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Radio-Electronics®

FOR MEN WITH IDEAS IN ELECTRONICS

DUAL-TRACE TRIGGERED-SWEEP SCOPES
Put One On Your Bench

MULTI-FACETED WORLD OF INFRARED

SEE HOW IT WORKS
Digital Clock On A Chip

BUILD YOUR OWN
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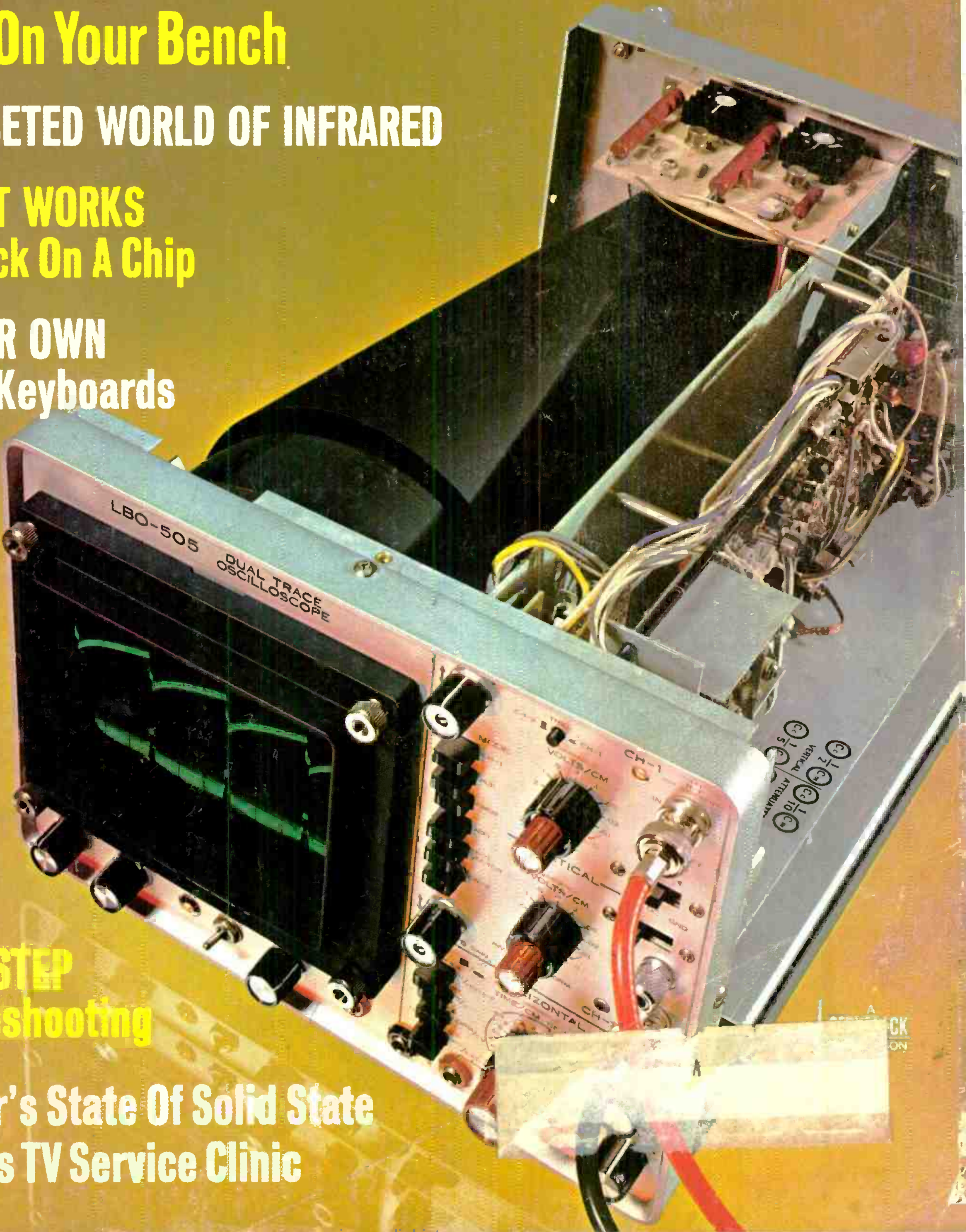

STEP-BY-STEP
TV Troubleshooting

Lou Garner's State Of Solid State

Jack Darr's TV Service Clinic

This is what this catalog is all about.

A complete new look from RCA in Antenna System Accessories

RCA's all new line of Antenna System Accessories has been planned and designed to fulfill specific requirements of any antenna system in every detail. Covering every requirement from a simple passive two-set coupler up to a complete amplified, 82-channel coaxial multi-outlet distribution system for houses, offices, stores and small apartment buildings, this new line is complete in every respect and represents a new standard of performance, convenience and styling.

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The RCA Antenna Systems Accessories Catalog is the TV service dealer's complete guide to better reception for his customers and more sales. So tune in and get your free copy today with absolutely no obligation. Ask your local RCA Parts and Accessories distributor how to get your free copy, or fill out and mail the attached coupon.

RCA

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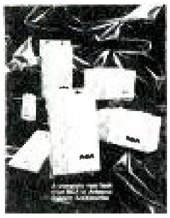

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Circle 1 on reader service card

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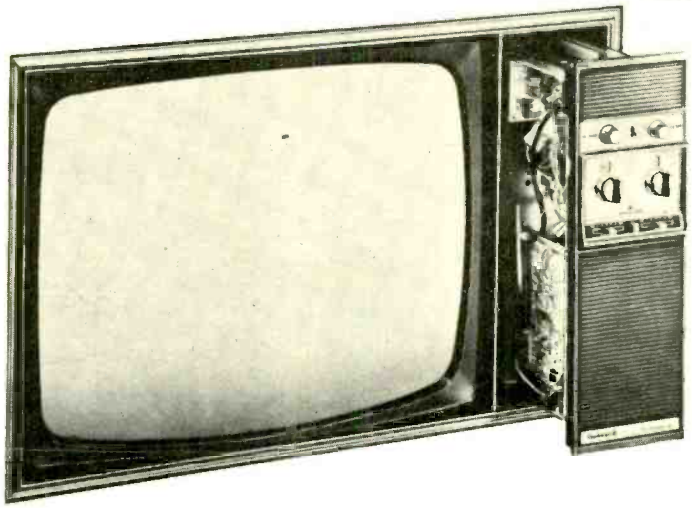

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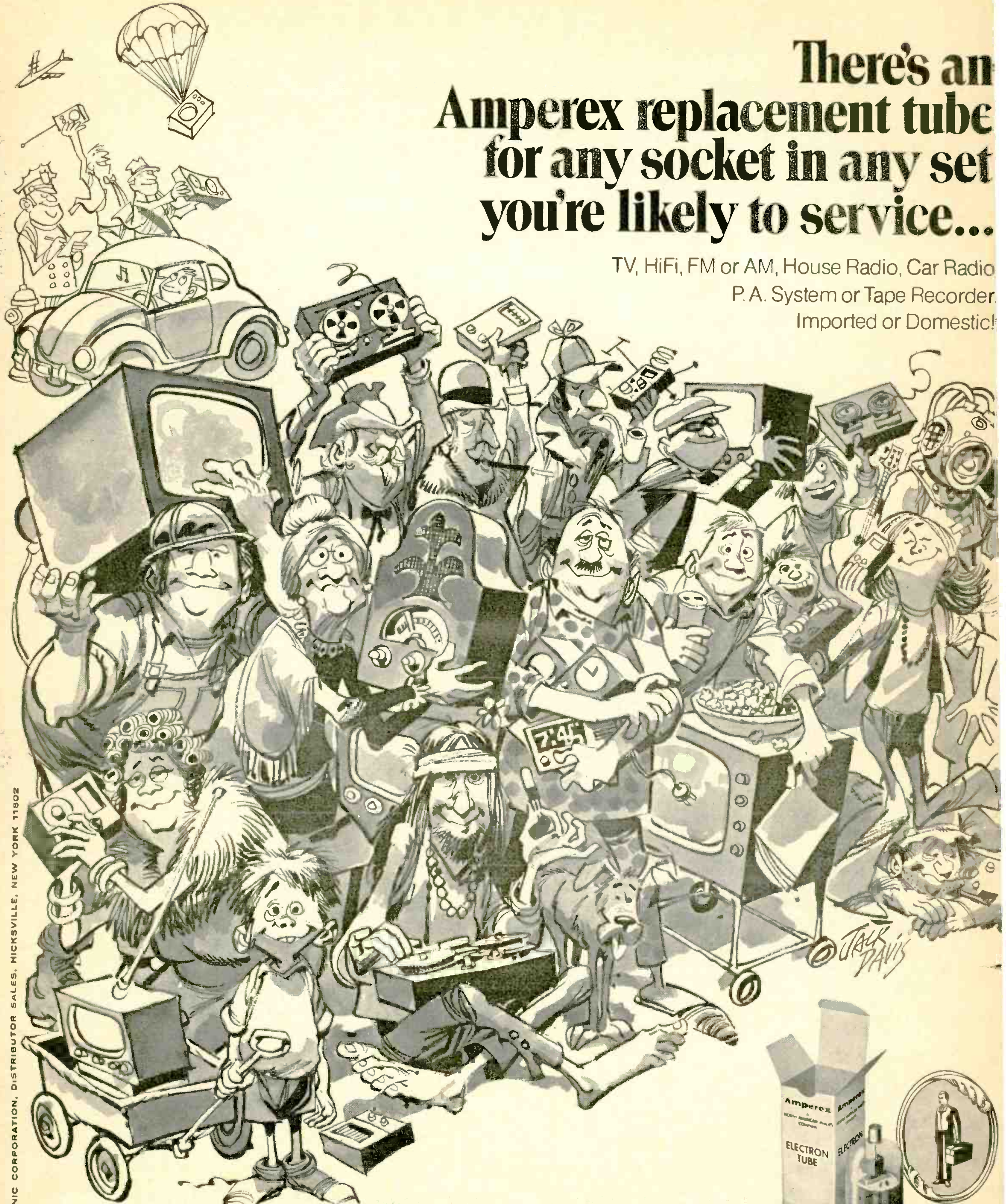

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Radio-Electronics

FOR MEN WITH IDEAS IN ELECTRONICS

February 1973

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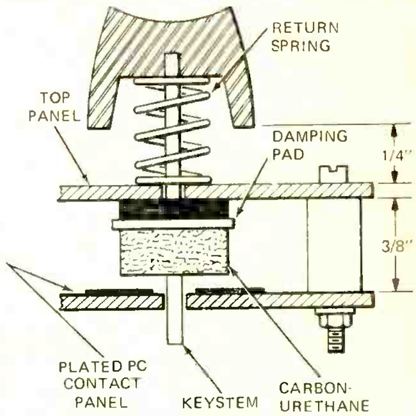

CONSTRUCTION DETAILS of a keyboard switch you can build for less than 25 cents.
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editorial

the whole story

In the *letters* column this month, you will find a detailed message from Frank Moch, executive director of NATESA (National Alliance of Television and Electronic Service Associations). It's addressed to Bess Myerson and is concerned with the practices used by consumer protection groups to check out TV service technicians.

Frank Moch's letter, coupled with a recent newspaper story in New York City, has prompted this editorial. A few months ago New York's daily newspapers carried a story that told of a check run on eight TV repair shops. It specified how seven of the eight shops checked proved to have a dishonest operation. The implication was that the TV set owner in New York City had only one chance in eight of finding an honest shop to get his set working.

Concerned by the article, we checked with the consumer protection agency and obtained a copy of their complete report. In reading the report, including the fine print, we found that it was true that seven of the eight shops were dishonest. But—and this is the key to the whole thing—the seven dishonest shops **were selected on the basis of numerous prior complaints.**

Therefore, this was not a random sampling and should not have appeared to be representative of the entire TV service industry in the city. Unfortunately, the qualifying remark was located near the bottom of the report and apparently was not noted by all of the newspapers who picked up the item.

All professions harbor small number of dishonest businessmen. But to distort and paint every TV service technician as a dishonest operator is a terrible injustice. The vast majority of TV service technicians are honest, hard-working businessmen—men who are really concerned with repairing a set and returning it in good shape to their customer as soon as possible and with as reasonable a fee as possible.

We call on all consumer protection agencies and news reporting media to be much more careful in how they fling their statements about. By all means, we do want to see the dishonest operator put out of business. But, unfortunately, the dishonest operation has considerable legal protection while the honest operator appears to be wide open to take the rap for the dishonest minority.

When reporting on any TV service operation, we ask that the media be sure to get the whole story in the first paragraph of their report every time. And wouldn't it be different, if just once, the typical **honest** technician was in the news?

——**Larry Steckler,** Editor

looking ahead

Narrowcasting

That word is the opposite of broadcasting. And it describes the new Multipoint Distribution Service (MDS) authorized by the FCC and expected to go into service early this year. MDS is a commercial service designed to provide low-cost visual communications between a central point in a metropolitan area and several receiving locations for private or semi-private use. The FCC has set aside the 2150 to 2160-MHz portion of the spectrum for MDS, allotting one channel per area.

Under the MDS system, the local FCC licensee establishes a central transmitting point in an area and sells time to local businesses which wish to transmit pictures to various points within a 15 to 25-mile radius. Small parabolic antennas are installed at the receiving locations. The transmitted signals may be digitally encoded so that specific program time segments may be received only by the locations for which they were intended. For example, if Coca-Cola is sponsoring a televised sales meeting from 2:30 to 3 PM and Pepsi-Cola a meeting from 3 to 3:30, neither location would be able to spy on the other's sales message.

Microband Corporation of America, which has received the first permit for such service, in Washington, D.C., and has applied for licenses in 32 other cities, is promoting MDS as the lowest-cost form of visual communications available—cheaper than videocassettes or even movie projection. If 10 or more viewers watch in a single location, Microband says, it should cost less than a dollar per viewer for each 25-minute program presented twice weekly on a year's contract.

Another firm, affiliated with Microband, has signed up most of the current applicants for MDS service to affiliation contracts, so that nationwide televised meetings may be held. The affiliates would receive the program material by microwave, communications satellite or air-expressed videotapes. In addition to business meetings, Microband says its services will be used for ethnic programming to community centers, religious services to churches and pay-TV movies to motels. The FCC is currently considering whether to assign a second MDS channel to the current service. It appears to be the start of a new nationwide TV intercom service—or, as Microband puts it, "hundreds of private TV networks."

Talking pictures

You have a couple of beautiful art masterpieces on your wall, see? And you turn on the stereo. Suddenly you get fantastic sound, with no apparent speakers in evidence. It's your paintings trying to tell you something. That's the latest audio product from Fisher Radio. The patented "Sound Panels" actually are flat speakers masquerading as paintings. But unlike some flat speakers, these are claimed to be superior to acoustic-suspension types in efficiency and sound dispersion, and equal in frequency response. Each speaker has two drivers attached to the rear of an expanded polymer diaphragm. The diaphragm radiates energy over its entire surface, dispersing sound in a 360-degree pattern. Eight different paintings, or "Sound Panels," are being offered, at about $138 each. The paintings are on fabric—you can't use one of your own pictures. The logical follow-up might be a kit which lets you paint your own loudspeaker by numbers.

The videoplayer market

The first cassette videotape recorders designed exclusively for the home are now on sale in most major markets throughout the United States and Canada. Sold under the brand names of Admiral, Emerson, Montgomery Ward, Sears and Teledyne Packard Bell, they all use the Cartrivision deck, manufactured by Cartridge Television Inc. A network of sales and rental outlets for pre-recorded programming is now being assembled. The first Cartrivision models are all 25-inch color sets with built-in recorder-players and sell at a relatively steep $1300 to $1600, with a black-and-white camera about $250 extra.

At these prices, obviously, this is not yet a mass-market product, but the manufacturer of decks is just starting up and couldn't fill huge orders. Toward the end of 1972, it's estimated that perhaps 5,000 units had been shipped to dealers, and total orders by manufacturers for the decks came to about 15,000. Later this year, some manufacturers will introduce a stand-alone playback-only Cartrivision deck for attachment to any color set at about $700.

That's the same price which RCA projects for its MagTape Selecta-Vision play-and-record deck, which has a built-in digital clock-timer so that programs may be recorded when the set owner isn't home. This is scheduled to come on the market late this year. It's not compatible with the Cartrivision unit, of course.

However, the most successful videocassette recorder isn't a home unit at all, but Sony's U-Matic system, which is finding many uses in education, industry and commerce. Sony has produced about 40,000 of these, selling most of them in the United States, and expects to make about 100,000 this year. In the United States, a record-and-play U-Matic costs $1,395 and a playback-only unit is $995. The principal attraction of the Sony unit is its operational simplicity and reliability. Although the U-Matic isn't compatible with either the Cartrivision or the upcoming Selecta-Vision system, Sony feels that it will become the consumer standard. However, Sony officials say a real market for a home U-Matic won't come for another five years—by which time mass production and integrated circuitry will have reduced the cost of a record-play unit to about $500. By that time, Sony foresees sales of at least a million units per year.

Midget digits

A new electronic watch circuit that is small enough to be incorporated into a petite ladies' watch, or to permit the addition of an automatic calendar, is being designed by the Inselek Corporation of Princeton, N.J., under contract to Optel, Inc., of the same city.

At the heart of the circuit is a newly designed "silicon-on-sapphire" (SOS) IC, to be used in combination with a liquid-crystal digital display. The SOS circuit is claimed to be smaller, more accurate and lower in cost than the conventional all-silicon ICs. The target for marketing the first SOS watches is late this year. Price of the new timepieces has not yet been determined by the manufacturer.

by **DAVID LACHENBRUCH**
CONTRIBUTING EDITOR

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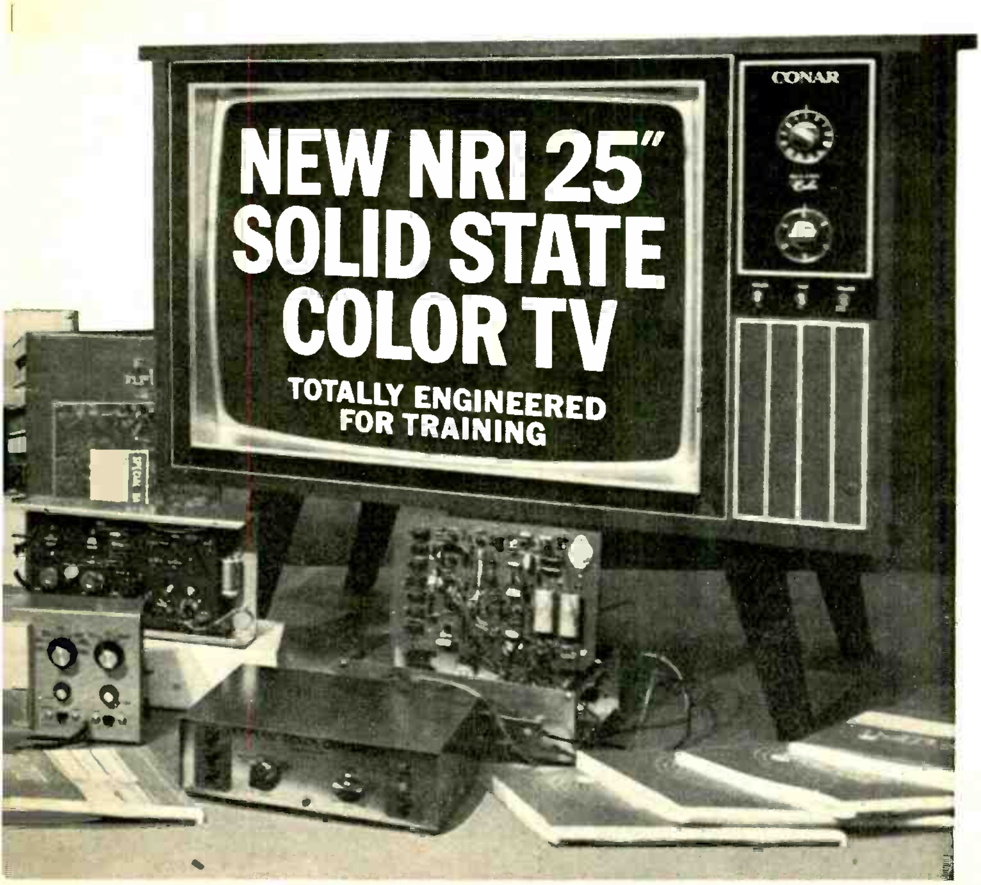


NRI Kits and Equipment

Dollar for dollar, you get more value from NRI training kits, because they are designed as educational tools. In the TV-Radio Servicing Course, for instance, the end product is a superb 25" color TV your whole family will enjoy. The set is designed so that, while building it, you can introduce and correct defects . . . for trouble-shooting and hands-on experience in circuitry and servicing. The kits include, at no additional cost, a wide-band service type oscilloscope and color crosshatch generator, and other valuable equipment that will let you start earning money in your spare time making repairs . . . even before the course is completed.

new & timely

Electronic tranquility machine relieves headaches, insomnia

An electronic "tranquility machine" that relieves nervous tension and quickly cures many types of headaches, was demonstrated at the 58th annual convention of the Jewish women's service organization, Hadassah. The device was developed by scientists of the Electro-Sleep Clinic of the Hadassah-Hebrew university in Tel Aviv, Israel. It is about the size of a large transistor radio.

No description of the electronic operation of the instrument was given at the convention. It appears to be a form of the electronic sleep instruments developed by researchers in the United States and Russia, as well as in Israel. As described, it is milder in its effects than the electronic sleep instruments; It is said to produce a state of relaxation "bordering on sleep."

Some headaches not curable by drugs have been successfully treated with the machine. On the other hand, according to Dr. Florella Magora of the University, some persons simply do not respond to it. Not only have headaches and insomnia been successfully treated, but general tension usually yields to the machine, and it has been effective in allergic asthma and certain types of migraine.

Five years experience with the device, states Dr. Magora, have shown decisively that its benefits have no detrimental side effects. This makes it possible for the patient to use it at home, simply placing three electrodes on the head, pushing the starting switch and setting a timer to turn off the instrument when the desired time of treatment has been completed.

Airborne nuclear refrigerator cools to –320° F.

A nuclear cryogenic refrigerator that produces temperatures as low as –196° C (–320° F or 77° K) has been demonstrated at the Mound Laboratories of Miamisburg, Ohio. It was developed for the Atomic Energy Commission by Hughes Aircraft Co.

Such low temperatures are needed to cool infrared and other sensors to temperatures at which they reach their greatest sensitivity. Earlier units, using electricity as a source of the heat energy that activates these refrigerators, have been used successfully in space, air and ground systems.

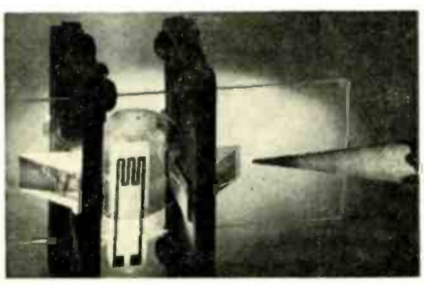
THREE CYLINDERS OF PLUTONIUM 238 provide the energy for the cryogenic 'fridge, which cools things down to more than 300 degrees below zero. The young lady inserting the tubes is Pamela Gleason of Hughes' cryogenic department.

But vehicles such as spacecraft often have no electrical power to spare, and this first nuclear unit, using radio isotopes, therefore has important advantages. Three small capsules of Plutonium 238 are all that is required to produce the super-cooling.

It may seem odd to use heat to produce cold, but the principle has been used in home gas refrigerators, such as the old Norge ("Cools with Heat!"). The heat evaporates a liquid, which absorbs heat as it returns to the liquid state.

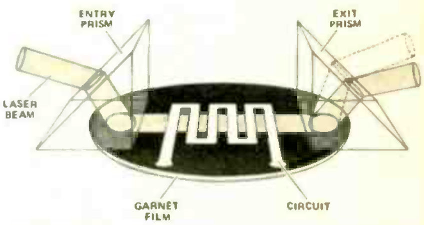
New laser-beam light switch has future in electronoptics

Bell Laboratories scientists have developed and demonstrated an experimental light switch, for switching a beam of laser light. Scientists have been seeking such a switch as part of future electro-optical systems that would transmit large amounts of information over light beams.



THE THIN FILM LIGHT SWITCH that may be part of future optical circuits for putting phone calls and data on a light beam. Pencil points the path of the light wave.

The switch is an yttrium gallium scandium garnet film, about 2.5 microns thick, grown on a gadolinum garnet substrate. It is the center wafer in the photograph. It acts as a waveguide for lightwaves, two types of which, the TM (transverse magnetic fields) and TE (transverse electric fields) can pass through it. The wafer also carries a zigzag (serpentine) electric circuit, which sets up a tiny magnetic field when current passes through it.



SCHEMATIC DRAWING of the light switch, showing how the output waves are separated.

The wafer is positioned between two prisms that couple the light beam into and out of it. The exit prism guides the beam in one direction if it is a TM type of lightwave and in a slightly different direction if it is of the TE type.

Light is fed into the input prism in the TM mode, and passes across the wafer, over the serpentine circuit, and out via the exit prism. When current is passed through the circuit, the beam is changed from TM to TE, and thus follows a different path on leaving the prism than does the light passed when the serpentine circuit is switched off. This makes it possible to code information into the beam.

Bell scientists see the possibility of many improvements over the present experimental device. These may result in simplifying it to a very small thin film and a tiny electric circuit, without the comparatively bulky prisms.

Sixth amateur radio satellite has several new features

OSCAR VI (Orbiting Satellite Carrying Amateur Radio) recently sent into space aboard a NASA Delta space rocket from the Western Test Range in California, dif-

(continued on page 14)

new & timely

(continued from page 12)

fers from the five previous Oscars in several important respects.

Using batteries rechargeable by the sun, its life is expected to be at least a year. It operates in a circular polar orbit 900 miles from Earth. It receives amateur signals on 2 meters and retransmits them in the 10-meter band, thus permitting international communication on frequencies heretofore limited to short-range operation, by many more amateurs than before, this includes many hams in developing countries who have not previously had any opportunity for experience with space communication via satellite.

OSCAR VI is also expected to offer greater opportunities to schools to provide laboratory experience in several aspects of space science. Three of NASA's "Spacemobiles" which visit schools for demonstration purposes will be equipped for OSCAR VI use.

Coordinating arrangements for the NASA launch is AMSAT—the Amateur Radio Satellite Corporation—a volunteer group of radio amateurs headquartered in Washington, DC. The official tracking station will be operated by a group of hams at the Talcott Mountain Science Center in Avon, Connecticut.

First domestic satellite is launched in Canada

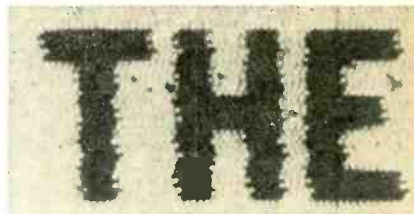
Anik, the world's first domestic communications satellite, went into orbit November 9 last, to tie all Canada together in one communications network. In an equatorial orbit 22,300 miles above Earth, it can "see" all of Canada from Newfoundland to the Yukon-Alaska border—a distance about 1,000 miles greater than that from New York to San Francisco—and from the United States boundary to points in the far north where broadcast listeners hear Moscow and Berlin better than they do Toronto and Montreal.

Anik (which means "brother" in Eskimo) will carry at least three television channels, two in English and one in French, and a multiplicity of communications channels, including telephone and data transmission. Telesat Canada, a private-public corporation created by the Canadian Parliament, already has 13 customers, including the Canadian Broadcasting Corp. and the Bell Telephone Co. of Canada.

One of the main objectives of the new system is to serve the far north and the Artic islands where wire communications are impossible because of the distances and rugged terrain, ordinary radio communication is often unreliable, and television is non-existent.

Laser beam used in new image transmission system

By using a laser beam to burn thousands of holes in a thin bismuth coating over a transparent plastic film, Bell Labs scientists have devised a way of making microfilm copies of photographs, printed copy or other graphic material transmitted from distant points.



THE WORD "THE" is made by leaving areas untouched by the laser beam, while burning off practically all the bismuth on other parts of the film. Individual holes may be seen around the borders of the individual letters. By simply reversing the modulation signal, the THE could also be white letters on black background.

The system uses a laser beam pulsed at a million pulses per second, to burn holes in a bismuth coating less than three millionths of an inch thick, deposited on a transparent Mylar plastic. Portions of the plastic not touched by the laser beam block 99 per cent of any incident light; the holes pass 80 per cent of the light falling on them.

As shown in the photograph, the holes are formed in a dot pattern somewhat like a halftone photograph in this magazine. The laser beam is scanned across the film by a small vibrating mirror to make the rows of holes. If no power is applied to the beam, the bismuth is left intact. As power is varied, the beam burns larger or smaller holes. Thus a wide range of gray tones can be produced. The film can be used in a slide projector to make a large image on a movie screen. Either printed pages or reproductions of photographs can be projected.

The system may make possible a high-speed, low-cost terminal for receiving data from a computer, or for obtaining information from remote files or records. A typical newspaper page can

(continued on page 16)

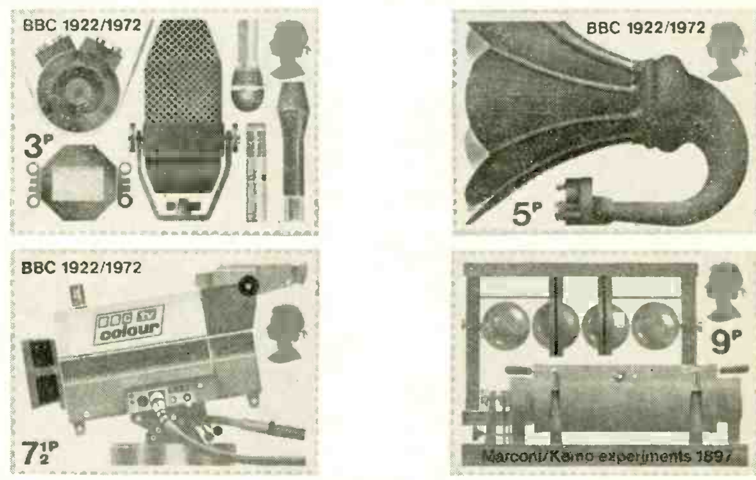
new & timely

(continued from page 14)

be transmitted in four seconds over a high-capacity transmission channel, or in about four minutes over an ordinary telephone line.

First TV repair co-op

Now open in New York City The Grand Street Consumers Cooperative Society is new. R-E Special report next month.



FOUR BRITISH STAMPS COMMEMORATE the 50th anniversary of broadcasting by the British Broadcasting Co. and the 75th anniversary of the experiments by Marconi and George Kemp that resulted in the successful radio test over water in 1897. The 3-penny stamp shows six types of microphones used in broadcasting from 1922 to the present. The 5-penny stamp pictures the Amplion loudspeaker, famous in the mid-'20's. A modern television camera is featured on the 7½-penny stamp, and the 9-penny stamp shows radio equipment used in 1897 for the 9-mile transmission across Bristol Channel. R-E

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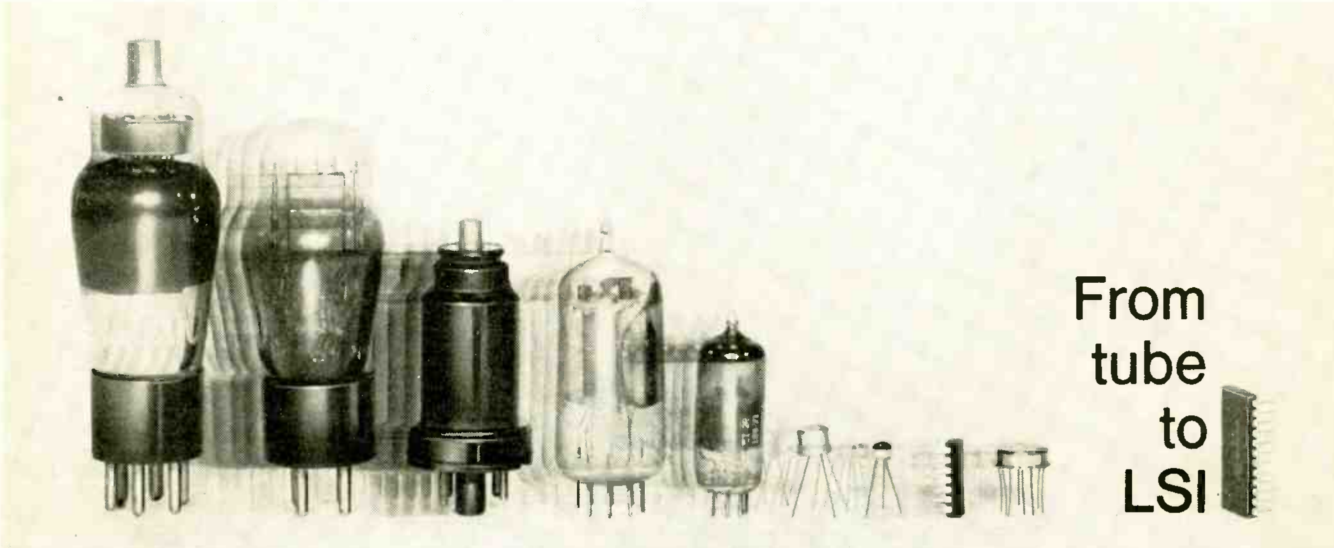

Take a look at the race in circuit technology. In the 1960's the tubes at the left made way for the transistors at the right. Today, transistors are surpassed by the large scale integrated circuit (LSI) at the far right. This circuit, less than a quarter inch square, replaces over 6000 transistors!

There's big money to be made by the men who stay ahead of this technology race. Put yourself ahead with NTS Home Training! You get the latest, most advanced equipment (at no extra cost). More solid-state units, and more advanced technology. Plenty of training with integrated circuits, too! As an NTS graduate, you enter a world of electronics you're familiar with. You have a thorough working knowledge of solid-state circuitry. You're ready to tackle bigger jobs at higher pay!

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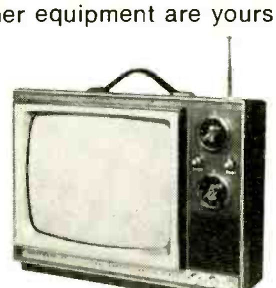
Build and keep the largest, most advanced color TV made! Over-all solid-state design, ultra-rectangular screen, matrix picture tube, built-in self-servicing features, "Instant On," A.F.T., solid-state, 24-channel detent UHF/VHF power tuning, and much more! Also build and keep AM-SW Radio, Solid-State Radio, FET Volt-Ohmmeter, and Electronic Tube Tester. Learn trouble-shooting, hi-fi, stereo, multiplex systems, radio, color and B & W TV servicing.

Learn sophisticated solid-state circuitry as you build this B & W TV receiver. Lo-Silho "Superhet" Radio, FET Volt-Ohmmeter, Solid-State Radio, Electronic Tube Checker, and Signal Generator. TV and all other equipment are yours to keep.

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



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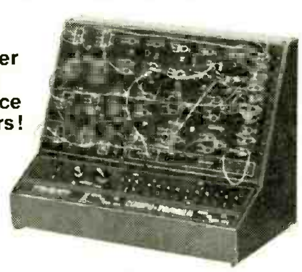
Build and keep this exclusive NTS Compu-Trainer. It teaches you the same principles used in million-dollar systems. Contains 14 integrated circuits! All Solid-State! You perform all wiring and patchcording. No shortcuts. No pre-wired circuit boards. Your training is complete! Also receive an FET Volt-Ohmmeter and a 5″ wide-band Solid-State Oscilloscope.

Solid-state Compu-Trainer 14 integrated circuits replace 198 transistors!



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Gain the prestige and earning power of owning an F.C.C. First Class Radio-Telephone License. Two comprehensive NTS courses cover the big opportunity field of transmitting and receiving.

You build and keep 14 kits, including this amateur phone 6-meter VHF Transceiver, NTS's exclusive 6-transistor Solid-State Radio, and a fully transistorized Volt-Ohmmeter. Also, learn 2-way radio, Citizens Band microwaves, and radar.

5-watt AM transmitter/receiver

letters

OPEN LETTER FOR ALL SERVICE TECHNICIANS

We are becoming very concerned with attitudes of many elected persons on consumer problems. It quite obviously has become the "in thing" to cast blanket condemnation upon entire phases of business. We hear at accelerating incidence, references by these people to *ALL* TV-radio service people being racketeers. Were this to be a fact, at least we could take consolation in a posh life style while being driven from bank to bank by our chauffeurs in our Cadillacs.

The most galling new aspect is justification of any and all rash charges by the politicos, with the statement, "Bess Myerson said so." This classic hiding behind a skirt by elected officials, using unfair and non-productive tactics, is quite abhorrent and cannot be tolerated.

The enclosed letter to Miss Myerson we hope will give her information on facts of TV service business life that will eliminate excuses for the would-be do-gooders.

Miss Bess Myerson
Department of Consumer Affairs
80 Lafayette Street
New York, New York 10013
Dear Miss Myerson:

We are getting from consumerism oriented elected officials what we are sure are distortions of your statements. We speak only for the TV-home electronics servicer. The usual approach is that almost all TV-radio technicians are totally dishonest and then in lieu of personal investigation, they try to justify their statements by saying in effect, "Bess Myerson says so."

This we believe is a perversion of what you are trying to do and serves *NO* honest purpose.

When a person without knowledge of a given business dealing with a highly complex product, attempts to arbitrarily determine cost and practices, he does a serious disservice to the public he claims to be protecting.

First, TV, and particularly solid-state color TV, is the most complex device in the home. The technology changes so rapidly that the service people "must run just to stand still" and so to expect a set owner to understand it, is idiotic.

Second, price of sets is predicated on the fact that most sets in total or at least major sections of it, has been automatically produced by foreign labor, most of it at $30.00 to $40.00 per week.

Third, service of *ALL* sets of necessity is a custom operation because of multiplicity of models, and a great variety of trouble symptoms, many of which can be caused by a number of distinctly different troubles. This work can be performed properly only by well trained technicians, all of whose costs are based upon American standards rather than Oriental or other depressed standards.

Fourth are the myths that the defective product is small or was bought at a bargain. These factors actually add to cost of service because smallness congests circuitry and cheap price is due to "stripping down" of components and reduction in safety tolerances.

A major unfair tactic by exposé shoppers is allegation of overcharging for estimates. This is compounded by shoppers who use marginal products and often "cutely" try to confuse the servicer by their explanation of symptoms, even though the injected planted evidence may be as simple as a blown fuse, which trouble if legitimate, could be due to major but possibly intermittent multiple component breakdown. The point generally missed is that a true estimate actually entails an entire correction operation, often requiring at least temporary installation of replacement components to verify correction or to move on past one defect to analyze a second. The degree of service performed depends on the servicer's desire to restore a set to as close to like-new condition, which in many cases, might be beyond the set owner's ability to recall because sets, like auto tires, WEAR OUT gradually.

95% of servicers recognize the set owners' right to determine how far restoration should proceed and so if the set owner says "Just make it work," the cost is far less than a full restoration. Most servicers will give "Guesstimates" for a very reasonable fee of as little as $5.00, but certainly cannot then be expected to give guarantees of any kind.

We would urge that when shopping, a claim check should be demanded on which restrictions, such as estimate only, be indicated in writing and minimum fee be indicated.

We assure you that most servicers, and certainly members of NATESA, are at least as honest as any segment of business, and that means 95%. They are

(continued on page 24)

Introducing the expensive curve tracer that doesn't cost a lot.

The B&K Model 501A.

It's a lab-quality instrument that provides fast analysis of all semiconductors including J-FET's, MOS-FET's, signal and power bipolar transistors, SCR's, UJT's and diodes.

You can test transistors in circuit for GO/NO GO condition. Badly distorted curves will indicate the stage where a defective transistor or other faulty component exists.

The 501A is complete—with scope graticule and FP-3 probe for fast, one-handed in-circuit testing. It generates true current and voltage steps, with 3% accuracy, for measuring beta at all current levels. And it has a sweep up to 100 volts and 100 milliamperes.

$129.95

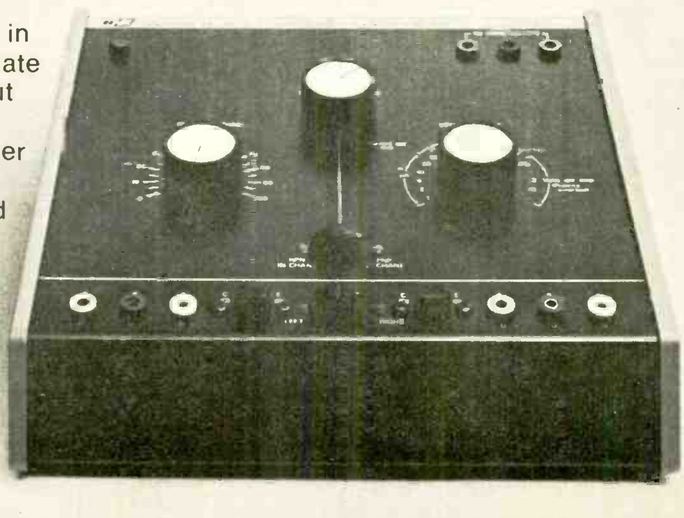
With the 501A, curves are displayed on an auxiliary scope screen. And you can hook it up to any scope—old or new.

All three controls can be set in quick-test positions to test and evaluate 90% of all solid-state devices without manufacturer's data sheets.

The 501A won't burn out either the semiconductors or itself.

With all these features, you'd think the 501A was an expensive curve tracer. But look at the price.

For complete technical data, call your B&K distributor. Or write Dynascan Corporation.



