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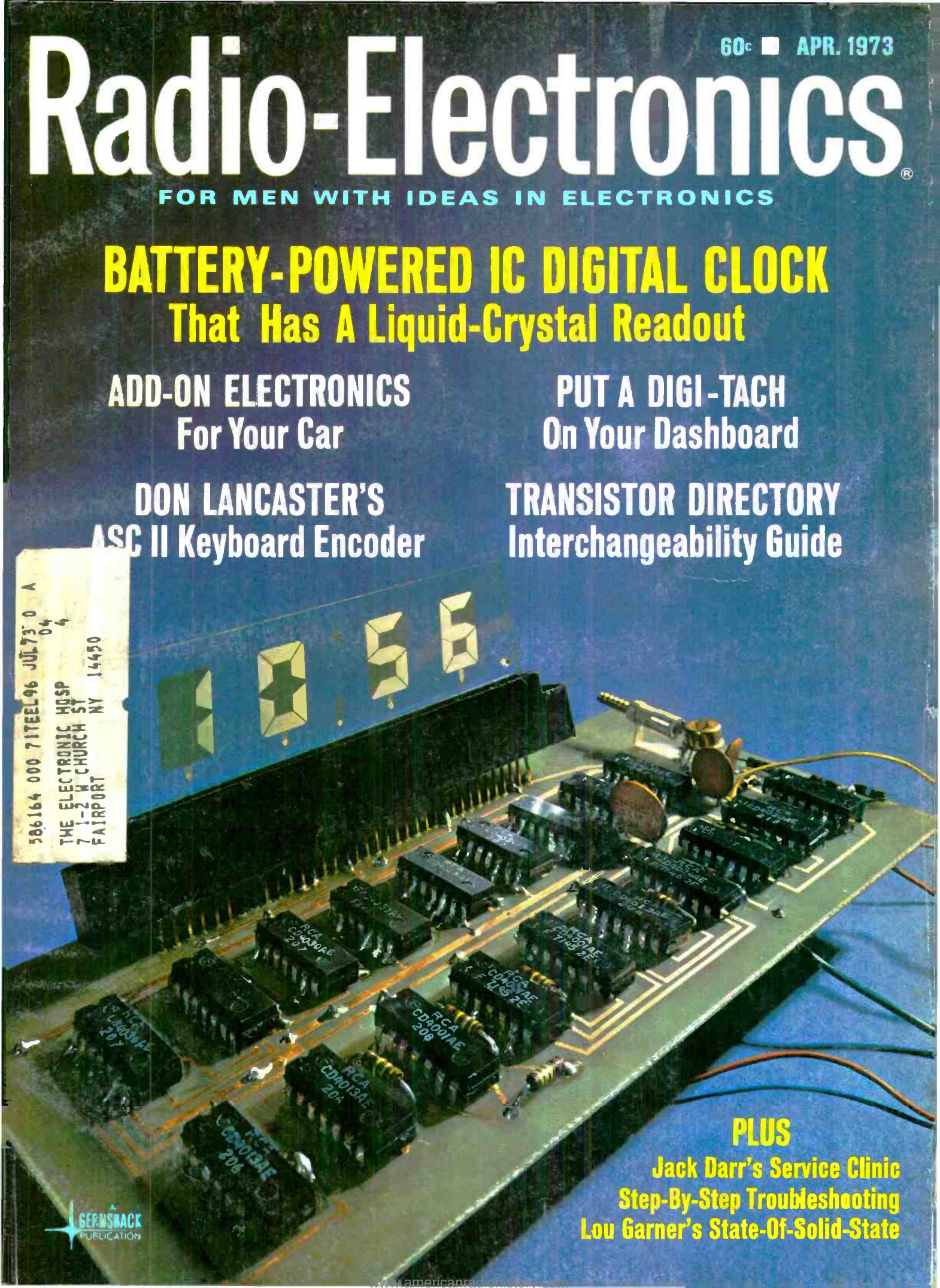

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The Model 1656 offers a cardioid polar pattern with 20 dB front-to-back discrimination. As well as the convenience of a lockable On-Off switch. The Model 1655 provides an omnidirectional polar pattern for uniform natural pickup from all directions. Output impedance of 200 ohms balanced integrates with conventional accessories.

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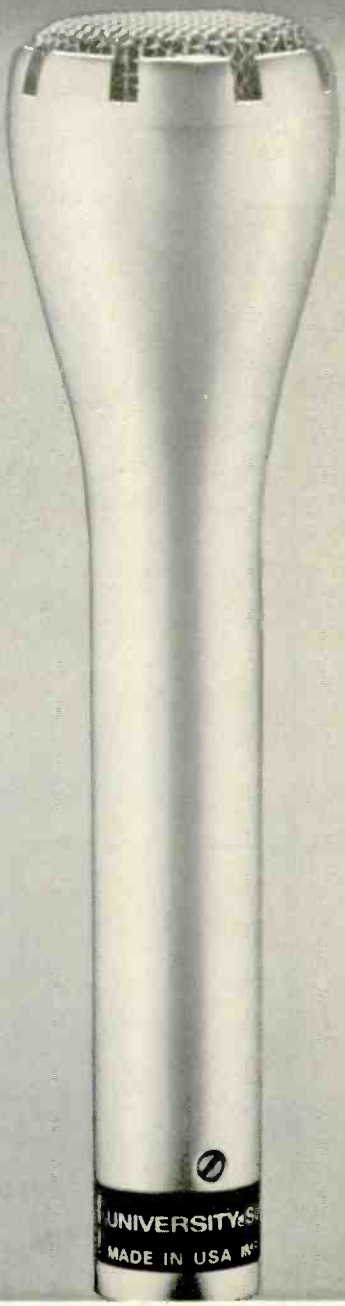

