The LDR can be any type that offers a resistance of less than

14.

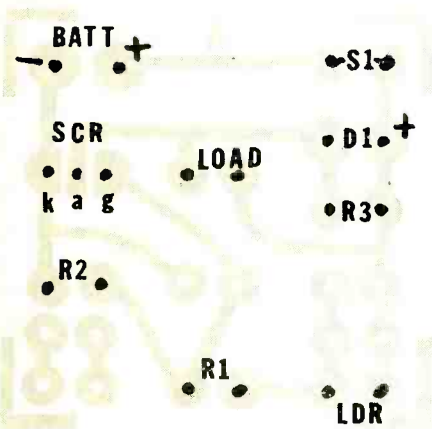




PARTS LIST

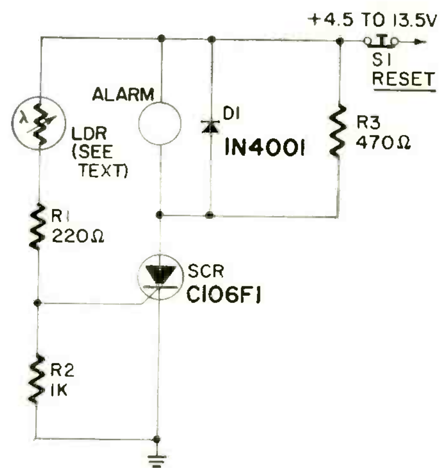
R1—3300 ohms, ½ watt
R2—220 ohms, ½ watt
R3—1000 ohms, ½ watt
R4—potentiometer, 1 megohm
C1—.05 μF, ceramic
D1—1N4001
Q1, Q2—2N3702
SCR—C106F1
Metal probes
Alarm device
Circuit board D

15.

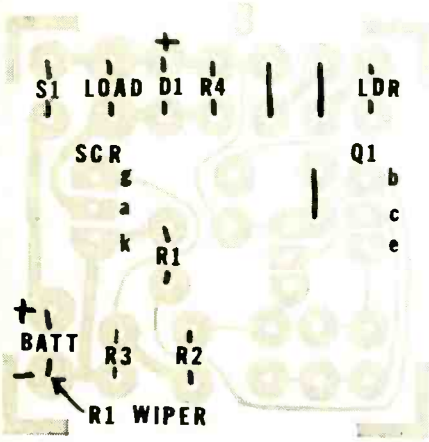


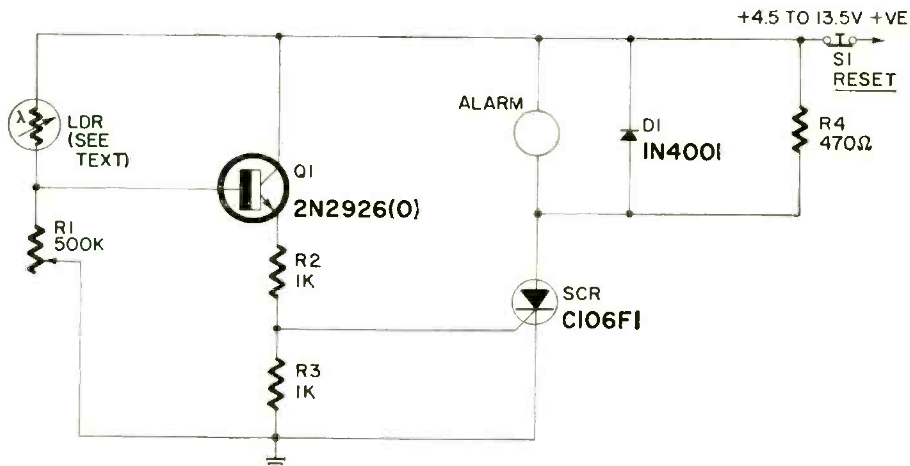
PARTS LIST

R1—220 ohms, ½ watt
R2—1000 ohms, ½ watt
R3—470 ohms, ½ watt
D1—1N4001
LDR—see text
SCR—C106F1
S1—spst normally closed
Alarm device
Circuit board A



16.

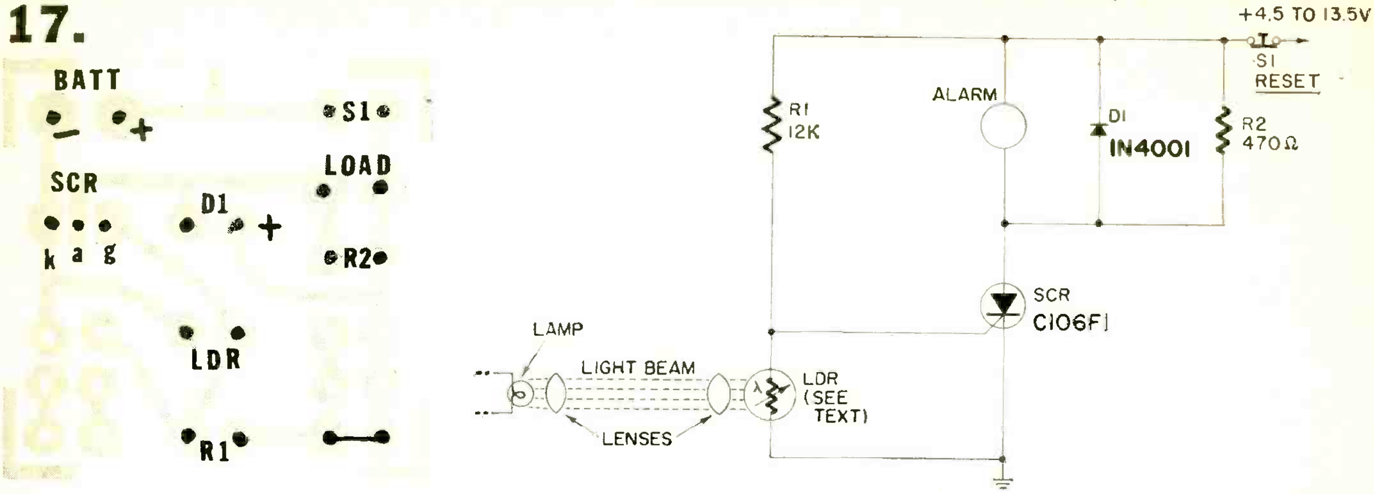




PARTS LIST

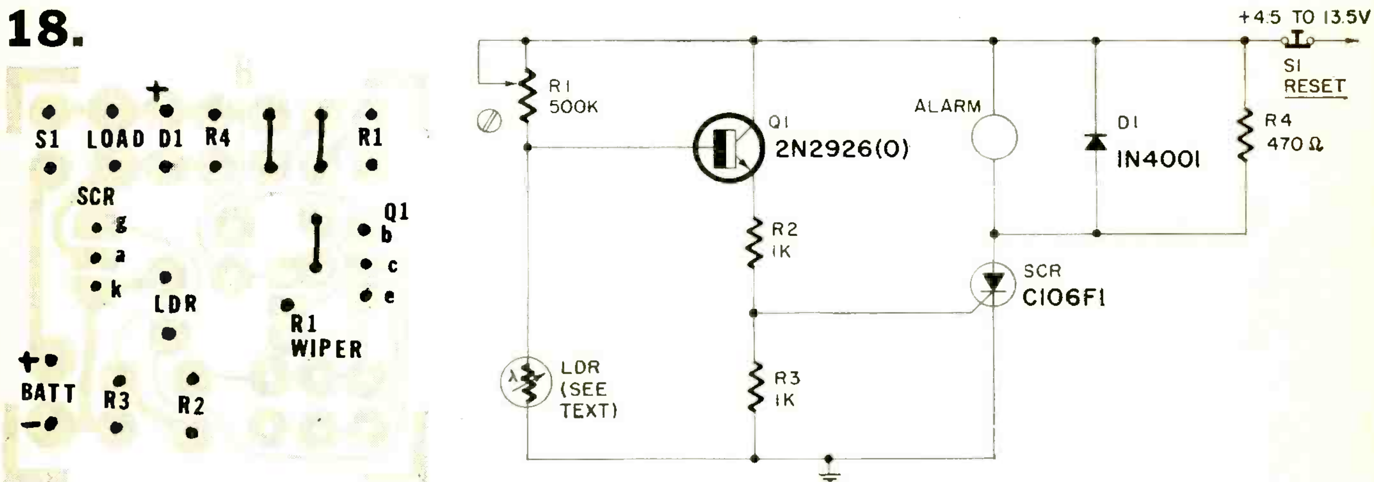
R1—potentiometer, 500,000 ohms
R2, R3—1000 ohms, ½ watt
R4—470 ohms, ½ watt
D1—1N4001
LDR—see text
Q1—2N2926(O)
SCR—C106F1
S1—spst normally closed
Alarm device
Circuit board B

17.



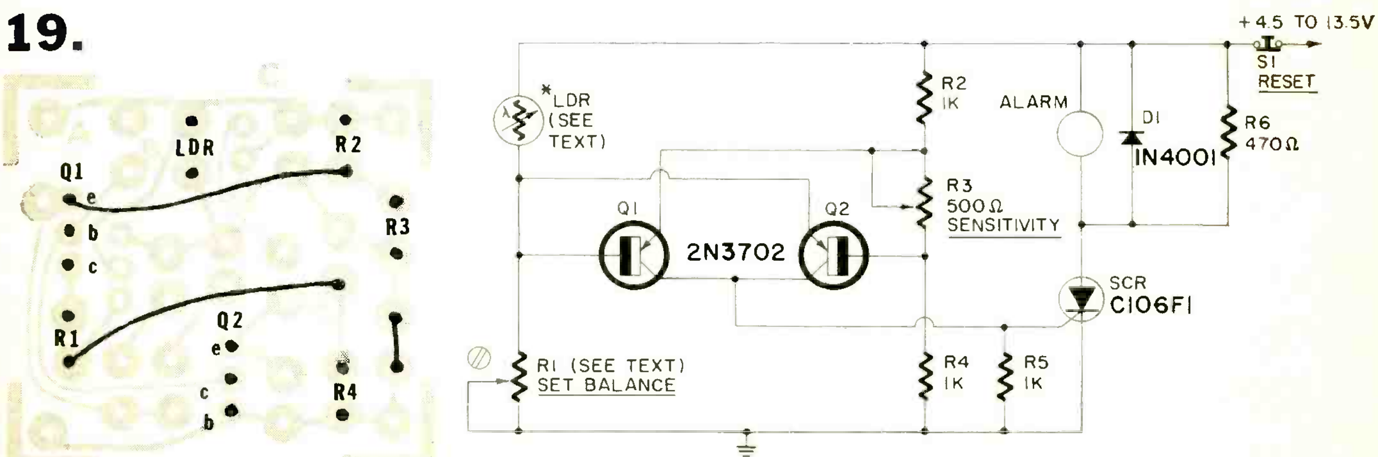
PARTS LIST
R1—12,000 ohms, ½ watt
R2—470 ohms
D1—1N4001
LDR—see text
SCR—C106F1
S1—spst normally closed
Alarm device
Lenses
Light source
Circuit board A

18.



PARTS LIST
R1—potentiometer, 500,000 ohms
R2, R3—1000 ohms, ½ watt
R4—470 ohms, ½ watt
D1—1N4001
LDR—see text
Q1—2N2926(O)
SCR—C106F1
S1—spst normally closed
Alarm device
Light source
Lenses
Circuit board B

19.



*LIGHT SOURCE AND LENSES AS IN FIG. 6

PARTS LIST
R1—see text
R2, R4, R5—1000 ohms, ½ watt
R3—potentiometer, 500 ohms
R6—470 ohms, ½ watt
D1—1N4001
LDR—see text
Q1, Q2—2N3702
SCR—C106F1
S1—spst normally closed
Alarm device
Lenses
Light source
Circuit boards C and A
Points A, B, C on circuit board C (at left) connect to circuit board A as set up in circuit 5 (June issue). Point A connects to B+ on board A; Point B connects to the SCR gate on board A; Point connects to B— on board A.

1000 ohms under the illuminated condition, and more than 3000 ohms under the "interrupted" condition; most general purpose LDR's will satisfy these needs.

Another version of the light-beam alarm is shown in Fig. 18. This circuit is similar to that of Fig. 17, except that emitter-follower Q1 is wired between the R1–LDR potential divider and the SCR gate. This emitter-follower enables R1 to be given a higher value than in the case of the earlier circuit, so that this circuit operates at a lower standby current and can use a less sensitive LDR. R1, now a potentiometer, sets the circuit sensitivity so the circuit can be activated by quite small decreases in light level if required.

The circuits in Figs. 17 and 18 perform as useful intrusion detectors. They are inexpensive and easy to construct. The lamps that activate them can be powered from either ac or dc. A disadvantage of each circuit, however, is that it can be 'disabled' quite simply by directing a bright light on to the LDR face; if this light has a greater intensity than that of the normal light-beam, an intruder can then walk through the beam without sounding the alarm. This vulnerability can be overcome in a number of ways.

One system that overcomes this particular vulnerability problem uses a code-modulated light-beam, and employs a code-sensitive detector in its alarm section. The circuit can not be disabled by shining a light on the alarm's photocell because the alarm is sensitive only to the correct code signals. Modulated-light-beam systems are widely used. They, however, have now been made obsolete by the development of glass-fibre light tubes or 'light pipes". Skilled intruders can use these pipes to divert the coded beam away from its original protective path without breaking its effective source-to-detector link; they can then pass through the original protected area without activating the alarm system.

Another way of overcoming the vulnerability problem is to use an alarm circuit that sounds if the intensity of the photocell light varies from a preset value, as when the light-beam is broken or a bright light is shone on the LDR face. A practical circuit of this type is shown in Fig. 19.

Here, the LDR is wired in a bridge circuit formed by R1-R2-R3-R4 and the LDR, and Q1-Q2 are used as a bridge-balance detector and SCR driver. Pot R1 is adjusted so that the bridge is balanced when the LDR is illuminated normally via the light-beam and R3 enables the sensitivity of the circuit to be varied over a reasonable range.

To understand the circuit operation, assume initially that R3 is replaced by a short, so that half the supply voltage appears at the R2–R4 junction, and that R1 is adjusted for balance, so that half-supply voltage appears at the LDR–R1 junction. Under this condition, zero voltage is thus developed between the base and emitter of Q1 or Q2. Both of these transistors are thus cut off, so zero current flows into the SCR gate via their collectors. The alarm is off.

Suppose now that the light-beam is interrupted, so that the LDR resistance rises. Under this condition, the voltage at the LDR–R1 junction falls to a value lower than that on the R2–R4 junction, and a forward voltage appears between the base and emitter of Q1. If this forward voltage exceeds 650 mV or so, Q1 is driven on, and its collector current feeds into the SCR gate, and the alarm circuit then turns on and self-latches.

Suppose, on the other hand, that the light-beam is not interrupted, but that a light with an intensity greater than that of the beam is shone on the LDR face. In this case the LDR resistance falls, so the voltage at the LDR–R1 junction rises to a value greater than that on the R2–R4 junction. A forward voltage thus appears between the base and emitter of Q2 under this condition. If this voltage exceeds 650 mV or so, the transistor is driven on and its collector current feeds into the SCR gate and drives the alarm on. The alarm thus operates if the light intensity on the LDR face changes sufficiently to cause the LDR–R1 junction voltage to vary by an amount in excess of 650 mV or so.

In the practical circuit of Fig. 19, R3 is wired in series with the R2–R4 voltage divider, and enables a preset forward bias voltage to be simultaneously applied to the base-emitter junctions of both Q1 and Q2, so their sensitivity can be controlled. If, for example, a preset bias of 500 mV is applied to each transistor, the LDR only has to produce an additional change of 150 mV at the LDR–R1 junction in order to turn one or other of the transistors on and thus activate the alarm. The circuit can thus be adjusted for a high degree of sensitivity.

The LDR used in this circuit can be any type that gives a resistance in the range 200 to 2000 ohms when it is illuminated by the light beam. R1 should have a *maximum* value approximately *double* that of the LDR resistance under the above condition. The sensitivity of the circuit varies by a certain amount with changes in supply voltage, and is greatest at the higher voltage levels. If the circuit is to be operated at very high sensitivity levels, the supply voltage should be stabilized.

First, adjust R1 so that roughly half the supply voltage is developed at the LDR–R1 junction when the LDR is illuminated. Then, adjust R3 so that roughly 400 mV is developed across R5. Now reset R1 to give a minimum voltage reading across R5. Readjust R3, if necessary, so that this reading does not fall to less than 200 mV or so. When the R1 adjustment is complete, the bridge is correctly balanced. R3 can then be adjusted to set the sensitivity of the circuit to the required level. If R3 is set so that zero voltage is developed across R5, a fairly large change in light level will be needed to operate the alarm, and if it is set so that a few hundred millivolts are developed across R5 only a small change in light level will be needed to operate the alarm.

Smoke alarm

Another useful type of light-activated circuit is the smoke-operated alarm. Figure 9 shows a practical example of a circuit of this type. Here, the LDR is again illuminated via a projected light-beam, and is connected in the bridge circuit formed by the LDR and R1-R2-R3. Potentiometer R1 is adjusted so that the bridge is normally just out of balance in such a way that Q1 is conducting, but is not conducting sufficiently to drive the SCR on, i.e., so that the voltage on the LDR–R1 junction is a few hundred millivolts less than that on the R2–R3 junction. Thus, the alarm is normally off.

When smoke enters the light beam, the intensity of the light on the LDR face inevitably falls by a small amount, so the LDR resistance rises. The voltage at the LDR–R1 junction then falls and Q1 is then driven on sufficiently to activate the SCR. The alarm turns on and self-latches. By adjusting R1, the circuit can be set to give any desired degree of sensitivity.

A minor snag with the circuit of Fig. 9 is that its precise operating point characteristics of Q1 are temperature dependent. The circuit is thus not suitable levels, or in conditions where the circuit is affected to some degree by variations in operating temperature, since the V_{be} for operation at very high sensitivity may be subjected to large temperature variations.

These snags are largely overcome in the sensitive smoke alarm in Fig. 10. Here, the LDR is again illuminated via a light beam, and is connected in the bridge network formed by the LDR and R1-R2-R3. In this case, however, the detector circuit comprises Q1 and Q2, which are connected as a differential amplifier. An outstanding feature of the differential amplifier is that its operating points are not greatly affected by variations in ambient temperature, since both transistors are subject to the same thermal changes, and thus tend to counterbalance one another in such a way that their operating points remain constant.

In use, R1 in this circuit is adjusted so that the bridge is close to balance when the LDR is illuminateed normally and so that Q2 is passing a collector current slightly less than that needed to operate the SCR. The alarm is thus off under this condition.

When smoke enters the light-beam, the LDR resistance rises and causes the voltage on the LDR–R1 junction to rise. The collector current of Q1 thus decreases and differential action causes Q2 collector current to increase to a level sufficient to activate the SCR; so the alarm turns on and self-latches. Since the operating point of the circuit is not greatly affected by variations in temperature, the circuit can be reliably operated at high sensitivity levels, or in areas that are subject to wide temperature variations. *(concluded next month)*

The following alarm parts are available from Photolume Corp., 118 E 28 St., N.Y., N.Y.
Kit RE671-PC consisting of 1-panel of 4 alarm circuit boards; 1-panel of 3 component-mounting strips; 100 plug-in-connectors . . . $6.25 postpaid.
Kit RE671-T consisting of 1 SCR; 1 diode; 4 transistors (2 npn, 2 pnp) and 1 photocell . . . $3.75 postpaid.

