

# Radio-Electronics

FOR MEN WITH IDEAS IN ELECTRONICS

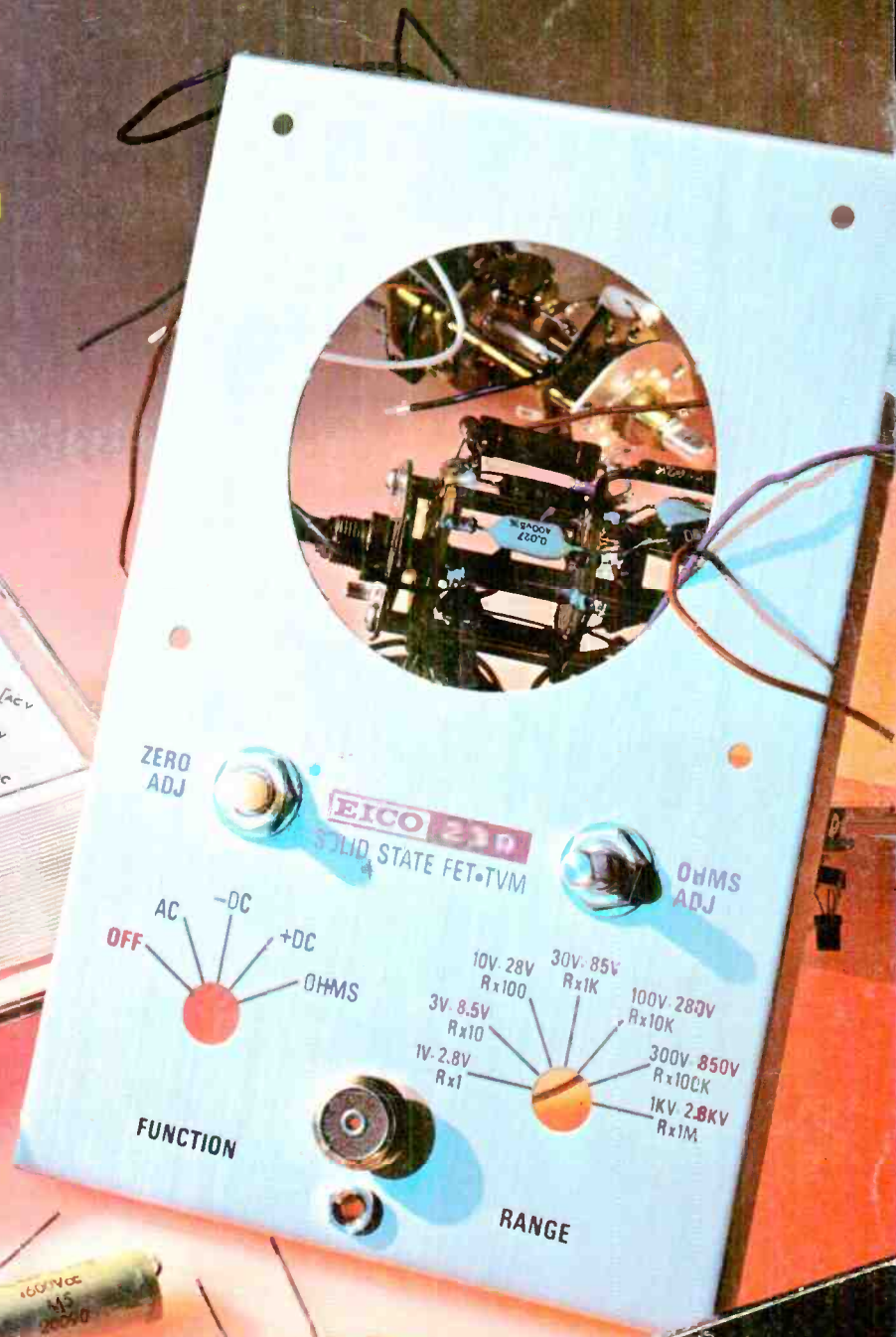
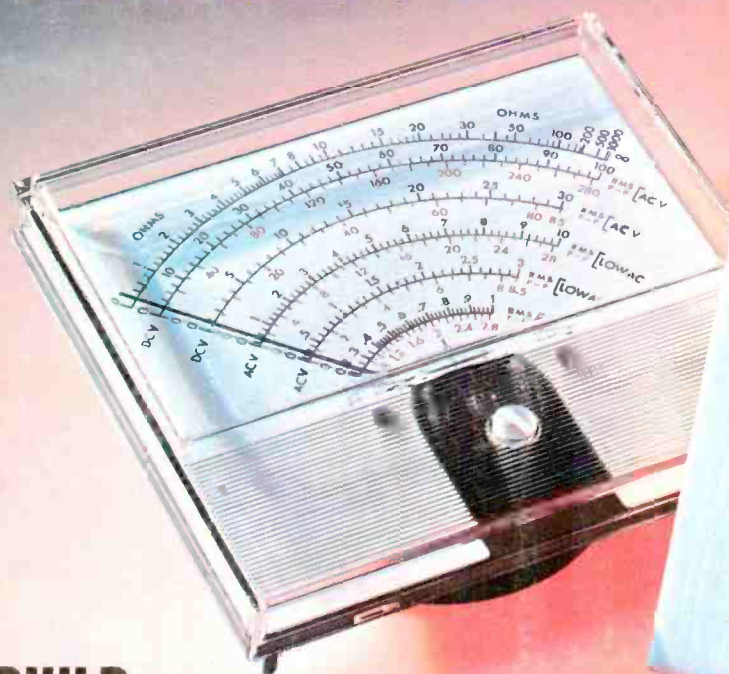
## FIBER OPTICS - NEW ERA IN ELECTRONICS

### THE VTVM, VOM, TVM

- How they work
- New ways to use them

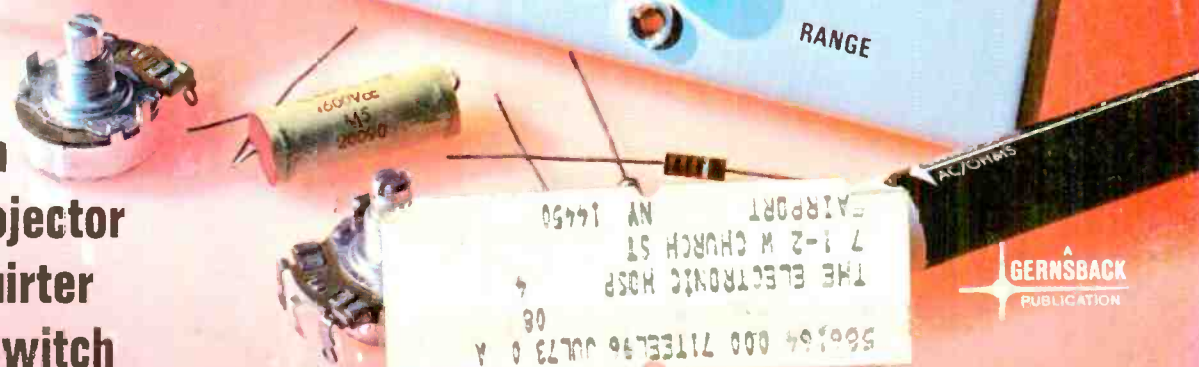
### NEW FEATURE

### Lou Garner's The State of Solid State



### BUILD:

- Kwik-Fix Circuits
- Digital Stopwatch
- Zirconium Arc Projector
- Pocket Signal Squirter
- Sensitive Touch Switch



GERNSBACK PUBLICATION



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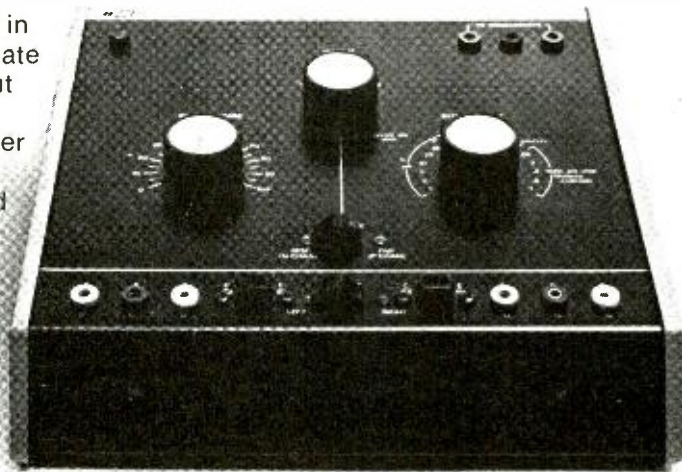
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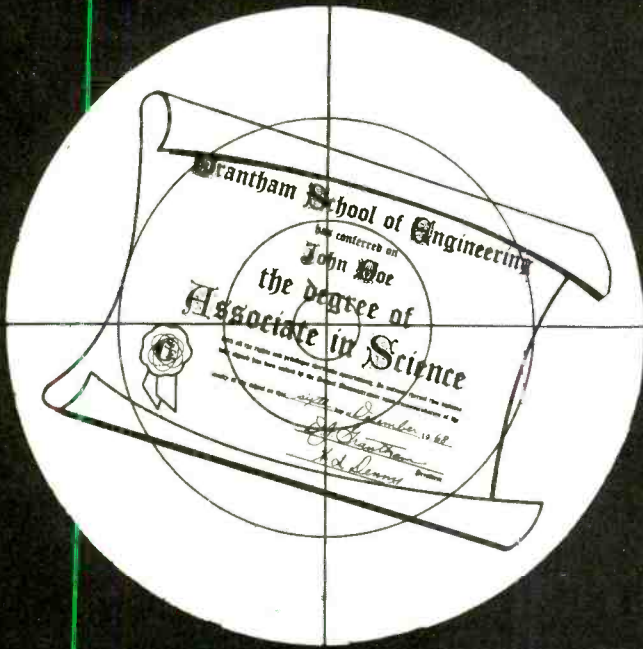


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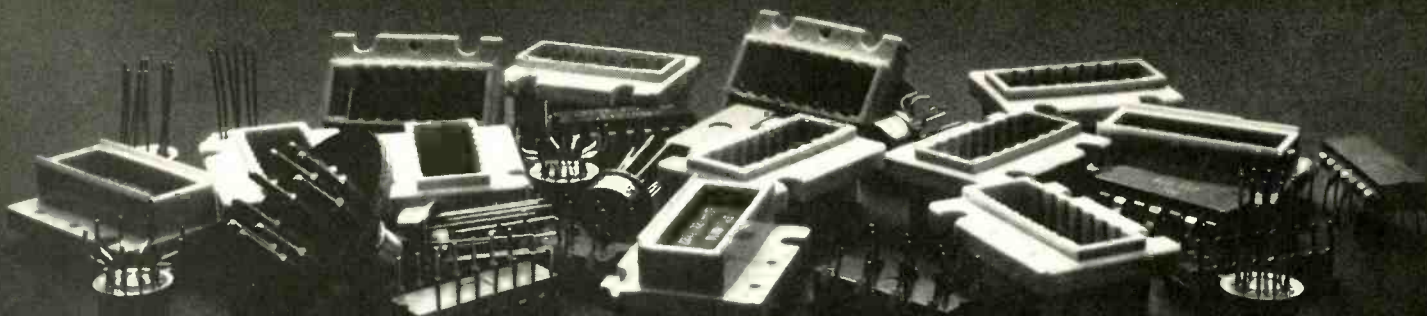
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CA3072	713	MC1303P	725
CA3075	723	MC1304P	718
DM-11	709	MC1304PO	720
DM-14	718	MC1305P	720
DM-24	719	MC1305PO	720
DM-26	721	MC1307P	722
DM-30	721	MC1307PO	722
EX4053	722	MC1314G	704
FF274	715	MC1328G	707
FL274	712	MC1328P	713
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# Radio-Electronics

FOR MEN WITH IDEAS IN ELECTRONICS

August 1972

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**ELECTRONIC STOPWATCH** uses modular construction to make it easy to duplicate. Measures time intervals from 0.1 second to 9 minutes 59.9 seconds. ....see page 39



**FIBER OPTICS** are playing an ever-growing role in modern electronics. Do you know about all the latest developments?.....see page 33

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# looking ahead

## New TV warranties

The full-year labor-inclusive warranty pioneered by Motorola and RCA is now sweeping the television receiver industry. As most manufacturers move to all-solid-state or mostly-solid-state color sets, they are extending the labor coverage on their warranties from the old 90 days to one full year, with service dealers generally reimbursed at their own full going rate. The reason, of course, is competition. Both RCA and Motorola have made big selling-points of these "in-boarded" service policies, and the manufacturers see this extended warranty as a way to dramatize the reliability of their solid-state chassis.

The exception to the rule is Admiral, which has continued its 90-day labor warranty but has added a five-year prorated picture tube warranty to all of its sets. The company's reasoning is that the picture tube is the most expensive component in the receiver and the consumer is more in need of protection against failure of this vital component than any other. Admiral's warranty works like the prorated warranties on tires or batteries, except that the prorated portion of the warranty starts after the full warranty expires—two years in the case of color tubes and one year in black-and-white. Admiral claims that even if the tube fails in the fifth year of the set's life, the owner saves one-half or more of the cost of the replacement tube.

Taking the most expensive 25-inch matrix color tube as an example—if it fails in the first two years the conventional policy of a free replacement applies—the customer paying the labor charge. If the tube fails in the third year, the consumer pays \$80 for the new tube (plus labor), in the fourth year \$90, in the fifth year \$100.

The cheapest tube in the Admiral line—a nine-inch black-and-white—is replaced free should it fail in the first-year. The second-year cost is five dollars, the third year \$10, the fourth year \$15, the fifth year \$20.

## New TV gadgets

The 1973 television set lines, like their predecessors, will be gadget-laden. The easy-tuning color gadget will enter a new generation on most sets, geared to pushbuttons and lights and with fancy names. Most use pushbuttons again, since they're easily demonstrable in the store and in TV commercials, restoring pre-set color, tint and brightness adjustments, along with afc. Magnavox has a new-old version of an automatic-picture device. It's "Videomatic."

Set manufacturers will make the biggest push in history on remote controls, which undeniably add a great measure of convenience to color viewing. With the various automatic tint and color controls now presumably solving many adjustment problems, virtually all TV set brands are offering limited-function remote units which add only \$30 or so to the price—a big comedown from the \$100 to \$150 differential for full-feature color remotes which controlled color and tint as well as volume and channel. RCA and others now are featuring single-button remote control systems (off-on, channel change) for portable color sets, and, for the first time, predictions are being made that some form of remote control will eventually be standard equipment on color sets.

RCA has gone further toward the cable TV age than other manufacturers. With an eye on the 10% of TV viewers connected to cable systems, RCA has added "cable-ready"

features to most of its color sets. In addition to a 75-ohm connector, RCA has shielded both the tuner and the antenna-lead input connections to prevent direct pickup when the set is fed by cable. Admiral has added eight-track stereo tape cartridge players and stereo amplifiers to its double-ended color consoles, permitting them to serve as a source of musical as well as visual entertainment.

Sharp has demonstrated a unique set, slated for September introduction, which displays the channel number in six-inch high numerals at the corner of the screen for two to three seconds after the channel has been tuned. The characters are generated by a special IC. Based on a similar principle is a Sharp "product of the future"—displayed but not now scheduled for production. It's a 19-inch color set with an on-screen digital clock display which can be ordered to appear in any corner of the TV picture.

## Uhf rule backfires

One of the technical refinements you'll notice in the new-model television sets is a decent uhf tuner with 70 click-stops for each of the 70 uhf channels and a positive read-out giving each individual channel number. This little wonder (described in Looking Ahead last March), together with the FCC rules on "tuner comparability," has given the set manufacturers a real headache and threatened to cause some plant shutdowns. Earlier this year, the Commission ruled such uhf tuners provided tuning which is comparable to vhf memory tuning and agreed to permit them under its tuner comparability rules, which provide that all new-model sets made after July 1, 1972—and 40% of all TV models produced after July 1—must have uhf

tuners as simple to tune as their vhf counterparts.

The principal supplier of these tuners was swamped with orders and was unable to meet delivery schedules of tuners meeting the FCC specs in time for most of the larger set manufacturers to comply with the rules. A series of conferences between set makers and FCC staff members brought a refusal by the Commission to suspend or postpone the deadline, but an agreement to grant waivers in case of hardship to individual manufacturers. The problem was complicated by the fact that a German supplier of special uhf tuners for remote-control operation went out of business, leaving two other set manufacturers without a source of supply for some of their models. By press time, eight manufacturers had applied for short-term waivers of the rules—mostly for just a couple of months—and the FCC was granting these waivers where the manufacturer could show that the alternative was a production shutdown.

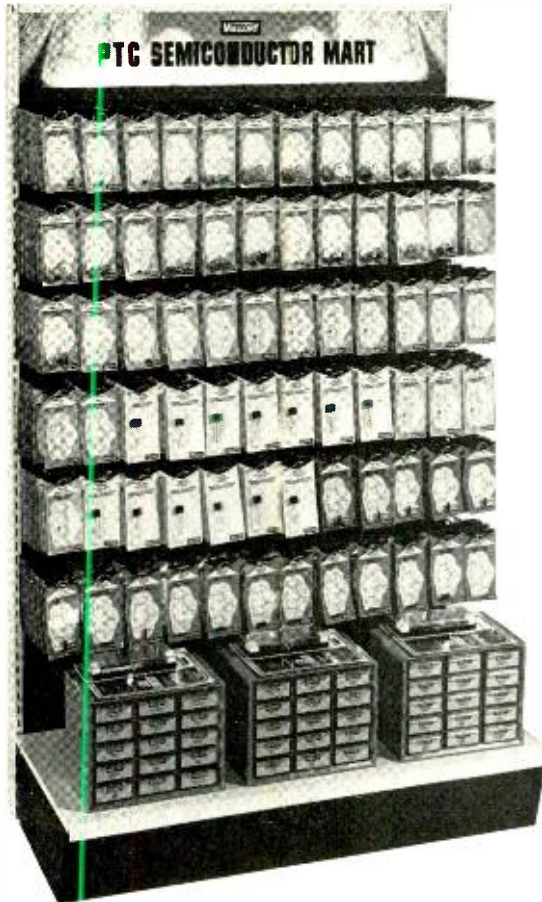
The problem is likely to recur in July 1973—when the FCC will require vhf-uhf tuner comparability in 70% of all TV models. Already many set makers are wondering whether tuner manufacturers can make that big a changeover in time.

## New tube sizes

Two more sizes have joined the color picture tube family to spread a little extra confusion. Among American manufacturers, the latest is the 17-inch, which is a square-cornered version of the 16-inch tube, the newest extension of the trend which squared off the 18-inch into a 19-inch, the 20-inch into the 21-inch and the 23-inch into the 25-inch.

by DAVID LACHENBRUCH  
CONTRIBUTING EDITOR

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# new & timely

## Blind see via nerves in skin with new electronic device

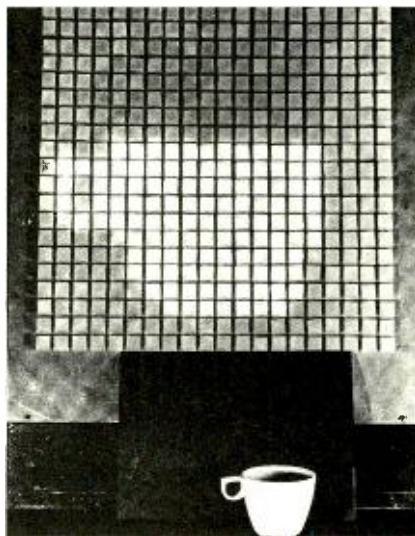
A new approach to aids for the blind is reported by two San Francisco doctors, neurophysiologist Paul Bach-y-Rita and biophysicist Carter C. Collins. Produce of eight years of research, the new system uses the techniques of television to give the user an actual picture of the object he



**USER FOCUSES CAMERA** on his own hand with the help of the unit in his left hand.

is viewing. (Most previous blind aids simply emitted a buzz or tone when the light reaching the equipment changed greatly. Thus a blind person, by sweeping a handheld receptor, could find the outlines of a door, for example.)

The new *Vision Substitution System* uses a small lens mounted on a pair of eyeglasses in the manner of some hearing



**HOW A CUP APPEARS** to the blind viewer is shown in this photograph.

aids, a one-pound TV camera that dissects the image sent to it from the lens via a fiber-optic cable, and a unit that transmits it to a matrix of 256 electrode points, which is worn on the user's stomach. Impacted by short (10 to 500  $\mu$ sec) pulses of from 1 to 3 mA, the nerves of the skin transmit the image to the brain.

The "viewer" soon learns to recognize simple objects. Indeed—so great is the adaptability of the human organism—he begins to "see" the images in his brain, instead of feeling them on his skin.

Resolution is comparable to that of television in the early '30's. Present matrices have 256 electrode points, but encouraging results were obtained with earlier ones of only 64 points. Plans are to use a 1,000-point matrix in the near future.

The present system has already been applied in teaching blind children and in prosthetic-hand projects. It is expected—as soon as a sufficient number of 1,000-point units are produced—to distribute them around the world to groups who work with the blind.

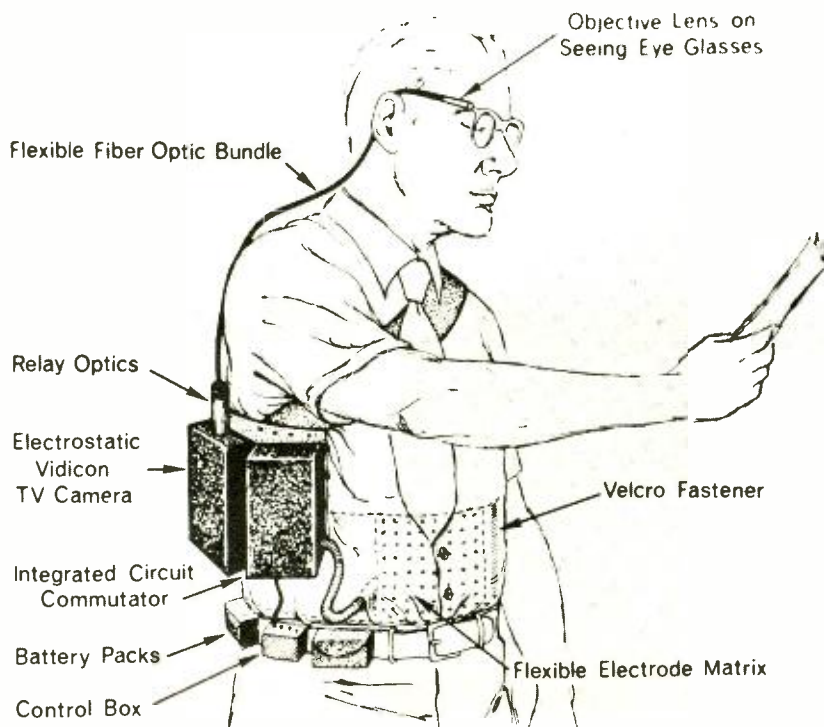
The 1,000-point matrix is not looked on as the ultimate, but only as a convenient stage—scientists are dreaming of a unit so miniaturized that it can be mounted in or over an eye socket and transmit its messages to the brain via the optic nerve.

## Cardiac patient sends doctor his own electrocardiogram

What is believed to be the first instance on record of a patient sending his own electrocardiogram to his doctor is reported from Palo Alto, California. A patient at the Stanford University hospital, Melvin Raymes of Cupertino, Calif., relayed his own electrocardiogram (EKG) by telephone to Manila, P.I. From there it was returned via a synchronous satellite over the Pacific to another telephone in the same room as the patient. Here it was analyzed by Dr. Donald C. Harrison, chief of cardiology at Stanford, and co-worker Dr. David S. Cannon.

The doctors reported that there was no distortion on the signal. This they considered very important, as demonstrating the possibility of sending EKG's long distances by telephone. Over 25% of cardiac deaths occur after the attack and before the patient can be got to medical attention in a hospital. Therefore a means of relaying an EKG to the patient's doctor at the beginning of an attack or even when the patient feels uncomfortable and suspects

*(continued on page 12)*



**DETAILS OF THE VISION SUBSTITUTOR** equipment on the body of the user.





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To Sony, of course. And to our new PS-5520.

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The hysteresis motor starts the 12-inch non-magnetic platter turning at precisely 33-1/3 or 45 rpm. (Belt drive keeps wow and

flutter below 0.1%, rumble down 42 dB.) The 12-inch, balanced arm settles precisely in the lead-in groove, its stylus centered by precise anti-skating, and its calibrated tracking force selectable from a maximum of three grams down to a mere fraction of a gram.

For manual operation, there's a cueing lift, of course.

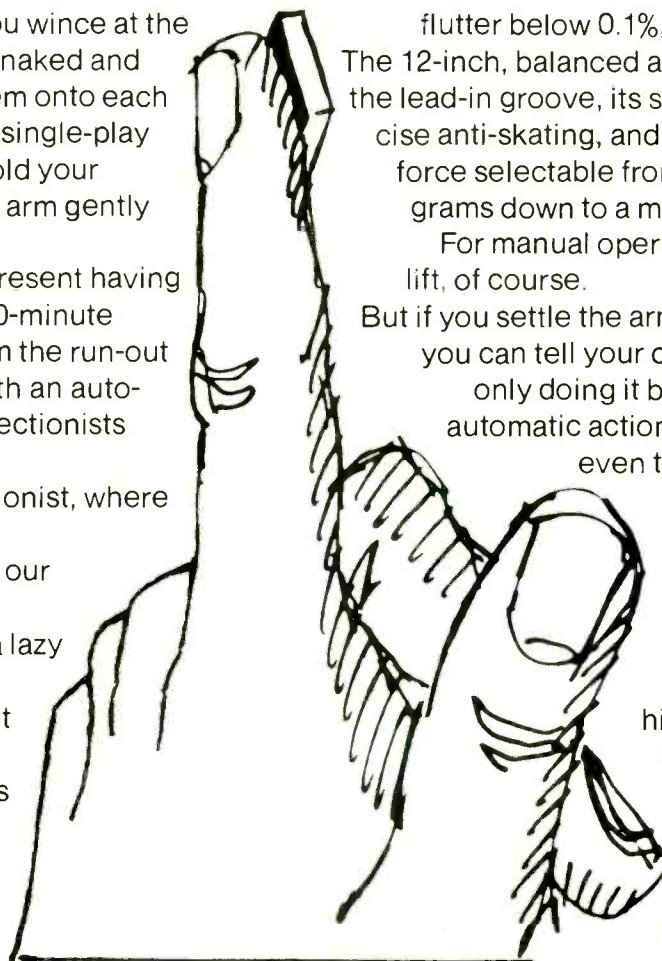
But if you settle the arm down automatically, you can tell your conscience that you're only doing it because the PS-5520's automatic action is so gentle. Gentler,

even than you are when you

hold you breath and brace your elbow.

The Sony PS-5520 turntable. Complete (less cartridges) with walnut base and hinged dust-cover. See it at your Sony dealer.

Or write Sony Corporation of America, 47-47 Van Dam Street, Long Island City, New York 11101.



## **New SONY® PS-5520 Turntable**

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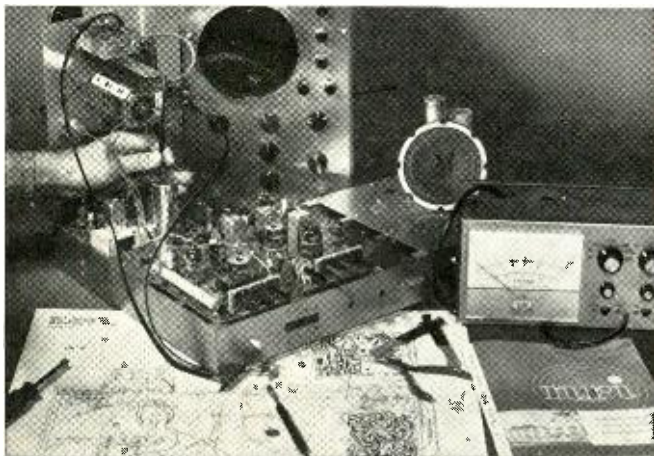
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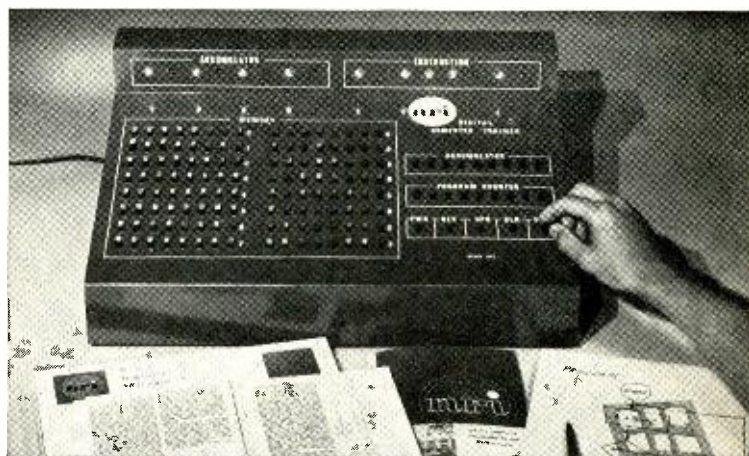
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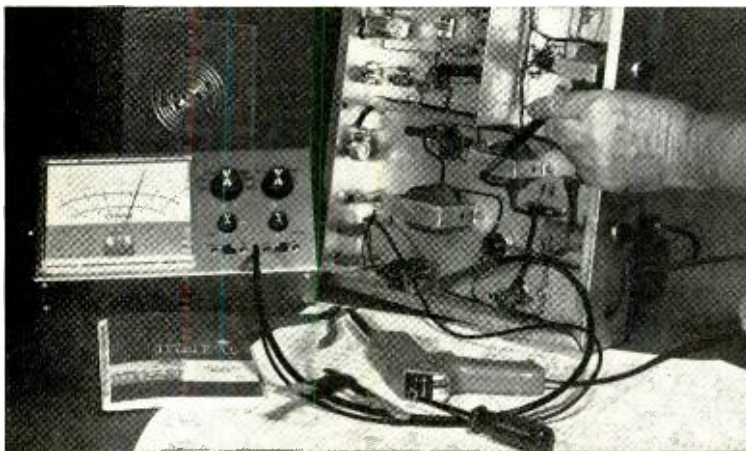
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**Electro-Voice**

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# new & timely (continued from page 6)

an attack may be approaching might save many lives, the doctors pointed out. His doctor, examining the EKG could prescribe medication, give advice, or in some cases, initiate emergency action.

The experiment was one in a series evaluating devices and techniques for preventing sudden death by heart attack.

## Electronic service groups form New York State council

A number of the most representative electronic and appliance service associations in the State of New York have formed a State Council. The new organization will be known as the Electronic & Appliance Service Associations Council (EASAC).

Charter members include: Association of Home Appliance Service Companies (AHASC), New York City area; Service Managers Association (SMA), New York City; Television Electronic Service Association of Suffolk County (TESASC); and Television Service Association of Northeastern New York, Inc. (TSANENY), headquartered in Albany, N.Y.

The purpose, aims, and objectives of the Council include joint activity on industry problems within the state of New York;

education of Government and the public; establishment of an industry code of ethics; legislative activity; and dissemination of trade and industry information. A further aim of the Council is to encourage qualified associations throughout the state to become affiliated.



Seated, left to right: Phil Holt and Ralph Warschauer, TESA; Hy Latman, AHASC; Lawrence Markman and Elliott Scheff, SMA, Inc. Standing: Irving Singer, SMA, Inc.; John Kozubal and Warren Baker, TSA, Inc.; Hy Sheffron, AHASC; Robert Plunz, TSA, Inc.

Council members have been active with the legislature and the Attorney General's office in the area of consumer pro-  
*(continued on page 14)*

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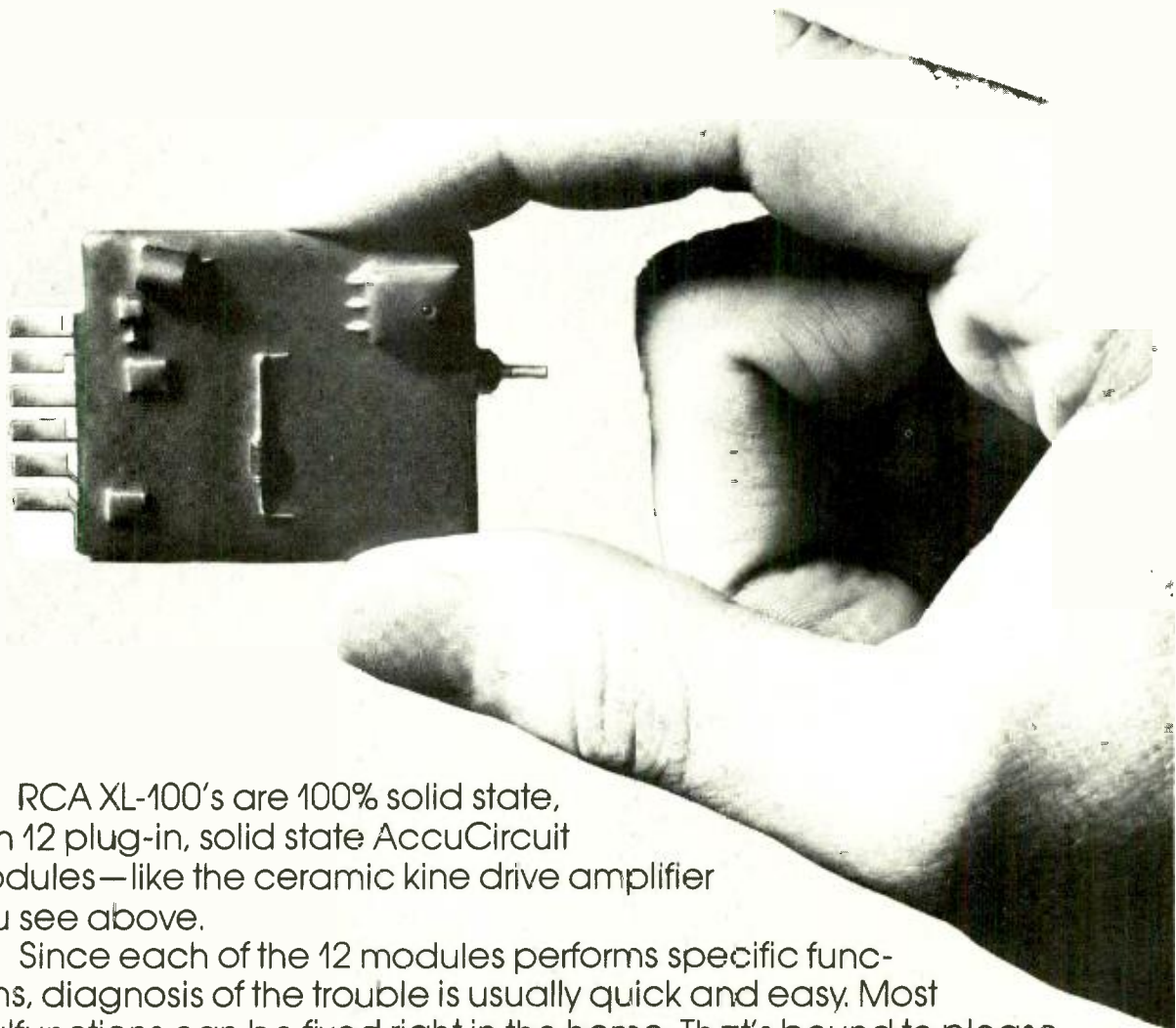
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# new & timely (continued from page 12)

tection. In addition, they have been cooperating with the Better Business Bureaus, Chambers of Commerce, and other consumer-oriented groups.

Any associations or trade groups interested in membership in the Council may contact TSA of Northeastern N.Y., Inc., 514 Second Street, Albany, N.Y. 12206, or any charter member.

## Hugo Gernsback scholarship winner

Edward Hourigan of Campbell River, British Columbia, has been named a winner of the second annual Hugo Gernsback Scholarship award by Bell & Howell Schools, leading Chicago-based electronics home-study institute.



This grant of \$125 is given annually in memory of Hugo Gernsback—founder of this magazine and others in the electronic and technical fields—to further Mr. Gernsback's interest in developing the technological skills of young people.

Mr. Hourigan, who came to Canada from Ireland in 1957, is enrolled in a Home Entertainment Systems course with Bell & Howell. He looks forward to starting a family business with his son and brother-in-law on completing the course. He now owns and operates a floor-covering shop in Campbell River—a community of 11,000 on Vancouver Island—where he lives with his wife and three children.

## New high-energy battery has 5 times normal life

A new high-energy cell, designed to meet the need for minimum size and high capacity in cordless equipment, has been demonstrated by Panasonic. A tape recorder that will operate for about five hours in continuous use and up to ten hours intermittent use with ordinary batteries, will operate for about 25 hours—ei-

ther intermittently or continuously—with only half as many of the new batteries.

Secret of the new cell's high energy is in the materials used—polycarbon mono-



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fluoride for the positive electrode instead of the conventional manganese dioxide, lithium instead of zinc for the negative electrode, and an organic electrolyte instead of an aqueous solution such as the common ammonium chloride (sal ammoniac).

The new battery has a long shelf life (at least a year at normal temperatures) and is hermetically sealed. Panasonic expects to have it on the market by the end of the year.

## Electrical bone healing again demonstrated

The remarkable healing of a Brooklyn boy born with a rare defect in a leg bone adds evidence that electric current can stimulate the healing of bone. The boy was born with a condition in which part of the tissue that should have been bone, developed instead as wobbly cartilage-like tissue. A bone graft at the age of 4 cured the defect, but at 11 an injury caused a new break through the old defective area. Further bone grafts, insertion of a metal rod and other attempts at treatment failed. Dr. Leroy Lavine, orthopedic surgeon who had done considerable experimental work in this field, then implanted electrodes in the bone of the tibia each side of the defective area and sent about 4 microamperes from two D cells across the gap. Treatment was continuous for about four months, at the end of which time the bone had healed.

Last Fall, surgeons of the University of Pennsylvania reported the successful use of electricity to heal a fracture in the ankle bone of a woman. The fracture was more than a year old, and had resisted all conventional treatment techniques. **R-E**



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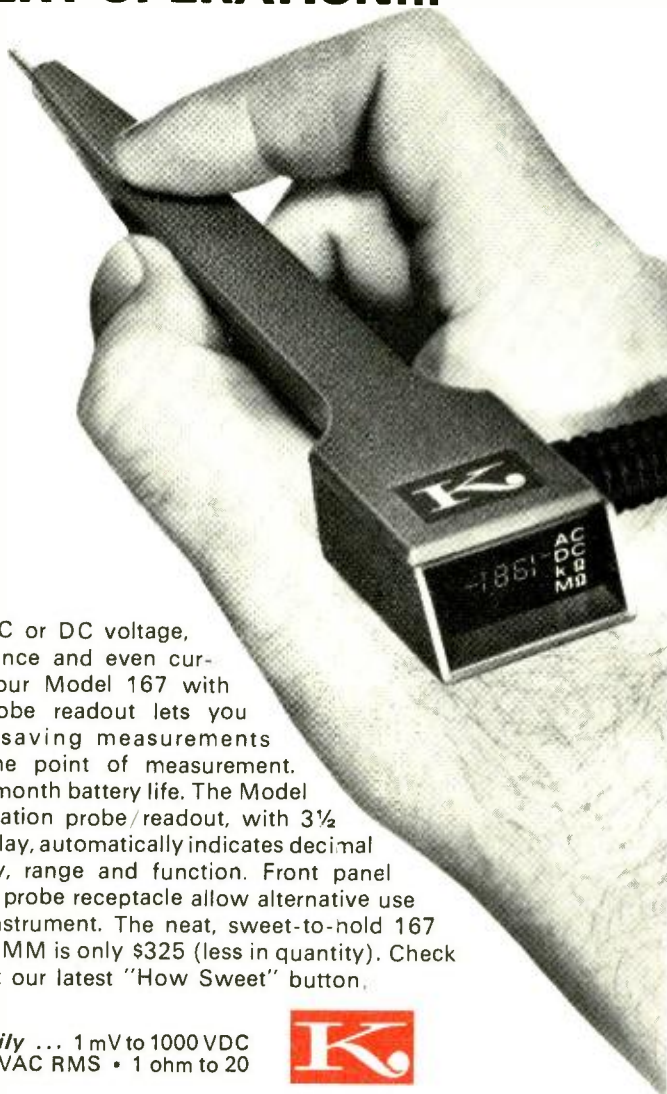
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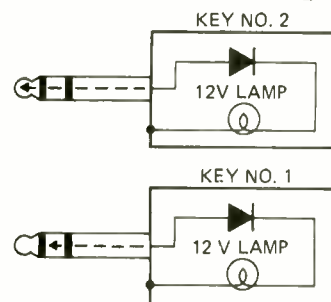
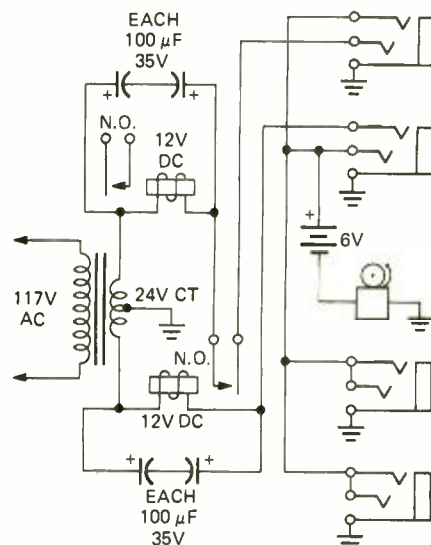


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# letters

## DIODE LOCK

I found Matt Mandl's article on "Switching Tricks With Silicon Diodes", **Radio-Electronics**, May 1972 very interesting; especially the electronic keys. Here is a combination lock that has two electronic keys. A stereo phone plug for each key, and four stereo jacks for keyholes were used. Key number one has its diode connected to the center of the plug, and key number two has its diode connected to the tip of the plug. With the keys constructed this way, the right key must be inserted in the right keyhole. An alarm



will sound if either key is inserted in any keyhole other than the right one. Also if a false key or a shorting wire is used the alarm will sound. Either key can be inserted first, but both keys must be in the lock at the same time. Of course any number of keyholes can be added.