Circle 1 on reader service card

Radio-Electronics

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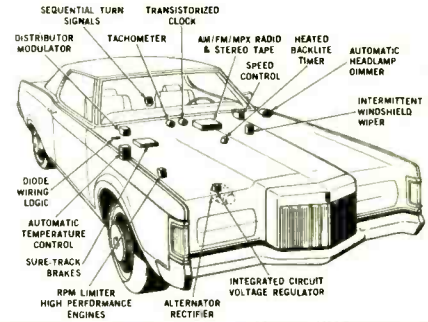
APRIL 1973



ELECTRONIC DEVICES can be found all over your car. Take a look at how some of them work. **see page 35**

CO-OP TV SERVICE SHOP is the first of its kind. Here's the story on how it operates. **see page 101**

Radio-Electronics is indexed in *Applied Science & Technology Index and Readers Guide to Periodical Literature.*

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looking ahead

Silent radio

"Radio for the deaf" is experimentally being programmed on New York City's municipally-owned WNYC-FM. But don't try to tune it in—you won't hear anything. The system, developed by Fax Net, Inc., uses an FM subcarrier to transmit printed and pictorial material to facsimile printers, that are expected to cost about $150 each. The service will provide news and other information of interest to the deaf. One potential use, if the service should be instituted on a regular basis, would be transmission of outlines or scripts of upcoming television shows.

Better TV sound?

The buzzing, humming and scratching that often passes for sound on television is going to undergo scrutiny from a major all-industry engineering committee. Acting on a proposal by Hartford Gunn, president of the Public Broadcasting Service, the study will be undertaken by the Joint Council on Intergroup Cooperation, an engineering liaison organization comprising representatives of the Electronic Industries Association, National Association of Broadcasters, Institute of Electrical and Electronics Engineers, National Community Television Association and Society of Motion Picture and Television Engineers.

The study will examine the entire television sound problem from camera to receiver, with special panels devoted to studio procedures and origination equipment, networking, transmission and reception. The group will look into such questions as the desirability of stereo sound or dual sound channels on television, determine how sound can be improved at each level, and whether new FCC regulations are necessary. The sound study parallels a similar one, now well under way with beneficial results, on the problem of color inconsistency on television.

Crossover point

Several years late, the age of solid-state has finally overtaken the television receiver. It's anticipated that about 50% of all color TV's sold this year will be all-solid-state (except for the picture tube). But solid-state color sets still sell at a premium of at least $50 over comparable hybrid sets. When will the crossover point come—that date when a solid-state set will be as inexpensive to build and market as a hybrid type? Semiconductor manufacturers say it will be here in less than two years, about the start of 1975. Receiver makers say it could come then, but they have reservations.

With the increased production of transistors and IC's for TV sockets, it's true that the crossover point in actual production costs could easily occur within the next two years. But set makers are considering other factors. All television manufacturers provide a one-year parts-and-labor warranty with solid-state sets, and this has turned out to be a costly proposition. Some say the major cost factor in this extended warranty is the nuisance call—if a user knows he's covered, he'll call for frivolous reasons. And set manufacturers take the long warranty into account as one of the major cost factors in moving to solid-state.

When the magic crossover date occurs, there still will be no immediate complete switch to solid-state. Why? Solid-state is a "step-up" feature, and manufacturers will still want to have "low-end" sets in their lines. Even when there's no cost differential, some will continue to market hybrid sets to have a retail price differential. The pattern is expected to be very similar to that in picture tube sizes. A 19-inch color set costs the manufacturer about the same as an 18-incher—yet it can command at least $50 more at retail. So set makers continue to manufacture "obsolete" 18-inch sets as price leaders, from which they can sell customers up to 19-inch sets. The same should be true for a time with regard to solid-state vs hybrid.

Calculator boom

Possibly no electronic product—not even television—has taken off on the consumer marketplace, or come down in price, as quickly, as the pocket calculator. Thanks to the development of the low-cost LSI chip, it's expected that about 3,000,000 relatively cheap pocket and desktop units will be sold this year. The figure would go higher, except for a shortage of IC's and display devices. Throughout 1972, prices of simple four-function (add-subtract-multiply-divide) units have declined steadily to well below the $100 mark. Forecasts are already being heard that pocket calculators could be available for as little as $39.95 before the year is over.

At the same time, more sophisticated pocket "calculator-computers" are becoming available for specialized purposes. Probably the most successful of these is Hewlett-Packard's pre-programmed engineers' calculator, which performs many functions never before possible without a large calculator or computer. An amazing 50,000 of these were sold last year at $395 each. Now the same company has introduced a businessman's version, programmed to handle calculations of interest rates, averages, medians, dates, etc. Other specialized programmed calculators can be expected soon from other companies.

International TV

Sony, Hitachi and Panasonic are Japanese television sets. Right? RCA, Zenith and Magnavox are American. Right? Not necessarily. If you buy a Sony, Hitachi or Panasonic color set today, it may well have been made—or at least assembled—in the good old U.S.A. The Zenith or RCA monochrome set you buy could be from Taiwan, the Magnavox from Mexico. Or your Admiral color set could be Taiwanese. The growing internationalization of consumer electronics is blurring world borders. The latest manifestation, since Japan's currency realignment, is the establishment of assembly plants in the United States by Japanese manufacturers. Panasonic for several years has had an assembly and cabinet manufacturing facility in Puerto Rico, U.S.A., and recently added a color TV production line. Sony has now started up an assembly plant for Trinitron color sets near San Diego, and Hitachi is building large-screen color near Los Angeles. All of these operations started with Japanese parts and subassemblies, but increasingly are using American components. At the same time, American manufacturers have gone across the border or overseas for production facilities. You can't tell a book—or a television set—by its cover.