The musical selections are chosen first, recorded, and the necessary mixing and editing done to produce an audio program. The audio is then reviewed and rough outline made of the types of slides and visual effects needed to create the desired moods and pacing throughout the show.

After the preliminary planning, a detailed script sheet is prepared that correlates visuals, narrative and music. Visual and effect changes are keyed to specific beats in the music on this script.

Using the scripts as a guide, the necessary visuals and a tape-punching schedule are prepared. The controller tapes are punched using the punching schedule as a guide. This is the most laborious part of programming, but with good organization of the punching schedule, several different people can alternate on the job. The punched tapes are then "proof read" against the punching schedule.

The last step in the programming is the actual synchronization of the punched tapes with the audio portion of the show. The punched tapes are placed on the controller, the slide trays are placed on the projectors, and the control tone multiplexers are set in the programmer mode. The tape recorder is started with the audio tracks played back through the premonitor heads while the control tracks are set on record.

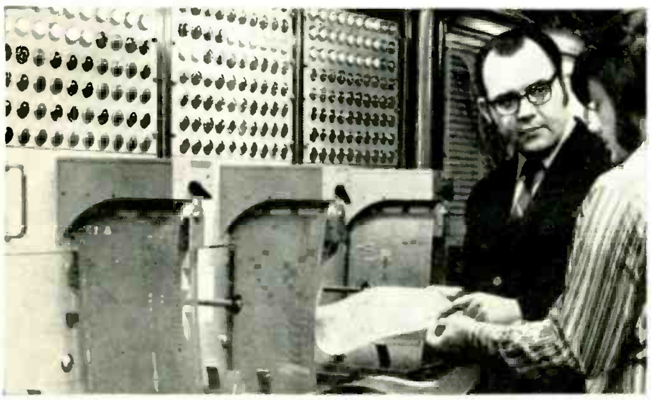
As the audio portion of the program is played back, a skilled operator "plays" the controller pushbutton switches on the manual console, in a fashion similar to playing a piano, except that the script is used in place of sheet music.

This generates control tones that are recorded on the control tracks of the audio tape while at the same time, all of the slide projectors and other devices operate exactly as they will in the finished show. A second person who is familiar with the script watches the show and if a mistake is seen, the tape recorder is stopped and any necessary corrections or alterations are made. When the show is completely programmed, the tapes are punched to bring all slide trays and sequential reprogrammer to their starting positions and they are spliced into continuous loops.

Problem of synchronization

For a light show to have maximum effectiveness, the various slide changes and the activation of lighting devices must be made in exact synchronization with the music. Since the audio tape is recorded first with the music and narration and the control tones are added later, it is impossible to have the control tones in exact sync with the recorded music unless the tape recorder being used allows simultaneous monitoring and recording from the same head.

Although this feature is available in some professional machines used for multiple track recording it is not included in all tape recorders. Many people who have used stereo recorders with simple slide-tape synchronizers have noted this lack of proper synchronization. It is usually caused by the recorded control tones being added to the tape some distance behind the actual associated audio material. This occurs because the record head of most machines is located about 1-inch behind the playback head. When the audio and control information are played back together, the control tones are delayed by some fraction of a second.



Paper tape programmer contains all the switching information to operate light and sound systems in sync.

This inherent delay, when coupled with the time it takes for a high-wattage projector lamp to come up to full brightness after it first receives electricity, and the various slight electromechanical delays in the control system, make it necessary to place the control signals slightly ahead of the audio information on the tape.

Assuming that the control signals are placed in the proper location all relay closure times and lamp delays can be compensated for so that the lamp reaches full brilliance at the exact moment desired.

The Edmund Light Show Theatre is open every weekday from 8:00 AM to 5:30 PM. It is open Friday evenings to 9 PM and all day Saturday from 8 AM to 9 PM. **R-E**

Tape-

Use a ruler to find out how long 7000 feet of tape will play at 3¾ ips

by RUDOLF F. GRAF
GEORGE J. WHALEN

This chart relates tape length, recording time and recording speed. It will also help you determine rewind time—a very useful bit of information.

You will find this chart particularly valuable if you edit your own tapes for home slide shows, parties, amateur theatricals, meetings, etc. It is especially handy for figuring tape requirements if you record recitals or other public performances.

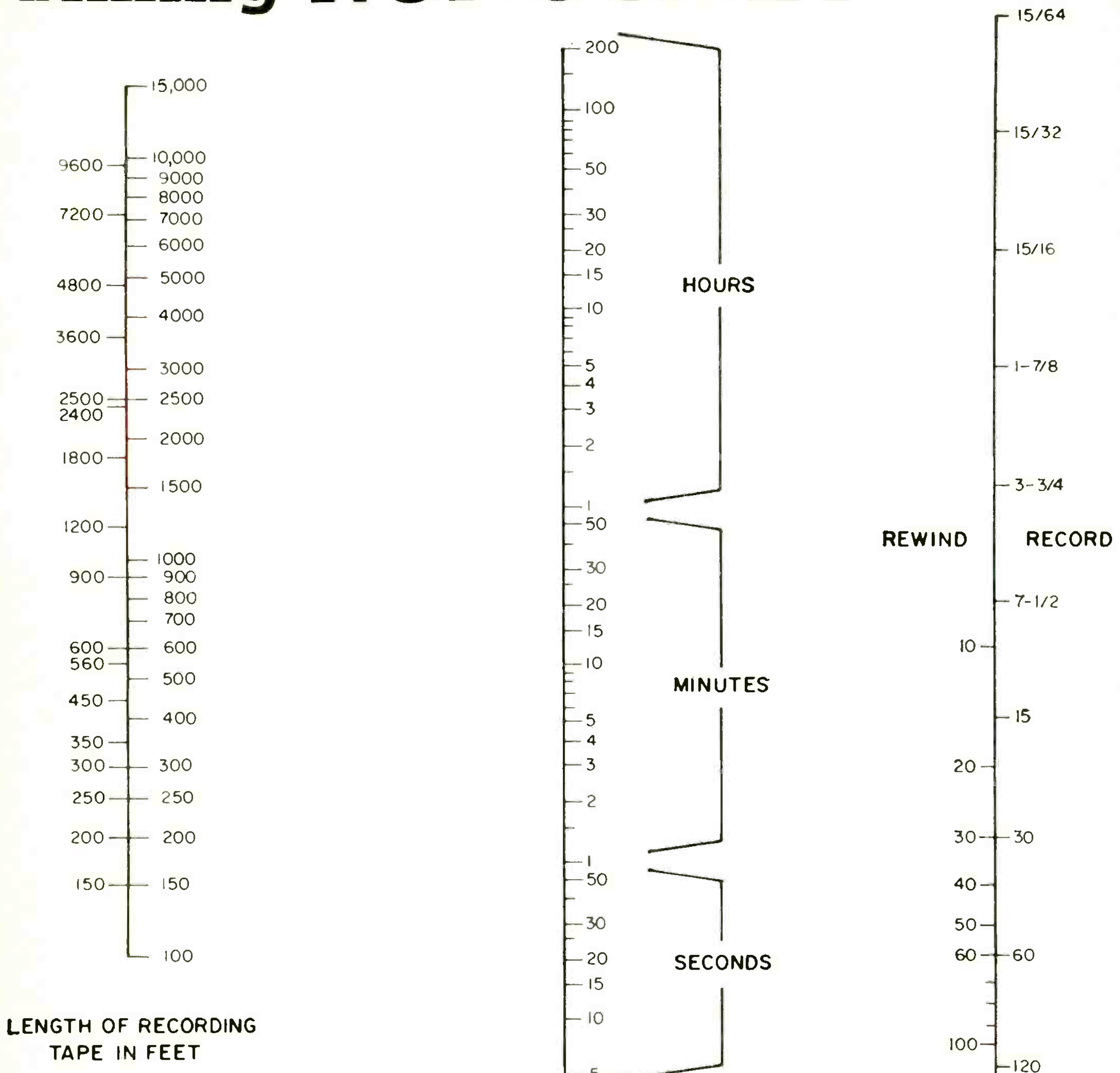
The chart works for all mono and stereo recorders that employ capstan drive (constant speed). Engineers call this kind of chart a nomogram or alignment chart. Simply interconnect the known values on two of the scales with a straight edge and read the answer on the third scale.

If you don't know the recording or rewind speed of your machine, here's how you find it. Use a tape of known length and measure rewind time with a watch that has a sweep second hand.

For example: If 100-foot length of tape rewinds in 40 seconds, your rewind speed is 30 inches/second. Now that you know your rewind speed, you can use this information to measure the lengths of tapes that are to be spliced or have been edited. You can now quickly determine playback time of any tape of any length.

Rewind each tape segment before splicing them together and add together all the rewind times. Since you know your rewind speed, you

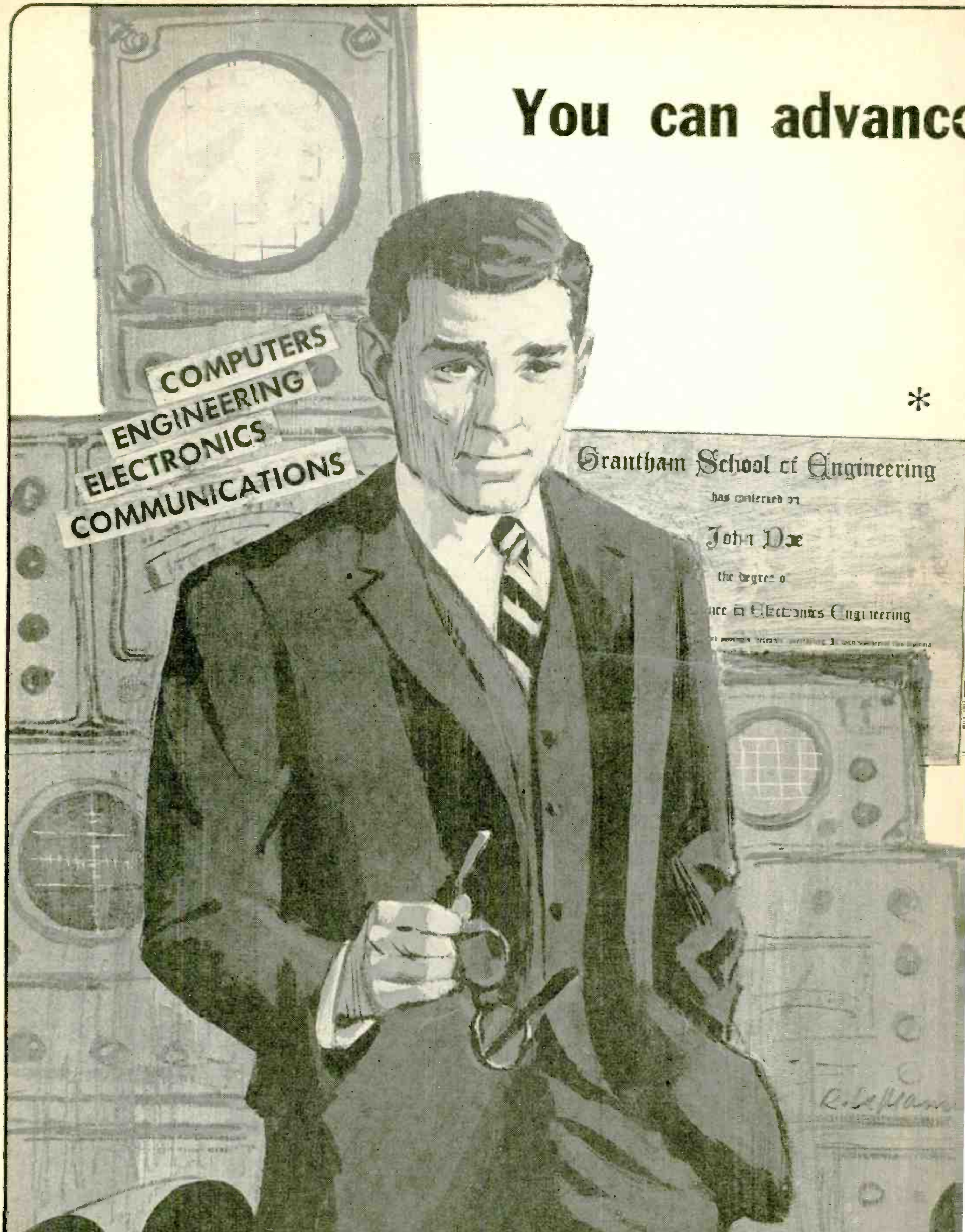
Timing NOMOGRAM



can use the chart to find the total length of your tapes before splicing. Use this length together with your known playback speed to read total playback time from the center scale of the chart. Thus you can determine **in just a few minutes** the exact **playback time** of any of your material. You can also use this chart to find the amount of tape to be snipped or added for a desired playback time.

The examples above are for single-track one-direction recording.

For total time on 4-track monophonic recorders multiply time by 4.
For total time on 2-track monophonic and 4-track stereo recorders multiply time by 2.
For total time on 2-track stereo recorders read answers directly.



You can advanc
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ENGINEERING
ELECTRONICS
COMMUNICATIONS
*
Grantham School of Engineering
the degree of

IC Power Supplies

more uA723 circuits

High-power regulated supplies can also use IC regulators. The secret is to provide "booster" transistors to handle the load

by WALTER G. JUNG

TO GET A HIGH-CURRENT SUPPLY WE turn to Fig 1 a μA723 regulator with a booster stage. The use of external booster transistors removes virtually all restrictions on the IC's power handling capacity, as it now only has to supply a small amount of base current to the booster transistor which handles the bulk of the power dissipated in the regulation process. The beauty of this approach is that it allows us to retain all of the previous good regulation features of the IC control amplifier and yet still handle a much larger current output. A booster stage can be used with either the low or high voltage regulator configurations, and enables either type of regulator to deliver up to 500 mA.

Schematically the circuit is rather simple. A silicon pnp power transistor (Q1, a 2N4918) is connected as shown in Fig. 1 to raise the power capability of this 12-volt circuit to 500 mA. An additional resistor (R_b) is needed from base to emitter of Q1, and the base control current for Q1 is delivered from pin 7

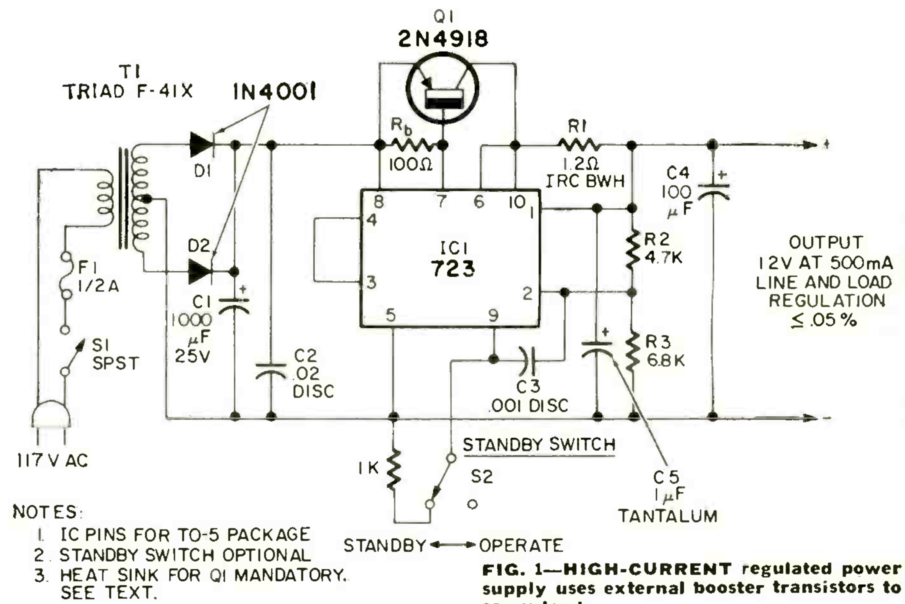


FIG. 1—HIGH-CURRENT regulated power supply uses external booster transistors to carry load.

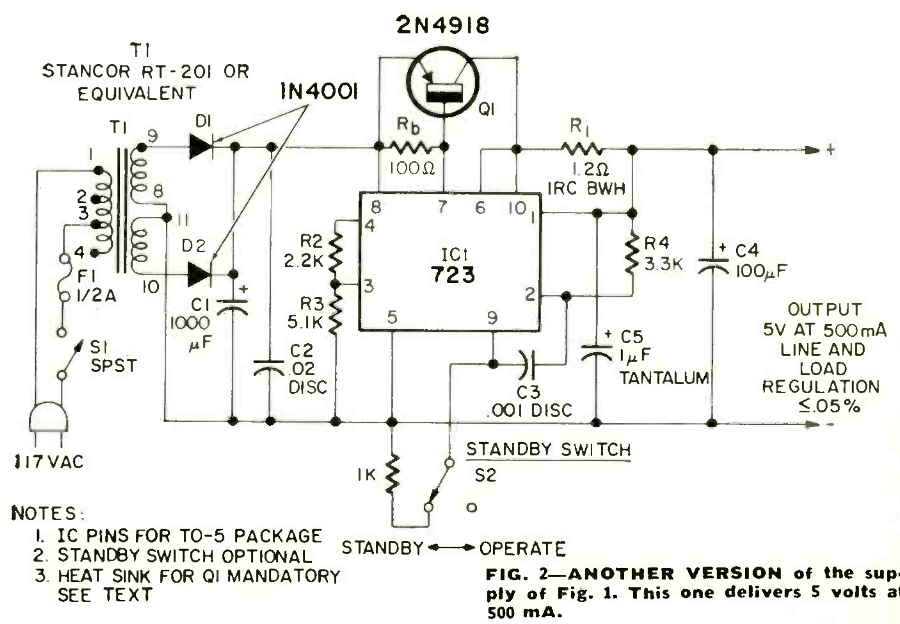


FIG. 2—ANOTHER VERSION of the supply of Fig. 1. This one delivers 5 volts at 500 mA.

of the IC. In this manner the bulk of the output current is handled by Q1 and the IC handles only the smaller base current of Q1. To illustrate what this does for us, let's look at some typical numbers. If we assume a dc current gain of 50 for Q1 at a current of 500 mA, the IC need only provide 10 mA to drive Q1. At lower load currents, even less than this. So we can see how this hookup reduces the strain on the IC, minimizing its temperature rise due to the lower power dissipation.

At 500 mA Q1 definitely needs a heat sink for prolonged operation. Figure 3 shows a simple method of heat removal using the chassis as a sink. Solder Q1's leads to the circuit board and position the metalized face over a chassis mounting hole. Secure the transistor to the chassis with the screw and insulating washer provided and use silicone grease on both sides of the washer.