The lamps in the keys have two functions, they work as a fuse and as a reminder not to leave them in the lock.

THOMAS E. SHAFFER  
Dwight, Ill.

(continued on page 22)



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*G. O. Allen*

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...and here's our famous CIE warranty that you will get your license if you study with us at home...or your money back!

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 great and still growing. Ten years ago there were more than 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 nearly two 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.

## Growth of UHF and CATV

To the 500 or so commercial VHF television stations now in operation and nearly 200 commercial UHF stations, add 200 more educational TV stations. And at the start of the Seventies more than 2,500 cable television stations are serving 4,000 communities.

## Opportunities in Industry

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 usually 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?

The answer: it's not that simple. The Government licensing exam is tough. There is one way, however, of getting the kind of preparation that will help you pass the FCC exam. And that is to take one of the FCC license-preparation courses offered by Cleveland Institute of Electronics.

Our training is so effective that better than 9 out of 10 CIE graduates pass the FCC exams. That's why we can offer this famous Money-Back Warranty: when you complete any CIE course which provides FCC License preparation, you'll get your FCC License or a full refund of all tuition paid. This warranty is valid during the entire completion period established for the course selected. You get your FCC License — or your money back.

There's a reason for this remarkable record. From the beginning, CIE has specialized in electronics courses designed for home study. We have developed techniques that make learning at home easier... even if you've had trouble studying before.

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Our files contain hundreds of success stories of men whose CIE training has gained them their FCC "tickets" and admission to a higher income bracket.

David Ferreira of San Diego, California, boosted his earnings and got a promotion after getting his FCC License. He says, "Even before I finished the course, I passed my First Class FCC License test. Since then I've been able to buy a home, get a camper and travel with my family."

CIE graduate, Rondlay Holmes, broadcast engineer for WKBF-TV, Cleveland, Ohio, passed his First Class FCC License exam on the first try. "Now I'm earning three times what I did before my CIE training," writes Holmes.

## Mail Card for Two Free Books

Want to know more? The postpaid reply card will bring you free copies of our school catalog describing opportunities in Electronics, our teaching methods, and our courses, together with our special booklet, "How to Get a Commercial FCC License." If card has been removed, just mail the coupon at right.

## THESE CIE MEN PASSED THE FCC LICENSE EXAM... NOW THEY ARE EARNING MORE MONEY

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"When I started my CIE electronics training, I was working in the engine room of a tugboat. Before finishing, I passed my First Class FCC License exam and landed a job as a Broadcast Engineer at KDFM-TV in Beaumont. I was able to work, complete my CIE course and get two raises... all in the first year of my new career in broadcasting. The course was interesting and well written."—Richard L. Kihn, Anahuac, Texas.



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## LETTERS

(continued from page 16)

### WOMAN'S VIEW

I am writing in reply to the letter from Trudye Connolly, appearing in the *Letters* section of the April, 1972 issue of **Radio-Electronics**, and your request to hear from other women readers concerning your magazine's "tag line."

I am in full agreement with Ms. Connolly; as a recent subscriber to your magazine, I find it very technically interesting and diverse, and enjoy each issue, but that tag line galled me the first time I saw it. "For men with ideas in electronics" is just a little old-fashioned, don't you think? When you are dealing with just such an advanced and fast-developing field as electronics, why does your thinking in other lines drop out-of-date?

As for myself, I am a radio ham, call letters W8GEN, and have been one for 22½ years. I hold a Second Class FCC Commercial Radiotelephone Operator's license, and am currently studying for the first class exam. Also, for the last 5½ years I've worked actively on a part-time basis as an electrical wireman, and for the last 1½ years have held a residential electrical contractor's license, which I actively use. My full-time employment is with an electrical utility company, where I am an apprentice in the meter department. I am constantly studying both electricity and electronics, to keep abreast of current developments in both fields, and to update my present knowledge.

We women that are of a technical turn of mind resent being more-or-less classed as "housewife types" or "office types." We are intelligent and able, and do well in our chosen fields, and it is rather nauseating to still see such tag lines as your magazine carries. Why don't you just get rid of that old fashioned tag and go modern?

CAROLYN C. COVEN  
Toledo, OH.

### AMERICAN RADIO HOBBYISTS ASSOCIATION

There seems to be a need for another effective national ham organization to give the amateur a choice. An organization that is progressive and innovative will appeal to the many hams that are not ARRL members. With "change" the order of the day, we should have an organization that is in tune with the times. This kind of competition will be good for ham radio, the amateurs, and even the ARRL.

Consideration is being given to having the national headquarters on the West Coast, and to establishing a memorial station at the headquarters. The latter idea is, of course, based on the not-yet consummated proposal presented to the ARRL for the Herbert Hoover, Jr., Memorial Station. A consolidated office will be maintained in Washington to serve the many

ham, CB and SWL groups involved. The emphasis is on a council, league, coalition or federation of national and regional organizations. We will assure them that we will not "take anything away" from them, and that we will assist, coordinate and communicate.

A successful welding together of hams, CBer's and SWL's would give considerable political muscle. Used widely there would be a great benefit to the hobby of radio. And, I believe that the concept is valid that a basic problem with CB is that there are too many two-way radio hobbyists (in effect, would-be hams). Yet, the FCC regulations requiring code, etc., are a hinderance (psychologically, perhaps) to their becoming licensed hams. One estimate is that one-half of the CBer's would like to be licensed hams. While a number of CBer's seem to be nuts, ham radio also has its share: jammers, etc. And, SWL's are another significant reservoir of potential hams.

Very helpful letters have been received from Senator Goldwater, FCC's Walker, many CB and SWL organizations, OTP, and even from some ARRL members and officials. The organizers of the ARHA include other long-term hams such as Tazewell, W4NGU/3 (almost 40 years). In Syracuse we have a ham class sponsored by a CB club with the club president, his son and his daughter among the students.

We will be grateful for anything you can do to give the ARHA a boost. And, your ideas, suggestions and participation will be appreciated.

WILLIAM S. DAWSON  
P. O. Box 123  
Syracuse, N.Y. 13210

### R-E's CROSS-HATCH GENERATOR

Many readers have reported problems in getting their single-cross-hatch generator **Radio-Electronics**, January 1972) to work properly. We have checked with the author and he suggests the following changes to improve performance of working units and to solve problems in non-working units.

Change the value of these resistors: R2, 6.8K; R4, 4.7K; R5, 4.7K; R14, 6.8K.

On the foil side of the board add an 18-pF ceramic disc capacitor from pin 13 of IC1 to pin 2 of IC2.

With some batteries a bypass capacitor is needed. Use a 50-µF electrolytic across the terminals of the battery holder.

For more reliable oscillator operation increase the diameter of coil L1 to ⅜".

Note that the basing of the 2N3393 transistor is emitter, collector, base and not the customary emitter, base, collector.

If you have trouble with hand capacitance effects while adjusting the controls, ground the front panel of the instrument to the ground foil on the circuit board.

Also, it may be wise to move the coaxial cable shield from the pad indicated to a position on the ground bus close to the ground end of capacitor C15.—Editor



# THE STATE OF

# SOLID STATE

Up to the minute happenings in solid-state development is the basis of this new **Radio-Electronics** feature. We know you're going to like it, every time it appears

by **LOU GARNER**  
SEMICONDUCTOR EDITOR

CUSTOMARILY, THE EDITOR OF A NEW magazine or the author of a new column prefaces his initial efforts with a few introductory remarks . . . an outline of his policy, approach, concepts and goals—his game plan, so to speak. While, personally, yours truly is all for independent thinking, he won't buck custom on this point.

Our game plan, then, is a simple one: to cover the field of solid state—to present to you, our readers, a smorgasbord of news about the field . . . products, processes and publications. We'll discuss technology and techniques, production methods, published literature, new devices, interesting circuits, and products using solid state circuitry. We'll report, describe, explain, comment and criticize. Avoiding abstruse mathematics wherever possible, we will, nonetheless, attempt to be serious and profound in a light-hearted way. At times, if it doesn't blow a fuse on our Editor's (or Publisher's) Policy Board, we may poke a little fun at the industry or at ourselves and our readers.

In the last analysis, however, *you*, our readers, will determine the final game plan, for we'll try to be flexible in our coverage. If your comments and correspondence reveal that a majority prefer to read about new devices, or new circuits, or new technology, we'll shift the emphasis in our coverage accordingly. If you prefer more humor and less profundity, we'll comply. After all, when you plunk down your hard-earned cash for a publication, you should be able to buy what you want.

Enough! You have the message—let's look at the *State of Solid State*:

## Functions, anyone?

Is there a Function Generator in your future? (With apologies to Ford.) If not, perhaps there should be, for these versatile instruments are becoming increasingly popular with design engineers, electronic technicians, serious students and advanced hobbyists. Fur-

nishing a variety of signal waveforms, these units may be used for studying network and filter response characteristics, testing experimental circuits, trouble-shooting equipment, and checking the operation of complex systems. Maybe you've wanted such an instrument in the past, but have been deterred by the relatively high cost of manufactured versions or the comparative complexity of build-it-yourself designs. Hesitate no longer—you can assemble a basic instrument in a few hours time for less than the cost of dinner and drinks for two at a better restaurant by using either of two commercially available MSI devices . . . the SE/ME 566 or the XR-205.

Comprising controlled-current sources, a Schmitt trigger, and a couple of multi-stage buffer amplifiers, as shown in the simplified functional dia-

gram given in Fig. 1-a, the SE/NE 566 can deliver both triangular and square wave signals simultaneously at any frequency from less than 1 Hz to nearly 1 MHz. Only three resistors, three capacitors, and a dc power source are required for single-frequency operation, as illustrated in Fig. 1-b.

A product of the Signetics Corporation (811 E. Arques Ave., Sunnyvale, CA 94086), the 566 is offered in both standard and more expensive high temperature versions in 8-pin TO-type packages as the NE566T and SE566T, respectively. The standard version also is available in an 8-pin dual-inline package as the NE566V. Unit prices range from \$9.50 for the NE566V to \$15.00 for the SE566T.

Referring to Fig. 1-b, the circuit's operating frequency is determined by R3 and C3: the lower the RC value, the

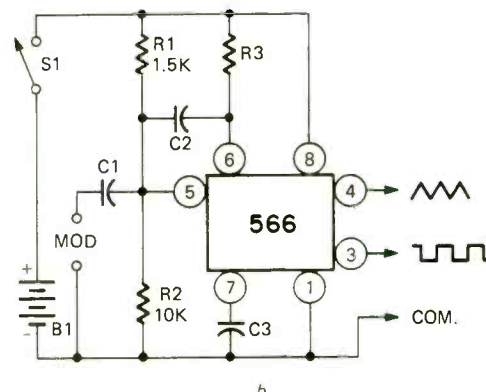
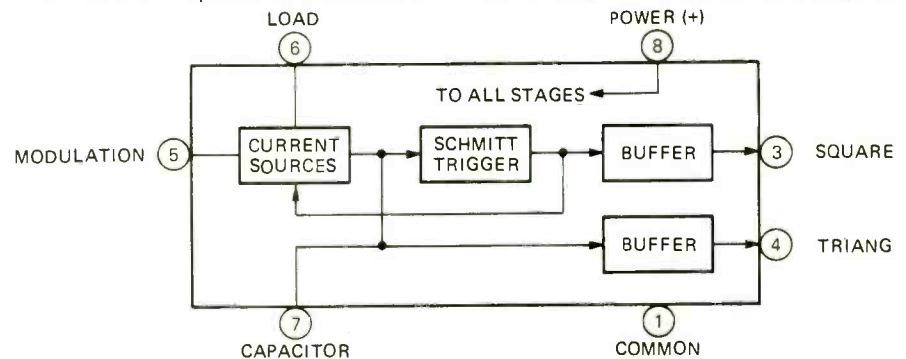


FIG. 1—THE SE/NE 566 USED AS A FUNCTION GENERATOR—(a) device block diagram; (b) practical circuit.

higher the output frequency, and vice versa. In practice,  $R_3$ 's value should be no greater than 20,000 ohms nor less than 2,000 ohms; if desired, a fixed resistor in series with a rheostat may be used here to provide continuous frequency control.  $C_3$ 's value may range from 10  $\mu\text{F}$  down to 100 PF; several capacitors may be used here for multi-range performance, with each selected by a suitable rotary switch.  $C_2$ , included to minimize possible oscillation in the controlled-current sources; is a nominally 0.001  $\mu\text{F}$ . Not essential to basic circuit operation,  $C_1$  permits the application of external frequency modulation; values from 0.01 to several  $\mu\text{F}$  may be used here, depending on the modulation frequency.

In operation, the 566 function generator will deliver 2-volt peak-to-peak triangular wave and 6-volt peak-to-peak square wave signals, both developed across 50-ohm sources, when operated by a 12-volt dc power supply.

"For a few dollars more," as the Used Car Salesman might say, you can

assemble a Function Generator which will deliver square wave, ramp, sine, and triangular wave signals by using the XR-205, an IC device manufactured by Exar Integrated Systems, Inc. (733 North Pastoria Ave., Sunnyvale, CA 94086). Priced at \$16.00 each in small quantities, the XR-205 is furnished in a 16-lead DIP. As illustrated in Fig. 2-a, the device consists of three principal operational sections—a voltage-controlled oscillator (VCO) which generates the basic signal waveforms, a balanced modulator for amplitude or phase modulation, and a buffer amplifier for a low-impedance output and high current-drive capability.

A typical circuit featuring the XR-205 is given in Fig. 2-b. Timing capacitor  $C_o$ , between pins 14 and 15, determines the oscillator's basic operating frequency according to the approximate formula,  $f = 400/C_o$ , where  $f$  is in Hz and  $C_o$  in  $\mu\text{F}$ . The unit's effective frequency range extends from less than 1 Hz to over 3 MHz. The buffer amplifier's load,  $R_L$ , between pins 9 and 11,

nominally is 750 ohms, providing an output impedance of 50 ohms.  $R_q$  serves as an amplitude control and  $R_j$  as the waveform trimmer for sine wave signals. With the component values specified, the maximum output is approximately 3-volts peak to peak, except for the square and ramp waveforms, which are lower—less than 1-volt for square, about twice this for ramp signals.

In operation, the buffer amplifier may be driven by any of the circuit outputs (pins 1, 2, 12, 14 or 15) to obtain low output impedance and high current-drive capability. For proper operation, however, pin 11 must be connected to the most negative potential in the circuit, and the maximum output current must not exceed 20 mA.

Various output waveform signals may be obtained by adjusting the circuit's controls and switches as follows: *Sine waves*—S2 open, S1 closed. Output from pins 1 or 2 (or 11 if the buffer amplifier is used).  $R_j$  adjusted for minimum harmonic distortion,  $R_q$  for amplitude.

*Triangular waves*—S1 and S2 both open. *Sawtooth*—S1 open, S2 closed. Signal polarity may be reversed by reversing the polarity of the dc bias across pins 3 and 4.

*Ramps*—S3 open, pin 10 shorted to pin 14. Output at pin 11 is about 1.4-volts peak to peak.

*Square waves*—Available at pin 12, approximately 0.7-volts peak to peak.

For detailed information on the XR-205 and its application, write directly to the manufacturer at the address given above.

### Device News

RCA's Solid State Division (Box 3200, Somerville, NJ 08876) has announced a fantastic array of new discrete and IC devices, including two new subsystems for FM i.f. and AM receiver applications, four new SCR's, a new power transistor for hf SSB operation, three new transistors for vhf/uhf power amplification, six new power hybrid high-current series voltage regulators, and eight new additions to their popular COS/MOS line.

The new FM i.f. subsystem, type CA3089E, includes an i.f. amplifier, quadrature detector, af preamp, and circuits for agc, afc, muting (squelch), and tuning meter. It features exceptional limiting sensitivity (12  $\mu\text{V}$  at -3 dB point), low distortion (0.1% typical with double-tuned coil), single-coil tuning capability, high recovered audio (400 mV typical), and internal supply-voltage regulators, and is supplied in a 16-lead plastic DIP.

Designated type CA3088E, RCA's new AM subsystem also is supplied in a 16-lead plastic DIP, and includes a low-noise converter and first i.f. amplifier, two i.f. amplifier stages, delayed age for

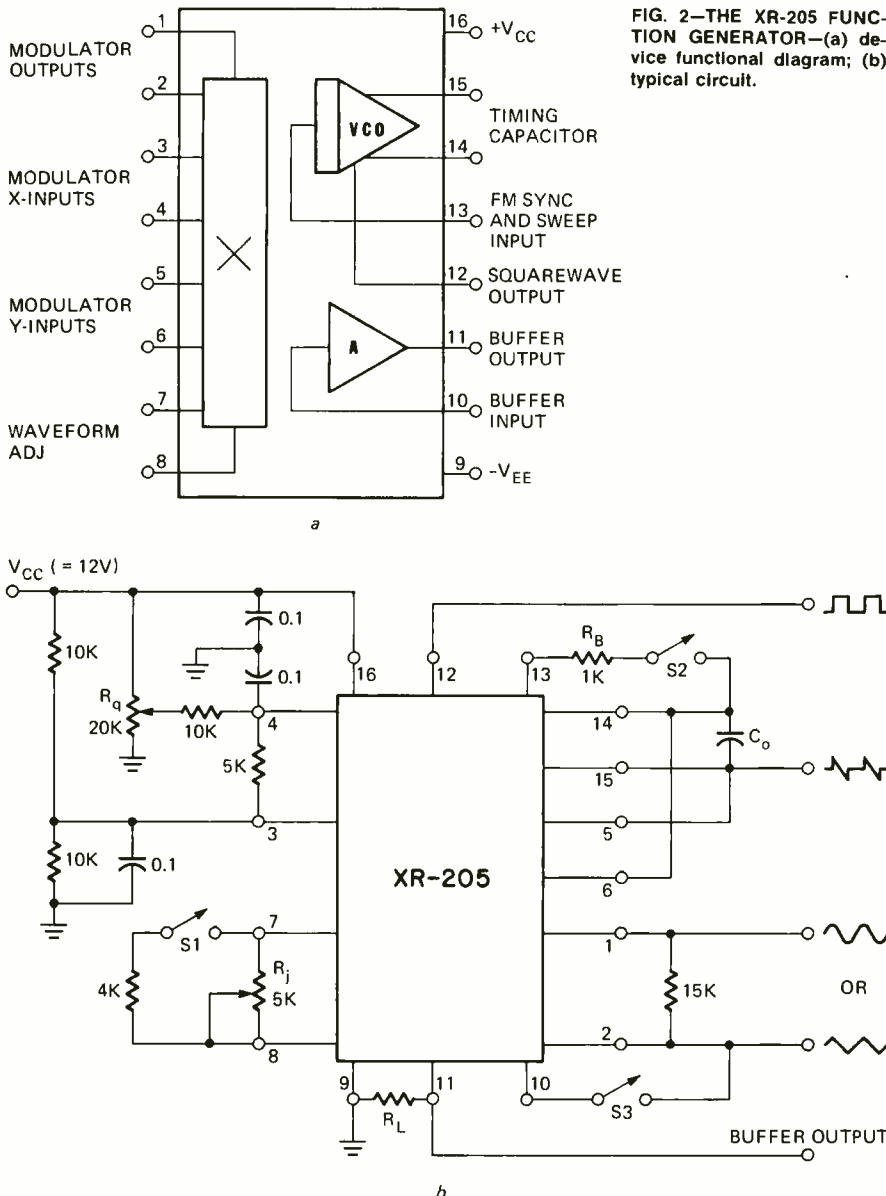


FIG. 2—THE XR-205 FUNCTION GENERATOR—(a) device functional diagram; (b) typical circuit.



an rf amplifier, agc for the i.f. amplifier, a buffered output for a tuning meter, an audio preamp, and internal Zener diode regulation for the voltage from the power supply.

The new SCR's, types 40942, 40943, 40944 and 40945 feature current ratings of 4.5 amps and a 200-amp surge-current capability and have voltage ratings of 100, 200, 400 and 600 volts, respectively. Suitable for use in ignition service, crowbars, and capacitive-discharge systems, all four units are furnished in hermetic TO-8 packages.

RCA's 40936 is a 28-volt emitter-ballasted transistor for 2 to 30-MHz SSB amplifiers and other linear applications. Providing a peak envelope power of 20 watts with 13 dB gain at 30 MHz and intermodulation distortion of less than -30 dB, the device is supplied in a TO-60 case.

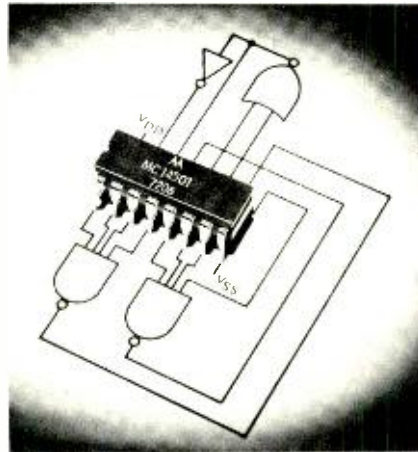
The new vhf/uhf transistors are types 40934, 40940 and 40941. Of these, the 40934 is a 12.5-volt vhf/uhf class C amplifier that can deliver 2 watts with 7 dB gain at 470 MHz; it is supplied in the RCA HF-31 radial-lead package. Types 40940 and 40941 are 28-volt amplifiers that provide 5 watts with 5.2 dB gain and 1 watt with 10 dB gain, respectively, at 400 MHz.

Intended for applications with load currents of up to 4 amperes, RCA's new hybrid voltage regulators are designated types HC4005, HC4005A, HC4012, HC4012A, HC4015 and HC4015A, and have output voltage ratings of 5, 12 and 15 volts, respectively. Total regulation is 1% for the "A" versions, 3% for the standard units. Additional current handling capability can be provided through the use of external booster transistors or by employing the regulators as Darlington drivers. All six units are supplied in special 8-pin "TO-3" style packages, with an optional companion socket, part No. DF-263A, available to simplify the installation of these semiconductors.

RCA's recently announced additions to their COS/MOS line include the CD4031A 64-stage static shift register, the CD4034A 8-stage static bidirectional parallel/serial input/output bus register, the CD4035A 4-stage clocked parallel-in/parallel-out shift register, the CD4037A triple AND-OR bi-phase pair, the CD4041A quad True/Complement buffer, the CD4046A and CD4046AD micropower phase-locked loops, and the CD4047A gateable astable/monostable multivibrator. All of these new devices are offered in multi-lead dual-inline packages, and several are also available in multi-lead flat packs.

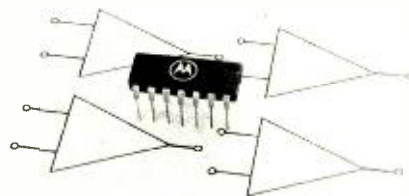
Motorola Semiconductor Products, Inc. (P.O. Box 20912, Phoenix, AZ 85036) has introduced a number of interesting new devices, including a versatile triple gate CMOS IC, the

MC14501AL/CL, and a unique quad op amp, the MC3401, specifically designed to operate from single-ended power supplies. Both devices are furnished in multiple lead DIP's (Dual In-line Packages).



**FIG. 4—MOTOROLA'S NEW TRIPLE GATE IC** which offers both NOR/OR and AND/NAND functions in a single device.

Illustrated in Fig. 4, the MC14501 is available in two versions—"AL" and "CL," both of which offer the same basic circuitry, differing only in their maximum voltage ratings and temperature specifications. This new logic device has both a 2-input NOR/invert gate and two 4-input NAND gates. More complex functions can be derived by interconnecting some of the device pins externally. In addition, by properly biasing the gate with one external pin interconnection, a 2-, 3-, or 4-input AND function is available. Using two external pin connections, up to an 8-input AND/NAND function can be implemented. The device has a high fanout, a typical noise immunity of 45% of supply voltage, a symmetrical output resistance of, typically, 500 ohms, and can be operated from either positive or negative single-ended dc supplies.

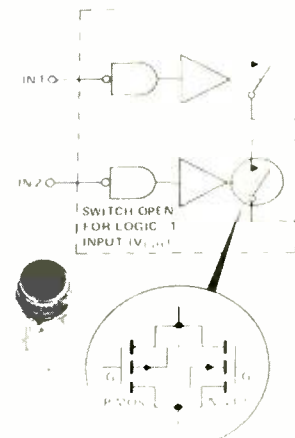


**FIG. 5—MOTOROLA'S NEW MC3401 QUAD OP AMP IC—Four op amps in a single package designed for operation from a single power supply.**

The MC3401, shown in Fig. 5, provides four independent amplifiers in a single plastic package. Internally compensated, the amplifiers use a unique "current mirror" circuit to obtain a non-inverting input rather than the differential amplifier normally associated with op amps, thus allowing usage of a conventional common-emitter input stage which can be biased more easily

from a single power supply. Input bias current is about 50 nA while unity gain bandwidth is 5 MHz; output voltage swing is approximately 1 volt less than the supply voltage used. Designed for use with 5- to 18-volt dc power supplies, the new device is intended for applications in industrial control systems and active filters for communication systems, but could be adapted quite easily to a variety of hobbyist and experimenter projects.

A new dual spst analog driver/switch combination has been added to the CMDS product line offered by Siliconix, Inc. (2201 Laurelwood Road, Santa Clara, CA 95054). Illustrated in Fig. 6, the new unit, type DG200, features break-before-make



**FIG. 6—NEW DUAL SPST ANALOG DRIVER/SWITCH** combination recently introduced by Siliconix, Inc.

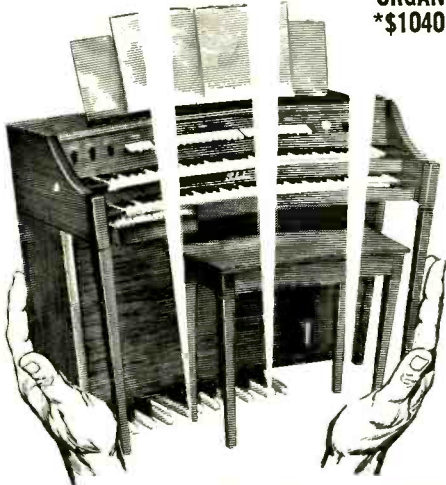
switching action, with  $t_{eff}$  and  $t_{on}$  ratings of 500 and 1000 ns at 25°C. The device as a  $\pm 15$ -volt analog signal range with  $\pm 15$ -volt supplies. Packaged in a TC-100 case, the DG200 can provide direct control interface with TTL, DTL, and CMDS circuits.

The Sprague Products Co. (North Adams, MA 01247) has introduced 14 new IC's for the replacement market. These solid-state devices are designed to replace at least 152 devices currently used in TV, FM, stereo and AM radio and communications equipment, and are exact factory replacements for integrated circuits used in receivers made by most major manufacturers. The line includes chroma demodulators, i.f./limiter/FM detectors, stereo processors, chroma amplifiers, FM gain blocks, phase-locked loop chroma sub-carrier regeneration systems, and dual audio preamplifiers. A complete cross-reference guide to original equipment part numbers is available from Sprague distributors.

That concludes our story for this month . . . until next time. *smile.* **R-E**

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## SOLID-STATE SPEED CONTROLS

by JACK DARR  
SERVICE EDITOR

SEVERAL HOME APPLIANCES USE MULTIPLE-speed control systems. Most common would probably be the food mixer, or blender. There are some with "continuously variable" speed-controls. Those will be dealt with later. More common are "step" systems; a button is pushed, and the motor runs at the desired speed until switched off.

The original system used a mechanical governor. It had a pair of contacts on the end of the armature shaft, actuated by weights. It was called a "centrifugal governor" because it was actuated by centrifugal force. When the motor reached the desired speed, the contacts opened, breaking the supply circuit. They stayed open until the armature slowed down. Then they closed, applying power again. The action is very rapid.

This method has a couple of disadvantages. For one, the contacts arced, and eventually got very dirty. Also, the arcing generated a healthy amount of TVI and RFI, upsetting any radio or TV in the vicinity!

Solid-state controls offer the same flexibility, but without the disadvantages of noise and possible bad contacts. One of these uses a tapped motor winding, as shown in Fig. 1, with

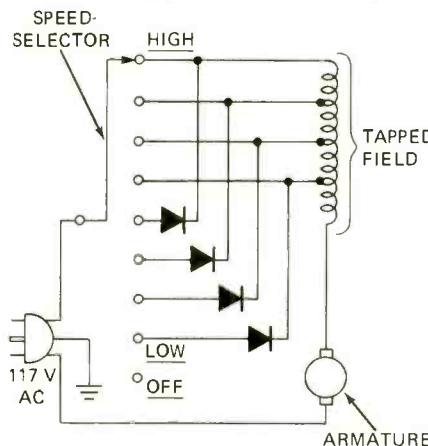


FIG. 1—FOUR TAPS ON WINDING are followed by diodes connected to the same taps, giving the mixer an 8-position speed control.

an 8-position speed-selector switch. The motors used in this type must *always* be the "universal" or "ac-dc" type.

For the highest speed, the ac line is connected direct to the full winding. The next three taps are lower speeds, with full-wave ac fed to the motor. From here on, the same four taps on the winding are used, but now a diode is connected in series with each one. So the motor gets half-wave rectified dc, with less than half the power. These diodes are often "encapsulated" in a single block, although they can be separate units.

Checking this kind of speed control can be simple. Only an ac voltmeter and ohmmeter are needed. If you have trouble on the higher speeds, check the selector switch and the motor windings, for continuity. For instance, if the motor will *not* run on the two highest-speed positions, but will run normally from "there on down," you have an open motor winding or selector switch. (Most probably the switch.) If it will run on positions 3 and 4, and 7 and 8, but not on 1-2 or 5-6, this would point to the upper taps on the motor as the cause.

If the motor runs on high speeds, and switches to lower speeds, but suddenly jumps back to full speed, say on position 7, the chances are that the diode in that position is *shorted*. If it runs on all other positions but *stops* on 7, the diode, or that switch contact, would be open. The ohmmeter will tell you which one it is. If you read the full ac line voltage on the input to the diode, but the motor won't run, there you are: open diode.

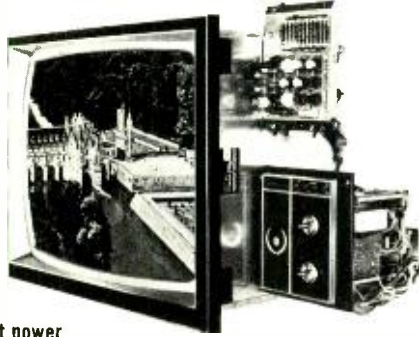
Fig. 2 shows another type of speed control. This one uses an SCR; the motor, of course must be designed to reach the highest speed needed on only half-wave rectified dc. An 8-position, two-deck selector switch is used, just as before. (Actually, the main purpose of the left side is to provide an OFF position!) The right side does the "business"; it switches taps on a voltage divider network to control the SCR gating. The greater the resistance in the gate voltage divider, the shorter the time the SCR will be ON, and the slower the motor will run. Unlike the previous type, in Fig. 1, this circuit provides speed con-

(continued on page 88)



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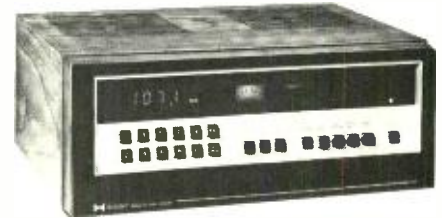
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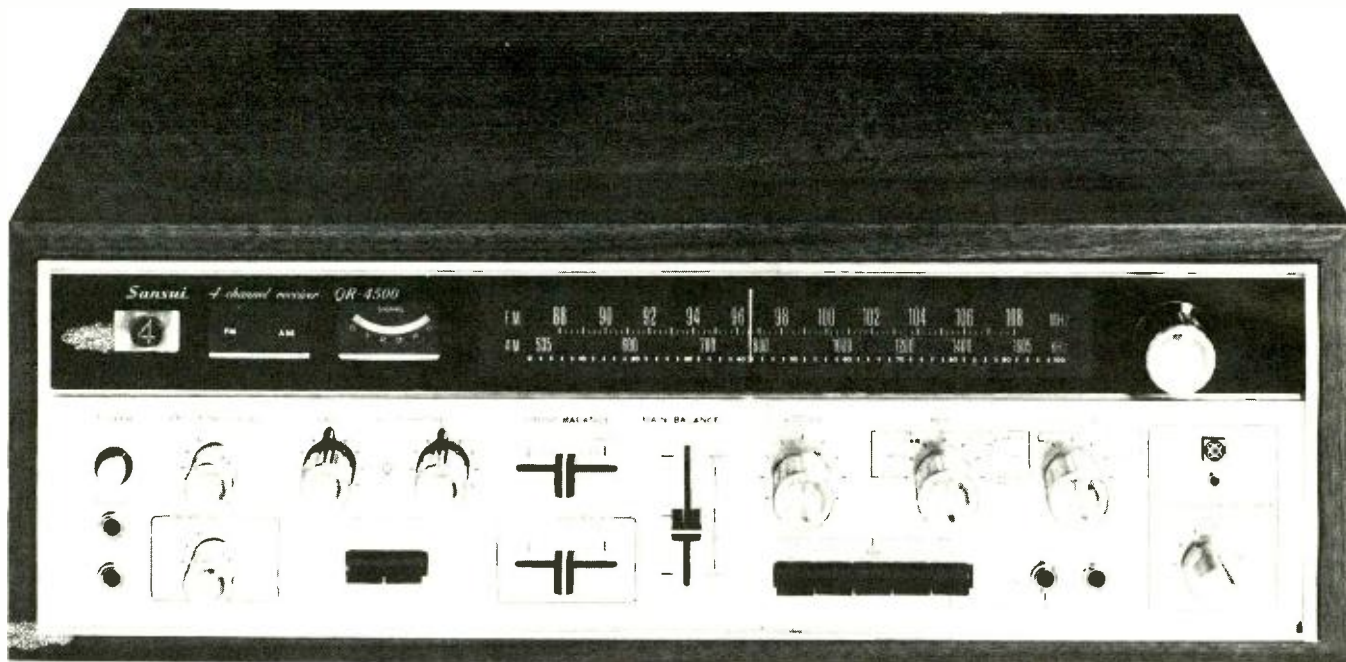
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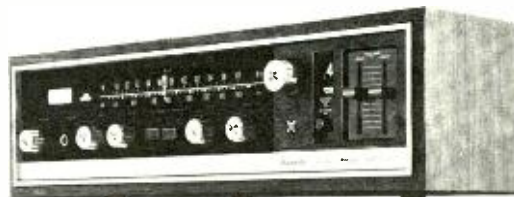
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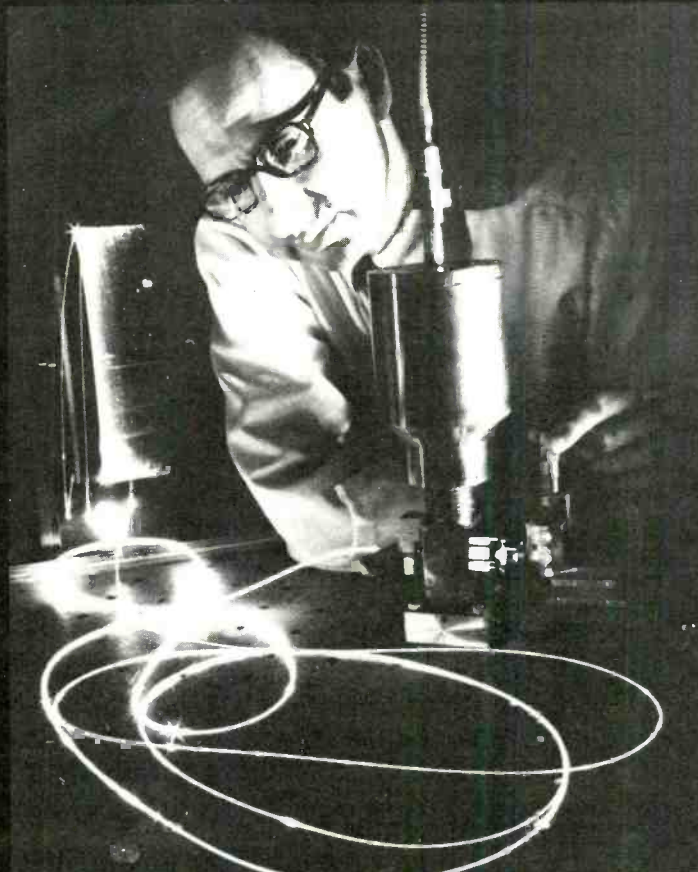
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Circle 13 on reader service card

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# fiber optics—NOW!



*Yesterday a laboratory curiosity; today a developing scientific field, fiber optics is finding uses in the home, automobile, industry and lab. Here is how it works; how it is used.*

by DAVID DOERING

WITHOUT RECENT ADVANCES IN THE FIELD OF FIBER OPTICS, innovative devices such as the point-of-sale data terminal recently introduced by NCR would not have been feasible. This unit enables a sales clerk in a store to enter pertinent data from a credit card or a price tag on an item, directly into an information system with minimum effort, training, and error.

The heart of the system is a reflection-sensing two-branch fiber-optic wand made by Dolan-Jenner Industries. This wand contains two separate 0.062" diameter light guides that are approximately 67 inches long.

One guide, or set of fibers, carries light from a source in the data terminal to the end of the tip, which is passed over a price tag having color coded bars. Light reflected off these bars is picked up by a separate group of light fibers in the same tip, and transmitted back to the sensing circuitry in the terminal. This type of fiber-optic assembly, in which light can travel over two separate paths, mixing only at one end is called a bifurcated, or two-branch light guide.

Whether your purpose is to service, experiment with or design devices using fiber-optic components, this article contains enough detailed information to help you.

## Where it all started

As early as 1870, the British physicist John Tyndall dem-

onstrated that light could be made to follow a curved path. He directed a light into a tank of water, from which a stream flowed through a hole punched in the side of the tank. The stream of water contained part of the light from the tank, and tended to illuminate the spot upon which it fell. However, not until 1950, did an intense investigation into optically-coated fibers begin, with simultaneous efforts starting in the Netherlands, England, and the U. S.

As the 1960's unfolded, fiber optics came of age, and both the news media and sales representatives were touting this new technology as a solution to many problems. In the U. S., the giant electronics and optical companies leaped into the production of light pipes for every application imaginable and as requests for prototypes were received by these corporations, their research and development also expanded. However, every product must eventually pay its way, and many of these corporations soon tired of simply drawing fibers and building prototypes. The finished assembled fiber optic product rarely materialized.

In the 1970's, this situation resulted in two types of fiber optic manufacturers. On one side is the supplier of raw materials. He primarily furnishes either chemically perfect fiber-optic glass, or fibers or bundles of fibers wound on spools like so much electrical cable. Corning Glass Works is one such

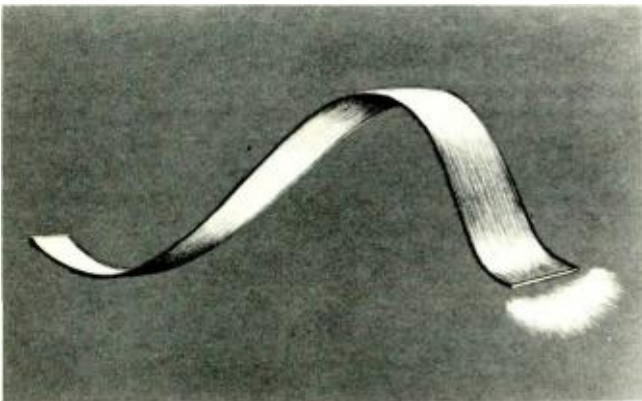


supplier and will deliver its #5010, with a transmission diameter of .045", in continuous lengths up to 10,000 feet, at approximately 14¢/ft.

Although Corning builds prototypes and manufactures specific fiber-optic devices such as its fused-fiber matrix face-plate, routine fiber-optic devices and specialty items are easier to get from the second type of supplier, the company that has purchased or manufactured the bulk fibers and constructed its own devices. Such routine devices include a two- or three-branch probe, a Peeperscope and a combination mark/edge sensor. Companies such as Fiber Photics, Rank Precision, Dolan-Jenner and American Optical fit this category.

### How fiber optics work

Light transmission through a fiber-optic guide is basically a wave phenomenon, in which the fibers serve as wave guides for electromagnetic radiation at visible frequencies. Wave-guide phenomena must be understood and used when fiber optics that have a diameter comparable to the wavelength of light are used, transmitting energy in complex patterns. But for the components discussed here, energy transmission theory can be approximated by conventional geometric optics, in which "rays" of light are traced through the system and used to explain the system's operation.



FIBER-OPTIC RIBBON for experiments and research is 1 inch wide and 1 foot long; sheets are 9 x 12 inches. Edmund Scientific has it.

The entire theory of fiber optics hinges on the principle of total internal reflection, a refraction effect, as the light rays travel along a fiber. Refraction occurs whenever light passes from one material to another. It occurs because light travels at different speeds in different materials. In Fig. 1, a light ray traveling in a material that has an index of refraction "n<sub>1</sub>" and an angle of incidence  $\theta_1$  is bent as it crosses the interface into a second material whose index of refraction is "n<sub>2</sub>" by an angle  $\theta_2$  according to the following relation, Snells Law:

$$n_1 \sin \theta_1 = n_2 \sin \theta_2$$

Angle "θ" is always measured with respect to a perpendicular to the interface of the two materials, and the direction of the light ray may be reversed without changing the path of the light ray. For this equation to be precise, the light should be monochromatic.

This refraction effect accounts for "apparent" distances when looking at an underwater object. When looking straight down, refraction causes a body of water to appear shallower than it actually is.