by DAVID LACHENBRUCH
CONTRIBUTING EDITOR

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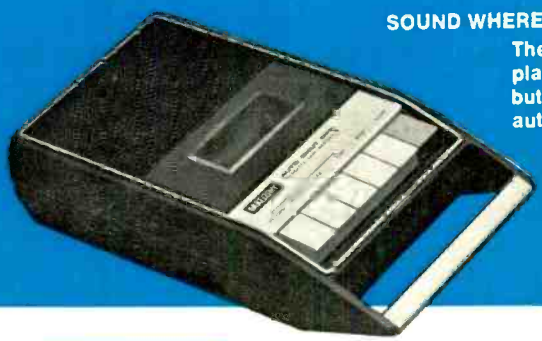

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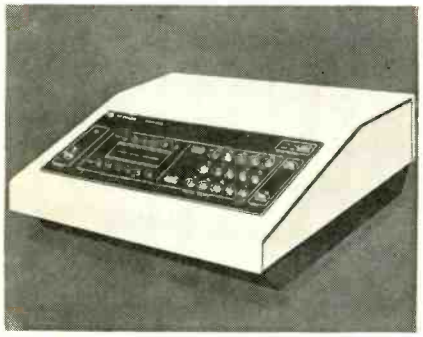
new & timely

New vision memory unit reaches backward in time

A memory disc unit that will not only store desired frames of a television program, either over-the-air or from an on-the-spot closed-circuit television camera, but can go back in time to some extent to retrieve and freeze selected frames that have already been received, has been demonstrated by Hitachi. The device is called a Multi Channel Disc Memory, and operates with color or black-and-white.

This is accomplished with a high-speed magnetically sensitive memory disc, less than 4 inches in diameter. The amplified signal is recorded continuously on this disc at a speed of 3600 rpm. As new signals are received, the oldest are erased.



THE MULTI-CHANNEL MEMORY UNIT made by Hitachi.

As many as 15 images spaced a maximum of 17 seconds apart can be selected from the data in the memory disc and stored for viewing. The device uses 15 magnetic heads to do this. Thus the first head of the 15, when they are spaced 17 seconds apart, can freeze a frame 255 seconds in the past. The time between recording images can also be set automatically for 0.1, 0.2, 0.3, 1.0 and 4.3 second intervals in addition to the 17 seconds.

The machine can also be programmed automatically to select "on line" or currently incoming signals for storing, with the same choice of intervals. The frames can be played back automatically if desired, or any one can be viewed by pressing one of 15 playback buttons.

The unit is expected to be especially useful in continuous observation and comparison of automatic industrial and chemical processes, as well as in training programs, especially athletic events and competitive sports. In both of these the "how's that again?" ability to reach back into the past and replay a frame is almost indispensable. Display of goods by merchandising departments to branch store buyers, and display of "today's specials" to consumers in retail stores are also cited as examples of specific uses.

Liquid crystals used in new image amplifier

A new device for intensifying a light image was announced by scientists of the Hughes Research Laboratories at the recent International Electron Devices meeting in Washington, D.C. Advantages claimed over current light intensifiers were longer lifetime, higher brightness, simpler operation and lower cost. These may result in the cell's use in large-screen television systems in the near future, the Hughes scientists said, and may bring home-projection TV a step closer.

The image to be amplified is projected, or "written," as indicated in the drawing, on the back of the new light valve, the main features of which are a flat liquid-crystal layer between two conductive transparent plates. A photoconductive layer behind the crystal changes the light pattern to an electrical one. This modulates the crystal so that a strong light projected onto the front of the valve is largely reflected from the lighter parts of the "written" image, and largely absorbed in the darker parts.

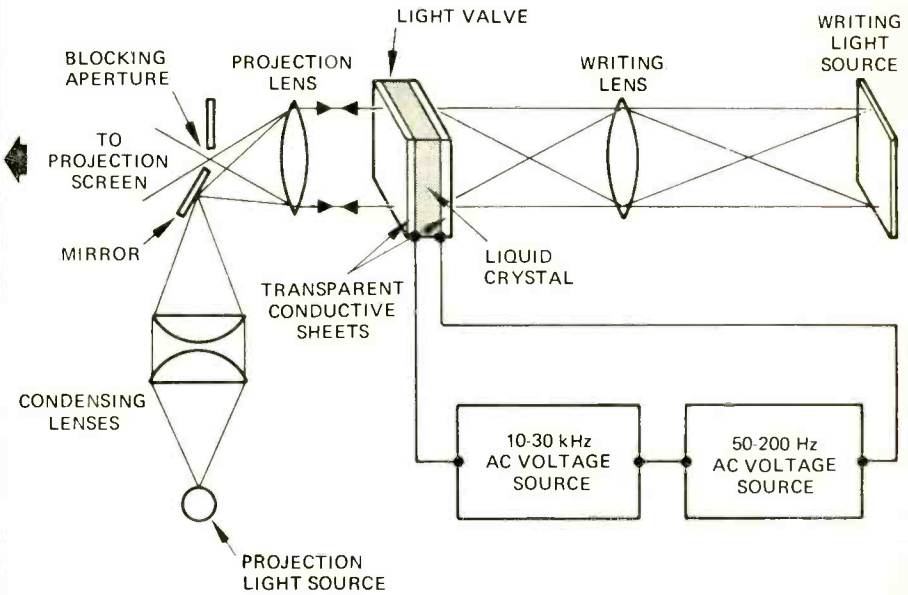
Images "written" with a light power of from 50 to 500 microwatts per square centimeter have been projected at 200 lumens per square centimeter of white light. The resolution is 50 lines per millimeter, giving more than a thousand lines across a 2.5-cm cell aperture, the Hughes scientists reported.