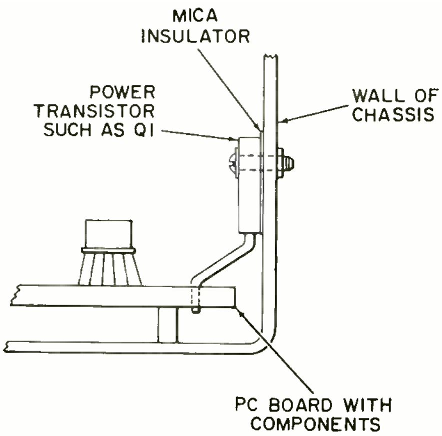


FIG. 3—RECOMMENDED HEAT-SINK arrangement for power transistors in Figs. 1 & 2.

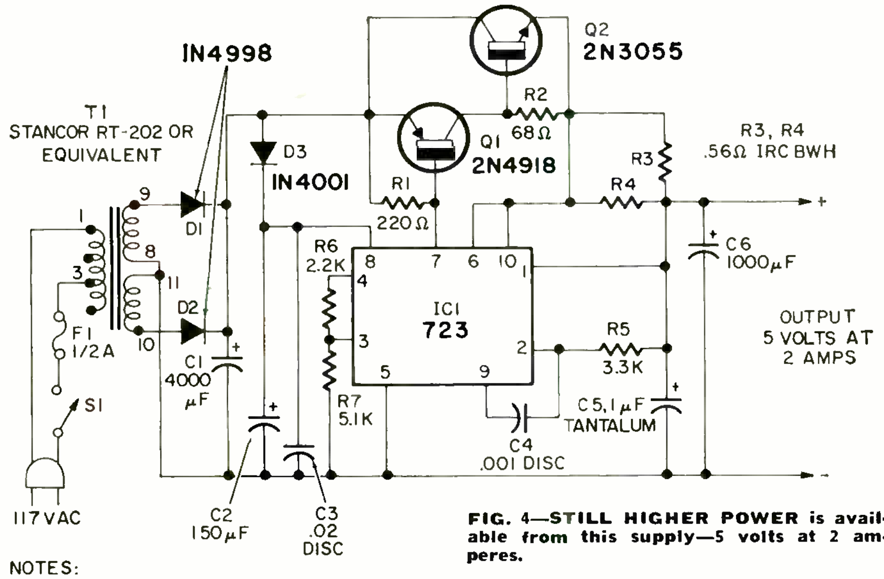
The same transformer is used in this 12-volt regulator but the input filter is raised to 1000 μF to keep input ripple down with the increased current drain. And the current limiting resistor is lowered to correspond to the increased output current.

Many of the above comments on the 12-volt version apply also to the 5-volt 500-mA regulator shown in Fig. 2. The booster transistor connections and current limit change are the same as for the 12-volt version. The main difference is the substitution of a different power transformer. This permits lowering the input voltage, minimizing the voltages across Q1 and improving efficiency. Q1 of course, should be mounted as before (see Fig. 3).

We can also carry this booster technique one step further and come up with a 2-ampere regulator. To do this we add one more pass transistor, increase the filter capacitance, substitute huskier rectifier diodes, a larger power transformer and lower the current limiting resistor value once more.

A circuit of a 5-volt, 2-amp regulator with the changes mentioned above is Fig 4. The additional booster transistor is Q2, a 2N3055 which is driven in turn by the 2N4918. A complementary Darlington connection is used to minimize voltage drop across the pair. Since Q2 can dissipate quite sizeable power in this application a large heat sink is mandatory. Use the type recommended or one with equivalent performance for best results, and don't skip the silicone grease under the mounting washer.

The short-circuit-current limit resistor is a two-resistor parallel combination because of wattage considerations. A separate rectifier and filter capacitor (D3-C2) is used to supply voltage to the IC. This is done to minimize input ripple feedthru which would otherwise be high due to the ripple across C1 at high current outputs. The extra filtering of C2 (which is isolated from C1's ripple by D3) smoothes the voltage at pin 8 of the IC and minimizes the effects of input ripple on the output.



NOTES:
1. IC PIN NOS. FOR TO-5 PACKAGE
2. HEAT SINK FOR Q2 MANDATORY-
WAKEFIELD NC623A OR EQUIVALENT
CHASSIS AREA.

FIG. 4—STILL HIGHER POWER is available from this supply—5 volts at 2 amperes.

Power supply systems

In this section we'll talk about using the power supplies we've developed thus far in various practical combinations. As we discuss these combinations we will also evolve another type of power supply—the *tracking* supply. This is the final circuit in this section, and the one most suitable for those electronic projects on the experimenter's workbench. We'll go as deeply into this one as possible so you can get the maximum out of it.

By themselves any one of the circuits we've talked about up to now have been entirely usable as they stand. You can pick the voltages and current rating you need and build that supply. But suppose you need two supplies, such as ±12 volts. You could just build 2 supplies (as in Figs. 1 or 3, *Radio-Electronics*, July 1971) and connect the output in series as shown in Fig. 5 and use them as a ±12 volt supply. This would certainly do the job, but there might be a simpler way.

If we review all of the circuits we have talked about so far we can note they have one thing in common. They are all *positive* leg regulators—they regulate the output voltage by a variable resistance in the *positive leg* of the circuit. This is either Q1, Q2 or the IC itself. (see Fig. 6).

The next section in the continuing series of articles will look into negative-leg regulators and will examine regulated power supplies using other IC types. **R-E**

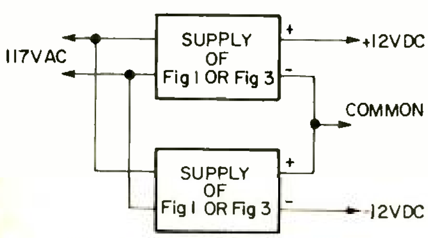


FIG. 5—FOR DUAL SUPPLIES just combine two of the circuits you have built.

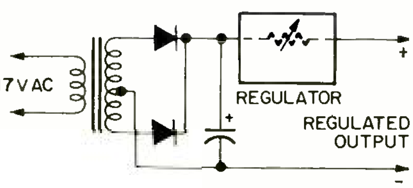


FIG. 6—POSITIVE-LEG REGULATORS have been described so far. The regulator is in the positive leg of the supply.

You and your ultrasonic clothes washer!

FINISHED ALARM is a little box with a red warning indicator on its front. Mount it on the dashboard of your car.

FOR YOUR CAR

Tail Light

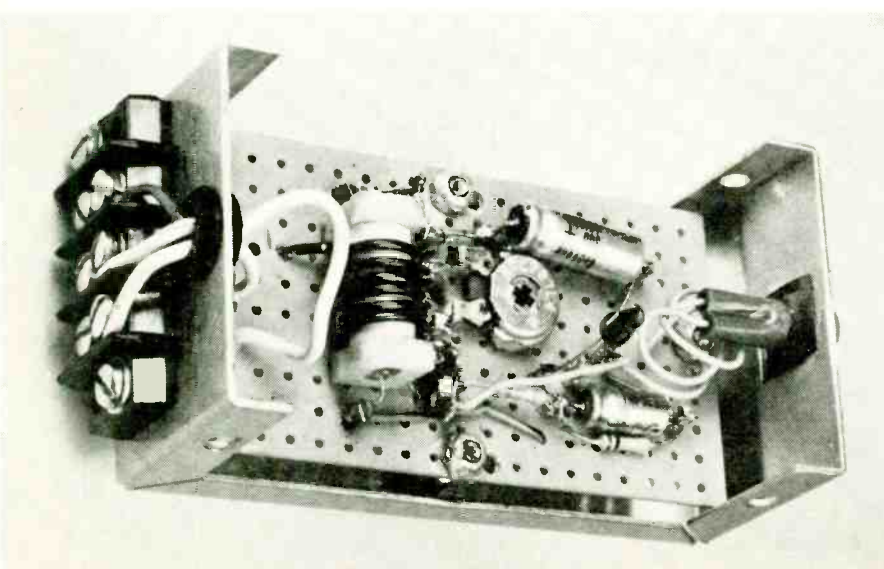
a safety device that lets you know, immediately, if one of your brake lights burns out. Use it to make your driving a less hazardous journey

by RUDOLF F. GRAF & GEORGE J. WHALEN

RELIABLE AS AUTOMOTIVE LAMPS ARE, they still do burn out at unexpected moments. Perhaps the most dangerous failure is the loss of a stop light, since it robs you of two important signalling functions: it reduces the warning provided the driver behind you that your car is braking; and it sharply curtails your turn signalling capability. Of course, the degree of severity of the failure is related to the number of lamps in your car's rear end signalling system. If your car has only *one* stop light for each side, a lamp failure is an open invitation to a rear end collision!

The most insidious factor in stoplight failures is that the filament opens quietly, and in a position that cannot be seen from the driver's seat. Occasional checking at a service station with the aid of the attendant may help but it is no guarantee that a stoplight won't fail two minutes later, after you've driven away. You can watch your ammeter (if you still have one of these "old fashioned" instruments in your car) as you step on the brake, but that still doesn't tell you whether only one or all shop lights are ok.

The Brakelight Monitor gives you with a dependable indication that your stop lights are functioning properly. Should any of your lights become inoperative for any reason, a light will go on in the monitor to alert you to check your brakelights.



INSIDE THE CASE you can see how all components are located on an ordinary piece of perf board. Flea clips and point-to-point wiring complete the unit.

How it works

The most important part of the circuit is a tiny reed relay to which a second winding consisting of 6 turns of No. 14 enamelled wire has been added. This added winding is connected in series with the lead that goes from the stoplight switch to the lamps, so that full lamp current flows

Monitor

through this winding enroute to the stoplight filaments. This lamp current produces a magnetic field which is directly proportional to the current required by the filaments. In a two-lamp stoplight system, this would be from 4 to 5 amperes—a rather respectable amount of current—which produces a fairly strong magnetic field, which is *added* to the magnetic field generated by the existing winding on RY1. The latter winding's field strength is adjusted by R1, to be just enough to close the reed contacts. Hence, the magnetic field produced by the stoplight current flow though the added winding is summed with the field of the existing winding, every time you step on the brakes.

If any one of the lamps is inoperative (either because it is burned out, or because of poor electrical contact) there will be proportionately less current through the 6-turn winding, and the reed relay will not close. Now for the rest of the circuit.

Capacitor C2 and resistor R2 together with Darlington transistor Q1 form a 1-second time-delay circuit. The collector of Q1 is connected through indicator lamp LM1 to the positive 12-volt supply. At the instant the brake pedal is depressed and 12 volts is applied to R2, the delay circuit is started. After one second, indicator lamp LM1 will go on **unless** the reed relay is closed. If it closes, the base of transistor Q1 is connected to ground, the delay is cancelled and the transistor cannot turn "on". As you can see, current flow corresponding to "good lamps" automatically disarms the circuit controlling the indicator lamp.

The directional light circuit causes your lights to flash, but the delay circuit keeps the FAILURE lamp OFF during the short period of time that the circuit is open to give your blinking action. If the delay circuit were not incorporated the brakelight monitor would flash every time you signal a turn. It is possible that directional lights flash only for a very brief period of time as may be the case when you have a defective flasher or use incorrect bulbs. In either case, the OFF period would be beyond normal limits. Thus if the circuit is interrupted for more than one second, the brakelight monitor will flash regularly (or occasionally) whenever your blinker lights are on, thereby warning you of a defect in your directional light circuit.

Construction details

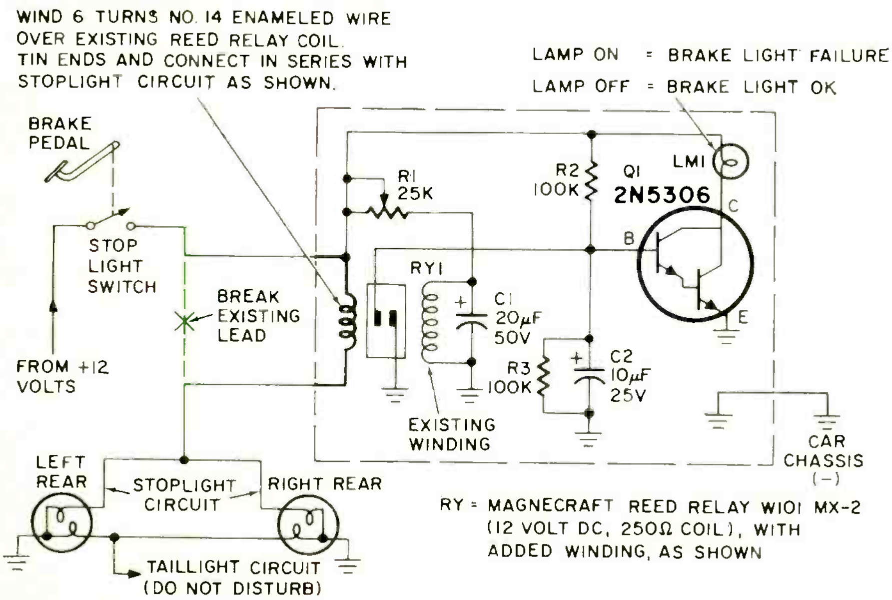
The unit is housed in a 4" x 2⅛" x 1⅝" aluminum miniature case. The failure indicator lamp is mounted on one face of the U-shaped channel, and the barrier terminal strip is mounted on the rear face. The left-most terminal goes to positive 12 volts through the brake light switch. The center terminal goes to the stop lights, and the third terminal goes to chassis ground. All electronic components are mounted on one side of a 2" x 3½" piece of perf board. Flea clips are used for ease of assembly as shown on the accompanying illustration. The perf board is held in place by two ¾" screws which go through a half-inch spacer that keeps the board a proper distance from the chassis to prevent shorts.

Calibration procedure

Circuit sensitivity is adjusted only once. Step on the brakelight pedal so that the stop lights go on and simultaneously adjust potentiometer R1 from full resistance (lamp ON) until the reed relay just closes and the indicator lamp goes off. To simulate lamp failure, reach into the trunk, unplug one stoplight assembly from the frame of the car and keep it from touching the metal body of the car. Now, when you step on the brake pedal again, the indicator light will go on after one second, signalling that the lamp circuit is not operating properly. If the indicator does not go on, increase R1 slightly until LM1 just goes on. Then re-insert the lamp assembly previously removed. Pump the brake pedal once again. This time the warning lamp should not go on, indicating that all is ok. For proper operation of the monitor it is necessary that the fields of both windings *aid* each other. If it is not possible to calibrate the monitor by adjusting the potentiometer over its full range, simply reverse the lead connection to the 6-turn winding so as to reverse the direction of its magnetic field. This will solve your problems and proper adjustment will then be possible. **R-E**

PARTS LIST

R1—potentiometer, 25,000 ohms (Mallory MTC 253L4 or equal)
R2, R3—100,000 ohms, ½ watt, 10%
C1—20 μF, 50 volts (Sprague TE 1305 or equal)
C2—10 μF, 25 volts (Sprague TE 1204 or equal)
Q1—2N5306 (GE or equal)
RY—12 volts dc, 250-ohm coil reed relay (Magnacraft W101 MX-2 or equal)
LM1—pilot lamp assembly, 12 volts, 100 ma (IDI B2990D1 or equal)
Case—4" x 2⅛" x 1⅝" (Premium PMC 1002 or equal)
3-termainal barrier terminal strips (2)
2 x 3½ perf board
½-inch spacers (2)
Miscellaneous hardware



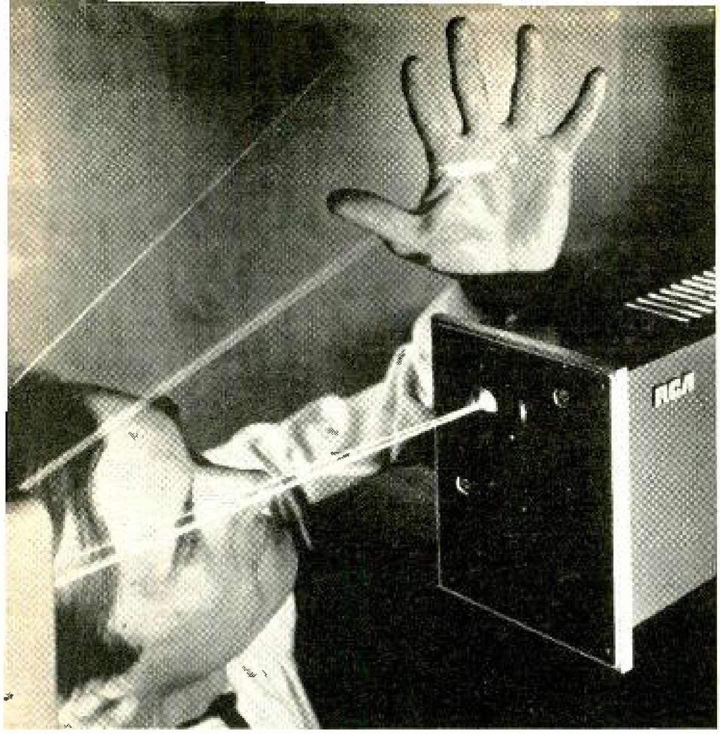


Photo courtesy RCA Princeton Labs

Basic laser experiment

by U.S. BUREAU OF RADIOLOGICAL HEALTH

Reflection of light is explored with the aid of the laser

Explanation:

Light and the manner in which it is reflected are of prime importance in geometrical optics. There are two types of reflection: (1) diffuse reflection, in which light striking a rough surface is randomly scattered in many directions, and (2) specular (i.e. mirror-like) reflection, in which the incident light is reflected from a smooth surface in accordance with the law of reflection (i.e., the angle of incidence equals the angle of reflection, as shown in Fig. 1). As discussed in most physics

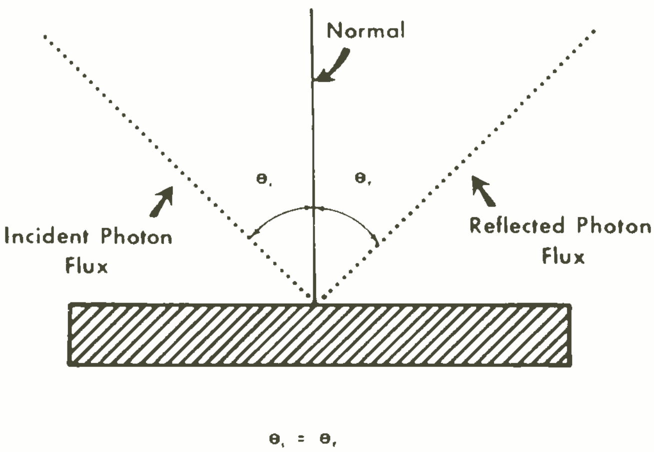


Fig. 1 LAW OF REFLECTION

texts, the behavior of light at an interface between two media is governed by both the law of reflection and the law of refraction.

Materials:

- Laser
- Display tank and display fluid
- Support for tank
- Mirror on pivot mount
- White paper
- Protractor

Experimental procedure:

Arrange the experiment as shown in Fig. 2 with the display tank near the laser and a mirror on a pivot mount arranged to reflect the beam back into the tank. Note that near the mirror the reflected beam has approximately the same intensity as the incident beam. You might, however, see a loss of intensity as the incident and reflected beams traverse the fluid. This is due to scattering of the beam by the fluid molecules, the process which makes the beam visible from the side.