A light ray traveling from a material having a high refractive index n<sub>1</sub> (an optically dense material) to a material having a low refractive index, n<sub>2</sub> (an optically rare material), crosses the interface and penetrates material 2 only if angle of incidence  $\theta_1$  is less than critical angle  $\theta_c$  as in Fig. 1-b. At incident angles greater than the critical angle, the light can not cross the interface, and instead is totally reflected back into medium 1 as in Fig. 1-c. This critical angle is determined

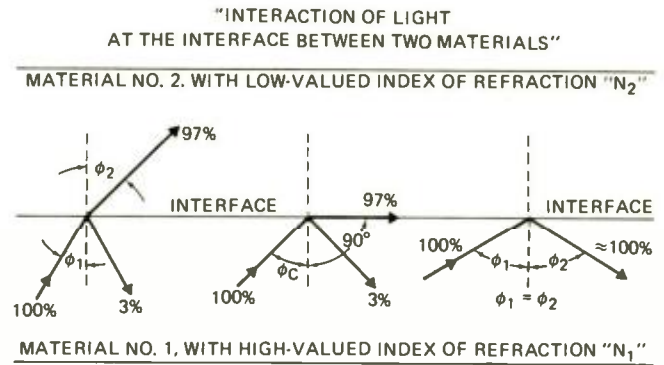


FIG. 1—HOW LIGHT BEHAVES as it moves from one type of material to another. Light may be refracted (a and b) or totally reflected as at c.

from Snells Law to be:

$$\sin \theta_c = n_1/n_2$$

The principle of total internal reflection is found in many optical instruments where glass prisms rather than silvered surfaces are used to reflect light, since even the best silvered surface absorbs a fraction of the incident light. To apply this principle to a fiber-optic light-guide filament, a cylindrical core glass with an index of refraction n<sub>1</sub> is clad with a second glass that has an index of refraction n<sub>2</sub>. For total internal reflection to occur, n<sub>1</sub> must be greater than n<sub>2</sub> and the incident light ray must fall within the angle of acceptance. This angle of acceptance is given by:

$$\sin \theta_a = \frac{\sqrt{n_1^2 - n_2^2}}{n_3}$$

Sin  $\theta_a$  is also called the Numerical Aperture (NA), and represents the maximum angle at which a ray of light that is incident on the transmitting core glass can be trapped within the fiber. Beyond this maximum angle, rays are either reflected off of the core face, or escape the core/cladding interface. The higher the numerical aperture becomes, the greater the angle of acceptance and the greater the light gathering power exhibited by the fiber. These relations are summarized in Fig. 2. In photographic terminology, the f/number = 1/2

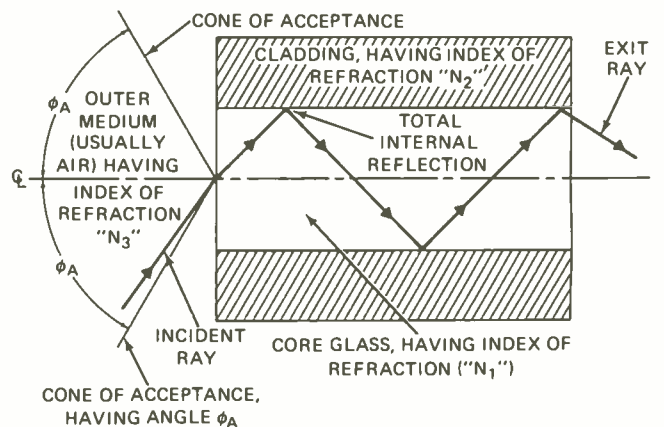


FIG. 2—ACTION OF LIGHT RAY inside fiber-optic filament. Cladding must have refraction index for total internal reflection.

(NA), where a low f/number indicates large light gathering ability by the lens. Since n = 1 for air, the NA can never exceed 1, and the f/number can never be less than 0.5.

Light loss during transmission through a typical fiber depends on several factors. The length of the fiber attenuates



the light ray in relation to the absorption coefficient of the core glass, which is dependent on the color of the source light. Over the wavelength range of  $4.5 \times 10^{-5}$  to  $10.0 \times 10^{-5}$  cm, average absorption loss is 7% per foot of length. Special core glasses can be obtained, however, to transmit ultraviolet.

The ends of a fiber optic bundle also have losses. The areas between fibers do not transmit light, and light energy incident on the clad glass portion of each filament is poorly transmitted. These losses are referred to as packing-fraction losses. They occur at the light source to fiber bundle interface, and account for a 30% loss of the incident energy falling within the acceptance angle of the device.

End losses also include those that occur at the air/fiber interface on each end of a device. Each reflection loss accounts for about 4% of the incident energy. For a one-foot bundle, these losses can be multiplied to yield about 60%



**FLEXILIGHT** light-guide pipes light around corners, through small holes, etc. It is 2 feet long and about  $\frac{1}{8}$  inch in diameter.

transmission efficiency. For longer lengths, this figure should be multiplied by 93% per foot (7% absorption loss per foot).

Although a single unclad rod, such as Lucite, can be used to transmit light, transmission efficiency is quite poor. The key to an efficient light transmitting rod is in the smoothness and purity of the reflecting surface. With an unclad glass or plastic fiber, the smooth outer surface along the length of the fiber can easily be scratched or contaminated with dirt and fingerprints. In addition, when single glass fibers are bunched together in a matrix, light can jump from fiber to fiber (cross-talk), degrading the transmission characteristics of the array.

Cladding provides several advantages. The critical angle remains constant along the length of the fiber; and the critical interface (between core glass and clad glass) is protected, and stays as smooth as when manufactured. Further, cladding provides a way to separate the individual fibers to prevent light leaks. In some optical arrays, a layer of opaque material is applied as a second cladding, resulting in light absorption outside the acceptance angle.

### The basic filament

Fiber-optic devices come in a multitude of sizes and forms, but most are based on the single clad-glass fiber or filament.

The simplest way to draw a single clad-fiber that has discrete index of refraction between core and cladding is the rod-in-tube method, in which a rod of glass (the intended core) is inserted inside a glass tube (the intended cladding) and then fed into a furnace that heats the glass to a temperature just below melting. Then the heated end is drawn out into a fiber that has, on a smaller scale, the same relative core-to-cladding refractive index ratio as the original rod-in-tube.

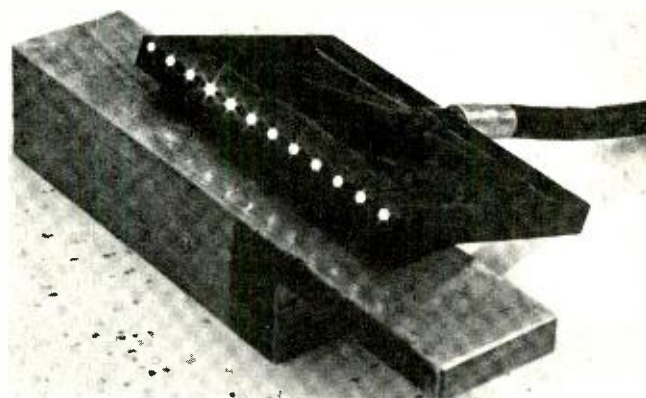
The conventional single-fiber optic filament can be made in any size from 20 microns up to  $\frac{1}{4}$ -inch in diameter (and occasionally larger and smaller). The larger size is frequently called a rod. These filaments are made of either glass or plastic. Glass has the advantages of being sturdier, resisting high temperatures without damage, resisting most chemical envi-

ronments, and is generally more efficient than plastic. Plastic fiber-optic filaments, however, are generally less expensive than glass, and can frequently be used without end polishing, if they are cut cleanly.

Single fibers by themselves are not very useful, except to demonstrate how fiber-optic bundles are made. Plastic and glass fibers can easily be purchased with or without simple experimenter kits from Edmund Scientific or Poly Paks, to mention only a couple of suppliers. The fiber optic experiment kit from Edmund (#70855, \$10.00 postpaid), for example, takes the experimenter step by step through the assembly, grinding, and polishing of a fiber bundle composed of duPont CROFON plastic fibers. The final polishing of the epoxied bundle ends goes faster if the bundle end is first held against a sanding belt to make a flat end. A useful addition to this kit is the set of plastic terminator lenses (#P-41,232 @3.75 ppd.) from Edmund, that is designed to fit over the ends of the bundles made from the kit. Among these lenses are a light-gathering lens, a 45° prism lens, and a diffusing lens.

However, while these kits are fine for the high school physics lab or the weekend experimenter, they are of little value to the serious designer. An equipment designer should not waste his time fabricating fiber-optic bundles and arrays since this approach presents more problems than it solves. Excellent design kits of production fiber-optic devices are available both from Fiber Photonics and Rank Industries. These kits make it possible to build a prototype instrument without worrying about a sloppy fiber-optic component.

An interesting offshoot from the basic fiber fabrication technique is the SELFOC fiber, recently introduced by Nippon Electric. It is a lenslike glass fiber optic light guide in which there is no separation of core and clad glass. Instead, the refractive index of the fiber changes continually in a radial direction from a maximum value at the center to a



**SINGLE LIGHT SOURCE** is a feature of this punched-card reader. Light shines on far end of 12-branch fiber-optics light guide.

minimum value around the circumference. As there are no internal reflections, the fiber itself acts as a lens, and the transmission efficiency appears to be greater than with a conventional fiber-optic filament. In addition, a SELFOC filament produces no phase differences during transmission. The phase of the exit signal is the same as the entering signal.

Perhaps the most interesting use of a single fiber is in the fiber-optic laser developed by American Optical for photocoagulation of the retina-choroid portion of the eye to treat detached retinas. A small cabinet contains the flashlamp and the portion of the laser-fiber that is excited. Output energy travels along the single large, 300-micron diameter, clad laser fiber to a handheld probe, that is directed toward the desired spot by a surgeon. This application allows the precise positioning of intense energy with minimal danger to patient or the physician.

### Making filaments into bundles

When a number of fiber-optic filaments are grouped together into a bundle, a fiber-optic light guide results. It is a bundle of single fiber-optic filaments, that are either epoxied or fused together at the ends and left free to flex in between. Since no effort is made to align the fibers at the ends of the bundle, the light transmitted through the bundle is scrambled or noncoherent, and the main application of these bundles is simple light transmission.

A noncoherent bundle is perhaps the most useful fiber-optic component available. This device comes in many sizes and shapes, although all have potted, ground and polished ends, and the ends are usually held in metal ferrules. An example of readily available quality bundles are those available from A-O and carried by Allied Electronics (#725-1112, A-O type LGM-1, .032" diameter, 12" length, \$5.34 each). A matching A-O quartz iodine lamp illuminator is also available (Allied #725-0500 @ \$142.73, plus adapter for LGM-1 bundles, LGM-1A @ \$1.78 each). The combination of illuminator and fiber bundle provides a source of cool, intense light for readouts, displays, photography, or medical uses—any situation that calls for intense, heat-free light.

The simplicity of a bundle of fibers that serve no purpose other than transmitting light is deceiving. Since light is energy, a fiber-optic bundle can be used to transmit raw energy to a load. One device that does this is the Solid State Laser System #LA-100 manufactured by Hi-Shear Corp. It is designed for failproof firing of explosives at a remote distance. The laser head contains a neodymium pulsed laser set to deliver one joule of energy into the fiber optic bundle. At the receiving end, a power cartridge contains the propellant and an

Another novel use of a fiber bundle is transmission of data. The Isoamp isolation signal amplifier (Develco) shown in Fig. 3 provides both a means of isolation and a means of data transmission. Each system consists of a transmitter, receiver, and connecting fiber-optic cable. Using a battery power source in the transmitter, the system can operate with immunity in areas of high ground-plane and common-mode voltages. The system is used to isolate medical instrumentation, safely measure high voltages, and isolated measurement of rf fields. A plug-in receiver is also available to match the Tektronix 500-series oscilloscope plug-in modules.

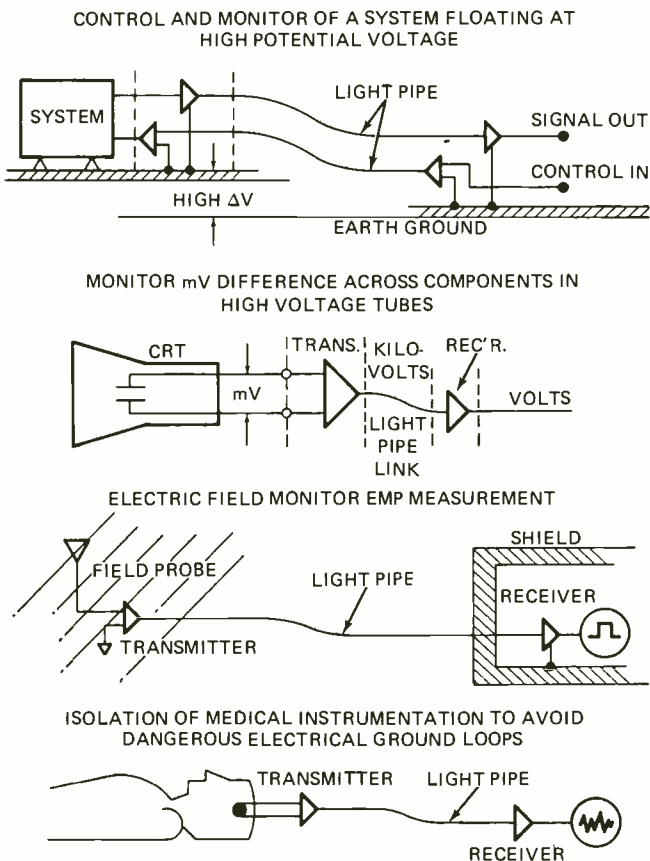
Although fiber-optic bundles can be used simply to supply light in an inaccessible area, a much wider application is in photoelectric sensing circuits. Although a light and photocell could be used without a fiber optic guide, for simple object detection, the light and photocell would be subjected to any mechanical stress that affected the measuring site such as vibrations on a conveyor system. With a fiber-optic guide, both the light and the photocell can be located at a remote point, increasing their reliability and serviceability.

In punched-card readers, a photocell-lamp combination has been superior to the earlier method of brushes and contacts. However, the lamps have a short lifetime because of the vibration set up by the card-handling equipment. By using a single incandescent light source, and a 12-branch fiber optic light guide, reliability is increased while the total number of lamps required is decreased.



**FIBER-OPTIC DEVICES** appear in many shapes and forms to satisfy various consumer, industrial and scientific applications.

A more interesting use for lamp-photocell combinations is in reflection sensing to sense a mark on a card. In use, a two branch (bifurcated) bundle is used, with light traveling from the control unit to the tip of the bundle along one branch, or set of fibers. This light illuminates the area of interest, while light reflected from this same area is picked up by the other light guide in the same bundle, and carried back to a photocell in the control unit. These units are widely accepted in industry for such things as mark sensing, color matching, color change determination and edge sensing. With proper selection of light source and light guide, a unit like this can detect a spot as small as 0.002". 50 or more feet from the sensing site. This type of sensing can be applied easily to an optical tachometer. IBM has also considered applying reflection sensing to temperature monitoring so a central control panel would monitor the temperature of remote devices that have been painted with a temperature indicating paint. When a given temperature reaches the alarm point, the paint changes color say from white to black. The level of reflected light that is carried back along the fiber bundle to the indicator lens changes accordingly.



**FIG. 3—SEVERAL APPLICATIONS** of Develco's Isoamp. Light pipe provides electrical isolation between the receiver and transmitter.

optical glass window that admits the laser light to the propellant. Such a device can be used to fire explosive bolts in rockets to separate stages, and since the firing mechanism has only a glass fiber input, it cannot be accidentally set off by static electricity or electromagnetic interference.



## Automotive applications

DuPont has just recently proposed that car instrument panels be illuminated from a single bulb. This light would be focused on to a many-branched fiber-optic bundle, with each branch being routed inside the wiring harnesses to a different point on the panel.

This year's Chevrolets have an optional level-indicator system that can be installed on the windshield washer tank. The system consists of a sending unit, a light conducting fiber-optic bundle, and a lens assembly for the instrument panel. Similar in design, but suited for washer tanks or any application where you want to sense a liquid level is a liquid-level monitor evaluation package, available for \$50.00 from Corning Glass Works (see Fig. 4).

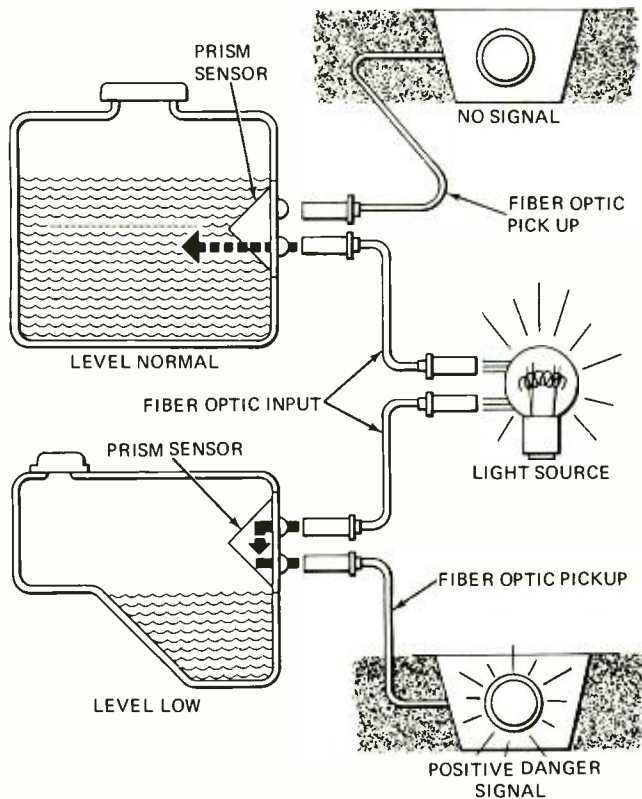


FIG. 4—FIBER OPTICS MONITORS two liquid levels. Single lamp excites the optics and provides alarm signal when needed.

Last, there is the question of whether or not the exterior lights on a car are burning correctly. While Detroit is pondering a solution, the experimenter can have his own fiber-optic light monitor. The "Litechex Kit I" monitors stoplights only (\$14.95), and the "Litechex Kit II" monitors headlights and stoplights (\$19.95). Both kits include a monitor panel that attaches to the dashboard, and all lenses, grommets, and wire ties. They are available from Electro Fiberoptics Corporation.

## Coherent fiber-optic bundles

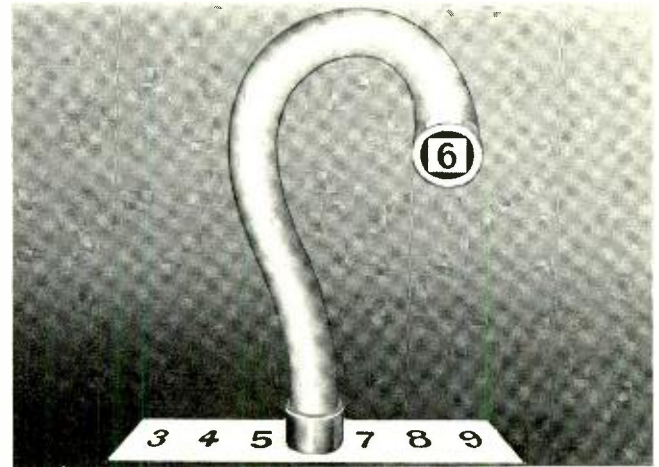
Manufacturing a bundle of fibers whose beginnings and ends are aligned in the same orientation produces a coherent bundle that can be used to convey an image, instead of simply transmitting light. This type of bundle is collectively called a flexible fiberscope, and enables observing inaccessible places such as the inside of the human stomach or the inside of a jet turbine. An introductory flexible fiberscope is available for \$40.00 either from Edmund Scientific (Flexible Fiberscope, #60,857) or from American Optical (Peeperscope).

## Sheet optics

Individual fiber-optic filaments can also be arranged side by side in a sheet. If the sheet of fibers is arranged in a circular shape at one end, and a different shape at the other end

(such as a straight line), the light accepted by the end formed into a straight line will be delivered at the other end in the form of a lighted circle. This is the line-to-circle-converter, and it has many applications in facsimile transmission.

Sheet material can also be used to project and detect a



FLEXIBLE PLASTIC FIBER OPTICS transmits Images in full color. Light loss is 20% per foot plus 10% at each end.

light curtain. This type of arrangement is frequently used on large punch presses to insure that a part has been ejected, prior to the start of a new punch cycle.

## Mosaics

Another important area of fiber-optics applications is mosaic fabrication. Here, many glass fiber-optic filaments are fused together into a plate or mosaic, having many parallel light channels. This is a difficult process, and some companies first surround each filament with an opaque coating (called extramural absorption) to deter crosstalk between adjacent filaments in the finished mosaic. They are used as image magnifiers, inverters, intensifiers, and faceplates in special-purpose cathode ray tubes.

A long-standing problem is obtaining a hard copy of an image on a CRT. Conventional CRT's simply do not deliver a sharp enough image, because of the scattering effect of the light as it passes from the phosphor layer through the glass faceplate. However, if the faceplate is a fiber-optic mosaic that has a phosphor coating over the internal ends of the fibers, then as the phosphor layer is scanned and excited by an electron beam, the emitted light travels only along the parallel filaments in its path to the outside world.

This configuration produces a very sharp image on the outside face of a CRT and can be used to contact print a dry photosensitive paper directly, resulting in a crisp hard copy picture.

## Getting involved in fiber optics

To illustrate some fiber-optic facts, there are several simple experiments that you can try.

When working with either single fibers or fiber bundles, there are two main points to keep in mind. First, glass fiber devices can be broken if bent too sharply. Never bend a bundle sharper than the minimum bend radius specified by the manufacturer. Secondly, glass fibers, and glass dust in particular can be very painful should they get under your skin or in your eyes.

**1. Numerical aperture of a Lucite rod:** The basic fiber optic effect can be observed quite simply, as well as the theory of the critical angle of admittance of incident light. A Lucite rod can be used, if the ends are first cut perpendicular to the axis, parallel to each other, and polished as smooth as possible (chuck the Lucite rod in a lathe chuck, and use jeweler's rouge to polish the spinning ends of the rod).

(continued on page 84)

# BUILD A ZIRCONIUM ARC PROJECTOR

*This lamp has a wide range of applications, all the way from demonstrating optical phenomena to enlarging photographs*

by HAROLD PALLATZ

YOU CAN MAKE YOURSELF A COMPLETE Zirconium arc projection system with a few low-cost, readily available parts. With your completed system you can make a number of experiments not feasible with other types of lights. For example, you can project images such as pinheads, tiny parts or color slides directly on a screen *without using a lens*. You vary the size of the projected image just by changing the distance of the object to the light source. It will be in sharp focus for the entire distance.

The high brilliance light (white light) is actually an arc formed between two zirconium electrodes. The reason for its ability to project "lens-less" images is its tiny area. The 2-watt lamp has a diameter of 0.005 inch, while the 10-watt lamp has a 0.016-inch diameter (at 29,300 candles per in).

## Construction hints

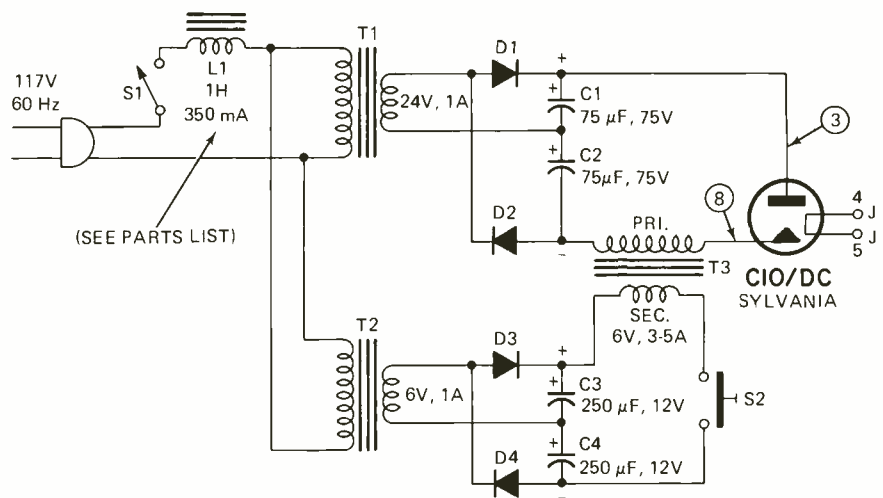
You will need a low-voltage power supply, a pulse starter circuit and some means of limiting the maximum operating current.

A 24-volt transformer forms part of a voltage-doubler circuit to provide 48 volts at less than 0.5 ampere for the arc current. It is limited with an ozone lamp ballast in the primary. You can substitute a 40-watt lamp or a 1-henry choke. Thus even under short-circuit conditions, less than one ampere dc current will flow.

The pulse transformer consists of a standard 6-volt transformer connected backwards. A momentary application of dc to the filament winding produces the necessary thousand volts to start the lamp. You might find that the lamp will start easier with a particular polarity on the filament. This is because either a positive or a negative pulse will then be developed across the arc. Do not apply the dc to the filament more than a fraction of a second at a time, to prevent overheating.

We used the 600-volt diodes specified in the schematic because they were handy. You can get by with lower-rated (say 300-volt) types.

**ARC PROJECTOR** in breadboard form and **SIMPLE SCHEMATIC** at right and below, respectively. The type C10/DC lamp is available from Edmund Scientific Co. The catalog No. is 41,548 and price is \$30.80.



## PARTS LIST

- |                                         |                           |
|-----------------------------------------|---------------------------|
| C1, C2—75 $\mu$ F, 75V, electrolytic    | choke; or 40W, 115V lamp. |
| C3, C4—250 $\mu$ F, 12V, electrolytic   | T1—115V pri, 24V, 1A sec  |
| D1, D2, D3, D4—Silicon, 600V PIV at 1A  | T2—115V pri, 6V, 1A sec   |
| L1—4W ozone lamp ballast; or 1H, 350-MA | T3—115V pri, 6V, 3-5A sec |

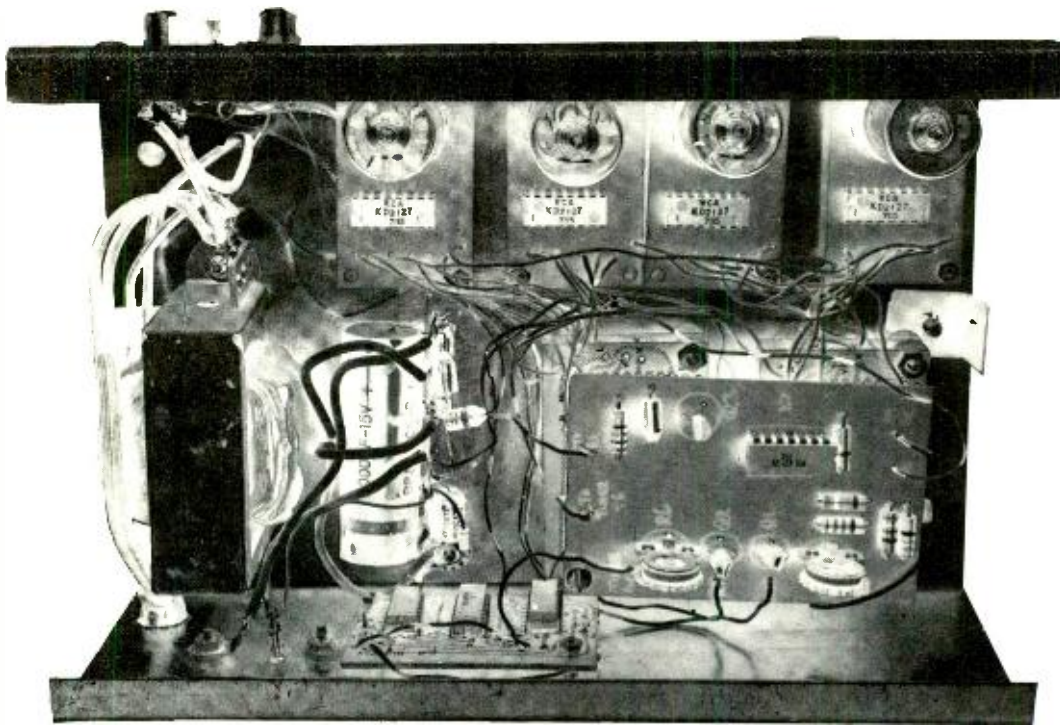
## Put it to work

Sometimes a new lamp will require many pulses to activate it. Once started the light will be unusually steady and constant in intensity. Do not look directly into the light—as its high brilliance can affect the eyes. Zirconium lamps are made by Sylvania Electric. We used a type C10/DC rated 10 watts, 21 volts operating (recommended power supply is 50 volts dc or more). A 1,000V pulse at 0.5A operating current

is required.

An unusual optical experiment you can perform is image reversal. Place a slide or other object between the light source and a lens. Move the lens back and forth. At some positions the image will be right side up. As the lens is moved, the image will be seen to turn upside down. An intense spot of light at a considerable distance can be obtained by placing a lens in front of the lamp and bringing the arc into focus. **R-E**





## ELECTRONIC DIGITAL STOPWATCH

*Time any stop-start interval from 0.1 second to 9 minutes  
59.9 seconds with this modular IC stopwatch*

by B. R. ROGEN

DIGITAL IC'S ARE CONSTANTLY DROPPING in cost, and a look at the various advertisers in this magazine will show a number of sources. However, to take advantage of these low-cost IC's, you need the circuits to use them. While some of us already have a number of digital circuits we would like to try, there are many others who would like to get their feet wet in this area, but just don't know where to start.

RCA has now entered the digital arena with a pair of readily available "blister packaged" digital IC kits—the KC4012 Digital Counter IC Project Kit (\$6.95) and the KC4011 Digital Display IC Project Kit (also \$6.95). These are available at your local electronics distributor that handles the RCA line.

The KC4012 kit contains three IC's—two KD2128's with each IC having a pair of independent J-K flip-flops; and a KD2129 that contains four two-input NAND gates. Both of these IC's are members of the DTL (diode-transistor logic) family and their "innards" are shown in Fig. 1. The kit also contains an etched and drilled PC board (Fig. 2 shows details of the board) having some interconnects already made, while providing clearly identified terminals for external connections. Also supplied in the handy plastic case is some solder and an instruction booklet that illustrates the various projects that can be



fabricated with the kit. These include various counters, electronic dice, 12- or 24-hour clocks, photoelectric counters, with most using the KC4011 kit for displaying the readout.

The KC4011 kit contains a Numitron seven-segment readout tube (KD2126), a plastic socket, a BDC-to-seven-segment decoder (KD2127), an etched and drilled PC board (Fig. 3 shows details of the board), some solder, and the same instruction booklet that comes with the KC4012 kit.

After playing with a set of these digital projects, we decided to build something that our local school has needed for a long time, but could not afford to purchase—an accurate timer for the track team that is capable of resolving to 9 minutes and 59.9 seconds in 0.1-second intervals, triggered on and off using light beams at the start and finish lines. We later found this project useful for timing bike races, chess moves, and even in slot-car races. It can also be used for photographic darkroom timing if a suitable dark red filter is used in front of

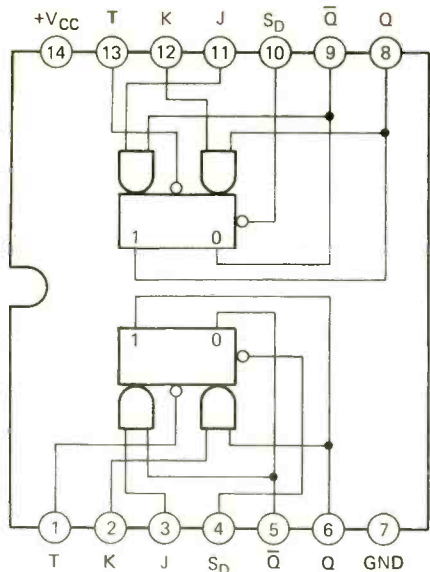
the Numitron readout tubes.

The timer schematic in Fig. 4 shows the connections to be made within each module to form a divide-by-ten (decade) or a divide-by-six (mod-6) for the ten's-of-seconds position. Also shown is the light beam gating circuit, and a suggested power supply.

**Timing:** The basic timing signal is derived from the commercial 60-Hz power-line as this frequency is accurate enough for most amateur applications. The 60-Hz waveform is squared up by transistor Q3 and applied to a divide-by-six counter using a separate KC4012. The output at terminal P1 is a 10-Hz (0.1-second) signal that will be used by the readout circuits.

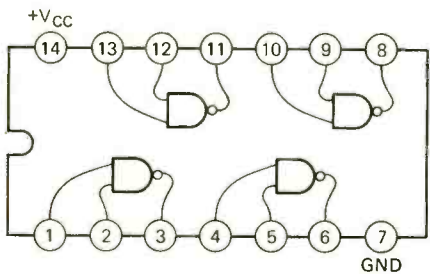
**On-Off Gating:** When you build the mod-6 counter (used in the tens-of-seconds stage), you will have a KD2129 quad two-input NAND gate left over. Three of these gates are used in the on-off timing. Gates A and B are arranged as an R-S flip-flop so that a negative-going pulse at their inputs will cause the flip-flop to change states.

A negative-going pulse suitable for this purpose is developed at each of the photoelectric circuits, with one used as the *start* pulse and the other used as the *stop* signal. As each circuit is similar, only one will be described. Transistor Q1 is base-biased via R1, sensitivity



**KD2128**  
(TOP VIEW)

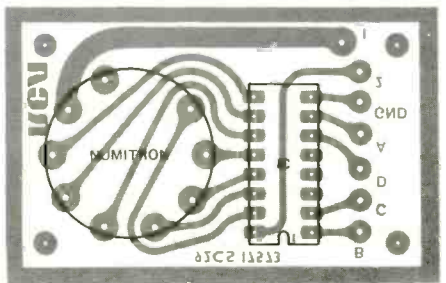
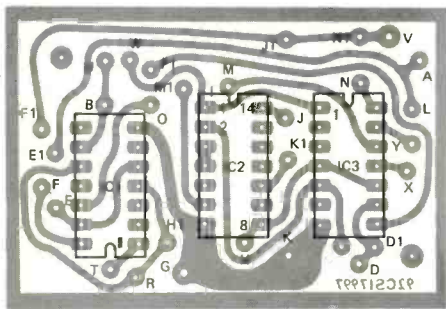
TRUTH TABLE		$t_n$	$t_n + 1$	
$S_D$	$\bar{Q}$	J	K	$Q_n$
1	N.C.	0	0	0
0	1	1	0	1
	0	0	1	0
		1	1	$\bar{Q}_n$



**KD2129**  
(TOP VIEW)

**NAND GATE**

POSITIVE LOGIC: OUTPUT =  $\overline{1 \cdot 2}$   
NEGATIVE LOGIC: OUTPUT =  $\overline{1 + 2}$

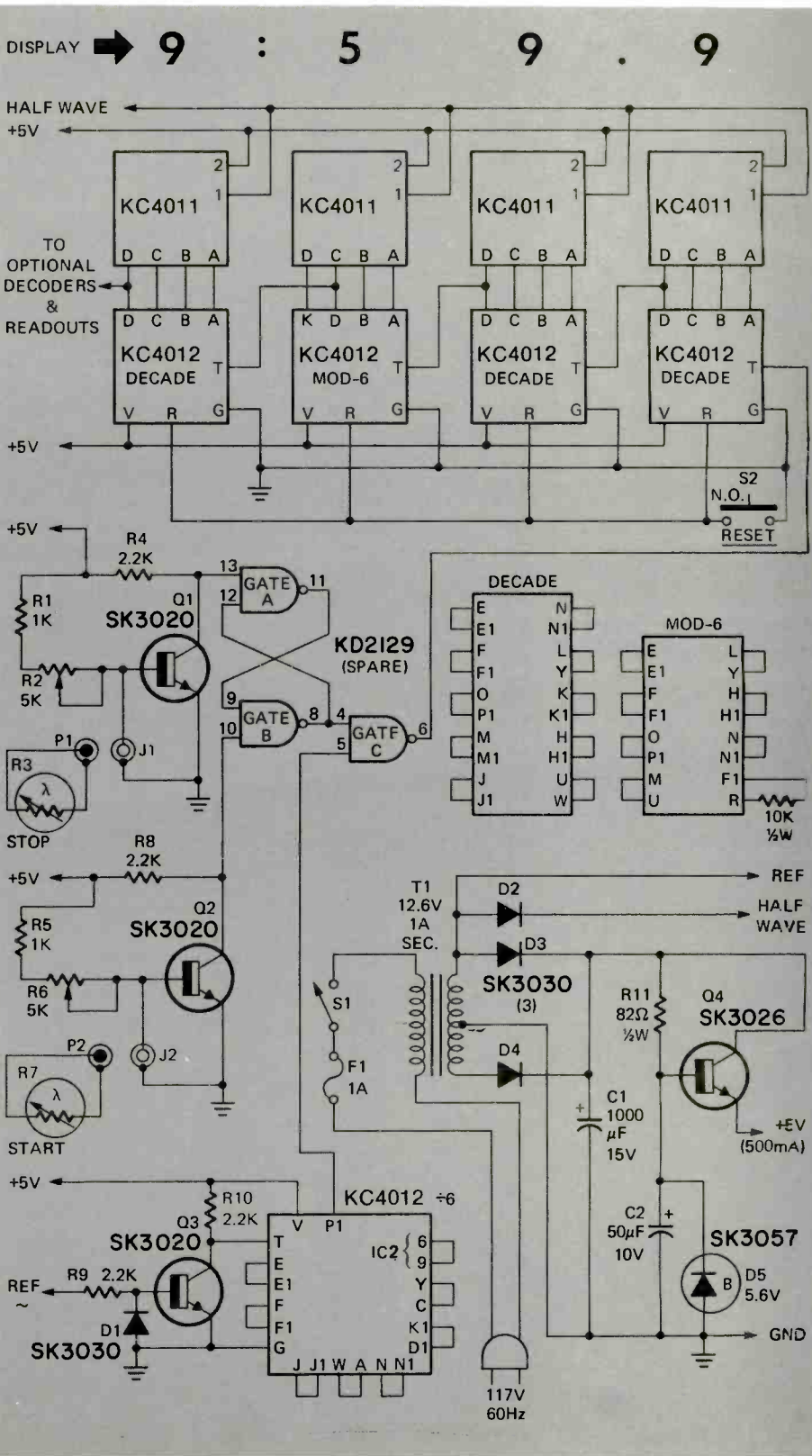


**FIG. 1—(left) BASE AND FUNCTIONAL** diagrams of the IC's in the KC4012 counter kit.

**FIG. 2—(center left) CIRCUIT BOARD** for the KC4012. Both foil pattern and parts location are shown.

**FIG. 3—(bottom left) CIRCUIT BOARD** for the KC4011. Both foil pattern and parts location are shown.

**FIG. 4—(below) SCHEMATIC OF THE TIMER.** The letters A through W refer to terminals on the PC boards supplied with the kits.





control R2 and the value of photoresistor R3. As the light beam is shining on R3, its resistance is low, thus causing Q1 to be cutoff making its collector maximum positive. If the light beam shining on R3 is interrupted, it will cause Q1 to saturate thus making its collector voltage drop close to zero during the shadowing. It is this spike that toggles the flip-flop. The output of the R-S flip-flop is coupled to one input of gate C with the other input accepting the previously described 0.1-second timing pulses. Each time that gate C is enabled, the 0.1-second pulses are passed to the digital readouts.

**Readout Modules.** Two types of readout modules are used in the timer: one is a conventional decade counter that displays from zero to 9 then picks up the count at zero at the tenth pulse while simultaneously generating a carry pulse for the next counter. The other counter is a mod-6 affair that generates the digits from zero to 5 then picks up

**parts list for Figure 4.**

- R1, R5—1000-ohm, ½-watt resistor
- R2, R6—5000-ohm, PC-type potentiometer
- R3, R7—KD2106 photoresistor (RCA)
- R4, R8, R9, R10—2200-ohm, ½-watt resistor
- R11—82-ohm, ½-watt resistor
- C1—1000-μF, 15-volt electrolytic
- C2—50-μF, 10-volt, electrolytic
- D1-D4—SK3030 (RCA) 200 PIV, 1-amp diode
- D5—SK3057 (RCA), 5.6-volt, 1-watt Zener diode
- F1—1-ampere fuse and holder
- J1, J2—miniature phono jack
- Q1-Q3—SK3020 npn transistor (RCA)
- Q4—SK3026 npn power transistor with insulating mounting (RCA)
- S1—spst slide or toggle switch
- S2—spst normally-open pushbutton switch
- T1—filament transformer; secondary 12.6-volts, 1-ampere
- Modules: KC4011—Digital IC Project Kit (4)
- KC4012—Digital Counter IC Project Kit (5)
- Miscellaneous: Photocell enclosure (2), matte black paint, interconnect cables with J1, J2 matching plugs, suitable light sources, line cord, colored transparent overlay for display, suitable chassis, multi-lug terminal strip, rubber feet (4).

the count of zero at the sixth pulse. This circuit also generates a carry for the next counter.

The KC4012 module has a "reset" terminal (R) which, when connected to ground, switches the logic within the module automatically to zero. Therefore, reset switch S2 is normally open, and when depressed, actuates the display zero.

As shown in Fig. 4 the display will indicate to 9:59.9 minutes, and if a longer timing interval is required, the output (carry) of the minute decade can be used to drive a mod-6 stage to produce 59 minutes and 59.9 seconds. If you want a more accurate timing to the right of the decimal point, then a crystal-controlled oscillator will be needed and some decade counters will have to be added to provide the desired digits

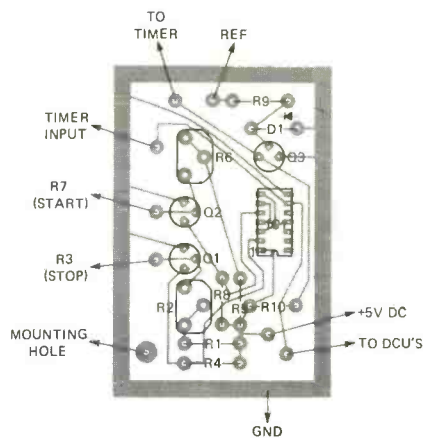


FIG. 5—PARTS LAYOUT for components in the time and gating circuits built on PC board.

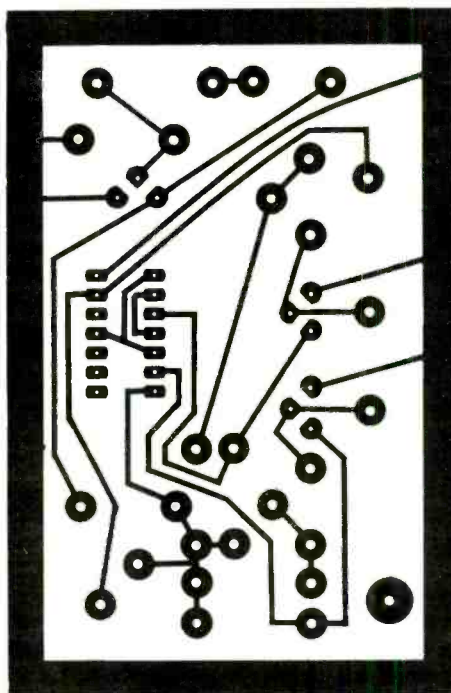


FIG. 6—FOIL PATTERN for the time and gating module. Point-to-point wiring may be used.

the right of the decimal point.