Satellite in space supplies information about Earth

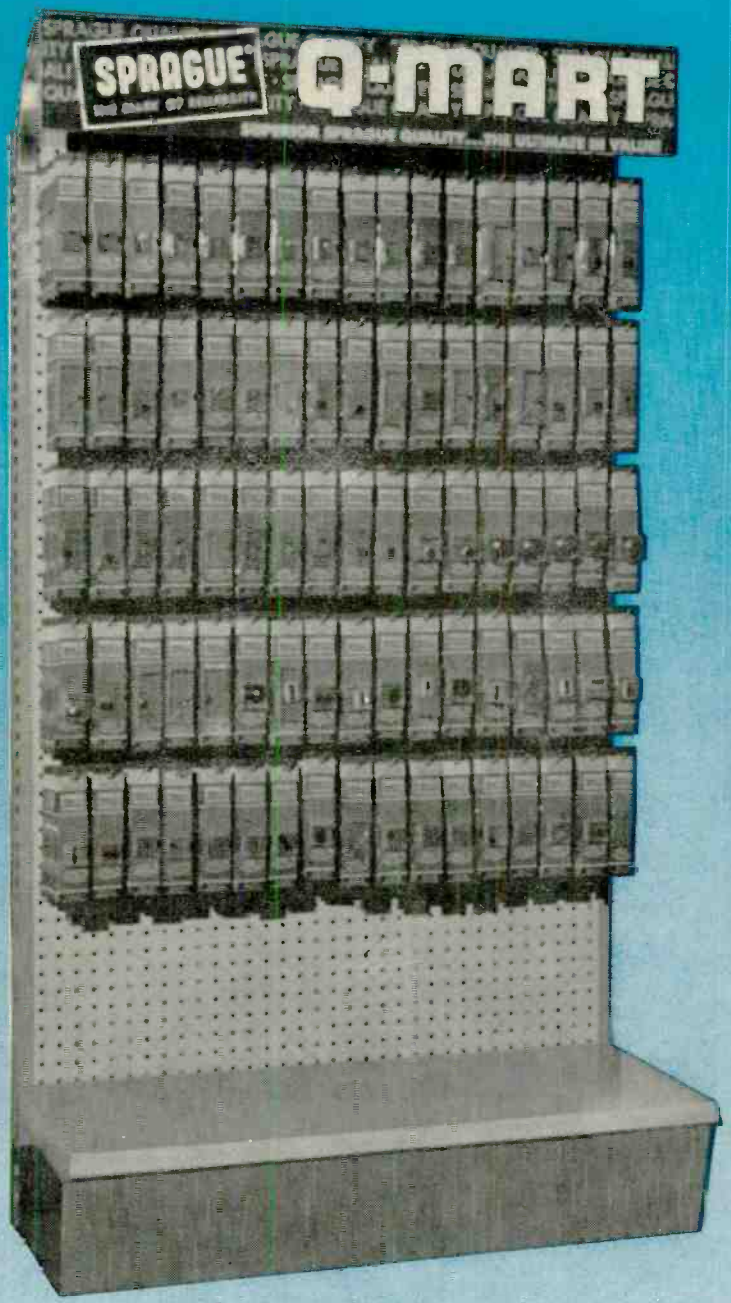
By pinpointing the exact position of a satellite in space over a large number of observations, scientists can get important information about Earth. Any deviations from the satellite's prescribed path, for example, reveal changes in the Earth's gravitational field. Observations from a number of stations may give information about the phenomenon known as continental drift.

The Institute of Applied Geodesy (IFAG) have established an observation post in Germany that will measure the trajectory of satellites to within a centimeter. The principal equipment is a Siemens pulse laser, sending out pulses of 20 to 50 nanoseconds duration with a peak power of 100 megawatts. The laser beam is reflected to the ground station from a corner reflector on the satellite. The exact distance is given by the time

(continued on page 12)



LIQUID CRYSTAL LIGHT AMPLIFIER. The light valve is not quite as simple as shown, and includes a photoconductive layer, a light blocking layer (to prevent leak-through of the "writing" light) and a dielectric mirror (all behind the crystal) in addition to those shown.