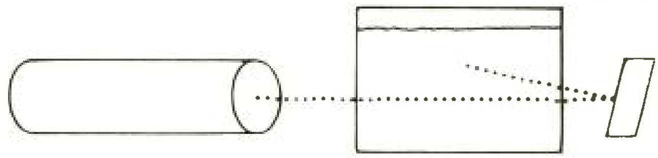


Fig. 2

SPECULAR AND DIFFUSE REFLECTION SETUP

Hold a piece of white paper in front of the mirror. The light will now be diffusely reflected and no beam will be seen re-entering the display tank. The point at which the light strikes the paper will be visible through a wide angle, because of this diffuse reflection. When the paper is removed, the reflected beam will again be visible in the display tank. The point at which the laser beam strikes the mirror will not be readily apparent from the side since the light is being specularly reflected. Whatever light is seen from the side is caused by diffuse reflection from small random mirror imperfections and to scattering of dust on the mirror surface.

The second part of this experiment illustrates the Law of Reflection which shows that the angle of reflection always equals the angle of incidence. Arrange the apparatus as shown

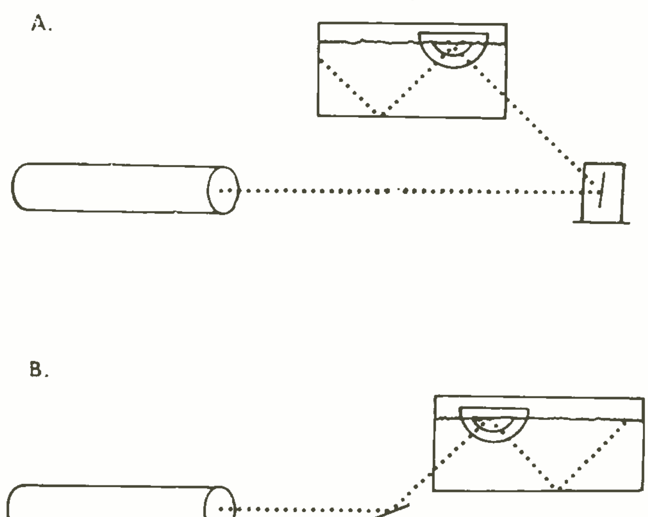
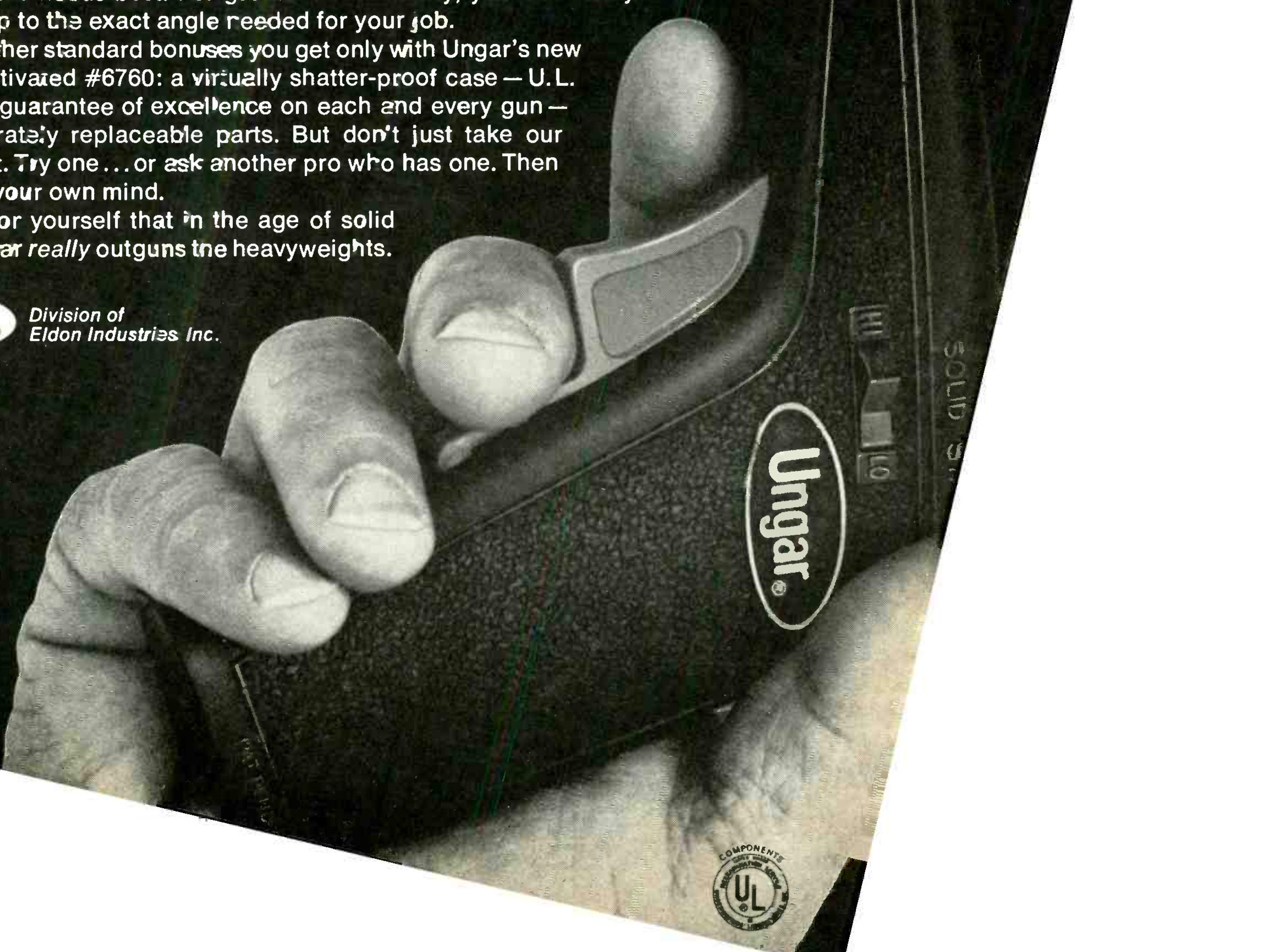


Fig. 3

in Fig. 3-a or Fig. 3-b so the laser beam enters the tank and is reflected off the upper surface of the display fluid. Using the surface of the fluid as a reference, measure the angles of incidence and reflection with a protractor. Now change the angle of incidence and measure angles again. At some angle termed the critical angle, the light will not be reflected. **R-E**

Circle 15 on reader service card ➤



Ungar

R-E's SERVICE CLINIC

vertical sweep wrap-up

Vertical sync, fake sync, leakage can all mess up the vertical hold

By JACK DARR
SERVICE EDITOR

HERE'S THE FINAL SECTION TO OUR REVIEW of vertical sweep circuits. Combined with the earlier Service Clinics you have a complete wrapup.

Vertical sync

In the first part, we mentioned sync troubles. In this circuit, the vertical sync is fed to the bottom end of the saw-former capacitor, the .039 μF, as a negative-going pulse. It is then fed on through the .1-μF coupling capacitor to the grid of the output tube. If the VERTICAL HOLD control is properly set, the oscillator will be running just a little bit *below* the correct frequency, and the sync pulses will cause the oscillator to "fire" at exactly the right time.

The most important thing about the vertical sync is its *amplitude*. The sync pulses must be high enough to fire the oscillator or you'll have a condition of weak-sync-lock, jitter, etc. This kind of problem is usually caused by a weak sync-separator tube, low dc voltages on that stage and leaky vertical integrators.

"Fake-Weak-Sync" problems

In some cases you'll see what looks for all the world like weak sync. In fact, the vertical lock will be pretty bad, although you'll see the characteristic jerk or snap of the picture as the blanking-bar rolls past the bottom of the screen. This can be (and often is!) due to misadjusted vertical height and linearity controls!

If they are set so the raster is considerably overscanned, they will cause flattening of the oscillator waveform, at the point where it should be sharply peaked (where the sync fires it). The waveform won't approach the firing point as rapidly as it should. The sync can then make it fire early, or late, and the whole thing looks like poor sync. You can cause this condition deliberately by overscanning the raster and checking the vertical hold action. For best sync, set the controls so the raster is overscanned by not more than half an inch at the top and bottom.

Other troubles

A slight leakage through the 0.1-μF coupling capacitor also causes a similar symptom. If this leakage gets worse, it flattens the peak of the waveform and causes foldover at the bottom of the screen. (Since the beam sweeps from top to bottom of the screen, remember that the *top* of the waveform represents the *bottom* of the TV screen!)

The best way to make sure that there is, or isn't, sync trouble: is to kill the vertical oscillator by pulling the tube, grounding a grid, etc. Then check the sync amplitude at the sync-injection

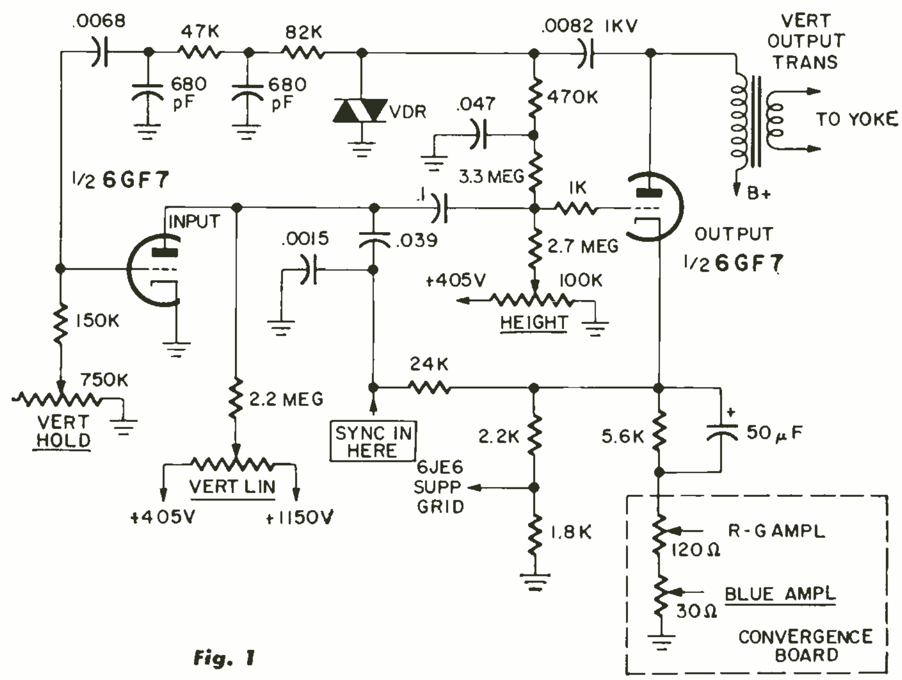


Fig. 1

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

If you're really stuck, write us. We'll do our best to help you. Don't forget to enclose a stamped, self-addressed envelope. Write: Service Editor, Radio-Electronics, 200 Park Ave. South, New York 10003.

point. Watch for two things; loss of amplitude, and any sign of video in the vertical sync. The last can be due to incorrect operating point in the sync-separator, a defective integrator, etc. It will cause vertical jitter, due to the varying voltages of the video. Vertical sync should always be very "clean."

Oddball troubles

In color sets you can get some very odd vertical troubles due to the many uses we make of the vertical stage. As you can see in Fig. 1, we are taking off a dc voltage of about +30 volts, from the 1800-ohm resistor in the cathode. This is fed to the suppressor grid of the horizontal output tube to prevent snivets on uhf. It has nothing to do with the vertical output stage; it's just a handy source of 30 volts dc. However, if the 6JE6 tube has a bad internal short, the 1800-ohm resistor burns up and all of a sudden we've got vertical output troubles.

Actually, because of the peculiarities of this circuit, this won't kill the vertical sweep completely as you'd expect with that cathode open. It does not open completely. You always have a parallel path to ground through the convergence board! Instead of losing all the sweep, you lose about half of the height. People get very flatheaded and nothing you can do will help in the vertical controls.

When you run into this kind of problem check the cathode circuit of the output stage. One key clue is the cathode voltage. Because of the higher resistance now present, this will be well above normal, usually from 75 to 100% more. If either the 2200- or 1800-ohm resistors open you'll have the 5600-ohm resistor and those two small controls left in the dc path to ground. This increased resistance raises the cathode voltage and the increased negative bias on the grid cuts the gain of the stage. (Positive voltage on cathode is the same as the negative voltage on grid)

If that 50-μF electrolytic capacitor across the 5600-ohm resistor opens you'll see very little effect in the vertical size and linearity, but your vertical convergence will go way off. This is a coupling capacitor, feeding convergence waveforms to the convergence board.

If the 50-μF capacitor shorts, you'll upset the total resistance in the cathode circuit. All you'll have left in the higher-resistance branch will be those two little controls on the convergence board, usually about 100 ohms or so. The bias voltage will drop and the picture will usually stretch at the top beyond range of the controls. Once again, a simple resistance test from output cathode to ground will catch this.

Broken wires in the cable from chassis to convergence board; wires in this cable pinched under clamps or shorted to ground; open controls on the convergence board—all can affect your vertical output stage and sweep. If you find mysterious cases of vertical troubles, don't forget to check out that cathode circuit of the vertical ouptut tube!

As a word of comfort before we go, the majority of your troubles will be easy ones—bad tubes (or transistors) leaky capacitors, burnt resistors, and so on. As long as you *know* how the thing works and how they hooked it up this time, you'll be ok. Parts-values will be changed between this and others, of course, but the purpose will still be the same.

NO COLOR, NO PICTURE

The picture on a Zenith color set looks very funny. When I turn the color control off, I get no picture at all! I'm just starting in color, and I've never seen this one before!—D. A., Babbitt, Minn.

The "picture" in a color set is made up of *two* parts; the color and the video. Color signals are applied to the grids of the CRT, video signals to the cathodes. In this case you have obviously lost the video signal completely!

Check the video output amplifier. More likely cause, check the video driver transistor. Incidentally, if you find one of these with a *negative* black and white picture and some really odd colors, this transistor is probably in its socket *backward*!

TRANSISTOR COLLECTOR CONNECTIONS

I've got a silly one! I replaced a bad output transistor on a little import set, and now it won't work. I can't read any collector voltage on the transistor case; got plenty on the supply lead! No smoke, just no sound at all.—R.Q., Waco, Texas.

Oh, ho, ho! You have just been zonked by the same thing I was, not too long ago! This is a bolt-on transistor, right? And, the original had a lot of insulating goop, under the transistor, and all over the screws, right? Well, when they say "insulating", they aren't kidding!

Take out the mounting screw that makes the collector connection. Clean off ALL of that insulating goop, and then put a small outside-star lock-washer under the screw-head. Tighten it, and then take a resistance reading between the supply lead and the transistor case. I did, and with the first hookup, I had the biggest fattest *open circuit* you ever saw! Screw was tight, too.

HEAT-UP DISTORTION

I've got a stereo amplifier that distorts badly after it's been on for about 5 minutes. I replaced some of the output transistors, and I've checked the heat-sinks to make sure that none of the leads were shorted. What could cause this?—L. J., Little Neck, N.Y.

Two things. This could be an overheating condition that slowly warms up the junctions of the power transistors and starts them clipping, etc. This could be due to insufficient heat-sink area, allowing the cases to get too hot, and the junctions with them.

There are two possible cures for this. One is larger heat sinks, or the addition of a small forced-air fan to the chassis. Might try spraying coolant on the transistors after the distortion shows up, and see if this clears it up. If so, better cooling *would* be the answer.

For the other, I would recommend replacing all of the original transistors. Use either matched pairs of high-quality replacement transistors, or "complementary-pairs" such as HEP-245 and HEP-246 (pnp/npn) if your amplifier has a complementary-symmetry output circuit.

In some cases, you might get rid of this trouble by using a slightly *larger* transistor. Many of the import amplifiers use the small "cigarette-filter-sized" output transistors, and run them hot enough to smoke! Replacement transistors such as those mentioned above, and others, have larger cases, and can be run at a higher level of power dissipation without overheating.

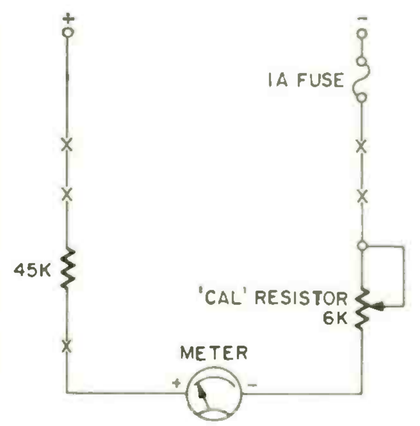
Check all transistors for leakage. This can cause a severe distortion, and overheating makes it get worse.

VOM TESTING

I blew the 1-ampere fuse in my vom. After I replaced it, I can't get any readings on the dc volts, ac volts or mA ranges. The ohmmeter works, though.—C. F., Tracy, Calif.

If the ohmmeter still works you didn't blow the meter movement. That's good! Evidently the protective diodes saved it.

You can trace the paths from the input jacks to the meter. From the fact that several functions are out, you have an open circuit in one that is common to them all. Set the meter on



the 2.5-volt dc scale and disconnect the meter itself. (To keep from slamming the 50-μA movement with the other ohmmeter battery.)

Now follow the circuit path from the + jack to the + terminal of the meter, as shown in the diagram. The "X's" indicate switch contacts. If this path has continuity, follow the − circuit. It's somewhere in there.

The most likely possibility is arcing at one of the switch contacts, when the surge that blew the 1-ampere fuse happened. This can make them open, from dirt or carbonization. In most cases, they can be cleaned up and made to work again.

MATV PROBLEMS

I'm overhauling an old installation of a MATV system and I've got troubles. There are 4 antennas feeding a mixer-amplifier, which in turn feeds a broadband line amplifier. This feeds a distribution system with 13 outlets. Stations are 30 miles away.

The pictures aren't good enough; quite a bit of snow, and weak sync, etc. How can I get a better picture?—S.K., Washington, Pa.

"Signal-trace" it, and I mean that quite literally. Get a field-strength meter and start at the antennas. At this distance you should have something like 400 to 500 μV minimum on each antenna. Now check the signal level at the mixer-amplifier output. Should be quite a bit more, around 1.000 μV per channel.

Then check the signal at the input of the line-amplifier. You shouldn't have too much loss unless your interconnecting cable is over 100 feet long. (If you don't have any signal, check the coax!) Output of this amplifier, too, should be *at least* 1,000 μV per channel, or more.

Your distribution system should not introduce too much loss. From your description, I'd say that your TV's are probably running on about 50 to 75 μV! There should be a minimum of 500 μV, or more, at the antenna terminals of each set.

Somewhere in there, you've got a weak tube or tubes, or a faulty dc power supply, or something like that. The signal-levels will tell you where.