**Construction**

Packaging the timer is at the discretion of the builder. The prototype was built within an 8 by 3 by 5 inch two-piece metal enclosure. The readouts were mounted on ¼-inch spacers along the front with a suitable cut out in the front panel for the display. The associated counter boards were "stacked" in two piles on one side of the chassis and interconnected to their display boards. The timer module and gating board were built up on a home-made PC board using the foil pattern shown in Figs. 5 and 6.

The power supply, (Fig. 4) was built up on a terminal strip, which along with T1 was mounted within the chassis. Regulator transistor Q4 is mounted (with suitable insulation) on the rear wall of the chassis. Besides the display, the power switch S1, reset pushbutton

S2, and the two photoelectric inputs (J1 and J2) are mounted to the front panel.

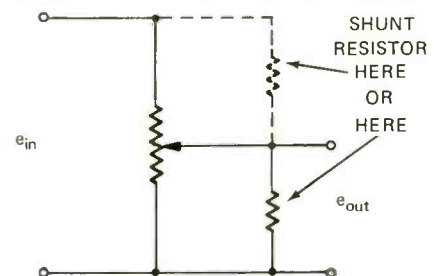
The two photocells (R3 and R7) must be mounted within light-tight tubular enclosures. We used a 5-dram plastic pill bottle painted matte black both inside and outside. The photoresistors are mounted with adhesive (making sure that the sensitive surfaces are in view) and their leads should protrude through a pair of drilled holes in the side or end of the case. The connections between the two photoresistors and the front-panel connectors were made with ordinary phono cable with a plug at the far end.

With the system turned on, depress S2 and note that each readout displays a zero (0). With a bright light shining into each photoresistor housing, pass the hand over the tube containing R7 (start) and note that the Numitrons start indicating the passage of time. Passing the hand over the R3 (stop) enclosure should cause the readouts to stop. The two sensitivity controls (R2 and R6) are set to make the system start and stop correctly depending on the amount of light reaching the photoresistors, and how long it takes the timing shadow to pass over the sensitive surface. If desired, the two controls can be screwdriver adjusted from the outside, if a pair of holes are drilled in the rear of the chassis.

The two light sources can be powerful flashlights, or line-powered bright lights preferably with lenses to concentrate the light on the associated photoresistor. A smaller lighting system can be used for slot-car race timing. For manual operation, a pair of normally-closed pushbuttons may be used in place of the photoresistors. **R-E**

**LOG TAPER FROM LINEAR POTS**

It is easy to change a linear-taper potentiometer to a nonlinear log-like type. Simply connect a fixed resistor between the slider (center terminal) and



one of the outer terminals as in the diagram. The value of the fixed resistor is approximately one-half the value of the linear pot.—Joseph Rotello, Jr.

(The subject of deriving nonlinear functions from linear potentiometers is an interesting one and additional information can be found in *Audio*, Feb. 1965, page 19.—Editor) **R-E**

*The multimeter is the most common and most under-utilized tester. Here is how to get more use from yours.*

THE VOM/VTVM IS PROBABLY "THE" basic piece of test equipment. And because almost every electronics enthusiast knows this, the vom or vtvm (or both) is usually the first piece of test equipment purchased and used. The basic multimeter is the training instrument, it gives first contact with the insides of the electronic circuit. Yet, despite the widespread use of the instrument, the meter is hardly used to its full capability. For instance, you can use a vom or vtvm for an extremely accurate light meter! You can use the meter for an idle tachometer, or by adding a black box you can have a linear ohmmeter. In fact, the multimeter can be working for you even when it is not working at all!

### The volt-ohm-milliammeter

The vom is an application of the simplest of all measurement principles—there is a direct relationship between applied voltage and current in a resistance. The basic schematic of the voltmeter portion of the typical vom is in Fig. 1-a.

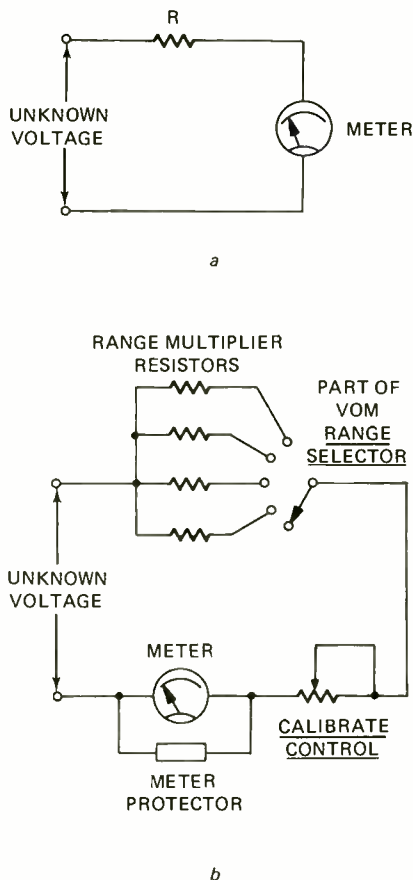


FIG. 1-a—BASIC VOLTMETER CIRCUIT. b—Typical dc volt portion of a vom. The meter protector prevents damage to the meter when the unknown voltage is higher than the selected maximum range.

The meter is calibrated so that with the maximum voltage for a range at the input, the meter reads full scale. If the meter movement is 0-1 mA, and the meter has no internal resistance, 1 volt applied through a 1000-ohm resistor causes full-scale deflection. The meter would read 1 volt full scale. If the same 1000-ohm resistor were used, and 0.5 volt applied, the meter would read 0.5 mA or half-scale. (We leave it up to the meter manufacturer to make sure his meter is linear.) That is basically how it works. In the real McCoy, Fig. 1-b, there are lots of resistances and these are switch selected so the meter can read various voltage ranges.

To read ac, simply insert a rectifier

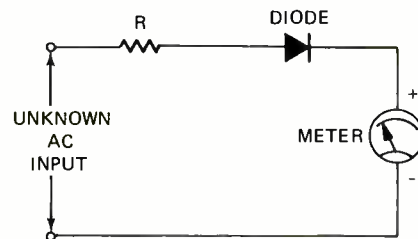


FIG. 2—BASIC AC MEASURING CIRCUIT. The meter reads the average diode output which is 0.318 the peak applied voltage. Frequency response is controlled by the diode and the capacitance of the meter. Very low voltage inputs will read non-linear on the meter because of the diode response.

in the input as shown in Fig. 2. The average current flowing out of the diode with sinusoidal input is .318 times its peak value. This simply means that if a 2-volt peak-to-peak signal (1 volt peak) were applied to the meter, the average current would be 0.318 mA, so the meter would read 0.318 mA, instead of 1 mA. You could either redo the meter calibrations to make it read 1 volt at 0.318 of full scale, or you could change the value of R so that you could use the same calibrations as the dc scale. Note how low the value of R would be to read 1 volt. Most practical ac voltmeters use a voltage-doubler to increase sensitivity to 0.636 value. This is why most of the less expensive multimeters do not

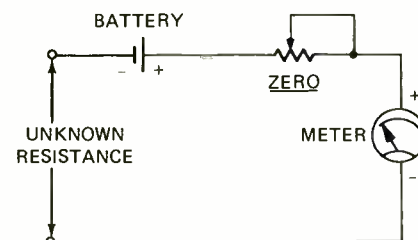


FIG. 3—BASIC OHMS MEASURING in a vom. Battery voltage is switched so various ranges of unknown resistance can be measured on the meter.

have a low ac volts range.

To read resistance in ohms, you use the basic setup shown in Fig. 3. Now the battery supplies a constant voltage, and the meter reads circuit current through the unknown resistance, R. With a 0 to 1-mA meter, and a 1-volt battery, a 1000-ohm resistor gives 1 mA current flow. If R is 10,000 ohms, the meter reads 0.1 mA, etc., etc. The meter scale is calibrated in ohms.

One thing not to be overlooked in the volt-ohm-milliammeter, is the milliampere scale. It is rather simple, just use the 0 to 1-mA meter by itself to read 0-1 mA. To reach some other current scales, you merely shunt the resistance of the meter with another resistor so a percentage of the current divides between the meter and the shunt. For instance, if the internal resistance of the 0-1 mA meter was 100 ohms, and you used a 100-ohm shunt, the meter would read 0-2 mA because half the current would flow through the shunt and only half through the meter.

All the circuits described are incorporated into the multimeter by using a system of switching so dc volts, ac volts, ohms, or current can be measured. Once the meter has been switched into a mode, various resistances and shunts can be switched in to select a range.

## THE VTVM, VOM, TVM





With vom in hand you have a pretty versatile instrument that can be used to make a variety of electronics measurements.

### The vacuum-tube-voltmeter

The vacuum-tube-voltmeter, like its name, can read voltages. Usually the bench type vtvm we are considering has an ohms scale but it is only an extension of its voltmeter configuration. The main advantage of a vtvm over a vom is its high input impedance.

The vom with the 0 to 1-mA meter, when used on the 0 to 1-volt scale, was made up of a 1000 ohms of resistance. This was the total input resistance or impedance of the instrument. In fact, the example was a 1000 ohms/volt meter. Had the meter been a 100- $\mu$ A meter, R would have been 10,000 ohms and the meter would have been rated at 10,000 ohms/volt. Because of the increasing value of R, a 1000 ohms/volt meter would have a resistance of 10,000 ohms when used on the 10-volt scale, the 10,000 ohms/volt outfit would look like a 100,000 ohms on a 10-volt scale. In other words, for every volt, the meter presents, its rated ohms/volt. This internal meter resistance can affect meter readings. For instance, if the 1000 ohms/volt meter is on a 10-volt scale, its

10,000 ohms can seriously load a circuit that has, say: 1-megohm impedance.

The vacuum-tube-voltmeter has a very high input impedance on every scale. Figure 4 shows the basic voltage measuring circuit of a vtvm. Notice that the meter is isolated from the input by the vacuum tube. The vtvm input is a very high input impedance. With such a high input impedance, it is nearly impossible to put a resistor in series with the vacuum-tube input for range switching. The tube and the meter read a given voltage (usually a volt or two). The grid is connected to a voltage divider that divides input voltages down to the 1 or 2 volts usable by the tube/voltmeter combination. Thus the input impedance of the vtvm is constant and is nearly always a function of the total resistance in the voltage divider network. Thus, there is no ohms/volt rating, just an input impedance figure, usually on the order of 10 megohms or so.

To measure ac volts, the vtvm is connected across a diode rectifier and reads the output voltage. This means that readings would be 0.707 of full scale, except that a filtering capacitor is usually used at the diode's output so the reading becomes 1.414 of full-scale. Sometimes, a different voltage divider network is used for ac volts to give the

## How they work New ways to use them

by JAMES R. HUFFMAN

proper full-scale readings. Another procedure raises the value of the resistor in series with the meter to scale-down the higher readings. When the rectifier arrangement is used, it usually means a lower input impedance on ac ranges. Even the lower ranges are usually on the order of 1 megohm or more. So they are negligible when compared with the vom.

Ohms are measured in most vtvm's by using the setup in Fig. 5. Here, the basic voltage measuring portion of the vtvm is set up (by changing the meter's series resistor) to read full-scale with a 1.5-volt battery. The battery is connected through the ohms-select resistors as shown. Now a voltage divider is formed by the ohms-select resistor and the unknown resistor. The meter merely reads the voltage across the unknown and is calibrated in ohms. In the vtvm the ohms scale reads backwards as compared with the vom. In the vom, higher resistance meant less current and a lower reading. In the vtvm, however, a higher resistance means a higher voltage drop and a higher reading.

### Applications

The traditional applications of the

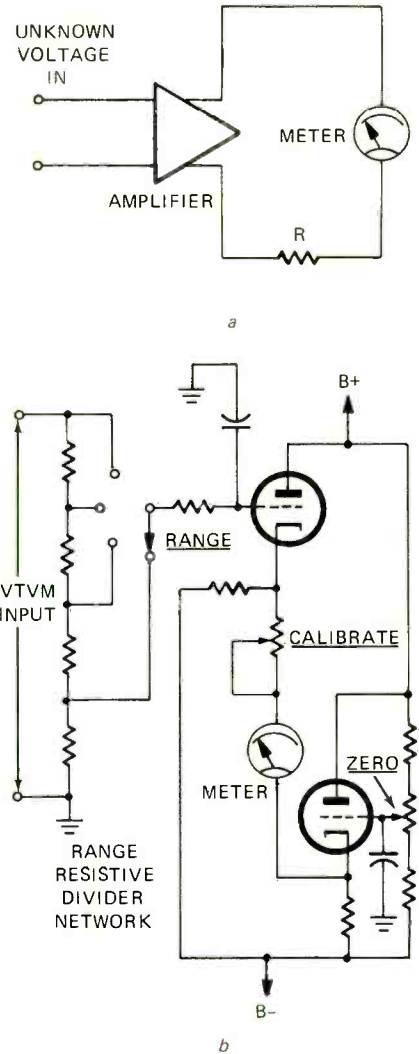


FIG. 4-a—THE VTVM. Shows the basic vtvm circuit. The meter that reads the unknown voltage is isolated from the circuit under measurement by a high-impedance vacuum tube amplifier. b—A simplified "practical" circuit. The meter measures the balance of a differential amplifier. The meter indicates the imbalance caused by the unknown voltage or the position of the "zero" control.

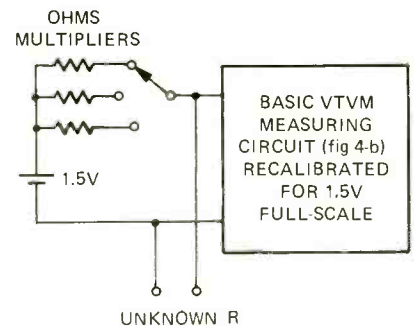
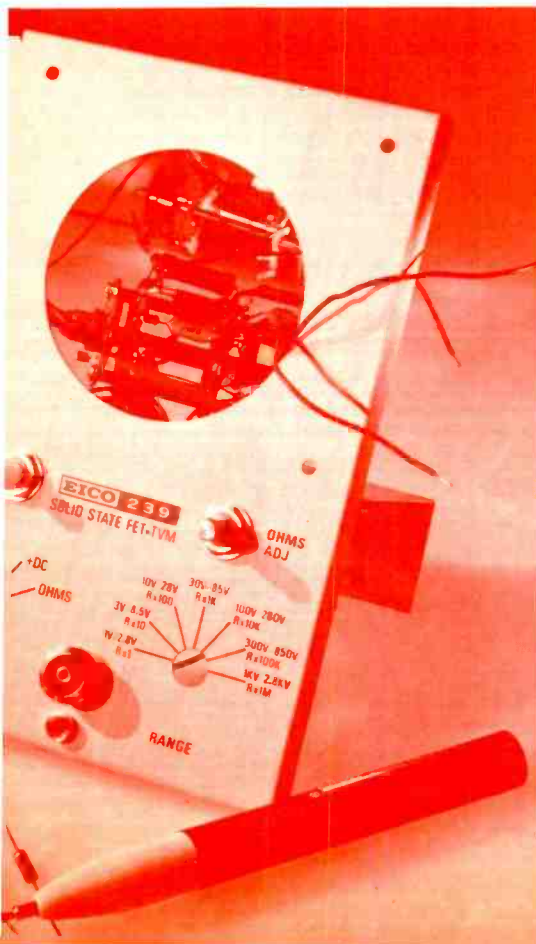


FIG. 5—OHMS RANGE ON A VTVM. A vtvm measures resistance by measuring the voltage drop across the unknown R. Two Fetvm manufacturers (Sencore and Triplett) offer a low-voltage ohms scale that uses only 0.1 volts. This low-voltage allows the user to check components "in circuit" without forward-biasing semiconductor junctions. The meter can be switched to high ohms for normal use.

vtvm and the vom are of course current: voltage and resistance measuring. All other applications are just variations of

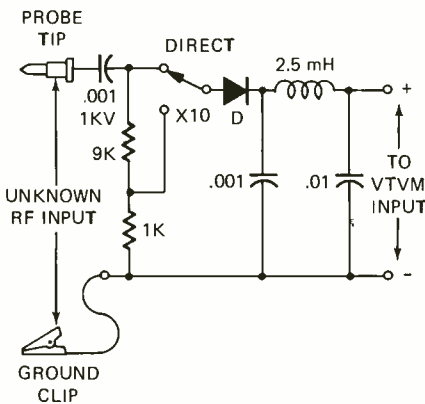


these uses. You'll probably find some applications you use every day and others you have used on occasion or possibly never. The applications have been divided into three categories: maintenance (trouble-shooting), experimentation, and automotive.

### Maintenance

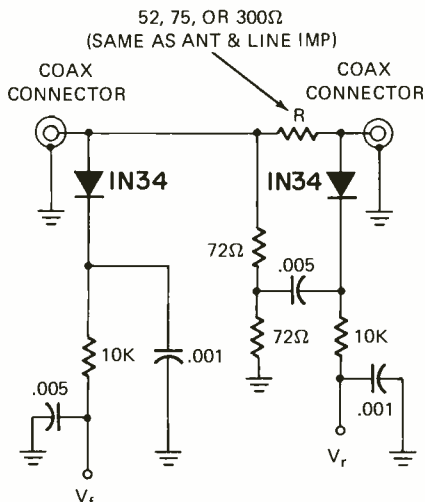
This is a category of applications that apply directly to maintenance uses of the vom/vtm. They are intended to go one step beyond the typical volts, amps, and ohms measurements.

**1. Rf voltmeter.** A vom or vtm can serve as an rf voltmeter when you use the diode detector arrangement shown in Fig. 6. The entire unit can be



**FIG. 6—A DIRECT/X10 ATTENUATOR** probe for rf measurements. This diode rf probe provides a dc output voltage in relation to the peak applied rf voltage. Diode D may be chosen for the highest frequency to be measured. With D a 1N34, the probe works to about 30 MHz. Max input voltage: 30 volts direct; 300 volts x10.

housed in a probe. The meter is used on the dc volts scale. The conversion data is simple: for peak rf volts, an ac-rms meter reads direct; for rf Vr<sub>ms</sub>, multiply the meter reading by 0.707. When using a vom, insure the probe sees at least 20,000 ohms, using your ohms/volt rating and range switch (multiply ohms per volt, times range setting).



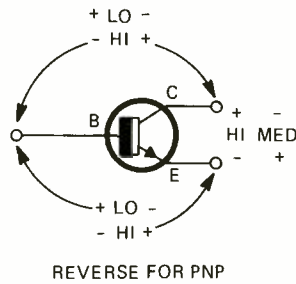
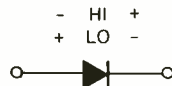
**FIG. 7—SWR BRIDGE.** This simple circuit and the formula given in the text yield pretty accurate SWR measurements.

**2. SWR bridge.** When used with the simple circuit shown in Fig. 7, the vom or vtm reads standing-wave ratio. First, measure the forward voltage then switch to reflected voltage and record. The standing-wave ratio is then found by the following formula

$$SWR = \frac{V_f + V_r}{V_f - V_r}$$

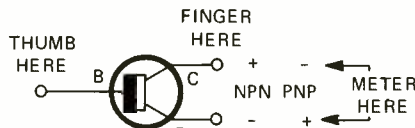
where  $V_f$  is forward-voltage reading and  $V_r$  is the reverse reading. This unit cannot be left in the line as it is designed for power levels of less than 1 watt. Actually, you shouldn't be adjusting an "on air" signal with full power anyway, so this is best for you, the FCC, and the others trying to operate while you test. You can check the circuit by connecting a 50-ohm non-inductive resistor on the output; you should get an SWR of 1:1. If not, adjust the value of R.

**3. Transistor/diode checker.** This should be familiar to the more advanced experimenter. The checkout procedures for diodes and transistors are given in full in Fig. 8. This allows a



REVERSE FOR PNP

a



b

pretty good check of diodes and transistors, both in and out of circuit.

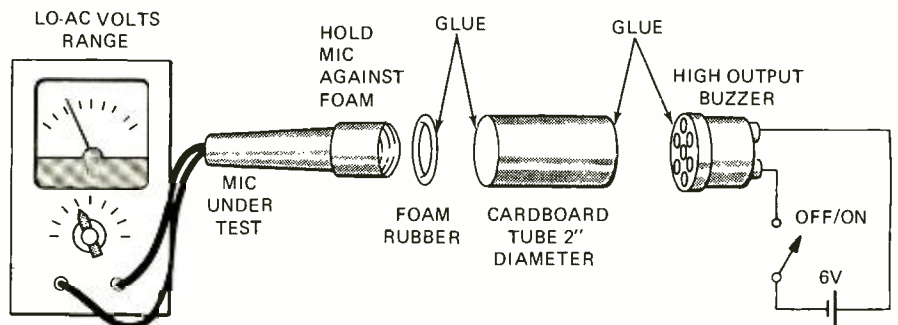
**4. Microphone testing.** The vom or vtm can be used to check the condition of microphones. Connect the unit shown in Fig. 9. This gives you an estimate of the performance of microphones.

If you have a vtm, just put the vtm on a medium ohms scale ( $\times 100$  or so) and connect the leads to the microphone leads. Listen for a click from the microphone. If there is no click and no resistance, the microphone is bad. If there is a click and no resistance, it is a crystal or ceramic unit. If there is no click and resistance, switch to a lower ohms scale. If there is still no click, the unit is bad, or is a carbon mike. If you are unsure of the type and the mike meets the last set of qualifications use the setup in Fig. 9. It is for carbon microphones. If it fails again, get a new element.

**5. Circuit tests.** A quick and easy way to find a trouble in a piece of transistorized equipment is by measuring bias. This procedure works only with single-battery-biased stages. Measure the voltage on the emitter of the transistor, and then the voltage on its base. There should be no more than 1 volt difference (except in some power circuits). If there is nearly the same voltage on base and emitter, chances are the device and circuit are good. If the voltage differs widely, the stage is probably bad. If the trouble has been traced to the stage, but it checks OK base to emitter, look for open or shorted coupling, or open bypass capacitors.

**FIG. 8-a—TESTING TRANSISTORS and diodes.** Basic check of transistor/diode practice here will perfect quick recognition of good and bad units. Remember that on ohms most vom's red leads are negative and black positive. In doubt? Use a marked known-good diode or another meter to determine polarity. Vtm's use "high ohms"; vom's use "low ohms" scales. b—Gain tester quick check. Finger and thumb work as resistor, if unit has good collector. Emitter resistance will drop when thumb and forefinger touch base-collector. Wet finger and thumb for lower resistance (low-gain units and power transistors).

**FIG. 9—MICROPHONE TESTER.** This setup will check most microphones. For carbon microphones, use the ohms scale that gives roughly a mid-scale reading with no input. For dynamic and crystal mikes look for about 0.1 to 0.5 volts output.

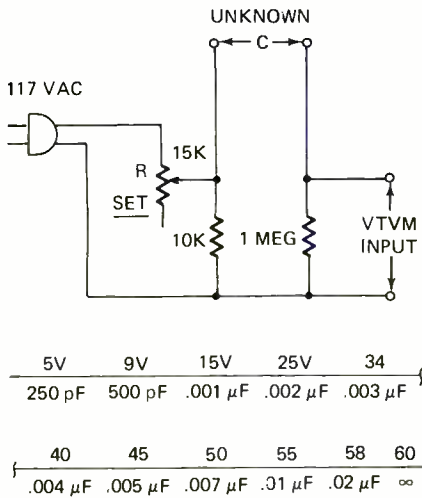




## Experiments you can try

The following applications are for experimenters.

**1. Measuring capacitor values.** By connecting an unknown capacitor in series with the ac line and a resistor, you can find, roughly, the capacitive reactance; thus, the capacitance. Figure 10



**FIG. 10—CAPACITOR VALUE measurement.** This circuit allows reasonable accuracy for measuring capacitor values from 250 pF to 0.02 μF. You cannot check electrolytics with this setup. For 50 Hz, multiply the capacitance by 1.2. The SET control is adjusted for full 60V reading with short at unknown C. Omit the 1-megohm resistor for vom (20,000 ohms/volt).

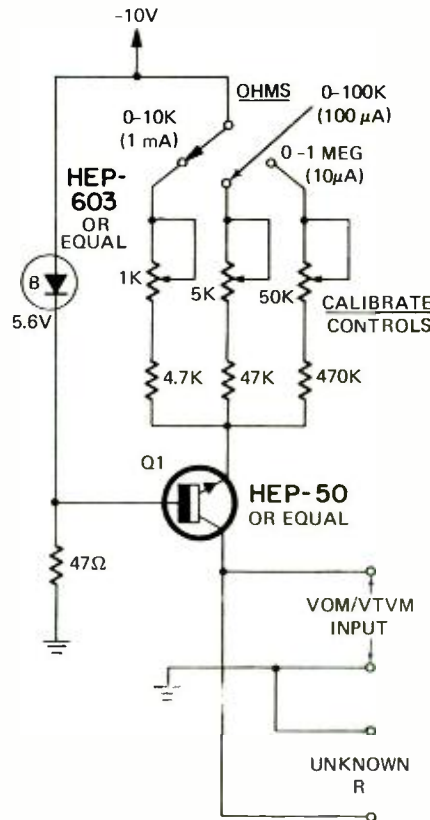
shows the hookup used to do this at 60 Hz. This is a rather simple arrangement, so accuracy is not absolute, but is adequate for most experimental uses. R is adjusted so the meter reads 60 volts with a short circuit across the capacitor check terminals. With a capacitor in-circuit, the effective resistance is found by using the voltage drop on the fixed resistor and Ohms law. The chart gives capacitance readings for voltage on the meter and 60 V applied.

**2. Ac amps.** You can add an ac amps scale to your meter by simply measuring the ac voltage across a low-resistance series resistor. With high ac voltages (such as power lines), the entry of the series resistance is negligible. A 1-ohm resistor can be included in a small case. With 1 ohm, you can measure 0 to 1-amp on 0 to 1-volt ac scale. Use  $I = E/R$  for current measurements for any value of R. Make sure the power ( $I^2R$ ) does not exceed the rating of the resistor.

**3. Light meter.** A very accurate light meter can be made merely by reading the resistance of a cadmium-sulfide or CdSe photocell. Charts and graphs are available to convert the ohms reading to illumination measurements in foot candles. You can get a free specification sheet on the Clairex line from Burstein-Applebee, 3199 Mercier St., Kansas City, Mo. 64111. Ask for stock number 16A1124. It will allow you to select the cell(s) that best meet

your needs and will give you information on meter calibration.

**4. Linear ohmmeter.** A linear ohmmeter can be built from Fig. 11. You



**FIG. 11—LINEAR OHMS.** This circuit provides a constant current to allow a direct relation between voltage readings and unknown resistance. This circuit is useful when an unskilled operator is using the unit (such as assembly lines, etc.). For other currents, just multiply or divide values by 10.

can choose values for the range resistors that provide a range better suited to your needs. A linear ohmmeter is handy when a fairly accurate measurement must be made, or when an inexperienced operator must take readings, such as on an assembly or checkout line in manufacturing.

Transistor Q1 is a constant-current generator. The diode provides a fixed voltage reference at the base. Emitter current is controlled by varying the value of the emitter resistor. The emitter voltage is constant, because of the constant base voltage, so the emitter current varies with the setting of the CALIBRATE control. The currents in the emitter and the collector are essentially the same, so the current applied to the unknown resistor is a constant, determined by the CALIBRATE control. The value of the CALIBRATE control can be switched for a range control. It would vary the current from the constant generator. The OHMS control merely makes the voltage equal to the maximum voltage readable on the meter you use. Thus, when no resistor is connected, the maximum current-generator voltage is equal to a maximum reading on the me-

ter. Voltage readings will be ohms readings and current should be selected for your vom/vtm scales. For instance, if your vom has an 0 to 3-volt scale, it will read 0 to 3000 ohms with 1 mA from the current generator. With 0.1 mA, 0 to 30,000 ohms; 0.10 mA gives 0 to 300,000 ohms, etc. (use  $E = IR$ ).

**5. Power output.** Power output from a transmitter, audio amplifier, oscillator, or whatever, is measured by connecting the device under measure to its specified load. Note for rf this means a 1:1 SWR or pure resistive load. Measure the output across the load using the appropriate dc, ac, or rf probe ranges of the meter. By simply plugging in the  $P = E^2/R$  formula you can determine the power out. For instance, a transmitter is connected to a 50-ohm (non-inductive) resistor. The voltage reading is 10 volts (should be rms reading). The power output is  $E^2/R = 100/50$  or 2 watts.

**6. Line voltage readings.** When you're not really using the vom, plug the test leads into a couple of pin jacks that are connected directly to the ac line. Thus, you can merely glance at your meter and read the line voltage at any time. The pin jacks will prove handy when you are working on some line-voltage-critical circuit, too. Just plug in the meter to check to make sure the trouble you are seeing is not line-voltage induced.

**7. Decibels.** You can measure dBm (continued on page 50)

	dB	VOLTS	
	18	6.152	
	17	5.483	
	16	4.887	
	15	4.335	
	14	3.882	
	13	3.460	
	12	3.083	
	11	2.748	
	10	2.449	
	9	2.183	
	8	1.945	
	7	1.734	
	6	1.545	
	5	1.377	
	4	1.227	
	3	1.094	
	2	0.975	
	1	0.869	
+	0 dB 0.7745	1 mW INTO 600Ω	
-	2	0.6885	
	3	0.6169	
	4	0.5499	
	5	0.4873	
	6	0.4355	
	7	0.3881	
	8	0.3461	
	9	0.3085	
	10	0.2749	
	11	0.2450	
	12	0.2182	
	13	0.1945	
	14	0.1735	
	15	0.1547	
	16	0.1377	
	17	0.1230	
	18	0.1095	
		0.0975	

**FIG. 12—DECIBELS VERSUS AC VOLTS.** The ac rms voltage readings on the right correspond to the decibels on the left. Note that these are dBm and are referenced to 600 ohms.

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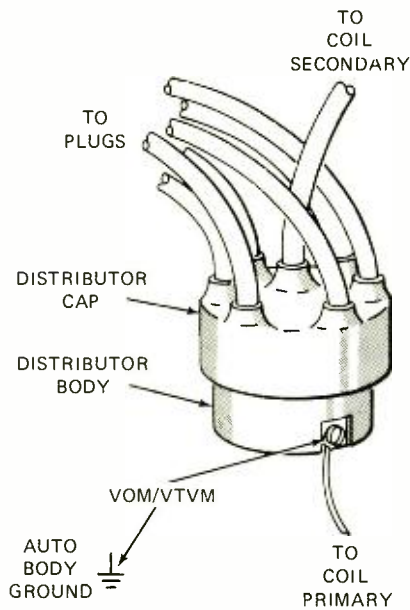


(decibels with 600-ohm 1mw reference) by using the chart in Fig. 12 and the ac volts range of the meter. Don't forget to measure across a 600-ohm load.

### Automotive

These applications apply either directly or indirectly to cars. Many electronics experimenters find themselves involved with servicing or tuning their own cars, usually because they spent the auto service budget on something electronic!

**1. Tachometer.** The vom or vtm can be used as a tachometer for tuneups. Figure 13 shows how to hook up the meter to the ignition. The chart in Fig. 13 shows the meter readings for



RPM	8 CYL -	
	12V	6V
200	8 V	3½V
300	8½V	4 V
400	9 V	4½V
500	9½V	5 V
600	10 V	5½V
700	12 V	6 V
800		6½V
1000	15 V	8 V
1500	17½V	10½V

RPM	6 CYL -	
	12V	6V
200	6 V	2½V
300	6½V	3 V
400	** 6½V	3½V
500	7 V	4 V
600	7½V	
700	9 V	
800		5 V
1000	11½V	6 V
1500	13 V	8 V

**FIG. 13—IDLE TACHOMETER.** The vom or vtm may be used as an idle tach by connecting as shown in a, and using the chart at b. This is not the most accurate tachometer made, but accuracy is adequate for "shade-tree" tuneups.

various rpm's. The accuracy of this chart is good enough for most general tuneups, etc., but will not work for super-critical applications. Chances are

you probably have no business messing with super-critical adjustments anyway!

**2. Timing device.** Timing can be set fairly accurately on your car using the ohms section of your multimeter. Final, more critical adjustment should be made with a timing light, but this method will get your car back in action if the timing is way off.

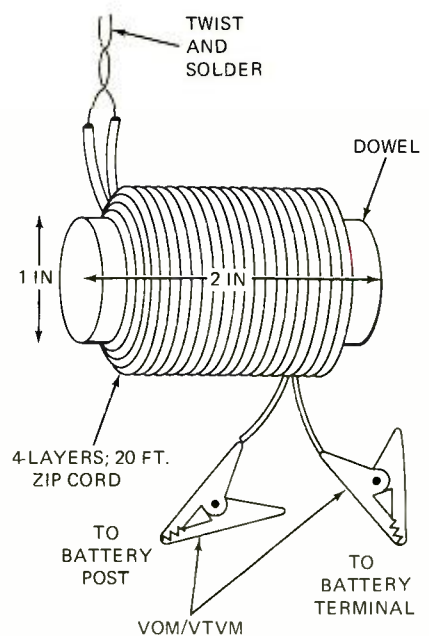
Rotate the engine so the rotor button is pointing in the general direction of No. 1 cylinder. Remove the spark plug from No. 1 cylinder and turn the engine (by hand) until the piston is at top of the cylinder. With the rotor button pointing in the direction of the No. 1 spark plug lead, simply connect the meter across the points and adjust the distributor position so the points just open.

**3. Alternator check.** You can check the alternator and regulator on your car by connecting the voltmeter across the battery terminals. If all is well, you should have a reading of around 12.5 to 13 volts at very low idle rpm's. As the speed of the idling engine is increased, the voltage should climb to around 14 to 14.5 volts and then should stabilize. No matter what the engine speed, the voltage shouldn't climb any higher than this 14 to 14.5-volt level. If the voltage is going much higher, you probably need a new regulator, or an adjustment on the old one. If the voltage climbs steadily until it reaches 15 or 16 or even more volts, the regulator is probably bad and cannot be adjusted.

A bad alternator will most likely show up as little or no output. Check the alternator by idling the engine and monitoring battery voltage. Disconnect the rotor winding on the alternator (this is the one that runs to the regulator) and apply 12 volts from the car battery directly to the posts. Now if the meter shows a charge and revving the engine runs the charge up to 15 or 16 volts, or even higher, the alternator is good. A bad diode in the alternator generally shows up as either insufficient charge (open) or running the battery down when the engine is running (short).

**4. Ammeter.** An ammeter like the one shown in Fig. 14 can tell you whether or not the generator or alternator is charging, and whether the starter is dragging. When the current is drawn through the 0.8188-ohm wire, a voltage in proportion to the current is induced and read by your meter. Just use Ohm's Law for determining the current. You may substitute wire or whatever, just make sure you can measure the resistance so you can calculate the current. Also make sure the wire can handle the high current.

The vom/vtm, usually the first piece of test equipment on the bench, is definitely the most economical piece of equipment that can provide so much information about a circuit. The uses



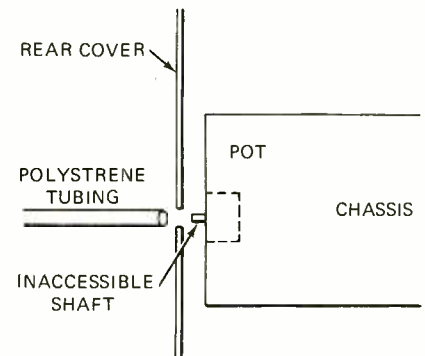
**FIG. 14—SERIES RESISTOR for ammeter.** This 0.8188-ohm resistor drops voltages in proportion to applied currents. When vom reads 8.188 volts there are 10 amps flowing.

given here are certainly not all of those that can be conjured up, but they do demonstrate the versatility of the instrument and its extension beyond the normal "voltage readings" applications. If any readers come up with additional vom/vtm applications, send them to The Editor, Radio-Electronics, Dept. VOM, 200 Park Ave. South, New York, N.Y. 10003. **R-E**

## reach inaccessible tv shafts

Some TV sets have preset controls with short knurled shafts recessed behind the rear cover. These shafts are not slotted so they cannot be adjusted with a screwdriver.

To adjust this type of control, slip a



short length of ¼-inch ID rigid polystyrene tubing through a hole in the rear cover and over the control shaft. The tubing comes in 12-inch lengths and its inside diameter makes a snug fit over ¼-inch control shafts. Leave it long or cut it to fit.—Alex Billos **R-E**


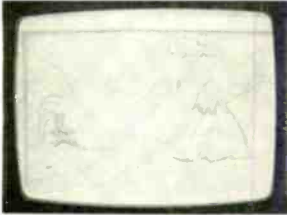
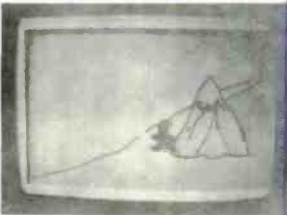

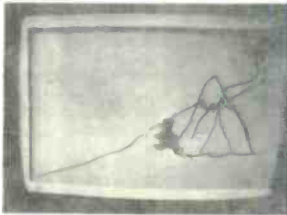



# Kwik-Fix™ picture and waveform charts

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SCREEN SYMPTOMS AS GUIDES

WHERE TO CHECK FIRST

SYMPTOM PIC	DESCRIPTION	VOLTAGE	WAVEFORM	PART
	Slight darkening; mild blooming of whites in scene	Test point A	none	R4, C1, C2
	Slight brightening; mild blooming of whites in scene	Test point B	none	R2, R3, R6, D1, and Terminal 2
	Dark picture	Test point B Q1 emitter	none	R4, R5, C2, C3, C4, Q1
	Picture too bright and blooming	Test point A	none	R4, Q1
	Brightness control has no effect; picture dark	Q1 emitter	none	R8, R9
	Brightness control has no effect; picture may be slightly bright	Test point B Q1 emitter	none	R7

\*an Easy Read™ feature by FOREST H. BELT & Associates ©1972

**NOTES:**

Use this guide to help you find which key voltage to check first, or to guide you to the causes of symptoms that don't have voltage clues. (There are no waveform clues for these stages.) Study the screen, with a local station tuned in, for action of BRIGHTNESS and ABL controls. The most helpful clues to the cause of whatever symptoms you

see are found at the key test points listed opposite them. Make whatever voltage measurements are indicated. Use the Voltage Guide to analyze the results of those measurements. For a quick check, test or substitute the parts listed as most likely to cause the symptoms you see.

DC VOLTAGES AS GUIDES						
Voltage change	to zero	very low	low	slightly low	slightly high	high
<b>Test point A</b> Normal 6V	R1 v. low R2 high, open R3 high, open R4 high, open R5 open R7 open C1 shorted NE shorted Term 2 open Q1 faulty*	R2 high R4 high D1 shorted	R1 low C1 leaky C2 leaky D1 leaky		R1 open R3 low	R2 low R4 low R8 open R9 open C1 open Q1 faulty
<b>Test point B</b> Normal 11V	C2 shorted Q1 faulty*	R4 open R5 open	R1 v. low R4 high R7 open C1 shorted D1 leaky NE shorted	C2 leaky	R2 high R3 high R4 low R8 open R9 open C1 open C3 leaky	
<b>Q1 emitter</b> Normal 5.8V	C4 shorted Q1 faulty*	R8 open R9 open	R4 open R5 open R9 high C2 shorted C3 leaky C4 leaky	R4 high C1 open	R7 open D1 shorted	R2 open R3 open Term 2 open
<b>Q1 collector</b> Normal 7.5V		R8 open R9 open C4 shorted	R4 open R5 open R9 high C2 shorted C3 leaky Q1 faulty	R4 high C2 leaky C4 leaky	R7 open D1 shorted	Q1 faulty

\*Negative

#### NOTES:

Use this guide to help you pinpoint the faulty part.

To keep voltage-sensing steady, feed the receiver a keyed-rainbow color-bar signal with color saturation full up.

Set BRIGHTNESS control(s) at two-thirds of full clockwise rotation.

Voltages at test points A and B depend on ABL setting. For testing, put ABL control at midrange.

Measure each of the four key voltages with vtvm or fetvm.

For each, move across to the column that describes whatever incorrectness you find in that voltage.

Read which parts might cause that alteration.

Finally, notice which parts are also named as possible causes of other voltage changes you find.

Test those parts individually for the defect described.

#### The Stages

The main purpose of an automatic brightness limiter (abl) is to eliminate overcurrent in a color picture tube. This protective function aims not so much to prevent damage as to avoid fuzziness in bright sectors of a video scene. Picture-tube beam current above a certain amount overdrives the screen phosphors. You see the result as fuzzing of the raster lines wherever the video (whiteness) level is high.

Automatic brightness limiting allows high ratios of black to white—high video driving levels for the picture tube and consequent high contrast—without the blooming that might otherwise accompany it. You can look on the abl system as a closed loop that encompasses the video amplifiers and picture tube beam.