Very good equipment at a very good price. B&K

Product of Dynascan Corporation
1801 West Belle Plaine Avenue, Chicago, Illinois 60613

Circle 11 on reader service card

LETTERS

(continued from page 22)

eager to serve the public because most independents are neighbors of their customers so can't hide from them. It is proven fact that the biggest problem is haphazard selection of service agency and generally at the critical moment of set failure. Expecting impossible bargains and perhaps gimmicks and gifts leads only to "fast pitch" unqualified sharpshooters who, because they continuously lose customers when they finally awaken, must advertise very extensively at cost that obviously is beyond their "hole in the wall" size to justify.

Let us also assure you that NATESA is very consumerism aligned, as the dates on the several enclosures will indicate. We worked with law enforcement and protective agencies during the entire existence of NATESA in the past quarter century. We can identify provable problem areas and problem operators, without maligning the vast numbers of ethical servicers.

NATESA
(National Alliance of Television & Electronic Service Associations)
FRANK J. MOCH
Executive Director
5908 S. Troy St.
Chicago, Ill. 60629

For Radio-Electronics editorial viewpoint on this important matter, see page 4 in this issue.

4 CHANNEL NOTES

It seems that the discrete/matrix debate is doing strange things to its leaders. In each side's enthusiasm to convince the reading public that the other side is inferior, they let themselves give less and less logical arguments.

Even I could find fallacies in the recent letters in **Radio-Electronics** between Gordon Holt and Peter Scheiber. Writing against discrete 4-channel records, Mr. Scheiber stated that total separation in playback is unnatural, forgetting or ignoring the fact that people who make records don't usually have a certain sound *only* in Channel A, but add a little to Channel B so as to give a stereo panaroma instead of two point sources with nothing in the middle between the speakers. What total separation means is the *ability* to have point sources, which musicians and engineers do want occasionally. In his reply, Gordon Holt made a similar mistake when he said that a frequency range past 10,000 Hz is useless. And Gordon Holt returned to argue that down, saying, "Let's not go 4-channel at the expense of *any* of the signal quality possible in the state-of-the-art recording". But separation and tight control of directionality are part of that sig-

(continued on page 89)

Channel Master's new Spartan Amplifier. It knows how to say "NO!"

Antenna amplifiers don't have a good reputation. They just seem to sit up there and attract all kinds of trouble. Channel Master knows that even one callback is too many. And, frankly, we felt that if the industry gave you a more reliable, trouble-free, high-performance amplifier, you'd put up a lot more. That's why we've just engineered a brand new one—the Spartan. It doesn't make problems. It solves them.

"No" to signal overloading. The Spartan uses new high-capacity semiconductors that can handle up to 200,000 microvolts of signal without distortion or cross-modulation. No amplifier can beat it.

"No" to lightning damage. Lightning surges are the #1 cause of amplifier failure. But now you've got the Spartan. Thanks to advanced new energy-absorbing circuits and components, it takes charge after charge—and still keeps working.

"No" to FM interference. It's the only amplifier with 2 built-in FM traps: a switchable filter that attenuates signals 25 dB across the FM band, plus a tunable trap—only 1 MHz wide—that gives you an extra knockout punch exactly where you need it.

"No" to tropical heat, sub-zero cold, and pouring rain. Exceptional stability and reliability in any kind of weather. And it maintains its flat gain, with no oscillation or hum, even when line voltages fluctuate.

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...for guys who can't afford trouble!

75 and 300 ohm models for every reception area. Write for technical literature.

CHANNEL MASTER
DIV. of AVNET, INC.
Ellenville, N.Y. 12428

Circle 14 on reader service card

equipment report

Aries pocket calculator kit from B&F

Circle 26 on reader service card

DESIGNED AROUND A 40-PIN DUAL-IN-line-plastic encapsulated integrated circuit, the Aries pocket calculator is a four-function machine that displays it's answers on an eight-digit LED display. It uses floating-point arithmetic so the decimal point is always positioned to give a maximum of significant figures in the calculated result. A "K" switch stores an entered constant in a memory register so it can be recalled by the machine to be multiplied by, divided into, added to, or subtracted from in a series of chain calculations. These calculators are great for doing all kinds of jobs from balancing checkbooks to doing homework. The slide-rule has passed it's heyday and soon will become extinct due to this modern gift of the electronics industry.

The Aries calculator is made up of three circuit boards; the main board, the clock/power supply board and the keyboard. From the outset it is clear that this is not a kit of beginners and will draw on the skills of the more experienced. It takes a great deal of precision and patient care to mount the components onto the fine board foil patterns. While the instructions are not highly detailed they are adequate for the experienced kit builder. Before beginning construction I recommend the following three items as pre-requisites: 1. A good magnifying glass or low-power microscope to inspect the connections. 2. A high-grade fine-tipped tweezers to assist in positioning leads, particularly those of the LED displays. 3. A spray can of flux remover to clean the boards after soldering to allow a careful inspection.

(The problem of possible damage to the fine LED leads has been eliminated. Kits produced now have the 8-digit readout as one composite unit.—*Editor*)

Assembly proceeds by mounting the components on the boards, interconnecting the boards, wiring the battery supply and the final mechanical case assembly. Mounted on the main board are the eight LED displays, the LED negative and overange indicators, the 40-pin IC, the 26 display driver transistors with their associated resistors, and two slide switches. The smaller clock/power supply board generates the dual phase 25-kHz clock and the -4.8- and +2-volt supplies required by the chip. The negative supply is taken directly off the batteries while the positive voltage is derived by rectifying the clock signal. The third board, the keyboard, is a clever economical printed-circuit affair that outperformed my expectations. The keyboard contacts are printed-circuit foil, bridged by a conductive rubber pad. The pad is separated from the board by a plastic mask with cutouts corresponding to the various keys.

Construction time was about 10 hours followed by an hour of troubleshooting. At first one digit did not light due to a resistor that was damaged during assembly (my fault). After replacing the resistor it was possible to enter numbers but not perform any of the four functions. You begin to feel quite helpless after realizing the defect may be out of reach on the chip. The feeling was soon dissipated by finding a cold solder joint at one of the IC terminals (my fault again) and with a touch of the iron the calculator sprang to life.

Operation of the calculator is

(continued on page 88)

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Knowing how to put an amateur radio kit together won't help when you're "on the job"—servicing two-way radio systems for aircraft or advising trucking companies about their land-mobile communications system. For that, you need "hands on" experience with the real thing. This unique new Bell & Howell Schools learn-at-home program that gives you just that. You can work with the equipment by attending one of our special "help sessions" or by dropping by one of the Bell & Howell resident schools. If neither of these plans is convenient, you can have the equipment shipped to your home in return for a $100 deposit, which is refundable when you return the equipment.

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equipment report

Onkyo TX-666
Solid-state stereo receiver

Circle 27 on reader service card

OUTSTANDING IN BOTH ELECTRICAL and mechanical construction and design the Onkyo TX-666 is obviously the result of attention to detail. Tuning the AM and FM bands with 40- and 1.8-microvolt sensitivities respectively, it delivers 60 watts of rms power to each of two 4-ohm speakers. If you are impressed with even bigger numbers this amounts to 200 watts IHF power. With 8-ohm speakers the output is reduced somewhat to 50 watts rms per channel.

FM image rejection is better than 70 dB, i.f. rejection ratio 100 dB and signal-to-noise ratio 60 dB as a result of a 4-gang capacitor/FET front-end combined with three pairs of ceramic i.f. filters. The remaining pertinent FM specifications are 50 dB minimum AM rejection, 0.5 dB capture ratio, 0.5% stereo distortion (0.2% mono), and 40 dB separation at 400 Hz. Total harmonic and intermodulation distortion are held below 0.2% and 0.3% respectively. At 1-watt frequency response is 10-40,000 Hz ± 1 dB with a power bandwidth of 10-40,000 Hz, IHF THD 0.2%. Bass and treble controls have an adequate ± 10 dB range.

AM performance is also enhanced by high-shape-factor ceramic filters. AM image rejection is greater than 40 dB, i.f. rejection ratio greater than 40 dB and signal-to-noise ratio 40 dB.

With the electrical specifications listed, here are the features we found subjectively interesting, rounding off the receiver's excellence. First the appearance and feel of the front panel controls are solid. From the tuning flywheel inertia to the tuning and signal level meter damping everything seems perfect. Swinging to their final positions quickly and decisively the two meters exhibit no observable overshoot. The meters use their full scale travel usefully. Switching to the AM band turns off the tuning meter illumination with the signal strength meter remaining operative. The knobs and switches are beautifully machined and the red dial pointer is strikingly illuminated by a travelling pilot lamp. A convenient feature is a front panel microphone connector and mixing level control. With a microphone plugged in, the receiver can be used as a PA amplifier without struggling with rear panel potentiometers, or by using the mixer control the microphone output can be mixed and faded with the receiver input signals in all operating modes.

Popping during on/off switching is prevented by a transient killer circuit. When switched on, the volume increases gradually until reaching the level determined by the volume control. The time constants of the FM muting circuit are ideal so there is no annoying excessive time lag when tuning across the FM band. Electronic temperature protection senses high temperatures due to internal or external sources. The output power transistors are mounted externally on the rear panel with shock protection shields, eliminating the main source of heat dissipation from the cabinet interior. Any slight internal heat buildup is taken care of by a neat screened vent slot along the rear top of the cabinet for enhanced reliability. Short circuit protection for the power output transistors gives fool proof main amplifier operation. The rear panel includes the normal phono inputs plus two pairs of auxiliary input jacks. Three pairs of tape jacks give versatility in mixing inputs with the supervision of the front panel volume and microphone mixing controls. Two sets of speakers can be hooked up and used in any combination selected by a front-panel switch. A large handling chart details the operating functions of all front panel controls and jacks. The

(continued on page 80)

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Radio Shack's exclusive Micronta® test instruments are proof that reliable measurements and rugged "knock-around" dependability can be yours at low cost. Whether you're setting up a service shop or laboratory, or need instruments in your hobby, pay less and get much more with Micronta. Exclusive at 1600 Radio Shack stores in all 50 states.

100k-Ohm Multitester. None finer at this price! Matched pair of silicon diodes prevents overload damage. Mirrored, no-parallax scale; 4" meter; ±2% accuracy. Reads DC volts: 0-500 mV, 0-2.5-10-50-250-500-1000 volts at 100,000 ohms/volt. AC volts: 0-2.5-10-50-250-1000 volts at 12,500 ohms/volt. DC current: 0-10-250 μA, 0-2.5-25-250 mA, 0-10 A. Resistance, 0-2k-20k-200k-20 meg. Decibels, –20 to +62 in 5 ranges. Batteries, leads, included. 34.95

20k-Ohm

30k-Ohm

50k-Ohm Multitester. Versatile "range doubler" circuit. Accurate for both current and voltage ranges—especially recommended for low-voltage transistor servicing. 4" meter has color-coded, mirrored scale. Ranges: DC volts: 0.125-1.25-5-25-125-500 at 50k ohms/volt; 0.25-2.5-10-50-250-1000 at 25k ohms/volt. AC volts: 1.5-5-25-125-500 at 10k ohms/volt, 3-10-50-250-1000 at 5k ohms/volt. DC current: 50 μA-5 mA-50 mA-500 mA-10 A; 25 μA-2.5 mA-25 mA-250 mA-5 A. Resistance: 0-16k 160k ohms; 1.6-16 meg. Decibels: –20 to +62 in 10 ranges. 50" test leads, plugs, batteries. Handle doubles as stand. 27.95

20k-Ohm Multitester. Low-priced VOM with "expensive model" features. Reads DC volts: 0-5-25-125-500-1000 at 20k ohms/volt. AC volts: 0-10-50-250-1000 at 10k ohms/volt. DC current: 0-50 μA, 0-250 mA. Ohms: 0-6k-60k. Decibels: –20 to +62. Mirrored scale, single-knob selector. With leads, battery. 11.95

30k-Ohm Multitester. 3½" meter is easy to read and has single-knob selection. DC volts: 0-0.6-3-15-60-300-600-1200-3000 at 30k ohms/volt. AC volts: 0-6-30-120-600-1200 at 15k ohms/volt. Resistance: X1, X100, X1000, X10k ohms. DC current: 0-.03-6-60-600 mA. Decibels: –20 to +63 in 5 ranges. Batteries and leads. 21.95

Variable DC Power Supply. Output voltages from 0-24 volts at one amp. Dual-function panel meter, volts and current. Input: 120 v. AC at 60 Hz. Output current: 1 amp constant over entire range with 1.5-amp surge. Equipped with circuit breaker. U. L. listed. 29.95

Dynamic Transistor Checker. Shows electrode open and short circuits, current gain . . . to test low, medium, high-power PNP and NPN types. Permits matching of similar transistors in operating circuits. GO/NO GO test from 5-50 mA on power types. Front panel quick-check socket; clip leads for "in-circuit" test. 12.95

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SEE HOW IT WORKS
Digital Clock On A Chip

Twelve- or 24-hour displays, alarm, snooze-alarm and clock-radio formats are offered in three MOS LSI circuits.

by LARRY SULLIVAN*

A NEW FAMILY OF THREE MOS IC'S FOR use in electronic digital clocks makes possible several different types of "single chip" clocks. These devices have been introduced by Mostek Corporation of Carrollton, Texas.

All members of this "clock family" are six-digit clocks that display time in hours, minutes, and seconds. If only an hours and minutes clock is desired the same IC may be used with only the two hours and two minutes digits connected to the display. Outputs from these clocks may be connected directly to fluorescent-anode display tubes. The high-voltage output transistors allow fluorescent-anode display tubes to be driven directly.

The MK 5017 P clock circuits are available now in an alarm clock version, the MK 5017 P AA; a clock radio clock, the MK 5017 P AN; and a unique combination clock/calendar the MK 5017 P BB. Time may be displayed in either 12-hour or 24-hour formats.

The standard United States 60-Hz power line frequency may be used as a reference. If the clock is intended for overseas operation where 50 Hz is the standard power line frequency, the 50-Hz input frequency reference may be selected. The MK 5017 P clock senses the power supply voltage and, if loss of power is detected, displays all "eights". A backup battery may be used as a power supply during temporary power loss. An adjustable 50-Hz or 60-Hz oscillator is included on the chip to furnish the frequency reference during temporary loss of power.

The clock circuits require only a single power-supply voltage, simplifying power supply design.

Time setting is easy, a matter of depressing and holding push-buttons which allow the internal counters to increment at a 2-Hz rate. Each of the minutes digits and the hours digits may be set individually with no "carrys" generated to the more significant digits. Thus, there is no "overrun" when setting the counter to a time such as 2:59. In a counter in which "carrys" are allowed between digits it is very easy to increment the minutes "9" by one extra count and change all three digits so that the time reads 3:00. This makes it necessary to reset the hours, tens of minutes, and minutes all over again.

How it works

Figure 1 is a functional block diagram of the MK 5017 P digital clock circuit. A 1-Hz reference frequency is generated for the time counter by the shaper-divider network from either a 50-Hz or a 60-Hz input. The 50/60-Hz input frequency may be derived from the ac line or can be provided by an external crystal-controlled oscillator and frequency divider for portable or automobile applications. When the ac

*Mostek Corp., 1215 West Crosby Road, Carrollton, Tex.

power line is used as a frequency reference, the user is faced with the problem of temporary power loss. An on-chip temporary R-C oscillator may be used to provide the frequency reference through temporary power loss periods if a battery is used to provide chip power through the power transient.

Time is measured by incrementing the time counter at a 1-Hz rate. The contents of the time counter are decoded from BCD to seven-segment form and multiplexed out as serial digits. An external resistor and capacitor may be used to control the frequency of the scan-rate oscillator and thus control the rate at which the display digits are scanned. This allows various display types with different scanning characteristics to be used. Six-digit output strobes identify the digit being multiplexed out of the circuit at a particular time. The digits are scanned sequentially from least significant to most significant. That is, the seconds digit is followed by the tens of seconds digits which is followed by the minutes digit.

An alarm counter may be set externally in the same manner as the time counter. While in the alarm set mode, the contents of the alarm counter are displayed. In the run mode when the alarm comparator detects coincidence between the time counter and the alarm counter the alarm control circuit generates an alarm tone. (The new Heathkit GC-1005 digital clock kit is built around a version of the Mostek IC. The description of the alarm clock that follows is the Heath clock.—*Editor*)

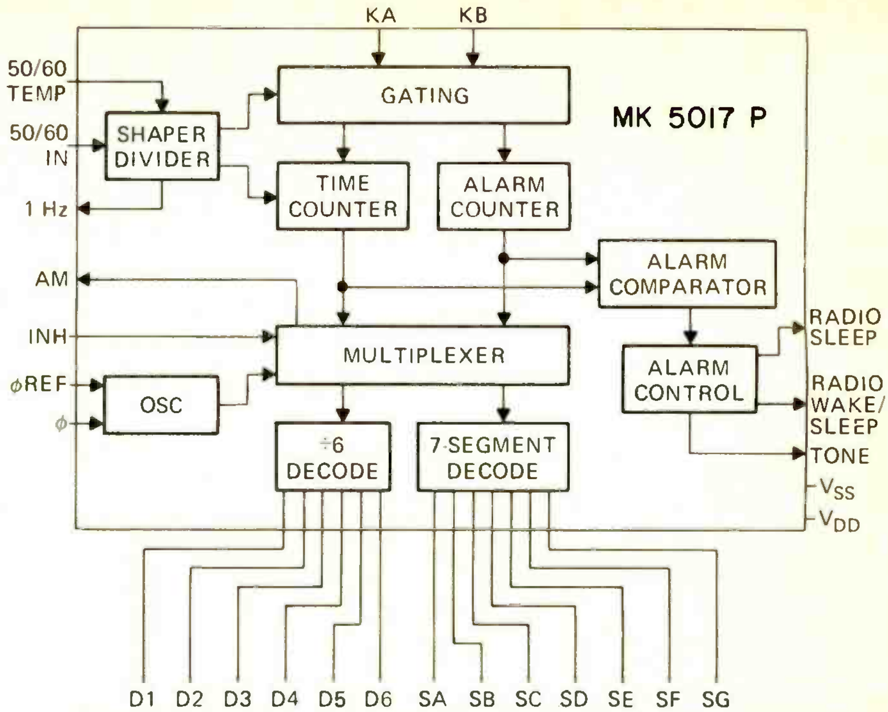


FIG. 1—BLOCK DIAGRAM of the IC for a digital electronic clock. The frequency standard can be a 50- or 60-Hz line, external crystal oscillator or the internal R-C source during power outages.

MK 5017 P AA

The alarm clock version of this chip, the MK 5017 P AA, features a 24-hour alarm. An alarm tone at a frequency of approximately 700 Hz is generated on the chip by an internal oscillator. This alarm tone, suitably buffered, may be coupled into an inexpensive miniature speaker.

An AM/PM indicator is also provided to allow setting the alarm on a 24-hour basis. The AM/PM output, designated AM in Fig. 2, is pulled high to V_{SS} by the transistor to indicate AM. The AM output appears as an open circuit for PM.

If seconds are not being displayed the user may wish to use the optional 1-Hz output, available upon request, to blink the AM/PM indicator. This provides a visual indication that the clock is running. Figure 2 shows a typical circuit for a digital alarm clock using the MK 5017 P AA or MK 5017 P AN and seven-segment fluorescent-anode display tubes. The power supply consisting of transformer T1, rectifier diode D4, and filter capacitor C3 generates approximately (–35Vdc). Reference diode D3 reduces the power supply output voltage to (–15V) for the IC's V_{DD} supply voltage. The optional backup batteries shown may be used to prevent loss of time during temporary power transients. Diode D2 remains OFF isolating the batteries from the power supply in normal operation. If ac power is removed, D2 is biased on by the batteries and provides the integrated circuit with V_{DD} supply voltage to prevent loss of time. While the ac power is OFF the voltage on the 50/60 IN pin remains at a steady logical one. The chip detects this condition and continues to measure time using its own 50/60 Hz internal oscillators as a time base.

The frequency of this oscillator may be set at either 50 Hz or 60 Hz by adjusting R1.

When ac power is present, the 60-Hz sinusoidal waveform from transformer T1 is half-wave rectified by diode D1 and reduced from a (–35) volt peak to a voltage one or two volts more negative than V_{DD} by the resistive divider composed of R2 and R3. Capacitor C2 serves as a noise-spike suppressor and prevents false counts from noise spikes induced on the ac line by equipment using SCR switching or universal motors.

Fluorescent-anode display tubes are shown in this example. As shown, fluorescent-anode tubes may be driven directly by the clock circuit. The display tube anodes are connected directly to the clock segment outputs. The cathodes are driven by the individual digit outputs.

These display tubes have a common cathode and heaters. The 6.3 Vac winding of transformer T1 is reduced to approximately 4.2 Vac by resistor R4 since the individual filament voltage is about 0.7 volt. This series filament "string" is biased at about (–25Vac) by transistor Q1.

Display brightness can be varied by adjusting variable resistor R5 which sets the base voltage of transistor Q1. Q1 acts as an emitter follower keeping a constant cathode bias on the display tubes.

There are two function input pins, KA and KB. Both KA and KB pins are sampled during each digit strobe. The intersection of the six-digit output strobe lines and the KA and KB lines forms a matrix that is 6 × 2. That is, there are 12 potential locations where a spst switch may be located. These switches may be used to define 12 separate functions or modes of operation for the circuit. For example, at *D6* time the KA line is sampled to determine if the time set switch is closed. If the time set switch is closed, the KA line will be pulled high to V_{SS} by the *D6* output driver transistor. Isolation diodes D5 through D16 prevent the digit outputs from being tied together in case of multiple switch closures. For example, if the time set switch at the intersection of *D6* and KA and the hours switch at the intersection of *D5* and KA were both closed, the *D5* and *D6* digit strobe outputs would be tied together if diodes D6 and D7 were omitted. At *D5* time D6 is reverse-biased so the *D6* line is not pulled high by the *D5* output. Similarly, at

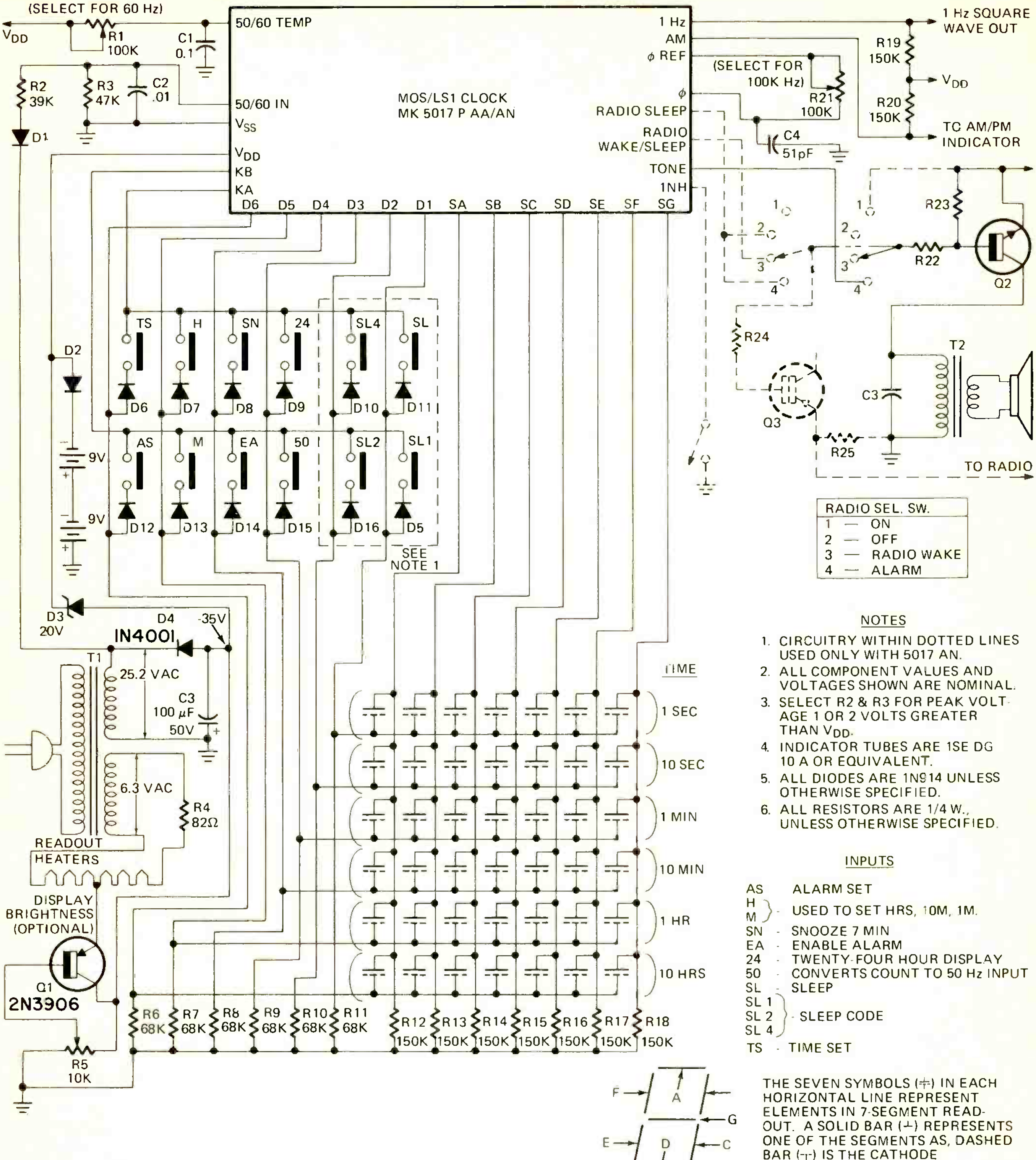


FIG. 2—COMPLETE DIAGRAM OF A DIGITAL ELECTRONIC CLOCK. Fluorescent-anode display tubes can be driven directly by the IC.

D6 time D7 is reverse-biased so the *D5* line is not pulled high by the *D6* output transistor. Since the KA and KB inputs are time multiplexed, it is possible to connect 12 switches to only two input pins keeping the circuit in a 24-pin package.

As shown in the INPUTS table on Fig. 2, the switch located at the intersection of the *D6* and KA line defines the TIME SET mode. The switch is closed in the TIME SET mode. In this mode of operation the contents of the time counter are displayed. Counting is stopped in the TIME SET mode and the seconds and "tens-of-seconds" digits are both held at zero. When the time set switch is released, the clock begins running.

The switch located at the intersection of *D6* and KB is used to define the ALARM SET mode. In the ALARM SET mode of operation the contents of the alarm counter are displayed. The time counter continues running while the alarm is being set.

Closing the switch located at the intersection of the *D5* and KA lines causes the hours digit to advance at the rate of two digits per second, (a 2-Hz rate). Closing the switch located at the *D5* and KB intersection causes the minutes digit to advance at a 2-Hz rate. If both the hours and the minutes switches are closed simultaneously the "tens-of-minutes" digit advances twice each second.

Enabling the alarm is accomplished by closing the switch located at the intersection of the *D4* and KB lines. When coincidence is detected between the time counter and the alarm counter, the alarm tone is generated for one hour if the enable alarm switch is closed.

When the alarm "goes off" the snooze switch located at the intersection of the *D4* and KA lines may be momentarily depressed to inhibit the alarm. After seven minutes the alarm will go off again. This cycle may be repeated indefinitely.

Twelve or twenty-four hour time displays may be selected at any time without disturbing the time counter. Closing the switch located at the intersection of the *D3* and KA line results in a twenty-four hour display.

For operation from a 50-Hz reference frequency, the switch located at the intersection of the *D3* and KB lines may be closed. When this switch is open, the clock assumes a 60-Hz reference frequency.

MK 5017 P AN

Clock radio clocks may be built using the MK 5017 P AN. This circuit includes all of the features normally found on a clock radio clock. Both the alarm clock - MK 5017 P AA, and the clock-radio clock - MK 5917 P AN are shown in Fig. 2. The circuitry shown by dashed lines applies to the clock-radio clock. The remaining circuitry is common to both.

In addition to all of the features found on the alarm clock circuit the clock-radio circuit also has a radio sleep output that may be used to keep a radio or other appliance on for selected periods of time up to a maximum of two hours.

Radio sleep operation is selected by closing switch SL at the intersection of the *D1* and KA lines in the input matrix. The switches located at the intersection of the *D1* and KB lines (SL1) at the intersection of the *D2* and KB lines (SL2), and at the intersection of the *D2* and KA lines (SL2), are used to select the desired sleep time. There are eight possible combinations that may be achieved with these three switches, so a total of eight different sleep times may be selected. The switches are arranged in a binary code with the switch designated as SL1 being the least significant bit. The switch designated as SL4 is the most significant bit. The times that may be selected, along with the switch closures required to program these times, are presented in table.

SLEEP SWITCH TABLE

Radio Sleep Time	*Switch Combinations* SL4	SL2	SL1
10 Min	open	open	open
20 Min	open	open	closed
30 Min	open	closed	open
40 Min	open	closed	closed
50 Min	closed	open	open
60 Min	closed	open	closed
90 Min	closed	closed	open
120 Min	closed	closed	closed

After selecting the desired radio sleep time from the table, close the sleep switch to start the timing interval. It is not necessary to install three switches and remember the binary code for sleep times. Instead, an eight-position three-pole rotary switch may be used to easily and rapidly select sleep times.

In addition to the radio sleep feature the MK 5017 AA also has a radio WAKE/SLEEP output. The radio WAKE/SLEEP output is operative during RADIO WAKE and RADIO SLEEP operation. For RADIO WAKE operation the radio WAKE/SLEEP output is on when the alarm counter and the time counter become equal. The radio WAKE/SLEEP output remains active for one hour during *radio wake* operation.

A display inhibit pin is included on the clock-radio clock circuit. All of the segment- and digit-output transistors are disabled (turned off) when the inhibit pin is connected to V_{SS}. This feature makes it possible to build a multifunction clock using only one display, without any external multiplexing circuits. **R-E**

COLOR TV RECORD GROWTH

As of October 1, 1972, the total number of households in the U.S. that have color TV increased to 37,300,000, according to the latest quarterly estimate by the National Broadcasting Company. This represents an increase of 3.8 million in color-TV households since January 1, 1972.

service notes

G-E C2/L2 COLOR CHASSIS TINT CONTROL INEFFECTIVE

Color rendition may or may not be close to normal. Check or replace the 3.58-MHz crystal. A universal replacement may not work. Original parts numbers are EP41X1 and EU41X3 for 3-lead and 2-lead crystals, respectively.—*G-E Service Hints*

TV REPAIR SAFETY CHECKS

Here are several safety precautions that should be observed when servicing television receivers:

1. Always use the original manufacturers' replacement component or a replacement that is of equal quality.
2. When service is required, observe the original lead-dress. Use extra care to assure correct lead dress in the area of high-voltage circuitry.
3. Where a short circuit has occurred, replace those components that show evidence of overheating.
4. When replacing the back cover of the set, check the position of the ac interlock to confirm a proper connection. **CAUTION.** Before returning any equipment to a customer, make sure that no shock hazard exists by performing the following checks:

a) Plug the ac line cord directly into a 120-volt outlet (do not use an isolation transformer for this check).

b) Using two clip leads of sufficient length, place a 1500-ohm, 10-watt resistor in series with an exposed metal cabinet part and a good earth ground such as a water pipe.

c) Use an ac voltmeter with a sensitivity of 1000-ohms-per-volt or more to measure the voltage across the resistor. **A reading of 3.0 volts or more indicates a shock hazard that must be corrected.**

d) Move the resistor connection to each exposed metal part (antennas, handle bracket, metal cabinet, screw heads, control shafts, metallized plastic overlays, etc.) and measure the potential across the resistor at each new connection.

e) Reverse the plug in the ac outlet and repeat the measurements in steps c and d.

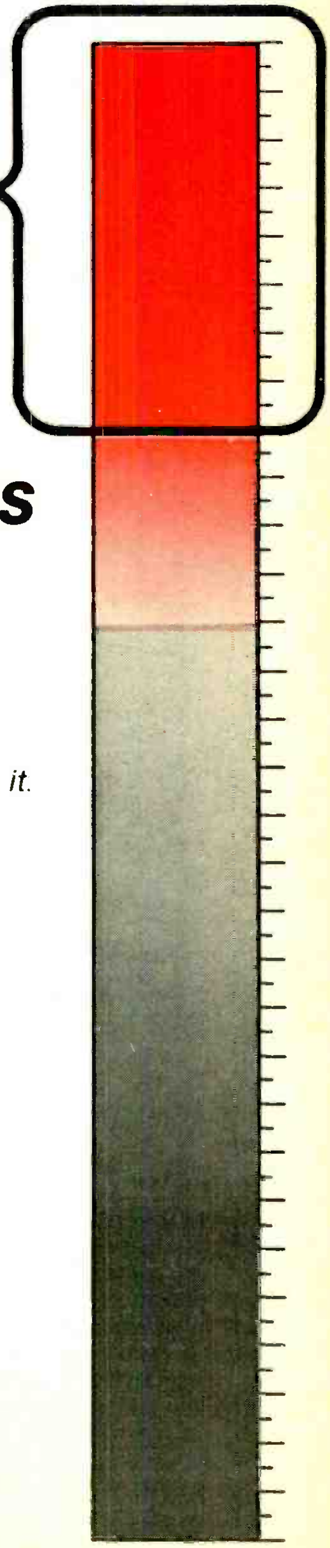
Correct any shock hazards before returning the instrument to the customer.—*RCA Television Service Bulletin*

NEXT MONTH
March is a special stereo issue. You won't want to miss any of the exciting articles. It goes on sale February 20th.

INFRARED and its many applications

Before infrared can be used for many applications, we must either detect or measure it. Here is how these are accomplished

by FORREST MIMS



ONE OF THE MOST EXCITING PARTS OF THE ELECTROMAGNETIC spectrum is the portion between visible light and radio waves, the *invisible infrared.* Sir William Hershell discovered the existence of invisible "light" just beyond the visible spectrum in 1800 when he noticed that a thermometer placed just adjacent to the red part of a spectrum produced by a prism indicated a temperature rise. Since the newly discovered radiation was just beyond the red, Hershell called it infra-(meaning *below*) red.

Since 1800, hundreds of applications have been found for infrared. But technological achievements in lasers and infrared detectors have greatly increased the variety of applications in recent years. For example, sensitive infrared detectors are being used in non-destructive testing of many forms of electronic components and circuits—including complex integrated circuits. The military is using infrared in a great variety of applications ranging from invisible beam communication systems to thermal mapping cameras that photograph enemy territory under cover of total darkness. A military application that has made news in recent months is the so-called "smart bomb." Guided to its target by the invisible infrared beam from a powerful laser, these new guided bombs give Air Force pilots uncanny accuracy in combat situations.

There are many other applications for infrared which are entirely new, and we'll discuss some of them shortly. But first let's see how infrared is generated and how it can be detected.

Infrared sources

Amazing as it seems, all matter with a temperature greater than absolute zero (a chilly −273° C) emits some degree of infrared radiation. This radiation may have a wavelength ranging from the near IR at about 0.8 microns to the far IR in excess of 30 microns. The wavelength is related to temperature, and cold objects emit at much longer wavelengths than warm objects. For example, human skin at its temperature of about 98.6° F emits IR radiation at a range of wavelengths centered around 9.3 microns. Objects with a higher temperature emit at shorter wavelengths which may even include the visible part of the electromagnetic spectrum—hence the expressions *red hot* and *white hot.*

Half the radiation from the sun is in the IR and more than 80% of the light from an incandescent lamp falls outside the visible spectrum and in the infrared. Many lasers, including most of the semiconductor versions, emit very narrow wavelength lines of infrared. For example, the gallium arsenide laser system described in the June 1972 issue of **Radio-Electronics** emits at a peak wavelength of about 0.91 microns, while certain lead-salt semiconductor lasers emit at wavelengths extending out to 30 microns.

Other sources of IR include flames, arcs, and what is called a *blackbody.* The blackbody emitter is used to calibrate IR detectors and operates on the principle that a perfect absorber of IR is also a perfect emitter. A typical blackbody may have the appearance of a cone (Fig. 1). IR

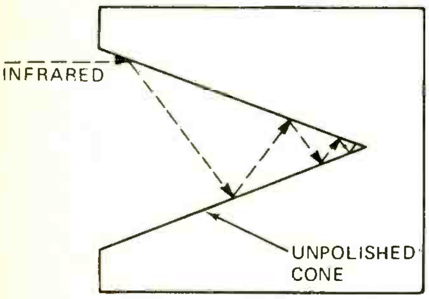
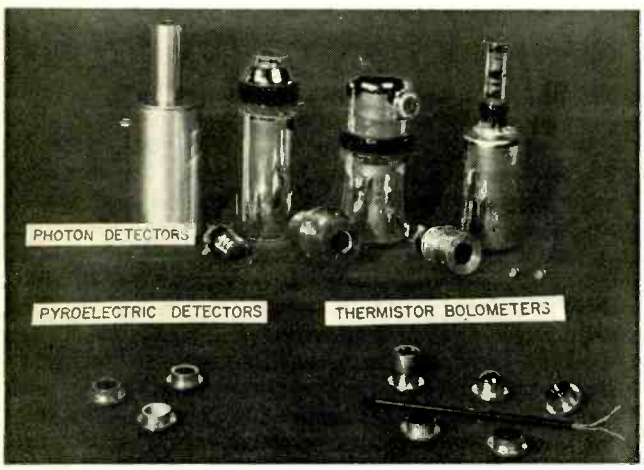


FIG. 1—BLACKBODY as an IR detector may be a block with cone-shaped aperture a near-perfect IR absorber.

entering the cone is reflected from wall to wall with a large amount being absorbed by the wall of the cone. By the time the radiation reaches the apex of the cone, most of it has been absorbed.

The blackbody emitter can also be used as an IR detector. Such a device is called a calorimeter and it is frequently used to measure laser energy. In operation, the outside surface of the cone is connected to an array of tiny thermocouples that measure the temperature increase of the cone as IR is projected into it. By comparing the temperature rise with a calibration curve, energy can be measured accurately.



TYPICAL IR DETECTOR TYPES. Most of the photon detectors shown are in Dewar vacuum bottles for low-temperature operation.

Most practical calorimeters use two cones. Each one is connected to a separate thermocouple array. One cone receives the IR being measured, and the other serves as a reference to counteract the effects of ambient temperature changes.

Detectors of infrared

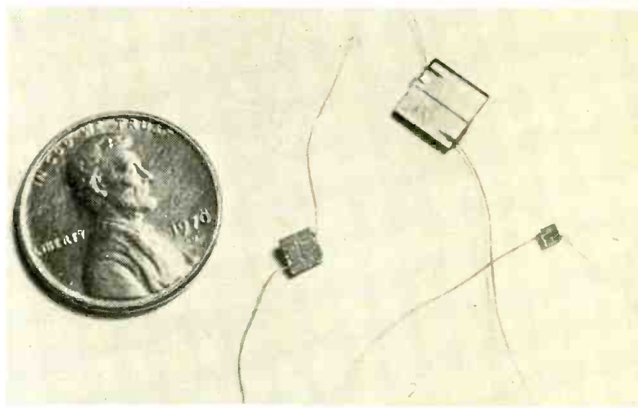
The cone calorimeter is actually one of two classes of IR detectors. The two classes are *thermal* and *quantum* detectors, and the calorimeter falls in the thermal class. Thermal detectors depend on the temperature increase that accompanies the IR projected onto a detector surface. Quantum detectors exploit electron-hole movement within a semiconductor.

The simplest thermal detector is the one used by Hershell in 1800, the common thermometer. IR striking the thermometer heats the liquid within. The liquid, typically colored alcohol or mercury, expands and rises through a glass capillary marked with a calibrated scale. More recently, a "solid state" thermometer using a coiled bimetal strip is commonly used. In operation, heat causes one side of the bimetal strip to expand more than the other, making the coil wind or unwind. A pointer connected to the center of the coil indicates the temperature.

Other thermal detectors also use mechanical techniques. The Golay Cell, for example, consists of a xenon-filled chamber that expands when IR is directed into it. The expansion of the cell, hence the amount of IR, is indicated by a tiny mirror connected to a bellows. A beam of light directed against the mirror and reflected onto a calibrated scale indicates the quantity of IR. This kind of detector is called a *thermopneumatic* cell.

Electronics has greatly improved the simplicity and reliability of thermal detectors. The thermocouple has already been described. Consisting of a junction of two dissimilar wires, thermocouples are among the simplest of IR detectors.

A more sensitive detector is the *bolometer,* a soot blackened piece of platinum foil. A wire attached to either



LEAD SULFIDE DETECTORS have PbS wafers between thin quartz layers for protection and transmission of IR it is designed to sense.

end of the foil is connected to a meter that measures the resistance change in the foil as it is heated by infrared. Because of the soot, the foil absorbs nearly all the infrared striking it, thus making measurements easier to perform when very small quantities of energy are involved.

A more sophisticated electronic thermal detector is the *thermistor.* Consisting of a tiny semiconductor chip, the thermistor is essentially a heat-controlled resistor. Its small size gives it fairly rapid response time. Thermistors are inexpensive and are frequently used for temperature stabilization of electronic circuits.

Recently, a new type of electronic thermal detector has become popular in IR sensing applications. Called the *pyroelectric detector,* its operation depends upon the absorption of heat by a thin wafer of a ferroelectric crystal such as triglycine sulfate (TGS). The crystal is fabricated in such a manner that it resembles a capacitor. Heat alters the value of the capacitor, and the resulting change can be monitored by suitable circuitry. Since the detector has a high output impedance, sometimes they are made with a self-contained FET stage to reduce impedance to a more acceptable level.