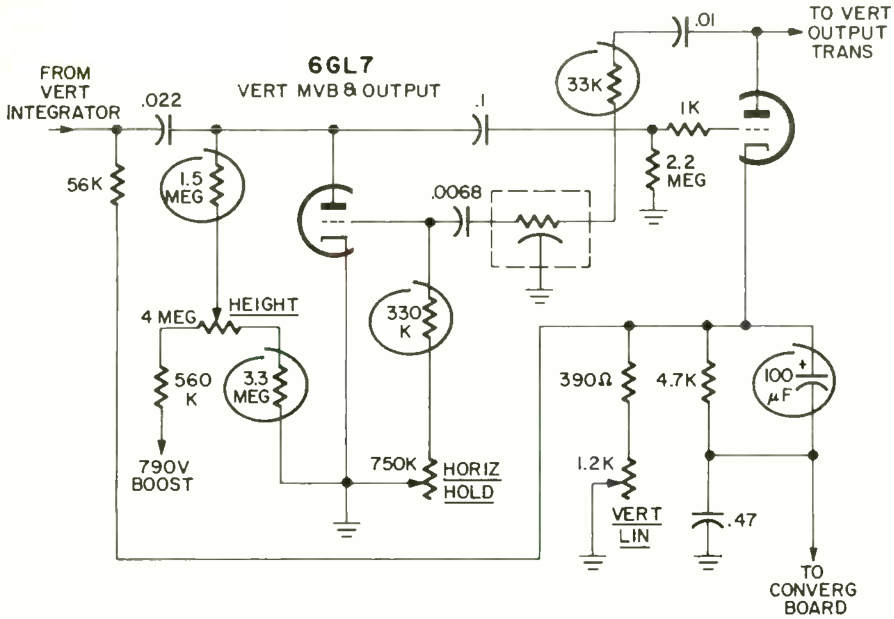
REPLACEMENT TRANSISTORS

I need a pair of replacement transistors for a Craig Pioneer Series 8 tapeplayer. In fact, I need two matched pairs. Originals are 2SB473. Found one listing in a replacement guide, but the cases aren't the same, so they won't work.—G.P., Hephzibah, Ga.

The 2SB473 transistors are in the "TO-66" case, which looks like a small TO-3. Sylvania's "ECG-131-MP" is a matched pair that will replace these. You can also mount the "flat-case" HEP-243, etc. transistors in the TO-66 mounts, if you can locate one in a germanium type, which the originals are.

SLOW WARMUP VERTICAL

I have a real headache in the vertical oscillator of a Zenith 27KC20 chassis. When it's turned on, the picture rolls.



The vertical hold control must be turned full ccw to stop it. After about an hour, the picture rolls again, and the vertical hold control must be turned cw from time to time to stop it. Holds after that, but vertical lock very weak.

I've replaced the integrators, and checked all capacitors. What do I do now?—N. M., Carbondale, Pa.

You've done the right things so far; you just stopped a little quick. This type of "*very slow*-drift" trouble shows up mostly in *resistors*. If one of the resistors is changing value with heat, it will cause this kind of problem. Not necessarily "internal" heating, as in a plate-load resistor carrying current (this shows up in about 10 to 15 minutes) but simply "radiated" heat from other parts: resistors, tubes, etc., and conduction through the chassis.

Quick-check. Turn the set on (this is when the trouble is worst, it seems). Let it warm up, and start rolling, then stop the picture with the hold control. Now, carefully spray circuit-coolant onto each resistor in the circuit, one at a time. The most likely ones are circled in the figure.

Whenever you hit one that makes a *change* in the rolling, etc., replace it. Don't stop though! If you find one bad one, there can always be another one just like it. Check them all to save being called back on the job.

Incidentally, although it doesn't look as if it would, high power-factor or loss of capacitance, or both, in that 100-μF electrolytic in the vertical output *cathode circuit* can also upset vertical sync, especially the "lock" action! Disconnect it and check it, to make sure.

NEGATIVE PIX

I've been working on an RCA CTC7 color chassis. The picture looks very odd. Colors look funny and unnatural, though they're close. I've checked the video stages all the way through, and they seem to be ok. Don't have a scope. All voltages close to normal. I'm lost! What next?—D.Y., Cleveland, Ohio.

Analyze! One thing that can make colors "look funny" is either a loss of the "video (Y component) or a negative picture. Try a few calibrated-eyeball tests. Turn the color completely *off*. See if the B/W picture is either very weak (or even completely missing) or *negative*.

If so, go and check the video detector diode. Since the video stages seem to be ok, this is now the most likely suspect. If the diode is leaky or almost open, it can cause just such symptoms.

PS: While you're there, check the video output, cathode capacitor on the contrast control.

SUBSTITUTE FOR 12R5

The vertical output tube, a 12R5, went out in this GE 14P1215 portable TV. Not having one, I replaced it with a 12CA5. Worked for about 5 minutes, then a white band showed on the bottom of the screen. Not too long after this the 12CA5 went out. All adjustments react normally, but the tube won't hold up. —A.E., Neptune City, N.J.

This looks like one of those cases of "same basing but different characteristics" in the two tubes. The 12CA5 has a maximum power dissipation of only 1.5 watt, the 12R5, 4.5 watts. Normal cathode current in this set is about 40 mA, which is above the rating of the 12CA5. I'd advise using an exact replacement tube.

If you still get the foldover, check the 12R5 coupling capacitor. This causes most of this type of trouble. **R-E**

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 on page 91 and circle the numbers of the new products on which you would like further information. Detach and mail the postage-paid card.

ACCESSORIES FOR PC BOARDS, *Circuit Zaps.* Line of copper component patterns and accessories for custom and prototype production of PC boards. *Circuit Zaps* available in four design groups. Each pattern is precision-etched on a 5-mil glass epoxy base material and backed with pressure-sensitive adhesive. The patterns are placed on either pre-

punched or unpunched circuit board in any desired schematic or component layout. Patterns offered include TO-type, with 3, 4, 6, 8, 10 and 12 leads; dual in-line with 14 and 16 leads; resistor/diode types, conductor pads and both single and dual component pads.—**International Rectifier Corp.,** El Segundo, Calif. 90245.

Circle 31 on reader service card

MIDGET RATCHET KIT, *model 6320,* consists of screwdriver handle *CMH-3,* miniature stainless-steel 20-tooth ratchet with 18° working arc, and extention shaft plus 17 snap-in drive tips. Twelve Allen Hex type adapters, two slotted-

head adapters, two Phillips head adapters and one ¼" square drive adapter. Brochure detailing several kits of tools and adapters in the line also available. *Kit 6320* is $12.95.—**Chapman Mfg. Co.,** Route 17 at Sawmill Rd., Durham, Conn. 06422.

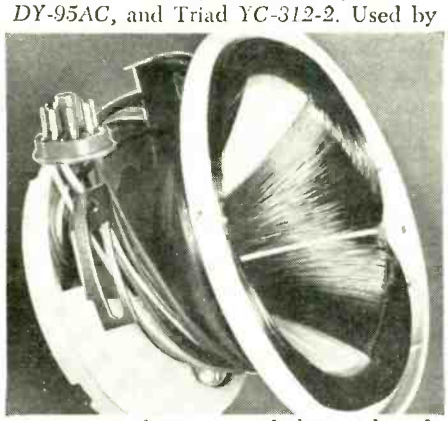
Circle 32 on reader service card

SOLDER GUN, *Ersa Sprint.* Lightweight 150-watt soldering iron and gun for home or shop, designed for fast spot soldering. Ten-second warmup. Normal operating power consumption drops to approximately 80 watts for continuous

soldering. Tip requires no filing or shaping during its life. Weighs less than 7 oz. including line cord. $8.55 plus cost of tip.—**Ersa of Germany, Edsyn, Inc.,** 15954 Arminta St., Van Nuys, Calif. 91406.

Circle 33 on reader service card

COLOR TV YOKE, *P/N OCY-95,* fits 19", 23" and 25" rectangular color picture tubes. One yoke replaces 35 original-equipment models. Exact replacement for Merit *MDF-145C,* T/M *Y-109,* Stancor *DY-95AC,* and Triad *YC-312-2.* Used by



major manufacturers including Admiral, Dumont, Emerson, Motorola, RCA, Sears, etc. Complete schematic and all manufacturer's part numbers enclosed with each unit. $58.95.—**Oneida Electronic Mfg. Co.,** 843 N. Cottage St., Meadville, Pa. 16335.

Circle 34 on reader service card

FET VOM, *model 3000 kit.* Input impedance, 10 megohms ± 1%; frequency response 20 Hz to 20 kHz ± 1% on 0.3V scale, 20 Hz to 100 Hz ± 1% or better on all scales. Ranges: ac-dc volts, 300 mV to 1000 volts full scale. 10 ohm center scale to 10 megohms center scale. IC operational amplifier. Two stage transistor current regulator and Zener diode on ohms. $74.95.—**Delta Products, Inc.,** Box 1147, Grand Junction, Colo. 81501.

Circle 35 on reader service card

MAINTENANCE IN A CASE, *model 990,* features portable test equipment for electrical, temperature and rotational speed measurements. Seven devices and accessories include the vom, the handheld tachometer/generator, temperature

probe, ac ammeter adapter, line separater, leads, shunt, with a black plastic carrying case. Weight is 10 lbs. with equipment. $221.00.—**Triplett Corp.,** Bluffton, Ohio 45817.

Circle 36 on reader service card

FIELD STRENGTH METER, *model 747,* solid-state portable, capable of measuring the signal levels of all uhf, vhf and FM channels, plus mid-band and super band CATV channels. Designed for the professional TV system installer, the meter tunes from 50 to 260 MHz and 470 to 890 MHz. Accuracy is ±1.75 dB; 50 to 260 MHz; and ±3 dB, 470 to 890 MHz over temperature range from

20°F to 100°F. Provides simultaneous readings in microvolts and dBmV, with a range from 10 μV (−30 dBmV) to 1.0 volts (+60 dBmV). Fully integrated with single input for entire spectrum and single knob tuning. $450.00.—**Jerrold Electronics,** 401 Walnut St., Philadelphia, Pa. 19105.

Circle 37 on reader service card

IC AMPLIFIER AND PREAMP, *Sinclair IC-12,* on one silicon monolithic clip. Mid-

band distortion 0.1% with harmonic distortion at any frequency and power less than

1% up to rated output. Output, 6 watts rms at 8 ohms. Integral heat sink is an aluminum extrusion. *IC-12* comes with a printed circuit board pre-drilled for the required external components. $12.00.—**Audionics, Inc.**, 8600 S.E. Sandy Blvd., Portland, Ore. 97220.

Circle 38 on reader service card

COLOR TV CONTROLS. Replacement controls of major TV manufacturers are packaged and indexed in standard inventory boxes containing 10 controls. The color controls are for convergence, audio, focus, color sensitivity, agc delay, brightness, vertical and horizontal centering, horizontal frequency and vertical linearity. Vest-pocket cross-reference for all TV manufacturers included with each box. Each manufacturer has own separate sets of boxes of controls.—**Workman Electronic Products, Inc.**, Box 3828, Sarasota, Fla. 33578.

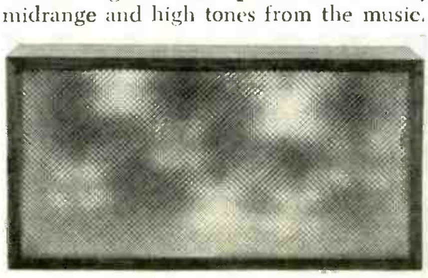
Circle 39 on reader service card

SPEAKER SYSTEMS, *Decorator Series.* Three variations of the *Model 6*. Hand-designed speakers feature grilles of either walnut *(6DW)*, antique brass screen *(6DS)*, or antique brass mesh *(6DM)*.

The *Model 6 will still be available with* its conventional grille. From $144.95 to $156.95, depending on region of U.S.—**KLH Research & Development Corp.**, 30 Cross St., Cambridge, Mass. 02139.

Circle 40 on reader service card

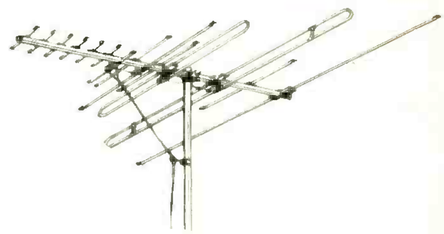
COLOR ORGAN, *MACH III*, coordinates sound, light and motion. Turns on colored lights with presence of low, midrange and high tones from the music.



Contains three sets of red, green and blue lights. With only one set of lights on at a time, the light will change from one set to the next to give motion. The rate of shift is determined by the major beat of the music. Organ operates from transistor radios to professional sound equipment without adjustments for music volume. Unit enclosed in walnut-stained cabinet, solid-state construction. $79.95.—**REO Enterprises**, Box 1292, Escondido, Calif. 92025.

Circle 41 on reader service card

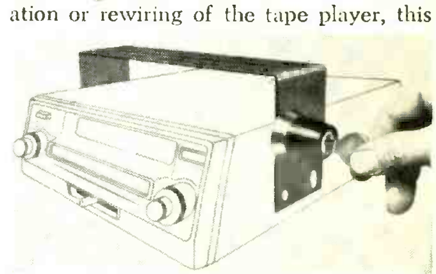
ANTENNA, *"Brand X" model AC-802* For black-and-white or color uhf-vhf reception and FM, this antenna has a 96" boom. Made of aluminum elements, high



impact insulators and crush-proof mast clamp, the antenna features snap-out elements. $26.95.—**Antenna Corp. of America**, Box 865, Burlington, Iowa 52601.

Circle 42 on reader service card

CAR STEREO SECURITY LOCK, *model 21*, locks auto stereo unit to its mounting bracket. Installed without alteration or rewiring of the tape player, this



lock features a tumbler mechanism and special key for owner. Recommended for use also with auto and truck CB radios, and mobile telephones. $5.95.—**Bolen Industries, Inc.**, 789 Main St., Hackensack, N.J. 07601.

Circle 43 on reader service card

RADIO CONVERTERS, *models KC4007, 4008, 4009, 4010*. Build an integrated circuit solid-state converter to use with standard AM radio for vhf reception from 118–164 MHz reception. Kit

KC4007 for aircraft bands; *KC4008* picks up ham, government, space research bands; *KC4009* for marine, mobile, fire and police frequencies; *KC4010* for police and fire communications. $10.95 each.—

RCA IC Kits, 415 So. 5th St., Harrison, N. J. 07029.

Circle 44 on reader service card

BURGULAR/FIRE ALARM, *"Sound-Off"*. Security alarm operates on 4 D-size batteries. Dual horns are triggered when illegal entry is attempted. Doubles as fire alarm: excessive heat in the room automatically sets off alarm. Time-delay

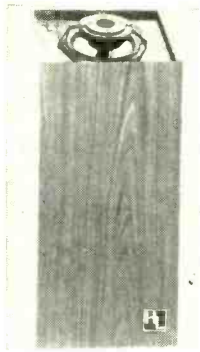
switch allows option for immediate reaction or 15 second delay time for turning off unit on entering. Transistorized, solid-state circuitry. Additional entrances can be protected by adding switches in series with the original device. $44.95.—**Airflyte Electronics Co., Security Div.**, 56 Hook Rd., Bayonne, N.J. 07002.

Circle 45 on reader service card

METAL CASSETTE, designed to eliminate static charge problems developed in

plastic cassettes. Metal housing contains two machined bearing tape guides for exact tape location and extremely low internal friction. Temperature and humidity do not affect the stability of this metal cassette. Fits any standard cassette machine. Comes in 60-, 90-, or 120-minute lengths. Five-screw design permits easy tape editing. Price begins at $3.95.—**Auricord Div., Scovill**, 35-41 29th St., Long Island City, N.Y. 11106.

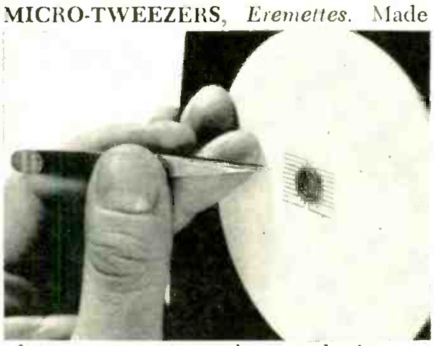
Circle 46 on reader service card



LOUDSPEAKER SYSTEM, *Hegeman 1*. Point source loudspeaker system uses a hemispherical radiation pattern to produce balance between direct and reverberant sound. The two-way coaxially mounted units each have one 6½" full-range high compliance driver and one 1" domed super-tweeter. Overall frequency response is 30 Hz to 20 kHz; power handling capacity is 25 watts. 5 kHz crossover frequency, and 8 ohms impedance. Floor standing speakers are teak vinyl finished with black grille. $180.00 per pair.—**Hegeman Labs., Inc.**, Glen Ridge, N.J.

Circle 47 on reader service card

MICRO-TWEEZERS, *Eremettes*. Made



of non-magnetic stainless steel, this assortment of twelve micro-tweezers is designed for use in microelectronic assembly, to be used under a microscope. Overall length of 3½" maximum. Available with heavy or fine tips, smooth or serrated, Teflon or Kynar coated. Free 160 page catalog available.—**Techni-Tool, Inc.**, 1216 Arch St., Philadelphia, Pa. 19107.

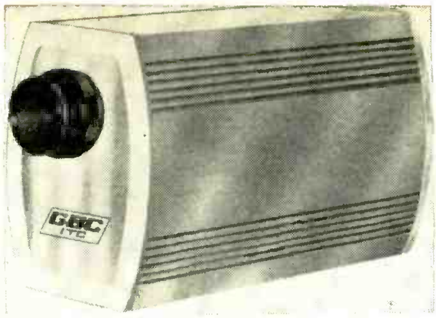
Circle 48 on reader service card

CCTV CAMERA, *model CTC-4000*. Solid-state fully automatic vidicon closed circuit TV camera. The only operating control is lens focus. The *CTC-4000* features silicon transistor circuitry, an FET input providing high signal-to-noise ratio, even under poor lighting conditions. Resolution exceeds 450 TV lines. Camera automatically compensates for scene illumination over a range of 4000 to 1. Pro-

Circle 65 on reader service card

Circle 66 on reader service card

duces usable pictures with as little as 2 footcandles of light and can handle up to



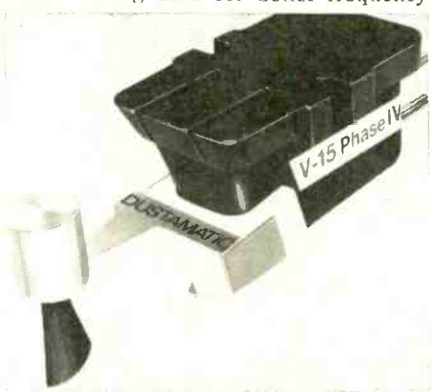
60,000 lux. An F1.6 16mm lens included. $199.50.—**GBC Closed Circuit TV Corp.**, 74 Fifth Ave., New York, N.Y. 10011.

Circle 49 on reader service card

SPRAY CLEANER, *MASK-N-GLAS, #840.* Antistatic glass and plastic aerosol spray for cleaning picture tubes, television masks, glass and portable cabinets. Non-abrasive, non-staining, leaves antistatic coating that will not attract dust or dirt. Each 8-oz. can includes lint-free polishing cloth.—**Chemtronics, Inc.**, 1260 Ralph Ave., B'klyn., N.Y. 11236.