The abl stages shown here make up the feedback portion of that closed loop. A beam-current sensing resistor initiates the corrective dc action, which feeds back to the third video amplifier. In this particular version, a video clamp transistor

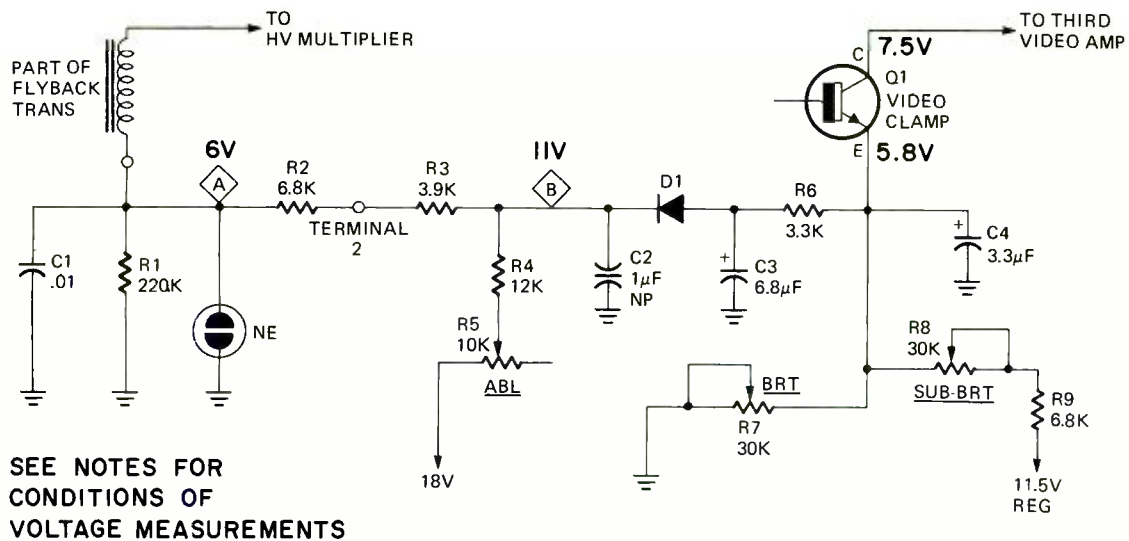
isolates the affected video amplifier from the abl feedback system. The same transistor manages brightness control from the hand-operated BRIGHTNESS knob on the receiver's front panel.

#### Operating Behavior

Even though the automatic brightness limiter takes the form of a feedback system, no signal is involved. The whole system must be considered a closed dc loop—although it responds quickly when necessary. Essentially, here's how this abl works.

Beam currents in the color picture tube collect finally at the second anode, the high-voltage connection. The high positive potential there is what keeps the beam hitting the phosphors. From the second-anode connection, electron current flows back through the high-voltage rectifier (or multiplier, in recent color chassis) and the flyback-transformer winding that drives the HV system.





The bottom end of that flyback high-voltage winding ordinarily connects to ground. But, for automatic limiting, a resistor goes between the cold end of the winding and ground. Picture-tube beam current must therefore flow through this sensing resistor. The resistor, R1 in the schematic, senses how much picture-tube beam current flows at any given instant.

You know what determines beam current. The video signal swings bias at the cathodes rapidly up or down, making the beam stronger or weaker for the various elements of the picture. A high positive excursion of video signal at the picture-tube cathodes cuts down beam current, making a dark picture element. High negative excursions let more beam current flow, accounting for bright picture elements.

Now just imagine any one single negative excursion that turns the beams on heavily. If current goes too high it causes the blooming that makes a white picture element indistinct. Heavy current through R1 makes point A more negative than before.

Resistors R2 and R3 carry the negative increase to D1. That diode conducts whenever its cathode (point B) becomes more negative than its anode. But first there's a "biasing" voltage from R5 and R6 to be overcome. Once the pix-tube beam current becomes heavy enough to raise point A enough to override that positive diode bias, D1 conducts. That lets the net negative voltage from point A and point B counter the normally positive voltage at the emitter of Q1, the clamp transistor.

Making Q1's emitter more negative is equivalent to an increase in positive base bias so the overall bias on this npn transistor is thus altered in the forward direction. Transistor emitter-collector current rises. Collector voltage falls—in the negative direction, since collector voltage is positive. That less-positive clamp voltage passes on to the third video amplifier.

The third video amplifier (not shown) inverts the voltage shift. A positive-direction shift reaches the cathodes of the color picture tube. Remember that a high negative video excursion was what initiated this action in the first place. The positive excursion opposes it, and beam current is kept from going too high.

The level at which that opposition begins is set by the ABL control. No dc feedback occurs unless beam current goes heavy enough to raise the negative voltage at point A high enough to override the positive diode bias at point B. Until that happens, D1 keeps the loop blocked.

### Signal Components

Although the whole system is dc-operated, certain signal-type components are important to its operation. Start with C1 for example. It signal-grounds the cold end of the HV transformer winding, and keeps the voltage across R1 from re-

sponding to video or horizontal signals. You can consider R1-C1 as a sort of time-constant circuit that responds fast enough to prevent blooming on sustained brightness peaks but slowly enough to smooth out transient reactions.

The neon lamp is overvoltage protection in case of large voltage spikes—such as from a high-voltage snapover. The gaseous lamp drains off surges in either polarity, shunting them harmlessly to ground. Otherwise, they might pop the diode or Q1.

C2, C3, and C4 are all electrolytics that keep video signals—and horizontal pulses—from working their way into the abl system. C2 is nonpolarized because its dielectric has to stay formed whether the net voltage at point B goes negative or positive. C3 keeps the anode voltage for D1 free of signal, and C4 decouples Q1 from the brightness controls and the dc feedback paths.

### DC Distribution

Of course, the whole system can be considered dc-operated. But for troubleshooting purposes, you must also recognize the stable-state dc paths and sources.

Bias for gating diode D1 comes from an 18-volt dc line through ABL potentiometer R5 and resistor R4. As long as point B stays more positive than the R6 side of the diode, no conductive path exists in that direction. The path is through R3, R2, and R1 to ground. With no beam current (picture tube black), the 18 volts divides up along that R1-R2-R3-R4-R5 path.

Dc for the emitter of Q1, and coincidentally for the anode of D1, comes from a divider comprising R7, R8, and R9. They get dc from an 11.5-volt regulated supply line. R7 and R8 are adjustable pots, the BRIGHTNESS and SUB-BRIGHTNESS controls respectively. The positions of their sliders determine dc emitter voltage for Q1—and, by the dc connection through the third video amplifier, set average operating bias for the color picture tube. They thus control raster brightness.

When R7 reduces Q1 emitter voltage to zero, bias for Q1 becomes far forward. The transistor conducts heavily. The consequent collector-voltage reduction is passed on by the third video amplifier to the pix-tube cathodes, though inverted (to a positive-direction dc shift). Beam current cuts off and the screen goes dark.

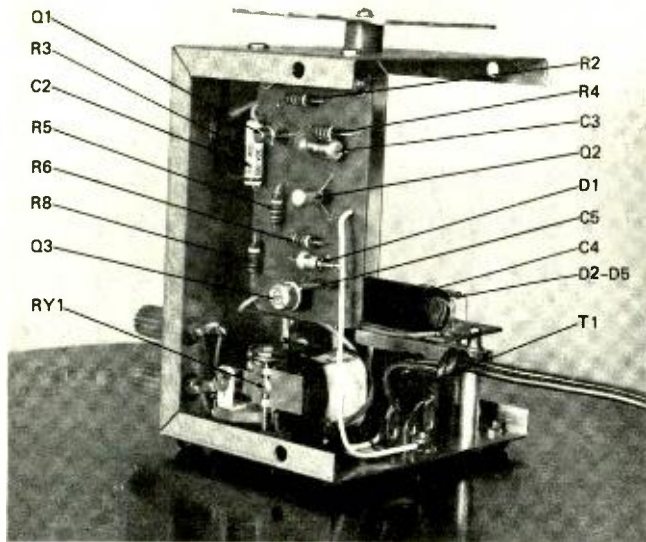
Through R6, the R7-R8-R9 divider also applies anode voltage to D1. The value is the same as the voltage at the transistor emitter, as long as D1 doesn't conduct. Once the diode does conduct, the negative voltage developed across R1, and modified slightly at point B, becomes the determining dc source for the emitter of Q1. The loop thus prevents crt overcurrent.

The effects of station signal are very pronounced in this (text continues on page 86)

# Sensitive Touch Switch

Made for a school demonstration project, this instrument can have a variety of uses.

by FRANK H. TOOKER



REAR VIEW shows as many parts as possible.

THIS SIMPLE, ELECTRONIC TOUCH-plate switch uses no mechanical latching and no ratchet relay. Yet touching its sensitive plate once with the fingertip turns it on, and touching the same plate again, a half-minute or so later, turns it off. If both hands are busy, touch it with your arm, your elbow, or even the tip of your nose! Even Rover can operate it that way!

The device—shown in the photo and the schematic diagram, Fig. 1—employs a silicon controlled switch (SCS) in a unique circuit which, when the SCS is off, makes it ready to turn on; and when it is on, makes it ready to turn off. The sensitivity in one direction may be made equal to that in the other with control R3, labeled BALANCE in the instrument shown in the photo. It can be used to apply line voltage to a receptacle and binding posts, as in this circuit, or—as in Fig. 2—as a simple switch to operate any external device.

## How it works

The silicon controlled switch has a reputation of being easy to turn on, but a so-and-so to turn off. That reputation is undeserved. In this circuit, the SCS turns off as sensitively as it turns on. And the mere touch of a fingertip flips it either way.

In the schematic, Q1 is the SCS. When it is off (nonconducting), current flowing through cathode resistor R4 is low. So low that for all practical purposes, it may be considered zero. The voltage drop across cathode capacitor C3 is, therefore, also practically zero. Under this condition, a small positive voltage at the cathode gate (GC) of the SCS turns it on. A negative potential has no effect.

When the SCS is on, it conducts heavily. Current flows through cathode resistor R4 and a voltage drop develops



TOUCH-PLATE SWITCH as demonstrator.

across capacitor C3. This voltage makes the cathode (C) positive with respect to the cathode gate (GC). As far as the SCS itself is concerned, this is equivalent to making the cathode gate negative with respect to the cathode. It is therefore a move in the direction of turning the SCS off. The cathode gate is otherwise held at an approximately fixed potential by the voltage drop across anode resistor R5 and the voltage divider made up of resistances R1, R2, and R3. For best stability, capacitor C3 should be a tantalum electrolytic.

Note especially that resistor R1 connects to the anode (A) of Q1 rather than to a point of full power-supply voltage. As a result of this connection, voltage divider current drops abruptly when the SCS turns on, and rises abruptly when it turns off. This current swing moves the cathode-gate potential in a direction that assists in turning the SCS on and off.

With the component values given in Fig. 1 and the parts list, the voltage developed across capacitor C3, when

the SCS is on, reduces the regenerative current flow within the SCS to a very low value: enough to keep it just turned on and no more. A small *negative* voltage at the cathode gate will turn it off. A positive one has no effect.

When the SCS turns off, capacitor C3 discharges through resistor R4, and the circuit thereby makes itself ready to turn on again. Because the circuit is sensitive, yet must be stable to be practical, approximately one-half minute is needed for it to ready itself to turn on when it has just been turned off, or to turn off when it has just been turned on.

Stability is assisted by a characteristic called hysteresis, which takes place within the semiconductor itself: When the SCS is turned on, current flowing through it raises its internal temperature slightly. This increase in temperature increases its sensitivity in the direction that helps to keep it turned on. Similarly, when it is turned off, the decrease in internal temperature helps to keep it turned off. Although this change in internal temperature is small, it is in the right direction to be useful.

The turn-on and turn-off signal is coupled from the touch-plate to the cathode-gate electrode of the SCS via capacitor C1. The signal itself is actually the minute ac potential developed on the human body (and everything else that is an electrical conductor) due to capacitance coupling with the house wiring. Small though it is, a positive-going excursion of this ac signal is quite enough to turn the SCS on when it is off, and a negative-going excursion enough to turn it off when it is on.

In either case, capacitor C3 maintains the cathode potential long enough to keep the SCS from fluctuating rapidly between its on-state and its off-state. (If the fingertip is held on the touch-plate continuously, the circuit can



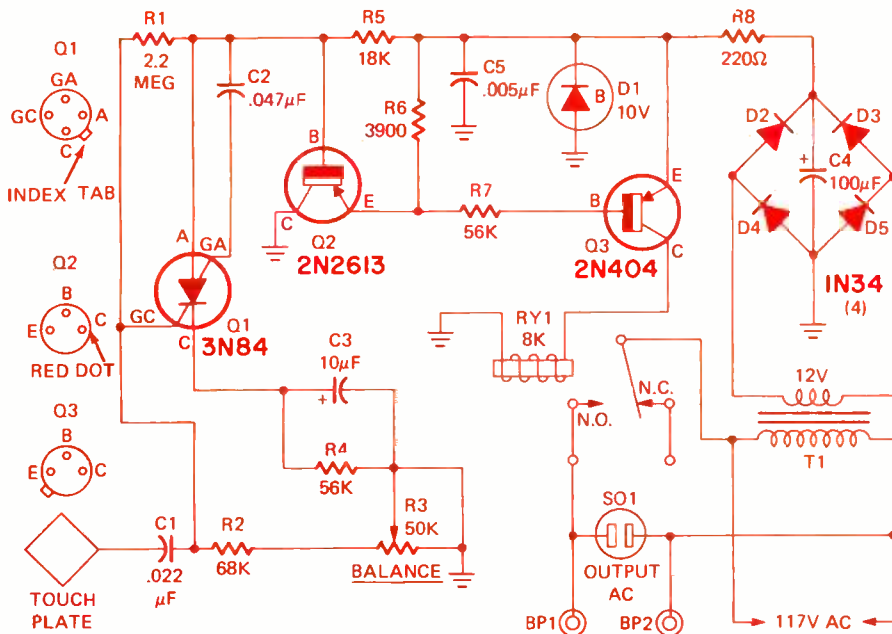
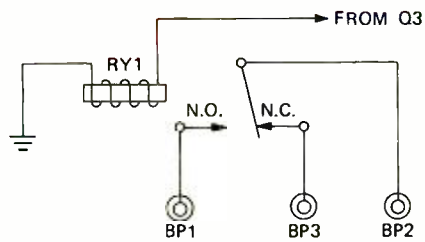


FIG. 1—ONE SCS AND TWO TRANSISTORS are the active elements of this switch.

**PARTS LIST**

**NOTE: All resistors are 1/2-watt, 2% tolerance, IRC type RG20, unless otherwise specified.**

- R1—2.2-megohm, 1/2-watt, 5%
- R2—68,000 ohms
- R3—50,000 ohms pot. linear taper (Ohmite CU5031 or equal)
- R4, R7—56,000 ohms
- R5—18,000 ohms
- R6—3900 ohms
- R8—220 ohms in prototype (see text)
- BP1, BP2—5-way binding posts
- C1—.022 μF, 100 Vdc, Mylar
- C2—.047 μF, 100 Vdc, Mylar
- C3—10 μF, 6 Vdc, electrolytic
- C4—100 μF, 25 Vdc, electrolytic
- C5—.005 μF, 50 Vdc, ceramic
- D1—Zener diode, 10 volts, 1/2 watt
- D2, D3, D4, D5—Type 1N34 or any general-purpose diode
- RY1—Sensitive relay, 8,000-ohm coil (Sigma 4F-8000-S/SIL or equal)
- Q1—Type 3N84 silicon-controlled-switch (G-E)
- Q2—Type 2N2613 transistor (RCA)
- Q3—Type 2N404 transistor (G-E, RCA, T1)
- SO1—117Vac receptacle
- T1—Miniature filament transformer, 12 volts at 10 mA (or more) secondary



**TOUCH-PLATE**

FIG. 2—WITH AC DISCONNECTED, the switch can be modified to make a simple spst, or—with another binding post—a dpst switch.

turn on and turn off at a very slow repetition rate.)

When the SCS is on, its output causes a voltage drop across resistor R5. This voltage is applied direct to the base of transistor Q2, which operates as an emitter-follower or current amplifier. It functions as a buffer between the SCS and relay-driver transistor Q3. Output from Q2, taken at the emitter, is fed to the base of Q3 via resistor R7. Q3's base-current limiter. The resulting voltage change at the base of Q3 is sufficient to drive that transistor from cut-off to saturation. Thus relay RY1 is pulled in sharply when the SCS turns on, and drops out abruptly when it turns off.

**Adjustments**

Balance control R3 permits adjust-

ing the circuit so that it turns on and turns off with equal ease. It compensates for variations due to component tolerances, including those of the SCS. When the instrument is first turned on, set control R3 to where its entire resistance is in the circuit. The SCS will then turn on of its own accord when power is applied to the circuit, and should remain on. Decrease the setting of R3 slowly until the relay armature just drops out, then advance the setting about 5 degrees. Touching the touch-plate now should cause the relay to pull in. Touching it again, a half-minute or so later, should cause it to drop out.

If it is found that the circuit turns on easily, but turns off by itself a few minutes later, adjust control R3 to put a little more resistance into the circuit. If the setup has a tendency to turn on by itself, adjust R3 in the opposite direction—to decrease the resistance in the circuit.

With control R3 properly set, the circuit should be able to maintain its on or off state indefinitely. Large transients—voltage spikes—on the power line have a tendency to trigger it, however. Capacitor C2—connected between the anode and anode-gate (GA) of the SCS—and capacitor C5—across the power supply—reduce this tendency significantly. Thus such moderate tran-

sients as those occasioned by switching a lamp on and off, or by an electric refrigerator, or even the cycling of an oil-burner furnace with electric ignition, do not affect the touch-plate switch at all. If a particular setup seems to be bothered by such transients, reversing the plug in the wall outlet that powers the unit will usually eliminate the difficulty. In an unusually well shielded location, the unit may operate sluggishly, due to weak control signals in the area near the touch plate.

Before assembling it into the circuit, adjust the relay for a pull-in current of 1.0 milliamperes dc, and a drop-out current of about 0.5 milliamperes. This assures positive operation, as the actual pull-in current is somewhat higher, and the drop-out current lower, than the values just specified.

The touch-plate circuit is operated from the power line by miniature power transformer T1, a full-wave bridge rectifier, and filter capacitor C4. The voltage is regulated by Zener diode D1. Resistor R8 should be chosen to limit the current through the diode to 10 mA. In the prototype, the value of this resistor is 220 ohms.

The unit shown in the photos was assembled for purely practical purposes—actually a demonstration device in a school science class. It occupies a 5 x 4 x 3-inch gray-Hammertone aluminum box. The touch-plate, located about 3/8-inch above the top of the box, is a 2 1/2-inch square stainless steel plate. Stainless steel was chosen because it stays bright, does not corrode easily. Corrosion would act as insulation, and interfere with proper operation. For the same reason, the touch-plate must be well insulated from the metal cabinet top, and must not be coated with paint, lacquer, or other insulating substance.

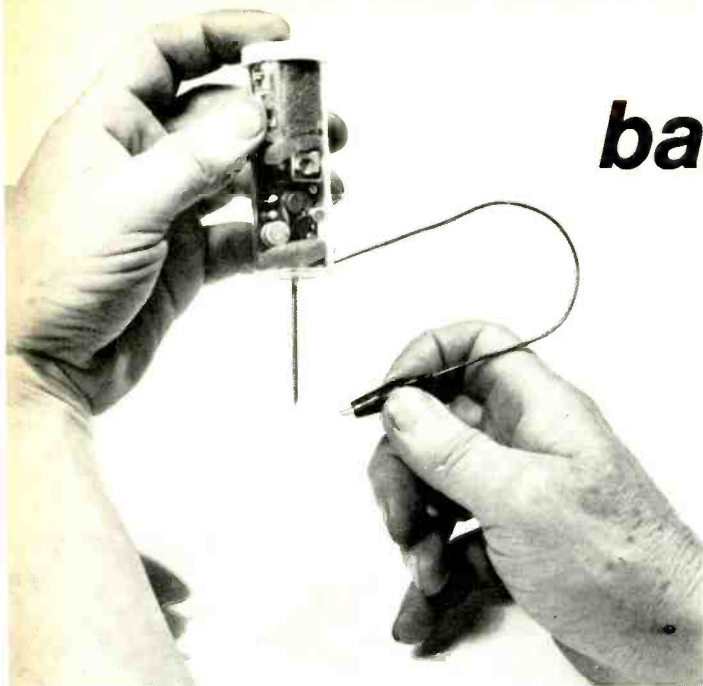
For living-room applications, this touch-plate circuit can occupy a plastic box or a polished wood enclosure, with a small, bright-metal ornament serving as the touch-plate. The BALANCE control can then be a screwdriver adjustment located underneath, out of sight. This control does not require frequent resetting, except at first, while the electrolytic capacitors are forming. Connections to the lamp, radio, phonograph, or other device being controlled, can be a receptacle on the back of the enclosure or a terminal plate using binder-head screws and located underneath.

In any assembly of the circuit, make the touch-plate no larger than necessary, and the lead to it short. The larger the plate, or the longer the lead, the more it has a tendency to pick up a control signal of its own. If this signal becomes large, the circuit will operate erratically. The relay specified in the parts list has the frame "hot" to the moving contact. So insulate the relay frame from the metal cabinet. R-E

# bargain transistor signal squirter

Simple one-evening project delivers a handy little signal generator for audio, i.f., and rf circuits

by JOSEPH V. D'AIRO



ANYONE WHO BUILDS OR SERVICES audio or rf equipment needs some type of signal generator. But as a rule, signal generators are bulky, expensive, complex, and inconvenient to use. This one is an exception to the rule.

Dubbed the *Signal Squirter*, it is a self-contained, hand-held signal generator that uses only two "bargain" transistors, and half a handful of other easy-to-obtain components.

By "squirting" a signal consisting of af and modulated 455 kHz i.f., with harmonics that extend above the AM broadcast band, it pinpoints defective stages in most types of audio and rf equipment at the touch of a button.

## How it works

The Squirter combines an audio-frequency multivibrator and a radio-frequency oscillator, which interact in a manner that produces a complex waveform with components that spread from the audio through the i.f. and into the higher radio frequencies.

A multivibrator is basically two cascaded amplifier stages, with the output of the second connected back to the input of the first. Each amplifier inverts the signal applied to it and feeds it back to its partner. In effect, each stage provides positive feedback for the other. This results in oscillation.

Q1 and Q2 in Fig. 1 are the two amplifiers, coupled together by C2 and C4. R3 and R4 provide bias, and R2 and R5 emitter stabilization. C6 bypasses R5 for the audio and radio frequencies, increasing stage gain. The frequency of audio oscillation is determined primarily by C2, C4, R3, and R4.

In the radio-frequency oscillator, T1 provides positive feedback, frequency selection, and impedance

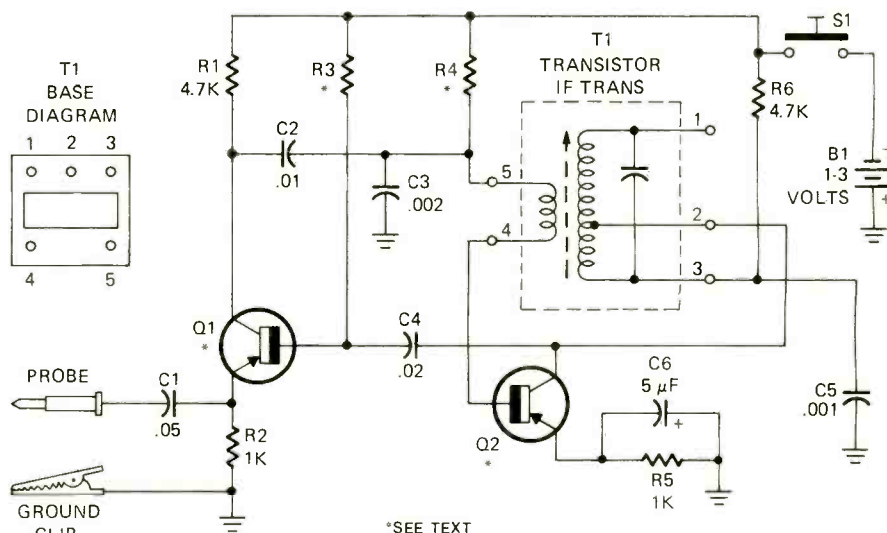


FIG. 1—SCHEMATIC SHOWS simplicity of unit, which uses only two transistors, a 3-volt battery, and several resistors and capacitors.

## PARTS LIST

### CAPACITORS:

- C1—.05  $\mu$ F, 200 volts or greater, ceramic
- C2—.01  $\mu$ F, 25 volts, miniature ceramic
- C3—2,000 pF, 25 volts, miniature ceramic
- C4—.02  $\mu$ F, 25 volts, miniature ceramic
- C5—1,000 pF, 25 volts, miniature ceramic
- C6—5  $\mu$ F, 3 volts, miniature electrolytic

### RESISTORS:

- R1, R6—4,700 ohms, 1/4 watt, 10%
- R2, R5—1,000 ohms, 1/4 watt, 10%
- R3, R4—1/4 watt—see text

### TRANSISTORS:

- Q1, Q2—Rf "bargain" transistors—see text

### MISCELLANEOUS:

- B1—1-3 volts; one or two type "N" cells or mercury button (Mallory RM520), or Nicad button (Eveready N24)
  - T1—Miniature 3rd i.f. transformer (Lafayette 99 F 63034, catalog 710)
  - S1—Subminiature spst normally-open push-button switch (Grayhill 39-1)
- Empty plastic medicine bottle and cap or other housing, two-inch finishing nail or other probe, miniature alligator clip and insulator, foam rubber or cotton wadding, phenolic or other circuit board.

matching for Q2. C3 and C5 bypass the cold ends of the two windings to ground, preventing rf signal loss in R4 and R6. Their values are too small to affect the audio frequencies materially.

The output signals are coupled through C4 to Q1, where they are amplified and then coupled to the probe by C1.

Since Q1 and Q2 are common to the signal paths of both oscillators, they act as modulator-mixers. All combinations of the two original and the sum and difference frequencies generated by the two oscillators, plus their harmonics, are present at the output.

## Parts selection

Parts for the Signal Squirter are readily available and easily substituted.

Q1 and Q2 can be either silicon or germanium. They should have betas of about 50 and collector-emitter leakages below 10 microamperes at three volts. If



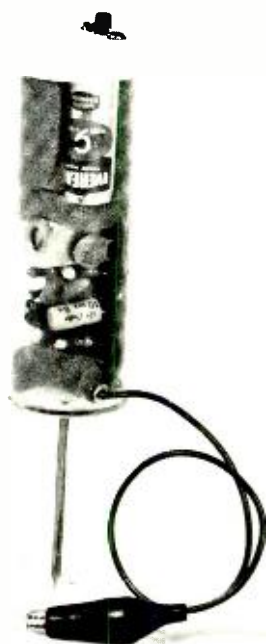
the transistors can't be checked out beforehand, select the best units by substitution in the Squirter.

Don't forget to reverse the polarity of B1 and C6 if npn transistors are used.

Quarter-watt resistors strike the best compromise between size and price, but you can use anything on hand that you have room for.

The capacitors can also be whatever there is room for. Miniature ceramic disc capacitors are generally good and maintain a moderate cost. C1 should be a high-voltage unit, especially if you expect to use the Squirter in tube-type equipment.

Most of the parts can be salvaged from a discarded transistor radio, if desired.



**CLOSE-UP** of the assembled "squirter". This one is built into a pill bottle.

### Construction

Any practical method of construction and any non-metallic housing can be used for the Squirter. The prototype model was built on a piece of perforated phenolic board and installed in a plastic medicine bottle, for easy handling.

No printed circuit pattern was developed—it would be nearly impossible to accommodate all the types and sizes of components that could be used.

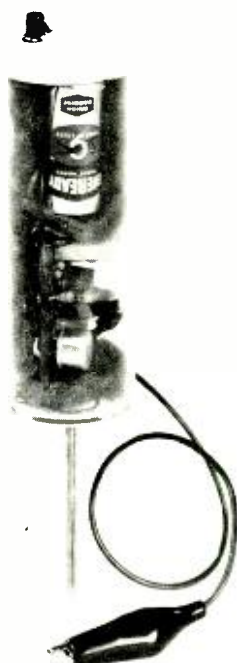
Whatever type of construction is decided upon, the general layout shown in the schematic diagram (Fig. 1) should be followed for best results. Don't forget to allow room in the housing for the batteries and the push-button switch.

The Squirter will operate satisfactorily with any supply voltage from about 1 to 6. However, it should be limited to a maximum of 3 volts to prevent

possible excessive signal radiation. A pair of type "N" cells were used in the original model, but a single Nicad or mercury button cell could be used to conserve space (see Parts List). In any case, be sure that adjacent cells are insulated from each other and from internal wiring.

A 2-inch finishing nail makes an excellent probe for the medicine bottle version. Heat the nail and push it through the closed end of the bottle to make its mounting hole. Drilling the plastic is not recommended, as it will crack easily. Punch a second hole for the ground lead.

Before installing the nail, solder a lead to it that is long enough to reach back out the bottle. This will allow the



**ANOTHER VIEW** shows how parts are cushioned with pieces of foam rubber.

probe to be connected before the board is installed in the bottle. After placing the nail in its hole, cement it in place, for rigidity.

The supply leads from the circuit board must be long enough to reach the batteries and switch when the Squirter is assembled. All wiring is completed before the Squirter is mounted in its case.

Pad the inside of the medicine bottle liberally with foam rubber or cotton wadding to support the board and batteries.

Begin actual construction with only Q2, R5, R6, C3, C5, C6, and T1. Omit all other parts temporarily. (A transistor socket can be used for Q2 if you intend to select transistors.) Substitute a one-megohm potentiometer for R4, setting it to about 500,000 ohms. Place an operating AM radio nearby—its antenna as close to the Squirter as possible.

Connect the batteries and tune the radio around the band, listening for a "swishing" sound or a prominent beat note. Adjust the pot to the highest resistance setting that gives a fairly even distribution of sounds across the band.

If no sound is heard, try different settings of the pot and tune again. If still no sound is heard, re-check wiring, move the radio closer, or try a different transistor for Q2. It may be helpful to attach a short piece of wire to the collector of Q2.

When the best setting for the pot has been found, disconnect it and measure the resistance it is set to. Use the nearest value fixed resistor (10%) for R4.

Next, wire in the rest of the components, substituting the pot for R3 this time. Connect a short piece of wire to the emitter of Q1, and again, listen for a signal in the radio. Adjust the pot for maximum output and best tone at about 910 kHz, then measure its value and substitute a fixed value resistor.

You may now want to re-adjust R4.

When the Squirter is operating to your satisfaction, connect the ground cliplead to a ground point in the radio, and the output from C1 to the input of an i.f. stage, or to a piece of wire that is as close to one as possible. Set the dial of the radio to about 1600 kHz and adjust the slug in T1 for maximum output.

As a final check, set the volume control on the radio to about one-third of the way up and connect the output from C1 to its center terminal. A loud squeal should come from the radio.

The board can now be installed in its case with its battery supply.

### Using the Squirter

When troubleshooting a piece of equipment with a signal generator, a repairman starts injecting signals into the last stage of a defective unit (usually the audio output stage) and works his way forward, checking each stage along the signal path. When he finds a stage that does not process the signal properly, he investigates that stage more closely, checking voltage, resistance, etc., to find the defective component(s). This is the procedure to be followed with the Squirter.

Connect the ground clip to a convenient ground point in the unit under test. Then, working forward from the last stage, touch the probe to the input of each successive stage while monitoring the output.

Assuming all circuits following the one under test have checked out "good", the stage is probably defective if no output is detected, and should be looked into more closely.

Make allowances for various differences in stage gains and impedances when using the Squirter (or any other signal injector). **R-E**

# TRANSISTOR TV

## Cure these 5

- Rf noise coming in
- Ignition noise
- Mismatch ghosts
- Self oscillation in
- Noise pickup via

by **MATTHEW MANDL**  
contributing editor

TRANSISTOR TV SETS ARE JUST AS susceptible to interference as tube types. But design engineers can get more rejection circuitry into the transistor TV, improving their performance. In tube sets the high line current discourages use of series noise-filter chokes—the large wire would increase cost and bulk. In transistor sets, the much lower line current makes such chokes practical. And additional transistors can be used for video noise suppression (or as age noise filters) without materially increasing cost or current drain.

Transistors have some disadvantages, though, as in rf stages where transistors must be neutralized to prevent the circuit from going into self-oscillation. And the additional stages often needed to raise amplification levels mean added circuitry, which could cause troubles.

In servicing for interference problems, study the service notes and schematic carefully for special noise-reducing circuitry which may develop component faults.

### Interference types

Streaks across the picture screen like those of Fig. 1 are caused by radi-



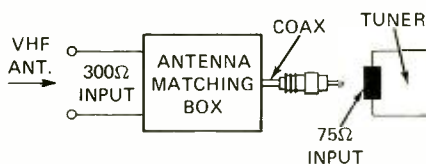
**FIG. 1—IGNITION INTERFERENCE** or other pulse-type signals may produce short, sharp lines or dashes. Increasing the received signal strength or shielding lead ins may help.

ated pulse-type interference picked up by antenna. A common source is ignition interference caused by passing cars and trucks. Because of signal-to-noise ratio factors, the interference will be worse for distant stations. Raising the

antenna or installing a more efficient one will help increase signal-to-noise ratio.

If twin-lead line is used it will pick up some interference signals because it is not a perfect transmission line. Giving the line a half turn every two or three feet sometimes helps because it creates out-of-phase conditions in the signals picked up by the line itself. If the interference is severe, don't expect too much from line transposition. A better approach, if possible, is to route lead-in away from the interference source. Thus, if both antenna and lead-in are in the front part of the house, near traffic, a rear installation may help.

Shielded twin-lead can be used, though the losses are greater than for the standard type. Losses are also greater for coaxial cable lead-in. Coax usually has an impedance of 75 ohms and thus mismatches the standard 300-ohm input to the tuner. Some receivers provide for both 300-ohm and 75-ohm input, as shown in Fig. 2 for the Silver-



**FIG. 2—MATCHING TRANSFORMER** is provided in the front end of many TV tuners.

tone 564-10000 series. If the set has a 300-ohm input only, a matching transformer is needed.

Remember that an impedance mismatch between antenna and transmission line is not as serious as between the line and the tuner. A mismatch at the antenna cuts down signal strength, but a mismatch at the tuner also causes line reflections. When this occurs some picture detail is lost, because of the re-entry of reflected (slightly out-of-phase) signals. There is not enough phase change to produce ghosts, but sharpness is reduced.

Jagged, closely-spaced horizontal-bar lines as shown in Fig. 3 are caused by interference from brush-type household appliances (cleaners, sewing-machines, etc.). Some of the noise is radi-

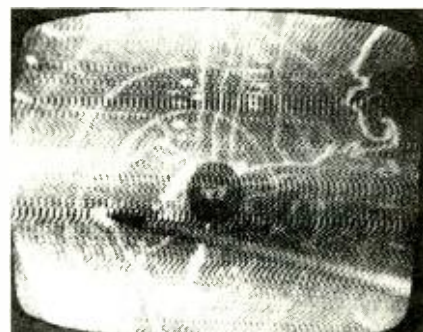


**FIG. 3—MOTOR BRUSH INTERFERENCE** may come from appliances in the same household.

ated and some feeds through the power mains. Dirty motor brushes can cause interference in TV sets over a whole city block, particularly for the weaker stations.

If the interfering item is in the home where the interference occurs, clean the motor brushes (or install new ones and connect an 0.15  $\mu$ F (ac type) capacitor across the motor line. Insert it on the motor side of the ON-OFF switch, so the capacitor is not across the line unless the motor is on. If the receiver does not have line filtering, place another such capacitor across the primary of the power transformer (or the line input in transformerless sets).

Interference from rf signals is shown in Fig. 4. It consists of a herring-



**FIG. 4—HERRINGBONE PATTERN OF RF interference**, too well known to technicians.

bone pattern with wiggling horizontal sections. This could also be caused by a misadjusted lower adjacent-channel trap. Checked out the traps before at-



# INTERFERENCE

## common varieties

on the ac line  
speckles in the picture  
and weak signals  
transistor circuits  
the antenna or lead in

tempting other measures.

When the interference is picked up by the antenna, an interference stub sometimes helps. As shown in Fig. 5, an

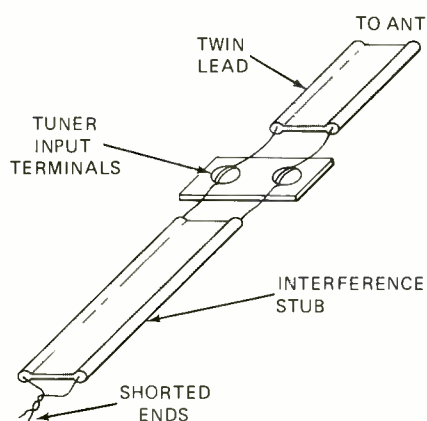


FIG. 5—THE SHORTED STUB is often good against interference on a single frequency.

extra length of twin-lead is attached to the antenna input terminals. Start out with about 30 inches of line and check results on interference. If there is no difference, cut off one or two inches of the stub and short the ends, again noting the effect on the interference. Continue until the best length is found. Now check for normal reception on other stations to make sure that the stub doesn't cut signal strength. If it does, it will have to be used with a switch so it can be disconnected when not needed. (An open line could be used, but is less effective because of end effects.)

### Line filtering

The filter shown in Fig. 6 (Motorola TS-592 series) is typical of a number of line filters in transistor TV sets. A single-core dual-inductance line filter is used, with one coil for each line as shown. In addition the primary is shunted with an  $0.15\text{-}\mu\text{F}$  capacitor, and one side of the line is chassis-grounded through a high-ohm resistance shunted by a  $470\text{-pF}$  capacitor for rf signal bypass.

Note the absence of an on-off switch in the primary side. In these receivers the on-off switch is in the secondary section and consists of a single-throw triple-pole unit which links in the rectifier section and ground, and also shunts the  $5\text{-ohm}$  series resistor (R1) for the picture-tube (V1) heater. This is done to maintain the "instant-on" characteristics of transistor circuitry. The picture tube heats slowly, so the resistor across the open switch maintains a low current through its heater even when the set is shut off. When the switch is closed, one switch section shorts out the series resistor and applies full heater voltage to the picture tube.

In this receiver two types of line choke replacements are available. One is the standard replacement with part No. 24V68611A85. If rf interference is entering the line, the other line choke can be used. It is resonant at the intermediate frequency and is an  $8.8\text{-}\mu\text{H}$  balun type, part No. 24C66772A11. In older models the  $0.15\text{-}\mu\text{F}$  capacitor may be found to the left of the circuit breaker. If so, it should be placed to the

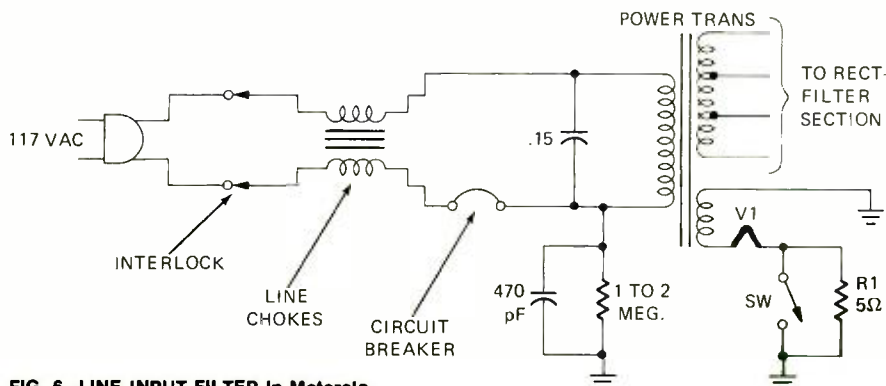


FIG. 6—LINE INPUT FILTER in Motorola.

right as shown in Fig. 6 to open the breaker in case the capacitor develops a short.

For general noise interference in transistor sets, check the components in the line filter section to make sure the shunting capacitor hasn't opened, or the chokes shorted. Excessive twin-lead behind the receiver can also pick up household noise signals. Cut the line to the receiver so only enough remains for the set to be pulled out of place slightly when necessary.

Triode-type transistors, like triode tubes, must be neutralized to prevent self-oscillation. Fig. 7 (the Sylvania A07-1 series chassis) is a typical circuit. A  $2.2\text{-pF}$  capacitor couples the lower

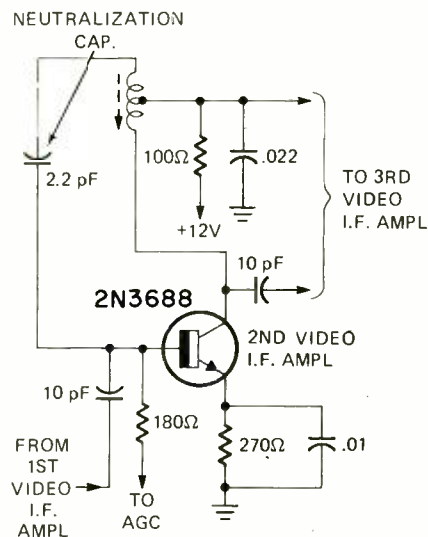


FIG. 7—TRANSISTOR neutralization in a Sylvania A06-1 series chassis TV receiver.

end of the collector coil to the base of the transistor. Thus a portion of the amplified signal is fed back out of phase to neutralize oscillation.

The feedback characteristics of the circuit are fixed to correspond to the general transistor parameters; hence it is important to use exact replacement transistors when one goes bad in video i.f. stages. An "equivalent" type may be far enough off to cause oscillation and result in an interference pattern like that of Fig. 4. Even with the proper

(continued on page 90)

# SUPERCLOCK— NEW DIGITAL TIMEKEEPER

LAST MONTH WE PRESENTED THE MAJOR portions of Superclock. This issue we conclude the story. You'll find a complete schematic for the power supply, time set controls, two kinds of time-base circuits, an AM-PM circuit. Circuit-board patterns for the time-zone change board and several additional photographic views of portions of the clock. You should now be able to complete the assembly of your unit.