The thermal detectors we have been discussing are too slow or not sensitive enough for many applications. The development of improved quantum detectors has helped alleviate this problem. Thermal detectors tend to have slow rise and fall times since the detector itself must become heated by the IR. Since the heating requires a finite time, the detector has a relatively slow response time. Quantum detectors do not depend on heating of the detector for proper operation. They use the movement of holes and electrons in a semiconductor material exposed to infrared.

There are three major classes of quantum detectors: photoconductive, photovoltaic, and photoelectromagnetic (PEM). The first two operate just like their visible light counterparts, photoresistors and photodiodes.

One of the most common infrared sensitive photoresistors is the lead sulfide cell. Closely related to the cadmium

QUANTUM INFRARED DETECTOR. The window visible in the bottom of the Dewar assembly is transparent to infrared wavelengths.

sulfide cell used to detect visible light, the lead sulfide (PbS) device employs bulk material without a pn junction. A typical cell consists of a quartz substrate containing two evaporated electrodes separated by a thin space. A strip of PbS is deposited across the space separating the electrodes in the form of a semiconducting bridge, and tiny wires are connected to the electrodes. The cell is completed by bonding a thin quartz cover onto the substrate to form a protective window. Quartz is frequently used because of its infrared transmission properties.

There is a great variety of other photoconductive infrared detectors. While PbS is used for wavelengths peaking near 2.5-3.0 microns, indium antimonide (InSb) is used for the 6-7 micron range. Doped germanium detectors are used for much higher wavelengths. For example, mercury-doped germanium (Ge:Hg) is used for 10 microns and zinc-doped germanium (Ge:Zn) for 20 to 38 microns. Ge:Hg is frequently used in military systems designed to detect human beings since its peak sensitivity nearly matches the peak IR emission of the target.

Photovoltaic IR detectors include silicon (Si), germanium (Ge), indium antimonide (InSb), and mercury cadmium telluride (HgCdTe). While photoconductive cells alter their internal resistance when illuminated by infrared, photovoltaic detectors generate a voltage. Silicon and germanium detectors have a peak response in the near IR at around 0.85 to 1.4 microns respectively. They are particularly useful for detecting near IR beams from lasers and light-emitting diodes. They have very fast response times and good sensitivity. The other detectors listed above are sensitive to longer wavelength IR and are used in a variety of detection applications.

PEM detectors operate on the principle that a magnetic field will separate charge carriers in certain semiconductors. Indium antimonide, the material used for both photoconductive and photovoltaic detectors, and mercury telluride (5% ZnTe, 5% CdTe) are both used in PEM detectors.

Infrared optics

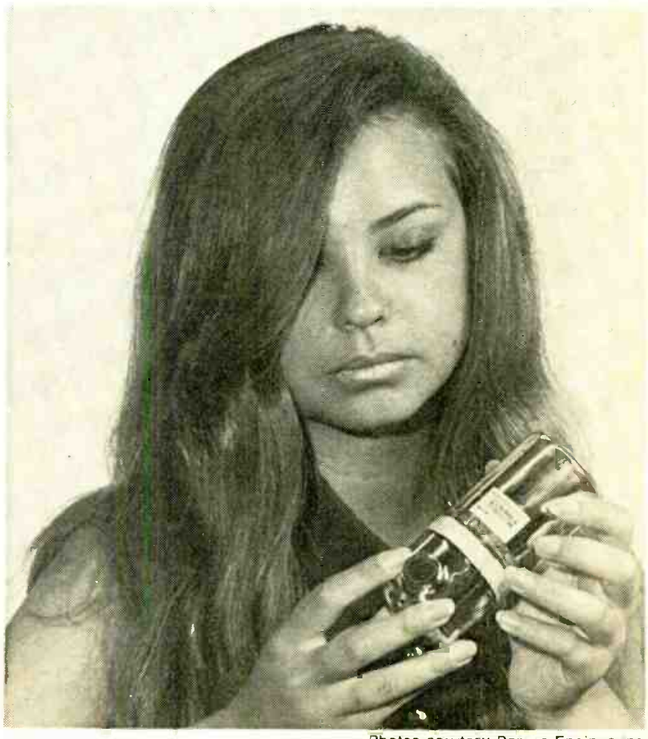
The question of infrared transmitting materials is an important one. Detectors must be protected by windows, and the windows must be rigid and transparent to the IR being detected. Furthermore, since many IR detectors are operated at very low temperatures for improved performance, the window material must be able to withstand thermal stress.

In visible light applications there are a great variety of materials that are transparent. But materials that are transparent to the human eye and visible light may be completely opaque at IR wavelengths. Conversely, objects that are opaque at visible wavelengths may be transparent to infrared. For example, standard window glass transmits little or no IR beyond about 4 microns, while germanium, which is completely opaque at visible wavelengths, transmits about 50% of the IR between 2 and 15 microns. Other materials that transmit IR include such exotic substances as potassium bromide, cesium iodide, cadmium sulfide, and sodium fluoride. Even common table salt, sodium chloride, is transparent to IR out to 20 microns.

Typical applications for infrared optics include missile seeker heads, Dewar windows, and laser systems. Optics for lasers that emit in the IR beyond several microns pose a difficult problem for research scientists. For the carbon dioxide gas laser, for example, emission is at 10.6 microns. Sodium chloride is one of the few materials that makes a suitable window at this wavelength but it has a tendency to absorb moisture and become clouded. Therefore, salt windows on some IR lasers are removed when not in use and stored in humidity free containers.

Putting infrared to Work

Since the infrared emitted by an object can be directly



Photos courtesy Barnes Engineering

THE PHOTON DETECTOR, shown in closeup photo at upper left, is in a Dewar vacuum jar for operation at temperature of liquid nitrogen.

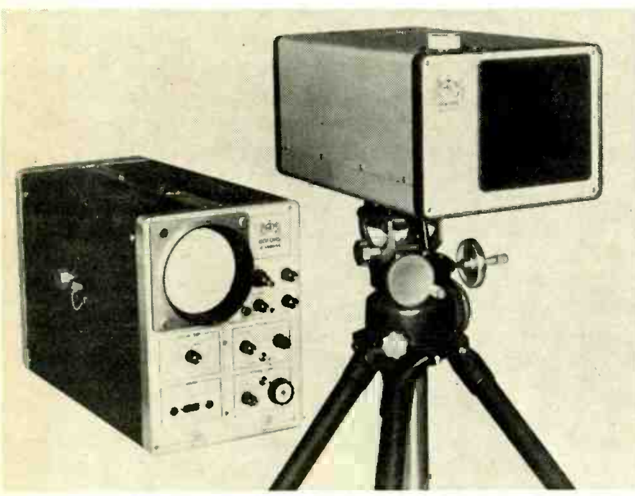
related to the object's temperature, devices that can sense infrared have many practical applications. For example, simple IR detectors are used to monitor equipment that becomes overheated and triggers an alarm when the temperature exceeds a certain level. The same technique is used in IR fire alarms.

In more sophisticated systems, IR detectors are used to detect animals and people. In one setup two slits in front of a detector cause the device to give an output signal only when the source of infrared has moved. In this way the detector ignores temperature changes and only gives an output when a valid signal is received.

Systems that use IR to form visual images have many valuable applications. The simplest technique for rendering a visible IR image is to use infrared-sensitive photographic film. The Eastman Kodak Company makes several kinds of black-and-white and color IR sensitive film. The films are sensitive to visible light and infrared out to about 0.9 microns and produce striking effects when used to photograph scenery and landscapes. The film is also useful for photographing the beam from near-IR lasers, detecting forgeries, inspecting art objects, and conducting aerial geological and agricultural surveys. Medical applications include locating certain skin diseases, photography of the retina, and studying human behavior without the knowledge of the subject.

For applications beyond 0.9 microns, image-converter tubes are frequently used. These tubes contain an IR sensitive photocathode coated on thin glass window at the front of the tube and given a high potential with respect to one or more electrodes at the rear of the tube. In operation, visible or near IR striking the photocathode triggers the emission of electrons which travel toward a phosphor coated viewing screen. The phosphor screen then glows in a pattern identical to that of the IR projected upon the photocathode.

Image converters are sometimes used with IR sources to permit vision in total darkness. Semiconductor lasers, light emitting diodes, or filtered incandescent or xenon lamps provide the IR. The military and police find night viewing systems particularly important, but biologists and astronomers also use image-conversion devices.



INFRARED CAMERA, manufactured in Sweden by A. B. Bofors, has numerous applications in medicine, science and industry.

Image-converter tubes are impractical at wavelengths beyond about 1.1 microns. For longer wavelengths, IR quantum detectors are employed in a mechanical scanning system. A system of mirrors scans the desired field of view and the output of the detector is fed into a CRT. The result is an image of the IR emitted by an object even though the object may be in total darkness. By using detectors sensitive to 10 microns, we get particularly startling results. For example, the system can "see" a human body and convert it into an image on a CRT screen even though the subject is in darkness.

Infrared scanning cameras are finding a host of applications in research and practical engineering. The cameras are expensive, but the applications frequently justify the price. Military uses are obvious, and each of the services is investigating thermal cameras for camouflage and personnel detection. The Army's Night Vision Laboratory at Fort Belvoir, Virginia, is particularly interested and active in this area of work.

Industrial applications include detection of hot equipment from a distance, non-destructive testing, analysis of welds, and studies of a variety of manufacturing and fabrication techniques. Medical applications include the detection of some kinds of cancer, circulation impairments, and vascular diseases. In earth science studies, IR scanning cameras are used to detect pollution in bodies of water, study the effect of irrigation systems, find diseased crops, and even prospect for mineral formations.

A modification of the scanning camera transfers the image to photographic film instead of a CRT. These systems preserve a record in hard copy of the scene detected and are commonly used in aircraft. Both the military and the Forest Service employ many of these systems, the former for reconnaissance under cover of darkness and the latter for finding forest fires.

What's ahead

The past few years have produced a genuine revolution in infrared generation and detection techniques, and if present developments are any indication, we can expect to see even more startling developments in the next few years. For example, the newly developed charge-coupled self-scanned silicon arrays, another Bell Telephone Laboratory invention (see New & Timely, **Radio-Electronics,** November, 1972, page 6; and June 1971 page 6.) will permit the fabrication of solid state television systems. The silicon used in present arrays responds to the near infrared, and if InSb and similar materials can be adapted to the technology, far infrared self scanned arrays may only be several years away. Other developments equally as impressive can also be expected, making infrared a field to be closely watched. **R-E**

OLYMPIC TD20 TAPE DECK

A problem of drive belts slipping off the motor pulley may be due to a coating of oil on the pulley and the inner surface of the drive belt. This is caused by oil spraying from the upper motor bearing as operating temperature rises. Therefore, a tape deck may not show signs of this condition until after the first hour of operation.

Handle complaints of displaced belts by: 1. Completely remove the belt from the mechanism.

2. Operate the motor continuously (without belt) for four hours.

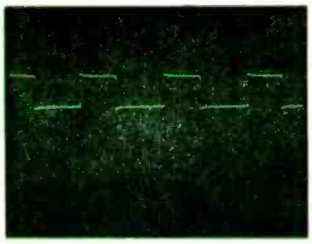
3. Wipe motor pulley and capstan pulley clean of oil.

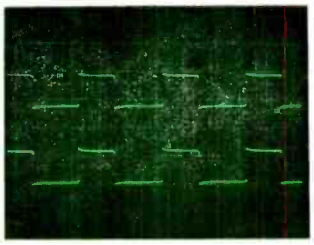
4. Invert belt and reinstall so the dry side becomes the inner running surface.

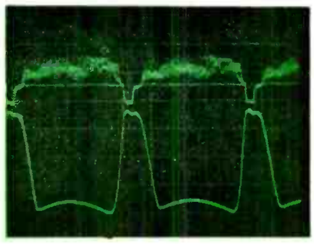
5. Replace the chassis and secure. No further recurrence of this problem should be anticipated.—*Olympic Service Bulletin*

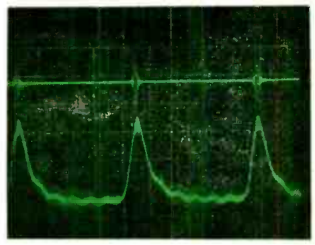
SQUEAL—INSUFFICIENT WIDTH

Squeal from the high-voltage cage along with possible reduced width may be caused by chips from the high-voltage transformer core. These chips will vibrate in their lodging place—usually in the air-gap between the halves. If the core is cracked (usually at the right-angle corners) chips will lodge in the crack. Removing the chips will reduce the squeal, but if the core is cracked, it should be replaced. If the portions of the cracked core are separated, insufficient width may occur.—*General Electric Service Hints*









DUAL-TRACE TRIGGERED-SWEEP SCOPES

Once a lab instrument, the triggered-sweep dual-trace scope is now a must on many service benches.

by **ROBERT L. GOODMAN**

LIKE THE PROVERBIAL MODEL T FORD the old single-trace, recurrent-type (free-running) service scope may soon become obsolete on the service bench.

With the many sophisticated solid-state electronic devices now on the market that require circuit diagnosis, the dual-trace triggered scope is well worth its cost. You can now choose from several models of these glowing one-eyed dual-sweepers. Some technicians tell us they cannot afford to be without one. Many models are now all solid-state, easy to operate and can cut your troubleshooting time considerably. The dual-trace scope is just like having two scopes in one unit, but at a very small additional cost.

Dual-trace scope features

The triggered-sweep oscilloscope, be it single or dual-trace, should have these features. The horizontal sweep speed should go to 500 kHz or higher (also referred to as the time-base generator frequency range). This means you have fewer waveforms to look at on the crt when checking high-frequency signals like the 3.58-MHz color CW oscillator.

The frequency response of the vertical amplifiers should be flat to at least 10 MHz. This is needed to see the color burst at 3.58 MHz and the harmonic content of the sharp rise wavefronts, without any overshoot. The faster the scope's rise-time the better. And of course, most all triggered scopes offer the choice ac or dc vertical amplifier modes at the flip of a switch. Both vertical amplifiers must be balanced and have identical frequency response and amplification.

The primary advantage of a triggered scope compared to a service scope is that its sweep can be started precisely at the same point on each trace. This lets you make very accurate comparisons between two signals or two pulses of the same frequency. This is needed to check for correct timing of the color burst, color killer and gated agc circuit operation.

The scope's sweep is actually turned on or "triggered" by the signal pulses that are fed into the vertical amplifier. These pulses are "picked-off" at the vertical amplifier of the scope and fed into the trigger sweep circuits. This is the reason for the rock-solid scope traces. For TV troubleshooting the scope should have the special horizontal and vertical (TVV and TVH) sweep or time-base ranges. To have solid lock on the vertical and horizontal TV sync pulses the scope should have a special TV-type sync separator or filter circuit. Without this filter the scope may not lock-on because of the many different pulses found in the TV video signal.

Triggered and automatic sweep modes

To make sure that every one understands what a triggered scope actually is let's take a brief look at its operation. The sweep circuits of a triggered scope are inoperative and the crt blanked (no trace visible) until the proper trigger "on" pulse is applied to the sweep circuit. When the correct pulse is received, a one-shot type of circuit goes into action, unblanks the crt, produces one sweep across the screen and resets to the "off" state. Sweep does not recur until another pulse of correct amplitude and polarity is applied to the sweep circuit. Most of these scopes also have a free-running sweep mode. A sample pulse is picked off the input signal that is fed into the vertical preamplifier stage to provide the sweep trigger pulse. This is why the triggered instrument produces a stable pattern and solid-as-a-rock lock and is easier to use than the old-time recurrent-sweep service scope.

The automatic triggered feature is no doubt the most useful mode. This mode of operation presets the trigger (sync) level so that adjustment of the sync level control is not needed. The automatic triggering provides a trace across the crt at all times, with or without an input signal present. The sweep runs at a slow irregular rate until a trigger pulse is sensed. When a signal is applied, the automatic trigger circuit goes into action and gives you a sharp, clean trace with triggered stability. All that has to be set is the input sensitivity and the correct sweep speed needed for signal display. Thus, fast waveform checks can be made without having to jazz around with all of the scope controls.

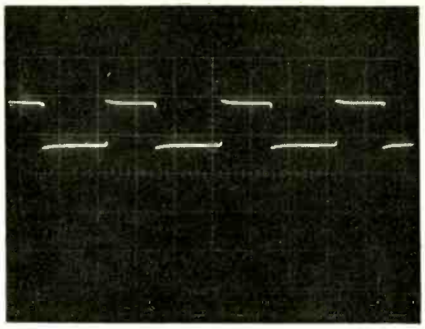


FIG. 1—IN A DUAL ALTERNATE DISPLAY only one trace may be visible.

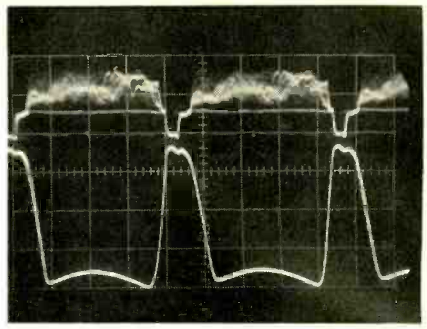


FIG. 3—KEYING PULSE and video signals must have this relationship for good agc action.

Alternate and chopped dual traces

Most dual-trace triggered scopes offer dual-alternate and dual-chopped sweep modes. The dual-trace alternate sweep is the most useful for TV trouble-shooting. The trace actually displays each scope channel alternately. The channel **A** trace is displayed on one sweep while the next sweep cycle displays the channel **B** input. Then the process starts over again with channel **A**. Both traces are controlled independently except for the triggering. It is controlled by whatever trigger source is selected. One signal is then displayed with reference to the other channel. When channel **A** is selected as the trigger source, the channel **B** signal is displayed in "real time" as compared to channel **A**. This results because the sweep, regardless of input signals being displayed, is controlled by the signal present at the channel **A** input. This is very useful when you wish to compare the phase between two signals. Not only are both signals seen, but with a dual-trace triggered-sweep scope, you can see them displayed on a "real time" basis for accurate comparison of timing or phase relationship. This, of course, is not possible with a single-trace triggered scope.

The chopped mode is primarily used for dual-trace display of low-frequency signals below 60 Hz. With such a slow sweep in the dual alternate mode, the trace blinks because the crt's phosphor persistence is not long enough to last until the next trace arrives. As an example, in Fig. 1, the scope is set for dual alternate sweep to look at two 20-Hz square-wave signals. Note that the bottom trace cannot be seen. However, with the scope set in the dual-sweep chopped mode both square wave signals are seen in Fig. 2. The dual-chopped mode provides a steady display by switching between channels **A** and **B** at a 100-kHz rate. This means channel **A** signal is displayed on the positive swing of the 100-kHz chopping square-wave, and the channel **B** signal is displayed on the negative swing. This reduces the amount of time between traces and helps to eliminate the flicker. The chopping frequency is high enough to provide an unbroken display of both signals even though they are displayed in segments. The chopped mode can be used to look at TV vertical sweep signals.

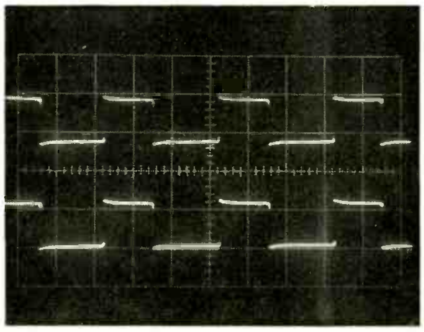


FIG. 2—CHOPPED MODE is best for dual display of signals below 60 Hz.

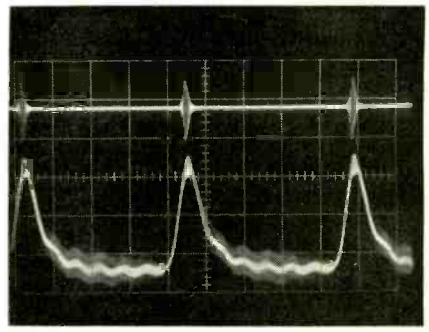


FIG. 4—COLOR BURST at burst amplifier plate compared to keying pulse on amplifier grid.

Color TV troubleshooting tips

The color TV receiver has some waveforms that must occur simultaneously. Some examples are the burst amplifiers, color killer and keyed or gated agc circuits. With a dual-trace scope two pulses can be monitored on the screen to see if they are arriving at the same time. This permits you to determine width and timing relation to each other and note how this would affect circuit operation.

Many concurrent waveforms are now found in modern electronic devices. One example of exact timing is in the keyed agc system. The agc keyer must have both the video signal at its grid and the flyback pulse at its plate, with correct timing, in order to develop agc voltage. The correct relationship and timing of these signals is shown in Fig. 3.

The color section of the TV receiver must have accurate pulse timing for proper operation. The color burst amplifier stage separates the transmitted burst signal from the composite video signal and must be keyed on precisely at the right time by the flyback pulse. The 3.58-MHz burst is present on the back porch of the horizontal blanking pedestal and has a 0.2-μs duration. Thus burst and keying pulse timing is very critical. If the color receiver has poor or no color, use the dual-trace scope to check the color burst gate circuit. The scope photo in Fig. 4 shows the correct timing of the keying pulse at the grid of the keyer tube and the 3.58-MHz burst on the plate.

For a receiver that displays incorrect color, connect the two scope probes (one for another scope channel) to the demodulator grids for a phase check of the 3.58-MHz CW demodulating signals. Compare both signals for proper phase angle. If the phase angle is not correct look for a fault in the phase-shift network.

The dual-trace scope is also handy for checking the delay line in the video amplifier section. Tune the set to a TV station and use the horizontal sync pulse as a reference. Connect amplifier **A** of the scope to the delay line input and amplifier **B** to the output terminal. Switch the scope to alternating sweep and the horizontal time base to 2.5-μs per division. Also use the expanded sweep, if the scope has this feature. Now, compare the leading edges of the two sync pedestals as shown in Fig. 5 and note, as in this case, the correct 0.7-μs time delay. This is a fast way to check the delay line action.

Stereo troubleshooting tips

Now let's use the dual-trace scope for some stereo channel-comparison testing techniques. The basic concept of this method is to compare the operative channel with the inoperative channel. With this system a very rapid procedure can be developed to pin point defective components for all types of stereo amplifier and multiplex FM systems.

The triggered dual-trace oscilloscope along with a square-wave audio generator are the instruments used to make these following checks. Of course, these techniques can be used for solid-state or tube-type stereo equipment.

To use this technique one of the amplifier channels must be operating correctly so you can compare waveforms with the defective one. Both waveforms may then be superimposed for an exact analysis and even minor distortions can easily be detected. When both channels are working correctly you see identical twin images of the two square-wave traces on the scope screen.

Before these scope checks are made some routine tests of the stereo amplifier will have to be performed. These initial checks include current drain, faulty or overheating transistors, burnt resistors, loose solder connections and cracked or broken circuit boards. Frequently, after these checks and necessary repairs are made, one of the amplifier channels will operate correctly.

Shown in Fig. 6 is a block diagram illustrating a dual-trace scope and square-wave generator connected to a stereo amplifier to perform these comparison testing techniques. The tests are begun by feeding the square-wave test signal into the left and right amplifier input channel jacks. The left and right channels are actually tied together. Tune the square-wave generator to 1 kHz initially. Now, the probes from channels **A** and **B** of the dual-trace scope are connected to the same, but opposite test points of the stereo amplifier's left and right channels. The two sets of square-waves on the scope are then compared for any discrepancy.

Tracking down the trouble

One channel of this stereo amplifier (Fig. 7) had developed a very low volume level. The square-wave generator and scope were connected for a few checks. When the probe from channel **A** of the scope was touched to the collector of Q402 and probe from channel **B** was placed at the base of Q403 the scope pattern in Fig. 8 appeared. Note the loss of signal gain in the lower scope trace. A defective coupling capacitor (C415) caused this loss of gain. This same technique is also useful to compare stereo multiplex signals. To quickly isolate the fault just put the scope probes at the various stages and evaluate the scope traces. Start at the amplifier input and work up stage-by-stage to the speaker. When the signal is lost or becomes very weak the preceding stage must be checked. Each time you move up one stage the amplifications should increase in level, but don't be fooled by gainless stages such as cathode or emitter followers as they add no voltage gain to the signal.

Rapid isolation of intermittents

Here is a way to use the dual-trace scope to isolate intermittent circuit faults. The volume of a stereo amplifier may go up and down occasionally or an intermittent distortion condition could be the complaint. Some of these amplifiers may operate for days before acting up. This method can help solve those intermittent conditions. Start by feeding a square-wave signal into the suspected channel and connect both scope probes to different sections of the amplifier as shown in Fig. 9. Now, when the trouble develops just look at the scope pattern and if no change takes place move the probes to other sections.

This technique was used on the stereo amplifier shown in Fig. 7. The dual-trace scope was connected and the fault was isolated to an intermittently open coupling capacitor. This was C412 at the base of Q402. This was found when one probe from the scope was connected to the high side of the bass control and the other

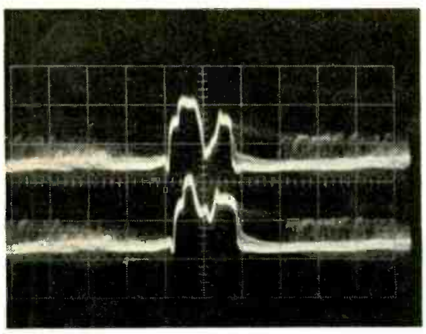


FIG. 5 (above)—DELAY LINE CHECK. Bottom trace of horizontal sync pulse is delayed 0.7 μs, proving that line is OK. FIG. 7 (below)—ONE CHANNEL of stereo amplifier tested.

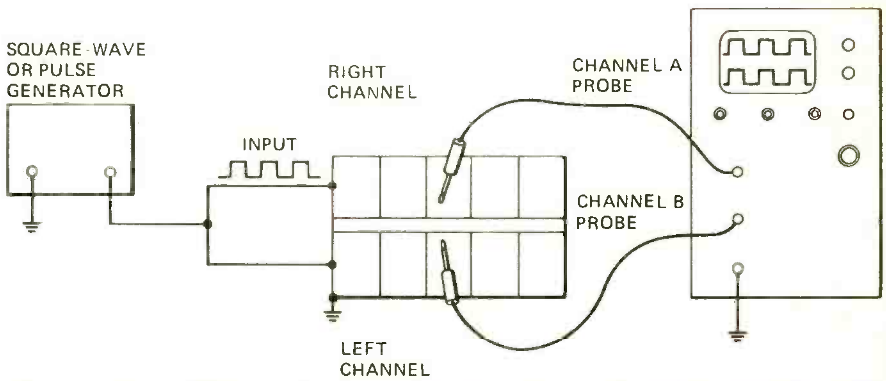
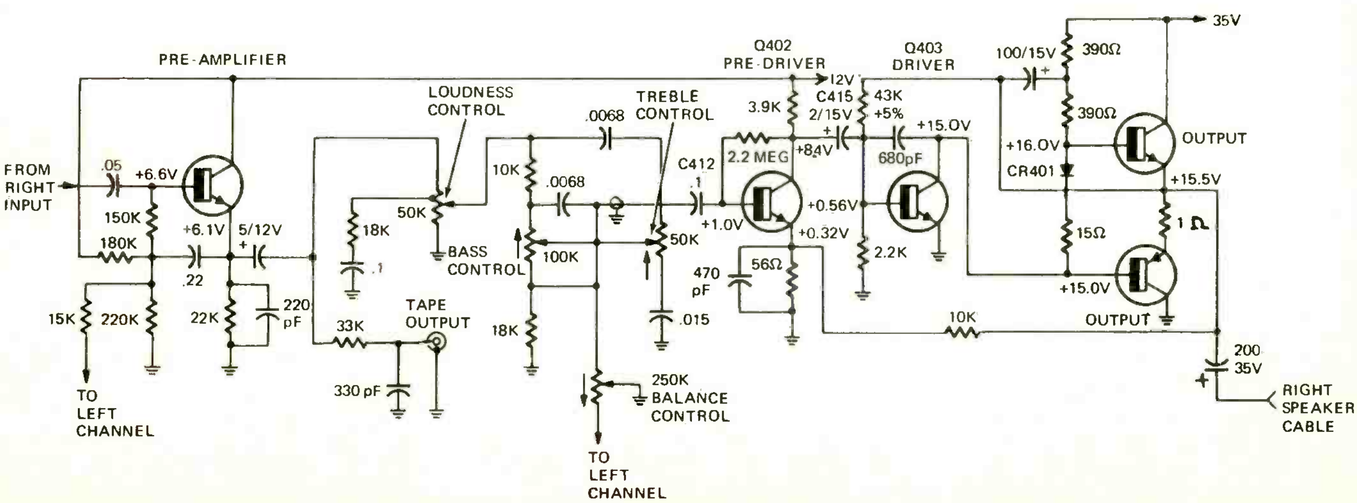


FIG. 6—BLOCK DIAGRAM showing how a dual-trace scope can be used to track down intermittents and other defects in a stereo amplifier. Dual traces make it easy to compare channels.



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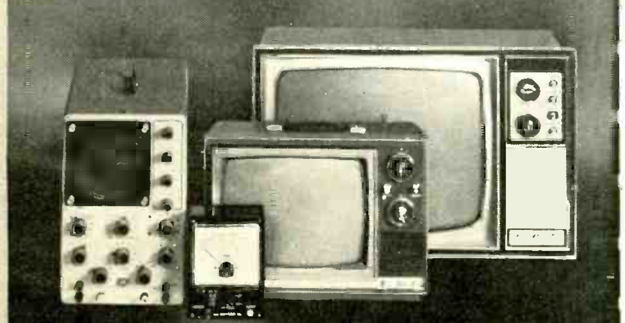

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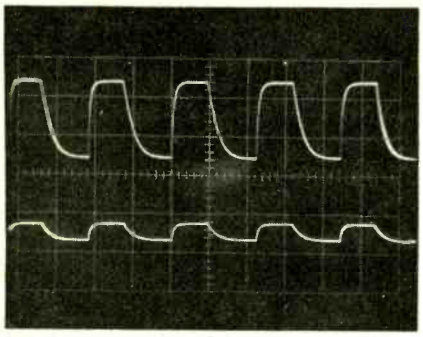


FIG. 8—LOW AMPLITUDE of one trace shows a loss of signal somewhere between the two probes.

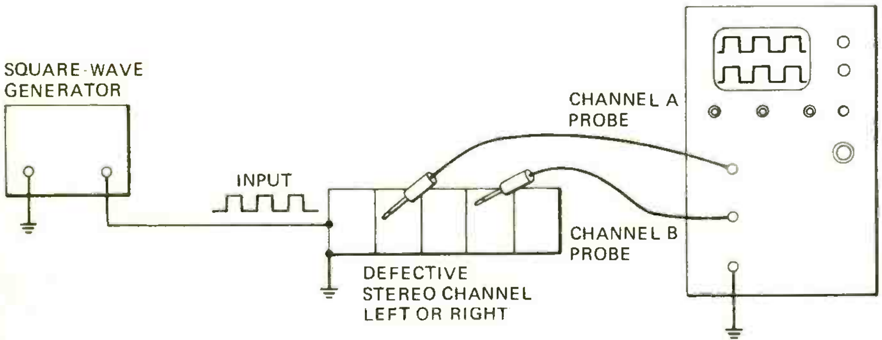


FIG. 9—SIGNAL TRACING in single channel of an amplifier is easy with a dual-trace scope. One scope channel views input signal; the other checks the signal stage-by-stage.

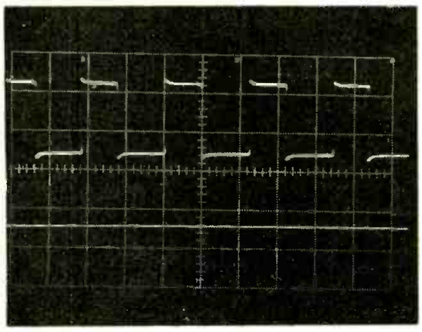


FIG. 10—SQUAREWAVE TEST SIGNAL at input; the straight line shows a loss of signal.

probe at the base of Q402. When the defect occurred we got the scope trace shown in Fig. 10. It doesn't take long to isolate an intermittent problem this way.

But if the intermittent is within a multi-stage feedback amplifier, this technique will not work unless the feedback loop is opened first.

In the example of Fig. 7, the defective capacitor (C412) was at the input to a three-stage feedback loop. This isolation technique would not have worked if C415 or C420 was intermittent.

With this technique you can quickly isolate the problem right down to the defective component. As a final check of the amplifier or if you suspect inadequate frequency response, use the square-wave generator and tune it throughout the audio range of the amplifier. Make these checks at about 1-kHz intervals and view both channels on the dual-trace scope at the same time. The frequency response of a stereo amplifier can readily be checked with this system.

Stage gain comparison measurements.

Modern dual-trace triggered scopes have identical vertical amplifiers and their gain is calibrated in volts per centimeter (volts/CM). This makes an ideal instrument to check one stereo channel against the other one to compare the signal gain of various stages. This can be used for checking the gain per stage throughout the amplifier and for overall performance of the left and right channels. This makes it very easy to compare the left amplifier with its twin on the right.

The dual-trace scope can also be used to simultaneously monitor the input and output signal of any type of electronic processing stage, whether it be oscillating, amplifying, switching or isolation, solid-state or tube type. Because of the ac or dc vertical amplifier mode of operation of these scopes the peak-to-peak ac signal level along with the dc voltage level can all be seen with just one glance at the scope screen.

Thus, you can double your pleasure in many instances by actually cutting your troubleshooting time almost in half.

The dual-trace triggered oscilloscope is invaluable for rapid troubleshooting of today's sophisticated solid-state space age electronic devices.

R-E

"The repairman wants to know if it's two-channel or four-channel!"

BATTERY SAVER

Battery-powered instruments are fine—except that if you are like us, you often forget to turn off the ones without the ever friendly and reassuring pilot light. This results in run-down batteries it seems, just when you need them most. Things sometimes get so bad that I forget to unplug the soldering irons at the end of the day. If it was not for plated tips, I would have had to spend a small fortune replacing burned-up tips.

In desperation I made several small battery-powered neon relaxation (RC) oscillators (Fig. 1) that I turn on

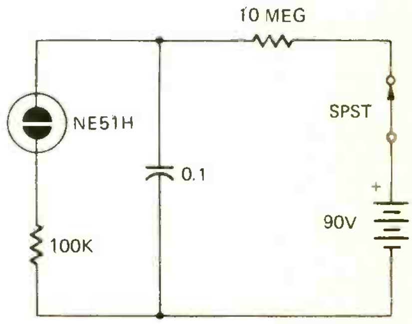


FIG. 1

whenever I turn on a battery-powered instrument. These are located strategically throughout the shop so that the blinking neon lamp is a reminder that a battery-powered instrument is on. The operating life should equal the shelf life of the batteries. Mine have been operating for over two years.

The soldering iron problem I solved in an equally simple manner. A neon lamp assembly wired in the soldering iron stand (Fig. 2) lights to

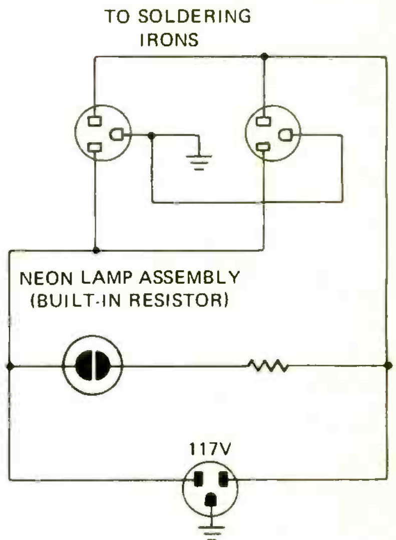


FIG. 2

show that the stand and soldering iron(s) are plugged in.

These may seem like a lot of work to solve simple problems, but they save in frustration and replacement costs!—*William D. Kranengel, Jr.*

GRINCHWAL READOUT MODULE

Complete your mainframe. Build this 4-digit readout assembly using LED's and get ready for the plug-ins that follow

by DON LANCASTER

HERE'S A FRESH, HIGH PERFORMANCE approach to digital counting and display—combine a bright red light emitting diode (LED) display with a *single* new high performance. MOS Integrated Circuit, and you come up with an easy-to-build *four decade* 0-9999 digital counter and display that neatly fits a single 2½" x 5¼" plug-in PC card. *Total* supply current, *including the readouts*, is a mere 6 volts at 100 mA, easily provided by ordinary flashlight cells. Now you can go truly portable with your digital instruments, free of any line cords, bulky storage batteries, or high-voltage display supplies. While the maximum counting frequency of this display is 250 kHz, you can easily count to 100 MHz and beyond by suitable scaling.

Figure 1 shows a simplified block diagram of the counting module. Practically everything is crammed inside the single *Mostek* MK5005 integrated circuit. *Monsanto* MAN-4 light-emitting-diode (LED) displays are used. These are a fifth of an inch high and readable beyond eight feet. Brightness is good enough for almost any reasonable room lighting, and you can even hold back on brightness to extend the battery life and still come up with a highly viewable display.

Construction

Figure 2 shows the actual circuit. Darlington driver transistors are needed to get the IC outputs up to a suitable level for display drive. These are pnp or npn transistor pairs as shown and have gains in the ten thousands. They cost 45 to 60¢ each. Ordinary transistors, even high gain ones, may NOT be substituted.

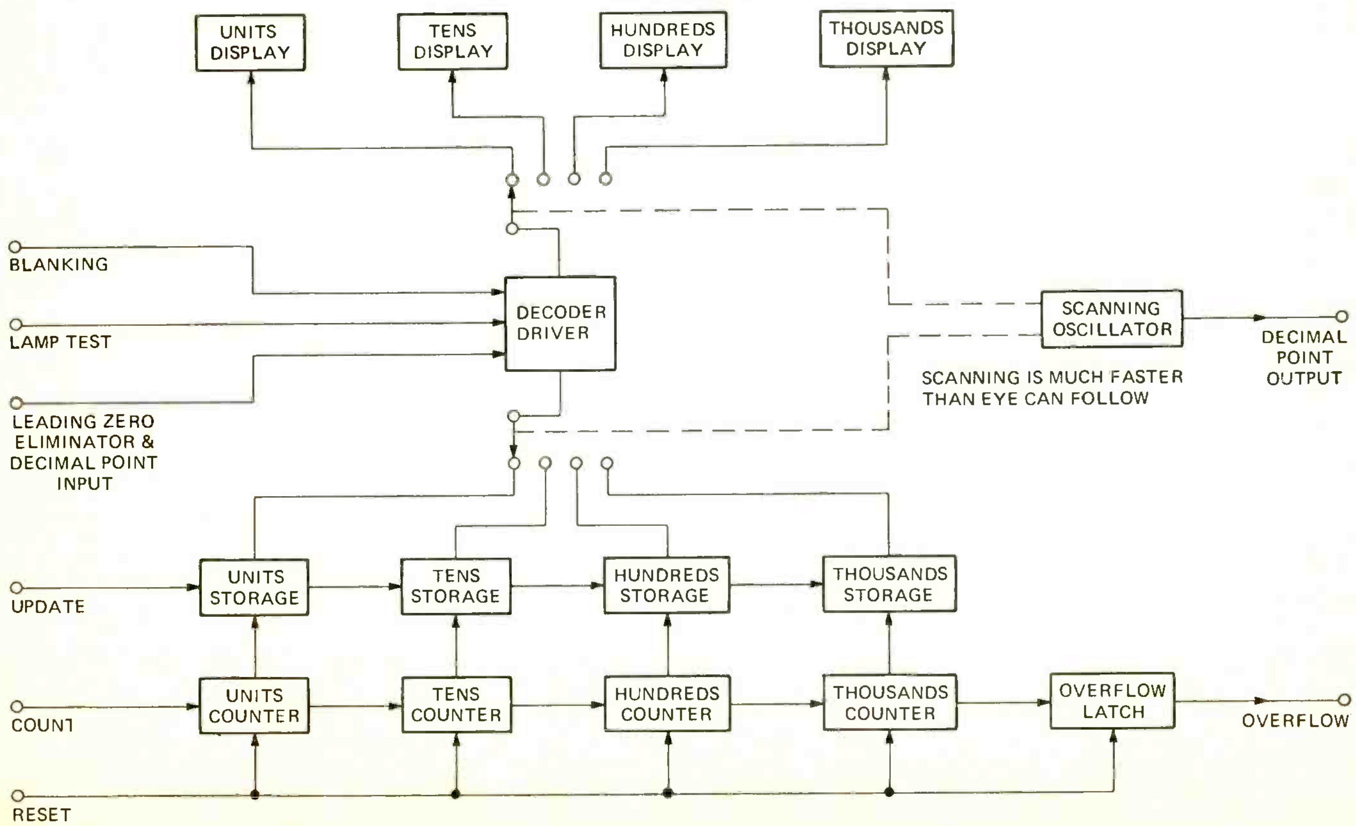
Capacitor C1 sets the scanning rate for the multiplexing while C2 gives a speed-up to the decimal point input that eliminates ghost decimal points. Feedback from the decimal point driver to the chip controls the leading zero blanking.

Brightness is controlled by resistors R2 through R9. The values shown are the *minimum* recommended values that give *maximum* display brightness. If desired, the resistors may be raised in value to give a not as bright display that has longer battery life.

A printed-circuit board is a must for this project. You can get one commercially or else you can use Figs. 3, 4 and 5 to make your own.

While the MOS integrated circuit

FIG. 1—DISPLAY MODULE BLOCK DIAGRAM. Single low-power integrated circuit does the job. It replaces more than a dozen conventional ICs.