Circle 50 on reader service card

MAGNETIC PICKUPS, *V-15 Phase IV-AT and V-15 Phase IV-ATE.* Cartridge models with replaceable floating stylus with *Dustamatic* brush. Stylus system redesigned from earlier model to provide lower moving mass for better frequency



response and greater tracking ability. Stylus size for IV-AT is .0007 Spherical, for the IV-ATE .0004 x .0007 Elliptical. The tracking force for both is 3±1 grams. Nominal frequency response 20 to 18,000 Hz.—**Pickering & Co., Inc.**, 101 Sunnyside Blvd., Plainview, L.I., N.Y. 11803.

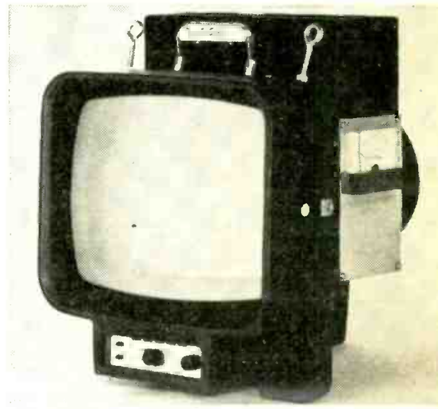
Circle 51 on reader service card

PRINTED CIRCUIT, *model 650.* This photo-etch printed circuit kit enables beginners and professionals to prepare PC's. Kit uses photosensitive method with no need for darkroom. Materials are included to make negatives from magazine circuits. *Kit 650* contains two photosensitized 3" x 4" copper clad boards, a photographic test negative and an ultraviolet light source. An exposure glass, clamps, developer, etchant, trays, resist

remover, drill and complete instructions are also included. $10.80.—**Injectorall Electronics Corp.**, 4 North Road, Great Neck, N.Y. 11024.

Circle 52 on reader service card

PORTABLE TEST COLOR JIG, *model P-1* comes completely assembled, weighs 30 lbs., matches all U.S. color sets. Basic test instrument without color bar, meters,



or special circuitry. Color picture tube and necessary cables included. $149.95.—**Pix-O-Scope, Inc.**, 3311 Shelby St., Indianapolis, Ind. 46227. **R-E**

Circle 53 on reader service card

NEW LITERATURE

All booklets catalogs, charts, data sheets and other literature listed here with a Reader's Service number are free for the asking. Turn to the Reader Service Card on page 91 and circle the numbers of the items you want. Then detach and mail the card. No postage required!

HAND TOOLS CATALOG. *No. 72.* lists complete line of screwdrivers, nutdrivers, scratch awls, 4-in-1 tools, window anti-rattlers. All items are illustrated.—**Upson Tools, Inc.**, Box 4750, 99 Ling Rd., Rochester, N.Y. 14612.

Circle 54 on reader service card

WARNING DEVICE BROCHURE, describes *DeltAlert, DeltaHorn,* and *Super DeltAlert Package,* all warning signal security systems. Includes ideas on effective use of the devices, diagram of the circuit operation, circuit description, and complete specifications.—**Delta Products, Inc.**, P.O. Box 1147, Grand Junction, Colo. 81501.

Circle 55 on reader service card

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

PARTS AND KITS CATALOG, *No. 212, Spring/Summer 1971.* Buying guide of electronic parts, accessories and kits for the builder, hobbyist, fix-it man, or experimenter. 116 pages of tubes, transistors, cables, tools, connectors, wire, plugs, adapters, antennas and test equipment.—**Allied Radio Shack**, 2725 W. 7th St., Fort Worth, Texas 76107. **R-E**

USE A VOM AS A DWELL METER

If you have a vom, you have most of the essentials of an automobile tune-up dwell meter. The construction of a simple probe, which is plugged into the meter, will allow the vom to be used to check the dwell angle at which the distributor points are set.

As shown in Fig. 1, the probe consists of a set of test leads, a capacitor, and a silicon rectifier. Observe the polarities shown.

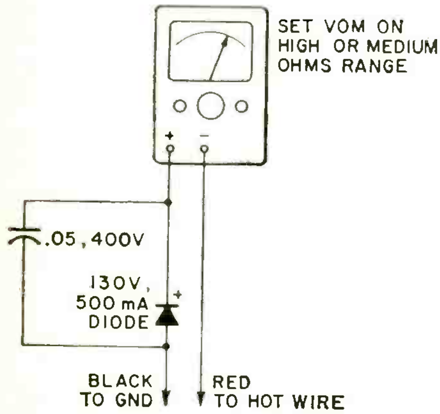
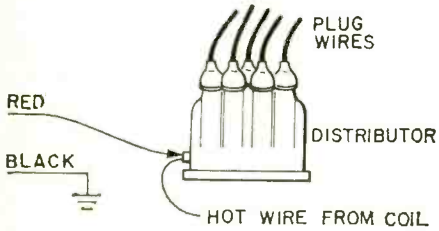


FIG. 1

Obtain the proper dwell angle for your car from the owner's manual, or other tune-up literature. Switch the vom to the high- or medium-resistance range and short the black and red test leads together. Set the OHMS ZERO knob for full scale, just as in normal use. Connect the leads to the car as shown in Fig. 2.



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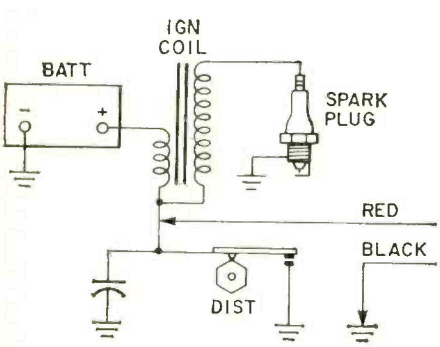

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FIG. 2

Observe the proper polarity, the the coil to the distributor, and the red lead to the hot wire going from black lead to the ground. If your car has a positive ground polarity, reverse the leads. Start the engine and

VOM AS DWELL METER

No. of cylinders	Dwell angle	Multiply by	Desired meter reading
4	From tune-up manual	0.0111	
6		0.0166	
8		0.0221	
	EXAMPLE:		
8	30°	0.0221	0.66

read the decimal equivalent of the cam dwell angle on a 1-, 10-, 100, etc., scale of the vom. Multiply the car's correct dwell angle by a constant determined by the number of cylinders (see table) to determine the proper reading for your car. Set the points until the proper reading is established.

The use of a dwell meter for tune-up allows longer use of a set of points and gives a much better tune-up than the feeler gage method of setting points. Since points erode in a rough pattern a feeler gage cannot establish a precise dimension on used points. The dwell meter, however, checks the percentages of electrical opened and closed time in order to accurately determine the dwell angle.
—*Henry Zave* **R-E**

COMING NEXT MONTH

SEPTEMBER 1971

- **TV Antenna Accessories**
  Bob Middleton takes a close look at all those extras—hardware, booster amplifiers, lead-in, etc.—that you must use every time you install an antenna.

- **All About Resistors**
  Complete picture of what resistors are, how they work, and the electronic rules that apply to them. As a device they may seem simple—but they aren't.

- **Build R-E's Waveform Generator**
  You get both square-waves and pulses from this solid-state instrument. Use two small circuit boards to make it work.

- **Sweep Alignment Techniques**
  Jack Darr tells how to use sweep alignment to SERVICE tv sets. As he so carefully details—this is vital to good color reception.

PLUS:

Home Appliance Electronics
Kwik-Fix Troubleshooting Charts
Designing Solid-State Amplifiers
IC Potpourri

EXPERIMENTERS DREAM BENCH
(continued from page 45)

former (Variac), which can vary the ac line voltage from zero to 10 or 15 percent above normal, thus converting almost any other kind of power supply into a variable one. Great for getting odd voltages from transformers, testing amplifiers, transmitters, etc., at reduced voltage. Such a transformer is especially convenient if it has its own switch, fuse, ac voltmeter, and a couple of outlets as well as a pair of (insulated!) binding posts. Such transformers are widely available for $10 or so on the surplus market. That's the cheapest way to get one. Mount it on a board or panel, in a box or old chassis or what-have-you, and that's a start. Refinements, like a meter, can come later. At the other end of the expenditure range is a complete thing like the Superior Electric UC1MB "Voltbox": 0-140 volts to 10 amps, line/load metering with built-in meter, receptacles, binding posts, fuse, linecord and all that for $122.50. Others are available at in-between prices.

Next most important are variable dc power supplies. For occasional powering of simple small-signal transistor circuits in the breadboard stage, something as inexpensive as the Radio Shack Micronta 22-008 ($7.95) will work as a battery-eliminator, giving a choice of four voltages at moderate currents. Several low-priced variable supplies are available, some regulated, some not. Check out the Eico 1020 (kit, $25.95; wired, $34.95), Heathkit IP-18 (kit, $21.95), or the Heath EUW-17 (wired only, $32). A somewhat more elaborate unit, which provides regulated, low-ripple dc from 0 to 30 volts, 0 to 500 mA, and separate voltmeter and ammeter, is Eico's 1032 (wired, $59.95). RCA makes a useful series of variable, regulated and metered supplies. The WP-700A delivers 0-20 volts at up to 200 mA, for $48. A dual unit, consisting on two WP-700A's in the same housing, with independent meters, output terminals and controls, is called the WP-702A and costs $87. Two other supplies in the series provide higher maximum output voltages or currents, each for about $60.

Heath's top-of-the-line is an excellent buy in a sophisticated power supply for solid-state experimental work. It's the IP-27 (kit, $79.95)/IPW-27 (wired, $125.) It provides voltages from 0.5 to 50 at currents from zero to 1.5 amperes, current-limiting overload protection, metering, a floating output (either negative or positive output terminal (or neither) can be grounded to the chassis. If you still do enough tube work to make it worth while, the Heathkit IP-17 provides 0 to 400 volts dc at up to 125 mA, 6- and 12-volt ac filament (heater) supplies, and up to 100 volts negative to ground at low current as a bias supply.

You will probably also want a 12-volt high-current source as a battery eliminator and charger. There are many to choose from: Heath, Eico, Electro, Lafayette, Schafer, Terado, and others. Battery eliminators generally have better filtering (less ripple and lower output impedance), but chargers often can supply a higher maximum current.

An inverter (to supply 115 Vac from a 12-Vdc source) can be useful in field or mobile work. Prices range from about $30 in kit form for a 200-W unit to over $600 (for a 1-kW unit, factory wired).

The inventory of instruments can go on and on almost forever. There's an enormous variety of commercial instruments and gadgets available, and if you add to that the more specialized instruments that you can design for yourself or build from magazine articles, there's hardly any limit. The whole thing is a little like trying to define infinity by thinking of a very large number: no matter how large a number I call out, you can always call out a bigger one. If we've missed a particular favorite of yours, it's not because it isn't useful; it may be that we just didn't think of it, or decided to draw our limits in such a way that that instrument was excluded. We've emphasized instruments for the serious hobbyist/experimenter, as contrasted with instruments for the service bench or research lab, or instruments for highly specialized applications. If your work takes you frequently into automotive areas, you will want a timing light, dwell meter, ignition analyzer or a complete engine analyzer. If you're heavily into remote-controlled models, you'll want to tip your assortment of instruments in that direction. And so on. But the range of equipment outlined here should enable you to do almost anything in electronics. Often a particular instrument merely makes a certain job easier, faster or more accurate; it's not that the job is impossible without it. For example, an oscilloscope is an almost indispensable tool; but an intermodulation distortion meter is not—you can do a very good job of measuring IM with an audio oscillator and a scope, but not as conveniently. That's something to think about before you blow a lot of bucks on a very specialized device that you won't need very often.

The same goes to some extent for your parts and tool assortment. If radio control is very much your bag, you will want a supply of resonant-reed relays; otherwise, you'd be smarter not to tie up the money, putting it instead into a larger quantity or variety of something more universally useful, like resistors, capacitors or transistors.

A final suggestion: It isn't necessary for everyone to own everything. A certain amount of sharing and cooperation can greatly cut down the cost of electronics as a hobby. To see expensive instruments collecting dust on a shelf is as frustrating as to see long lines of large, costly automobiles jammed end to end, each carrying only a driver. That's a very inefficient, uneconomical use of resources. Two or more of you could certainly get together and own some of the more exotic instruments in common, taking joint responsibility for their care. This could make it possible for you to have access to equipment that you alone couldn't afford to own. **R-E**

USING THE RIGHT PROBE
(continued from page 25)

that i.f. signals can be displayed on a scope screen. Note that a comparatively small value of coupling capacitance is used (270 pF). This capacitance, along with the 120,000-ohm shunt resistor, provides a short time constant. Thus, the detected signal can rise and fall rapidly, as required to reproduce the main outline of a composite video i.f. signal. The 220,000-ohm series resistor is basically an isolating resistor, and does not usually have a calibrating function.

Note in Fig. 8 that a demodulator probe has a low value of input capacitance (2.25 pF in this example). This is helpful when checking in tuned circuits, to avoid disturbing the alignment. Because of the diode characteristics, the input resistance of a demodulator probe is considerably lower than might be supposed at first glance. The input resistance also decreases as the frequency increases. At 500 kHz, the input resistance of the demodulator probe is 25,000 ohms, but at 200 MHz the input resistance has dropped to 2,500 ohms. At TV i.f.'s, the probe input resistance is approximately 10,000 ohms, which will load the circuits appreciably. Therefore, *a demodulator probe is generally used only to check for the presence or absence of signal.* In turn, a demodulator probe from one scope can be used satisfactorily with another scope.

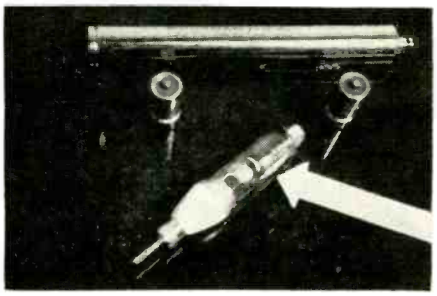


FIG. 9—SIGNAL-INJECTOR PROBE disassembled to show the electronics. Arrow points to blocking oscillator.

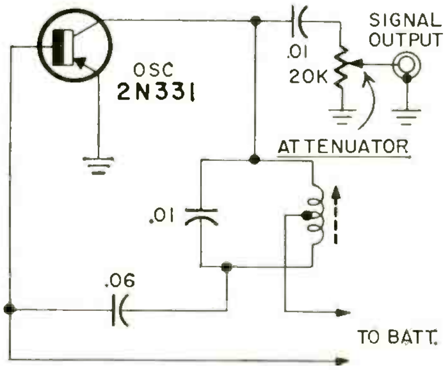


FIG. 10—BLOCKING OSCILLATOR is used in some signal-injector probes.

Next, let us briefly consider current probes for scopes. The clamp-around current probe illustrated in Fig. 5 can be used to good advantage with a service-type scope. To check a horizontal-deflection current waveform, we merely connect the probe to a scope, and clamp the probe around the "low side" lead to the horizontal-deflection coils. In turn, the sawtooth deflection waveform is displayed on the scope screen, without any disconnection and reconnection of the circuit.

A signal-injection probe (also called a signal-tracing probe) is basically an oscillator that operates at about 2 kHz. Since a complex waveform is generated, strong harmonics are also produced, which are useful for quick checks of radio and TV circuitry. Fig. 9 shows the internal appearance of this type of probe, and a typical circuit arrangement is depicted in Fig. 10. This is a blocking-oscillator, which develops a pulse-type output (some others use a transistor multivibrator to develop a similar output signal). Some injection probes provide a simple attenuator, and others apply the full output in all tests. The chief advantage of this device is its compactness and convenience.

When applied in audio circuits, the fundamental output from the injector probe is utilized, and normally produces a 2-kHz note from the speaker(s). In rf or i.f. circuits, the appropriate harmonic is picked off by the tuned circuits. A 2-kHz note is normally heard from the speaker, and in TV receivers we will normally see random "blobs" or noise streaks on the picture-tube screen. By working back step-by-step in a defective receiver, a defective stage that "kills" the signal can be quickly located. Then, more sophisticated instruments can be used to pinpoint the defective part.

The chief probe used with a vom is the high-voltage dc type of probe, as mentioned previously. The only difference between the vtvm and vom types is in the value of the multiplier resistor. For example, a vom probe may have a multiplier resistance of 600 megohms, while a vtvm probe may have a resistance of 1090 megohms. As an example, let us consider a probe used to measure up to 30,000 volts on the 3-volt range of a 20,000 ohms-per-volt vom. Ohm's law is applied as follows:

Since a 20,000 ohms-per-volt vom is being used, its input resistance on the 3-volt range is 60,000 ohms; the multiplier resistance is operative in series with this resistance, as shown in Fig. 11. Therefore, to obtain a 3-volt drop across the 60,000 ohms of input resistance, the multiplier in the probe must have a value of 599,820.000 ohms. In other words, we will use a 600-megohm multiplier resistor in this example. Note that the 3-volt scale will employ a multiplying factor of 10,000. It is not practical to use some other scale on the vom, because an awkward multiplying factor would be involved.

Another type of probe used with a vom is called an rf diode probe. A typical arrangement employs the circuit shown in Fig. 12. In this example, the probe is suitable for operation at frequencies from 100 kHz to 100 MHz. It can be used to measure up to 20 volts rms. When used with the 50-μA current range of specified vom's, rms sine-wave voltage values are indicated directly on the 50-volt dc scale of the vom. Typical applications include checking the flatness of output from a signal generator, making relative field-strength measurements with a dipole antenna, and neutralizing CB transmitters.

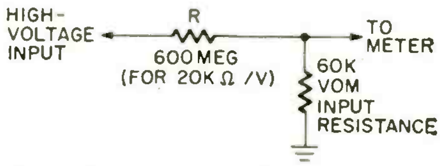


FIG. 11—HIGH-VOLTAGE DC PROBE circuit normally follows this arrangement.

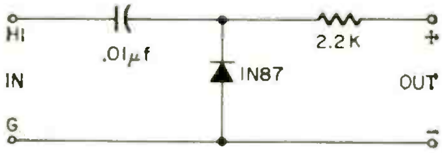


FIG. 12—RF DIODE PROBE is used at high frequencies. This one can measure up to 20 volts rms.

Conclusion

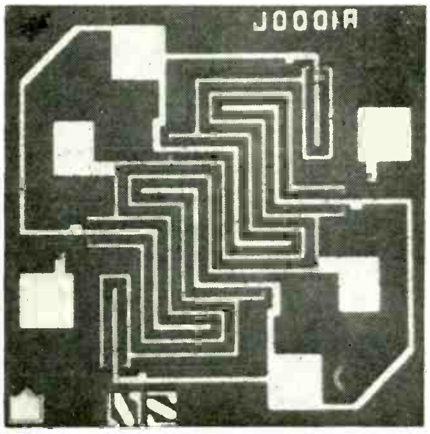
Probes add greatly to the usefulness of electrical and electronic test equipment. The chief precautions are to use the correct type of probe with each instrument, and to select a probe that processes the signal as required. For example, we cannot signal-trace an i.f. amplifier with a scope unless a demodulator probe is used. If we make a mistake and try to use a low-capacitance probe, we will obtain no display on the scope screen. Similarly, if we try to use an rf probe instead of a demodulator probe, we will obtain no display.