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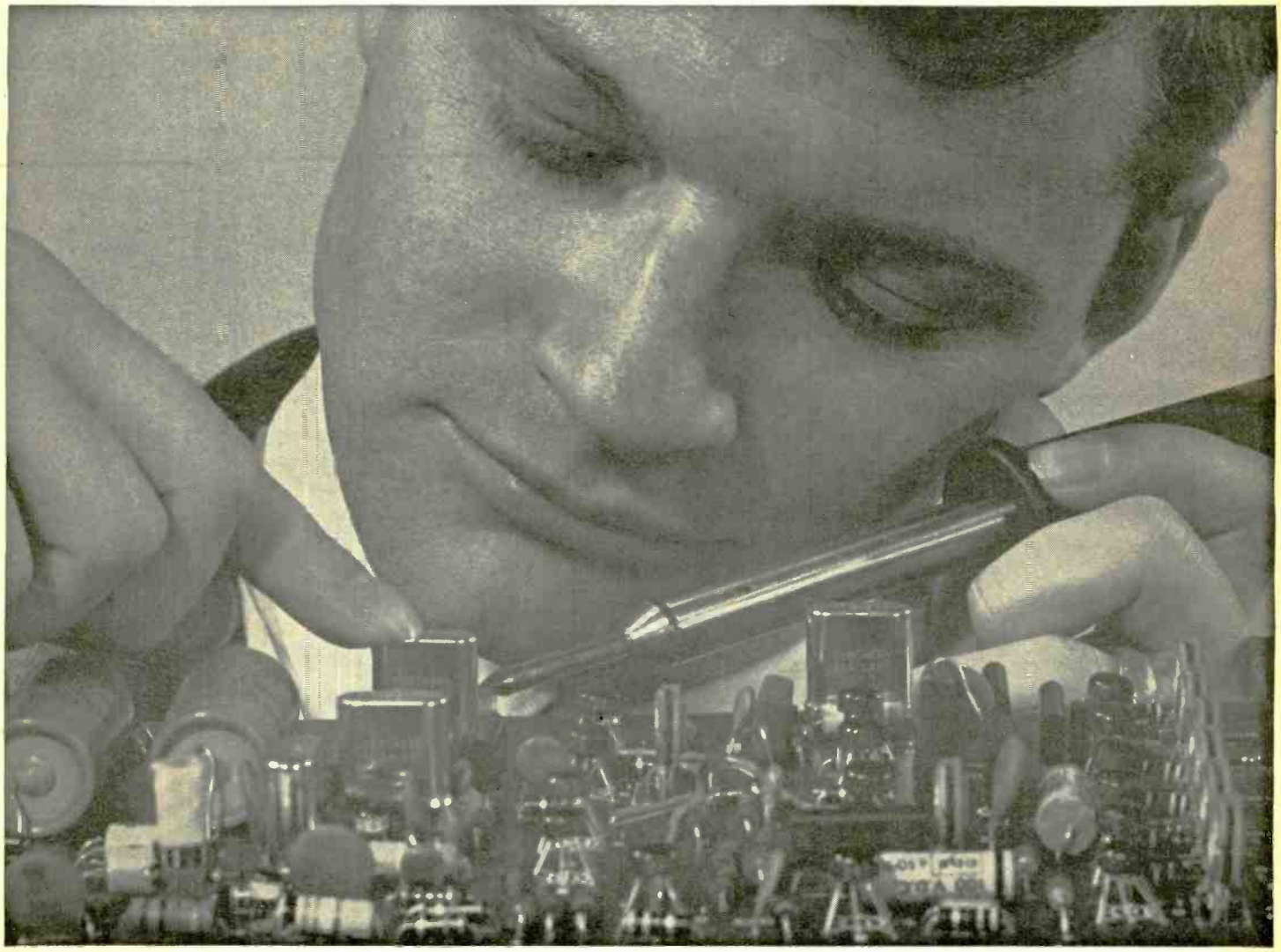

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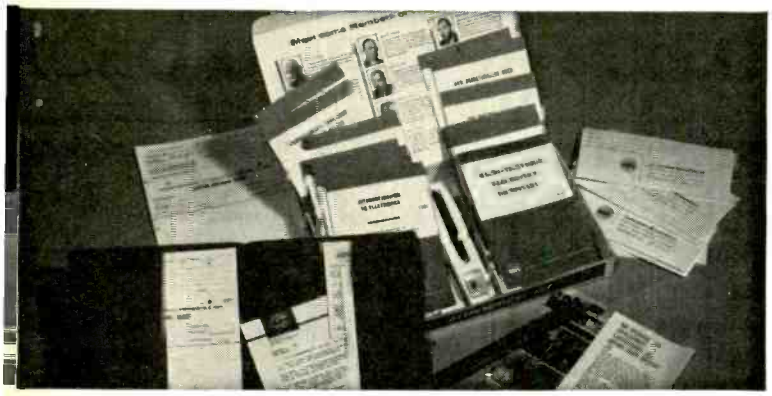

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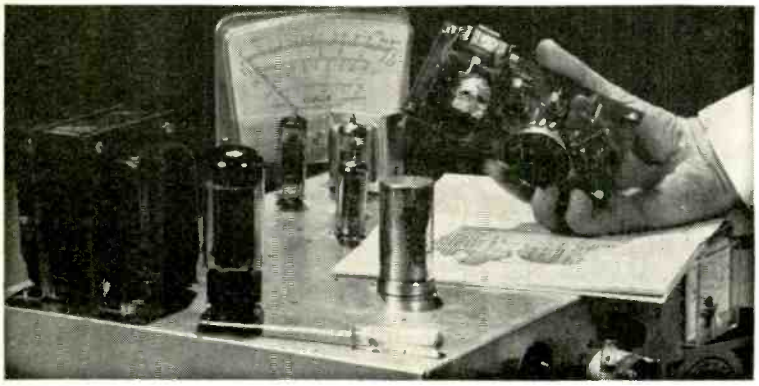

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new & timely (continued from page 6)

LOOKS LIKE A HOWITZER? Don't be too surprised—It's mounted on what was formerly an artillery piece. One of the large barrels is a laser transmitter—the other an optical camera.

taken for the pulse to go and return. At the same time, an optical photograph of the satellite is taken, to record its position in relation to the constellations.

Telephone line handles 10,800 calls at a time

A new coaxial-cable carrier telephone system capable of handling 10,800 telephone calls simultaneously has been put into operation over a 90-kilometer (56-mile) stretch between Västerås and Örebro, Sweden. This 10,800 voice channel capability is four times as great as that of the previous system.

The new advance was made possible by the development of new wideband amplifiers by Siemens, who supplied all the line equipment for the system. They amplify smoothly over a bandwidth of 60 MHz, thus being able to cope with future telephone, data and also videotelephone traffic.

As compared with the 2700-channel amplifiers, the new units require completely new construction methods. Components had to be arranged very compactly to avoid phase shifts. The problem was met by using hybrid circuitry, combining thin-film conductors, resistors and some capacitors with conventional transistors and coils.

The amplifiers are placed a mile apart along the route to regenerate the signals. They are installed underground and supplied with power via the inner conductors of the coax.

The Swedish telephone administration expects shortly to extend the system from Örebro to Gothenburg (Göteborg) on the North Sea coast, a distance more than four times as great as that between Örebro and Västerås. Further 60-MHz routes to the north are planned for the near future.

Canada's national satellite begins commercial operation

A telephone call January 11, from Resolute, Cornwallis Island, above the Arctic Circle, inaugurated service via Anik 1, the world's first national synchronous satellite. (Anik is the Eskimo word for brother.) The call was placed by the settlement's Eskimo community manager, Rudy Pudluk. He greeted Gerard Pelletier, minister of communications, and David Golden, president of Telesat Canada, the company that operates the satellite. Mr. Pudluk, considerately, spoke in English.