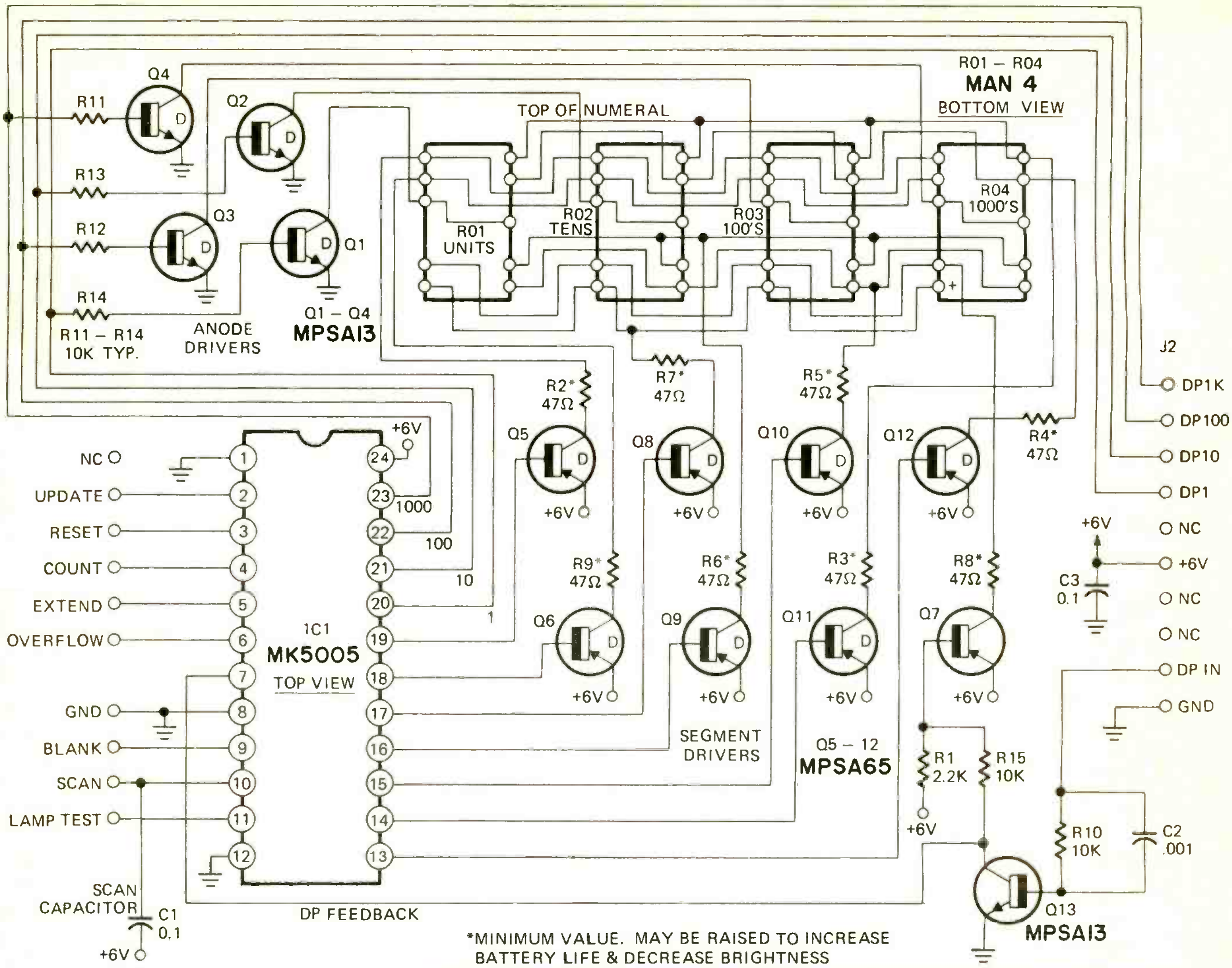
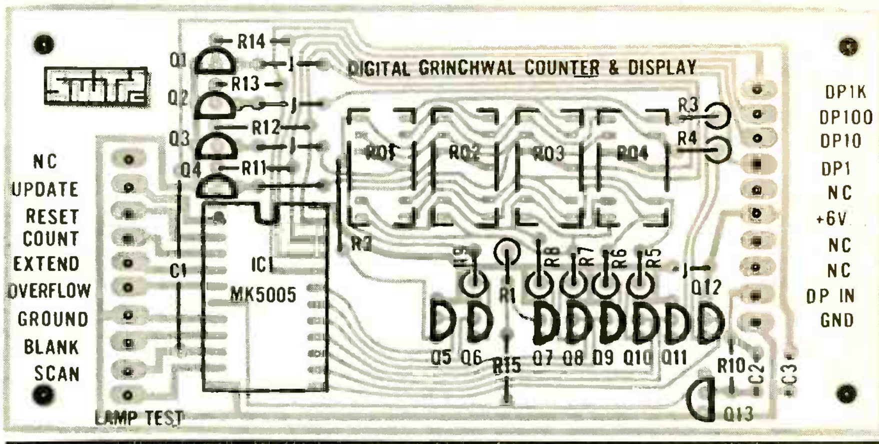
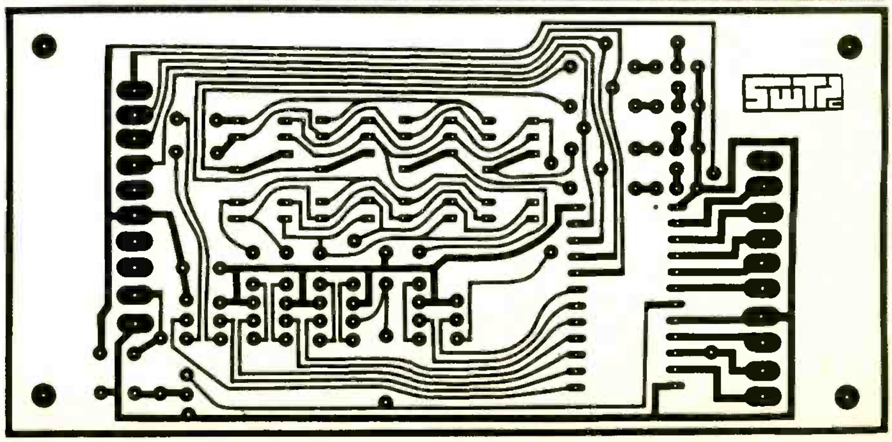


FIG. 2—(above) COMPLETE schematic of the readout circuit.
FIG. 3—(bottom right) FOIL PATTERN of the readout board is 5¼ x 2½ inches.
FIG. 4—(right) PARTS PLACEMENT for the readout board.

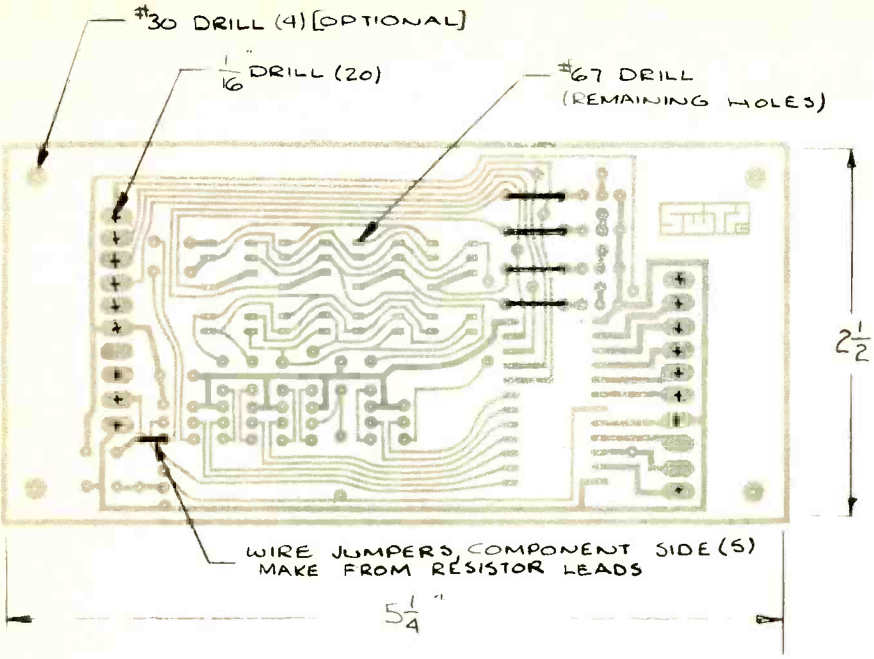


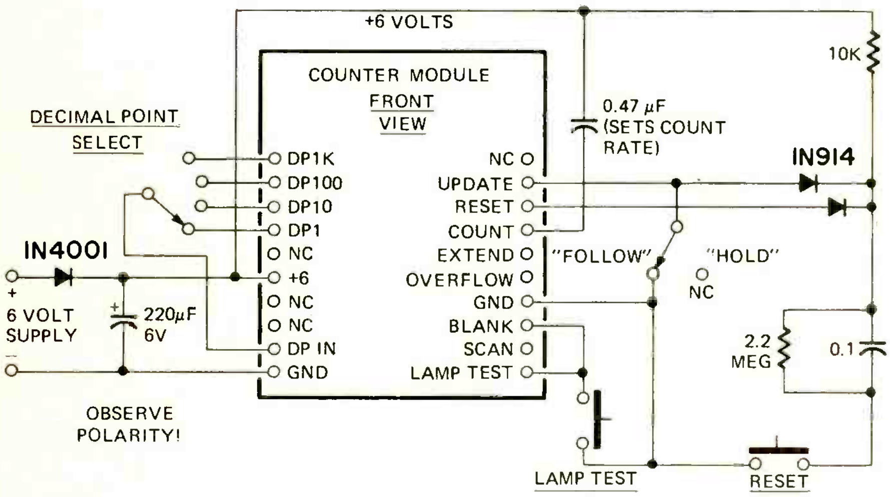


is now pretty well protected against static and overvoltage, REVERSED SUPPLY POLARITY WILL IMMEDIATELY AND PERMANENTLY DAMAGE THE DEVICE. IN ALL OF YOUR CIRCUITS AND ALL OF YOUR CHECKOUT WORK, A SERIES DIODE OR OTHER "IDIOT PROOFING" *MUST* BE PLACED BETWEEN THE MODULE AND THE SUPPLY.

Before starting assembly, note three very important details: (1) don't unwrap the MOS integrated circuit or remove its protective foam until immediately before you solder it in place; (2) note that the readouts mount *foil* side, *opposite* the rest of the components; and (3) note that the pins on the plug in connectors stick out from the component side, opposite to the foil side that supports the readouts.

A deep red optical filter is absolutely essential for proper display contrast. A piece of ⅛" red plexiglas





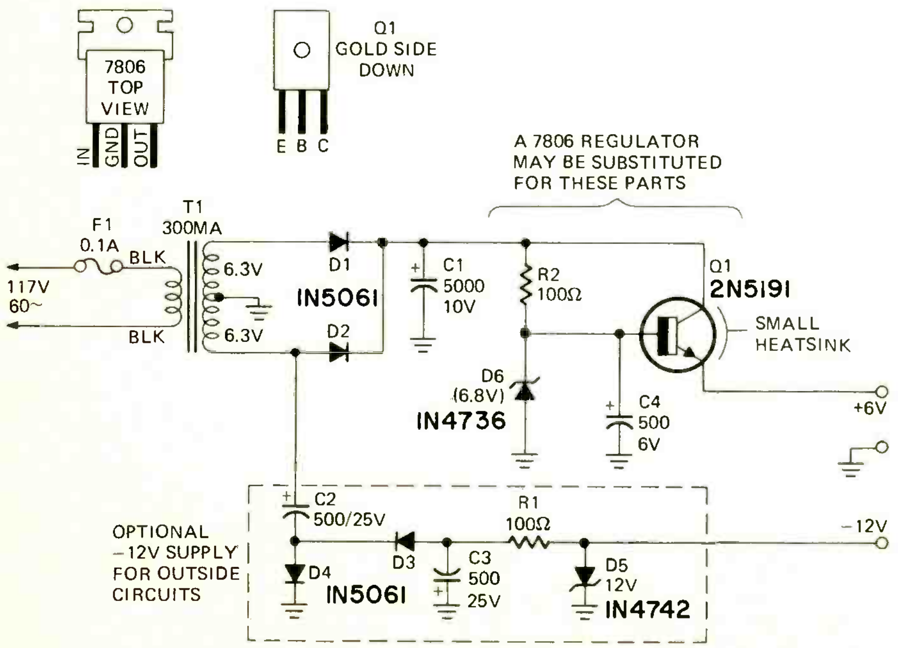


FIG. 5—(top) DRILL AND JUMPER GUIDE for the readout circuit board. FIG. 6.—(middle) TEST CIRCUIT for breadboarding initial checkout. FIG. 7—(bottom) RECOMMENDED POWER SUPPLY fpr ac operation. For portable use simply use four "C" or "D" cells connected in series.

PARTS LIST (Fig. 2)

R1—2200 ohms, ¼ watt, 10%
R2, R3, R4, R5, R6, R7, R8, R9—47 ohms, ¼ watt, 10% (see text)
R10, R11, R12, R13, R14, R15—10,000 ohms, ¼ watt, 10%
C1, C3—0.1-μF disc ceramic
C2—1000 pF disc ceramic
IC1—MK5005P (Mostek) DO NOT SUBSTITUTE
J1, J2—10-pin male connector (modified Molex 09-57-1105)
Q1, Q2, Q3, Q4, Q13—MPS A13, npn Darlington transistor pair (Motorola) DO NOT SUBSTITUTE
Q5, Q6, Q7, Q8, Q9, Q10, Q11, Q12—MPS A65, pnp Darlington pair (Motorola) DO NOT SUBSTITUTE
RO1, RO2, RO3, RO4—MAN-4 LED seven-segment readout (Monsanto)
MISC: PC board; 5 jumpers; red filter, 1¼ x 2½ x ⅛" #2423 Plexiglas; sockets for J1 and J2, Molex 09-52-3103

NOTE: The following are available from Southwest Technical Products, 219 W. Rhapsody, San Antonio, Tex. 78216.
Etched & drilled circuit board—DGR-b, $3.85.
IC1—$20
Kit of all parts—DR-c, $34.50

PARTS LIST (Fig. 7)

R1, (R2*)—100 ohms, ½ watt, 10%
C1—5000 μF, 10V, electrolytic
C2, C3—500 μF, 25V, electrolytic
C4*—500 μF, 6V, electrolytic
D1, D2, D3, D3—1N5061 silicon diode
D5—1N4742, 12V, 1W, Zener diode
D6*—1N4736, 6.8V, 1W, Zener diode
F1—0.1 A fuse and fuseholder
Q1*—2N5191 npn silicon transistor
T1—transformer: primary, 117Vac; secondary, 12.6V, 100mA with ct
*Regulator: A Fairchild No. 7806 regulator may be substituted for these parts.
MISC: PC board, line cord, strain relief terminals, mounting hardware

NOTE: The following items are available from Southwest Technical Products, 219 W. Rhapsody, San Antonio, Tex. 78216
Etched & drilled circuit board—DRP-B, $2.50
Kit of all parts—DRP, $8.75

#2423 is ideal for this and may either be bolted directly to the module (using long enough spacers to clear the readouts) or the filter may form a front window for a display or instrument package.

Using it

The module may be powered from a six volt unregulated supply, four D cells, or a regulated supply. One suitable line operated supply is shown in figure seven. This particular supply also puts out -12 volts which is handy for a companion time base chip, the MK5009, or for other external circuitry.

The display goes out before the counter quits. If ultra-long battery life is essential, you can reduce the brightness by increasing the values of R2 thru R9 to perhaps to 220 ohms, or to whatever tradeoff between battery life and brightness you want. Or, you can go to alkaline D cells or NiCad's. Ordinary heavy-duty D cells should last you around 40 hours of intermittent operation. **R-E**

low cost keyboards

Flexible, versatile, medium duty, professional quality keyboards are yours for a quarter a key and customized to your particular needs

by DON LANCASTER

WHAT COULD YOU DO WITH A LOW-cost keyboard? Besides such traditional uses as adding machines, ham radio-teletype and automatic Morse-code senders, electronic security locks, etc., there's a whole new world of wonderful new integrated circuits that open the doors to a wide range of new projects. Projects that right now aren't practical because commercial custom keyboards are too expensive and too hard to get in small quantities.

For instance, you can now get MOS calculator chips for less than $16. This and a low-cost keyboard and a display gives you an add-subtract-multiply-store calculator for way under the going price. Or, one keyboard, an encoder, and a coupler buys you one half of a computer terminal you can call up your timesharing service with—at a tiny fraction of commercial unit or rental costs.

Low-cost keyboards also open the doors to programmable calculators, sports car rally computers, computer data entry, and such new blue-sky projects as cable television "answer back" systems, electronic notebook and message centers, communications aides for the deaf, sophisticated electronic security devices, elaborate electronic games, programming for music composers and synthesizers, teaching machines, tape or cassette file search systems, credit card verifiers, inquiry systems, recipe, bibliography or literature data banks, "anti-drunk driver" gadgetry, and many, many others.

But, commercial custom keyboards are expensive. Normally, you pay 80¢ to $2 per key for a 12- or 16-key assembly, and as much as $6 per key for a fully-encoded teletypewriter style keyboard. Surplus is a help, but only if you can use the keyboard as is. And the "Let's use pushbuttons!" route usually ends up with hard-to-read characters, harder operation, and impossible wiring.

Yet, for a few nickles worth of materials, you can build yourself a custom medium-duty keyboard set up for your particular task.

We'll show you how to build two keyboard versions here. The first is a 12-key version for calculators, electronic security locks, Touch Tone systems, or data entry. The second is a full 55-key teletypewriter-style keyboard for computer terminals, communication systems, and deaf listening aides. A later article will show you a low-cost ASCII encoder that converts the contacts of the big keyboard into an eight-bit parallel IC logic-compatible standard computer code. Along with this, we'll show you a 100 word-per-minute adaptor. Together the keyboard, encoder and adaptor can give you a complete sending end of a teletype style computer terminal for a fraction of the usual rental or purchase price.

How it works

Figure 1 is a cross section of one keyswitch. We use a ¼-inch thick soft carbon-urethane sponge contact. The contact is made by pressing the foam against a pair of plated contacts on a printed circuit board. This system generates very little switch noise and bounce, as the sponge particles progressively make and bring about a smooth change from an open circuit to a low resistance. ON resistance is usually under 500 ohms for an operating force of 3 to 5 ounces. This is low enough for the keyboard to talk to virtually any integrated circuit logic system without any buffering or isolation. It is also smooth enough to give "soft start" click-free contacts for electronic music operations. While the key travel is typically 3/16-inch, you can easily make it anything you want. There's also a definite increase in mechanical force well *after* contact is made, so for most applications, you can easily tell when contact has been made, particularly if you have a display alongside you can watch. Optional "clickers" of one sort or another can be added if they are absolutely needed. The assembly is reasonably thin, projecting only 13/16-inch behind the keybottom. I used standard, commercial two-shot molded keytops. These are white on grey and are available in a wide variety of characters, numerals, and punctuation. Blank and oversize keys are also available. The two-shot molding process means the character goes all the way *through* the keytop. It cannot wear off, come loose, or change color. Conventional springs and an optional damping pad return a pressed key to its home position. Optional *Belleville* washers or a snap-action strip of polypropelene can be

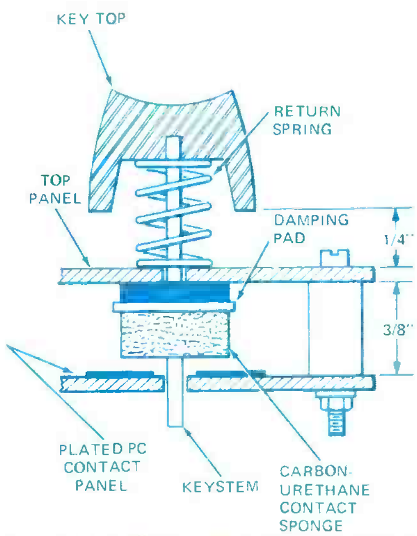
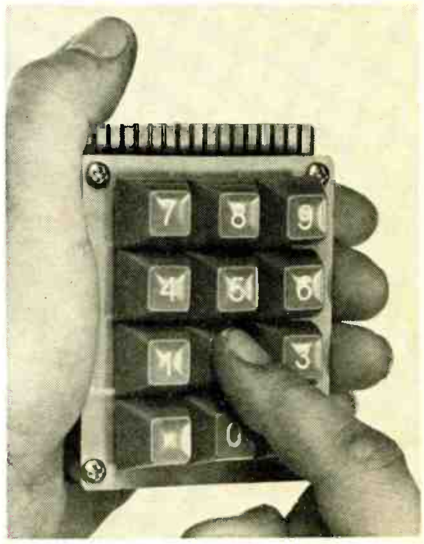


FIG. 1—INDIVIDUAL KEYS are made from a few easily obtained components.



CALCULATOR KEYBOARD ready for mounting. Note the printed-circuit connector.

added for snap-action or tactile feedback, but this only adds to the cost and complexity for most users.

The parts are detailed in Fig. 2. A *keystem* assembly is made up of a piece of 3/64 x 3/16 x 1¼-inch solderable soft steel and a 17/32-inch disc of light gauge solderable steel. Be sure the part of the keystem that goes into the keytop is cut to fit tightly. You should *lightly* centerpunch 4 or 5 "pockmarks" on each side of the very top of the keystem, or else glomp on a small self-grip locking plier-wrench heavy enough to cut in teeth marks. This helps lock the keytop firmly in place during final assembly.

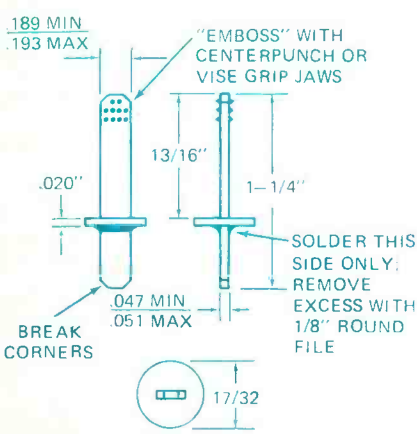
The disc is soldered to the keystem exactly as shown in Fig. 2-a, keeping it positioned exactly 13/16-inch from the keytop end and keeping the solder only on the keypad end. A small wood or other non-heat conducting jig is absolutely essential during soldering. A simple one is shown in Fig. 2-b. The disc *must* be perfectly square with respect to the keystem. Immediately before soldering, carefully clean both pieces with a typewriter style ink eraser to guarantee the solder will smoothly and strongly adhere. Liquid rosin solder flux helps greatly, but isn't essential. As with any electronic assembly, don't use acid core solder or flux.

After soldering, remove all excess solder with a ⅛-inch diameter *round* file, and smooth and polish all edges. Also remove any remaining flux.

Press a slit 0.4 x 0.4 x 0.25 inch piece of carbon urethane onto the keystem. You might like to *optionally* glue it to the keydisc. If you do, use an absolute minimum of adhesive and be sure not to fill any of the sponge voids. The glue really isn't necessary. The carbon-urethane foam may be obtained from the source listed, or you can use the foam many MOS integrated-circuit manufacturers wrap their IC's in for shipment. If you're using the free material, check several companies, for some of the material is more suitable than others. A good material will be soft yet still give 500 ohms or less resistance, and it won't crumble or tear. Be absolutely sure that the keypad sponge is centered and square with respect to the keystem.

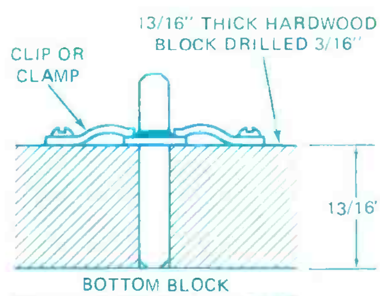
Two 1/16-inch panels support the switches. These are spaced ⅜ inch apart using 6-32 threaded spacers. Since the keystem is a conductor, both panels must be insulators *except* where contact is to be made. Use an ordinary 1/16-inch single-sided printed circuit board for the bottom panel, contact side up; and an etched-off piece of PC material or other 1/16-inch fiber glass for the top panel.

Be sure to follow these guidelines in your PC layout. Keys are normally ¾-inch apart. The contact areas should be 0.4" square total, with enough clearance between both contact halves and the keystem. Conductors between the contact pads should be small enough and centered enough so that a slightly misaligned keypad can't cause an unwanted short. With a calculator or telephone style keyboard, the rows of keys are usually centered on top of each other. With a typewriter style keyboard, the rows are usually offset to allow normal typing. Normally you'll also want to provide a PC edge-card connector on your layout for system interconnection. While you can go to multiple contacts and self-encoding keys, this does add complexity and



(a)

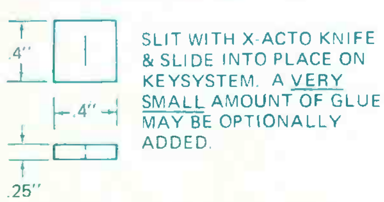
KEYSTEM IS MADE BY SOLDERING A STEEL DISC & STRIP TOGETHER



(b)

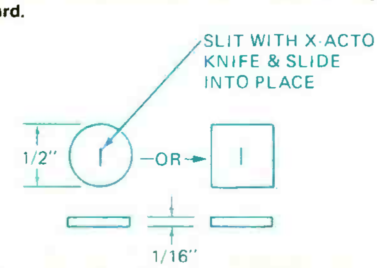
USE A JIG LIKE THIS FOR SOLDERING

FIG. 2—HOW KEY IS MADE. Construction of the keystem is simple and well within the abilities of most technicians and experimenters. Care and precision insure a reliable keyboard.



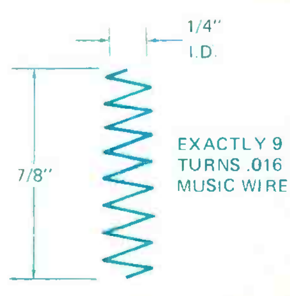
(c)

CONTACT PAD IS MADE FROM 1/4" CARBON URETHANE FOAM. SLIT SHOULD BE ACCURATELY CENTERED.



(d)

DAMPING PAD IS MADE FROM 1/16" THICK INNERTUBE STYLE RUBBER.



(e)

SPRING LOOKS LIKE THIS. START WITH AN EXTENSION SPRING, STRETCH IT & CUT EVERY NINTH LOOP might be difficult to do on a single-sided board.

Holes for the keystems are moderately critical, and the bottom and top panels must be match-drilled or match-punched in their exact final position. Start with the bottom panel, foil side up and either punch or drill and file rectangular holes for each keystem. The holes should be large enough to allow the keystem to slide freely by, but not so large that the keystem can rotate excessively. Edges should be beveled slightly. After the PC panel is punched, drill the mounting holes and firmly bolt the top and bottom panels together *backwards*, so the drilled panel is on top and the undrilled one is on the bottom. File notch across both panels to indicate their alignment for final assembly. The top panel can then be match-drilled or match-punched to the bottom. This way, all the keystems are perfectly vertical and freely slide after final assembly. If you try to drill top and bottom separately, some of the keystems are sure to bind or be crooked.

The return springs may be chopped out of larger hardware store springs, or wound with music wire. The inside diameter should be somewhat over 0.2 inch. The uncompressed length should be around ¾ inch and the spring should squash beyond ¼ inch without bottoming. Wire diameter is 0.16 inch. The restoring force should be around 3 ounces when compressed ¼ inch and 6 ounces when compressed ½ inch. The ends should be wound or ground so they do not cut into the top panel or keytop when in use.

The bare copper contacts on the PC board must be protected against long term corrosion that will raise the contact resistance. Gold, nickel, or tin plating is ideal, but you can use ordinary silver ink "PC Repair" paint provided you thin it properly and bake it on. A better product is *Sel-Rex SIL-PAINT* 2065-01. It is thinned with denatured alcohol and brushed on. You then bake it in a kitchen oven at 200 degrees for two hours. The resultant carbon on silver contact is almost as good as gold plating and is far easier to do with limited equipment. Commercial keyboard kits are already plated.

During final assembly, you might like to add an optional damping disc that goes below the top panel and above the steel disc on the keystem. This pad can be about 1/16 inch thick and can be made of innertube rubber or most anything similar. The pad quiets the keyboard operation, and shortens the keystroke. Changing the pad thickness lets you control the keystroke.

Be sure to polish, smooth and clean everything during final assembly. A rough edge or a thumbprint can cause long term wear or contact resistance problems. Also check to be sure each keypad seats flat on its contacts. Assembly starts with the bottom panel and threaded bushings, followed by the keystems, the damping pads, and the top panel. These are all bolted together and operation is carefully checked. Once smooth operation is obtained, the springs are added, followed by the keytops which are pressed on till they firmly seat. A tiny amount of silicone grease may be optionally added to the keystems. Keep

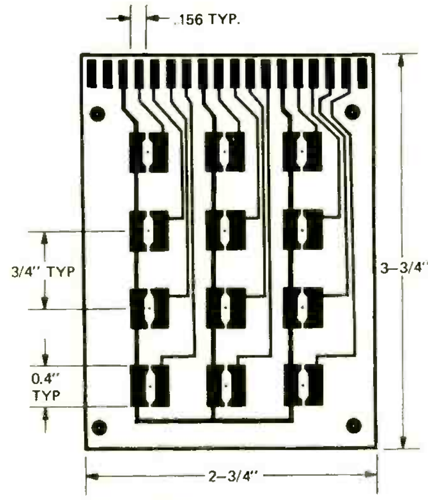
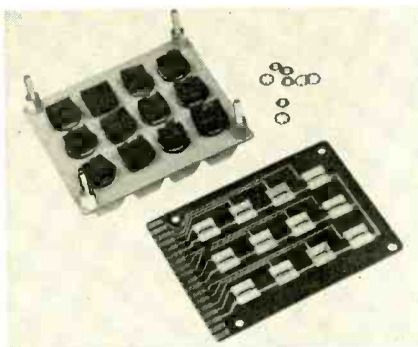


FIG. 3—PC PATTERN for a keyboard. Use extreme care when drilling holes for keystems.


DISASSEMBLED KEYBOARD showing keystems and the carbon-urethane sponge contacts.

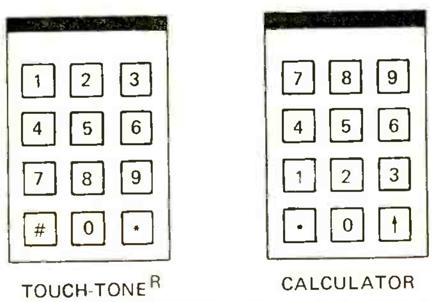


FIG. 4—TWELVE-BUTTON KEYBOARDS in the standard Touch-Tone and calculator formats.

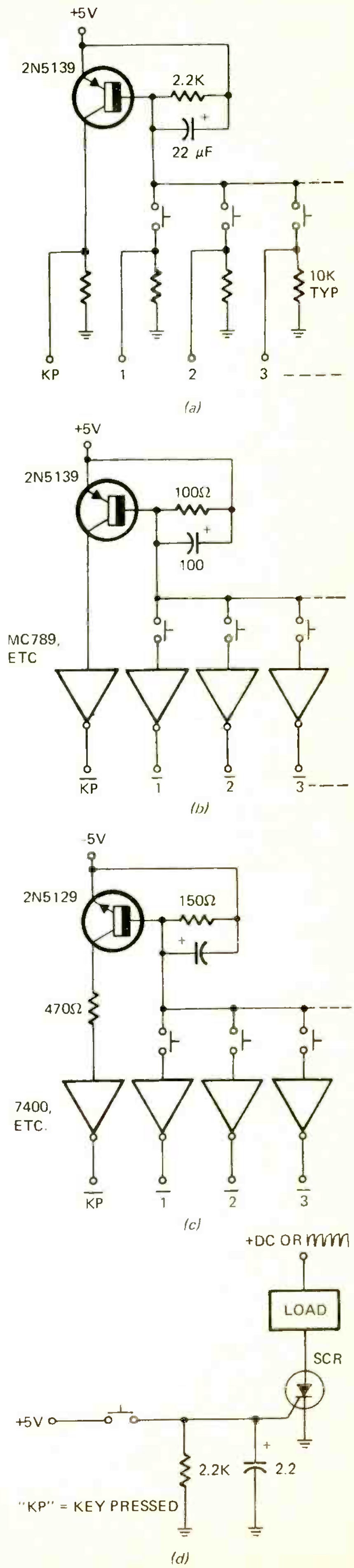


FIG. 5 (right)—WHEN A KEY IS PRESSED collector current flows in the transistor.

all grease well away from the contact areas.

12-key keyboard

The printed circuit pattern for the 12-button keyboard is shown in Fig. 3 and in the photo below it. One common connection is provided, but you can easily break this if you are using your contacts in a matrix form. You can arrange your keys any way you like, but output does, be sure you use only the *leading edge* of your "key pressed" command. Should a second key be depressed before you let go of the first one, it will not be entered, giving you a form of "2-key-rollover" protection. If desired, an external speaker, solenoid, or Sonalert clicker may be added to the basic keyboard to provide additional operator feedback.

A standard 18-connector PC edge conjunction with the American Standard Code for Information Interchange (ASCII). The key arrangement of Fig. 7 can be used, or you can set up your own. A cross-section of the keyboard is in Fig. 8.

The big keyboard is slightly more complex than the little one. Mechanically, extra spacers are needed to provide a "honeycomb" type of support all the way across the keyboard. Two

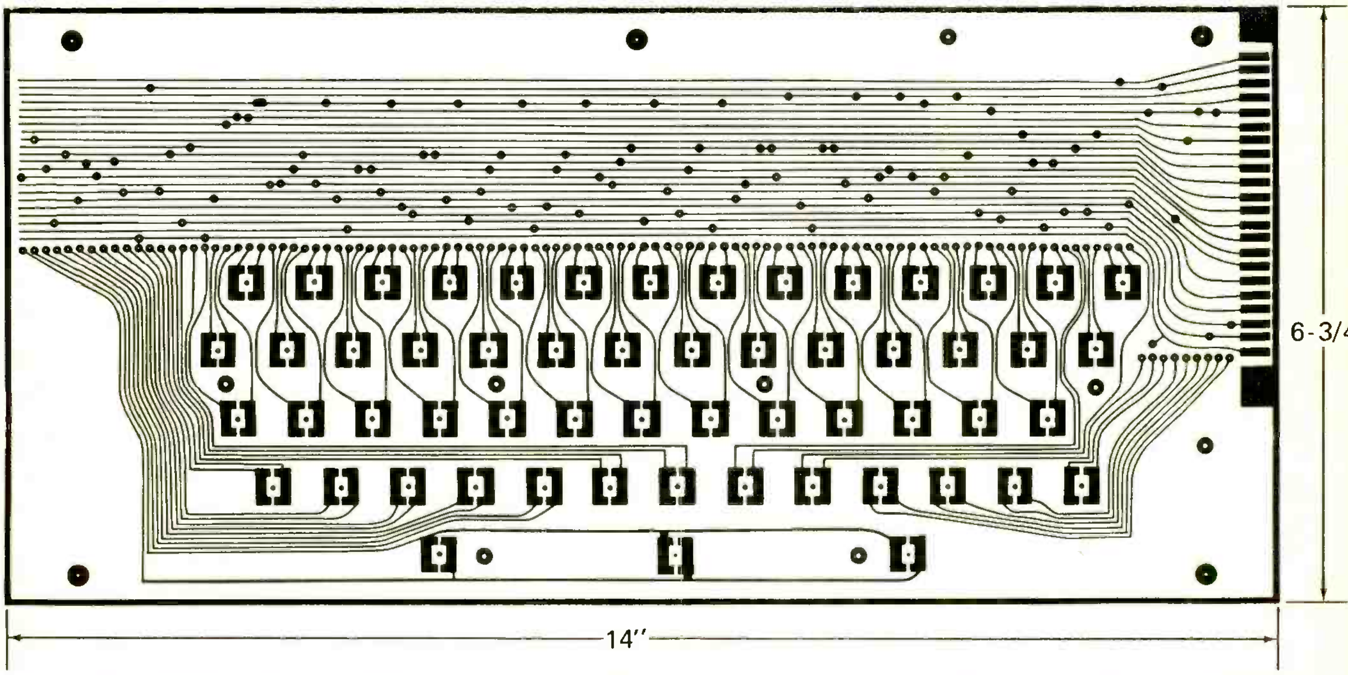


FIG. 6 (above)—PRINTED-CIRCUIT PATTERN for full 55-key typewriter or teletype keyboard. Each key has two contact pads connected to PC lands. Add a jumper vertically from each key-contact land to the land that is directly above it in one of the 22 horizontal rows.

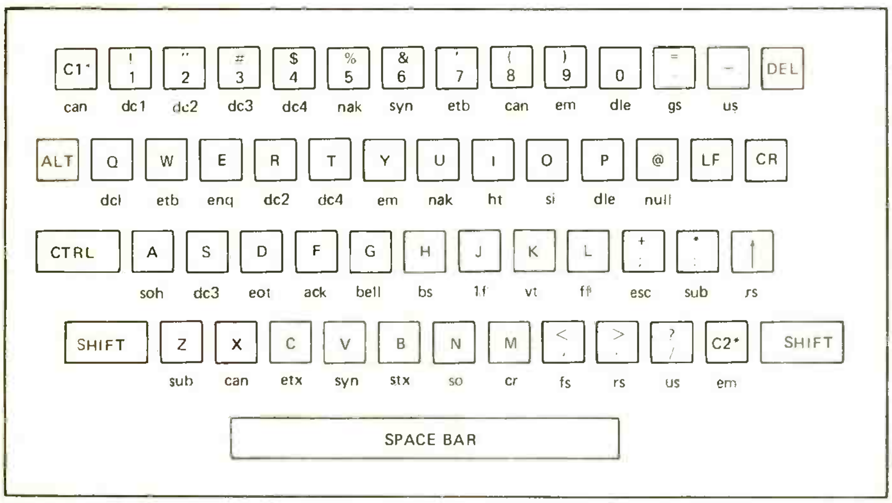
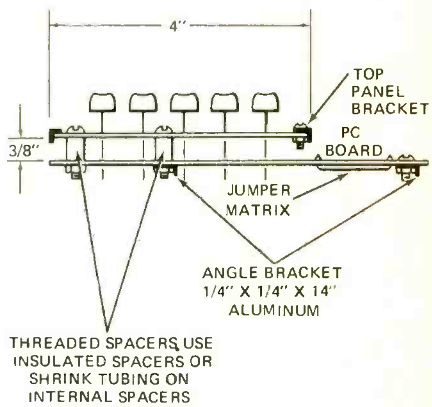


FIG. 7 (left)—TELETYPE KEYBOARD for ASCII computer code. Make yours anyway you wish. Fig. 8 (below)—CROSS-SECTION OF A COMPUTER KEYBOARD. Extra spacers provide stiffening.



two "standard" formats are the "calculator" and "Touch-Tone®" arrangements shown in Fig. 4.

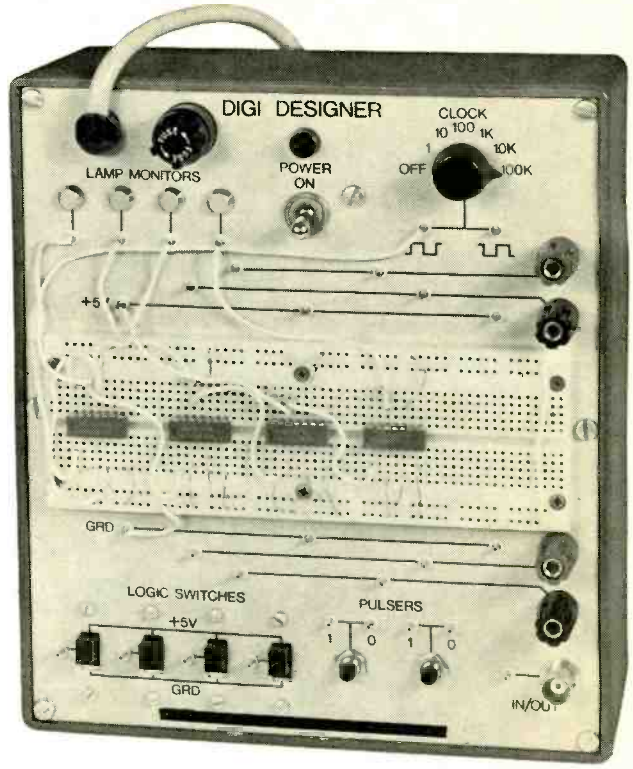
Several "key pressed" systems are shown in Fig. 5. All are based on detecting a key being depressed by pulling base current through a common transistor. The large capacitor delays the key-pressed command long enough to insure a settled contact. Since the key lets go before the "key pressed" card socket fits the keyboard. One suitable mating connector is the Amphenol 143-018-03.

55-key typewriter keyboard

The full typewriter or teletype style keyboard is shown in Fig. 6, and in the head photograph. This particular keyboard is modeled more or less after the ASR-33 teletype, the "standard" computer entry device used in aluminum angles run the length of the bottom panel for added rigidity. The progressive rows of keys are offset from each other just as an office typewriter is. A long spacebar is also provided. It is really *three* switch contacts to allow realiable operation from the middle or either end. Enlarge the end spacebar slots slightly. Electrically, we have to provide for keys that don't

(continued on page 88)

DIGITAL IC BREADBOARD
Build It Yourself



Interested in a quick and painless way to patch together an experimental or development digital circuit about as fast as you can read its schematic? This unique device described last month and concluded in this issue is a logical answer to your problem.

by JACK CAZES

LOGICAL AND DIGITAL ELECTRONIC CIRCUITS ARE PERHAPS the least understood by most readers. But, experimenting to learn more about them can be a chore when we must find some sort of base for the circuit and then solder the test components into the circuit. This drudgery can be turned into a pleasure when you use the Digi Designer to breadboard and operate your logic circuits. All components, including diodes, IC's and transistors can be plugged in. All connections are made without soldering.