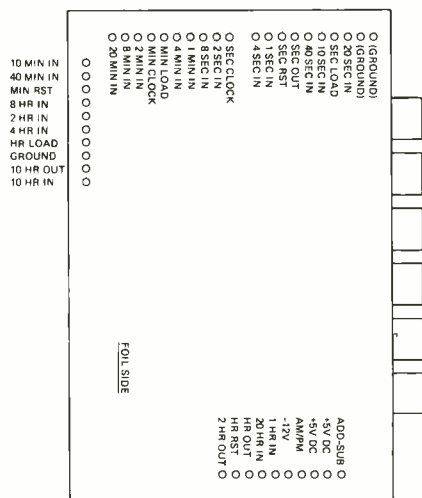


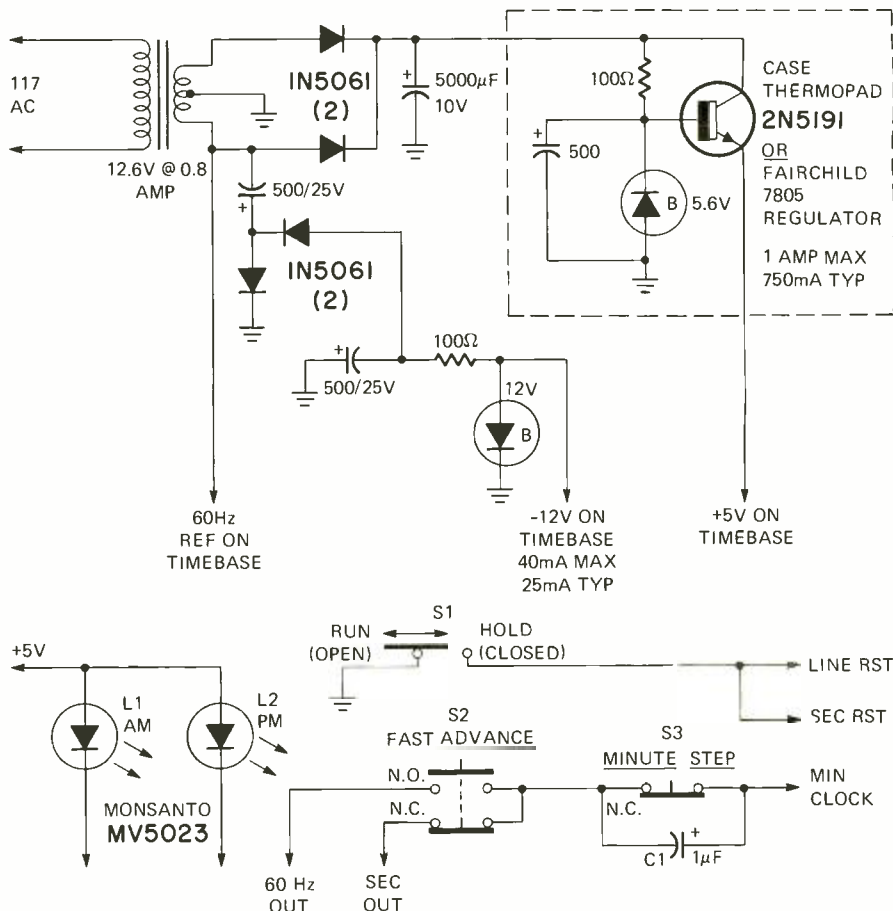
FIG. 4—(above) CONNECTIONS on clock board mate with corresponding terminals on the board with the support circuitry.

FIG. 5—(right) POWER SUPPLY schematic and details of time-set circuitry. Close-up photos of the power supply are shown at the bottom of pages 60 and 61.

Fig. 4 shows the external connections to the main clock board, viewed from the *foil side* or the rear. If you design your own time base or decoder board, note that the connectors

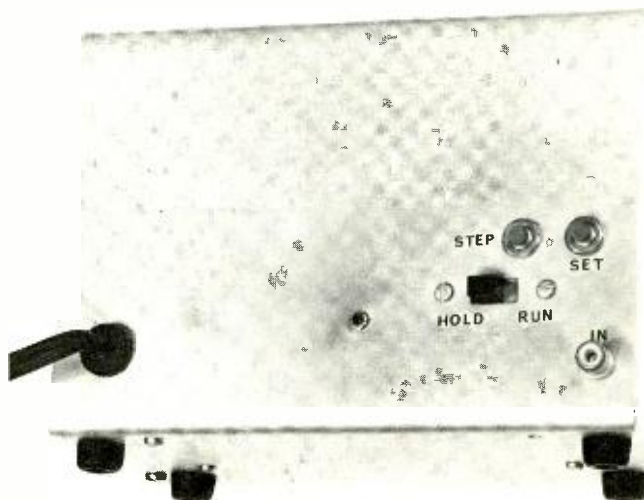
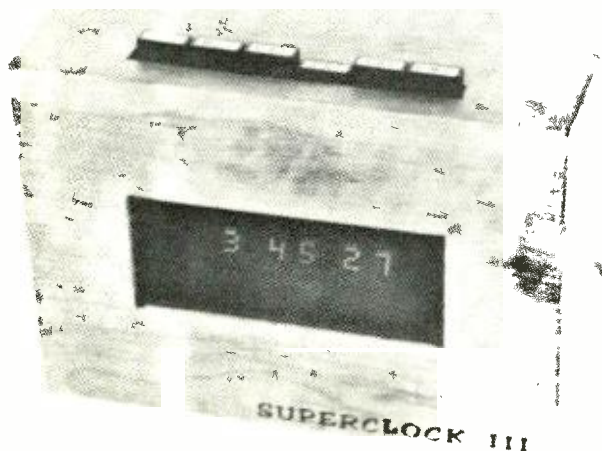
are offset slightly between their pins and their holes, and be sure to allow for this on the PC layout.

A conventional time base (line operated), a crystal time base using a



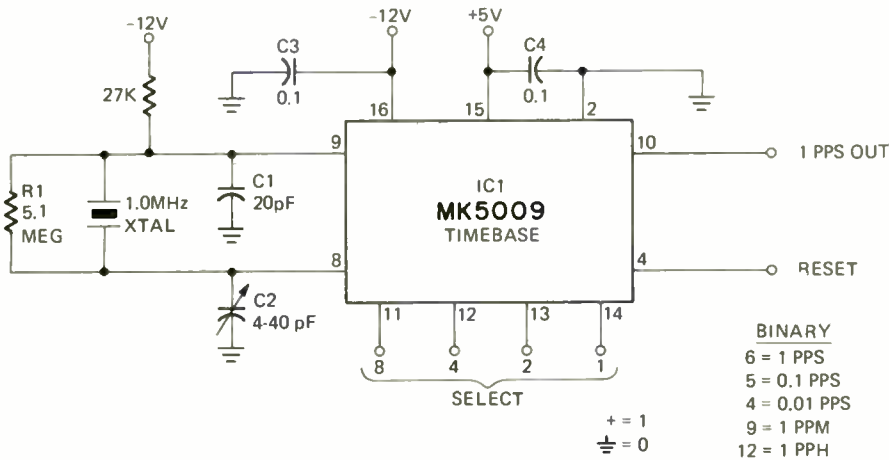
FINISHED SUPERCLOCK in one possible case configuration. It will be interesting to learn what case styles readers use.

REAR VIEW OF SUPERCLOCK CHASSIS. Note positions of Step, Set, Hold-Run switches and BCD Input.

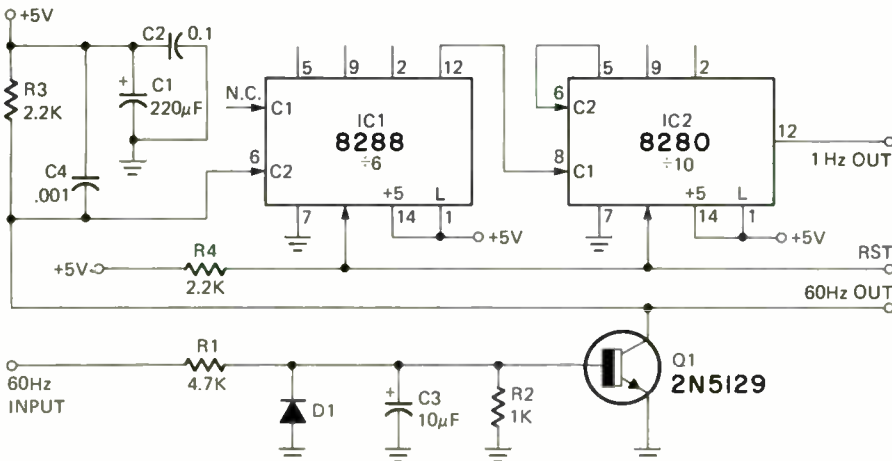




*Part II: Final details of Superclock construction.  
Power supply, timebase generators, and optional AM-PM circuit  
are described. Photos of the power supply are included*



**FIG. 6—(above) CRYSTAL CONTROLLED timebase circuit is actually easier to build than the line-frequency timebase circuit shown in FIG. 7 (below). However, the timebase IC used in the crystal circuit is relatively expensive.**



single IC and automatic AM-PM display circuitry, is shown in Fig. 6 and Fig. 7. The parts list is on page 62. If you are doing your own PC board, free drawings are available as described on page 62.

Fig. 5 shows the power supply and the setting circuitry. Keep the leads short on the setting switches and push-buttons.

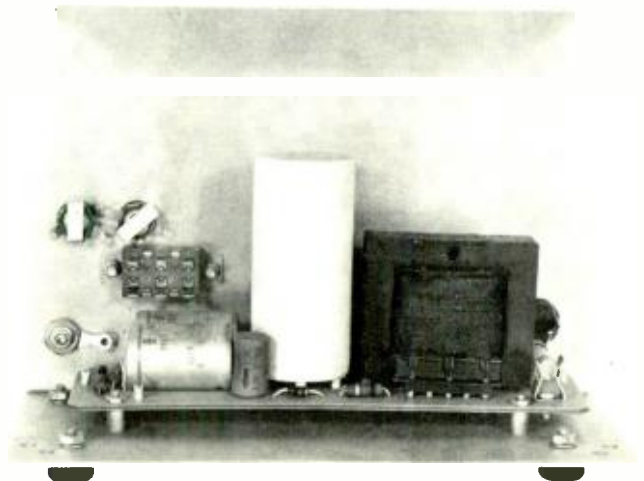
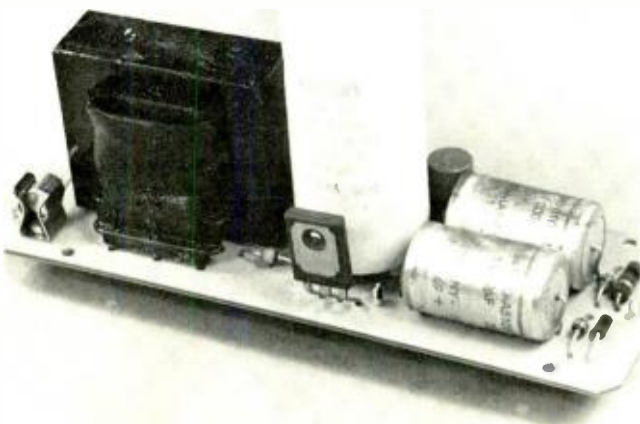
The setting circuit consists of a slide switch and two pushbuttons. You arrange things so the slide switch resets the divider chain on the time source and the seconds counter, and so that one pushbutton routes 60 Hz into the *minutes* counter and the remaining one *steps* the minutes counter. Thus, to set the clock, you switch the seconds to "hold" and a 00 display. Now, run the fast setting button till you have the AM-PM right and are a dozen minutes shy of the right time. Finally hit the minutes step pushbutton often enough to get the right time. Then release the count-hold switch. This scheme is much faster, easier, and more foolproof than the majority of circuits used on most conventional digital clocks.

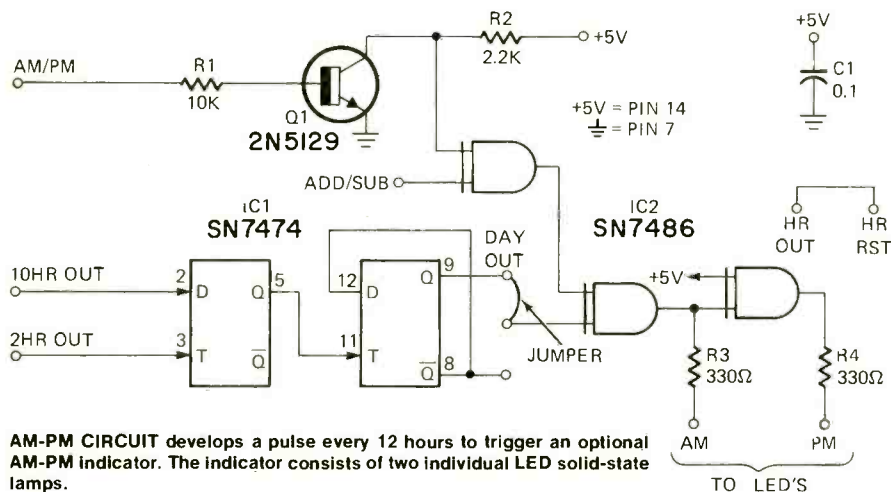
A suitable wooden case may be added, along with a front window of red Plexiglas. A red front filter is essential for best contrast; red #2423 Plexiglas in 1/8-inch thickness is ideal. **R-E**

More information on the support module can be found on the next page, along with a complete parts list for the support module.

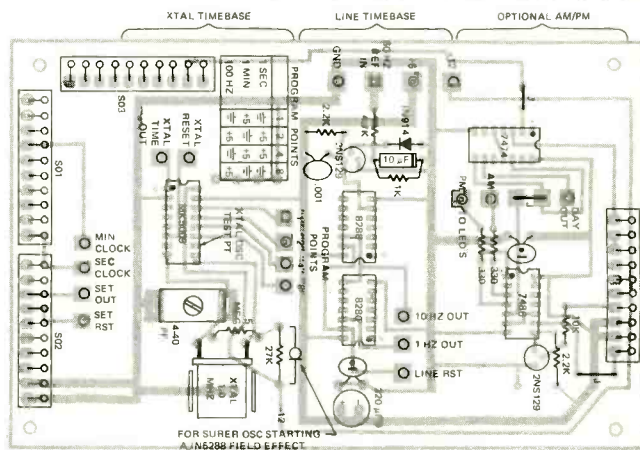
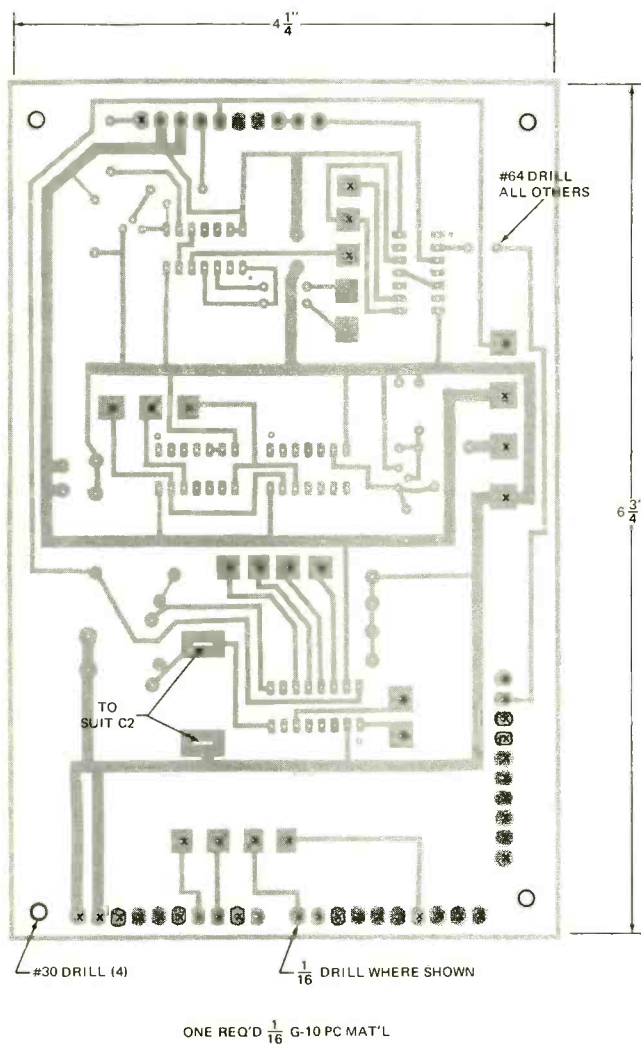
**REGULATED POWER SUPPLY** is bolted to clock chassis. Use insulated hardware when mounting the supply.

**LOOKING INTO THE REAR OF THE CASE** you can see how the regulated power supply is mounted and positioned.

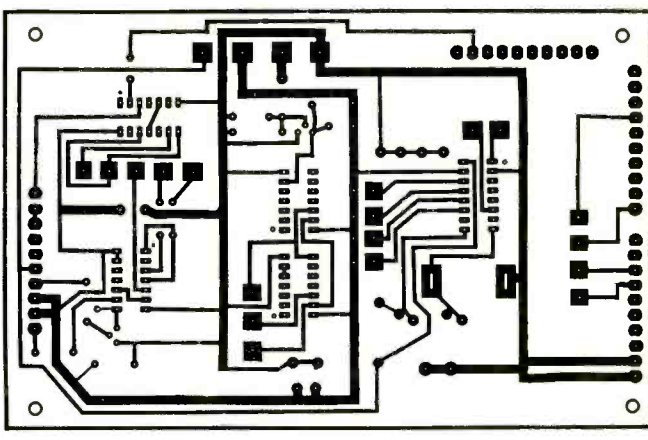




**AM-PM CIRCUIT** develops a pulse every 12 hours to trigger an optional AM-PM indicator. The indicator consists of two individual LED solid-state lamps.



**THREE CIRCUIT-BOARD DIAGRAMS** needed to assemble your own support board. View at left shows jumpers and drill sizes. Drawing above indicates position of components on the support module board. Diagram below is half-size illustration of the foil pattern on the support circuit board. Enlarge it photographically before making your board.



**PARTS LISTS  
SUPPORT MODULE**

- (A) Crystal Timebase:**  
 R1—5.1-megohm, 1/4-watt carbon  
 C1—20 pF mica  
 C2—4-40 pF trimmer  
 C3, C4—0.1 μF, 10-volt disc ceramic  
 IC1—MK5009 Timebase Divider (MOSTEK), a special design by and build for Don Lancaster for this project.  
 XTAL1—1.0 MHz xtal, parallel resonant into 32-pF load
- (B) Line Timebase**  
 R1—4,700-ohm, 1/4-watt carbon  
 R2—1,000-ohm, 1/4-watt carbon  
 R3, R4—2,200-ohm, 1/4-watt carbon

- C1—220 μF, 6-volt electrolytic  
 C2—0.1 μF, 10-volt disc ceramic  
 C3—10 μF, 10-volt electrolytic  
 C4—1,000-pF disc ceramic  
 D1—1N914 silicon diode  
 IC1—8288 Base 12 counter (Signetics)  
 IC2—8280 Base 10 counter (Signetics)  
 Q1—2N5129
- (C) AM/PM Circuitry**  
 R1—10,000-ohm, 1/4-watt carbon  
 R2—2,200-ohm, 1/4-watt carbon  
 R3, R4—330-ohm, 1/4-watt carbon  
 C1—0.1 μF, 10-volt disc ceramic

- IC1—SN7474 Dual D flip-flop, TTL  
 IC2—SN7486 Quad EXCLUSIVE-OR TTL  
 L1, L2—Red LED panel lamp, Monsanto MV 5023 or equal  
 Q1—2N5129 transistor
- (D) Setting Circuitry and Connectors**  
 S01, 4—10-pin female connectors, Molex 09-52-3103  
 C1—1 μF, 10-volt electrolytic  
 S1—spst slide switch  
 S2, S3—spdt pushbutton  
 —Misc. mounting hardware  
 —Red Plexiglas front filter

Those readers who are interested in obtaining a diagram showing the parts layout on the main Superclock board can get a copy of this diagram, free along with time-zone switch programming details, until December 3 by sending a self-addressed envelope to:

**SUPERCLOCK**  
 c/o Radio-Electronics  
 Editorial Department  
 Radio-Electronics  
 200 Park Avenue South  
 New York, 10003



# R-E's Service Clinic

## diagnosis puzzler, in sections

Only careful analysis  
finds early solution

by JACK DARR  
SERVICE EDITOR

YOU LIKE PUZZLES. THAT'S A STATEMENT, not a question. If you didn't, you wouldn't be working on TV sets; they can offer some of the most fascinating puzzles in the world.

Here's one for you, in two steps: just as it happened. I made notes as I went, and for once it turned out I was right! Here are all the symptoms, just as I found them, and you can spot the trouble.

Diagnosis is comparatively easy if you remember the rules: What is happening? Why is it happening? What can we do to make it stop happening? The last is the "fix" that makes the thing work again.

The set is a Sylvania DO-3 color TV. The visible symptoms are: no vertical sweep, bright line across the screen. If I throw the SERVICE switch, about 2/3 of the line disappears. Plenty of brightness. In fact, I had to turn the screens down so that I wouldn't have too bright a line while I was working. There is a very slight odor of 'burnt resistor', and a low hum in the sound, with an occasional motorboating.

Taking the back off, I see a 1200-ohm resistor very badly scorched. It is in the cathode of the 21LU8 vertical output section. Resistance measurement shows about 200 ohms to ground, but there is a 1500-ohm resistor and a convergence winding in parallel. So we clip one end loose and find that it reads about 500 ohms now.

I tack another resistor in here, for luck, and go on. Now, measuring the voltage on the vertical output tube plate, pin 4, I get about 15 volts. This is bad, alone, but in this case, worse, for this is 15 volts *negative!* Screen grid the same. What's going on here?

### Diagnosis Number 1

At this point, I made some standard checks, just for luck; and substituted the 21LU8 tube, although it tested OK. No help.

From previous experience, as mentioned numerous times before in the Service Clinic, this "negative plate voltage on vertical output" symptom meant one thing; the whole stage was in violent oscillation. The net result of this is

to develop a voltage on that plate that reads negative to ground. Support for this was in the sound: the low hum and motorboating. Now let us go on.

Diagnosis and test, second section. Although I was pretty sure by this time, I ran a couple of confirming tests. Checking on the 21LU8 plate with a scope, I found a high amplitude waveform like Fig. 1. It was about 100 volts

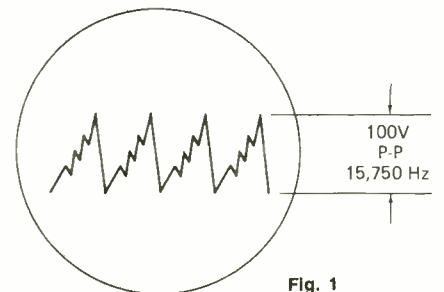


Fig. 1

peak-to-peak, and turned out to be sawtooth waveforms at about 15,750 hertz. Next, I grabbed the electrolytic-capacitor substitution box, and hung a big capacitor on the B-plus test point that fed the output stage. This is L on the schematic, to 270 volts B-plus. Same waveform here.

When I pushed the button, the hum dropped and the raster filled up. However, this didn't clear up the hum completely, and there was a very bad rippling in the raster. Now, you have all of the information necessary for a complete diagnosis.

### Diagnosis Number 2

There is one thing that causes most of the "violent oscillation" troubles and that's a bad filter capacitor. This is what I suspected. The scope waveform verified the conclusion that the circuit was oscillating. Bridging the capacitor cleared it up, so that part was OK. Now, I knew what I was looking for.

An open capacitor? No. One with a very high power factor, for bridging a new unit across it did not cure the symptoms, but did *help*. This action is almost a sure clue to the presence of an electrolytic filter with a most extremely high power factor.

(continued on page 68)

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

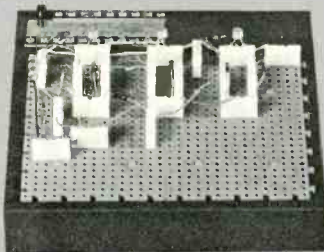
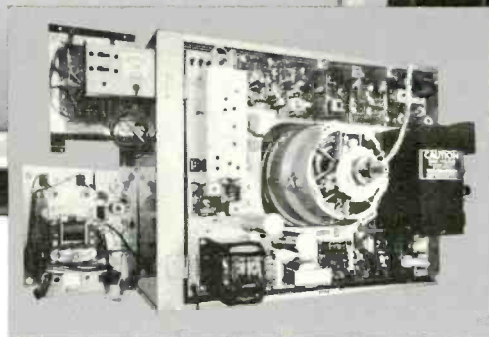
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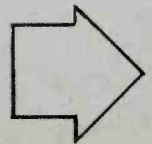


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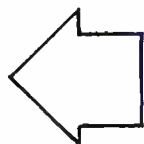


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Circle 14 on reader service card

## SERVICE CLINIC

(continued from page 63)

From the schematic, I saw that the output stage was fed from the 270-volt line. After tracing this out we found that it came from the 275-volt line, through the 10-ohm vertical centering control, and that there was only one filter directly connected to that point, a 250- $\mu$ F at 350 volts, marked C512A on the schematic. So, this was my most likely suspect.

Now, back to work. I found all the filters mounted on the front apron. Hooking up the capacitor tester, we checked them all one at a time, and found a big triple unit that showed no response at all: no "eye"; this was evidently C512.

An ohmmeter check of the wiring showed this was correct. So, we took all of the wires off, and rechecked; This was it; we could get no eye opening at all, even with the checker set up to 65% power factor, as high as it would go! So, there it was; diagnosis confirmed. We smiled happily, and went and got a cup of coffee. Job Over, except for replacing the capacitor.

## Using hindsight

Did you get it as it happened? Let us analyze the situation, using our well-known 20-20 hindsight. The negative voltage on a plate that should have had 250 volts or more positive told us that the stage was in violent oscillation; Fact 1. The hum and motorboating in the sound confirmed this; Fact 2. The high-amplitude waveform with a fundamental around 15.750 Hz gave further confirmation; Fact 3. Bridging with a good unit helped but did *not* cure: Fact—this confirmed that I was looking for a bad capacitor and also told me what the defect was; high power factor, not a completely open one. Actual tests after pulling the chassis confirmed this.

In case you were wondering, I measured a "Do Not Measure" test point because I knew that there was *no* high-amplitude 60-hertz spike present! One look at the scope screen told me that. So, I checked, and found the negative voltage. That, plus the hum, and later on the scope checks, told me that I did indeed have a case of violent oscillation. Experience told me that the most likely cause was a bad filter, and the character of the responses to my tests showed me that it was apt to be one with a very high power factor, and it was.

Someone in the back row wants to know about that burnt-up resistor in the cathode circuit. That is apparently one that the set threw in to fool us. Just like a child's riddle. Evidently, when the oscillation began, and the vertical output stage lost its normal drive signal, it drew

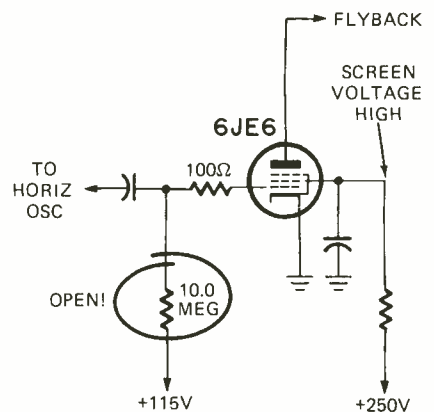
so much plate current that the resistor overloaded and burned up. If the set was left in operation long enough, this heavy current could have damaged the tube; so, I checked very carefully to see that it was OK: by checking the raster, linearity, amount of overscan obtainable, etc. If anything had shown up here, we would have replaced the 21LU8 tube before taking it back.

## Reader Questions

### VOLTAGES HIGH, CURRENT LOW

*I have a Sears-Silvertone 4294 color TV with an odd problem. I don't have enough width, HV or boost, etc. However, the grid-drive waveform on the 6JE6 is 250 volts p/p. The 6JE6 screen grid is +225 volts, which is too high. Control grid voltage is -70 volts or so, but the cathode current is only 150 mA.—J.K. Trenton, NJ*

Your screen voltage is too high, because the tube isn't drawing *enough* current. The outputs are low for the same reason. Since your grid-drive waveform is well up to par, there's only one thing that can do this. Notice that your dc grid voltage is away too high negative!



(Normal about -50 volts.)

There is a "hold-down" resistor in the 6JE6 grid circuit, 10.0 megohms, returned to +115 volts. The purpose of this resistor is to feed in a little *positive* voltage, to hold the grid down, and keep it from driving itself *too far* negative. When this resistor opens, the grid goes negative, and almost cuts the tube off. Since the tube is drawing too little current, your screen grid voltage goes up, but the outputs (HV, sweep, boost, focus, etc.) will go down, because the tube is not developing enough *power*.

Lift one end of this resistor and check it. You'll probably find it is open, or increased to about 30-40 megohms.

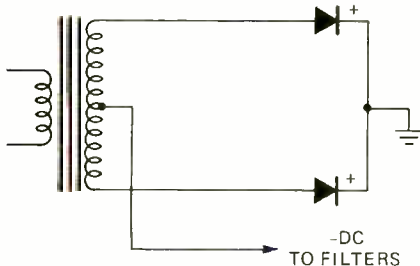
### RECTIFIERS REVERSED

*I've got a Zenith 10YT26 stereo am-*



plifier, and it's weird. The customer jumped the fuse after it blew, and several resistors were burnt up. Still blows the fuse. Draws a very heavy current, and I can't find out why. I can get about +15 volts on the collectors of the output transistors for a moment.—J.D., Greenville, OH

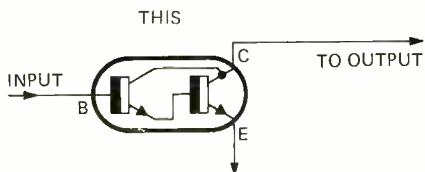
No wonder. The customer evidently did something else beside put



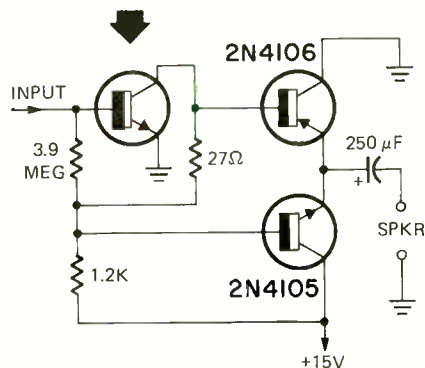
a 30-amp fuse in it. If you're getting a positive voltage on the output collectors, your rectifiers are reversed! The diagram shows how these should be connected. The positive voltage on the filter electrolytics is causing them to draw a heavy reverse current; incidentally, it would probably be a good idea to replace them too. This can damage even a good capacitor.

#### WATCH OUT FOR THOSE DARLINGTONS

I'm working on a little Truetone 4DC6963 amplifier. The output transistors were bad, so I replaced them. It still didn't work, so I replaced the driver transistor with a HEP-53, since that looked like a good substitute. Now it works, but has a horrible distortion and the volume is away down.—E.C., Hampton, VA



IS OFTEN DRAWN LIKE THIS



Take out that HEP-53 and put it back in stock. The 55-641 "driver transistor" here is actually a single-unit Darlington pair.

There are several of these available now, in single-unit cases, with only 3 leads. They look exactly like a single transistor, but they're not. (By the way, if you can't find one, you can make one with two HEP-53's. Just connect them as shown. A pair of RCA SK-3020's will do, also.)

#### AGC PROBLEMS

This Curtis-Mathes CMC-29 came in with a bad flyback. I replaced it. Now I have a nice clean raster and plenty of high voltage, but no picture! Just a clean raster. I am reading a -80 volts on the plate of the agc tube. The terminal markings were slightly different on the replacement

flyback, but I followed instructions in replacing it, and that much seems to be OK. Why do I get this high negative voltage on my agc tube plate?—J.D., San Angelo, TX

I have a sneaking feeling that I know why. Check your keying pulse on the agc tube plate. You'll probably find that it isn't there at all, or that it's of the wrong polarity. This often happens where there have been terminal changes on replacement flybacks, or in a few cases where someone has picked up the wrong flyback transformer in the parts depot.

If you do not get the correct keying pulse here, trace the circuit back to the

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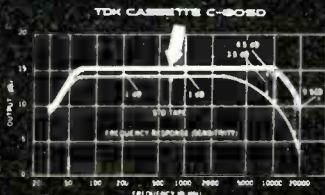
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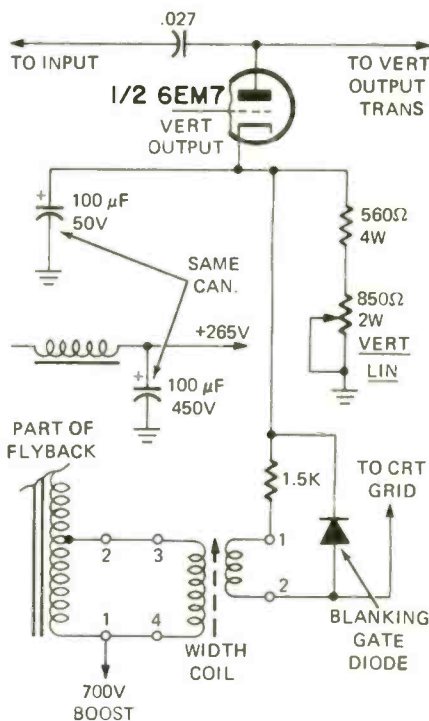
flyback, and find out why not. You should have a 600 volt peak-to-peak, positive-going pulse on this plate. This should come through a 68 pF, 4-kV capacitor from terminal 6 of the flyback.

The cause for your "clean raster" symptom is undoubtedly that high negative voltage; you're cutting off the video i.f. completely. If you want to check, override the age and see if this will bring the picture back. If so, then go and dig in the age plate circuit and see where you have lost the pulse.

### VERTICAL DEFLECTION WITH TUBE OUT

*This RCA KCS-136M has me mystified. The vertical linearity control burns up as fast as I put a new one in. The width control was shorted so I replaced that too, and the linearity control still burns up. Another wild one. With the tube out, I still get about 2 inches of vertical deflection. — L.H., Hitchcock, TX*

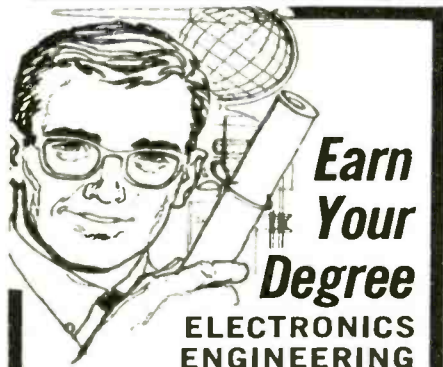
In this chassis, if the width coil shorts between the two windings, it will put the boost voltage on the cathode of the vertical output tube. This will burn



up the little 2-watt 850-ohm vertical linearity control. However, this control is also the cathode resistor for the 6EM7 triode.

So if something is upsetting the bias on this tube, the control will burn up because of the excess current being drawn. Check the bias on the grid. Also pull the tube and check the cathode to see what's there. Check for dc voltage, which should be zero, and for any sign of hum, signal, with a scope. This should also be zero.

I suspect that deflection without the tube is caused by hum getting into



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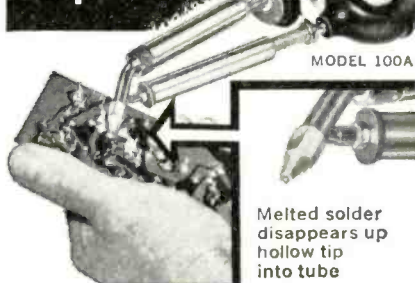


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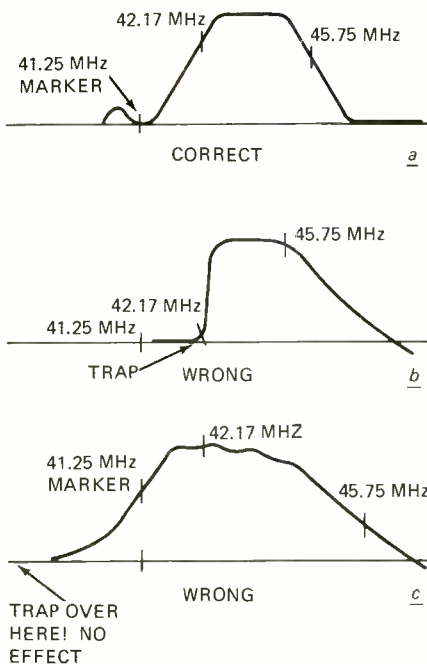


the vertical yoke. The scope will tell you for sure. There is a 100- $\mu$ F electrolytic on the cathode. This should stop *anything* in the way of hum or ripple, if it's not open. Second possibility; rare, but has happened—an intersection short between this 100- $\mu$ F. section and the 100- $\mu$ F section in the multiple electrolytic. This would put the +265 volts supply on the 6EM7 cathode, and again the linearity control would burn up.

### TRAP SETTING, AND SO ON

*I have problems with setting traps in sweep alignment. Should you set the marker as low as possible, or what? How do you do this properly?—D.M., Camdenton, MO*

Any trap in the i.f.'s should be set for *minimum* response at that frequency. For example, the 41.25-MHz sound trap if it is working properly, will make a "notch" in the response curve.



The diagram shows several possible conditions, and the correct setting.

Moving the trap-tuning core should make this notch "walk" back and forth along the curve. If you can't find the notch, tune the trap all the way from one end to the other. You may find it, as I did once, clear over on the *wrong* side of the curve! Set it so that your marker is exactly in the middle of the notch.

### LOSS OF HEIGHT

*The raster on this Zenith portable is only about 2 inches high, and "ripply". Changed the tube, changed a vertical linearity control which was open, and so on. Now everything checks fine but it won't work!—H.M., Gainesville, FL*

Under the circumstances I'd check the *yoke*. We have had a good deal of assorted yoke troubles lately, in several makes. Mainly in the little import yokes

with blue plastic.

Open the yoke circuit, find the center tap, and check the two halves for *balance*. While the resistance won't tell you too much, it must be the same for each half. Any unbalance is a sign of trouble. Look for signs of arcing, etc. Best check; connect a new yoke.

### "JIG SMEAR" IN MONITOR TV

*We have a small TV receiver that we're using as a monitor. We've remoted the picture tube from the cabinet, and housed it about 36 inches away. The picture lost detail and seems to have a horizontal smear. Controls are working, but the picture just isn't as crisp as we want.*

*What can we do about this?—S.L., Barrie, Ontario.*

This is very apt to be what I have christened "Jigsmear". It is caused by the added shunt capacitance of the extension cables in the video circuits. You see the same thing when operating a color TV chassis on a test jig. It reduces the high-frequency response of the picture tube by shunting these signals to ground, etc. (You can run a video sweep test and make sure.)

Possible cure would be to isolate the pix-tube cathode lead from all the rest by a couple of inches. Try using a plain wire lead instead of coax or use very low-capacitance coax. R-E

## CHEMISTRY

Or, do you know all our secrets?

The other day, we got quite a shock. And the discovery we made could mean \$100 or more a week in added sales to every serviceman in the country.

In taking one of our regular surveys, we discovered the startling fact that most servicemen are unaware of the broad variety of chemical tools available today. And the profits they can build from the extra service calls chemicals make possible.

Sure, you know about tuner degreasers and cleaner/lubricants. And what you know has made Chemtronics TUN-O-WASH and TUN-O-FOAM the world's best-selling degreaser and cleaner/lubricant.

But if that's all you know about chemicals, you're missing dozens of ways to save time, do a better job and make more profits.

**GRIME GETTER.** Our TUN-O-BRITE has a controlled polishing action that powers stubborn dirt out of hard-to-reach contacts. It's also good for unfreezing telescopic antennas, locks, motor shafts and more.

**WRENCH-IN-A-CAN...PLUS.** CHEM-OIL's penetrating/lubricating action does thousands of jobs, from freeing frozen yokes to un-squeaking hinges.

Many servicemen buy three—one for shop, one, home, one garage.

**THE HOUR SAVER.** Take SUPER FROST AID, for example. It helps find intermittents in minutes instead of hours. But servicemen have also used it as: a portable small-fire extinguisher, blister-preventer (used on minor burns immediately), heatsink before soldering...and even chewing-gum remover (cold makes gum brittle).

**PUSHBUTTON PEACE & QUIET** One spray of SUPER TROL AID or CONTACT KLEEN quiets noisy pots, switches and relays. Some servicemen make a lot of money "curing" noisy transistor radios, balky dimmers, antenna rotors...even thermostats. Not to mention tape recorders, CB sets, marine radios...

**LAUGH AT THE WEATHER.** KLEER SPRAY and NO-ARC will help, since they're both excellent insulators and weather-proofers. Besides flybacks, antenna terminals, splitters, feed-thru's and the like, you can use them on ignition wiring, exposed metals—even wood!

**NEW LIFE FOR OLD RUBBER.** DUSTZAPPER, TRACK RECORDS, STICKY STUFF AND SALES. As you can see, we have many more lend-a-hand products. To restore idler wheels and belts. Polish tube guards. Improve performance of reel-to-reel, cassette and 8-track recorders. Clean records. Repair and mend all kinds of materials. And even sell to customers while you're in the shop or on call.

For more information about our professional chemicals, and ideas on how to make money with them, see your local Chemtronics distributor. Or write to us for a catalog.

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Circle 19 on reader service card

## FIBER-OPTIC MATERIALS LIST OF SUPPLIERS

Allied Electronics  
2400 W. Washington Blvd.  
Chicago, IL 60612  
*Distributor for American Optical fiber bundles, A-O bundle illuminators, simple fiber optic kits by other manufacturers.*

American Optical (A-O)  
Space-Defense Group  
14 Mechanic Street  
Southbridge, MA 01550  
*Bundles, illuminators, magnifiers, Peeperscopes, misc. components and materials.*

Bendix Corporation  
Mosaic Fabrication Division  
Galileo Park  
Sturbridge, MA  
*Fiber optic faceplates, mosaics and related equipment.*

Corning Glass Works  
Flexible Fiber Optics Dept.  
Houghton Park  
Corning, NY 14830  
*Liquid-level monitor kit, finished flexible bundles, raw fibers; and from the Fused Fiber Optics Dept., fused faceplates.*

Develco  
2433 Leghorn Street  
Mountain View, CA 94040  
*ISOAMP Isolation Signal amplifier and transmission system.*

Dolan-Jenner Industries  
200 Ingalls Court  
Melrose, MA 02176  
*Probes, reflection sensing control units, bundles, and components.*

Edmund Scientific  
300 Edscorp Bldg.  
Barrington, NJ 08007  
*Fiber optic kits and components, liquid crystal materials, lenses.*

Electro Fiberoptics Corporation  
99 Hartwell Street, Box 154  
West Boylston, MA 01583  
*"Litechex kits", bundles, lamps, and sensor assemblies.*

Fiber Photics, Inc.  
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Santa Cruz, CA 95060  
*Fiber Optic Kits, bundles, sensors, sheet fibers, fused coherent optics.*

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Commercial Products Division  
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El Segundo, CA 90245  
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Laser Systems Dept.  
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Torrance, CA 90509  
*Solid state laser system for initiation of pyrotechnics and explosives using fiber optic signal cable.*

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NEC America, Inc.  
Pan Am Building, Suite 4321  
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New York, NY 10017  
*SELFOC fiber optic fibers, and SELFOC devices.*

Poly-Optics, Inc.  
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Santa Ana, CA 92705  
*Raw plastic fibers, fiber optic kits, and plastic fiber bundles.*

Rank Precision Industries  
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West Nyack, NY 10994  
*Fiber Optic Kits; probes, sensors, assemblies; bundles, mosaics, faceplates.*

Welch Scientific Company  
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Skokie, IL  
*Classroom demonstration apparatus for fiber optic principles.*

R-E

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- Extended Range Covers 950 MHz Band
- Pin Diode Attenuator for Full Range Coverage as Signal Generator
- Measures FM Deviation

The **FM-2400CH** provides an accurate frequency standard for testing and adjustment of mobile transmitters and receivers at predetermined frequencies.