The best way to become familiar with meter and scope probes is to work with them. Most meters and scopes are accompanied by instruction manuals, which give application data. After the apprentice discovers what a full set of probes can do for him at the bench, he will wonder how he ever managed to get by without this vital aid to modern troubleshooting. **R-E**

NEW SEMICONDUCTORS

N-CHANNEL DUAL FET'S

A series of monolithic, N-Channel, dual FET's have been introduced by National Semiconductor. The



FM3954 series eliminates the difficulties in matching and testing individual transistors by integrating both on one chip. The geometries of both FET's are intertwined to obtain a perfect match. The geometry of the pair is illustrated in the photo of the chip.

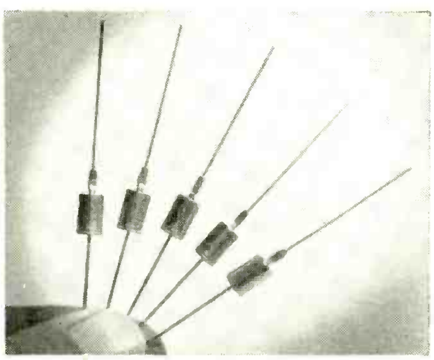
Features of the series include very close tracking regardless of bias point, from 50 μA to 500 μA, low leakage of 100 pA and high gain of 1,000 μmhos. Applications for these IC's include use in balanced modulators and mixers, analog switching, multiplexers, agc, rf applications up to 30 MHz and in high slew-rate op amps.

Types, matching specs and prices (100-999 lots) are:

Type	100-999	Matching Specs	
FM3954A	$10.30	5mV	5μV/°C
FM3954	6.00	5mV	10μV/°C
FM3955A	4.70	5mV	15μV/°C
FM3955	3.50	10mV	25μV/°C
FM3956	2.40	15mV	50μV/°C
FM3957	2.30	20mV	75μV/°C
FM3958	1.80	25mV	100μV/°C

NEW TRANSIENT SUPPRESSORS

A new series of TransZorb transient voltage suppressors—capable of dissipating 1500 watts of peak power —is available in voltages from 6.8V to 200V (types 1N5629 through 1N5665A). All dissipate 1500 watts of peak power for 1 msec with instantaneous clamping capability thereby affording complete protection to systems incorporating IC's and other voltage-sensitive components.



The General Semiconductor Industries TransZorb can actually dissipate over 10,000 watts of peak power for up to 10 μsec and protects whenever and wherever large voltage transients threaten—as in airborne applications, rural or remote areas subject to induced lightning, or in mobile electronic units.

All TranZorbs are available in the standard DO-13 axial-lead package. Priced from $3.25 each in 100-piece quantities, the units are available in small quantities from stock. **R-E**

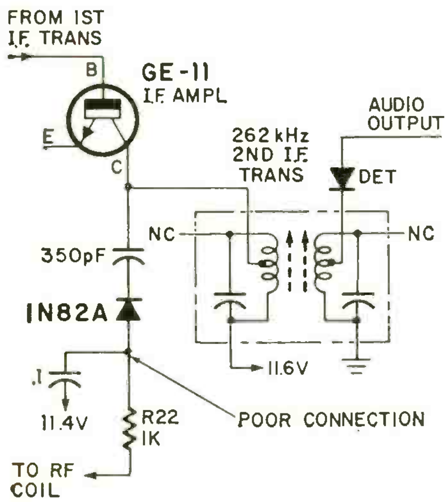
"Poor Chester! After he built this solar-cell radio he discovered the sun can't get through the atmosphere to operate it."

TECHNOTES

NOISY FORD 6TBB RADIO

A Ford model 6TBB radio came in with no reception on the lower end of the band; only two local stations could be heard on the high end of the dial. Loud hissing and frying noises were heard across the band.

Sometimes by twisting the circuit board the radio would act normal. The converter transistor tested OK. We still felt the converter transistor was at fault since no stations could



be heard on the low end of the dial. A new GE-11 transistor was installed and the auto radio played perfectly all day.

The very next morning the frying and hissing condition started up again. Bypass and filter capacitors tested OK. With the radio in the noisy condition, we started at the rf section and began to resolder all connections on the circuit board. The radio began to play when we reached the first i.f. amplifier section. We found a poor connection at one end of R22, a 1000-ohm resistor.—*David Held*

NO BRIGHTNESS—EMERSON COLOR SETS

The probable cause of this complaint is a leaky capacitor (C110) in the tuner. When leaky, this 27-pF capacitor lowers the 140-volt supply applied to the second video amplifier and the brightness control, thereby affecting the operation of the third video amplifier.

Replace C110. It is located at the top side of the tuner between the mixer output terminal and ground.—*Emerson Field Service Bulletin*

ZENITH 20Z1C37 TV CHASSIS

When a Zenith TV Chassis 20Z1C37 has a picture that is narrow and blooms, with the high-voltage regulator inoperative, replace the defective 6HS5 regulator and open 220-ohm cathode resistor. Re-check high voltage.—*B. J. Brown*

CTC 31-A, LOW BRIGHTNESS

An RCA CTC 31-A color chassis had very low brightness. In fact only the outline of the TV program could be seen. The brightness control had no effect on the picture.

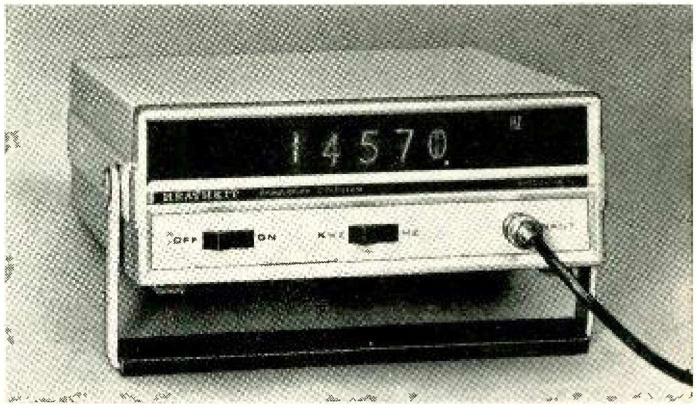
The high voltage measured 25kV. This led us to believe the trouble was in the video section since there was plenty of high voltage to the CRT. Replacing the 12HG7 video tube did not clear up the dark picture. Voltages on the video amplifier were higher than normal.

A resistance check indicated an open contrast control. Undoubtedly, the video amplifier had arced over and burned a spot in the 100-ohm contrast control. Since then, three other color chassis have come in with the same trouble. In some cases, the contrast control can be rotated to the extreme end of rotation and a bright picture can be seen. Be sure and replace both tube and contrast control.—*Homer Davidson.* **R-E**

EQUIPMENT REPORT

Heathkit Frequency Counter, Model IB-101

For manufacturer's literature, circle No. 18 on Reader Service Card.



A FREQUENCY COUNTER, WITH A DIGITAL readout is one of those dream instruments most of us have often wished we could own, but could rarely afford. This kit solves the cost problem—it goes for $199, and does just about everything the more expensive units will.

There's a 5-digit readout with Hz and kHz ranges. Overrange indicators warn you when you're off scale. An automatic decimal locator puts the decimal point where in belongs. A low-drift, temperature-compensated 1-MHz crystal time base oscillator provides a stable time base.

A frequency counter has almost unlimited uses, depending only upon the imagination of the user. For example, we were aligning the multiplex circuits of an FM stereo tuner and wanted to set the SCA trap to precisely 67 kHz. We had an audio oscillator whose calibration was accurate within four or five kHz. It was a simple matter to connect the counter across the oscillator output and adjust for precisely 67 kHz. A similar procedure was used to make sure that the 38-kHz multiplex oscillator was exactly on frequency.

We also used the unit to help service a small broadcast receiver. The problem with this receiver was that the oscillator would not track properly across the broadcast band. We decided to connect the counter to the i.f. output (with a BC station tuned in). This immediately spotted the trouble. Instead of being 455 kHz as it was supposed to be, the i.f. was actually only 400 kHz. We connected an i.f. signal generator and realigned the i.f. to 455 kHz. We then readjusted the oscillator circuit. The tracking problem had disappeared. A final use we found for the frequency counter was in checking the calibration of a communications receiver. This receiver used a double-conversion system with crystal-controlled high-frequency oscillator and a very precise tunable second oscillator as the main tuning control. This precision oscillator tunes from 6 to 6.5 MHz, regardless of the shortwave band to which the receiver is tuned.

The frequency calibration is supposed to be accurate within a quarter of a kHz. However, dial calibration was off as much as 1.5 kHz at some points. We connected the frequency counter to the oscillator output and tuned the precision oscillator thru its full tuning range, nothing the discrepancies between the dial reading and the frequency counter readout for every kHz marker on the receiver dial. Then, by careful adjustment of the slotted end plates on the oscillator tuning capacitor, it was a simple matter to get the dial readings to coincide with the frequency counter readings.

We're sure readers will find many other uses for this handy unit and we would like to hear about the ways you use frequency counters. **R-E**

SPECIFICATIONS

Frequency Range:
1 Hz to >15MHz

Accuracy:
±1 count ±time base stability

Gate Times: 1 msec or 1 sec; with automatic reset

INPUT CHARACTERISTICS

Sensitivity:
1 Hz to 1 MHz—<100 mV rms
1 MHz to 15 MHz—<250 mV rms
after 30 minutes operation

Trigger Level: automatic

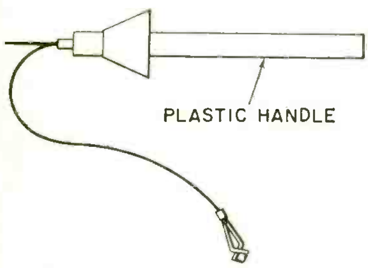
Impedance:
1 megohm shunted by <20 pF

Maximum Input:
ac only, 200 V rms; (dc coupled) 1 Hz to 1 kHz. (Derate 48 V per frequency decade.)

TRY THIS ONE

CONSTRUCTING AND USING A SHORTING STICK

Most electronics technicians realize the limitations of such protective devices as interlocks and bleeder resistors. In some circuits a blown fuse can keep the circuit's capacitors from discharging properly. TV picture tubes can hold lethal charge. Transformers with bifiler windings and pulse-forming networks can also shock or kill the unwary technician.



The shorting stick is a safety device, which if used properly, can eliminate much of the danger. It is easily constructed from materials found in most shops. Bend one end of a stiff wire, such as brazing rod or other heavy gauge wire, into a "hook" shape. Cement or thread the other end into a hole, drilled in the end of a plastic rod. Lucite, Plexiglas, polystyrene, polyvinyl chloride, or some other high-dielectric strength material can be used for the handle. Wood *is not* a desirable material for this application. Cement a plastic disk or funnel on the front of the handle to act as a flash shield. Solder a length of multistrand insulated copper wire with an attached alligator or battery clip onto the metal rod next to the handle.

The shorting stick is used by grounding the clip and discharging the components, with the power off. Never take a chance, always discharge a circuit before touching it.—*Kenneth R. Scott*

CHEAP BATTERY CONNECTORS

Cut the case from your exhausted 9-volt batteries with a hacksaw and salvage the terminal strips. They make excellent no-cost battery clips for future transistor projects.—*Armas Kajander*

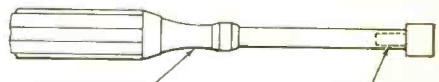
RAWL PLUGS HOLD TOOL HANDLES TIGHT

The annoyance of small files and other tools continually loosening and dropping out of their handles, is eliminated by removing the file and driving a Rawl plug into the hole in the handle, then forcing the file tang back into the plug.

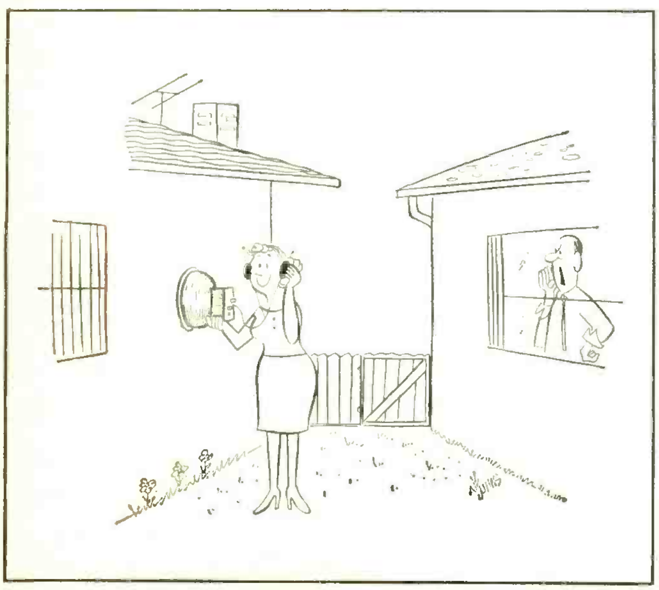
This expands the plug and the lead in it will make a tight fit and hold the file firmly, indefinitely.—*H. Muller*

MAGNET HELPS START HEX-HEAD SCREWS

A very useful tool for starting hex-head screws on TV and radio chassis is made from a worn-out nut-



driver by installing a small round magnet in the hollow shank.—*Miller Service* **R-E**



"HELEN"

NOTEWORTHY CIRCUIT

NOVEL STEREO RECORDING METER

A number of interesting circuits and features are included in the design of a high-quality stereo tape recorder described in a construction article in *Wireless World* (London, England). One of these is the unusual metering circuit shown in Fig. 1. The circuit is designed so the meter reads the peak value of whichever of the two channels is greater at a given instant.

The recording preamplifiers (not shown) are designed for 0dB (25 mV or 250 mV) inputs from a mixer or other source having individual level controls so balanced signals are fed to the recorder. The incoming signals are fed to the ganged RECORD GAIN controls and then to the preamps and the metering circuit through a MONO-STEREO selector switch.

Two sections of a CA3052 IC amplify the 0-dB signal to 1 volt rms. The positive peaks of these signals are rectified and used to charge C1 to the peak positive value. The forward resistance of the diodes depends on the current level so the attack time—depending on the difference in amplitude of two successive peaks—has a minimum value of around 25 μsec. The decay time, around 2 seconds, is approximately equal to the product of R3 and the betas of Q1 and Q2. The two Zener-diode networks shunting the meter give it a logarithmic response as in Fig. 2. Sine-wave response of the meter is flat within ½ dB from 10 Hz to 10 MHz.

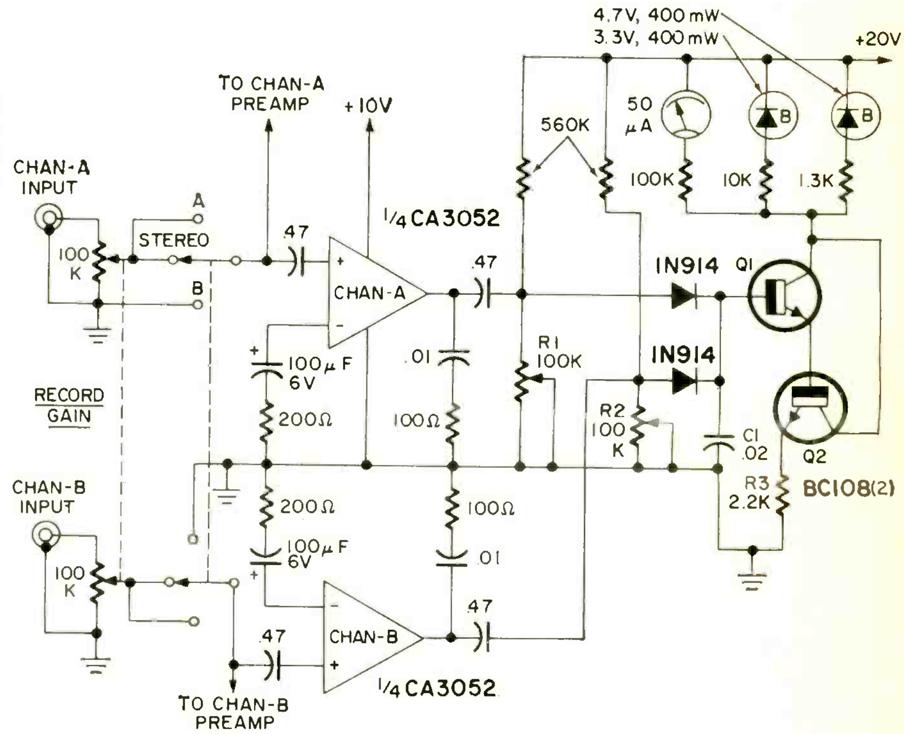


Fig. 1

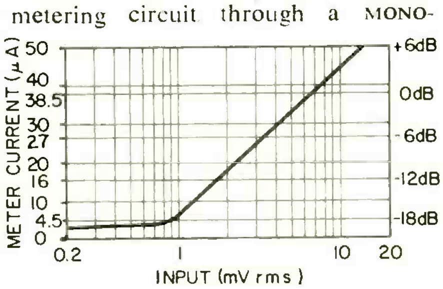


Fig. 2

To calibrate the meter, set R1 and R2 wipers to ground, feed in a signal and adjust R1 for a 2-μA reading and then adjust R2 to raise the reading to 3 μA.

Additional switch circuits (not shown) are included so the meter can be used to indicate bias and playback levels. **R-E**

USING THE TONE-BURST GENERATOR
(continued from page 35)

11. External timing

The switching of the gate may be synchronized with something other than the gated signal. This is easily done by feeding a timing signal into the SYNC INPUT jack on the rear panel. The INTERNAL-EXTERNAL SYNC selector switch on the rear panel must be switched to the EXTERNAL position. Input impedance will be about 5000 ohms.

This mode of operation is handy for gating signals that are random or sporadic in nature. The gating of a noise generator to create noise bursts is a good example.

The tone-burst generator can be used as a pulse generator by feeding dc into its input and triggering or gating externally. The pulse width of the output equals the on gate-time and the time between pulses equals the setting of the PERIOD control. The pulse amplitude and polarity are controlled by the dc voltage fed in.

12. Power-line transients

Controlled power line transients are useful when developing or testing line-noise filters, regulated power supplies, ac-dc converters, etc. Figure 14 shows how the tone-burst generator and a high-

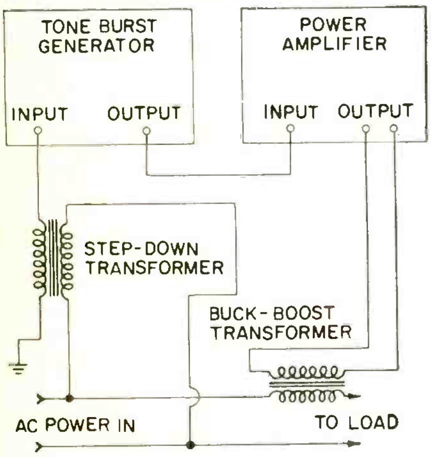


FIG. 14—CONTROLLED TRANSIENTS on power line can be developed by using tone-burst generator in conjunction with a high-power audio amplifier.

power amplifier are used to superimpose transients on the power line. Stepdown transformer T1 feeds burst generator input. The burst is amplified and fed to power line through buck-boost transformer T2. Transformer T2 may not be needed if the amplifier output is transformer coupled.