A CANADIAN ESKIMO bids big brother Anik farewell before the all-Canada communications satellite was lifted into orbit.

The call from Resolute, 150 miles due east of the magnetic pole and more than 2000 miles northwest of Ottawa, was made via one of the twelve Northern Telecommunications stations that provide two-way medium-density service between Canada's scattered far northern communities and the relatively densely populated south.

Anik 1, first of three satellites ordered from Hughes Aircraft Co. by Telesat Canada, weighs 1200 pounds and can handle 5000 telephone circuits or twelve color television channels simultaneously. Travelling in an equatorial orbit, it blankets all Canada, linking 37 Canadian-built earth stations spread over some 3.8-million square miles—the world's second largest land mass.

SIEMENS ENGINEER CHECKS an underground repeater on 60-MHz Orebro-Västerås line.

Excessive-speed warner sounds note of caution

A dashboard-mounted gadget sold in Britain is claimed to save drivers' licenses in that strictly regulated country by giving an audible warning when they

(continued on page 14)

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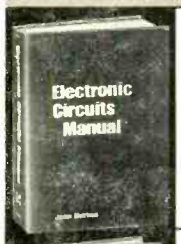

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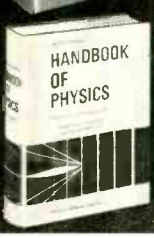

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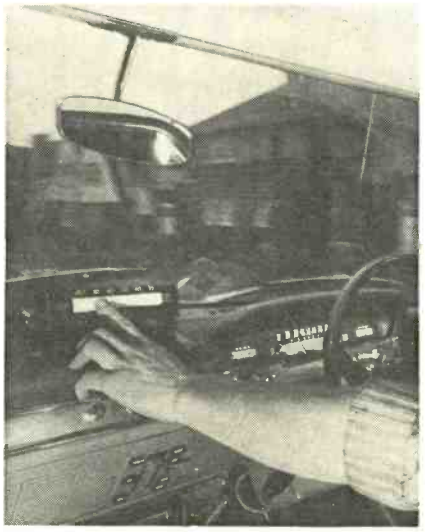
E33209

new & timely

(continued from page 12)

go over the speed limit. It can be set by pushbuttons for five speeds, beginning at 30 miles per hour and going to 70 in 10-mph steps. When a driver exceeds the speed for which the instrument is set, it emits a loud, continuous buzz.



PUSHBUTTON WARNER TELLS DRIVER when he is exceeding safe or legal speed limits.—*BIPS Photo*

The alarm can be set for any speed within the instrument's limits. The 30-mile button, for example, can be set for any speed from 28 to 38 mph (and the 70-mile button will go up to 78).

A special advantage claimed for the instrument is that it makes it unnecessary for the driver to take his eyes off the road to glance at the speedometer. This can be distracting, especially at night.

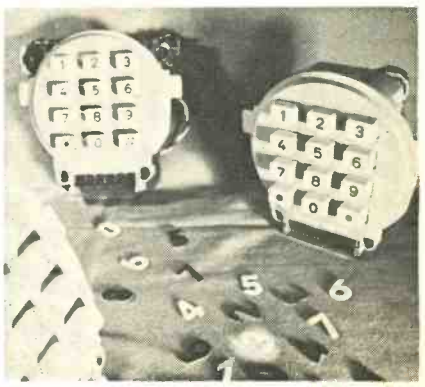
The easily installed device fits any car. Based on solid-state electronics, it is maintenance-free and uses less current than a parking light.

The Speedset audible speed warning computer is made by Automets, Ltd. of New Street, Oadby, Leicester, England.

Telephone keyboards operate wide range of controls

A means of generating signals for controlling industrial equipment, making selections in automatic vending machines and operating illuminated displays or other types of equipment was demonstrated by Siemens at the European exhibition "electronica 72." The signals are generated with a 12-button keyboard originally developed for the modern telephone.

Two methods of signalling are possible with the equipment—the time-honored digit code as used in dial telephones, in which numbers are transmitted in sequence to build up a code signal that initiates the desired action at the receiving end, or multifrequency code (MFC) signalling, as used



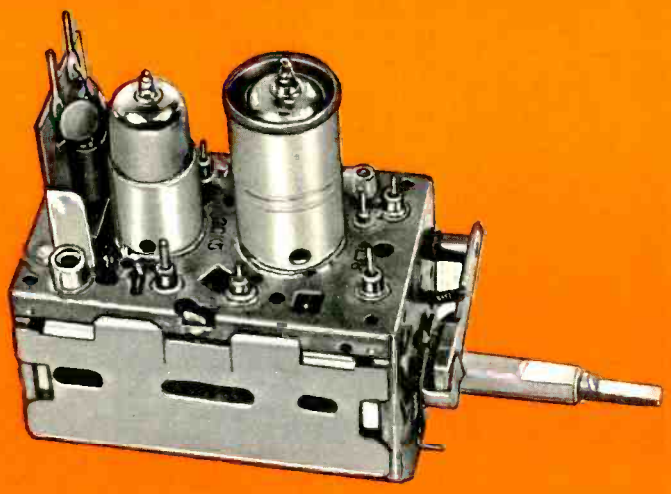
TELEPHONE KEYBOARD has a host of new applications.

on recent pushbutton telephones.

In the MFC approach a specific combination of two frequencies is transmitted for each digit. Eight oscillators provide two groups of four frequencies each. To generate a signal, one frequency from each group is used. The lower group generates signals of 697, 770, 852 and 941 Hz; the upper group, 1209, 1136, 1477 and 1633 Hz. This makes 16 signal combinations possible.