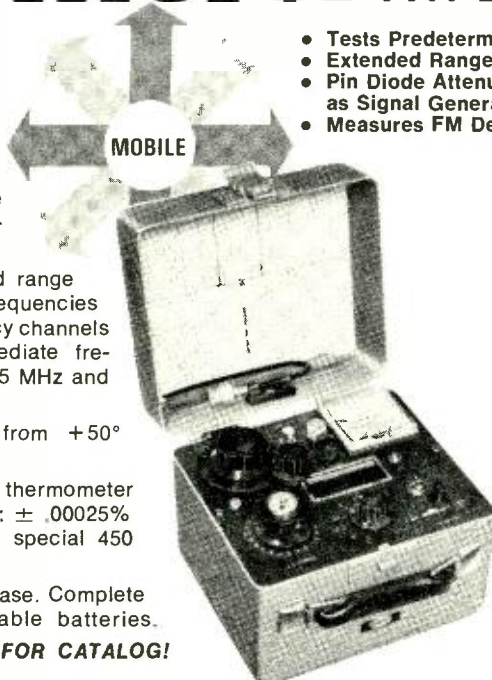
The FM-2400CH with its extended range covers 25 to 1000 MHz. The frequencies can be those of the radio frequency channels of operation and/or the intermediate frequencies of the receiver between 5 MHz and 40 MHz.

Frequency Stability:  $\pm .0005\%$  from  $+50^\circ$  to  $+104^\circ\text{F}$ .

Frequency stability with built-in thermometer and temperature corrected charts:  $\pm .00025\%$  from  $+25^\circ$  to  $+125^\circ$  (.000125% special 450 MHz crystals available).

Self-contained in small portable case. Complete solid state circuitry. Rechargeable batteries.

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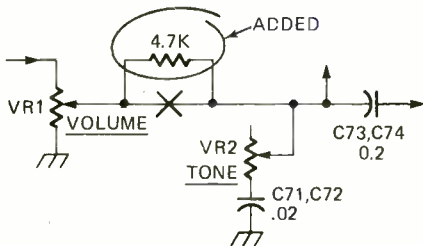
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IF crystals.....catalog price

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## OLYMPIC 329, 329-3 CHASSIS

This procedure corrects complaints that the tone control is ineffective at low listening levels: Locate the dual volume control (VR1). Remove the two leads connected to the center tap of each section. Insert a 4700-ohm, 1/2-watt resistor



between the center lug and the two open leads just removed from each section of the control as shown in the diagram. Note that the tone control (VR2) is wired with the high end open as shown, rather than connected as in some schematics.—*Olympic Service Bulletin*

## PLUG-IN MODULES, RCA CHASSIS

This caution note applies both to the 36-terminal-type socket used in the CTC 47 tuner control assembly and the 6-terminal sockets used in the CTC 49 and several black-and-white chassis with plug-in modules. Certain ingredients in spray-type chemical troubleshooting aids—especially circuit coolers—attack the socket material and cause failures.

In those instances where high contact resistance at plug-in connections is suspected, clean the edge of the connectors with an ordinary pencil eraser. Normally the socket contacts can then be cleaned by inserting, and then removing the module two or three times.—*RCA Television Service Tips*

## GENERAL ELECTRIC KE CHASSIS

In the KE and KE-II chassis, there is a type of failure of the 6AG9 video amplifier tube that produces excessive cathode current. This may burn a spot on the contrast control and change its resistance to between 200 and 300 ohms, causing a drop in cathode bias.

When only the 6AG9 (V6) is changed the picture will bloom and pull in at the sides at maximum brightness and contrast—even when the picture-tube bias is at minimum. The pull-in is

due to loss of high-voltage regulation. Even under these conditions a reasonably good picture can be obtained by readjusting the picture-tube bias and gray-scale but the adjustments are critical.

The correct procedure, whenever you replace the 6AG9 video amplifier, is to measure the contrast control and replace if it measures 290 ohms or lower.

One possible cause of 6AG9 failure is the position of a stiff steel wire support that extends upward from the board near pin 12 of the video amplifier tube. This wire has a loop supporting an insulated lead. In many cases the steel wire touches the glass envelope of the 6AG9 and causes an extremely small hole in the glass—resulting in a loss of vacuum. This can account for the high cathode current and the burned spot on the contrast control.

Whenever you service a KE chassis

or replace the 6AG9 video amplifier, bend the steel wire support away from the 6AG9 so no part touches the glass envelope.—*G-E Service Talk*

## OLYMPIC 330R RADIO CHASSIS

In many instances where a shorted output transistor was suspected, we found the shorted indication due to a breakdown in the Mylar insulator (part No. INJ 70179) between the transistor body and the heat sink. Before you replace this transistor, inspect the insulator to insure that it has not broken down. This condition will not damage the transistor.—*Olympic Bulletins* R-E



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Circle 21 on reader service card

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# new products

More information on new products is available from the manufacturers of items identified by a Reader Service number. Use the Reader Service Card on page 101 and circle the numbers of the new products on which you would like further information. Detach and mail the postage-paid card.

**LOW COST ALARM**, Stock No. 71,633 detects fumes, gas, fire and smoke. Non-sparking buzzer warns of emergency conditions. Unit can help preserve life and property by detecting escaping gas from a blown-out pilot or other gas source as well



as fuel oil leaks and smoke and fire hazards. Measures 5-1/2" x 2-1/2" x 2" and is easily installed. Plugs into any 117 volt ac outlet. \$35.95.—**Edmund Scientific Co.**, 380 Edscorp Bldg., Barrington, NJ 08007.

Circle 31 on reader service card

**UNIVERSAL POWER SUPPLY**, model UPS 164, for use whenever a battery or low-

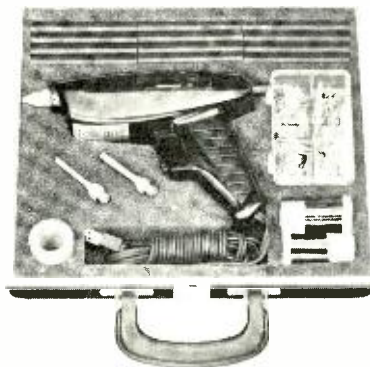


voltage supply would be required. The unit provides a 0 to 30 volt regulated and

highly filtered variable supply that delivers virtually pure dc for powering any solid state circuit or circuits. As a well-filtered, high-current, regulated 6 and 12-volt supply, it provides up to 20 amps for powering radios, tape decks, aircraft, marine and other equipment. Fully protected with automatic current limiting—any terminal can be shorted with a screwdriver without internal damage. Current limiting adjustment on the highly filtered section can be set at any level to protect the circuit being powered. \$240.—**Sencore, Inc.**, Sioux Falls, SD 57107.

Circle 32 on reader service card

**INSTANT CONNECTOR KIT**, can make on-the-spot mating injection-molded polyethylene connectors to fit almost any of the countless connector configurations that exist. The complete kit consists of a heavy-duty heat gun with three inter-

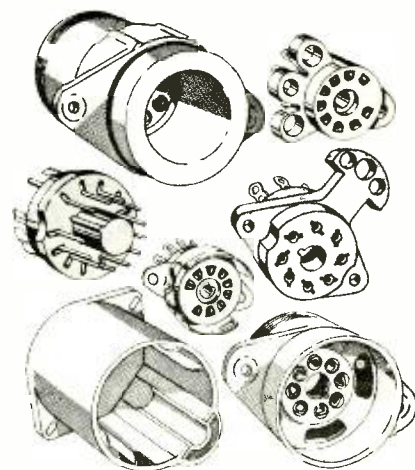


changeable nozzles, 25 polyethylene cartridges and 400 connector contacts, enough to make up to 40 10-contact connectors. The kit comes in a carrying case as shown. \$98.—**Wiring Analyzers, Inc.**, 9015 Wilshire Blvd., Beverly Hills, CA

Circle 33 on reader service card

**RADIO AND TELEVISION SOCKETS**, are available as a part of a complete line of replacement sockets. These include octal, novar, printed circuit, tube and miniature sockets in laminated and molded models. Seven, 9- and 12-pin plug sockets with Nuvistor, transistor, silicon rectifier, crystal and general purpose sockets are included. To round out the line there are high-voltage cups, sockets and lids to fit the high-voltage cups together with

needed socket components such as mica collector and Nylon screw insulators, power transistor mounting kits and sock-



ets.—**Workman Electronic Products, Inc.**, Box 3828, Sarasota, FL 33578.

Circle 34 on reader service card

**FIRE & SMOKE DETECTOR**, model ION-1, detects the invisible products of combustion, not heat or smoke, meaning that the device can "detect fire before it reaches the flame stage". One detector will supply adequate protection in bedroom areas or other locations of similar size. Operation



completed by adding four penlite batteries. Can be mounted on wall or ceiling. Has own self-contained alarm system. Weighs 12 oz. and has brushed aluminum and walnut finish case. \$34.95.—**MuTronic Products**, P.O. Box 10306, Denver, CO 80210.

Circle 35 on reader service card

**ANALOG COMPUTER**, model AC1. Designed to introduce students, teachers, experimenters and technicians to analog techniques, this modular analog computer



includes four co-efficient pots, one 7-input operational amplifier, a null-indicator module, patch cords, and a manual. Requires a 6-V supply. The AC1 can be expanded to any desired extent. Integrators,



multipliers, and other modules now being designed. The AC1 modules are also available separately. \$45.00.—**Scientific Measurements, Inc.**, 2945 Central, Wilmette, IL 60091.

Circle 36 on reader service card

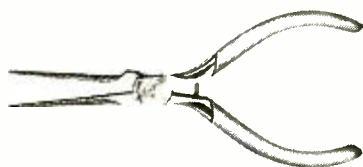
**SECURITY SYSTEM, Failsafe FC-100.** A security control center for do-it-yourselfers with expandability concept. Start with the FC-100 and add-on alarms, sensors, accessories at any time. The FC-100 is a home protection device with alarm activating circuits to accommodate burglar alarm bells, separate fire horns, as well as



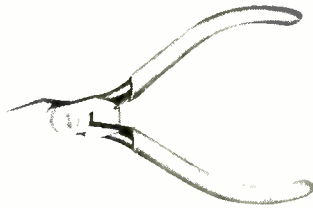
various combinations of fire and burglar alarm bells and horns. Powered by a 117 Vac power supply that supplies 6 volts dc for operating the system. Space provided for an optional 6-volt lantern battery for standby/emergency operation. \$49.95.—**EICO**, 283 Malta St., B'klyn, NY 11207.

Circle 37 on reader service card

**NEW PRECISION PLIERS, Little Champ.** The two newest models in this series are an extra long needle nose plier and a flush-cutting, sharp nose diagonal cutter. Both tools have coil spring actuated han-



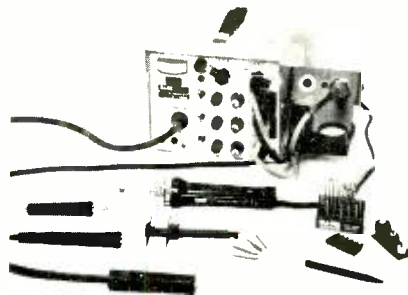
dles. Box joint design prevents handles from spreading too far, thus avoiding spring disengagement. Hand honed, specially hardened, perfectly mated cutting



edges; high luster polished steel finish; blue dipped plastic grips.—**Channellock, Inc.**, Meadville, PA 16335.

Circle 38 on reader service card

**POWER SOURCE, model PRC-150A.** A power source for the "Bench-Top Rework



Center". Provides pneumatic, mechanical, and electrical modes of operation which

can be combined in various sequences. Front-panel controls provide easy regulation of all operating modes. System requires a single phase, 117 Vac, 50/60-Hz electrical supply. Other operating voltages available. Applications for PRC-150A include removing solder joints; machining for circuit repair; replating damaged electroplating; reflow soldering high-strength lap joints; forming component leads; and resistive and conductive soldering. System weighs 25 lbs.—**Pace, Inc.**, 9329 Fraser St., Silver Spring, MD 20910.

Circle 39 on reader service card

**IGNITION SYSTEM, Hot Rodder model JG-10.** This solid-state ignition system for internal combustion engines having a 12-volt negative-ground system is designed to



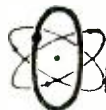
enhance high compression, prolong spark plug and point life and help keep exhaust pollutions within manageable levels by more complete combustion. It contains a

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Circle 62 on reader service card

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Circle 40 on reader service card

**RECORD ALBUM, Stereo Quadraphonic, No. 28-01447.** Columbia Records has produced this SQ album featuring some of to-

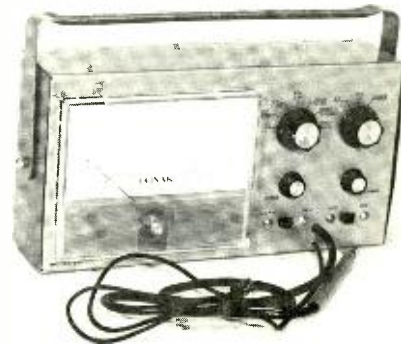


day's popular artists, including Barbara Streisand, Johnny Mathis, Dean Jones, Andy Williams. To achieve the full four-di-

mensional sound possible from the album, it must be played through a 4-channel stereo system incorporating SQ Decoder circuitry. No special turntable, stereo cartridge, or stylus is required. The album conforms to RIAA equalization standards, has full dynamic range, is compatible, and may be played with any conventional 2-channel stereo system. \$5.98.—**Lafayette Radio Electronics**, 111 Jericho Turnpike, Syosset, NY 11791.

Circle 41 on reader service card

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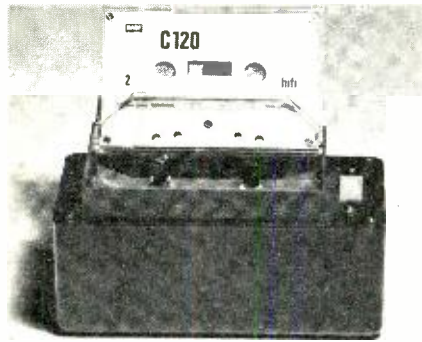
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vided for by two extra zero-center dc scales; full-view 6-inch meter gives accurate readings at a glance; polarity reversing switch works on ohms scale and also makes testing semiconductors easier; no-warmup battery-operated for portability. \$29.95 for kit; \$42.95 assembled.—Conar Instruments, N.R.I., 3939 Wisconsin Ave. N.W., Washington, DC 20016.

Circle 42 on reader service card

**CASSETTE REWINDER.** Battery-powered high-speed cassette tape rewinder measures 4-1/4 x 2-3/4 x 3 in. and is made of high-impact plastic. It will rewind a C-90



(90 minute) cassette in under 20 seconds. \$5.95 without batteries.—Edsearch, Inc., 6 East 43rd St., New York, NY 10017.

Circle 43 on reader service card

**DESOLDERING TOOL, DeLuxe Soldavac,** removes solder quickly from joints by a simple thumb release of the high-capacity

spring-loaded plunger. Low-inertia plunger and shaft fully enclosed to protect user. Barrel is molded from high-impact clear Cyclocac for quick inspection of



plunger and solder trap chamber; easily removed for fast plunger cleaning when necessary.—Edsyn, Inc., 15954 Arminta St., Van Nuys, CA 91406

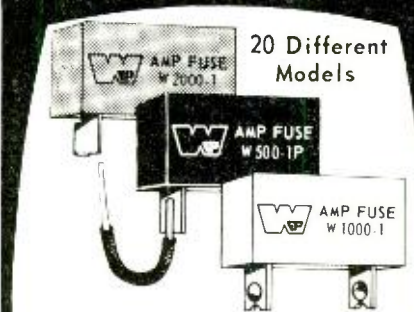
Circle 44 on reader service card

**NOISE REDUCTION UNIT, Decilinear Compressor/Expander model 117.** Gives the tape recordist an improvement of up to



20 dB beyond the normal limits of his tape recorder. Improvement is in both signal-to-noise ratio and dynamic range. Model 117 has a compression/expansion slope (continued on page 82)

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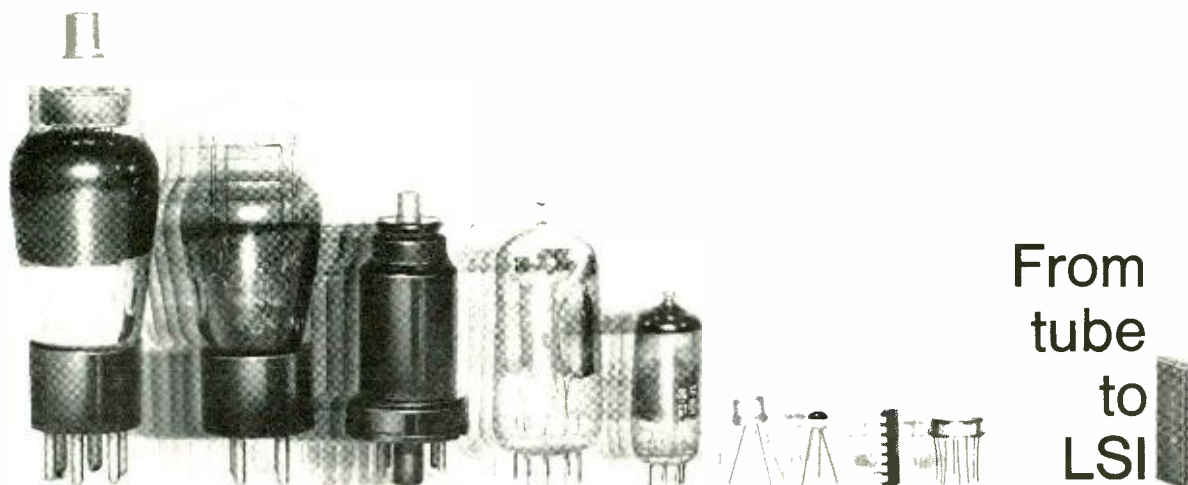
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Circle 64 on reader service card

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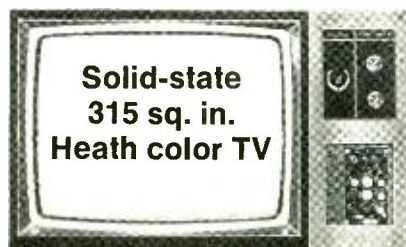
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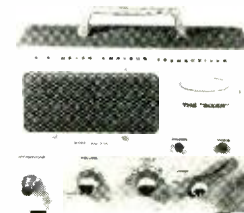
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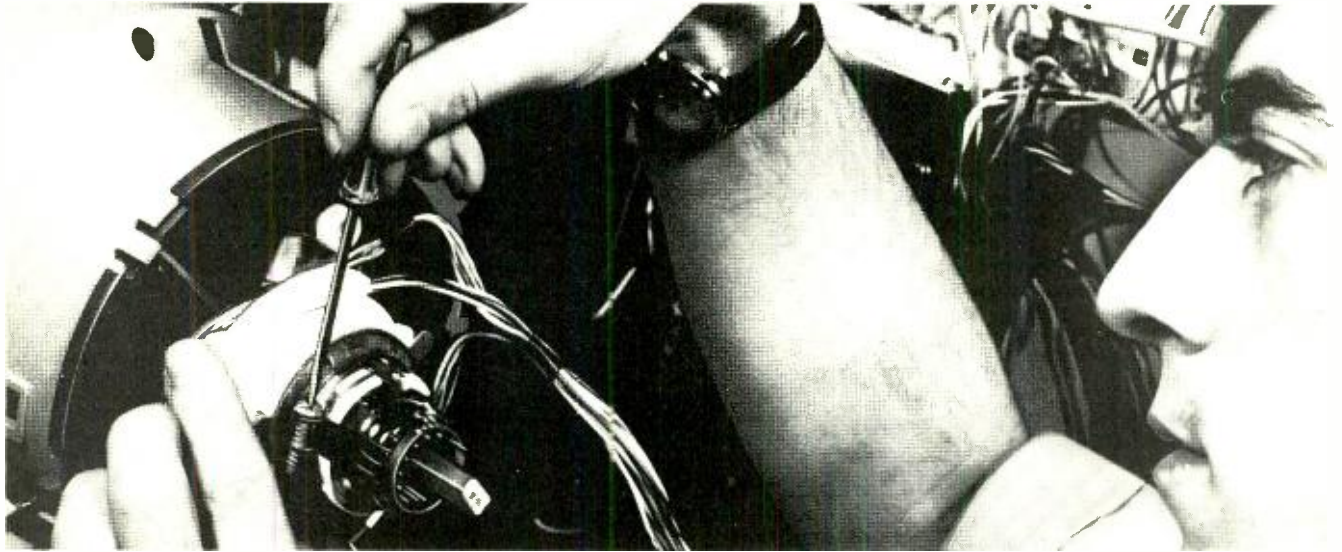
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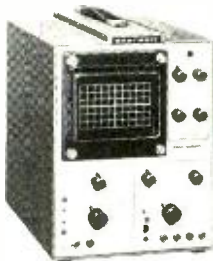


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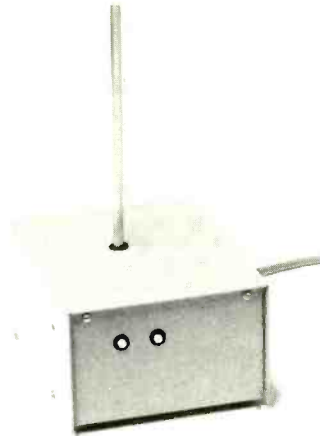
**NEW PRODUCTS**

(continued from page 77)

continuously variable from 0.5 to 2.0. Frequency response is from 20 Hz to 20 kHz  $\pm 1$  dB, with distortion of 0.2% typical. Dynamic range over 100 dB. \$145.—**DBX Inc.**, Bolton Road, Harvard, MA 01451.

Circle 45 on reader service card

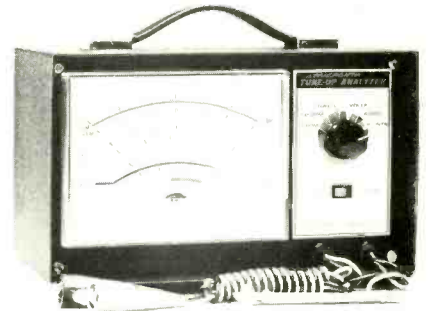
**BURGLAR ALARM SYSTEM, model 7100**, a solid-state, low-cost microwave radar system operating in the 400-MHz range, provides total protection from wall to wall and from floor to ceiling. The system detects any motion in an area of up to 3500 sq. ft. Sustained human movement for four



seconds or more within the protected area energizes the alarm relay contacts. On/off switch circuit is impedance controlled and either shorting or cutting the cables between the shunt-switch and unit sets off the alarm. Unit can be powered from either 117 volts ac or 12 volts dc.—**Artronix Surveillance**, 716 Hanley Industrial Court, St. Louis, MO 63144.

Circle 46 on reader service card

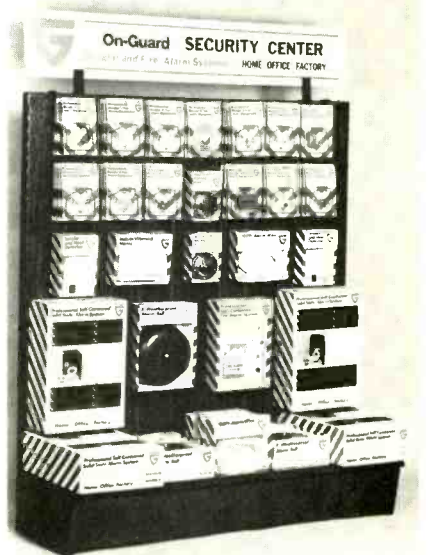
**TUNE-UP ANALYZER, Micronta** features 6" color-coded scale for reading engine speed and dwell angle on any 4, 6, or 8-cylinder engine. Also has voltage and amperage scales for checking the alternator or generator, regulator, diodes and battery, and a good-bad point condition test.



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combination burglar and fire alarm systems, as well as a full complement of accessories to fit all applications and installations.—**On-Guard Corp. of America**, 350 Gotham Parkway, Carlstadt, NJ 07072. R-E

Circle 48 on reader service card

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E122



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**TRANSISTOR REPAIR KIT \$100**

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Circle 65 on reader service card



# new lit

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**ELECTRONICS CATALOG, 1972**, displays complete line of over 200 electronic kits and factory assembled instruments in the fields of test instrumentation, security, stereo and high fidelity, automotive and marine electronics, and science projects. Fully illustrated.—**EICO Electronic Instrument Co., Inc.**, 283 Malta St., Brooklyn, NY 11207.

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**PROFESSIONAL HAND TOOLS CATALOG, No. 171**, in full color with photos and sketches of all the items. Covers adapters/extensions, automotive service tools, metric tools and sets, nut-drivers, hex drivers, screwdrivers, wrenches, beryllium copper tools and sets, etc. Lists types of tools with sizes and colors of handles, plus model numbers and descriptions.—**Xcelite Inc.**, Orchard Park, NY 14127.

Circle 50 on reader service card

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Circle 51 on reader service card

**COLOR AND MONOCHROME TELEVISION PARTS REPLACEMENT GUIDE**, lists over 500 Stancor transformer and deflection components for 200 television manufacturers. This catalog provides the TV technician with replacement data for more than 14,000 original parts. A separate section in the new book covers the Stancor line of flybacks, deflection yokes, vertical outputs, filter chokes, power and output transformers.—**Stancor Products**, 3501 West Addison St., Chicago, IL 60618.

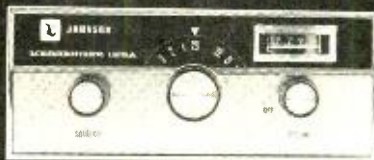
Circle 52 on reader service card

**1973 SEMICONDUCTOR CROSS REFERENCE AND TRANSISTOR DATA BOOK**, 58-page book is packed with listings of International Rectifier replacements for thousands of semiconductors. The book is a valuable guide that every service technician will want to have.—**Semiconductor Division, International Rectifier Corp.**, 233 Kansas Street, El Segundo, CA 90245. R-F.

Circle 53 on reader service card

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Circle 67 on reader service card

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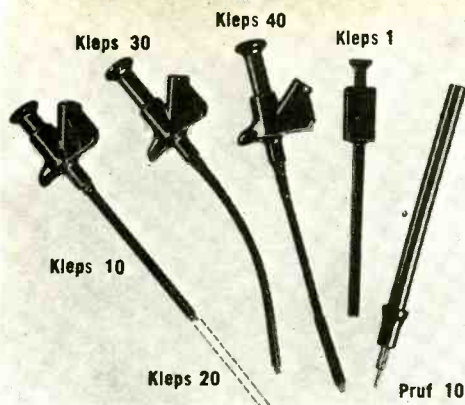
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Circle 68 on reader service card



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- Kleps 10.** Boathook clamp grips wires, lugs, terminals. Accepts banana plug or bare wire lead. 4¾" long. **\$1.19**
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  - Kleps 30.** Completely flexible. Forked-tongue gripper. Accepts banana plug or bare lead. 6" long. **\$1.47**
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  - Kleps 1.** Economy Kleps for light line work (not lab quality). Meshing claws. 4½" long. **\$ .99**
  - Prof 10.** Versatile test prod. Solder connection. Molded phenolic. Doubles as scribing tool. "Bunch" pin fits banana jack. Phone tip. 5½" long. **\$ .79**
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 Circle 69 on reader service card



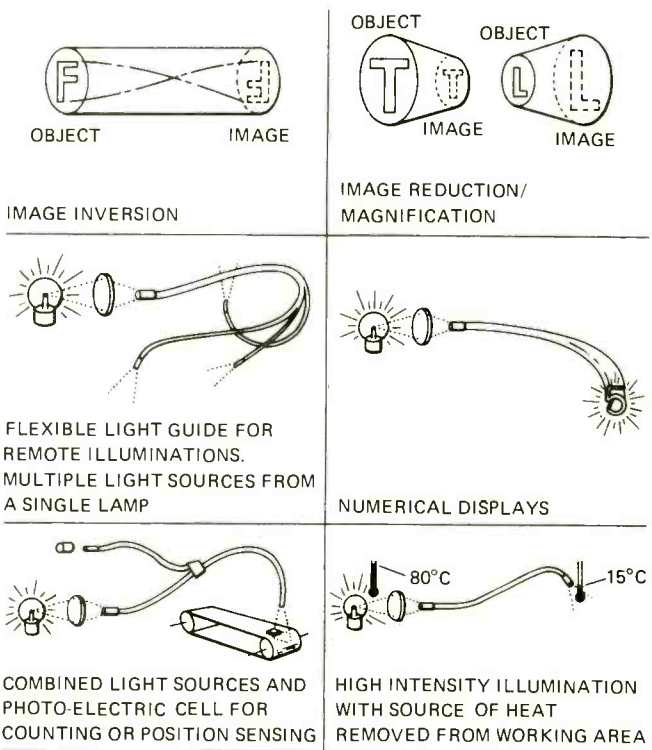
## FIBER OPTICS—NOW

(continued from page 37)

Shine a light (use a focused pen light flashlight) on one end of the rod, and use a light meter to measure the light exiting the other end. Without changing the distance between the light source and the light meter, remove the rod and recheck the light meter reading.

Now place the rod between the light and the light meter. As the angle of incidence of the light on the end of the rod is varied between head on and 90°, the transmitted light decreases. For a typical Lucite rod, once the light is held so the angle of incidence is at least 30°, the transmitted light begins to fall off appreciably. This proves that light must hit a Lucite rod "head on" for efficient collection and transmission.

**2. Fiber optic fan:** The light bending capability of a fiber-optic filament can be demonstrated by using a fiber-optic fan (Fiber Photics part K-103-1) and a penlight. As the steel-jacketed end of the fan is illuminated, many tiny points of light can be seen at the other end. Each point of light is the end of a separate glass filament. As the filaments are bent or positioned, the light bends with them. Very little light escapes through the sides of these glass fibers or filaments.



# Put it to Work!

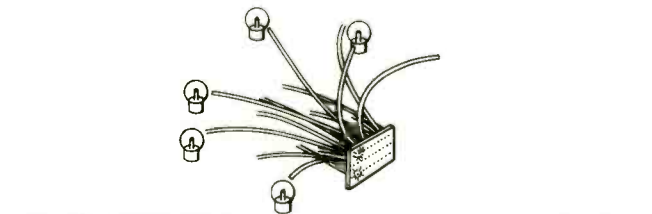
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**FIBER-OPTIC APPLICATIONS** are more numerous than we realize. Several different categories are illustrated here.

**3. Conduction of "cool" light:** Using an American Optical fiber-optical bundle (referenced earlier—Allied Radio), or the Fiber Photics #K-103-2 light conductor bundle and a floodlight, the transmission of cool light can be observed. With the floodlight on, position one end of the bundle in front of and aimed directly at the lamp. Bend the other end in a gradual 90° bend and lead it away from the lamp. The out-



put end of the bundle does not get warm due to the hot floodlight.

**4. Retro-reflective sensing:** With a dual-branch (bifurcated) fiber-optic bundle the principles of reflective sensing can be observed. If a bifurcated bundle such as the Fiber Photics #K-103-3 is used, you'll see that the two separate branches at the one end and the sensing tip at the other end are covered with stainless-steel for reliability and protection. Also, if you illuminate one of the two branches, you can view the sensing end and notice how the fibers from the two branches are intermixed for even light distribution and sensing at the tip.

To use this component for reflection sensing, direct a penlight at one of the two branches. Alternately, a small incandescent lamp or LED can be butted against the branch and held in place with shrink tubing. A diffusing lens can be placed over the other branch at the two-branch end, or a phototransistor can be butted against the end of this branch and held in place with shrink tubing.

In use, the lamp should be lit and the diffusing lens or phototransistor attached to the other branch. Then, as the sensing end is held perpendicularly and in loose contact with the surface to be scanned (such as a newspaper), you can see the intensity of light reflected from the paper and shown in the diffusing lens change as the tip is drawn over different light and dark areas of the surface. If, alternately, you wish to sense objects, or holes in a paper tape, use a reflecting surface and pull the punched tape over the plate.

With this reflection setup, an important characteristic of reflection sensing can be observed. As you scan across a dark area on a surface, such as a letter in the headline of a newspaper, notice that the amount of reflected light depends on the pressure with which you hold the sensing tip in contact with the surface of the paper. If the tip is pressed down too hard on the surface, all of the reflected signal is destroyed.

In use, a small space must be left between the tip of the sensing probe, and the surface being sensed, to allow the light from the source to escape the tip, spread out, and be picked up by the receiving fibers. If the light cannot spread out, it cannot be picked up. In practice, use either a shim or glass spacer over the end of the sensing tip, to guarantee an air gap between the tip and the surface to be scanned. This space should be about 0.040 inch (40 mils).

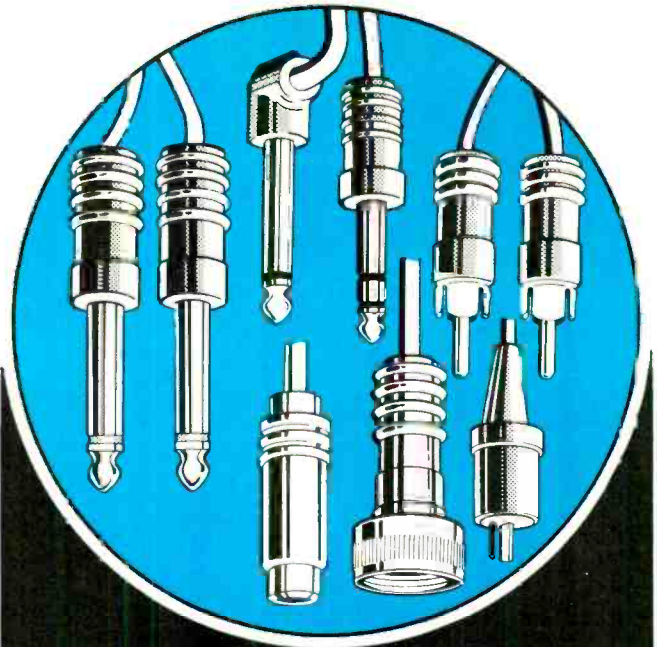
**5. Reflective temperature sensing:** The bifurcated fiber-optic bundle can also be used to detect temperature remotely, in a manner similar to the IBM scheme of remote temperature indication given earlier. Liquid crystal sheet material makes this a simple task.

To use this scheme, determine the temperature range of the surface to be monitored. Next, get a sheet of liquid crystal material (such as Edmund Scientific #71,249, Individual Sheet of Encapsulated Liquid Crystals) that has a temperature indicating range corresponding to the expected temperature of the surface to be monitored. The *reflected light color* of nematic liquid crystal changes, corresponding to the temperature of the surface to which it is attached. For example, if illuminated by white light, nematic liquid crystals may be red at 20°C, yellow at 23°C, green at 24°C, and blue from 26°C to 30°C. This color spread is definite, repeatable, and reversible.

Attach the sheet material to the surface to be monitored, and hang the tip of the fiber-optic probe perpendicularly above the material, separated by a distance of approximately 0.040". For this application, use an incandescent lamp for the light source. By viewing the color in the diffusing lens, the temperature of the surface can be monitored remotely (and compared to the manufacturer's temperature chart for the particular liquid crystal used) with a lamp power source the only electrical energy necessary.

R-E

**For a complete list of names and addresses of suppliers of fiber-optic materials turn to page 72—fifteen listings of suppliers and the type of product they handle.**

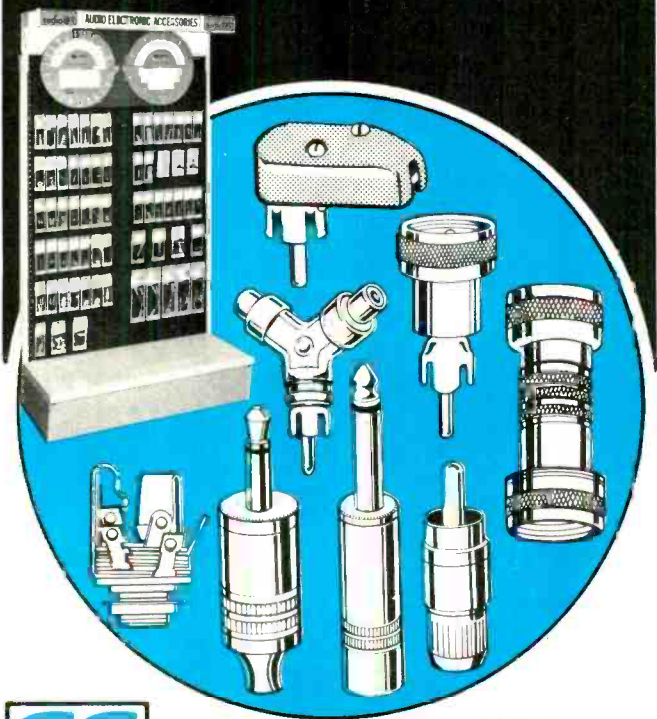


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(continued from page 53)

abl system. Ditto for changes in control settings, both in the system and outside. For troubleshooting, fixed settings and a steady signal are necessary; the Voltage Guide notes make this clear.

To understand control effects, consider a steady video signal, such as from a color-bar generator. That keeps signal influences from confusing what the controls do. Turn either brightness pot up, to make the raster brighter, and the dc voltage at point A swings widely. At full brightness, the voltage goes as much as 10 volts negative, thanks to current through R1. With the raster black, at minimum brightness settings, voltage at point A can go to 10 volts positive. The dominant positive voltage comes from R5 and R4 through R3 and R2.

ABL potentiometer R5 varies the voltage at A or B, but mainly at B. With full positive bias applied by R5, turning the brightness pots can only swing the voltage at point B between about 4 and 12 volts. Of course, at some brightness point, equilibrium occurs because D1 conducts. That point depends on the setting of R5.

With R5, R7, and R8 all at some "normal operation" setting, station signal level itself has no effect. But the average video content of a scene does. If you clip a meter at point A, at point B, or at the emitter or collector of the transistor, you'll see variations in reading that follow overall scene brightness. That's why the fixed input signal for troubleshooting.

**Quick Troubleshooting**

With no signal in the stage, your scope is useless. Rely on your vtvm or fetvm. In some cases, you just have to test parts individually. The best way to start troubleshooting is with the Voltage Guide (unless you're completely familiar with all the ins and outs of this stage).

R-E

**Transistor Analyzer Model 212**

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# new books

**ELECTRONIC INSTRUMENTATION**, by Sol D. Prensky. Prentice Hall Inc., Englewood, NJ 07632. 7 x 9 in. 536 pp. Hardcover edition, \$13.95.

There has been an impressive growth in the amount of development of electronic instruments for measuring tests and control purposes in recent years. Not only are there more electronic instruments in use but they are being used in a greater variety of ways. This revised edition gives a careful overview of the many common instruments in use today. It shows both the instruments themselves, how they operate and how they are used. While the text is obviously intended for the student, it is good instructional material for the technician and engineer who wants to know more about the test equipment he used.

**BATTERY CHARGERS AND TESTERS: OPERATION—REPAIR—MAINTENANCE**, by Charles R. Cantonwine. Chilton Book Co., 401 Walnut Street, Philadelphia, PA 19106. 6 1/4 x 9 1/4 in. 249 pp. Hardcover, \$9.50.

Batteries are used on more electronic equipment and in increasing numbers every year. Many of these are rechargeable types and require battery chargers and battery testers. To merely publish wiring diagrams and parts lists of all the different battery chargers and testers manufactured would require several volumes and really might not provide all the technical data to service such equipment. This book provides the basic knowledge of all the electronic components used and fills the gap between common knowledge and its specific application to battery chargers and testers. An appendix listing sources of supplies for parts and equipment will be extremely useful. Although the book is written primarily as a service manual, it should be of interest as a general reference to anyone interested in battery and battery service equipment.

**SOLID STATE DEVICES**, by Irving Tepper. Addison-Wesley Publishing Co., Inc., Reading, MA 01867. 6 1/2 x 9 1/2 in. 257 pp. Hardcover, \$7.95.

This is the first of two volumes covering the theory and application of solid state devices. It assumes a background in high school algebra and a knowledge of both dc and ac theory. Following a brief historical review, atomic physics as it pertains to semiconductors is discussed. Diode junctions and parameters and Zener diodes are then covered next. The chapter on small signal amplifier design covers the various types of circuit parameters including feedback, calculations of stage characteristics for different configurations, and cascading and coupling of stages. The fundamentals discussed in this volume will be useful in understanding these devices. Many examples of applications are given to illustrate the various design methods.

**AUTOMATIVE ELECTRONICS**, by Rudolf F. Graf and George J. Whalen. Howard W. Sams & Co., Inc., Indianapolis, IN 46206. 5 1/4 x 8 1/4 in. 320 pp. Softcover, \$6.95.

The applications of electronics in the modern automobile are so numerous that the average car owner would be likely to be surprised at its length. The list grows steadily as manufacturers continue to add new features and improve the old ones. This book divides the car's electronic system into several small parts and each of these is detailed. Among them are the starting system, the charging system, the ignition system, lighting and signaling systems and sensor instruments and indicators. All systems are explained in detail and more than enough artwork is provided to show the circuitry for individual arrangements. There is even a chapter on test equipment and its use. These instruments include timing lights, dwell meters, tachometers, voltmeters and ignition-analyzer scopes. Definitely good reading for the man who wants to know about the electronics that are under the hood.