13. Single burst operation

For some uses, it may be desirable for the operator to initiate bursts on command. This is done by placing the PERIOD switch in the SINGLE-BURST position. Every time the RESET jack is grounded, a single burst will be initiated by the internal sync circuits. This grounding is best done with a hand-held, push-button switch connected to the RESET jack with a cable.

A positive pulse of at least 1 volt into the RESET jack will reset the tone-burst generator. This feature enables external equipment to control the burst-repetition rate. An example of such a use would be the generation of standard time ticks.

14. Standard time ticks

Standard time ticks are tone bursts of about 5 cycles of 400 Hz or 1 kHz audio every second. These are often used for time-reference marks on data recorders. Radio station WWV is a good source. However, the need may arise for time ticks of a different length, frequency or repetition rate than those available from WWV. The tone-burst generator can fill this need very nicely.

To generate time ticks with the burst generator, set the PERIOD control to SINGLE BURST. Into the RESET jack, feed in a reset pulse at the desired repetition rate. Feed the signal to be converted into ticks into the input. Use internal sync. The cycle count in the tick is controlled by the WIDTH controls. **NOTE:** The reset pulse just arms the circuits, so to speak. The signal to be gated actully starts the burst. In order to prevent a time jitter of the ticks, the reset pulse and the signal to be gated must come from the same frequency source.

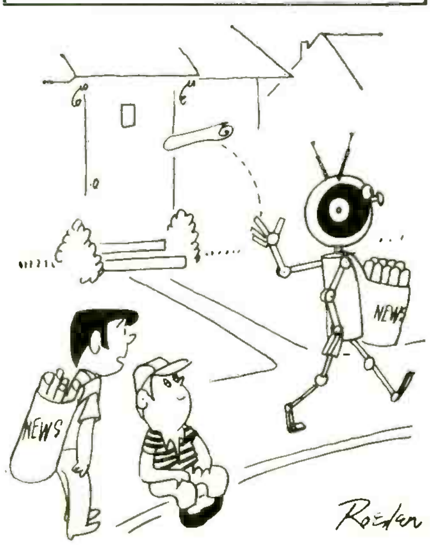
Slow repetition rates

Burst repetition rates of less than 1 burst per second is possible. This is done by placing the PERIOD control in the SINGLE BURST position. A positive pulse at the desired repetition rate is fed into the reset jack. The tone bursts generated will still be phase coherent because the gated signal itself switches the gate.

Summary

This article shows some of the many applications of the tone-burst generator. These are by no means the only things that can be done with this versatile instrument. As more people learn about them, their scope of application will greatly broaden. **R-E**

Another test instrument you'll want to build is a function generator. The complete article on this solid-state instruments appears in the October 1971 issue.



"I wish my dad would build one for me!"

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CONVERT any television to sensitive big-screen oscilloscope. Only minor changes required. No electronic experience necessary. Illustrated plans $2.00. **RELCO**-A25, Box 10563, Houston, Texas 77018

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BCD COUNTER KIT consisting of:
1—PC Board 12707
2—7476 IC's
2—Silicon diodes
1—Set of instructions

When assembled by enclosed instructions, this kit will count pulses from 0-9 in BCD. These boards can be connected in series to count as high as desired. Example, two will count to 99, three to 999. $6.95

ER900 TRIGGER DIODES. These biodirectional trigger diodes are one of the best and cheapest methods to trigger SCR's and triacs ..4/$1.00

LIGHT EMITTING DIODES (LED's)
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TRIACS

PRV	1A	10A	15A
100	.40	.70	1.00
200	.70	1.10	1.40
300	.90	1.35	1.80
400	1.10	1.60	2.20
500	1.50	2.00	2.60

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Similar to Raytheon 8754 with socket & data sheet $4.75

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PRV	3A	12A	30A
100	.09	.24	.40
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400	.16	.35	.90
600	.20	.50	1.10
800	.28	.70	1.40
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PRV		PRV	
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Silicon Control Rectifiers

PRV	3A	7A	20A	70A
50	.25	.28	.60	
100	.30	.38	.85	3.50
200	.50	.60	1.10	6.50
300	.60	.68	1.30	
400	.70	.75	1.50	9.50
500	.80	.85	1.70	
600	.90	1.20	1.90	11.00

TIS 43 General purpose Unijunctions $ .50
2N3819 General purpose N-Channel FET'S $ .45

Send for our latest catalog featuring Transistors and Rectifiers; 325 Elm St., Cambridge, Mass.

SOLID STATE SALES
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Somerville, Mass. 02143
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Circle 84 on reader service card

ADVERTISING INDEX

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NON-COMMERCIAL RATE (for individuals who want to buy or sell personal items) 60¢ per word . . . no minimum.

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28

(continued from page 40)

bolts, terminal lugs, plate caps, knob springs, and all of the many little things we need. (Don't spend a dollar's worth of time looking for a 2-cent part! Keep it where you can grab it.)

17. My pet gadget. A couple of precision resistors, say a 1.0 megohm and a 1,000 ohm, on a small terminal strip. Used for quick-checking of ohmmeter accuracy if you have doubts about a resistance reading!

18. A "record-player stand". Adjustable metal stand, with clamps, for holding any kind of record-changer for servicing.

Mechanical work

We do a surprising amount of "mechanical work"; sheet-metal work, carpentry, and so on! For this kind of work, I want a minimum set of power tools, to make things easier.

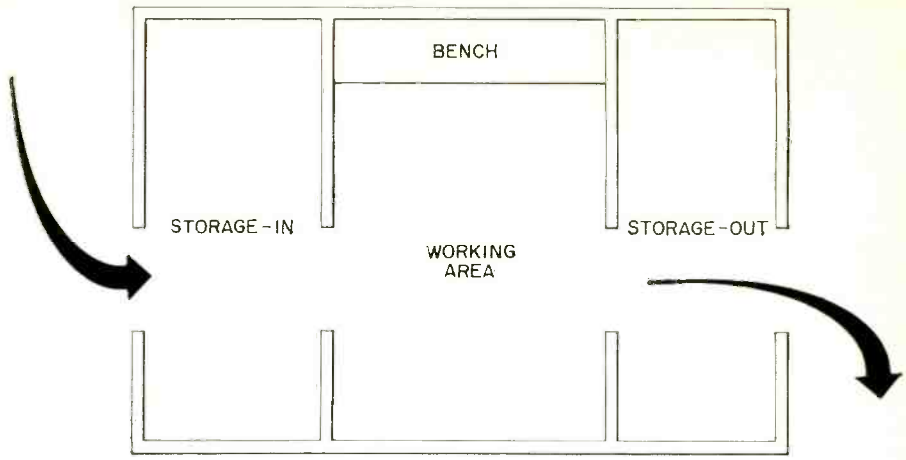
The most useful is a ¼-inch electric drill, preferably a variable-speed type. A full set of **GOOD** bits, up to ¼ inch by 16ths. A set of "masonry bits" for drilling holes in cement, brick and masonry walls. A set of "power woodbits" which beat the old-fashioned "hand-fired" brace and bit all hollow! Small grinding wheels, wire-brushes, and other things can also be powered by the drill.

For audio installation work, antenna work, and that kind of job, you will also need a medium-sized saber saw. These have fine and coarse blades for wood, etc, and can be used with hacksaw blades to cut tubing, metal angles, and anything like that, in a much shorter time.

For shop work, a stout vise is absolutely necessary. You've got to have something to hold things while you drill holes in them, saw off pieces, etc. You can clamp the drill, with the grinding-wheel accessory, in the vise, and use it to sharpen bits, screwdrivers, grind off parts, etc.

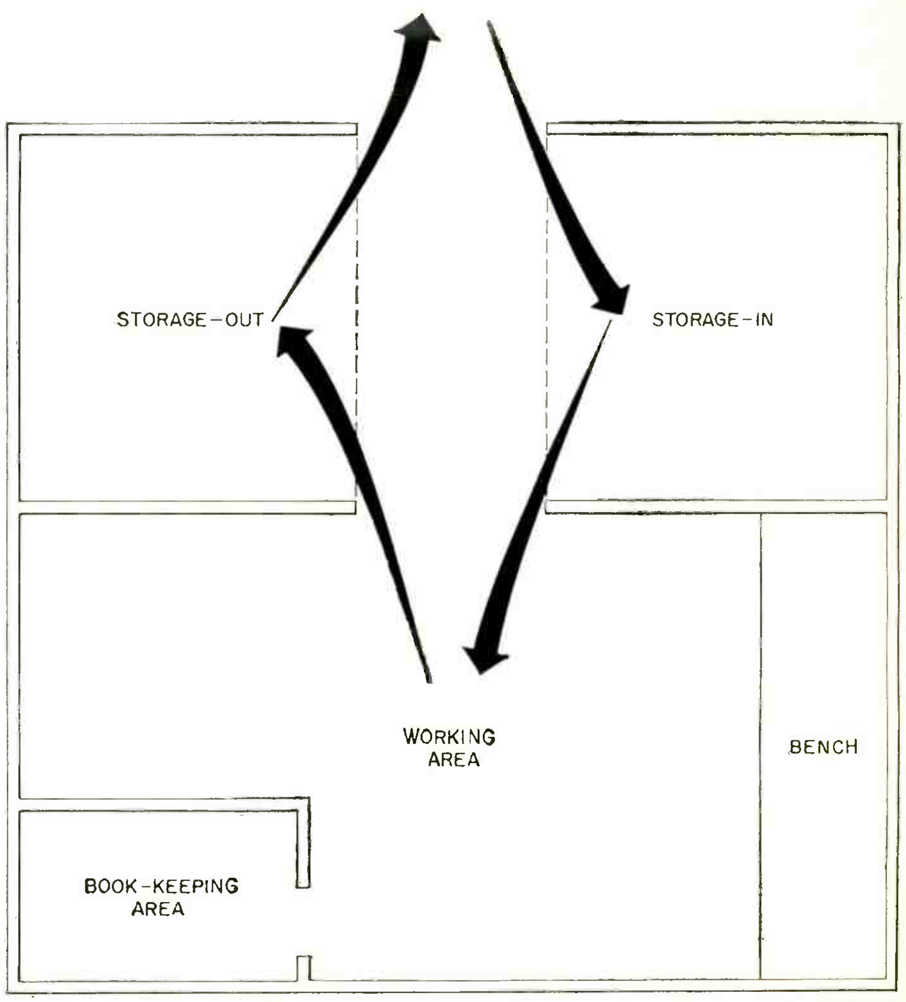
For big soldering jobs, one of the little propane torches is very useful. There are also small oxygen-propane torches which will do light welding, or even cutting!

For use with the power tools, and for other uses, I'll want a good 100-foot extension cord, with a trouble-light on the end, and a dual outlet. For safety, this should have a third-wire and a grounding plug; for prevention of shock while working on grounded towers, under houses, etc.



WORK FLOW ARRANGEMENT is the key to this shop's layout. Large arrows show work flow of new sets into storage area to work area and on to storage area for delivery.

ANOTHER APPROACH to work flow layout. Note one corner of the shop has been set aside for book-keeping purposes.



The shop

Now, I have gotten to the final, and perhaps the most important instrument in the bunch—the shop itself! I want a shop where the working-space is so arranged that it will let me work with the least expenditure of effort, and the least loss from wasted time. I can speak as an expert in this line, since I believe I have made all of the possible mistakes!

I have also had the opportunity to run some actual experiments, and make tests, in this area. From these. I have worked out some basic principles. You can adapt these to your own shop, and I believe they'll be of a lot of help; they certainly were to me.

Shop layout

The Ideal Service Shop is like those ideal capacitors we read about in the textbooks. No leakage, no inductance, just pure capacitance, and it, like the ideal capacitor, doesn't exist. We can try, though. The ideal shop would provide three major areas, to give a continuous, uninterrupted "work-flow".

The three major areas are "Storage-in", unfixed sets waiting for repair; "Working Area"; the shop itself, bench and parts storage, and "Storage-Out", finished work ready for delivery.

Next month we will conclude this article with a look at "white space," mobility of test gear and sets for repair, test equipment layout, bench width and other concluding points of interest. **R-E**

Circle 86 on reader service card

NEW BOOKS

CIRCUIT PROBLEMS AND SOLUTIONS, by Gerard Lippin. Hayden Book Co., 116 W. 14th St., New York, N.Y. 10011. In 3 softcover 6 x 9 in. volumes. Vol. 1, 190 pages, $3.95; Vol. 2, 126 pages, $3.95; Vol. 3, 92 pages, $3.55.

These reference texts are a course in electrical problem solving. Circuit theory and application format shows step-by-step solutions to specific problems. after reviewing a particular aspect of circuitry. *Volume I* on *Elementary Methods* covers ac and dc situations, from simple series circuits to series-parallel RLC circuits. *Volume 2, Network Theorems*, demonstrations how to apply such methods as delta to wye. and wye to delta transformation. Thevinen's Theorem, Norton's Theorem. loop currents, nodal analysis. superposition. and Millman's Theorem. *Volume 3, Transistor and Tube Circuits*, reviews transistor and tube constants, decibels, and tuned circuits and covers such topics as transistor and tube audio amplifiers. power amplifiers. and r.f. and i.f. amplifiers.

ELECTRONIC DESIGNER'S HANDBOOK, 2nd Edition, by T. K. Hemingway. Tab Books, Blue Ridge Summit, Pa. 17214. 294 pages, 5-⅝ x 8-⅝ in. Hardcover, $9.95.

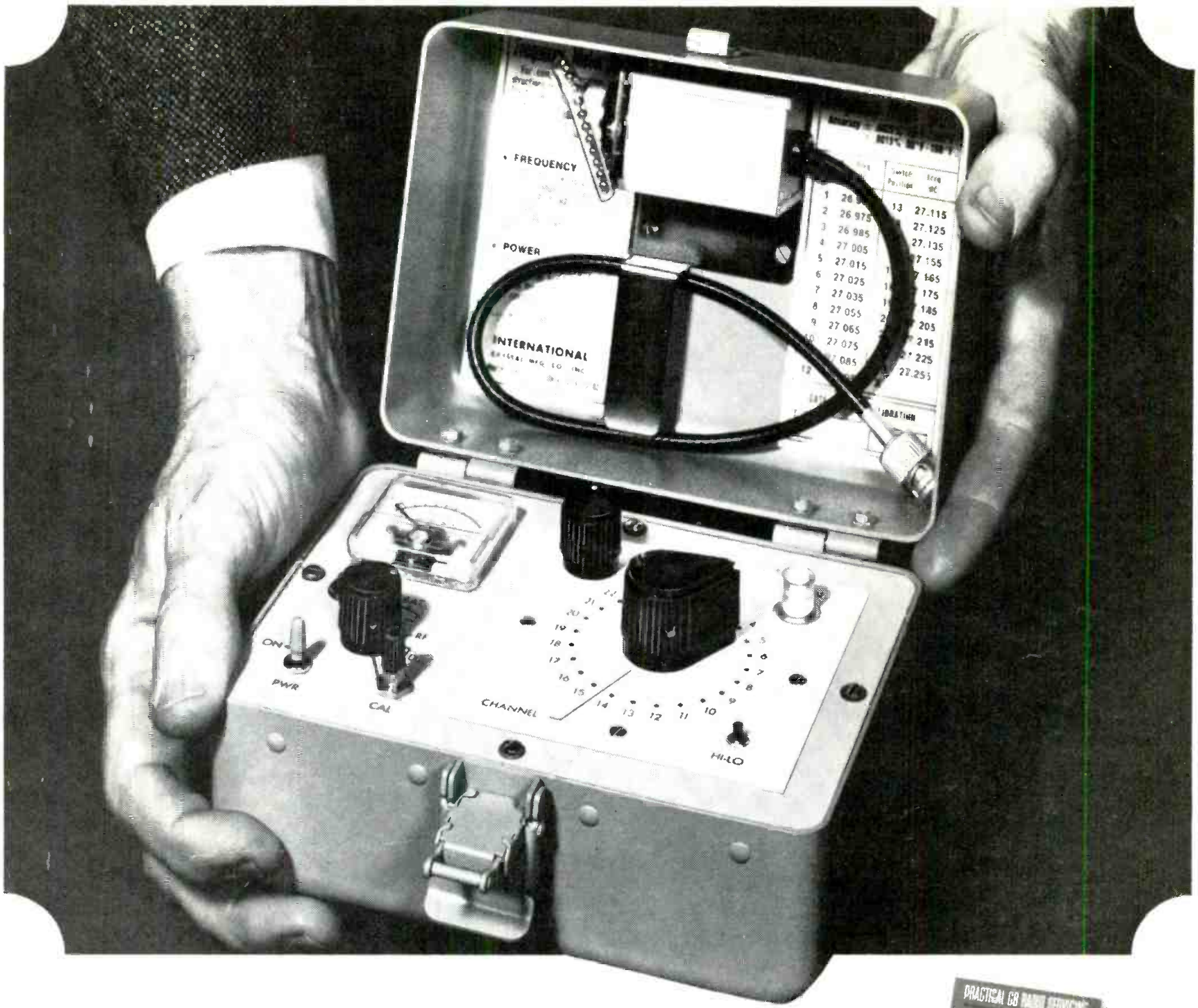
A guide for the practicing circuit designer, this new edition brings in the latest developments in transistor circuit design. Handbook gives detailed coverage of the transistor used as a switch and as a small-signal amplifier, as well as circuit operating principles and consideration of transistor parameters in practical design, along with several unusual circuits. Intended to show reader how to design his own circuits: specific circuits are analyzed in detail so that, armed with underlying design techniques, the reader can apply them to developing his own specific circuits.

SEEING BEYOND THE VISIBLE, edited by A. Hewish. American Elsevier Publishing Co., 52 Vanderbilt Ave., New York, N.Y. 10017. 150 pages, 5-⅝ x 8-¾ in. Hardcover, $6.00.

This is a collection of essays embracing the theme of the electro-magnetic spectrum and the way in which its component radiation bands are used by scientists. The contributors are professors of astronomy, chemistry, electronic and electrical engineering, and physics, who each discuss one aspect of our attempts to peer out at the Universe and into the atom—optical and radio astronomy, X-rays and crystallography, microwaves and radar, masers and lasers. Illustrated with photographs and diagrams, this book can be understood by the layman and student.—*MCL*

GUIDE TO LOW-PRICED CLASSICAL RECORDS, by Herbert Russcol. Hart Publishing Co., 510 Sixth Ave., New York, N.Y. 831 pages, 5½ x 8 in. Softcover, $2.95.

Recordings of over 300 composers are covered with some 1,500 works appraised and over 3,000 records briefly evaluated. Concluding chapters cover anthologies and the "new music." **R-E**



three in one...

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- POWER METER

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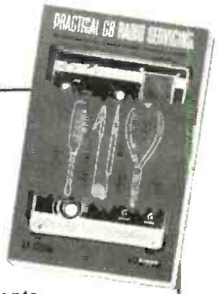

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This book covers virtually every servicing problem faced by CB radio enthusiasts, technicians, servicemen, and students. It provides all the theory and detailed procedures needed to repair and maintain equipment in a professional manner. Ideal tool for spot-testing and trouble shooting. Complete with tables and charts. **$4.75** postpaid

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