32-Function Arithmetic/Logic Computer Circuit— Here's a digital computer circuit that should provide many hours of educational, as well as entertaining, experimentation. The SN74181 integrated circuit is a complete arithmetic/logic computer in a single 24-pin DIP unit. With it you can enter two 4-bit words and perform any of 32 different logic and arithmetic operations with them. The desired functions are selected by setting four FUNCTION-SELECT inputs according to the function tables given by the manufacturer. The essentials of these are reproduced below.

Plug an SN74181 IC into the Digi-Designer. Make certain it straddles the groove running up the center of the breading socket. Supply power to it by connecting pin 12 to ground and pin 24 to +5 volts. Connect pins 3, 4, 5, and 6 to the common leads of the logic switches (S5, S6, S7, and S8, respectively). These serve as the FUNCTION-SELECT inputs. The two 4-bit data inputs are made to the pins shown in the following table with the resultant outputs being read at the pins indicated. Observe the output logic levels by connecting their respective IC pins to lamp monitors.

Input/Output IC Pin Connections

Binary Value	8	4	2	1
"A" Word Input	19	21	23	2
"B" Word Input	18	20	22	1
Outputs	13	11	10	9

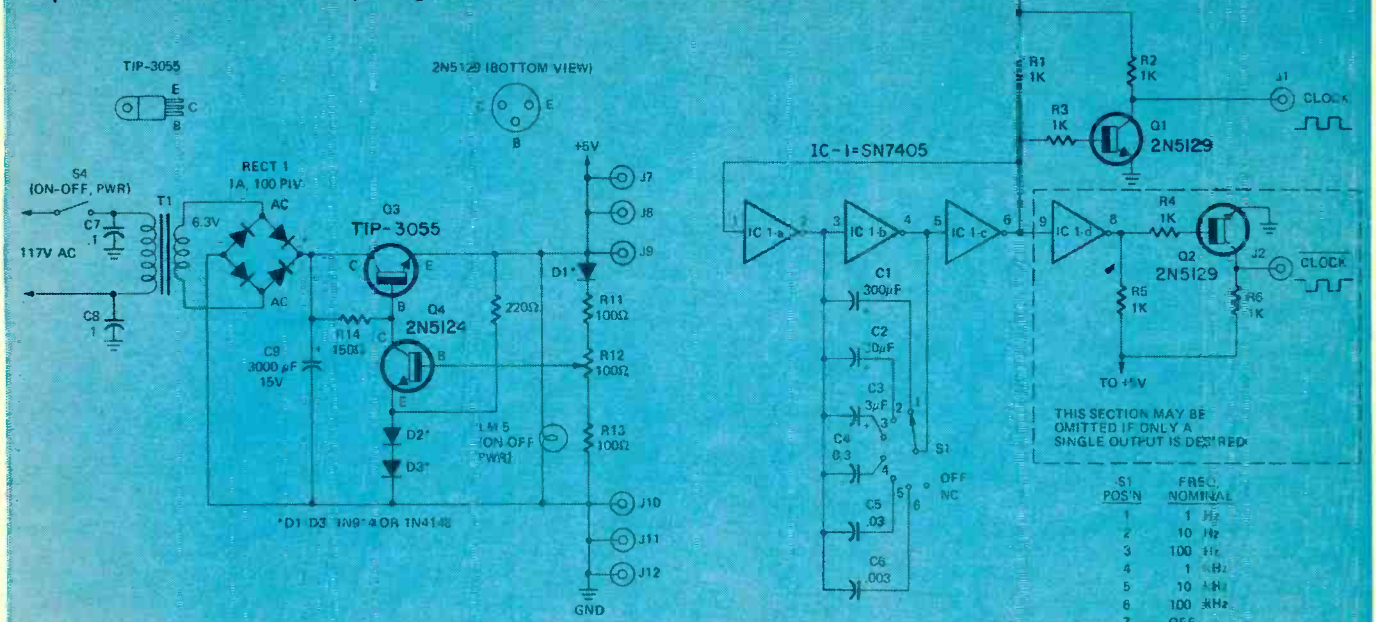
The following tables list the settings for the FUNCTION-SELECT switches (S5 thru S8) for the 32 arithmetic/logic functions:

Arithmetic Functions—In this mode of operation, an internal "carry" is operative and the "A" and "B" word inputs are handled on this basis. Ground IC pins 7 and 8.

Function—Select				**Function**
S5	S6	S7	S8	
Gnd	Gnd	Gnd	Gnd	F = A
Gnd	Gnd	Gnd	+5V	F = A + B
Gnd	Gnd	+5V	Gnd	F = $A + A\bar{B}$
Gnd	Gnd	+5V	+5V	F = Minus 1 (as its 2's complement)
Gnd	+5V	Gnd	Gnd	F = A plus $A\bar{B}$
Gnd	+5V	Gnd	+5V	F = [A + B] plus $A\bar{B}$
Gnd	+5V	+5V	Gnd	F = A minus B minus 1
Gnd	+5V	+5V	+5V	F = $A\bar{B}$ minus 1
+5V	Gnd	Gnd	Gnd	F = A plus AB
+5V	Gnd	Gnd	+5V	F = A plus B
+5V	Gnd	+5V	Gnd	F = [A + $\bar{B}$] plus AB
+5V	Gnd	+5V	+5V	F = AB minus 1
+5V	+5V	Gnd	Gnd	F = A + A (This results in each bit of binary A shifting to the next more significant position)
+5V	+5V	Gnd	+5V	F = [A + B] plus A
+5V	+5V	+5V	Gnd	F = [A + $\bar{B}$] plus A
+5V	+5V	+5V	+5V	F = A minus 1

Logic Functions—In this mode of operation, the internal "Carry" is disabled; thus, each word bit is handled individually, regardless of the logic states of the other bits. Connect IC pin 8 to +5-volts.

THE DIGI DESIGNER INCLUDES A POWER SUPPLY AND CLOCK GENERATOR and uses them for powering and operating the logic and digital circuits you may breadboard. Bounce-less switches, lamp drivers and other circuits and operating details are in the December 1972 issue.



All resistors ¼ watt 10% unless noted
R1 thru R10—1000 ohms
R11, R13—100 ohms
R12—100 ohms, trimmer
R14—150 ohms
R15—220 ohms
R16 thru R19—22,000 ohms
All capacitors 15V ceramic unless noted
C1—300-µF electrolytic
C2—30-µF electrolytic
C3—3-µF electrolytic
C4—0.3 µF
C5—0.03 µF
C6—0.003 µF
C7, C8—0.1-µF 400V
C9—3000-µF electrolytic

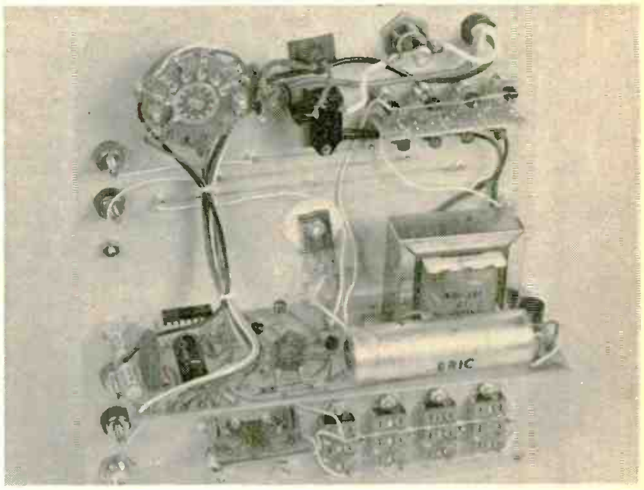
Q1, Q2, Q4 thru Q12—2N5129
Q3—TIP3055 or 2N3055
IC1—SN7405
IC2—SN7400
D1, D2, D3—1N914 or 1N4148
RECT—Full-wave bridge rectifier, 1 amp, 100 piv
T1—117 Vac primary, 6.3V secondary, 1.2A (Stancor No. P6134 or equal)
S1—single pole, 7-position, non-shorting selector switch
S2, S3—spdt mometary pushbutton
S4—spst toggle
S5 thru S8—spdt toggle
LM1 thru LM5—5V, 50mA lamps
SOCKET—EL breadboarding socket SK-10
J1 thru J29—EL breading pins

J30, J31, J33, J34—Five-way binding posts
J32—BNC panel connector
Misc:—PC boards, DIP sockets, case, etc.
A complete kit of all parts needed to build the Digi-Designer, including a case, is available for $49.95 including postage. An SK-10 socket and 29 breading pins are available for $24.95, postpaid. E. L. Instruments, Inc., 61 First Street, Derby, Conn. 06418.
Kit DES-1, consisting of the IC's needed to perform the experiments described in this article (3-SN7400, 4-SN7490, and 1-SN74181 selected for the computer circuit described is available for $17.95, postpaid, from Electronetics Co., Inc., P.O. Box 278, Cranbury, N.J. 08512.

Function-Select				Function
S5	S6	S7	S8	
Gnd	Gnd	Gnd	Gnd	F = $\overline{A}$ (Inverter)
Gnd	Gnd	Gnd	+5V	F = $\overline{A + B}$ (Nor)
Gnd	Gnd	+5V	Gnd	F = $\overline{A}B$
Gnd	Gnd	+5V	+5V	F = Logical 0
Gnd	+5V	Gnd	Gnd	F = $\overline{AB}$ (Nand)
Gnd	+5V	Gnd	+5V	F = $\overline{B}$ (Inverter)
Gnd	+5V	+5V	Gnd	F = A ⊕ B (EXCLUSIVE-OR)
Gnd	+5V	+5V	+5V	F = $A\overline{B}$
+5V	Gnd	Gnd	Gnd	F = $\overline{A}$ + B
+5V	Gnd	Gnd	+5V	F = A ⊕ B (EXCLUSIVE-NOR)
+5V	Gnd	+5V	Gnd	F = B
+5V	Gnd	+5V	+5V	F = AB (And)
+5V	+5V	Gnd	Gnd	F = Logical 1
+5V	+5V	Gnd	+5V	F = A + $\overline{B}$
+5V	+5V	+5V	Gnd	F = A + B (OR)
+5V	+5V	+5V	+5V	F = A

NOTE: A + B is read "A or B"
AB is read "A and B"
$\overline{A}$ is read "not A".
The bar over a letter or a number indicates a NOT function, so $\overline{B}$ is read as NOT B.
The plus sign within a circle indicates an EXCLUSIVE OR operation.
Plus *signs* represent logical OR operation whereas arithmetic functions are spelled out.
These are logical expressions in Boolean algebra.

In addition to the arithmetic and logic functions shown above, the SN74181 computer circuit also provides a versatile digital comparator function. Connect IC pin 8 to ground, IC pin 16 to one of the lamp indicators, and IC pin 7 as shown in the following table:



Comparator Functions

Function-Select				IC Pin	If Lamp	This Means
S5	S6	S7	S8	No. 7	is	That
Gnd	+5V	+5V	Gnd	Gnd	On	A ≤ B
Gnd	+5V	+5V	Gnd	+5V	On	A < B
Gnd	+5V	+5V	Gnd	Gnd	Off	A > B
Gnd	+5V	+5V	Gnd	+5V	Off	A ≥ B

I think that these examples have shown you how you can make use of your Digi-Designer to conveniently design, assemble, and test relatively complex digital circuits, even a small computer, without soldering . . . and in only a few minutes. **R-E**

the state of SOLID STATE

Of prime interest this month are a bunch of new IC's. The most exotic include a complete transmitter on a chip and a pressure transducer.

by **LOU GARNER**
SEMICONDUCTOR EDITOR

IF YOU'VE EVER CONSIDERED ASSEMBLING a subminiature AM transmitter, chances are you've thought in terms of a barely stable, limited performance modulated oscillator using one or two transistors. After all, a subminiature design is not compatible with the handful of components needed for a crystal-controlled oscillator, buffer amplifier, power stage, audio preamp, and modulator. *No longer!*

A new semiconductor device recently introduced by a West Coast manufacturer, Lithic Systems, Inc. (10010 Imperial Ave., P.O. Box 869, Cupertino, Calif. 95014), permits the assembly of a subminiature design with all the operational features, except for power output, of a commercial quality multistage transmitter.

Called "the world's first radio transmitter on a chip," the new device, designated the type LP2000 *Microtransmitter*, is a monolithic IC assembled in a 10-pin hermetic TO-100 package. Its functional block diagram is given in Fig. 1-a, its internal schematic in Fig. 1-b. As shown, the device comprises an oscillator, two rf buffer amplifiers, a power output stage, a combination audio preamp or code generator, a unique transformerless modulator, and a latching-type power regulator using a total of 16 transistors, 5 diodes and 9 resistors. Designed for operation on dc power supplies furnishings from 3 to 15 volts, the LP2000 is capable of supplying up to 100 mW of pulse modulated or CW rf or a 50 mW AM signal at 27 MHz. Its intended applications are in hand-held, mobile, airborne and marine two-way radio equipment, as well as in R/C, biomedical monitoring, security alarm, and short-range telemetry systems.

Referring to Fig. 1-b, the LP2000's power supply regulator/latch circuit consists of transistors Q1, Q2, Q3, Q4, Q5, Q6 and Q7, plus diodes D1, D2 and D3. Q8 is used as the oscillator and may be crystal-controlled. Q12 and Q13, together with diodes D4 and D5, make up the rf buffer amplifiers, while Q15 is the final power output stage. The audio preamp, which also can be used as a tone coding generator, consists of Q9, Q10 and Q11, with Q14 serving as the driver and Q16 as the final stage modulators.

A typical 27-MHz AM transmitter circuit, as suggested by the manufacturer for the LP2000, is illustrated in Fig. 2. According to Lithic Systems, this design can furnish 100 mW CW output, requiring 50 mA from a 12-volt supply, or 50 mW when operated as an AM transmitter, using 28 mA from its dc source. In the AM mode, it will accept up to 90% modulation with less than 10% distortion.

Available in quantity directly

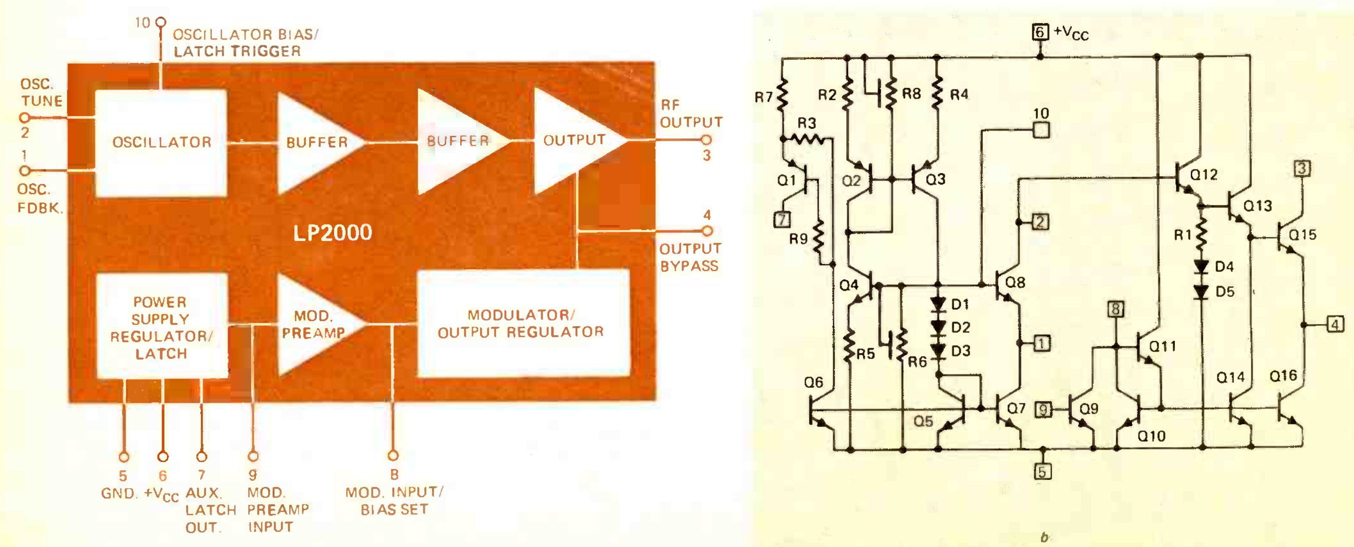


FIG. 1—FUNCTIONAL (a) AND SCHEMATIC (b) diagrams of the LP2000 microtransmitter IC.

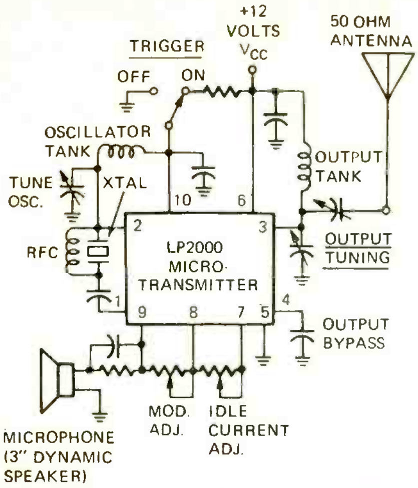


FIG. 2—SCHEMATIC OF A COMPLETE 27 MHZ AM transmitter using the LP2000.

from the manufacturer, the LP2000 may be purchased in small quantities and single units from *Circuit Specialists* (P.O. Box 3047, Scottsdale, Ariz. 85257). The distributor's single unit price is $16.00, plus postage and, if applicable, sales tax.

Product/device news

The National Semiconductor Corporation (2900 Semiconductor Drive, Santa Clara, Calif. 95051) has introduced a number of interesting new devices, including the world's first semiconductor absolute pressure transducer, a dual audio amplifier IC, and a complete digital clock circuit on a single monolithic chip.

Intended for a wide range of applications in fuel metering and ignition controls, heating, refrigeration, automotive safety and diagnostic controls, utility metering and fluid or pneumatic systems proportional controls, the new pressure transducer, designated type LX1600A, contains four functional transduction elements in a single hybrid IC package—diaphragm-vacuum reference, a piezoelectric sensor, a signal discriminator-conditioner, and a signal amplifier-processor. The first three elements are contained in one silicon die, while the fourth is provided by a standard linear operational amplifier. Illustrated in Fig. 3, the LX1600A is supplied with a calibrated range between 0 and 15 psi, but can be used up to 27 psi. In operation, the device is equivalent to a simple potentiometer without loading problems, having an input impedance in the thousands of ohms and an output impedance measured in megohms, thus providing protection for both input overvoltage and output short circuits. The device's maximum output is 5 mA, its maximum excitation voltage 30 Vdc.

National's new dual audio amplifier, type LM377, can provide up to 2 watts of continuous rms power into 8-ohm loads on each of its two channels while providing complete short-circuit protection and thermal limiting. It has an input impedance in excess of 10 megohms, making it ideal for use with ceramic phono cartridges. Assembled in an 8-pin dual-in-line batwing heat sink package, the LM377 can provide 100 dB gain with a maximum distortion of only 0.5% at 1 kHs. It is designed for operation on an 18-volt dc source and has an internal power supply regulator.

Identified as the MM5314 series, National's new digital clock IC's contain all of the counting, decoding and multiplexing circuitry required for 4-or 6-digit electronic clocks. Intended for operation on a single 11 to 19-volt supply and a half-wave rectified 50 or 60 Hz input, the new devices are designed to work with inexpensive plastic transistors for digit and segment driving of standard LED's or incandescent displays.

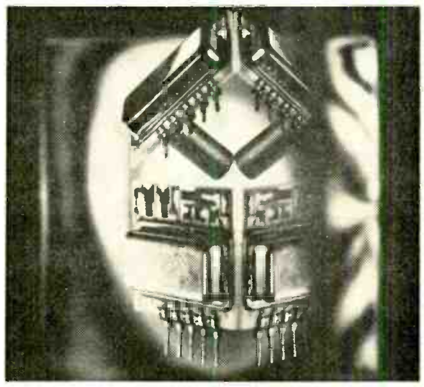


FIG. 3—NATIONAL SEMICONDUCTOR'S LX1600A absolute pressure transducer IC.

FIG. 4—TI'S NEW SN54/74284 AND SN54/74285 digital ICs.

Two new TTL/LSI IC's from Texas Instruments, Inc. (P.O. Box 5012, Dallas, Tex. 75222) can be used together to generate an eight-bit binary product in only 40 nanoseconds. Designated types SN54/74284 and SN54/74285, these 4-bit-by-4-bit parallel binary multipliers each contain the equivalent of over 200 gates on a monolithic chip. Illustrated in Fig. 4, the new units are fully TTL/DTL compatible. The devices are offered in 16-pin plastic and ceramic DIP's as well as in ceramic flat packs.

Motorola Semiconductor Products, Inc. (P.O. Box 20912, Phoenix, Ariz. 85036) has introduced four new high-threshold logic (or HTL) IC's intended for use in demanding commercial and industrial applications, such as machine tool and process controllers, computer peripherals, appliances, measuring and dispensing equipment, and so on. The new devices include the MC686, a 4-bit shift register, the MC684, a decade counter, the MC685, a binary counter, and the MC688, a dual J-K flip-flop. With a typical switching threshold of 7.5 volts and a dc noise margin of (typically) 6 volts, all four units are designed for operation on a 15-volt dc source. Shown in Fig. 5, each of the four new HTL devices is available in either black plastic or ceramic DIP's. Depending on type, unit prices range from $2.55 to $6.30.

FIG. 5—HTL DEVICES RECENTLY INTRODUCED by Motorola.

A new high-voltage display-driver IC is now available from Precision Monolithics, Inc. (1500 Space Park Drive, Santa Clara, Calif. 95050). Exhibiting the highest breakdown voltages yet attained by a conventional linear processing technique, the new device, Fig. 6, is designed to drive the cathode segments of high-voltage gas discharge displays, such as the Burroughs Panaplex® and Sperry numerical display devices used in miniature calculators and electronic test instruments. Identified as the monoDRV-01, the new unit is compatible with MOS logic and has a guaranteed breakdown of 145 volts (160 volts typical), compared to the previous industry maximum in the 80 volt area. **R-E**

FIG. 6—MONO DRV-01 HIGH VOLTAGE DISPLAY DRIVER now available from Precision Monolithics, Inc.

step-by-step TV TROUBLE

Proper agc action is a prerequisite for a television picture with optimum brightness and contrast. Here is how the all-

by ART MARGOLIS

AS MENTIONED IN AN EARLIER ARTICLE concerning the agc keyer, (**Radio-Electronics**, September, 1972) there are two more agc stages, the agc amplifier and the agc delay. This month we'll discuss the agc amplifier. The delay will be covered in a future article.

Why have the amplifier and the delay? Why not just use the varying dc control voltage that comes out of the agc keyer and apply it directly to the rf and i.f. amplifiers to keep total gain constant?

It's because agc has to always be applied to the i.f. stages but only sometimes applied to the rf stage. The rf amplifier output is critical. To maintain a snow-free picture, it must be strong. That way it produces a high rf-mixer noise ratio. Such a high ratio overrides mixer noise and a snow-free display is assured.

Therefore the following agc action is desired. On strong signals agc should be applied to both rf and i.f. During medium strength signals agc should be applied to the i.f. but not the rf. When a weak signal is received no agc should be applied to the rf and little or none to the i.f.'s.

The agc amplifier takes the keyer's dc output and analyses it. During strong signals the amplifier sends plenty of signal to the delay and the i.f.'s. The delay turns on and sends a control voltage to the rf.

When medium signals are received, the amplifier sends enough voltage to the i.f.'s for control but not enough to the delay. The delay does not turn on and lets the rf amplifier run wide open.

When weak signals are received, the amplifier produces little or no output and neither the rf or i.f. are controlled. They both run at maximum gain.

Typical transistor agc amplifier

The agc amplifier receives a filtered dc control voltage from the negative end of the 8-μF filter in the keyer collector circuit. The dc that is varying slightly as a result of the height of the horizontal sync pulse in the video, is applied to the base of the agc amplifier from a voltage divider consisting of a 5000- and 33,000-ohm resistor.

The agc amplifier is forward biased by voltage from the plus 12V source. The voltage is developed as current flows from the base to the emitter and through the 470-ohm emitter resistor to the 12V source. The base is driven from the keyer through R1. Resistor R2 isolates the base from the emitter.

The dc voltage from the keyer varies with signal strength. As signal strength rises, the forward bias on the agc amplifier increases. As a result, collector current increase makes the collector more positive in voltage. A higher positive voltage is applied to the i.f. amplifiers and the delay. This tends to make them have a strong agc control.

As signal strength drops the amplifier forward bias decreases. This makes the collector less positive in voltage. Therefore less plus voltage is applied to the i.f. amplifiers and delay. This tends to reduce the agc control.

The agc delay won't turn on unless the amount of plus voltage is relatively high. The i.f.'s are controlled even though the agc amplifier voltage is not positive enough to turn on the delay.

Typically the emitter voltage is around 10V. The base is about 9.3. This gives the pnp transistor a forward bias of around 0.7V. When this bias is present the collector ends up with about 5V. This is obtained from the 12V supply through resistors R6 and R7 in series.

Agc amplifier troubleshooting

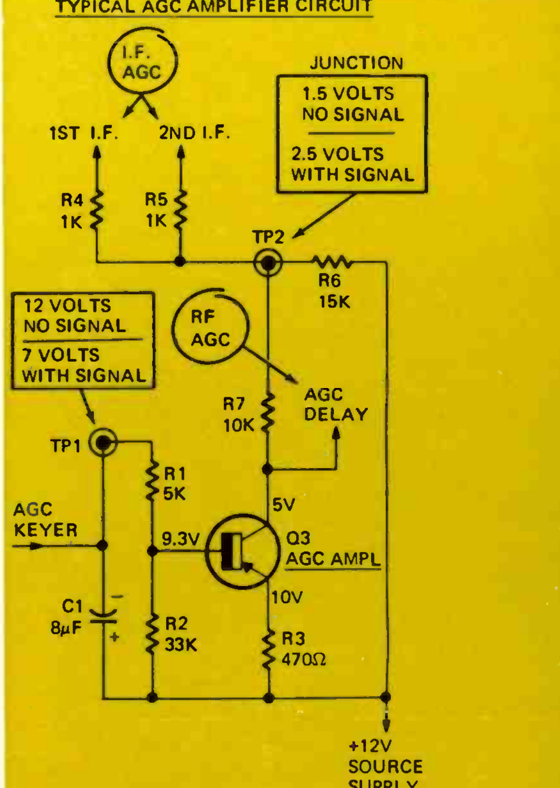
The agc amplifier circuit consists of all components clustered around its input and output. It does not include the i.f.'s, delay or keyer.

The technician arrives at the agc amplifier and considers it a trouble suspect when agc trouble is occurring and the keyer has been exonerated. Strong local channels are coming in overloaded, or not at all, while the weak distant channels are being displayed fine. Sometimes the weak channels are blanked out.

The technician has been to the first test point, TP1, the negative end of the 8-μF filter capacitor. Two dc readings were taken there. One with a strong channel tuned in and the other with the channel selector cocked between two channels. The on channel reading was between 5 and 7 volts while the off channel reading was 12 volts. The keyer is cleared of trouble.

The next test point is TP2, the junction between the 15,000-ohm and

TYPICAL AGC AMPLIFIER CIRCUIT



AN AGC AMPLIFIER is used almost universally in solid-state TV sets. Its purpose is to amplify and invert—when necessary—the varying dc voltage developed by the agc keyer.

SHOOTER'S GUIDE

that is snow-free with good horizontal and vertical sync along important agc amplifier works in solid-state TV sets.

10,000-ohm agc amplifier collector resistors. The strong channel and off channel readings are made. One of three things is noted. The vtvm shows normal readings, there's a constant low voltage or a constant higher voltage. The trouble chart shows the three pathways. You have arrived at a diagnosis except if a constant higher voltage is read, then there is excessive agc control and you go to its next step.

One side of the 10,000-ohm resistor is unsoldered and a dc voltage reading made at the junction.

The voltage will be near source or around a volt or two. If it is near 12V source, then the video i.f. stages are at fault. If the voltage is low the agc amplifier and delay become the suspects.

The next step is to resolder the resistor back in the circuit and carefully disconnect the emitter of the agc delay. Then read the test point once again. If the test-point voltage remains the same now, the trouble is in the delay circuit. However, if the test-point voltage rises high, then the agc amplifier is the guilty party.

Once the agc amplifier circuit becomes the known guilty party, the end of the job is to locate and replace the bad part.

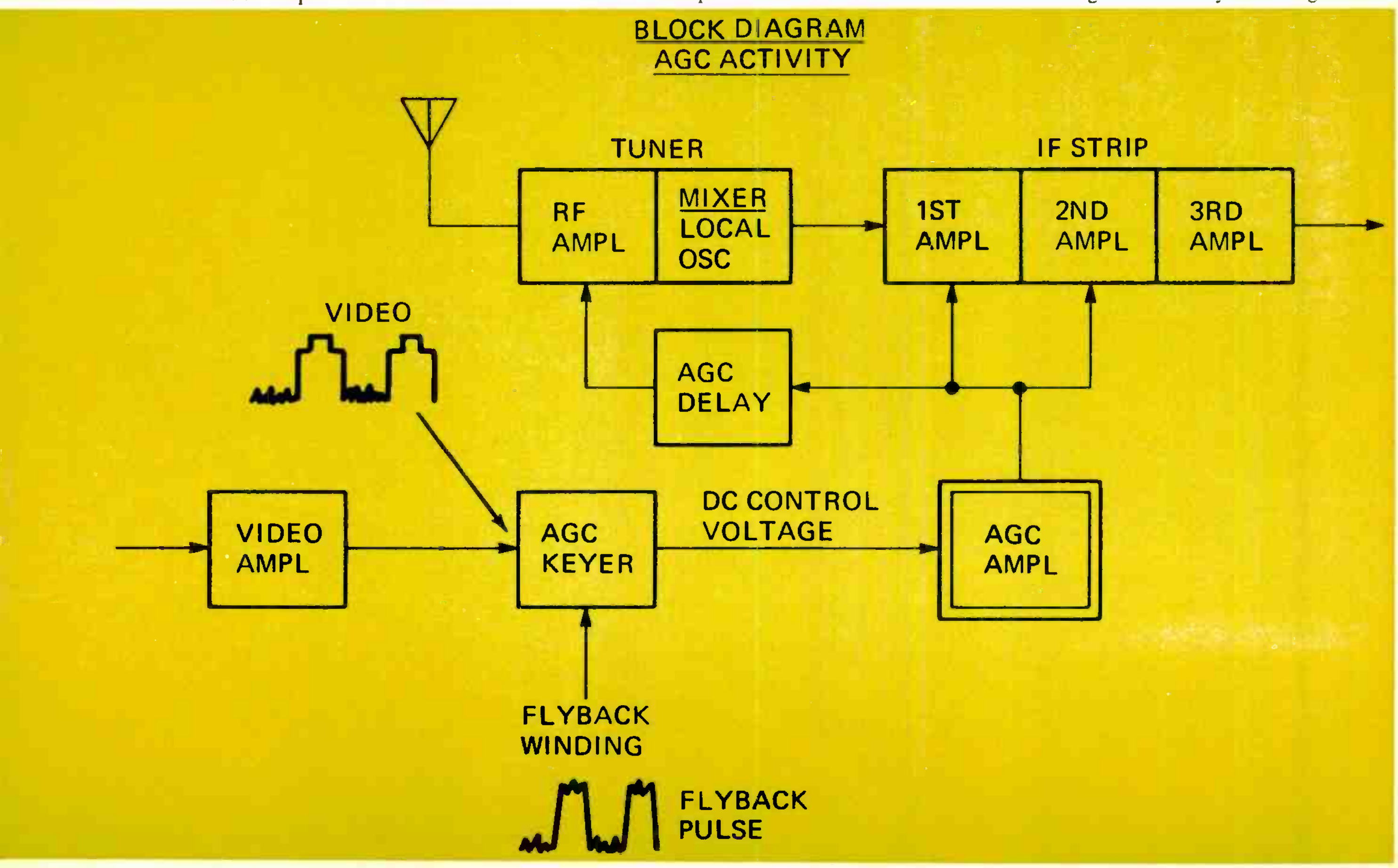
The agc amplifier is the pnp transistor with 15,000-ohm and 10,000-ohm collector resistors, 470-ohm emitter resistor and the 33,000-ohm base resistor. The 5000-ohm resistor is also involved, but it is really part of the keyer collector leg.

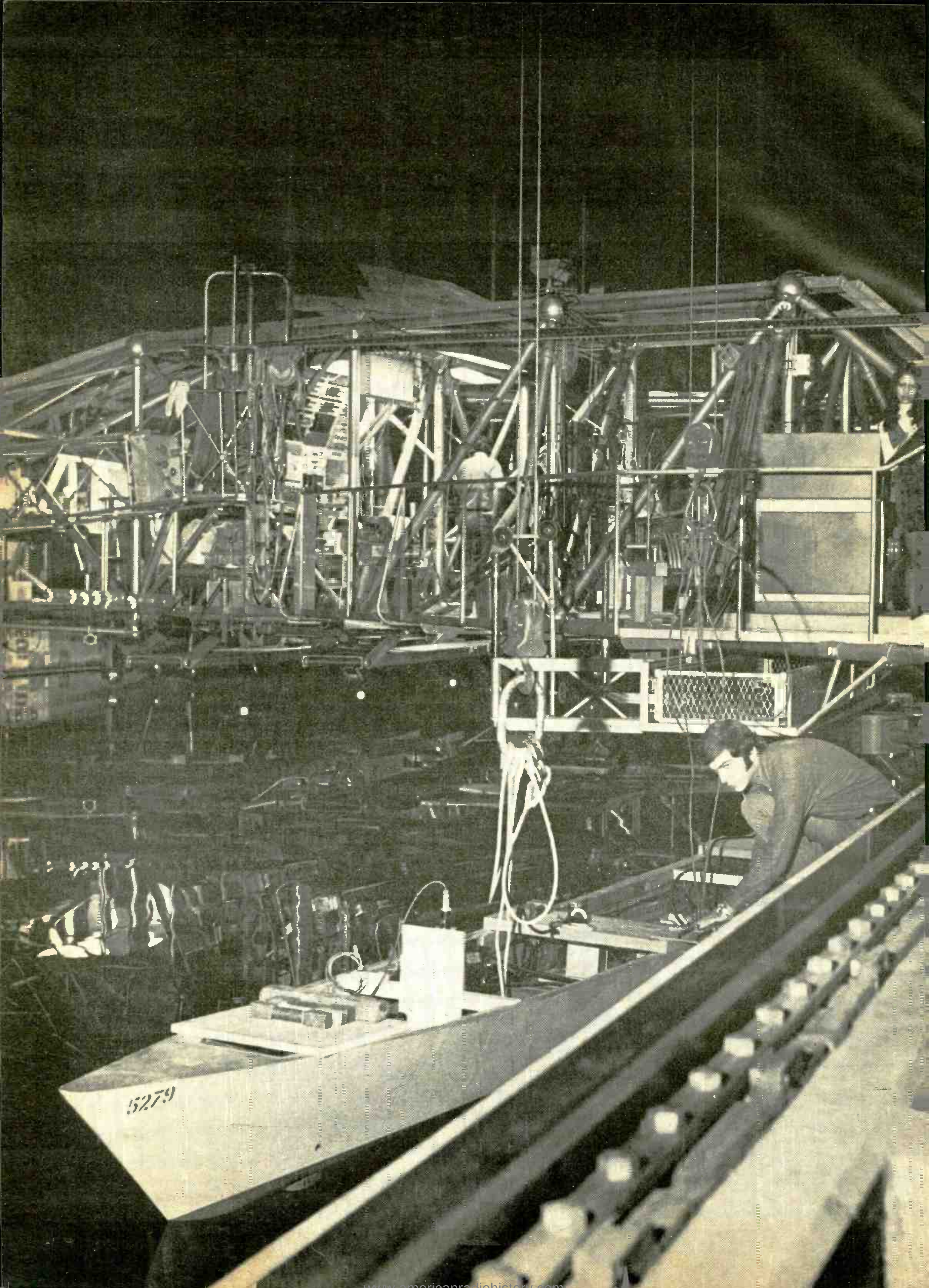
The test points now become the base, emitter and collector. Voltage tests are next, with the collector first in line.

A reading is made and the collector, when not normal, is either high or low in voltage. Since current flows from the i.f. amplifier bases and the delay emitter to the amplifier collector, they must pass through the 10,000-ohm resistor on their way. The 15,000-ohm resistor is an isolation resistor between the amplifier collector and positive 12-volt source. Note the emitter is at +10 volts.

Collector high—If the collector is high then the 15,000-ohm resistor becomes the prime suspect. It could have shorted.

Another possibility is that Q3 is conducting too heavily drawing more

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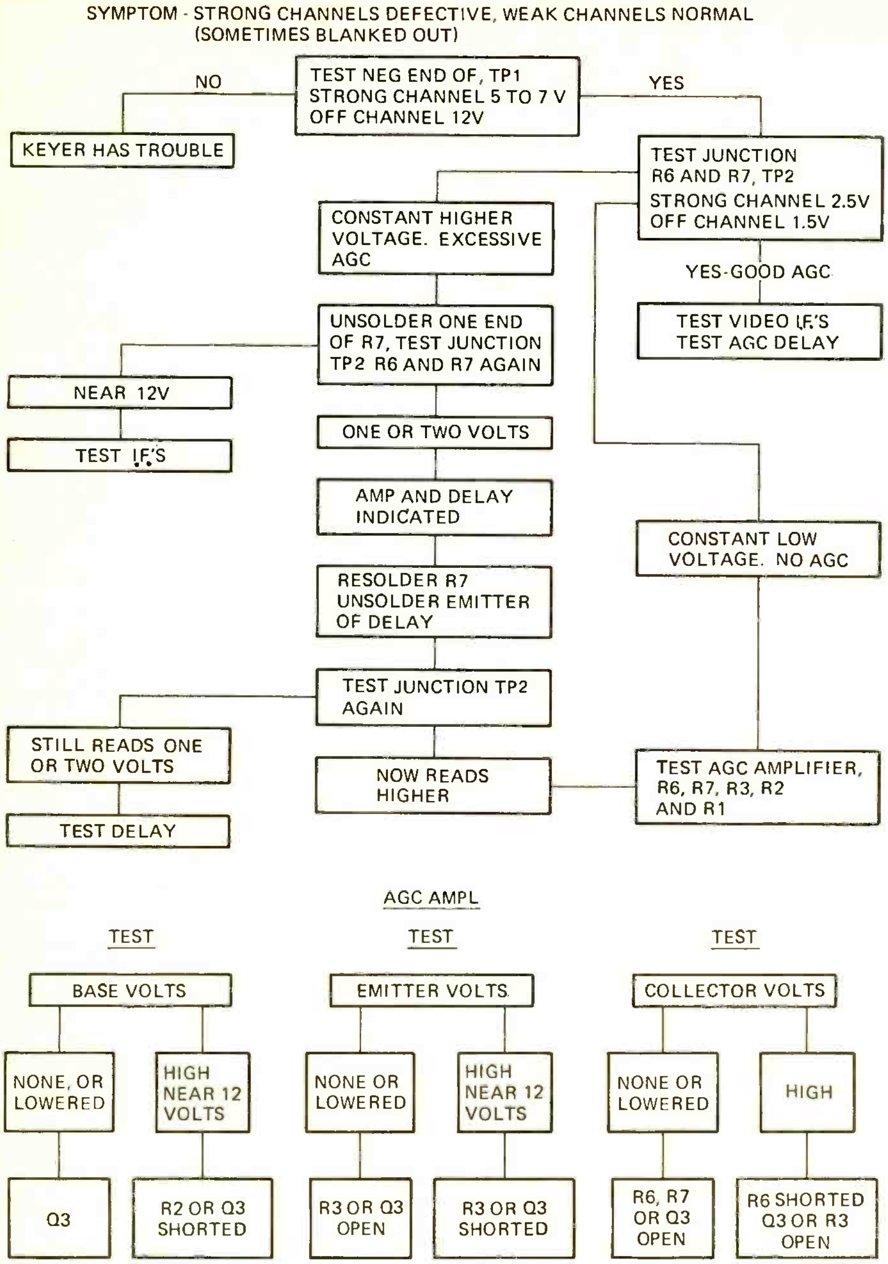


TWO TROUBLESHOOTING CHARTS help locate and repair the trouble speedily and efficiently. The top one localizes the trouble and the bottom one helps to find the defective component.

electrons from the i.f.'s and delay. This increases the positive voltage on the collector.

Q3 can conduct too heavily if it is leaky or shorted, or the 470-ohm emitter resistor becomes shorted.

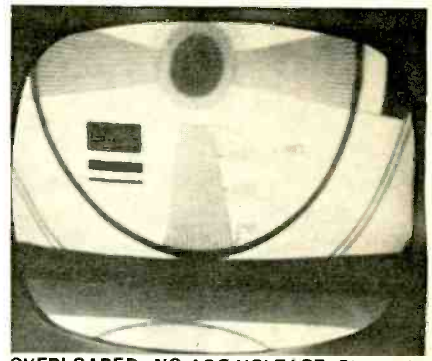
Collector low—When the collector is low, then the flow of current from the i.f.'s and delay has lessened. The collector becomes more negative, or less positive.

This can happen if the conduction of the transistor is lessened or turned off. If the 15,000-ohm resistor opens then the i.f.'s lose their base forward bias and the delay loses its emitter or forward bias. The i.f.'s and delay turn off. The amplifier collector loses its positive voltage and the amplifier turns off.