HEADPHONE STEREO is now important enough to support a demonstration van like the one above. Launched by a leading stereo headphone manufacturer, the 28-foot van is a training classroom for headphone sales personnel and a mini hi-fi show that can be presented to the public on shopping malls, college campuses or other suitable places. It contains sophisticated two and four-channel equipment and a complete audio-visual system for dealer meetings.

(continued on page 16)



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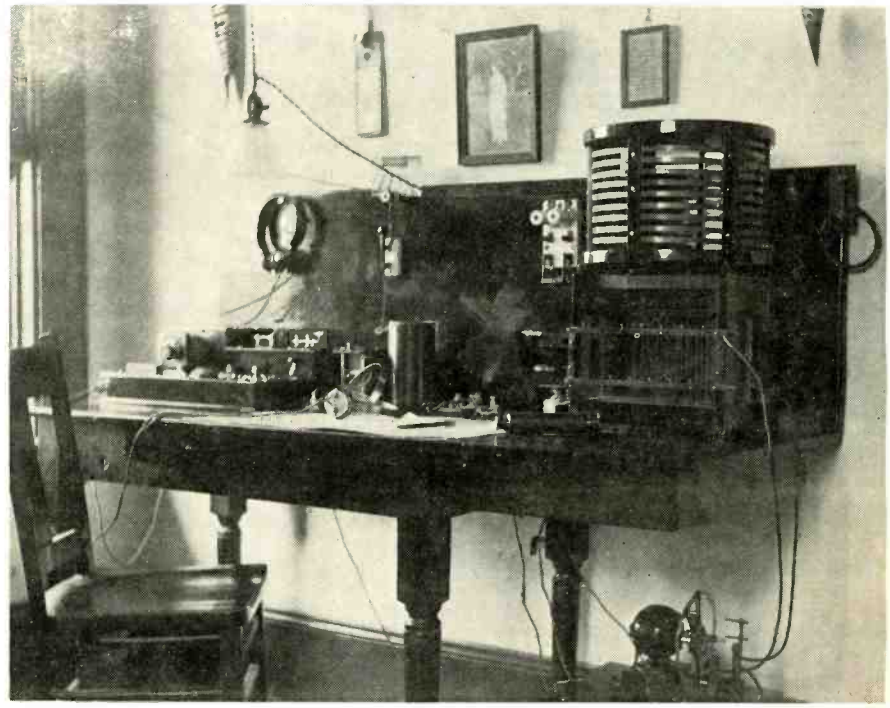
(continued from page 14)



RADIO 60 YEARS AGO. This photograph, taken in 1915, shows the amateur radio station built by C. P. Cooper in California during 1912 and 1913. R-E

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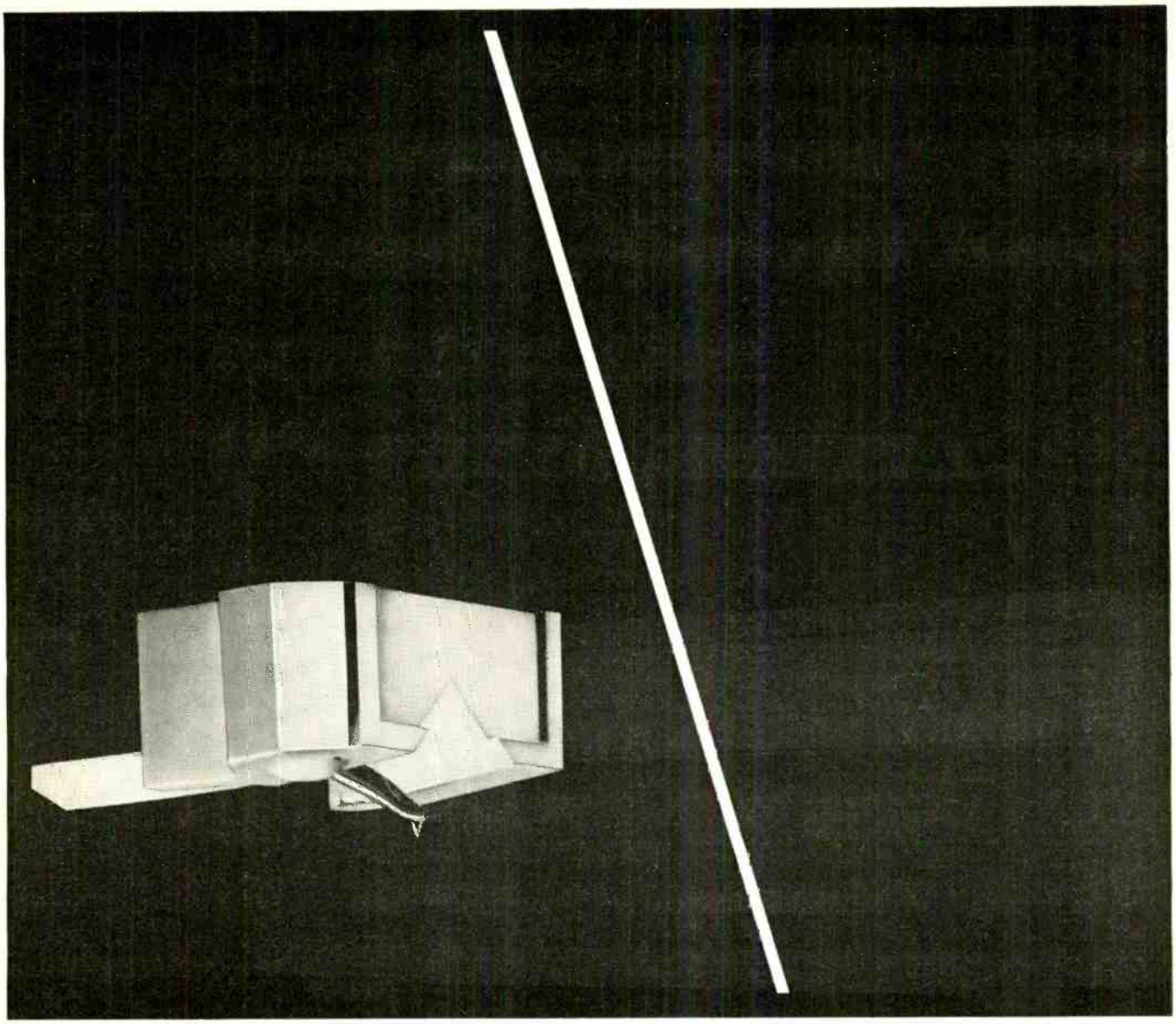
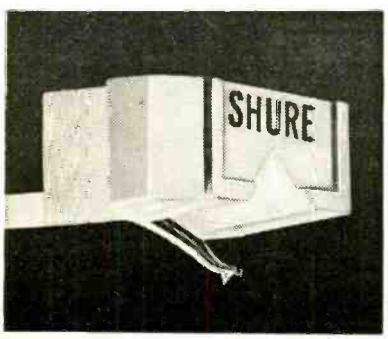