**101 QUESTIONS & ANSWERS ABOUT HI-FI & STEREO**, by Leo G. Sands and Fred Shunaman. Howard W. Sams & Co., Inc., Indianapolis, IN 46206. 5 1/4 x 8 1/4 in. 128 pp. Softcover, \$3.50.

This book, prepared in question-and-answer format, is intended for a prospective and existing audiophiles, service technicians and anyone interested in hearing faithfully reproduced music. It explains hi-fi in simple language and is based on a long experience of the authors in the field of audio. The text is divided into six major parts covering high fidelity systems, amplifiers, tuners, record and tape players, speakers and trouble shooting and maintenance.

**IEEE STANDARD DICTIONARY OF ELECTRICAL AND ELECTRONICS TERMS**, by Institute of Electrical & Electronics Engineers, Inc. John Wiley & Sons, Inc., Publishers, 605 Third Avenue, New York, NY 10016. 7 x 10 in. 716 pp. Hardcover, \$19.95.

To quote from the jacket, this book "defines 13,000 technical words from every area from electrical and electronics engineering. Each definition is an official standard of The Institute of Electrical and Electronics En-



gineers, Inc. Not merely a collection of previously published documents, the dictionary contains hundreds of new terms as well as revisions of earlier ones, making it the most up-to-date and complete volume of its kind." Certainly a dictionary that will be of much assistance to engineers, technicians, students, writers, editors, publishers and anyone working in the field of electronics.

**HI-FI FOR THE ENTHUSIAST**, by M. L. Gayford. TAB Books, Blue Ridge Summit, PA 17214. 5½ x 8½ in. 166 pp. Hardcover, \$6.95.

A good guide for the audiophile who wants to get first class reproduction from radio tape or records. The main emphasis of the book is the efficient selection assembly and use of modern hi-fi equipment. Following the hints laid out here, the enthusiast should be able to assemble a system that suits both his individual needs and delivers a high standard of reproduction quality. Subjects such as room acoustics, amplifiers, pickups and loudspeakers are covered in detail. It might well pay to read this book before buying your next stereo system.

**SEMICONDUCTOR DIODE LASERS**, by Ralph W. Campbell and Forrest M. Mims, III. Howard W. Sams Co., Inc., Indianapolis, IN 46268. 5½ x 8½ in. 192 pp. Softcover, \$5.95.

One of the authors of this book, Forrest M. Mims, has recently had one of his laser stories published in the June 1971 issue of *Radio-Electronics*. This book is a natural follow-up for anyone interested in learning more about injection semiconductor lasers. The first chapter discusses the history and development of the laser. It explains light-emitting diodes, injector laser theory and other types of lasers. The following other chapters describe the properties of the injection laser along with coherent, perhaps the most significant aspect of laser light.

The remainder of the book covers mainly circuitry and practical applications, complete details are included. If you are interested in lasers and laser operations, this book is one that you will have to have. R-E

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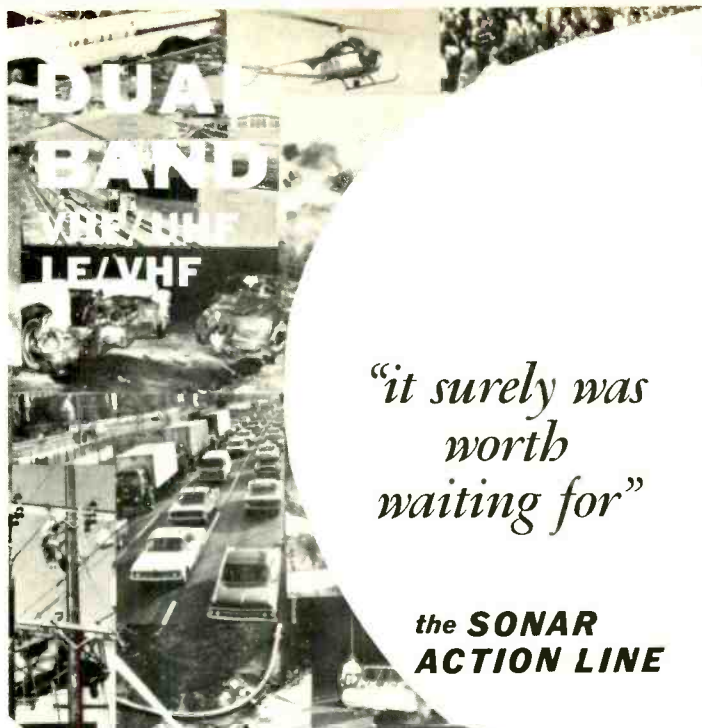
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## APPLIANCE CLINIC

(continued from page 26)

trol and speed regulation, with the RC  
networks and extra diodes, etc.

Once again, testing can be quite  
easy. If the motor runs at full speed at  
all times, the motor and SCR are OK.

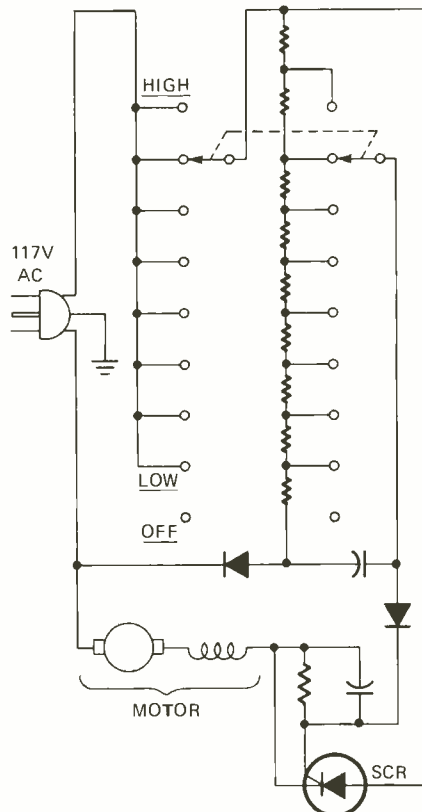


FIG. 2—SCR CONTROLS SPEED of motor. Gate  
voltage of SCR is controlled by a switch and re-  
sistors. This type has speed regulation.

The chances are that the selector switch,  
or one of the resistors in the gate vol-  
tage divider, or both, would be open. If  
the SCR is shorted, the chances are that  
the motor would run at a speed much  
faster than normal, since it would then  
have full-power full-wave ac applied to  
it. The SCR can be checked for shorts  
with an ohmmeter.\*

Incidentally, you should be able to  
make a substitution test for a suspected  
SCR: just unhook it, and temporarily  
connect a standard silicon diode recti-  
fier (with sufficient current capacity, of  
course!) into the circuit in its place. If  
the motor will run at full speed, the mo-  
tor itself is OK, and you've got trouble  
in the SCR, switch, etc.

Here again, you may run into en-  
capsulated or "Black Box" controls. The  
tests described can be made on the mo-  
tor, and if these show that it is in work-  
ing order, the entire control unit must  
be replaced. (You can't get into 'em—  
they're sealed.)

R-E

\*Thanks very much to R. W. Fox of GE Applications En-  
gineering Department, for the data on these control systems.

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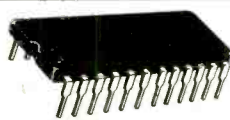
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□ 2N5169	200V/20 amp stud	3.75
□ 2N5170	500V/20 amp stud	4.75
□ 2N5171	700V/20 amp stud	6.75
□ 2N3896/C30A	100V/25 amp stud	2.95
□ 2N3897/C30B	200V/25 amp stud	3.95
□ 2N3899/C30E	500V/25 amp stud	4.95



## CALCULATOR CHIP SPECIAL

B and F has purchased a quantity of MOS large scale integration chips for calculators. We are not allowed to mention the manufacturers name, however, the specs should make them self-evident.

- Set "X" - Four 24 pin I.C.'s, BCD output, 16 digit, fixed automatic decimal point, possible memory expansion, constant ..... \$29.00
- Set "Y" - Single 40 pin, 7 segment output, 12 digit, fixed automatic decimal, no constant ..... \$15.00
- Set "Z" - Single 40 pin I.C., 7 segment output, 8 digit, floating point, constant ..... \$19.50

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□ 7401 - .22	□ 7453 - .22	□ 74151 - 1.13
□ 7402 - .22	□ 7454 - .22	□ 74153 - 1.55
□ 7403 - .22	□ 7460 - .22	□ 74154 - 2.30
□ 7404 - .27	□ 7470 - .40	□ 74155 - 1.39
□ 7405 - .27	□ 7472 - .36	□ 74156 - 1.39
□ 7406 - .50	□ 7473 - .48	□ 74157 - 1.48
□ 7407 - .50	□ 7474 - .48	□ 74158 - 1.48
□ 7408 - .30	□ 7475 - .76	□ 74160 - 1.79
□ 7409 - .30	□ 7476 - .53	□ 74161 - 1.79
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□ 7420 - .22	□ 7486 - .55	□ 74167 - 4.75
□ 7421 - .22	□ 7489 - 4.00	□ 74170 - 5.75
□ 7426 - .32	□ 7490 - .76	□ 74180 - 1.13
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□ 7450 - .22	□ 74145 - 1.33	

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- SI3554M 5 Volts, 3 Amperes ..... \$7.00

## SANKEN HYBRID AUDIO AMPLIFIER MODULES



We have made a fortunate purchase of Sanken Audio Amplifier Hybrid Modules. With these you can build your own audio amplifiers at less than the price of discrete components. Just add a power supply, and a chassis to act as a heat sink. Brand new units, in original boxes, guaranteed by B and F, Sanken and the Sanken U.S. distributor. Available in three sizes: 10 watts RMS (20 watts music power), 25 watts RMS (50 watts M.P.) and 50 watts RMS (100 watts M.P.) per channel. 20 page manufacturers instruction book included. Sanken amplifiers have proved so simple and reliable, that they are being used for industrial applications, such as servo amplifiers and wide band laboratory amplifiers.

- SI1010Y 10 watt RMS amplifier, industrial grade ..... \$4.75
  - SI1025A 25 watt RMS amplifier, industrial grade ..... \$14.75
  - SI1050A 50 watt RMS amplifier, industrial grade ..... \$22.50
  - SI1025E 25 watt RMS amplifier, entertainment grade ..... \$14.00
  - SI1050E 50 watt RMS amplifier, entertainment grade ..... \$21.00
  - Transformer for stereo 10 watt amplifiers (2 lbs.) ..... \$3.95
  - Transformer for stereo 25 or 50 watt amplifiers (5 lbs.) ..... \$5.95
  - Set of (3) 2000 mfd 50V capacitors for 10 watt stereo ..... \$4.00
  - Set of (3) 2200 mid 75V capacitors for 25 or 50 watt amplifiers ..... \$5.00
  - 4 Amp Bridge Rectifier, suitable for all amplifiers ..... \$2.00
  - Complete kit for 100 watt RMS stereo amplifier (200 watt music) including two 50 watt Sanken hybrids, all parts, instructions, and nice 1/16" thick black anodized and punched chassis ..... \$88.00
  - Same for 50 watt RMS stereo amplifier, includes two 25 watt Sankens, etc. .... \$58.00
  - Same for 20 watt RMS stereo, includes two 10 watt Sankens, etc. .... \$30.00
- ### SGS TAA 621 AUDIO AMPLIFIER
- 1 C. audio amplifier in 14 pin DIP package, provides up to 4 watts power with proper heat sink, and 28 Volt supply. Can be used at 12 Volts with reduced output power. \$1.95 ..... \$6 for \$10.00

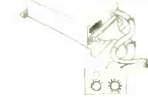
## MOLEX SOLDERCON CONNECTIONS



Molex soldercon connections for I.C.'s. With these you can build low cost I.C. sockets by just cutting off the number of connections required, i.e., two strips of seven for 14 pin socket.

- 500 Molex soldercon ..... \$4.75

## ELECTRONIC PRESET COUNTER



This counter is from a copying machine. It uses two Durant electro-mechanical decade counters, and includes a nice power supply, etc. Two rotary switches allow the unit to be preset with any number from 1 to 50, when the number of pulses in reaches this count, a relay opens, shutting off the controlled unit. Should be useful for coil winders, and other applications requiring shut-off at a predetermined count. The parts alone at our low price represent a "steal", as the unit has high quality switches, silicon rectifiers, transformers, etc.

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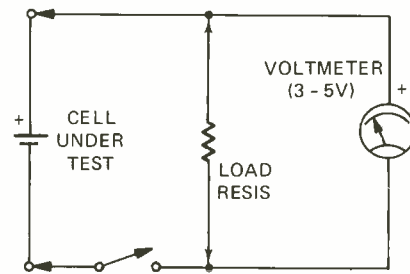
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## MORE LIFE FROM DRY CELLS

Tired of keeping charge-discharge records on carbon-zinc dry cells and wondering whether or not all this bother really extends battery life? Then use the "matched cell" system I have used for years. Here is how it works. Assume that you have a transistor radio, flashlight, or any gadget that uses two or more individual cells of any size from

### DRY CELL LOAD TEST

CELL TYPE	LOAD RESIS.	LOAD CURRENT
AAA OR N	40 OHMS	37 mA
AA	25 OHMS	60 mA
C	10 OHMS	150 mA
D	5 OHMS	300 mA



### TEST CIRCUIT

AAA to D. Start out with a new set of cells and use them until performance is no longer satisfactory. Remove the cells and load test them according to the table and diagram, discarding any cell that tests below 1.2 volts. You will usually find only one cell that is absolutely "shot" compared to the others.

Set the "good" cells aside and install another set of new cells. When these fail, give them the same load test as above, discarding any worn out cells. You now have the remains of two sets of used cells from which you can easily make up a matched set that will give further service. As cells wear out, replace them with other used ones. When all the old cells have been used up, start the cycle over again with a new set of cells. You will find that this procedure will increase effective battery life by at least thirty percent.—F. J. Bauer

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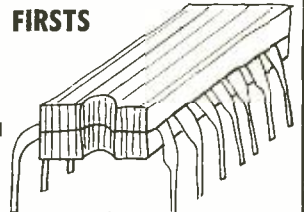
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# next month

SEPTEMBER 1972

## ■ MATV Systems That Went Wrong

Bob Middleton describes case histories of real troubles in actual systems and how they were resolved.

## ■ Electronic Watchdogs

An overall look at a variety of intrusion detection systems, how they work and how they can be used effectively.

## ■ Ghosts Due To Mismatch

The problem of ghosts and what the technician can do to prevent and cure them.

## ■ Duo-IC Signal Tracer

An R-E construction project—uses an IC to make a simple yet effective signal tracer for rf and audio circuit troubleshooting.

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NE 565 Phase Locked Loop 3.50

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## TRANSISTOR TV INTERFERENCE

(continued from page 59)

transistors, a change in characteristics caused by overload (or overheating during installation) may be enough to cause the stage to go into oscillation.

If the transistor checks out all right, test for an open neutralizing capacitor, or higher-than normal voltages. Also check the bypass capacitor tapping the collector inductor, because an open one will also contribute to oscillation.

Some transistor receivers use a noise cancellor circuit, as shown in Fig. 8 for the Emerson 9P50 receiver. Here, an npn transistor ties into the base and emitter of the first video amplifier as shown. The noise cancelling transistor has a negative potential on its emitter. Thus, instead of a positive forward bias,

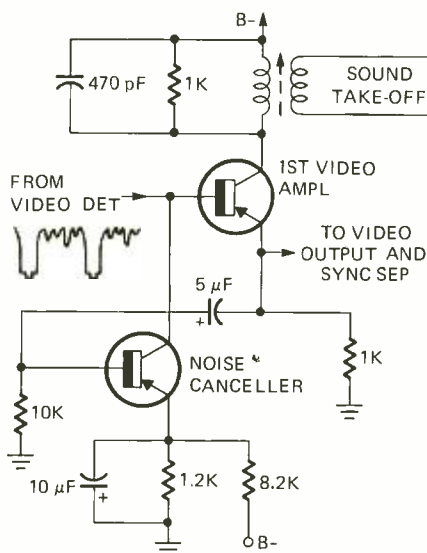
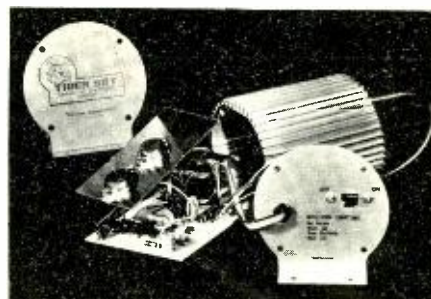


FIG. 8—NOISE CANCELLING CIRCUIT employed in the Emerson 9P50 TV receiver.

a reverse bias is applied to keep the transistor below the conduction level.

When a noise pulse appears at the emitter of the video amplifier, it is coupled to the base of the noise cancellor. If amplitude of the noise signal is greater than the sync tips, it produces a high enough negative voltage at the base of the noise cancellor to forward-bias the transistor (base negative with respect to the emitter). Now the transistor conducts. The low impedance between its collector and emitter shunts the noise signal at the base of the video amplifier minimizing effects of noise.

If noise signals picked up by the antenna tend to affect vertical and horizontal sync stability, or produce highly noticeable streaks on the screen, check the noise cancellor circuit for proper voltages, and check components for possible defects. Make sure the coupling capacitor from the emitter of the video amplifier to the base of the cancellor is not open or shorted. R-E



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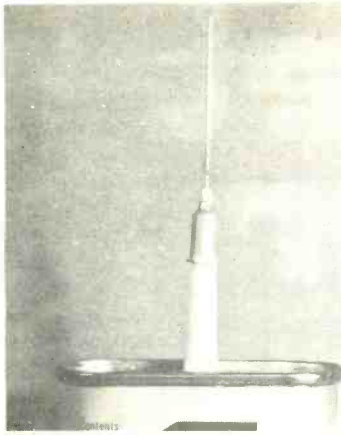
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oil to another container. Dull the needle tip with a file and store out of reach of children.—*B. T. Pearce* **R-E**

### TESTING LOW-VOLTAGE ELECTROLYTICS

If your capacitor tester will not check low-voltage electrolytics safely, you can use your vvm or solid-state voltmeter for leakage tests and rough capacitance measurements. Any meter with a 10- or 11-megohm input and an "R x 1 MEG" ohms range will do very nicely. First check the capacitor for leakage as follows:

1. Connect capacitor to ohms leads, observing polarity, with a clip lead jumper *across* the capacitor. (The jumper insures that there is no residual charge across the capacitors.)

2. Set the meter range switch to a medium range such as R x 100 or R x 1000, remove shorting clip lead, and permit capacitor to assume a full charge.

3. Set meter range switch to R x 1 MEG range and leave capacitor connected for a minute or so.

a. A low-leakage capacitor will hold the meter on full scale or drop 10% below full scale at the very most.

b. A leaky capacitor will slowly continue to drop the meter reading, coming to rest with a meter deflection of only 20% or 30%.

After a capacitor has passed the leakage test, you may roughly determine its capacitance by comparing the charging time in seconds to the charging time of a known good capacitor. Pick a resistance range on your meter that will give you a charging time of at least 3 or 4 seconds with a meter deflection of 50% or less. Start the charge cycle by removing the short across the capacitor as in the leakage test above. Although this is not an accurate test, it is adequate for most purposes since there is a fair variation in capacitance from unit to unit anyway and most electrolytic capacitor applications are non-critical. As a matter of fact, for most solid-state applications low leakage is far more important than accurate capacitance value.—*F. J. Bauer* **R-E**

### 50 MEGAHERTZ LOW COST COUNTER



Here is a new item, featured because of numerous customer suggestions. We have taken the basic power supply, chassis and cover from our clock kit, and by substituting a new front panel and printed circuit board, have made a

lowest cost frequency counter. The unbelievable low cost is due to our use of our large stock of unused surplus nixies, the new 74196 50 MHz decade counter, and the commonality of parts with our other kits. Readout is to six decades, time base is 1 second, 0.1 seconds, or external. Design is modular, for ease of construction, compactness, and expandability.

- 50 MHz six digit counter, using line frequency as time base, complete except for cover ..... \$97.50
- Optional crystal controlled time base plug-in conversion ..... \$23.50
- Cover, blue or black anodized ..... \$ 4.50

### BUILD YOUR OWN ELECTRONIC CALCULATOR FOR ONLY \$108.00!



A complete calculator kit, complete with self contained power supply and case. Indispensable in the home, office or school. Simple enough for a child to build. Some of the features of the calculator are as follows:

- MOS integrated circuits (extra large scale integration) reduce the number of components to a minimum, for easy assembly
- Displays eight digits on large size seven segment displays
- Full function complement keyboard features addition, subtraction, multiplication, division, alternate display, multiplication by a constant, clear all, clear entry, and decimal point set
- Sixteen digit entry and sixteen digit results are possible with alternate display key
- Leading zeroes suppressed
- Chain operation
- All integrated circuits and displays are socket mounted and replaceable

So reliable and simple to build, we can make this guarantee: If for any reason you cannot succeed in getting your calculator to function properly after completing construction, for a flat handling fee of \$10.00, B and F will repair and ship back your calculator anywhere in the USA. This applies regardless of the age of the assembler, barring gross negligence or the use of acid core solder in construction.

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### DIGITAL CLOCK KIT WITH NIXIE DISPLAY



We have well over 20,000 surplus nixies in stock, and because of this bargain purchase we can sell a complete digital clock kit for less than the usual cost of the display tubes only. We provide

a complete etched and thru-plated circuit board, all integrated circuits, complete power supply, display tubes, I.C. sockets and a nice front panel with polaroid visor. We have never seen anyone offer this kit for less than \$100.00 before. Includes BCD outputs for use as with timer option. May be wired for 12 or 24 hour display. Indicates hours, minutes, seconds.

- Clock Kit, complete less outside cover ..... \$57.50
- Aluminum blue or black anodized cover (specify) ..... \$ 4.50
- SHRINK TUBING SPECIAL. Assortment of 200 pieces of shrink tubing, diameters 1/8" to 1/2", length 1/2" to 2". ..... \$1.25

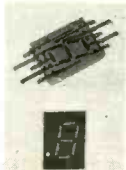
### KEYBOARDS



Three keyboards are available; 20 key calculator keyboard, 40 key alphanumeric, and 12 key touch tone. All have separate contacts carried out to edge connector.

- Touch Tone Keyboard ..... \$ 9.50
- Calculator Keyboard ..... \$14.50
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### LIGHT EMITTING DIODE NUMERIC DISPLAY



This display is excellent for small portable electronics, such as DVM's, calculators, etc. Equivalent to Monsanto MAN 3A. Operates from 5 volts, 20 milliamperes, with 47 ohm dropping resistor.

- \$3.25 Each
- 10 For \$27.50
- Complete counter kit, 7490, 7475 latch 7447, printed circuit board, led readout ..... \$9.50

### IMPOSSIBLE? THIS MONTH'S FEATURE ITEM



### POCKET CALCULATOR KIT

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As a student, engineer, salesman, accountant, or anyone who would like fast accurate answers, this calculator fills the bill, and at a price that unquestionably makes this the lowest price high quality calculator available.

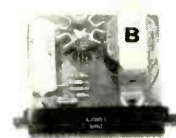
- Pocket Calculator Kit ..... \$75.00

### RECHARGEABLE BATTERY/CHARGER KIT

This option allows the throw-away alkaline battery to be replaced with a nicad battery, and includes a charger to recharge this battery. The unit may be run during the recharge cycle.

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- Figure A, potted logic supply, 5 Volts at 1 Ampere, short circuit proof, ultra high regulation, ultra low ripple ..... \$16.00
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- Same as above, in kit form ..... \$7.75
- Mating connector for above ..... \$1.00
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Monsanto MV 50 or equivalent LED's. Now less expensive than filamentary bulbs. At this price wire them into logic circuits as status indicators, build low cost counters or use them as panel lites. Rated at 10 - 40 Ma @2V.

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This giant size burroughs B7971, 16 segment tube, displays all numbers and letters of the alphabet in giant 2" numerals. Driver board allows operation from standard TTL levels. With instructions and schematics, provided as two tubes with sockets mounted on single board.

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Circle 94 on reader service card  
• AUGUST 1972

Circle 95 on reader service card



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Includes SN7490, decade counter, SN7475 latch, SN7414 BCD decoder driver, 0-to-9 Nixie tube, socket & instructions.

**6.50** 3 for \$18.

#### LED READOUTS

0-9 plus letters, for SN7446 or SN7447. Snaps in 14-pin DIP socket. 7/8" x 3/8" characters. 1/4" x 3/16" 5V, 20-mils per seg. characters. 1/4" x 3/16" Famous MAN type.  Sockets, 50 ea.

**4.50**

#### LED READOUT COUNTING SYSTEM

**8.88** 3 for \$24

#### NIXIE TUBE SALE

**\$2.50** 3 for \$6.

Burroughs B7971, 0-to-9, A-to-Z, 2 1/2" high characters, 170V. With socket.

#### INTEGRATED CIRCUIT SOCKETS

Buy Any 3 - Take 10% Discount!

14-Pin, dual in line	\$.45
16-Pin, dual in line	.50
TO-5, 8 or 10 pins	.29

#### STEREO PREAMP 1-WATT AUDIO AMP

Dual 739-739 8-transistors per channel. 50K in. imp.; for phono-tape. TO-20,000 mc. DIP, Fairchild. 3 for \$4.50

Choose Any **1.95**

8-transistors in TO-5 case. 400K in. imp. Westinghouse WC334, TO-5.

#### ALLEN BRADLEY MICRO-POTS

Type G, 1/2" dia. x 1 1/2" high, Mounts 1/4" high, with shaft, linear, hysteresis-proof high freq.

Ohms:  75  20K  7.5K  25K  100  2.5K  10K  75K  50K  100K  100M

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Catalog Number	Any Quantity Per Item (Mix)			Multiples of 10 Per Item (Mix)			Catalog Number	Any Quantity Per Item (Mix)			Multiples of 10 Per Item (Mix)		
	1-99	100-999	1000-9999	100-999	1000-9999	10000 up		1-99	100-999	1000-9999	100-999	1000-9999	10000 up
7400	.26	.25	.23	.22	.21	.20	7474	.50	.48	.45	.43	.40	.38
7401	.26	.25	.23	.22	.21	.20	7475	.80	.76	.72	.68	.64	.60
7402	.26	.25	.23	.22	.21	.20	7476	.56	.53	.50	.48	.45	.42
7403	.26	.25	.23	.22	.21	.20	7480	.76	.72	.68	.65	.61	.57
7404	.28	.27	.25	.24	.22	.21	7482	.99	.94	.88	.83	.78	.72
7405	.28	.27	.25	.24	.22	.21	7483	1.63	1.55	1.46	1.38	1.29	1.20
7406	.52	.50	.47	.44	.42	.39	7485	1.42	1.35	1.27	1.20	1.12	1.05
7407	.52	.50	.47	.44	.42	.39	7486	.58	.55	.52	.49	.46	.44
7408	.32	.30	.29	.27	.26	.24	7490	.80	.76	.72	.68	.64	.60
7409	.32	.30	.29	.27	.26	.24	7491	1.43	1.35	1.28	1.20	1.13	1.05
7410	.26	.25	.23	.22	.21	.20	7492	.80	.76	.72	.68	.64	.60
7411	.28	.27	.25	.24	.22	.21	7493	.80	.76	.72	.68	.64	.60
7413	.58	.55	.52	.49	.46	.44	7494	1.18	1.12	1.05	.99	.93	.87
7416	.52	.50	.47	.44	.42	.39	7495	1.18	1.12	1.05	.99	.93	.87
7417	.52	.50	.47	.44	.42	.39	7496	1.18	1.12	1.05	.99	.93	.87
7420	.26	.25	.23	.22	.21	.20	74100	1.52	1.44	1.36	1.28	1.20	1.12
7421	.26	.25	.23	.22	.21	.20	74107	.52	.49	.47	.44	.42	.39
7423	.80	.76	.72	.68	.64	.60	74121	.56	.53	.50	.48	.45	.42
7425	.50	.48	.45	.43	.40	.38	74122	.70	.67	.63	.60	.56	.53
7426	.34	.32	.31	.29	.27	.26	74123	1.21	1.06	1.00	.94	.89	.83
7430	.26	.25	.23	.22	.21	.20	74141	1.63	1.55	1.46	1.38	1.29	1.20
7437	.56	.53	.50	.48	.45	.42	74145	1.41	1.33	1.26	1.18	1.11	1.04
7438	.56	.53	.50	.48	.45	.42	74150	1.63	1.55	1.46	1.38	1.29	1.20
7440	.26	.25	.23	.22	.21	.20	74151	1.20	1.13	1.07	1.01	.95	.88
7441	1.73	1.64	1.55	1.46	1.37	1.27	74153	1.63	1.55	1.46	1.38	1.29	1.20
7442	1.27	1.21	1.14	1.07	1.01	.94	74154	2.43	2.30	2.16	2.03	1.89	1.76
7443	1.27	1.21	1.14	1.07	1.01	.94	74155	1.46	1.39	1.31	1.23	1.16	1.08
7444	1.27	1.21	1.14	1.07	1.01	.94	74156	1.46	1.39	1.31	1.23	1.16	1.08
7445	1.71	1.62	1.53	1.44	1.35	1.26	74157	1.56	1.48	1.39	1.31	1.23	1.15
7446	1.24	1.17	1.11	1.04	.98	.91	74158	1.56	1.48	1.39	1.31	1.23	1.15
7447	1.16	1.10	1.04	.98	.92	.85	74161	1.89	1.79	1.68	1.58	1.47	1.37
7448	1.44	1.37	1.29	1.22	1.14	1.06	74164	1.89	1.79	1.68	1.58	1.47	1.37
7450	.26	.25	.23	.22	.21	.20	74166	1.98	1.87	1.76	1.65	1.54	1.43
7451	.26	.25	.23	.22	.21	.20	74180	1.20	1.13	1.07	1.01	.95	.88
7453	.26	.25	.23	.22	.21	.20	74181	5.20	4.90	4.59	4.28	3.98	3.67
7454	.26	.25	.23	.22	.21	.20	74182	1.20	1.13	1.07	1.01	.95	.88
7460	.26	.25	.23	.22	.21	.20	74192	1.98	1.87	1.76	1.65	1.54	1.43
7470	.42	.40	.38	.36	.34	.32	74193	1.98	1.87	1.76	1.65	1.54	1.43
7472	.38	.36	.34	.32	.30	.29	74198	2.81	2.65	2.50	2.34	2.18	2.03
7473	.50	.48	.45	.43	.40	.38	74199	2.81	2.65	2.50	2.34	2.18	2.03

TRANSISTORS AND DIODES

1N270	.15	.14	.13	.12	.11	.10	1N4003	.13	.12	.11	.10	.09	.08
1N751A	.30	.28	.26	.24	.22	.20	1N4006	.15	.14	.13	.12	.11	.10
1N914	.10	.09	.08	.07	.06	.05	1N4154	.15	.14	.13	.12	.11	.10
1N4001	.10	.09	.08	.07	.06	.05	2N3860	.25	.23	.21	.19	.17	.15
1N4002	.11	.10	.09	.08	.07	.06							

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ALL IC'S are supplied in 8-, 14-, 16-, or 24-pin DIP (Dual-in-Line) plastic package. We give FREE data sheets upon request, so ask for those data sheets that you NEED, even for those listed IC that you are not buying.

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 \$4.95 Each

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Large 7/8" 7-segment LED readout similar to the popular MAN-1 but with improved brightness. Has left-hand decimal point. Fits in a DIP socket. Expected life: Over 100 Yrs. Regularly \$12.95 in single Lots. These are BRAND NEW with full data sheet and 4-page MULTIPLEXING Application Note. Needs a 7447 for driver and ONE CURRENT-LIMITING RESISTOR PER SEGMENT. We can supply you with one or ten thousand FROM STOCK. Also available, ±1 OVERFLOW digit at the same prices. Mixing of Regular & Overflow digit allowed.

Package of 8, 1/4W Limiting R's ..... 30¢

Incandescent Type of 7-segment display. With right-hand decimal point. Rated 8mA per segment at TTL supply of 5V. Design life of 50,000 hours. Needs a 7447 as a driver. In DIP Package. Each \$3.25



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CERAMIC DISC CAPACITORS, Type 5GA-10000WVDC.  
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 All values are available in both, axial or upright (PC Board) mount. PLEASE INDICATE YOUR CHOICE.  
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 50 µF, 15V ..... 10¢      2 µF, 50V ..... 10¢  
 100 µF, 15V ..... 10¢      3 µF, 50V ..... 10¢  
 220 µF, 15V ..... 15¢      5 µF, 50V ..... 10¢  
 500 µF, 15V ..... 20¢      10 µF, 50V ..... 15¢  
 1000 µF, 15V ..... 30¢      20 µF, 50V ..... 20¢  
 20 µF, 25V ..... 15¢      50 µF, 50V ..... 20¢  
 30 µF, 35V ..... 20¢      100 µF, 50V ..... 20¢  
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16-PINS 0.75	0.70	0.65	0.60	0.55	



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### UNIQUE HARD-TO-FIND BARGAINS FOR FUN, STUDY OR PROFIT

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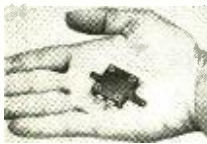
Fastest, easiest, safest way to remove dust and lint from optics, negatives, slides; any hard-to-reach area. Saves hours of brushing, cleaning, spotting, gets rid of microscopic dust. Patented solid propellant Fluorogel 8-oz. aerosol gives 2,500 jet sprays of moisture-free water. Works in any position. Handy 5" extension snorkle incl. Like having a pinpoint portable 70-lb. pressure compressor. Instrs. Stock No. 60,902EH ..... \$2.85 Ppd.

#### BLACK-LIGHT MIGHTY MITES



Relatively small (12") fixtures give surprisingly bright blacklight. Mirror-finished reflector makes instant starting 8-watt, high-intensity bulb look like 40-watter. Up to 5,000 hours of safe, long-wave (3650A) black-light to really turn-on particles, light & theatrical shows, psychedelic Shockproof end-caps remove for safe, easy replacement of bulb and starter. Stands upright or horizontal. Alum. case. Stock No. 71,274EH ..... \$14.95 Ppd. No. 71,299EH OUTDOOR/INDOOR ..... \$19.95 Ppd.

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#### BETTER BUG TRAP—BLACK LIGHT!



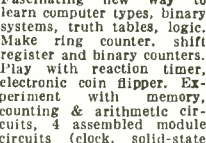
Feel free outdoors with a genuine "black light" trap—3 to 10 times more alluring to insects than simulated kind. Long-wave black light lamp attracts nite-flyers to a watery death. Weatherproof easily cleaned unit is effective up to 1/2 acre of cleared area (patio, pool, stable, golf courses, into grounded elec. outlet. Incl. 2 yr. bulb, powerful motor & fan. 110v, 26 watts. No. 71,657EH ..... (12 1/2 x 7 1/2 x 9 1/2) ..... \$39.95 Ppd.

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Build your own see-through motorized model of revolutionary pistonless type engine, rights for which GM recently paid \$50 million! Only one considered modifiable to meet new standards. Replaces piston, cylinder, crank assemblies with rotating discs (sections removed for firing chambers). Smaller than conventional; fewer parts, rel. speed w/less h.p. Switch, Req. 2—1.5V batt. (not incl.). No. 71,424EH ..... (4 1/2" x 5" x 9") ..... \$6.75 Ppd. 519 Pg "Wankel" BOOK—#9439EH ..... \$15.25 Ppd.

#### DIGITAL COMPUTER LOGIC LAB



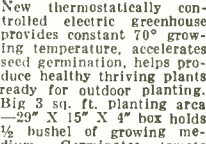
Fascinating new way to learn computer types, binary systems, truth tables, logic. Make ring counter, shift register and binary counters. Play with reaction timer, electronic coin flipper. Experiment with memory, counting & arithmetic circuits, 4 assembled module circuits (clock, solid-state NAND gates, flip-flop, display), 20 patch cords for 100's of circuits—25 computer experiments. No electronic know-how needed! 74 pg. illustr. manual explains all. Req. 6v batt. (not incl.). Stock No. 71,403EH ..... \$39.75 Ppd.

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Be ecological and artistic... with this low-cost Bottle Cutter Kit. Easiest-to-use one we've found. Make saleable, attractive glasses, lamps, dishes, candleholders, vases... from ordinary no-return smooth-surface bottles, jars. Cut any bottle safely, easily in less than 5 minutes for fun, profit, home decorations with just an ice-cube and this superior kit. Includes cutter (3/8" x 7/8" x 2 1/4"), candle, 2-oz. grinding powder, smoothing cloth. Complete inst. Stock No. 71,475EH ..... \$10.95 Ppd.

#### STARTS SEEDS IN 3 TO 5 DAYS!



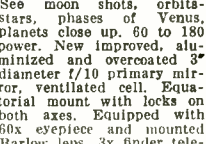
New thermostatically controlled electric greenhouse provides constant 70° growing temperature, accelerates seed germination, helps produce healthy thriving plants ready for outdoor planting. Big 3 sq. ft. planting area—29" x 15" x 4" box holds 1/2 bushel of growing medium. Germinates tomato seeds in 3-5 days; asters, dahlias, petunias, wk. or less. Incl. 3 X 4 ft. clear plastic cover, supports 4 pkgs. of veg. & flower seeds. Uses reg. home current. Stock No. 80,153EH ..... \$12.95 Ppd.

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See moon shots, orbitars, phases of Venus, planets close up, 60 to 180 power. New improved, aluminumized and overcoated 3" diameter f/10 primary mirror, ventilated cell. Equatorial mount with locks on both axes. Equipped with 6x eyepiece and mounted Barlow lens, 3x finder telescope, hardwood tripod. Included FREE: "STAR CHART"—"HOW TO USE YOUR TELESCOPE". Stock No. 85,050EH ..... \$32.95 Ppd. No. 80,162EH ..... DELUXE 3" ..... \$59.90 Ppd. Stock No. 85,105EH ..... 4 1/4" ..... \$94.50 Ppd. Stock No. 85,086EH ..... 6" ..... \$239.50 FOB

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Easy, quick, low-cost way to spot Marijuana, Hashish, Amphetamines. 5-min. test tells if drug is the real thing, detects presence of alien matter. Scientifically accepted reliable method used by testing labs, law enforcement agencies to identify & prevent use of harmful, illegal drugs. (Warning: permits 30-50 tests (as low as 12¢ ea.) Instrs. incl. No. 71,615EH (Marijuana & Hashish) ..... \$5.95 Ppd. No. 71,617EH (Amphetamines, Opiates) ..... \$5.95 Ppd.

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New 2 channel Color Organ Lamp translates sounds into exciting visuals. Get flashing, pulsing colors from tapes, records, radio, TV, instruments—within 50 ft. Whisper as low as 65 decibels and see it react! Great party fun, conversation piece, hard-of-hearing aid—visually alert to doorbell, phone, footsteps. Plugs into any elec. outlet, 8" unbreakable wht translucent sphere, 4" dia. base. Incl. 2 colored bulbs, instrs. Stock No. 71,575EH ..... \$13.95 Ppd.

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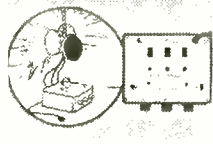
Direct reading up to 2 mi. Has 3 interchangeable pre-computed scales. In seconds, get exact fix, check distance & speed, correct compass. Gives 210 field of view at 500 yds; less than 1/2% error at 50 & 100 yds. 6 x 18X monocular detaches for sep use. Ideal for hunters, boaters, rollers, engr's., contractors, estimators. Weatherproof. 2-yr warranty. Stock No. 71,648EH ..... (1 1/2 x 1 1/2) ..... \$35.75 Ppd. No. 71,649EH CASE HOLSTER ..... \$7.75 Ppd.

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Frighten prowlers, muggers, vicious dogs with 118 decibels. Just press and this Free powered, pocket-sized horn can be heard a mile away to signal for help or fun. Great for boating (it floats), hiking, camping, hunting, seashore, rooting for your team. Can be heard over traffic and constr. noises to sound fire drill, emergency. Weighs only 3 oz. but contains up to 100 mile-piercing blasts. Stock No. 41,423EH ..... \$3.25 Ppd. No. 71,630 EH Giant 9-ounce horn ..... \$8.20 Ppd.

#### 3-CHANNEL COLOR ORGAN BARGAIN!



Create tremendous variety of unusual & beautiful lighting effects with this low-cost top-quality 1500-Watt unit (500 W. per channel). Compare with others selling for twice the price. Has pilot light, plus individual sensitivity controls and channel indicator lights. Can operate ten 150 W. "spots" or 200 Christmas lights. Uses reg. house current—attaches to audio source w/RCA-type phone plug, 5 1/2" x 6 1/2" x 2 1/2", 2 1/2 lbs. Thermal setting plastic case, 6-ft. cord, including complete instructions. Stock No. 71,223EH ..... \$49.95 Ppd.

#### \$8.95 ELECTRONIC STROBE!



Hand-sized solid state electronic strobe light at fantastically low price. Produces bright, psychedelic effects like larger, far more expensive Xenon strobes, yet it's just 2-1/4 x 4 x 1-1/2" thick. Adjustable flash rate, approximately 3-10 flashes per second. Make stop motion effects, posters come alive. Great to take with you to parties, dances, outings, etc. Requires 2 9v transistor batt. (not incl.). Instructions. Stock No. 41,443EH ..... \$8.95 Ppd. 4 REPLACEMENT LAMPS P-41,444EH .. \$1.00 Ppd.

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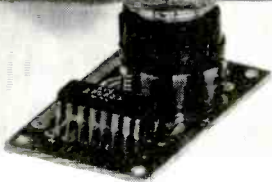
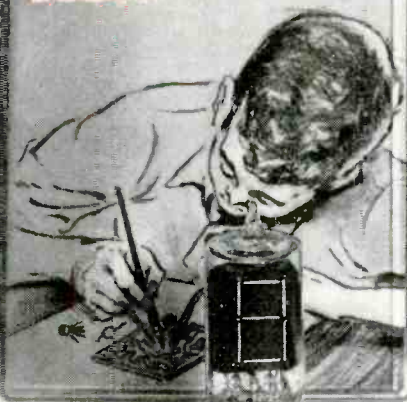
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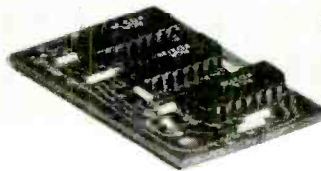
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