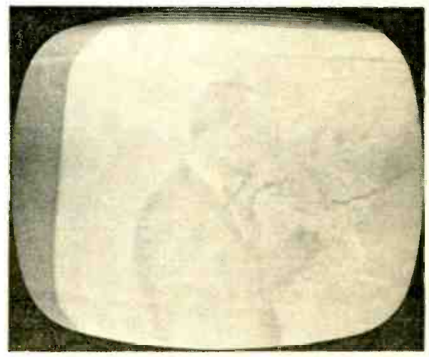
When the transistor or resistor R6 or resistor R7 opens, the collector voltage will drop all the way to zero.

Emitter—The emitter has one component attached. If the 470-ohm resistor opens the emitter loses its 10 volt potential. Should the 470-ohm resistor short, plus 12 volts will appear on the emitter. The shorting, leaking or opening up of the transistor can make the emitter voltage disappear, drop or rise to plus 12-volt source.

THE PICTURE BENDS—NOT ENOUGH AGC. Video is too strong and beginning to overload.



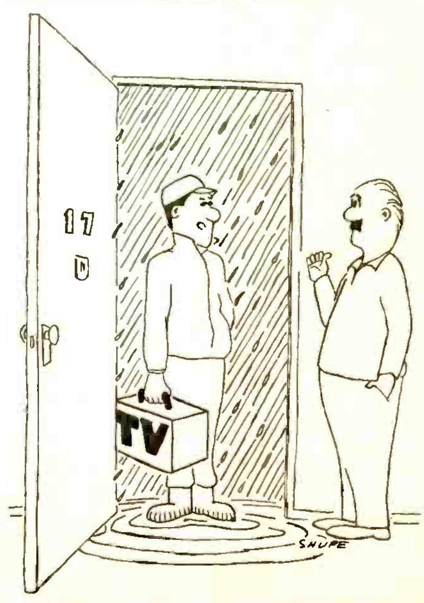
OVERLOADED—NO AGC VOLTAGE. Picture is out of sync and shows signs of overload.



WASHED OUT—TOO MUCH AGC VOLTAGE. Rf and i.f. amplifiers are tending to cut off.

Base—The base voltage is tied in with the keyer collector circuit. Since the keyer has been exonerated, the base circuit is practically given a clean bill of health too. The 33,000-ohm resistor could possibly cause the base voltage to rise, if it shorts.

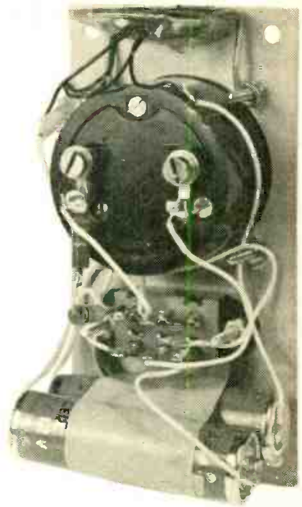
Usually though an incorrect base voltage in this case could only happen if either the emitter-base or base-collector junction shorts. Then the voltage could change. **R-E**



"What do you mean, your set 'fixed itself'?"

two-in-one light meter

This instrument combines an ordinary light meter with a color-temperature bridge. It will give you both the quality and intensity of your light



by HAROLD PALLATZ

THIS UNIT COMBINES A SIMPLIFIED color-temperature bridge[1] with a light-intensity meter. Simply flip the switch to convert from one to the other. Three convenient light-intensity ranges permit making measurements from the weakest to very high intensity illumination. Total construction cost is just over $10.00.

A little additional experimenting resulted in a truly "starved circuit," reducing the number of components to the minimum: a single resistor, a pair of cadmium sulfide (CdS) cells (98¢ pair), a meter and two penlight cells. In spite of the lack of complex parts, the accuracy will compare favorably with expensive laboratory type instruments.

Circuit theory

The color temperature meter, uses two filters, a red and a blue. Place one over each CdS cell. These form a bridge circuit (Fig. 1). The other two arms of the bridge are the penlight batteries. Under balanced conditions (where the amount of red light is equal to the amount of blue light), the zero-center microammeter will read center (or zero). Should there be more red than blue light, the meter will deflect to the left according to the amount of unbalance. Thus readings made under tungsten lamps will differ from readings made under sunlight or fluorescent lights. Since batteries make up the other two arms, and their impedance is low, bridge sensitivity is maximum. While I made no attempt to do so, it is possible to calibrate your meter dial directly in degrees K (Kelvin).

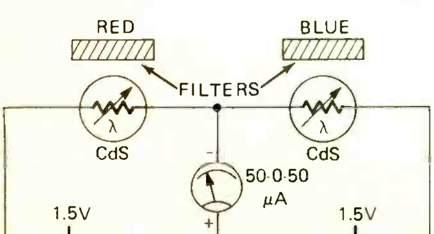
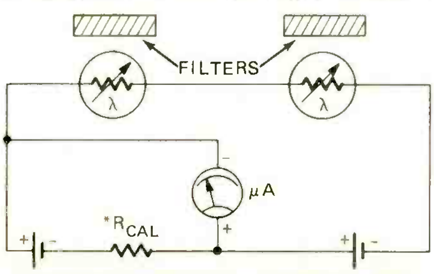


FIG. 1—COLOR TEMPERATURE METER is a bridge that balances red and blue light.

MATERIALS LIST

Meter, 50-0-50 microamperes. Calrad CMO 38-3
Case, 4" x 2⅛" x 1⅝". Olson Radio CA 356 $1.09
Photocells (2), cadmium sulfide. Resistance range 200 ohms to 1 meg, sensitivity 500-600 Angstroms. 150 Vdc max, 150 mW. Olson Radio TR-091 98¢ pair
Switch, slide type, dpdt with center OFF position. Calrad SS-7
Penlight cells (2), leakproof type. Size AA
Resistor, calibrating (approx) 18,000 ohms, ½ watt
Red filter* Note; these filters can be made with transparent dial light dip paint.
Blue filter*
Parts may be purchased at Olson Electronics 260 S. Forge Street, Akron, OH 44327, Radio Shack Corporation, 730 Commonwealth Ave., Boston, Mass. 02215, and Lafayette Radio, 111 Jericho Toke., Syosset, L.I., NY 11791
*Filters are also available from Edmund Scientific Company, Barrington, NJ 08007
For red use Edmund No. 82,015 (Medium Red). For blue use Edmund No. 82,033 (Light Blue). They come in sheets 20 x 24 inches and are $2.50 each. Also available from Edmund is a small Color Filter Sample Book. This has all their colors (size 1 x 4) and costs $1.50. (use No. 40,675 for ordering the book).



*ADJUST VALUE OF R_{CAL} (APPROX. 18K) TO READ EXACTLY FULL SCALE (AT FULL LEFT) WITH ZERO LIGHT ILLUMINATION ON Cd CELLS.

FIG. 2—LIGHT INTENSITY is measured by one cell; the other supplies a bucking voltage.

The light intensity meter is conventional. The two CdS cells are in series with the meter and a single battery. The second battery (Fig. 2) is connected in reverse through a calibrating resistor to bias the meter from its normally zero center position to full left scale deflection with zero light intensity. Thus the full meter swing can be realized. The circuit serves a second function, that of a battery check. The batteries should be changed when full left deflection is off by more than one division. Under normal conditions, you should realize almost as normal shelf life (one year) of the batteries.

The basic range of our instrument was found to be 8 foot-candles (at full scale). A white cardboard disk (Fig. 3)

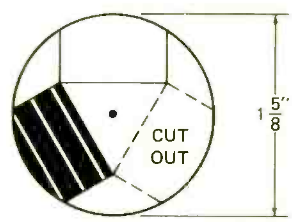


FIG. 3—RANGE EXTENDER, three shields that let the filters get more or less light.

was cut out to increase the light range 10 times (0 to 80 foot-candles). I used the cardboard wrapper of CONTAC Cold Capsules. It is also possible to use a piece of metal with small holes pierced in it. For the HIGH range (0 to 800 foot-candles), I drew India ink stripes on a sector of the disk. The first results with the ink showed that too much light still passed through the cardboard, so some black plastic tape was added. This did the trick.

Construction

Use template (Fig. 4) for the panel layout. A battery clip cannot be used because the Olson meter case is a squeeze fit. Solder the wires directly to the battery terminals. Solder fast, using a minimum of heat, or battery life may be reduced. The meter hole required proved to be 1/32-inch larger than a standard 1½-inch socket punch. Use a half-round file and apply muscle! The slide switch (must be of the center OFF type dpdt), requires a ¼ x ½-inch rectangular hole. Drill quarter-inch holes

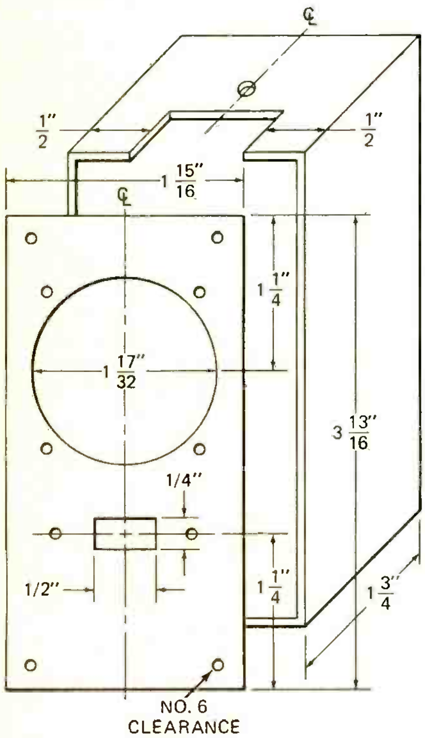


FIG. 4—TEMPLATE FOR METER PANEL.

and file to shape. After all work is completed on the panel, go over its surface with fine steel wool to remove nicks and scratches and provide "tooth" for the paint. We used Dove Grey (Krylon 1605) spray enamel to finish the panel. Use press-on decals for the lettering.

The red and blue filters may be made of sheet cellophane, or purchased glass filters may be used. You can also use transparent paint (such as General Cements Dial Light Color Kit 66-6). I suggest that rather than coat the face of the CdS cell directly (it might craze the plastic shell), use transparent tape and coat that instead. Both the red and blue should transmit light approximately equally. You can check the light transmission by switching your meter to L and placing a filter in front of both cells. Then try the other color. Readings should fall within one meter division. The photocells were set in the top of the case, near the front, close enough together so that they would be covered by any section of the light extender.

Fig. 5 is the complete circuit dia-

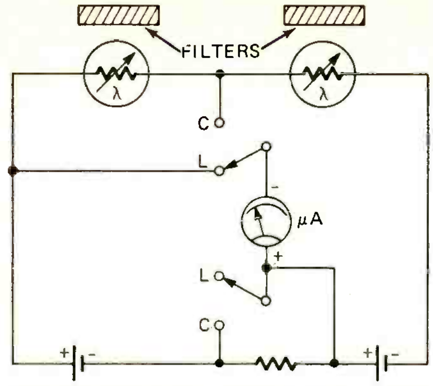


FIG. 5—COMBINED CIRCUIT, with a dpdt switch. Center position of the switch is OFF.

gram. Always use fresh new batteries. Our battery is held down with a piece of stiff wire (taped to the batteries) and wrapped around the slide switch mounting screws. Transparent tape is used to hold the CdS cells in place, the tape holding the cells to the meter mounting screws.

Calibration

The color balance meter may be

Color-temperature chart of common light sources

Color Temp (°Kelvin)	Source
1900	Plumbers candle
2760	40-watt tungsten lamp
2865	100-watt tungsten lamp
3200	G-E Mazda 3,200K lamp
3400	Photoflood lamp
3000	Warm white fluorescent
4500	Cool white fluorescent
6500	Daylight fluorescent
5400	Noonday sun
6500	Overcast sky

calibrated directly in degrees K (Kelvin) by using the table. Where maximum precision is desired, make this calibration at some constant level of illumination (such as 4 C.P. or half scale on the meter), by sliding the switch to the L setting. Then return to the C setting for the color calibration. Noonday sunlight is 5,400° K. An overcast sky runs 6,500° K. A photoflood lamp is 3,400° K, a 100-watt tungsten lamp 2,865° K. Where a particular color temperature falls on your meter dial will be primarily related to the red and blue filter you have used. Thus every instrument will read somewhat different. Once calibrated, the repeatability will be good and reference chart can be made up and pasted on the bottom of the meter case. If you wish, it would be possible to calibrate the meter dial directly. This is not advised—you must be very careful when removing the protecting meter cover—the slightest dust or iron filing will impair meter operation. The color balance readings will hold true for a wide range of light intensity levels. Near zero illumination levels, do not expect consistant color temperature results.[2,4].

The L light intensity range is most easily calibrated by direct comparison with another light meter. Your local photographic store may let you compare your meter with theirs. Our meter turned out to have a basic 0–8 foot-candle range. Your range will depend upon the CdS cells used, their placement inside the case and a number of other factors such as case opening size, meter sensitivity, battery voltage. You can use the table for a cross-check of illumination light values[2,5]. The light intensity values can be made into a reference chart or marked directly on the meter face.

Applications

In color photography, it is very important to know the color temperature of the light source if perfect color pictures are to be made. This may be easy when photographing under a noonday sun, but what is the temperature at early morning or at sunset? Your meter will give an instant answer. Also when sunlight is mixed with fluorescent or tungsten light the color balance of the light must be measured accurately if the best results are to be achieved. You can also test out the color value of photographic filters by inserting the filter in front of the meter and noting the readings. You can also check your 3,200° K color photography lamps to see how close they are to new condition.

The photographic applications for the intensity function will be numerous[2,5]. You can use it for enlarging by placing the meter directly on the easel and adjusting the diaphram for some known reading. A constant meter reading will mean a constant exposure time. Twice the light reading means that the exposure should be cut in half. You can also use the meter for picture taking [3], but a discussion of the various exposure times, *f* stops and film speed relationships are beyond the scope of this article. It is possible to purchase a small exposure-guide calculator in most photo shops and convert your meter readings directly to exposure values by using them together. **R-E**

References

1. Zworykin and Ramberg, *Photoelectricity and Its Applications*, 272, bridge circuit for determining color temperature of a lamp.
2. Ibid, page 19. Temperature and brightness table.
3. Ibid, pages 292-293, measurement of photographic exposure.
4. Clark, Walter, *Photography by Infrared*, John Wiley & Sons. Page 139, color temperature table.
5. Barrows, *Light, Photometry and Illumination*, McGraw Hill Co. (1912). Page 38, brightness of light sources table.

R-E's Service Clinic

Intermittents—how to locate them

A little heat, a little cold—fine intermittent locator

by JACK DARR
SERVICE EDITOR

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

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

LET'S HAVE A FEW WORDS ABOUT INtermittents. Not the words normally used around the shop; this magazine must go through the mails. First, let's look at a few facts about these infuriating things.

An intermittent is just that; something which makes intermittent *contact* in a circuit. It can be a short, but most of the tougher ones seem to be opens. They can be broken down into two general types—the "physical" or jar-intermittent, where you can make it act up by tapping the chassis; and the thermal, caused by heat.

The "jar" intermittents are much easier to find. By tapping the chassis very carefully you can find the most "sensitive" area, and from this point, it's not too hard to locate a guilty part or solder joint. The eraser of a lead-pencil makes a dandy tapper.

Thermals are tougher. Even in a transistor chassis, you're going to find thermal intermittents. This is especially true of those "long-term" intermittents that cut out once a day. Something in there is getting hot and expanding. The circuit opens (or shorts to other parts) and there you are. In the standard thermal no amount of jarring the chassis (or kicking the cabinet) will faze it.

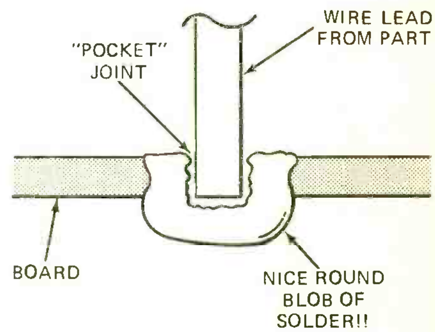
There are a couple of tricks you can play on these. One is running the set with the ac line voltage just a little above normal. This won't hurt anything unless you leave it on for too long. The high line voltage will raise the dc voltages. It will also raise the temperature of things and make the intermittent more apt to act up. If this doesn't work, try running it with line voltage a little below normal. This leaves things a little cooler than they usually are.

Determine the characteristics of the trouble. Does it cut out once a day, every 2-3 days, every hour or so, etc. Questioning the owner is a very good way to get this information. If this is a long-term intermittent, and irregular, the chances are that it is a thermal.

There's a division here. If the intermittent shows up within a short time after the set's turned on, say 5 to 10 minutes, the chances are that it is in some part which generates its own heat; a current-carrying resistor and so on. Solder joints are frequent offenders in this category.

The other and much more difficult type, is the long-term intermittent. These show up at irregular intervals, from hours to days. They're also thermal, but are caused by "conducted" heat, from other parts on the chassis getting hot. This heat is conducted through the chassis, or the air. In "touchy" intermittents, the frequency of cut-out often depends greatly on the ambient temperature. (We'll show you a real wowser like this in a moment!)

In both types, heat is the trouble-maker. It causes physical movement of the part, making or breaking contact. This can be as little as a thousandth of an inch, if it's inside a resistor, coil, or capacitor, but it's enough! Printed-circuit board solder joints are frequent offenders. A "pocket joint" (see diagram) can make perfect contact. But if



the board expands slightly, whammo. If you suspect this, you can "get out the shotgun"; remelt and resolder *all* solder-joints in the area of the trouble. You may never know which one it was, but you'll fix it.

Isolation

The first thing you must do is isolate the area of trouble. From the characteristics, you know *about* where it is; that is, signal circuits, sync, sweep. Observing the characteristics will give you clues. Now, check every part of the circuit that could affect that particular function.

Now, see if you can make it show up. To do this, you can either apply more heat, or less heat—cool it. The reaction to these tests will give you a lot of data and that's what you need. You can apply heat with a heat-lamp, or by touching the suspected part with the tip of a soldering iron, or by blowing hot air on it with a heat-gun or old hair-drier. Cooling is much easier. The spray-can coolant is a very useful weapon for locating intermittents.

Here's a good example. I had a Zenith color TV set on the bench. The picture flickered on and off at highly irregular intervals, leaving a white screen. This was a very fast flicker, sometimes repeated three or four times. After doing this, it would play for a couple of hours. In fact, it sat on the bench under observation for two days; no flicker! Fortunately for my production ratio, I was working on other things at the same time!

Then I got after it in earnest. Turning it on, I waited. This time, it started to flicker in only about 20 minutes. A quick check with the scope and a crystal-detector probe showed a steady signal at the i.f. input, and a severe flicker at the video detector output. So, I had it pinned down; it was in the i.f. (Clamping acc made no difference.)

Now I made thermal tests. With a junk hair-drier which still worked, I blew hot air on the i.f. stages. On the first and second stages, no result. As soon as I hit the last i.f. stage and detector, wham! It started flickering like mad. To verify this, I blew spray coolant on it. The picture came back as steady as a rock. Now I had it.

The i.f. stage in these sets can be taken out in toto, by pulling off some push-on connectors and taking out three screws. Making up a set of connecting leads, I put it on the bench and turned it on. Despite a tendency to oscillate, it worked well enough for testing. I checked each part in the output stage, by touching it with the tip of a soldering iron. When I hit the output transistor, out it went!

Verifying this, I sprayed the thing with coolant. It came back on. Replacing this transistor cleared up the trouble. Hooking the original transistor to a curve tracer, it checked perfectly. Heating it with the soldering iron, in about 20 seconds it went to the horizontal line; it was opening up internally! Spraying it with the coolant brought it back again. I could repeat this as often as I wanted to. For a definite check, I warmed up my replacement transistor with the soldering iron. Absolutely no change in the picture.

About this time, someone will say "But you'll ruin those delicate transistors, heating them up like that with a soldering iron." To which I can reply, "Possibly so. However, I have never damaged one yet with this method, and I've *tried!*"

I will admit that I've been guilty of saying that there was no such thing as an intermittent transistor. I stopped this; people kept sending me intermittent transistors, and I kept finding them in sets I was working on.

They *can* be thermal. In fact, a post-mortem analysis of the case of the Zenith brought out an interesting fact. The reason it sat on the bench and played for two days was that during those days the shop *air-conditioner* was running, and blowing right at it! On the day that it started cutting out, the air conditioner was turned off! This comparatively small difference in the ambient temperature was enough to make it start acting up.

There are many ways you can go after this kind of trouble; don't ne-

(continued on page 78)

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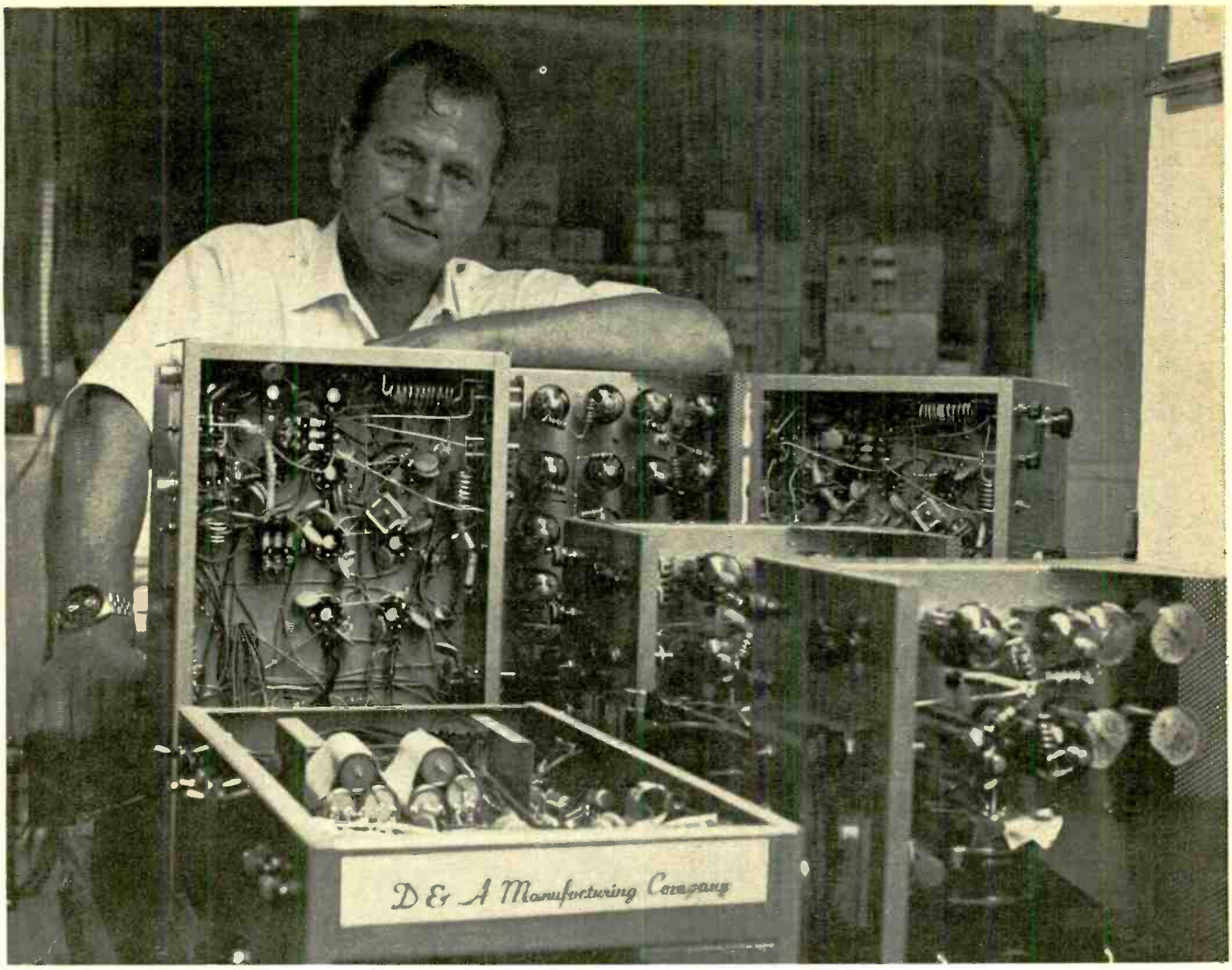

D & A Manufacturing Company

SERVICE CLINIC
(continued from page 72)

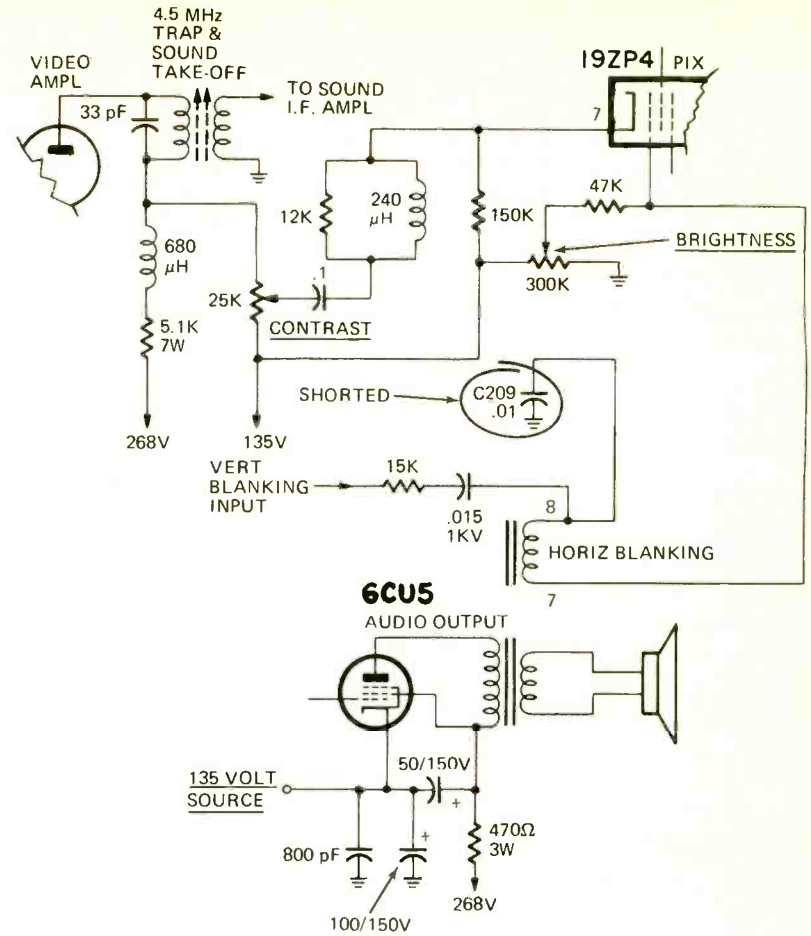
glect any of them. You can jar it, you can change the supply voltage, or you can heat it or cool it. Somewhere in this list, you should be able to find something that will make it show up. When you do, you've practically got it licked. **R-E**

reader questions

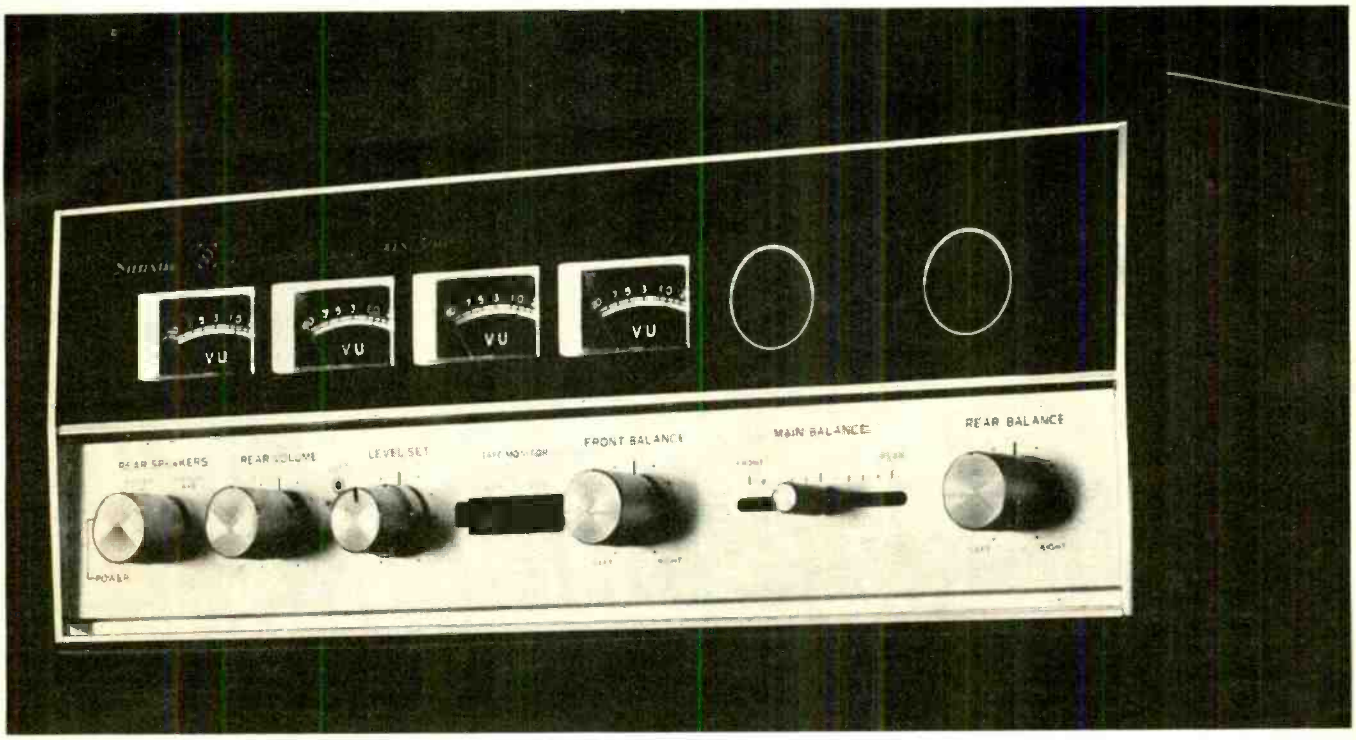
BLACKOUT EXPLANATION

In this column in the October issue Jim Franks told us about a G-E that did not display a raster until the audio output tube was pulled. The basic trouble was due to a shorted .01-μF capacitor on the blanking network. The accompanying diagram did not include the audio output circuit and the connection between the blackout and the audio circuit was not immediately obvious.

This TV receiver used a stacked B+ supply with the cathode of the audio output tube serving as the 135-
(continued on page 80)



if you go for four channel...



you don't have to go for broke

Buy yourself a miracle for as little as $214.95 That's all it takes to get your conventional two-channel stereo to do anything any total four-channel receiver and control center can do, now or in the future.

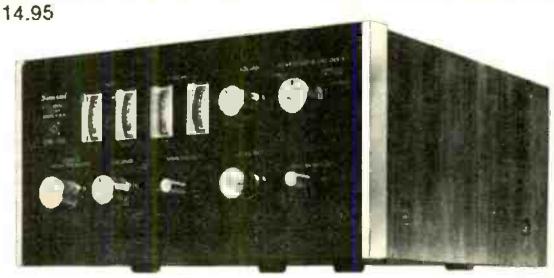
The Sansui QS500 and QS100 converters are complete Four-Channel Synthesizer-Decoder-Rear-Amplifier-and-Control-Center combinations that transform standard two-channel stereo totally. The only other equipment you need is another pair of speakers.

You can decode any compatibly matrixed four-channel broadcasts or recordings and reproduce them in four authentic channels. You can detect the ambient signals present in most two-channel recordings or broadcasts and propagate them through the rear channels. In Sansui matrixing, the exclusive phase-shift technique prevents the cancellation of some signals and the change in location of others that occur in many matrixing systems. And the exclusive phase modulators restore the effect of the live sound field.

You can plug in a four-channel reel-to-reel or cartridge deck or any other discrete source. In the future — if you should have to — you can add any adaptor, decoder or what-have-you for any four-channel system for disc or broadcast that anyone's even hinted at. And a full complement of streamlined controls lets you select any function or make any adjustment quickly and positively.

The QS500 features three balance controls for front-rear and left-right, separate positions for decoding and synthesizing, two-channel and four-channel tape monitors, electrical rotation of speaker output, alternate-pair speaker selection, and four VU meters. Total IHF power for the rear speakers is 120 watts (continuous power per channel is 40 watts at 4 ohms, 33 watts at 8 ohms), with TH or IM distortion below 0.5% over a power bandwidth of 20 to 40,000 Hz. In its own walnut cabinet, the QS500 sells for $289.95

An alternate four-channel miracle-maker is the modest but well-endowed QS100, with total IHF music power of 50 watts (continuous power per channel of 18 watts at 4 ohms and 15 watts at 8 ohms). In a walnut cabinet, it sells for $214.95



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READER QUESTIONS

(continued from page 78)

volt B+ source supplying, among other circuits, the cathode and grid of the picture tube (see diagram).

Normally, the cathode is biased at a fixed value of 120 to 130 volts and the control grid bias varies from 0 to 135 volts with the setting of the brightness control. When C209 shorted, it pulled the control-grid bias away down so the picture tube was cut off. Pulling the audio output removed +135 volts as a source of bias for the picture tube. The bias voltages—now available from the 268-volt line through interconnecting resistor networks—are such that the picture tube is biased on so the raster returns.

VERY THIN HORIZONTAL LINE

This one happened to me, and it illustrates how reasoning intelligence (and a good deal of luck) will help. (A-Hem!) There was nothing but a very thin horizontal line on the screen of this Zenith portable; only one scanning line thick, really.

Applying the standard tests, I pulled the yoke, and read the resistance; fine. Resistance of yoke section of vertical output transformer also fine. 9 ohms just as in the book. Tube good; dc voltages all good. With scope, no signal of any kind at any point in oscillator circuit.

Check all capacitors and resistors; they're good too. Now, try some of the clever little tests you keep telling other people to do, Darr. Clip lead to heater voltage at a 6-volt point. Feed this to grid of 10GK6 output section. Hmmm. Nothing. Still very thin line. Try higher voltage. 35 volts ac on grid, still nothing on screen. Up scope. Signal reads 35 volts (rms) on grid. On plate, about 2 volts peak-to-peak, at the most.

Well! Recheck dc voltages on output section just for luck. All present and accounted for. Now what's going on? Sit back and try something brand-new—THINK! *What* could cause an amplifier tube, with plenty of signal on its grid, to have absolutely zero gain?

One thing—a *load impedance* of absolutely zero ohms. Pick up ohmmeter, turn set off, read resistance of primary section of vertical output transformer. Is it 275 ohms, as it says on the schematic? It is not! It is just what you thought; absolutely zero. Replace transformer, everything lovely. (This was apparently a lead-short, from the very low resistance. It was in warranty, so I replaced it)

MORAL

There *is* always a legitimate, theoretically correct cause for everything, if you can just find it. **R-E**

EQUIPMENT REPORT

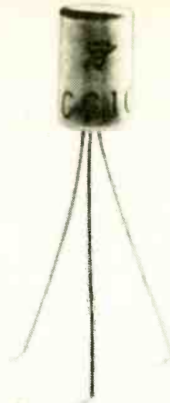
(continued from page 32)

reverse side of the chart shows a complete system hookup clearly diagramming all rear panel receiver connections.

Internal construction is on a number of printed circuit boards most of which have connectors for easy removal for repair or replacement. [Onkyo's attention to detail is completed by the inclusion of an assortment of phono plugs and speaker and line fuses along with a polishing cloth for the nicely veneered standard cabinet.]

After having seen and operated many stereo receivers in the past we are always suspicious of a new instrument. We try not to be misled by good looking mechanical construction and reserve our opinions until the equipment has been used for a few days and we are completely familiar with it. We were delighted with the TX-666 and the way it did not let us down. Take a good look at this one before making a final choice.

The TX-666 weighs 28 pounds and measures 18⅜" wide by 15⅛" deep by 5½" high. **R-E**



Our ECG 102A transistor replaces...

To Be Replaced	ECG Replacement	To Be Replaced	ECG Replacement
HB33	102A	MA393E	102A
HB54	102A	MA393G	102A
HB55	102A	MA393R	102A
HB56	102A	MA815	102A
HB75	102A	MA881	102A
HB75C	102A	MA882	102A
HB77	102A	MA883	102A
HB77B	102A	MA884	102A
HB77C	102A	MA885	102A
HB156	102A	MA886	102A
HB156C	102A	MA887	102A
HB171	102A	MA888	102A
HB172	102A	MA889	102A
HB175	102A	MA890	102A
HB176	102A	MA891	102A
HB178	102A	MA892	102A
HB186	102A	MA893	102A
HB187	102A	MA894	102A
HB263	102A	MA895	102A
HB270	102A	MA896	102A

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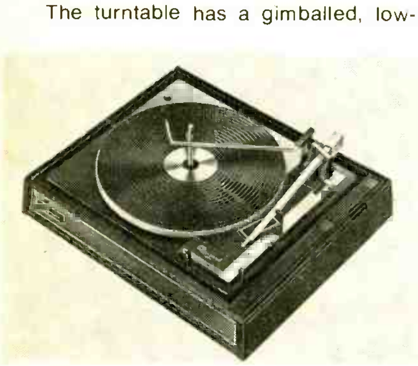
new products

More information on new products is available from the manufacturers of items identified by a Reader Service number. Use the Reader Service Card inside the back cover.

AUTOMATIC TURNTABLE, *42M Pre-Pack* includes choice of Shure or Pickering magnetic cartridge with elliptical stylus. Three-speed unit comes with base. Selected cartridge is premounted and accurately balanced in the pickup arm.

The turntable has a gimballed, low-



mass aluminum arm with a fixed counterweight balanced for the particular cartridge in the unit. A damped cueing and adjustable anti-skating device are also featured. $90.85.—**Garrard,** Div. British Industries Company, South Service Road, Westbury, N.Y. 11590.

Circle 31 on reader service card

DIGITAL ELECTRONIC CLOCK KIT, *GC-1005* employs solid-state digital circuitry with illuminated readouts for hours, minutes and seconds. The electronics is contained in one large-scale integrated circuit. Secondary solid-state circuits drive the cold-cathode readout tubes and make up the power supply section

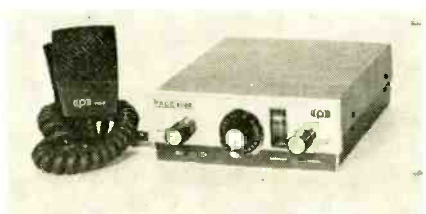
which can be pre-wired to accept either 120 or 240 Vac.

A 24-hour "beeper" alarm with seven-minute "snooze" button is included. The clock can be wired to display conventional or 24-hour international time. Alarm and time settings are made with hold-and-run switches in the clock base. Cabinet is black Cycolac with walnut-finished vinyl trim. Following the simple step-by-step assembly manual, the electronic digital clock can be assembled in two evenings; no knowledge of electronics is necessary. $54.99 plus shipping.—**Heath Company,** Benton Harbor, Mich. 49022.

Circle 100 on reader service card

CB TRANSCEIVER, *Prestige 2300* has easy-to-read dial indicator for quick channel identification. An accessory plug is provided for remote operation. In addition to operating in the AM mode for all 23 channels, the model may be used to monitor any of the 46 SSB channels in the Class D frequency.

Works on 12 volts dc. Model *P5804A*



regulated power supply provides for easy conversion to base operation. A locking mobile mount and plug-in high-impedance ceramic microphone are included. Remote speaker and public address features are also provided.—**Pace Communications,** Pathcom, Inc., P.O. Box 306, Harbor City, Calif. 90710.

Circle 32 on reader service card

CAR STEREO TAPE PLAYER, *C976* is a theft-proof 8-track AM-FM-FM MPX car stereo tape player that is easily and professionally installed into the dash.

It features: five pushbutton AM/FM tuning, 8 watts output per channel on

FM and tape, local/distant switch, volume and tone controls, front-to-rear and left-to-right balance control and automatic and manual track switching.

The unit has a solid-state chassis with 18 transistors, 12 diodes and 4 integrated circuits and operates from 12 volts dc. Output impedence for the matched 4-speaker system is 8 ohms.

7⅝" x 3⅜" x 7"; 8.8 lbs.—**Audiovox Corporation,** 150 Marcus Blvd., Hauppauge, N.Y. 11787.

Circle 33 on reader service card

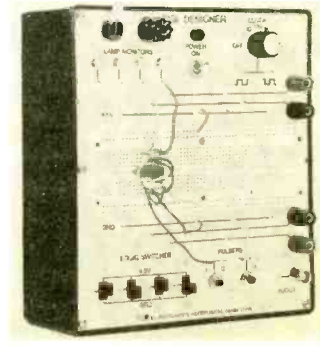
CASSETTE TAPES, *Professional series 261* uses wide-range full-fidelity tape. Torque-control liners are made of graphite coated polyester and the case is high-impact plastic with sealer windows. Tape guide system has lubricated stain-

less steel pins with rotating guide rollers.

Packed in unbreakable plastic albums, prices are $1.80, $1.85, $2.90 and $3.45 for 40-, 60-, 90- and 120-minute tape cassettes.—**Irish Magnetic Tape,** 270-278 Newton Road, Plainview, N.Y. 11803.

Circle 34 on reader service card

BREADBOARD AID, *Digi Designer* incorporates the *SK-10* component socket, a variable, six position 1 to 100 kHz clock, four logic lamps, four switches, two bounce-free pushbuttons for use as pulsers and an internal 5-volt dc power supply. There are numerous terminal



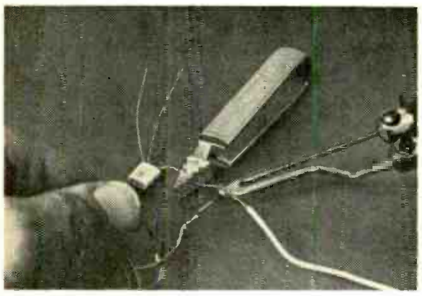
points on the front panel for external inputs or patch cords.

The model enables the user to completely design and test a circuit by merely plugging his components into the SK-10 socket and interconnecting with standard No. 24 AWG hook-up wire. No soldering necessary.

Available in kit form $49.95 or wired $95.00.—**EL Instruments, Inc.**, 61 First Street. Derby, Conn. 06418.

Circle 35 on reader service card

HEAT SINK, *NO. 80* is used for absorption and dissipation of heat in soldering operations where adjacent, delicate elec-



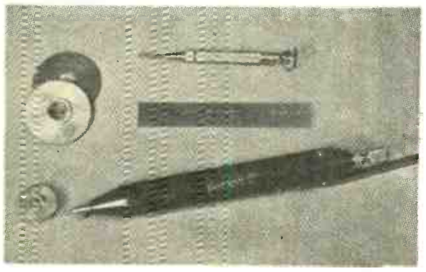
tronic parts might be damaged by overheating.

The copper jaws have nickel-plated surfaces to prevent adhesion of solder. The spring-loaded gripping surfaces will not slip, yet have a smooth finish to prevent scratching fine wires. An insulating cushion grip permits burn-free handling.

3¼", weighs ½ ounce. $2.40.—**Xcelite, Inc.,** Orchard Park, N.Y. 14127.

Circle 36 on reader service card

MARKING AND ETCHING INSTRUMENT, *Mark VII Electro Stylus* is precision made, rugged, dependable and easily handled. Weighs 7 ounces and is



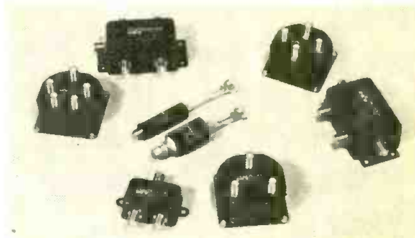
¾" in diameter. It plugs into any ac outlet. Noise level is very low.

Electro Stylus is used to mark permanently tools, test equipment, TV's and radios.

$19.95 with set of standard steel points, carbide point $2.95 additional, diamond point $7.95 additional.—**Electro Stylus,** 31 Cheyenne Blvd., Colorado Springs, Colo. 80906.

Circle 37 on reader service card

INDOOR SPLITTERS & MATCHING TRANSFORMERS, *models 3021* and *3022* are two-way splitters; *models 3031* and *3032* are three-way devices and

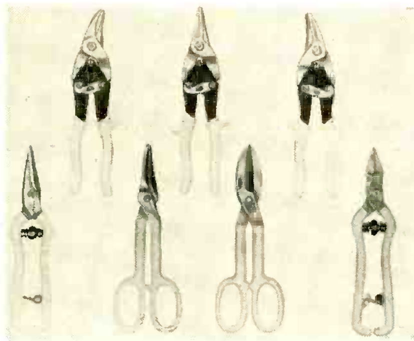


3041 and *3042* are four-way types. All have an output impedance of 75 ohms at all ports and operate over a bandwidth of 5 to 300 MHz.

The transformers, *models 3000* and *3002*, also operate over the same bandwidth and are similarly rated except for mechanical configurations.—**GTE Sylvania, Inc.**, 730 Third Avenue, New York, N.Y. 10017.

Circle 38 on reader service card

METAL CUTTING SNIPS. A new line of aviation snips, metal snips and light metal and wire cutting snips are specially designed to yield maximum cutting power with minimum effort. Blades are scientifically heat-treated to assure uniform hardness, machine hollow ground



to provide long-lasting cutting edges and individually fitted to give uniform cutting action. Handles on all styles are equipped with dipped heavy vinyl, hand-ease cushion grips.—**Channellock, Inc.**, Meadville, Pa. 16335.

Circle 39 on reader service card

AUTOMATIC DIALER, *Name Caller.* New low-cost telephone dialer. Works on home and business telephones. You install it yourself, program up to 38 names with special pencil supplied with each

unit. Home model $49.95; business model $59.95.—**Video Systems, Inc.**, 12530 Beatrice Street, Los Angeles, Calif. 90066.

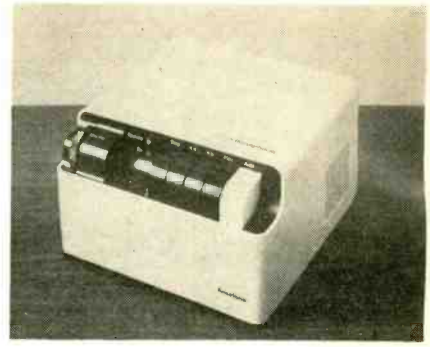
Circle 40 on reader service card

ANSWERING SYSTEM, *Ansafone 640* can be programmed in advance to set the time allowed for incoming messages.

The outgoing message cartridge is plugged inside the unit. The user lifts the hinged cover, plugs in the cartridge, connects a small hand-held microphone and records the outgoing message.

The incoming message controls are within easy reach and include an on-off and volume switch. When a call comes in, it is automatically answered, the message given and the recording begun in one continuous and automatic cycle. Reproduction of the play-back cassette offers outstanding sound quality with signal-to-noise ratios of 35-40 dB.

8½ x 8½ x 5 inches, molded in



scuff-proof plastic with grey finish. $325.—**Dictaphone Corporation**, 120 Old Post Road, Rye, N.Y. 10580.

Circle 41 on reader service card

POCKET CALCULATOR KIT, *AR-420K* provides all full four-function electronic calculation using an MOS/LSI integrated circuit. Entries are quickly made on a compact elastomar keyboard and answers are displayed in floating-point format on eight bright LED displays.

Chain features allow for long, mul-

tiple-step calculations. A constant-register makes multiple powers, conversions, reciprocals and (indirect) square roots easy to obtain.

9½ ounces, $75 with batteries.—**Aries, Inc.**, 119 Foster Street, Peabody, Mass. 01960.

Circle 42 on reader service card

ALARM SYSTEM, *SS-200* is a complete self-contained ready-to-install solid-state closed-circuit burglar alarm system. Opening any door or window, cutting the alarm wires or tampering with the cabinet sounds the alarm. A 25-30-second time delay eliminates the need for an on/off entrance door key switch and allows you sufficient time to shut the alarm off upon entering the apartment.

System includes: tamperproof weather-resistant steel cabinet with 8-inch alarm bell; front and rear tamper switches; solid-state control module with time delay; electrical switch lock with two keys; three pairs of closed-circuit window contacts; exit door contact (N.O.); interior on/off switch; panic/battery test switch; warning decals; 100 feet of hook-up wire; installation instructions; operates on standard

12-volt lantern battery (not supplied); $74.95.—**EICO Electronic Instrument Co., Inc.** 283 Malta Street, Brooklyn, N.Y. 11207.

Circle 43 on reader service card

DIGITAL MULTIMETER KIT, *IM-1202* can be assembled in two or three evenings. A 2½-digit cold-cathode readout ends parallax and interpolation errors. Accuracy is within 1% on dc volts, 1½% on ac volts and alternating and direct current, 2% on ohms. 29 selectable ranges measure voltages from 10 mV to 1000 V on dc, either polarity; 10 mV to 700 V rms on ac; 10 μA to 2 A on ac or dc and 1 ohm to 2 megohms on resistance.

Features include: three-wire line cord, dual-primary power transformer, overload protection on all ranges, isolated floating ground, rugged heavy-gauge aluminum case, tinted viewing

window and universal banana jacks. $79.95.—**Heath Company,** Benton Harbor, Mich. 49022.

Circle 100 on reader service card

SOLID-TUBE, *R-3AT2* is the solid-state high-voltage rectifier that replaces 3AT2, 3AW2, 3BL2, 3BM2 and 3BN2 vacuum tubes.

Operating without a filament, the *R-3AT2* eliminates the need for filament windings on the flyback transformer. It starts instantly, operates cool and reduces X-radiation.

Peak inverse voltage is 45 kV, peak repetitive forward current, 5 mA, average forward current, 5 mA and voltage drop is 50 volts at 5 mA.—**Electronic Devices, Inc.,** 21 Gray Oaks Avenue, Yonkers, N.Y. 10510.

Circle 44 on reader service card

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MEMBERSHIP DRIVE ends March 31, 1973.

new literature

All booklets, catalogs, charts, data sheets and other literature listed here with a Reader Service number are free. Use the Reader Service Card inside the back cover.

PRINTED CIRCUIT BOARDS CATALOG, 12 pages of new sensitized printed circuit boards in this company's line of breadboard and printed circuit supplies. The catalog also gives information on chemicals used in electronic servicing and maintenance.—**Injectorall Electronics Corp.,** 98-100 Glen St., Glen Cove, N.Y. 11542.

Circle 45 on reader service card

TECHNICAL BOOKS *1972-1973 Edition.* 28-page catalog describes more than 235 current and forthcoming books plus ten new electronic book/kits. Books listed in the catalog cover amateur radio, appliance repair, audio & hi-fi, basic technology, computer technology, electronic book/kits, electric motors, engineering & reference, general electronics servicing, hobby & experiment, license study guides, test equipment, transistors & semiconductors and TV schematic/servicing manuals.—**Tab Books,** Blue Ridge Summit, Pa. 17214.

Circle 46 on reader service card

ELECTRONIC KITS *1973 catalog.* All kinds of electronic project kits including color TV's, audio equipment, marine gear, amateur radio equipment, automotive electronics, electronic organs, electronic clock, electronic calculators, security systems and a complete range of electronic test equipment. Complete descriptions of the kits and the specifications of the completed equipment are included in this 80-page catalog.—**Heath Company,** Benton Harbor, Mich. 49022.

Circle 47 on reader service card

EXPERIMENTER'S CATALOG *No. 731* contains more than 4,500 unusual bargains for experimenters and hobbyists. This 164-page catalog lists items in almost every area of interest from astronomy to weather instruments. Along the way are all kinds of electronic gear as well as items to fit the needs of associated hobby interests. While this is a catalog, it is most certainly also an interesting book to read.—**Edmund Scientific Co.,** 700 Edscorp Bldg., Barrington, N.J. 08007.

Circle 48 on reader service card

FRONT PANEL COMPONENTS *condensed catalog CC-72-8.* 12-page listing of miniature switches, toggles, push buttons, printed circuit types, etc.; high-quality aluminum and plastic knobs; isolation relays combining relay transformer and contacts in one small package; neon and incandescent 7-segment single-plane readouts, lamps and indicator assemblies; and ceramic terminal strips.—**Alco Electronic Products, Inc.,** 1551 Osgood Street, North Andover, Mass. 01845.

Circle 49 on reader service card

PTS EXPANDS FACILITIES. Bloomington, Indiana facilities have been doubled in size. The new plant includes provisions for repairing 8-track and cassette players in addition to the usual TV tuner repair facilities. More than 60 trained technicians at six PTS locations give the electronic technician the tuner and tape player service he requires.—**PTS Electronics, Inc.,** P.O. Box 272, 5233 Hwy. 37 S., Bloomington, Ind. 47401.

Circle 50 on reader service card

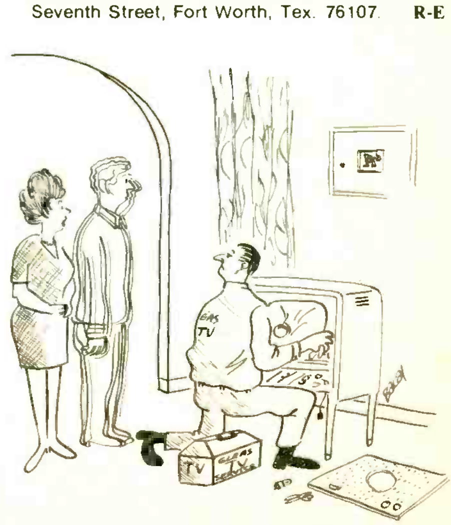
TOOLS CATALOG *1973 Edition.* A 64-page catalog of high-quality, professional tools and other products. The collection includes hard-to-find hand tools and small power tools used extensively by technicians, designers and service personnel. Many items listed in the catalog are rarely sold by industrial distributors or commonly found in stores.—**Brookstone Co.,** Peterborough, N.H. 03458.

Circle 51 on reader service card

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

STEREOSCOPIC TELEVISION. A new technical paper presented recently at a technical symposium. This paper surveys a number of 3-dimensional television systems and describes in particular the Stereotronics System which optically converts normally flat closed-circuit television into 3-D TV.—**Stereotronics Television Co.,** 13720 Riverside Drive, Sherman Oaks, Calif. 91408.

TRANSISTOR SUBSTITUTION GUIDE *catalog 276-2000.* This guide lists 15,000 commercial transistor types which in most cases may be directly replaced or substituted for with one of 29 Archer transistors. Detailed specifications and electrical characteristics for each of the 29 transistors are given in the booklet. 24 of them are custom made for Radio Shack by Texas Instruments and five are imported. The 96-page book also contains data on the care and handling of transistors, details on testing transistors and important suggestions on the use and replacement of transistors. The guide is priced at **$1.00.**—**Radio Shack,** 2617 West Seventh Street, Fort Worth, Tex. 76107. **R-E**



"When you're finished, I'd like you to take a look at my husband."

(continued from page 24)

nal quality, and it is in these areas that matrixing just doesn't make it.

Discrete will give us these things, but at present will also limit the dynamic and frequency ranges. So let's just concentrate on our 2-channel systems (except with tape) and wait for the day when RCA announces that it has available those top two octaves and 30 dB more dynamic range (with Dolby C?). With the present speed of development in electronics, it shouldn't be longer than a couple years.

MICHAEL SABLOSKY, USIS-AM.
EMB., APO San Francisco

ABOUT STRIPES OF ANOTHER COLOR

Some Stupid—)(* + /%&%*@—Put In The Wrong Resistor—or—The Case Of How To Solve A Color Problem By Making It Worse.

Some time ago, the problem of how to see a brown color stripe on a brown resistor was brought to the attention of resistor manufacturers. The resistor manufacturers responded with great haste (since they desire in every way to please all their customers).

However, the response has proven to be too much—too soon. The result—the brown color code paint was made more red, in fact, some brown color stripes are now red.

So . . . watch out for that brown color stripe. If the schematic shows a 680-ohm resistor and the third color stripe on the resistor looks red, don't be too sure the resistor is the wrong value—measure it. The rule to follow now is don't trust your eyes to see a brown color stripe on a resistor. That orange or red stripe could be the new industry Shade of Brown.

GTE SYLVANIA SERVICE BULLETIN

"OPEN-AIRE" HEADPHONES have all the makings of a perfect gift: professional quality and reasonable price. New design principle combines unusually light (5 oz.) weight, wide (20-20,000 Hz) response . . . all the realism of stereo without cumbersome size and uncomfortable ear seals. Give a gift of privacy and perfect sound. Only $39.95 from Sennheiser Electronic, 10 W. 39 St., N.Y.C. 10018.

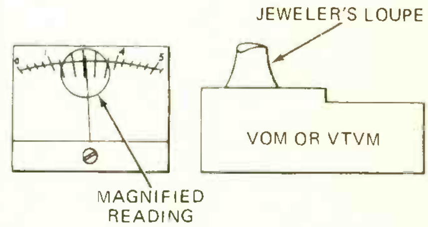
Circle 95 on reader service card

try this

LOUPE AIDS METER READINGS

A jeweler's loupe is a handy device for increasing visual resolution when reading small movements of meter pointers. It is especially useful when sensitive meters are not readily available. It can be used when measuring a true or a relative value.

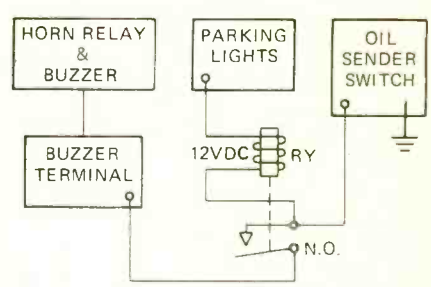
To illustrate, you want to see if a particular circuit action causes an in-



crease or decrease (a very small change) in the meter reading. Use the correct meter scale if you are interested in true values. For relative readings, use the scale that has the greatest number of minor divisions. You can detect any change more easily as a numerical value (two divisions, three divisions, etc.).—*Alex Billos*

SIMPLEST "LIGHTS-ON" REMINDER

I needed a headlight/parking light reminder for a new car so I searched back issues of **Radio-Electronics** for a circuit. I found plenty of them—but each schematic specified one or more parts that I did not have in stock. I decided to design my own



and came up with the one shown. No transistors, no diodes, no speakers—just a simple relay (12 volts dc, spst, normally open).

The new car has a buzzer that sounds when you open the driver's door without removing the ignition key. We use it for the "lights-on" reminder. The sketch shows the hookup.—*E.A. Orlowsky*

LOW COST KEYBOARDS

(continued from page 57)

shift, keys that shift, and the ability to use "control" keys that do not enter a character but that tell things at the other end to start, stop, linefeed, carriage return, change mode, clear, etc. These are called *transparent* commands and you'll find out more on them in another article.

Somehow the keys have to be arranged to end up with all these functions and still have a reasonable number of leads coming out of the keyboard. If we bring everything out, there would be 110 contacts and 110 wires. If we go to a common contact on each key, this drops to 56 contacts, still a ridiculous number and worse yet, we'd find the encoder got more complex in the bargain. To get around this, we arrange the keys in a *pre-encoder* matrix. This matrix is shown in Fig. 9. It simply groups keys that are related in the encoder together. You end up with only 22 connections on the keyboard's output connector and still can use an extremely simple encoding scheme. The pre-encoder is designed specifically for the ASCII encoder to be described in another article. You wire the pre-encoder by providing 100 jumpers as shown on the top of the PC pattern; these can be quickly "sewn" into the board in one continuous run; you then cut off the unwanted jumpers you get on the back side, and the job ends up much simpler than it seems at first.

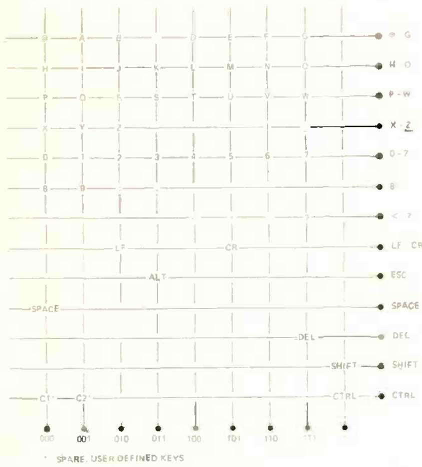


FIG. 9—PRE-ENCODER MATRIX groups the related keys to simplify the encoding scheme.

Should you want another code, you simply work up your own pre-encoder matrix by changing the jumpers. The matrix has purposely been kept this flexible so you can use this keyboard in many systems without added expense or unreasonable modifications. If you are absolutely sure of

(turn page)

EQUIPMENT REPORT

(continued from page 26)

straightforward with the exception of the subtraction function. This operation is done the same as addition except a special equal sign reserved for this purpose is used. This quirk soon becomes second nature. Entering a number with too many digits lights the overange indicator as does a calculated result outside of the −99,999,999 to +99,999,999 range. When this indicator lights further calculations are locked out since they would lead to erroneous results. The keyboard worked well with a sensitive touch despite the lack of tactile and audible feedback.

Anyone purchasing the kit should seriously consider the charger/ac power option. Some of the components for this option are added to the clock/power supply board.

If you are an experienced kit builder the Aries calculator kit will give you a cache of arithmetic power that you can conveniently carry in your jacket pocket with its 3 13/16 × 4⅝ × 1¼ inch dimensions. Sold by B & F Enterprises for $75 the recommended charger/ac power option is $17.50 including the four nickel cadmium AA cells. **R-E**

LOW COST KEYBOARDS

(continued from page 87)

the pattern you want, a double-sided PC board may be used, but this freezes your design and ups the cost.

Assembly of the big keyboard is pretty much the same as the smaller ones. Two blank keys are provided; they are ASCII encoded as "can" and "em". This lets you transparently pass two special commands on for the rest of your system without needing to press the CONTROL button. You can make it do anything you like on the other end.

PARTS LIST *(12-key keyboard)*

- 12 Keytops, two shot molded plastic, 0-9, (.), and (†)
- 12 Contact stems per Fig. 1 & Fig. 2
- 1 2" x 2" contact pad material, carbon urethane sponge ¼" thick. Cut into 0.4" square keypads
- 1 2" x 2" damping pad material, 1/16" soft rubber cut into a dozen ½" round damping pads
- 1 Extension spring, ¼" i.d. x 3" long x .016 music wire. Stretch to Fig. 2-e and cut every 9th turn, forming a dozen keysprings
- 1 Top panel per Fig. 3 and text 3½" x 2⅞" x 1/16" fiberglass or other insulator
- 1 Bottom panel, 1/16" plated PC material per Fig. 3 and text 3¾" x 2⅞" x 1/16"
- 4 6-32 x ⅜" threaded spacers
- 4 6-32 x 1" machine screws
- 4 6-32 nuts
- 4 No. 6 shakeproof washers
- **MISC:** solder and rosin flux; optional adhesive; template for contact stem assembly

PARTS LIST *(55-key keyboard)*

- 55 Keytops, two shot molded plastic, standard ASCII characters and spacebar
- 57 Contact stems per Fig. 1 & Fig. 2
- 1 4" x 4" contact pad material; cut into 57 0.4" square contacts
- 1 4" x 4" damping pad material, cut into 57 0.5" round damping pads
- 4 Extension springs, cut into 57 springs after extending
- 1 Top panel, insulated PC material, 4" x 4"
- 1 Bottom panel, per Fig. 6; 6¾" x 14"
- 2 Support brackets, 14" long
- **MISC:** Threaded spacers, shrink tubing, and mounting hardware; No. 24 solid wire; solder; optional glue or epoxy; keystem soldering template.

Contact material is available from Custom Materials, Inc., 279 Billerica Rd., Chelmsford, Mass. 01824. It's their #7611 Velofoam ¼" thick, and runs around ⅓¢ per keytop, but is only available in large sheets.

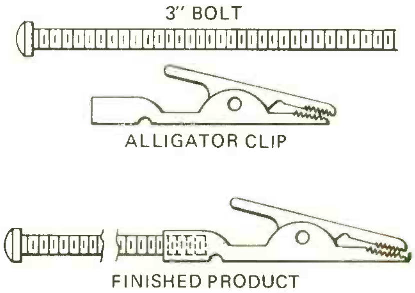
Keytops are available from Mechanical Enterprises, 5249 Duke St., Arlington, Va. 15¢ each, any reasonable callout. Space bars are 35¢ each. $2 service charge on orders under $25.

Other configurations

You can easily work up other arrangements for this low cost keyboard. Even if you only need a few pushbuttons for an electronic lock, music synthesizer or game, this system easily adapts itself and its real beauty is that you can custom design your own. **R-E**

HANDY TRANSISTOR PULLER

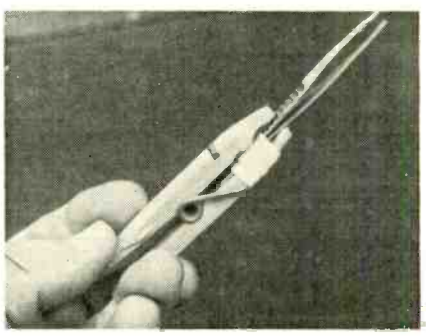
Here are details on a handy transistor puller that you can make in just a few minutes. It was described in a recent issue of *GTE Sylvania Service Notebook*. All you need is one alligator clip and a 3-inch long thin screw or bolt.



Use gas pliers to flatten and turn up the tip of the lower jaw of the alligator clip. The turned up tip forms a lip to catch the transistor case for better pull ability. Screw the bolt into the clip shank and solder securely as shown.

EXTENSION HANDLE FOR TWEEZERS

A handy extension handle for tweezers can be readily devised by using a spring-type clothes pin. Taper both jaws of the clothespin and attach the tweezers to one jaw with a strip of tape. Position the tweezers so the pincher ends are held closed by the spring action of the clothespin. When the clothespin jaws are opened, the tweezer also opens.



This quickly improvised tool (see photo) is most effective in inserting pins, screws and keys in close quarters.—*Glen F. Stillwell* **R-E**

"Don't look now, but I think our challenge of the day has arrived."

12 exciting new Heathkit® projects you can assemble yourself ...and save!

(There are 350 more in your free '73 Heathkit Catalog)

NEW Heathkit 21V Color TV — Solid-State Plus Detent UHF Tuning... 499.95* less cabinet

Power detent selection of all VHF and any 12 pre-selected UHF channels; exclusive angular tint control for consistently better flesh tones; voltage controlled varactor UHF tuner & MOSFET VHF tuner for unmatched sensitivity; black matrix tube, built-in dot generator, convergence panel and volt-ohm meter — full remote control options, too. It's Heathkit TV at its finest in a space-saving size. **Kit GR-271**, less cabinet, 121 lbs.

Assembled GRA-501-21, table model cabinet shown, tough walnut Marlite® finish, 33 lbs. **54.95***

NEW Heathkit 30 MHz Counter... 169.95*

Gives 1 Hz to over 30 MHz counting on a full 5-digit readout with 8-digit capability. The lighted overrange indicator makes misreading virtually impossible. Stable timebase circuitry assures accuracy better than ±3 ppm from 22° to 37° C. Diode protected J-FET gives improved triggering over 100 mV to 150 V input range. Solid-state circuitry mounts on one large board. **Kit IB-1100**, 6 lbs.

NEW Heathkit 2½-Digit VOM... 79.95*

Four overlapping ranges to measure voltages from 10 mV to 1000 V on DC (either polarity), 10 mV to 700 V rms on AC, 10 uA to 2.5 A on AC or DC current. Five resistance ranges measure from 1 ohm to 2 megohms. Front panel polarity switch reverses inputs without changing leads. **Kit IM-1202**, 6 lbs.

NEW Heathkit/Thomas Spinet Organ with two 44-note keyboards... 689.95*

Full 44-note keyboards for Solo and Accompaniment, exclusive Color-Glo keys that light up to indicate notes and chords. There are six solo stops, five accompaniment stops, plus both regular and a new "light" vibrato effects. Other features include keyboard jacks for private earphone listening or use of a tape cassette deck. Cabinet is shipped fully assembled, includes bench. **Kit TO-1160**, 211 lbs.

NEW Heathkit 4-Channel Amplifier with "Universal" decoder circuitry... 359.95*

You select discrete 4-channel, or switch-in the "Universal" decoder for reproduction of all the matrixed 4-channel discs now on the market, plus "derived" 4-channel from conventional stereo. Four solid-state amplifiers produce 200 watts (4x50 IHF) into 8 ohms, with power bandwidth on all channels from less than 5Hz to greater than 45 kHz at 0.25% distortion. **Kit AA2010**, 37 lbs.

AAA-2004-1, pecan cabinet, 7 lbs. 24.95*

NEW Heathkit "Universal" 4-Channel Decoder... 39.95*

Reproduces all matrixed discs, plus "derived" 4-channel from conventional stereo material. Plug it into your receiver's tape monitor circuit, add a second stereo amp and speakers and you're set. **Kit AD-2022**, 4 lbs.

NEW Heathkit Ultrasonic Intrusion Alarm... 49.95*

Disguised as an ordinary library book, this novel device fits unobtrusively anywhere in the home or office, yet detects any significant movement in the room, ultrasonically. The transmitter disperses a 41 kHz signal which bounces off walls & returns to the receiver where it's monitored for any change in amplitude. The device triggers lights and any conventional alarm device — just plug them into AC outlets on the rear panel. Can be installed anywhere there's a 120 VAC outlet. An enjoyable 2-evening kit... for a lifetime of reliable home security. **Kit GD-39**, 5 lbs.

NEW Heathkit 8-Channel VHF Band-Scanning Monitor with digital readout... 119.95* less crystals

Crystal-controlled monitor tunes any selected 9 MHz segment of the 146 through 174 MHz band — gives you police, fire, marine, ham 2-meter, etc. Features manual or automatic scanning with numerical readout; priority channel; built-in speaker and rear-panel jack for remote speaker; gimbal bracket for either base-station or mobile use. Operates on either 120/240 VAC or 12 VDC. Includes crystal OSC/Mixer signal source for easy alignment. Order up to eight Crystal Certificates with kit. **Kit GR-110**, 9 lbs.

GRA-110-1, Crystal Certificate, postpaid .... each **4.95***

NEW Heathkit Engine Analyzer... 64.95*

For 3, 4, 6 and 8-cylinder engines. Includes leads and accessories for testing conventional, transistor, and magneto ignition systems, regardless of voltage or grounding. Uses 3 "C" batteries (not included). **Kit CM-1050**, 9 lbs.

NEW Heathkit C-D Ignition System... 39.95*

Increases spark-plug and point life up to 50,000 miles on any car or truck using a 12-volt, negative ground system. Automatically varies spark duration. Screw-on terminals make installation easy; external pushbutton lets you override system without removing leads. **Kit CP-1060**, 4 lbs.

NEW Heathkit 6-Digit Electronic Alarm Clock... 54.95*

Displays hours, minutes and seconds on highly visible cold-cathode readout tubes. A gentle "beeper" alarm can be set for 24-hour cycle and features a snooze switch that gives you seven more minutes of sleep before the alarm sounds off again. Conventional 12-hour or 24-hour international time display. **Kit GC-1005**, 4 lbs.

NEW Heathkit Dolby® Cassette Deck... 249.95*

A kit-form cassette deck utilizing the famous Dolby® noise reduction system. Accommodates the greater fidelity and dynamic range of chromium dioxide cassettes. Independent switches provide Dolby on/off and regular or CrO_2 bias control. Domestic-make tape transport comes preassembled for easy kit building. **Kit AD-1530**, 21 lbs.

See them all at your nearest Heathkit Electronic Center... or send for FREE'73 Heathkit Catalog.

HEATH
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HEATH COMPANY, Dept. 20-2
Benton Harbor, Michigan 49022

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☐ Enclosed is $__________, plus shipping.
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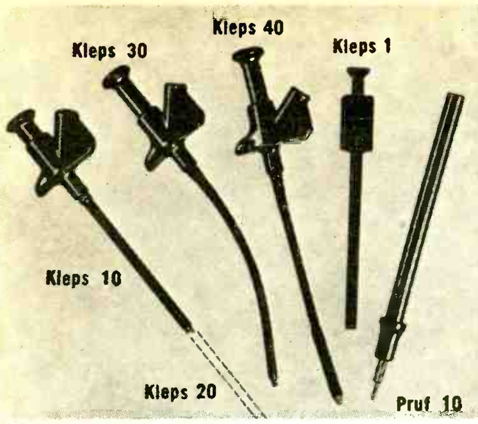
HEATHKIT ELECTRONIC CENTERS — ARIZ.: Phoenix, 2727 W. Indian School Rd.; **CALIF.: Anaheim**, 330 E. Ball Rd.; **El Cerrito**, 6000 Potrero Ave.; **Los Angeles**, 2309 S. Flower St.; **Pomona**, 1555 Orange Grove Ave. N.; **Redwood City**, 2001 Middlefield Rd.; **San Diego (La Mesa)**, 8363 Center Dr.; **Woodland Hills**, 22504 Ventura Blvd.; **COLO.: Denver**, 5940 W. 38th Ave.; **CONN.: Hartford (Avon)**, 395 W. Main St. (Rte. 44); **FLA.: Miami (Hialeah)**, 4705 W. 16th Ave.; **GA.: Atlanta**, 5285 Roswell Rd.; **ILL.: Chicago**, 3462-66 W. Devon Ave.; **Downers Grove**, 224 Ogden Ave.; **IND.: Indianapolis**, 2112 E. 62nd Ave.; **KANSAS: Kansas City (Mission)**, 5960 Lamar Ave.; **MD.: Baltimore**, 1713 E. Joppa Rd.; **Rockville**, 5542 Nicholson Lane; **MASS.: Boston (Wellesley)**, 165 Worcester St.; **MICH.: Detroit**, 18645 W. Eight Mile Rd. & 18149 E. Eight Mile Rd.; **MINN.: Minneapolis (Hopkins)**, 101 Shady Oak Rd.; **MO.: St. Louis**, 9296 Gravois Ave.; **N.J.: Fair Lawn**, 35-07 Broadway (Rte. 4); **N.Y.: Buffalo (Amherst)**, 3476 Sheridan Dr.; **New York City**, 35 W. 45th St.; **Jericho, L.I.**, 15 Jericho Turnpike; **Rochester**, Long Ridge Plaza; **OHIO: Cincinnati (Woodlawn)**, 10133 Springfield Pike; **Cleveland**, 5444 Pearl Rd.; **PA.: Philadelphia**, 6318 Roosevelt Blvd.; **Pittsburgh**, 3482 Wm. Penn Hwy.; **TEXAS: Dallas**, 2715 Ross Ave.; **Houston**, 3705 Westheimer; **WASH.: Seattle**, 221 Third Ave.; **WIS.: Milwaukee**, 5215 Fond du Lac.


IM-1202
AA2010
GD-39
CP-1060
GR-271
AD-2022
Kit GR-110
GC-1005
AD-1530
IB-1100
CM-1050
TC-1160



new books

MODERN RADIO REPAIR TECHNIQUES, by Art Margolis. TAB Books, Blue Ridge Summit, Pa. 17214. 260 pp. 5½" x 8½". Hardcover, $7.95; Softcover, $4.95.

The seasoned TV technician gains considerably from the numerous troubleshooting tips in this book. Beginning technicians, with a few hours study, begin to turn out profitable work. The book reveals many simple shortcuts and test techniques for making radio repair a profitable sideline or even a profitable main line of business. It provides up-to-date service data on today's radio receivers, including AM, FM, FM stereo and multi-band plus a foldout section containing complete schematics for a dozen brand-name receivers. Directions on how to set up and equip a radio repair bench are included.

BASIC COLOR TELEVISION COURSE, by Stan Prentiss. TAB Books, Blue Ridge Summit, Pa. 17214. 420 pp. 5½" x 8½". Hardcover, $9.95; Softcover, $6.95.

A completely up-to-date textbook giving the beginning technician or student a thorough background in color and B&W television receiver basics. The text covers everything from the antenna to picture and sound. The book teaches how TV signals are "put together" at the broadcast station, radiated into the air and how these signals are picked up by a receiving antenna, sent to the receiver and reproduced; how colors are mixed and reproduced on a picture tube screen. All circuits are thoroughly discussed, including brand-new receiver circuits using transistors and integrated circuits and those used only for monochrome reproduction. Also covered are cable systems and major foreign TV systems.

99 WAYS TO IMPROVE YOUR HI-FI, by Len Buckwalter. Howard W. Sams & Co., Inc., 3 W. 57 St., New York, N.Y. 10019. 128 pp. 5½" x 8½". Softcover, $3.50; In Canada, $8.35.

All inclusive coverage on methods for improving your hi-fi and stereo sound systems. Many items are simple adjustments that can be performed at little or no cost. Only very basic technical knowledge or none at all is required to follow the instructions and no special tools are required. Some of the topics covered are installation of the hi-fi, FM stereo reception, phonos and turntables, amplifiers, tape equipment, speakers, stereo headphones and microphones, accessories, and troubleshooting tips.

101 QUESTIONS & ANSWERS ABOUT AM, FM, & SSB, by Leo G. Sands. Howard W. Sams & Co., Inc., 3 W. 57 St., New York, N.Y. 10019. 96 pp. 5½" x 8½". Softcover, $3.95; In Canada, $4.95.

Questions and answers covering both the history and basic technical aspects of the three types of modulation as well as receivers that are used for demodulation. Divided into three parts, the guide contains material concerning the advantages and disadvantages of each modulation and demodulation method as well as the basic circuits employed in the process. Examples of questions answered are what is a noise blanker, why do most mobile stations use FM, and how is SSB used in telephone systems.

PRACTICAL SOLID-STATE PRINCIPLES & PROJECTS, by Ken Sessions. TAB Books, Blue Ridge Summit, Pa. 17214. 176 pp. 5½" x 8½". Hardcover, $6.95; Softcover, $3.95.

A project-oriented approach to learning about the latest semiconductor devices and circuits anyone can understand and build; projects such as an electronic burglar alarm, a solid-state timer, a metronome, an automatic night light switch. Fifty-two unique projects, some with multiple applications, include Citizens band receiver, stereo amplifier, integrated circuit code-practice tone oscillator, battery charger, precision tachometer and many more practical projects. R-E

Circle 76 on reader service card

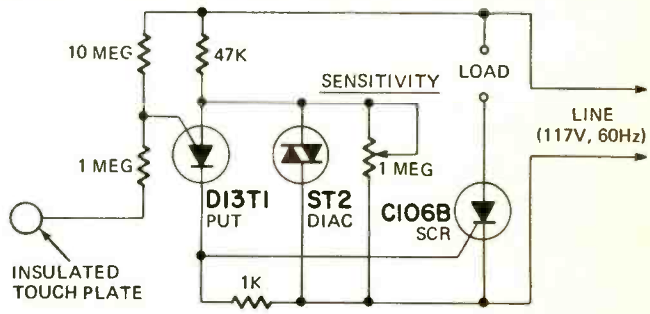
Circle 77 on reader service card

circuits

TOUCH OR PROXIMITY SWITCH

This circuit can be adjusted to switch when a human body approaches to within a few inches of an insulated detector plate. Thus, it can be used as an electrically isolated touch switch or a part of an intruder alarm. The design was credited to International General Electric Co. of New York in *Electronic Engineering* magazine.

The PUT (programmable unijunction transistor) turns on when its anode voltage exceeds the gate voltage by about 0.5 volt. Its anode voltage is held constant at the

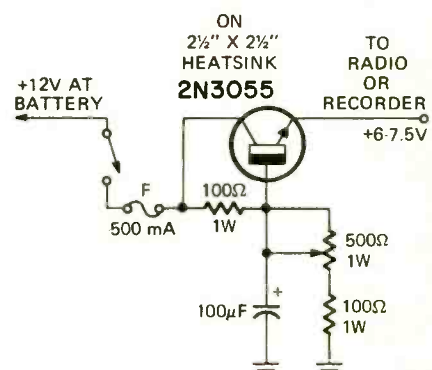


"on" voltage of the diac. A body approaching the detector plate changes the capacitance between the plate and ground. This change in capacitance causes a shift in the phase angle between the PUT's anode and gate voltages. The phase angle widens until, at some time, the voltage difference is high enough to fire the PUT. The voltage developed across the 1000-ohm resistor fires the SCR used as the solid-state relay controlling the load. The SENSITIVITY control determines the voltage level at which the PUT's anode is clamped.

MOBILE POWER SUPPLY FOR CASSETTE RECORDER

Quite a few business men use a cassette recorder in their cars for recording dictation, keeping records, etc. These recorders get fairly heavy use and the batteries seem to go dead just when the driver is many miles away from a store where replacement batteries are available.

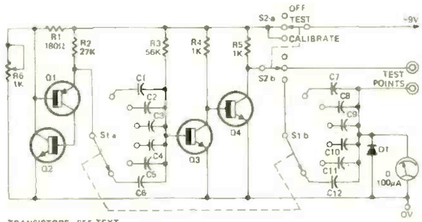
The diagram shows a simple regulated supply for op-



erating 6–7.5-volt portable radios and cassette recorders from the car's 12-volt battery. The circuit is adapted from *Radio Electronica* (Netherlands). The 2N3055 transistor should be mounted on a good heatsink at least 2½ inches square. The heatsink and case of the transistor must be insulated from ground and possible contact with the body of the car. Use the 500-ohm pot or adjustable resistor to set the output voltage to the desired level.

DIRECT-READING CAPACITANCE METER

The average technician's or experimenter's workbench is equipped for nearly any type of test or operation imaginable except for quick capacitance measurements. The diagram shows a simple capacitance meter for measuring capacitance from 1 microfarad down to a few picofarads. (G3XGP called it "The Puffmeter" when he described it in *Radio Communication.*)



TRANSISTORS SEE TEXT
C1, 7 = 1.0μF C4, 10 = 1,000pF
C2, 8 = 0.1μF C5, 11 = 100pF
C3, 9 = 0.01μF C6, 12 = 10pf

Transistors Q1 and Q2 along with R1, R2, potentiometer R3, the capacitor selected by S1-a and the base-emitter junction of Q3 form a regenerative-type ramp generator. The sawtooth-like ramp voltage is converted to a square wave by Q3 and Q4 and fed through the unknown capacitor or one of the standard capacitors (C7 through C12). The capacitor and diode D1 convert the square wave to a sharp positive pulse whose amplitude is determined solely by the value of the capacitor. The diode current is related to frequency and capacitor value. The meter integrates these values. If the FREQUENCY control is varied so the meter reads fullscale on any range with a standard capacitor, the unknown produces a reading in direct proportion.

Q1 must be a high-gain pnp transistor such as a 2N4125 or 2N4288. Q2 is an npn device such as a 2N3493 or a *low-gain* 2N706. Q3 and Q4 may be a 2N706 or any small-signal npn transistor.

To use the capacitance meter, connect the unknown capacitor across the test terminals. Throw S2 to CALIBRATE and move switch S1 to the range of the probable value of the unknown. Rotate pot R6 for a fullscale reading on the meter. Throw S2 to TEST. The meter now reads in direct proportion to the value of the standard capacitor.

Accuracy of the instrument depends on the precision of the standard capacitors (C7 through C12). You can purchase one precision—1% or better—capacitor and use it as a standard when hand-picking the others from ordinary stock. For example, suppose that for C10 (1000 pF or .001 μF) you have a 1% or better tolerance device

(continued on page 104)

next month

MARCH 1973

This stereo spectacular issue is crammed with high-fidelity articles of all kinds.

- **Build A Four-Channel Power Amplifier**
  Each channel delivers 60-watts sine-wave continuous output into an 8-ohm load with less than 0.01% IM. It's a real powerhouse.

- **4-Channel Tape For Your Car**
  A survey of what's available and in what configurations. A story you must read before buying an add-on tape system.

- **Off-Beat 4-Channel Speaker Systems**
  Flat styrafoam, acoustic transducers, pictures, balls, cubes, lamps columns—they're all speaker systems you should know more about.

- **Tape Bias And Magnetic Recording**
  How much effect does the bias have? We tell you and show you with a set of scope pictures. You may not believe the results.

PLUS:
State-Of-Solid State
Plug-In-Stopwatch
Step-By-Step Troubleshooting

We were unable to kick off the Semiconductor Interchangeability Directory in this issue because of last minute delays in verifying the data. Rather than take a chance on unnecessary errors we decided to delay presenting the first section until the March issue.

IMPOSSIBLE? BARGAINS IN SURPLUS ELECTRONICS AND OPTICS

NEW – COSMOS INTEGRATED CIRCUIT

Said to be the "New Wave" in integrated circuits of the future. Ultra low power drain (microwatts)

- ☐ 4000AE Dual 3 Input Nor & Inv . . . $ .99
- ☐ 4001AE Quad 2 Input Nor . . . . $ .99
- ☐ 4002AE Dual 4 Input Nor . . . . $ .99
- ☐ 4006AE 18 Stage Static Shift Register $4.99
- ☐ 4007AE Dual Complementary Pair & Inv . . . . $ .99
- ☐ 4009AE Hex Buffer, Inverting $2.19
- ☐ 4010AE Hex Buffer Non Inverting . . . $2.19
- ☐ 4011AE Quad 2 Input Nand . . . . $ .99
- ☐ 4012AE Dual 4 Input Nand . . . . $ .99
- ☐ 4013AE Dual "D" Flip Flop $1.99
- ☐ 4014AE 8 Stage Static Shift Register $5.99
- ☐ 4015AE Dual 4 Stage Static Shift Register $5.99
- ☐ 4016AE Quad Bilateral Switch $1.99
- ☐ 4017AE Decade Counter W/Decoder . . . $5.99
- ☐ 4018AE Presettable Divide by "N" Counter $5.99
- ☐ 4019AE Quad and/or Select Gate $2.39
- ☐ 4020AE 14 Stage Binary Ripple Counter $5.99
- ☐ 4021AE 8 Stage Static Shift Register $5.49
- ☐ 4022AE Octal Counter W/Decoder . . . $5.19
- ☐ 4023AE Triple 3 Input Nand . . . . $ .99
- ☐ 4024AE 7 Stage Counter $3.99
- ☐ 4025AE Triple 3 Input Nor . . . . $ .99
- ☐ 4026AE Decade Counter/7 Segment Decoder $7.49
- ☐ 4027AE Dual J-K Flip Flop $2.99
- ☐ 4029AE Presettable Up/Down Counter $7.99
- ☐ 4030AE Quad Exclusive Or $1.99
- ☐ 4033AE Decade Counter/7 Segment Oecoder $7.49

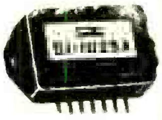
SPECTRA – STRIP FLAT BONDED

We know this is what everyone wants for their home-brew projects, because they always ask for it. We now have over 5 by 10^6 feet, but it won't last long, so order now before it's all gone. We don't want any broken hearts. Specs: 20 conductors, 24 AWG, 7 strands, size is .88" x .044". We could give all its virtues, but most people know them or could easily look it up in any industrial electronics house catalogue.

Sh. Wt. 1lb./10 feet . . . . . Order No. SSFBRC (ft.)

☐ $ .35/1 ft. ☐ $ 1.00/3 ft. ☐ $ 5.00/18 ft.
☐ $30.00/100 ft. ☐ $ 55.00/200 ft. ☐ $100.00/400 ft.
☐ $200.00/900 ft. ☐ $500.00/2000 ft.

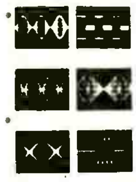
SANKEN HYBRID AUDIO AMPLIFIER MODULES



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. Twenty-page manufacturer's instruction book included. Sanken amplifiers have proved so simple and reliable that they are being used for industrial applications, such as servo amplifiers & wide band laboratory application.

- ☐ SI1010Y 10 watts 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, economy grade $14.00
- ☐ SI1050E 50 watt RMS amplifier, economy 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 mfd 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

WAVEFORM GENERATOR, BF-5



Just one of these BF-5 devices produces sine, square, traingle, ramp and sawtooth waveforms without additional active components. By adding a second BF-5, you can create amplitude, frequency or phase modulated varieties of these waveforms. They are able to replace large discrete waveform generators costing from \$200.00 to \$1300.00. At the same time, they greatly reduce system weight and power consumption. Full technical data, P.C. layout, assembly, and hook-up instructions included.

☐ BF-5 WAVEFORM GENERATOR . . . . $ 9.75

GENERAL ELECTRIC PA-234, 1.4-WATT POWER AMPLIFIER, $1.25

This amplifier is housed in a plastic dual in-line package with a tab for heat transfer. Has only four active terminals, and requires only one capacitor for stabilization. Compatible with 8, 16, or 22-ohm loads. Applications include P.A. systems, phonos, movie projectors, TV, AM and FM receivers.

☐ PA-234 POWER AMPLIFIER . . . . $ 1.25

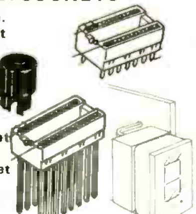
GENERAL ELECTRIC PA-265 5-WATT VOLTAGE REGULATOR

Housed in plastic dual in-line package with staggered leads and power tab. Usable over wide range of input and output voltages, input voltages to 37 volts and outputs from 3 to 30 volts. Usable in a wide variety of circuits.

☐ PA-265 VOLTAGE REGULATOR . . . . $ 1.25

SUPER QUALITY I.C. SOCKETS

Sockets made by T.I. and Cinch. All are low-profile, compact types.



- 14 Pin Dip Solder Tale Sockets 3 for \$1.25 16 for \$5.00
- 16 Pin Dip Solder Tale Sockets 2 for \$1.00 13 for \$5.00
- 14 Pin Dip Gold Wire Wrap Socket 2 for \$1.25 10 for \$5.00
- 16 Pin Dip Gold Wire Wrap Socket 2 for \$1.50 8 for \$5.00
- 10 Pin to 5 Gold Sockets (Cinch) 2 for \$1.00 13 for \$5.00
- 14 Pin Right Angle Socket. Used to mount L.E.D. displays directly to P.C. board at correct viewing angle \$1.00

CALCULATOR CHIP SPECIAL!!!

One of the largest manufacturers of MOS Integrated Circuits has discontinued his three-chip set in favor of a single chip. This is the hobbyist's gain, since he can now obtain this fully tested, highly flexible set at a fraction of what even the largest calculator manufacturers pay. Consists of three 24-pin I.C.'s, has debounced input, eight-digit capacity, decoded seven-segment output. Full data included.

☐ 8-Digit Floating-Point Calculator Set $9.75

LOGIC AND OPERATIONAL AMP. SUPPLIES

- ☐ Figure A, plotted logic supply, 5 Volts at 1 Ampere, short circuit proof, ultra high regulation, ultra low ripple $16.00
- ☐ Figure A, potted Op Amp supply, +15 Volts, and -15 Volts at 0.5 Amperes. Mfg. by Analog Devices, similar to their model 902. Short circuit proof, ultra high performance $29.00
- ☐ Figure B, 5 Volt 1 Amp supply, regulated by Fairchild 9305, short circuit protected . . $ 9.75
- ☐ Same as above, in kit form . . . . $ 7.75
- ☐ Mating connector for above . . . . $ 1.00
- ☐ 5 Volt 5 Amp regulated supply, by Blulyne, (not shown) $29.00
- ☐ Op amp and logic supply. Supplies ±15 volts at 100 milliamperes and 5 volts at 1 ampere. Similar to Figure "B" but larger. Ultra-low ripple. Built by Elcom $32.50

64 CHARACTER ASCI CODE ALPHANUMERIC L.E.D. DISPLAY

This display consists of 35 L.E.D.'s (light emitting diodes) arranged in a 5 x 7 matrix. Numbers and letters of the alphabet can be formed by lighting the appropriate segments, i.e. from our 2513 character generator Rom. One 2513 can be used to drive up to 64 displays by time sharing. In 14 Pin Dip Package.

- ☐ 64 Character 5 x 7 LED Display . . . . . . $ 9.75
- ☐ 2513 Character Generator Rom $12.00

SINGLE CHIP 7-SEGMENT DISPLAY COUNTER, AND DECODER.

That's right! A single chip TTL decade counter with latches, BCD outputs, a 7-segment decoder driver, AND a 7-segment LED display (with decimal) on top. Only 0.15" thick (not counting pins), the chip mounts in a standard 16-pin DIP socket. Digits are 0.270" high and can be latched in during the next count or blanked.

☐ 0.27 DLD \$15.00

70 WATT RMS AUDIO AMPLIFIER BASIC PACKAGE, STEREO $5.50

Take advantage of Signetic's NE540 power driver, (class AB amp). Designed for 35 watts RMS per channel. Distortion .5% frequency response, ± .5db 20Hz to 100 Hz. NE540 requires two power transistors, a 2N5296 (NPN) and a 2N6109 (PNP), supplied per NE540. Kit package includes (2) NE540, (2) 2N5296. (2) 2N6109, information on P.C. board layout, parts and circuitry, and a list of miscellaneous small parts required to build the 70 watt amplifier for stereo.

- ☐ NE540 . . . . \$2.25/ea.
- ☐ 2N5296 35 watt NPN . . . . .75/ea.
- ☐ 2N6109 40 watt PNP . . . . .75/ea.
- ☐ 70 watt Stereo Kit . . . . \$5.50/ea.
- ☐ 35 watt Mono Kit . . . . \$2.95/ea.

FAIRCHILD VOLTAGE REGULATORS

This is the UA 7800 Series. Three terminal regulator, with thermal overload protection and internal current limiting, making it essentially blow-out proof. Because simple circuitry is used with this device, designing regulated power supplies is duck soup. Output is rated at 0 to 1 ampere; maximum input voltage is 35 volts. Choice of voltages: 5, 6, 8, 12, 15, 18, or 24 Volts. Order as 7805, 7806, 7808, etc.

☐ Voltage Regulator (Sepcify Voltage) \$2.00

PRINTED CIRCUIT MATERIAL

Epoxy glass G10 material. Specify single or double copper clad. Thickness 1/16 inch.

- ☐ 4 x 12 Sheets . . . . \$1.00, 5 for \$ 3.50
- ☐ 12 x 12 Sheets . . . . \$2.50, 5 for \$10.00
- ☐ Assorted cut pieces at least 4" x 4" 2 square feet \$2.50

TTL INTEGRATED CIRCUITS

Unfortunately we have had to raise our TTL prices due to a shortage of material. The following are our new prices. Deduct 15% for 10 or more assorted, 20% for 50 or more.

☐ SN7400	\$ .25	☐ SN7447	1.50	☐ SN74121	.49
☐ SN7401	.25	☐ SN7448	1.25	☐ SN74122	.65
☐ SN7402	.25	☐ SN7450	.25	☐ SN74123	.99
☐ SN7403	.25	☐ SN7451	.25	☐ SN74141	1.45
☐ SN7404	.28	☐ SN7453	.25	☐ SN74145	1.25
☐ SN7405	.27	☐ SN7454	.25	☐ SN74150	1.25
☐ SN7406	.45	☐ SN7455	.25	☐ SN74151	1.13
☐ SN7407	.45	☐ SN7460	.21	☐ SN74153	1.25
☐ SN7408	.29	☐ SN7470	.39	☐ SN74154	1.95
☐ SN7409	.29	☐ SN7472	.32	☐ SN74155	1.39
☐ SN7410	.25	☐ SN7473	.44	☐ SN74156	1.39
☐ SN7411	.25	☐ SN7474	.39	☐ SN74157	1.25
☐ SN7413	.75	☐ SN7475	1.00	☐ SN74158	1.48
☐ SN7416	.48	☐ SN7476	.44	☐ SN74160	1.79
☐ SN7417	.48	☐ SN7480	.65	☐ SN74161	1.79
☐ SN7420	.25	☐ SN7481	1.10	☐ SN74162	1.79
☐ SN7421	.25	☐ SN7482	.88	☐ SN74163	1.79
☐ SN7426	.32	☐ SN7483	1.25	☐ SN74165	3.50
☐ SN7430	.25	☐ SN7486	.49	☐ SN74180	1.10
☐ SN7432	.25	☐ SN7489	3.50	☐ SN74181	4.50
☐ SN7437	.50	☐ SN7490	1.00	☐ SN74182	1.10
☐ SN7438	.51	☐ SN7491	1.10	☐ SN74184	2.50
☐ SN7440	.25	☐ SN7492	.71	☐ SN74185	2.50
☐ SN7441	1.30	☐ SN7493	.71	☐ SN74192	1.75
☐ SN7442	1.12	☐ SN7494	1.10	☐ SN74193	1.75
☐ SN7443	1.21	☐ SN7495	.95	☐ SN74195	1.19
☐ SN7444	1.21	☐ SN7496	1.10	☐ SN74198	2.65
☐ SN7445	1.50	☐ SN74100	1.41	☐ SN74199	2.65
☐ SN7446	1.50	☐ SN74107	.49		

CATALOG. Check reader's card or write.

ALL ITEMS (WHERE WEIGHT IS NOT SPECIFIED) POSTAGE PAID IN THE U. S. A.

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\$10.00 MINIMUM CHARGE

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Phone (617) 532-2323

P.O. Box 44, Hathorne, Massachusetts 01937

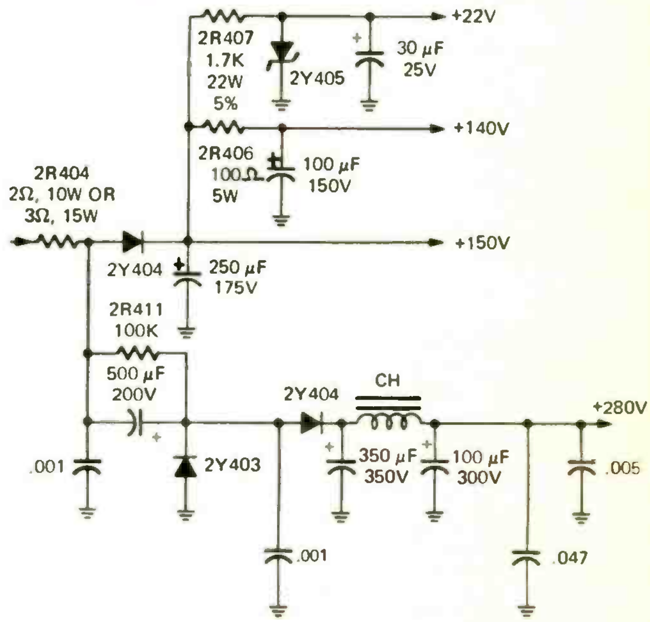
Circle 84 on reader service card

technotes

GENERAL ELECTRIC C-2/L-2 CHASSIS

Complaints of no raster and no sound may be traced to an open circuit in resistors 2R406, 2R404, or 2R407; shorted Zener diode 2Y405 (see diagram) or an open heater in the 19CG3 damper tube.

IF 2R406 is the troublemaker, replace it with another resistor of equal value. If the trouble is in 2R404, replace a 2-



ohm, 10-watt original component with a 2-ohm, 15-watt unit (part EP14X9). Replace the 3-ohm, 15-watt resistor used in late production with a 3-ohm, 22-watt unit (part EP14X24).

If the Zener diode is shorted or has a low resistance, there is no 22-volt B+; the 22HU5 horizontal output tube runs hot and the breaker trips.—*G-E Troubleshooting Guide*

SYLVANIA D-12 CHASSIS

Overbright picture and blooming may be a tough-dog complaint on this chassis. This trouble has been traced to R428, the horizontal oscillator plate resistor. This resistor overheats and its value drops from 18,000 to around 9,000 ohms. Replacing it with a 1-watt resistor eliminates the complaint.—*GTE Sylvania Service Notebook*

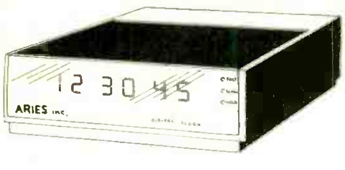
MAGNAVOX T979 COLOR CHASSIS

Intermittently a bright horizontal bar moves vertically through the bottom one-third of the screen. Vertical jitter may also be present. Some cases can be corrected by tapping or moving certain parts on the "D" panel.

Investigation shows that this condition may be caused by a contaminate, such as solder flux, on the "D" panel plug-in socket pins—on pins 5, 6 and 7 in particular. If you encounter this condition, both the male pins on the chassis and the female connectors on the "D" panel should be cleaned with an approved cleaner, which will not react with the PC board or adjacent components. The inside of the female connectors should be cleaned using an applicator such as a toothpick and then thoroughly dried.—*Magnavox Service News Letter*

R-E

ARIES



NEW FROM ARIES!
ULTRA LOW COST DIGITAL CLOCK (STANDARD TIME CHRONOMETER)

Aries/BF has sold over 12,000 digital clocks, to the best of our knowledge more that the combined output of all other manufacturers. Because of our huge purchasing power, and the engineering background gained, we can offer the features listed below. Compare with any other manufacturer and see if they can offer all these features:

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- Superb accuracy, seconds per month
- Choice of 50 or 60 Hz operation, 12 or 24 hour display in hours, minutes, seconds.
- BCD outputs, for auxiliary readouts etc.
- Excellent beginners kit, elaborate step by step instructions debugged by trial construction by experimenters who have never built a kit before. Only a soldering iron, wire snip and screwdriver needed. Guaranteed success (maximum repair charge $10.00)

☐ Low-cost Digital Clock Kit $47.50

OPTIONS

☐ 00 – Standard readouts, GE florescent standard unless otherwise specified. Cool blue green color, best for decor of living rooms, bedrooms etc., this is the unit that draws Oh's and Ah's.

☐ 01 – Burroughs B5750 nixie tube readout instead of GE hot orange color. Looks at home in a lab. No extra charge.

☐ 02 – Man 1 L.E.D. readouts. Intense red, monochromatic light output, laboratory environment type display. Add $22.50 additional for this display.

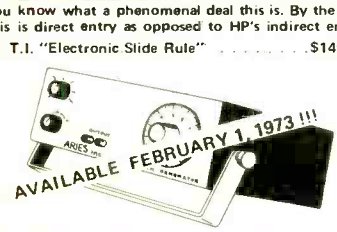
☐ 03 – Quartz crystal time standard. In most environments standard line operated units will give accuracy of a second a month. If you live in an area where line frequency is poor, this will give you an independent time base of .0005% accuracy when properly trimmed. Add $22.50 for this crystal time base.

- Special – National MM5311 clock chip and readouts only, with instructions for do it yourself clock projects. Specify GE florescent or Burroughs B5750 nixie tubes as readouts $24.50

TEXAS INSTRUMENTS "ELECTRONIC SLIDE RULE" CALCULATOR

This brand new calculator from T.I. promises to revolutionize engineering calculations! Use scientific notation, i.e., 4235.7867 is expressed as 4.2357867 x 10^3. Does squares, square roots, reciprocals, adds, subtracts, multiplies, divides. If you have been looking at electronic slide rules you know what a phenomenal deal this is. By the way this is direct entry as opposed to HP's indirect entry.

☐ T.I. "Electronic Slide Rule" $149.00



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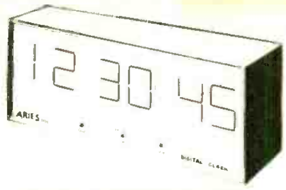
A $700.00 function generator for $99.00? But true! The new, low-cost EXAR-205 monolithic waveform generator makes this price possible. Our kit uses two generator circuits — one is a carrier generator, and produces sine, triangle, square, sawtooth, ramp and pulse waveforms. The second is a modulation generator, for amplitude or frequency modulation of the output waveforms. Output frequency range is from 20 Hz to 1.5 megaHertz. Modulation is switch-selectable for internal AM, internal FM, or external modulation.

☐ Model AR-620K Function Generator . . . $99.00



GIANT 2½" NUMERAL "NIXIE" CLOCK KIT

New! For factories, offices, and commercial establishments, and those people who like large displays, characters appear as a bright continuous line which can be read from distances as great as 150 feet. All drive circuits are solid state, and unit employs new custom LSI clock chip. Indicates hour, minutes, and seconds. May be wired for 24 hour or 12 hour operation with a simple jumper change. Kit offered complete with or without case for custom installations. Parts include P.C. board, sockets, solid state components, hardware, resistors, caps, viewing filter, etc.

Sh.Wt. 15 lbs.

☐ GNNC/C With Case $98.50
☐ GNNC Without Case $84.50

VIEW HOLOGRAMS! PERFORM OTHER EXCITING EXPERIMENTS LASER KIT!

Now available only from Aries! Brand new Hughes "Hip Pocket" type tube, and Aries power supply kit, plus complete experimental accessories. These tubes are completely guaranteed by Aries and Hughes, but are available at this bargain price because their power output is slightly below Hughes standard. Because of this fortunate purchase, you can purchase the complete experimental kit for less than the price of the tube alone. The Hughes specification for this tube is 1.4 milliwatts output power when new, so that minimum power specification of 1 milliwatt can be met throughout life of tube. Our specification is initial power between 0.9 and 1.4 milliwatts, guaranteed not to go below 0.5 milliwatt during the guarantee period (6 months continuous operation!) Our kit includes experimental accessories such as lenses, pinholes, mirrors and a hologram to perform hundreds of fascinating experiments. Holograms viewing is easily demonstrated with this kit, hologram making is possible, but is recommended only for advanced experimenters.

☐ Laser Experimental Kit $119.00

AIRCRAFT/AUTO/BOAT QUARTZ CRYSTAL CHRONOMETER

Revolutionary!, was the reaction of our customers when they saw our latest kit. Measuring only 2½" x 2½" x 2-3/8", and accurate to 10 seconds a month, this chronometer promises to entirely replace mechanical clocks in cars, boats and airplanes.

Fits into a standard 2¼" instrument panel cutout. The displays are bright L.E.D. displays that should last a lifetime. Setting controls are recessed and operate from a pointed object such as a pencil point or paper clip, in order to keep non-authorized hands off. The clock should only have to be reset at very great intervals, or in the event of power loss (i.e. replacing battery in car). The clock is wried so that the timing circuits are always running, but the displays are only lit when the ignition is on, resulting in negligable power drain. The low price is only possible because of a new one chip MOS clock circuit, developed for quartz crystal wristwatches.

Operates from 10-14 Volts D.C. An accessory unit which mounts on the back adapts the unit 59 20-28 volts for twin engine aircraft and larger boats using 24 Volts ignition. Know how disgusted you are with the usual car clock? Order this fine unit now for rallying, sports events, navigation, or just to have a fine chronometer that will give you a lifetime of superbly accurate time.

☐ Quartz Chronometer, Kit Form.................. $69.50
☐ Quartz Chronometer, Wired $99.50
☐ 24 Volt Adapter $10.00

50 MHz DIGITAL COUNTER LABORATORY SPECIFICATIONS AT A BUDGET PRICE!

We feel the most important thing about building a kit is saving money. There are a lot of other advantages of course . . . maintainability, use of standard parts, complete documentation, and the experience and fun of building it, but the overriding consideration is economy. This kit costs less than half that of the lowest priced competitive unit on the market.

The Aries 50 MHz counter is designed for years of maintenance free service. MSI integrated circuitry, cold cathode display tubes and conservatively rated transformers mean low temperature rise. All displays and I.C.'s are in sockets for easy maintainability. The master oscillator is a 1.0 MHz crystal in a custom designed cosmos oscillator circuit, having a stability of ± 3 PPM. Accuracy is 0.005% worst case, 0.0002% or better when adjusted to WWV with a communications receiver. A front panel selects a timing interval of 1.0 seconds, 0.1 seconds or 10 milliseconds. A variable monostable multivibrator holds the count on the front panel for a period of a fraction of a second to infinity. For use in the period mode, the 1.0 MHz oscillator is connected to the main counting chain and gated by the input signal.

Assembly time for the kit is approx. 10 hours. The semiconductor complement is (1) 7400, (1) 7408, (1) 7442, (10) 7490, (2) 74122, (6) 74141, (1) 74193, (1) 74196, (1) 74S11, (1) CD 4007AE, (1) LM309, (6) Diodes, and (1) Transistor. If you always wanted a laboratory quality counter, but could never justify the price, here is your chance.

☐ 50 MHz Counter Kit, Complete with Crystal Time Base and Case – Postpaid in USA $125.50

POCKET CALCULATOR

We expected a favorable reaction to our calculator, however, we were overwhelmed when we received orders for hundredds at a time. The reaction of our customers was that they felt this was the most advanced pocket calculator on the market, and priced so low, they could assemble and market it at a profit. The features that make this so exciting are:

- So compact it fits in a shirt pocket (3-13/16 x 4-5/8 x 1-1/4).
- Performs every function you would expect in a desk calculator, and then some, multiplies, divides, adds, subtracts and gives true credit balance. Includes constant and chain operation, full floating decimal, suppressed trailing zeroes, and automatic single entry squaring.
- Powered by self contained AA batteries with up to six hours operation (Nicad batteries with charger option, up to five hours per charge).
- Calculations performed by a single 40 pin LSI (large scale integration) chip. Displays are 8 digit LED's (light emitting diodes) and overflow and minus signs are also LED's.

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
☐ Pocket Calculator Completed $99.00
☐ NiCad Batteries & Charger $17.50
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(617) 532-0450

Circle 87 on reader service card

CIRCUITS

(continued from page 99)

purchased or selected on a bridge from 5% or 10% stock. The other standard capacitors can be selected to near-equal precision from service-grade capacitors.

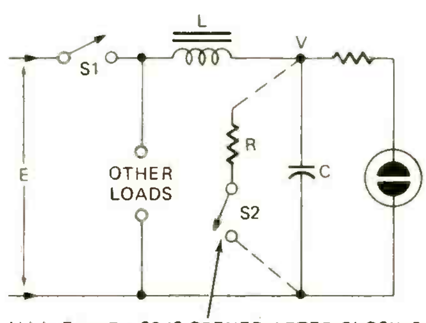
Simply set the range switch to the 1000 pF range, connect the 1000-pF precision capacitor to the TEST terminals and adjust the pot so the meter reads one-tenth fullscale or 10 on a 100 μA scale. Now, without touching the pot setting, select and substitute a .01-μF capacitor that will cause the meter to read exactly fullscale. Thus, selected capacitors can be used to select other range capacitors with ten times and one-tenth their value.

STARTING NEGATIVE-RESISTANCE DEVICES

A bit of inductance (L) in series and a little capacitance (C) in shunt, will start negative-resistance devices whose firing voltage is a little higher than the supply voltage. For example, neon lamps that work on 115 volts ac but not on 115 volts dc.

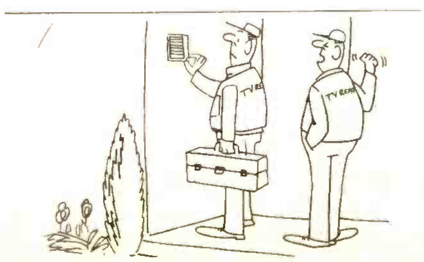
In the circuit shown, the theoretical peak voltage is 2E when we disregard the resistance in inductor L. Thus type NE-2 neon lamps connected this way will light on 90 volts or less and are handy as low-drain pilot lamps.

V→2E WHEN S1 CLOSED



V >> E WHEN S2 IS OPENED AFTER CLOSING

Of course, if you add a switch with a limiting resistor to temporarily short C—as is done when starting fluorescent lights—you get a peak voltage many times E when you open this switch. In this case C may be only stray capacitance.—*A. H. Taylor* **R-E**



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Circle 101 on reader service card

Circle 102 on reader service card

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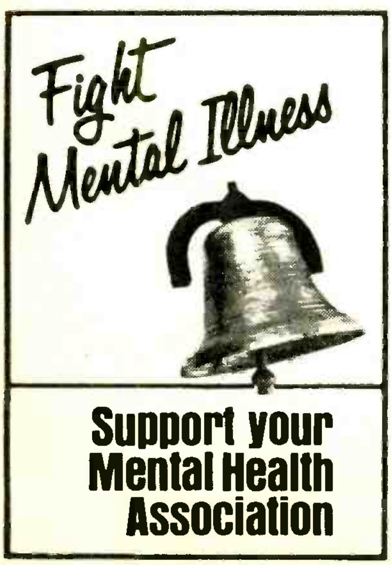

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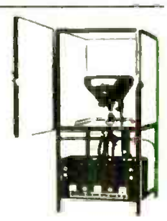

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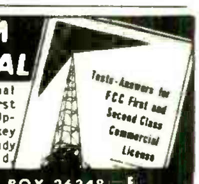

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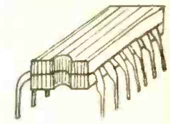

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558 (DUAL 741) TO-5	.90¢	10/$8.25
LM309K TO-3	$2.25	5/$10.00

GENERAL PURPOSE SILICON TRANSISTORS

2N3638	PNP	20¢	10/$1.65	100/$15.00
2N3638A	PNP	22¢	10/$1.80	100/$16.50
2N3641	NPN	23¢	10/$2.00	100/$17.50
2N3643	NPN	23¢	10/$2.00	100/$17.50
2N5133	NPN	15¢	10/$1.25	100/$10.00
2N5134	NPN	15¢	10/$1.25	100/$10.00
2N5137	NPN	18¢	10/$1.50	100/$13.65
2N5138	PNP	15¢	10/$1.25	100/$10.00
2N5139	PNP	15¢	10/$1.25	100/$10.00

1 AMP SILICON SUBMINIATURE RECTIFIERS

1N4005 600PIV ....10/$1.00 100/$7.50 1000/$60.00
1N4007 1000PIV ....7/$1.00 100/$9.95 1000/$84.00

DTL INTEGRATED CIRCUITS DIP PACKAGE

930, 936, 945, 946 and 962 ....Specify number of each type ....20¢ 10/$1.75 100/$16.00

SILICON SIGNAL DIODES

1N4148 (1N914 equiv.) ....20/$1.00, 100/$4.00

RTL INTEGRATED CIRCUITS TO-5 EPOXY PACKAGE

uL900, uL914 and uL923 ....Specify number of each type ....5/$1.00 100/$15.00

MOLEX IC SOCKET PINS

100/$1.00 200/$1.80 300/$2.60 500/$4.20 700/$5.80 1000/$8.20 ea addn 1000/$7.50

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5 Volt 7 Segment Readout Tube $2.95. Counting and Display Kit (Readout Tube +7490+7475+7447) $5.25, 3 Kits for $15.00

½ WATT 10% RESISTORS

Pick Values 4¢ 25/75¢ 100/$2.50 500/$11.25

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BOX 126H THIEF RIVER FALLS, MN56701

Circle 104 on reader service card

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Dollar Stretchers

- ☐ 1 - 2N3055 npn, 100w 15A, TO-3, transistor ... $1
- ☐ 2 - 2N3572 UHF,1000mc, npn, TO-92, plastic transistor ... $1
- ☐ 5 - ER900 TRIGGER DIODES for SCRs & Triacs ... $1
- ☐ 4 - 2.5 AMP 1000 PIV ITT, silicon epoxy rectifiers ... $1
- ☐ 5 - VARACTOR DIODES, 10pf, 20pf, 30pf, 40pf, 50pf ... $1
- ☐ 2 - FET'S 2N5457 N channel 5000 umhos, TO-92 plastic ... $1
- ☐ 1 - 90 WATT PNP, 15A, 2N2612, TO-3, silicon ... $1
- ☐ 3 - 2N389 npn, silicon, 85 watts, Vce 80, square case ... $1
- ☐ 3 - 2N1212 npn, silicon, 85 watts, Vce 60, stud case ... $1
- ☐ 10 - 1N914 fast switch diodes, silicon 4 nanoseconds ... $1
- ☐ 10 - 2N404 germanium pnp, TO-5 chrome case* ... $1
- ☐ 2 - 6 AMP TRIAC 200 PRV, TO-5 ... $1
- ☐ 40 - G-E MICRO MINI RECTIFIERS, silicon, porcelain to 1 KV* ... $1
- ☐ 40 - RECTIFIERS & ZENERS, 1W, & 1A, bullets, assorted volts* ... $1
- ☐ 30 - WORLD'S SMALLEST RECT. & zeners, 1W, assorted volts* ... $1
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- ☐ 5 - 2N3638 PNP, silicon, TO-5 plastic transistors ... $1
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- ☐ 4 - 2N4269 Nixie tube driver transistors 100V, npn ... $1
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- ☐ 6 - TRIGGER DIODES, for SCRS only, axial leads ... $1

ALPHA-NUMERIC 7-SEG. READOUTS

2.50 3 for $6.

☐ MINI-7 — Flourescent Blue-Green ☐ Socket — 50c

☐ SLIM-7 — Flourescent Blue-Green ☐ Socket — 50c

	H.	x W.	Characters	Filament V.
MINI-7*	1.75	x 1.7"	.360 x .570"	1.5V AC/DC 42 mils
SLIM-7*	1.6	x 0.375"	.40 x .20"	1.5V AC/DC 42 mils

*Compatible to 7-segment driver IC's.

All 3 have 0-9 numerals, decimals and letters.

MINI-7 SLIM-7

- ☐ 3 - 2N2646 UNIJUNCTIONS, plastic transistors, Texas ... $1
- ☐ 5 - 2N107, GE, most commonly used pnp, germanium ... $1
- ☐ 3 - 3-AMP 1000 PIV epoxy bullet, silicon rectifiers ... $1
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- ☐ 5 - 2N170, GE, RF, germanium, npn, transistors, TO-22 ... $1
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- ☐ 30 - 500 MW ZENERS, axial 4, 6, 9, 10, 12V rectifiers ... $1
- ☐ 4 - 2N3055, HOBBY, 40W npn silicon transistors, TO-3 ... $1
- ☐ 5 - 2N155, HOBBY, 10W pnp germanium transistors, TO-3 ... $1
- ☐ 3 - 50 AMP SILICON RECTIFIERS, silicon, 6, 12, 24 volts ... $1
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- ☐ 10 - 709 LINEAR AMPS, 741's too, DIPs* ... $1
- ☐ 5 - HOBBY MEMORY CELLS, SN7481, up to 16-cell, DIP* ... $1
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- ☐ 4 - 1000 HFE DARLINGTON transistors, TO-18 case ... $1
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- ☐ 2 - 2N6109 HOBBY 40 watts, plastic powers PNP ... $1
- ☐ 5 - PLASTIC 35W powers, npn, silicon, hobby 2N6121 ... $1
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- ☐ 2 - MOS FETS, DUAL GATE, N chan., 3N187-1, TO-18, RCA ... $1
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*Untested, guaranteed satisfaction

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2 3/8" x 1 3/8" x 7/8".

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Size of cabinet: 6" x 5 1/4" x 6" deep

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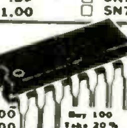

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This display is excellent for small portable electronics, such as DVM's, calculators, etc. Equivalent to Monsanto MAN 3A. Operates from 5V, 20 milliamperes, with 47 ohm dropping resistor.

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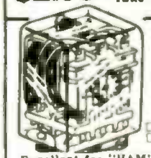

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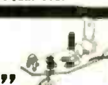

Unique Scientific Device, "hand claps", sensitizes crystal mike amplifier, triggers SCR. Needs only 3 to 6vdc. Use as burglar alarm, intrusion device. Use with photo cell, triggers SCR's, relays, LED's. Even fiber optic light pipe may be used. With hand booklet.

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

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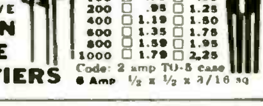

PIV	2 Amp	6 Amp
50	☐ $.69	☐ $.89
100	☐ .79	☐ .99
200	☐ .95	☐ 1.25
400	☐ 1.19	☐ 1.50
600	☐ 1.35	☐ 1.75
800	☐ 1.59	☐ 1.95
1000	☐ 1.79	☐ 2.25

Code: 2 amp TO-5 case
6 Amp 1/2 x 1/2 x 3/16 sq

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PRV	3 amp	6 amp	10 amp	15 amp	25 amp
• 50	☐ $.22	☐ $.38	☐ $.45	☐ $.65	☐ $.85
100	☐ .35	☐ .52	☐ .64	☐ .85	☐ 1.05
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500	☐ 1.25	☐ 1.39	—	☐ 2.55	☐ 2.25
600	☐ 1.50	☐ 1.69	—	—	☐ 2.65

3 & 6 amp TO-5, 10 amp TO-66, 15 & 25 amp stud.

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Dual 739-739 8-transistors per channel. 50K in. imp. for phono-tape 20-20,000 mc. DIP. Fairchild.

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1-WATT AUDIO AMP ☐

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

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- ☐ 14-Pin, dual in line ... $.45
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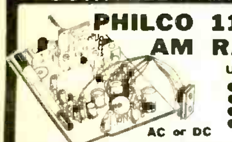

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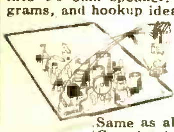

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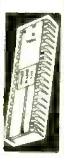

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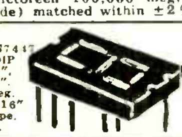

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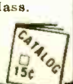

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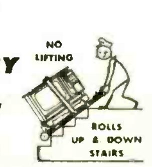

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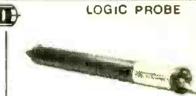

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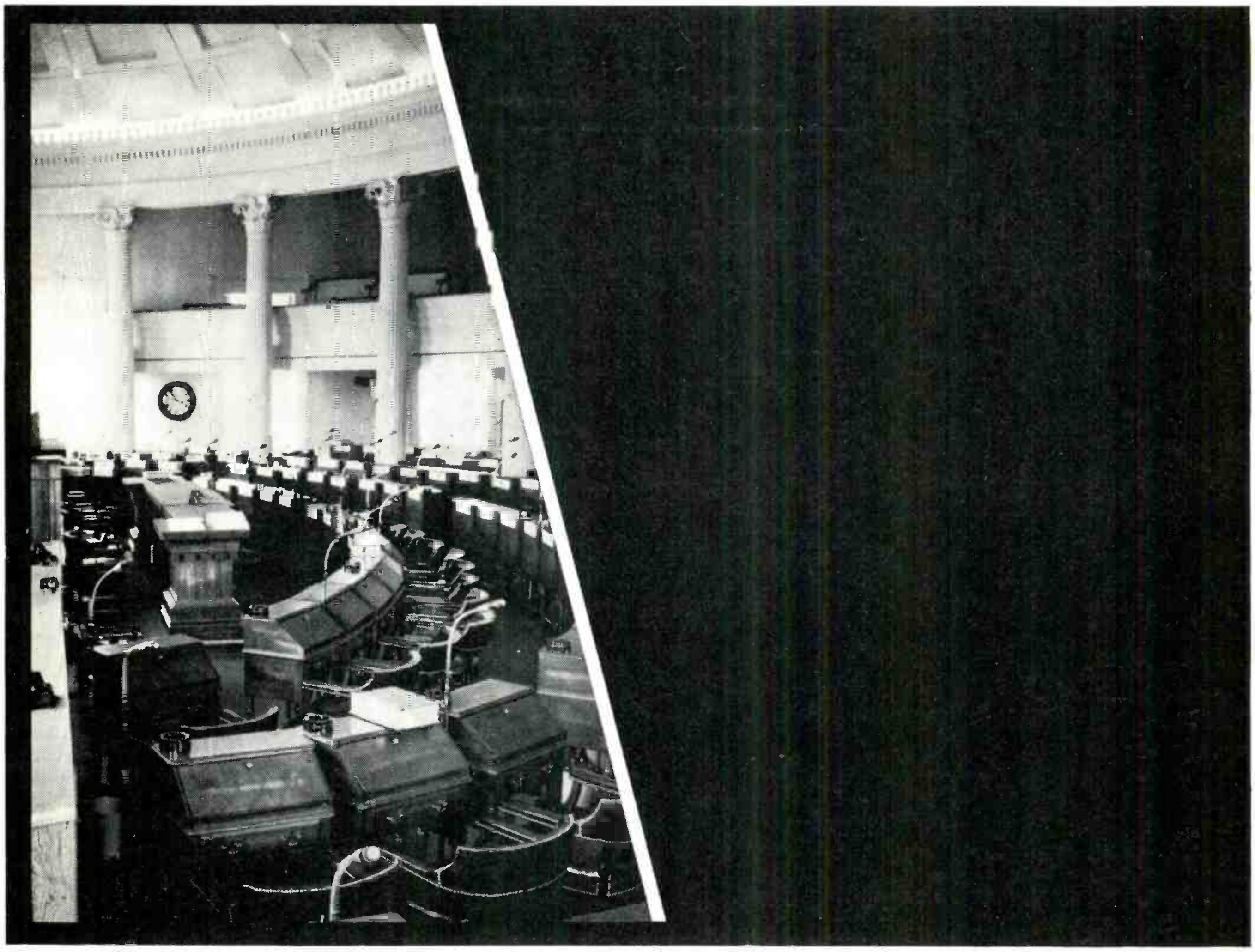

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