The three-dollar bill.



The stylus shown above is phony. It's represented as a replacement stylus for a Shure-cartridge, and although it looks somewhat authentic, it is, in fact, a shoddy imitation. It can fool the eye, but the critical ear? Never! The fact is that the Shure Quality Control Specialists have examined many of these impostors and found them, at best, to be woefully lacking in uniform performance — and at worst, to be outright failures that simply do not perform even to minimal trackability specifications. Remember that the performance of your Shure cartridge *depends* upon the stylus, so insist on the real thing. Look for the name SHURE on the stylus grip (as shown in the photo, left) and the words, "This Stereo Dynetic® Stylus is precision manufactured by Shure Brothers Inc." on the box.

Shure Brothers Inc.
222 Hartrey Avenue, Evanston, Illinois 60204

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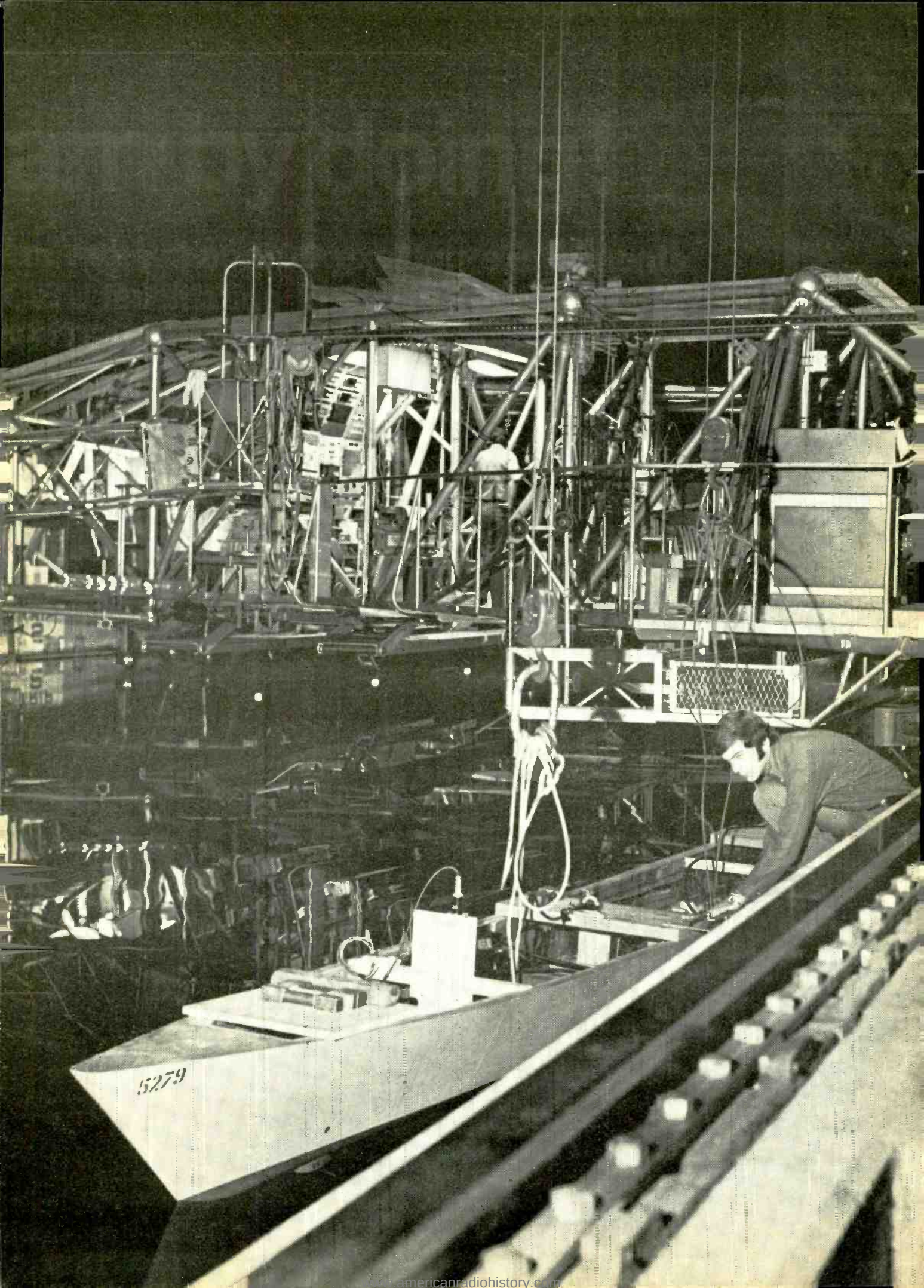
SHURE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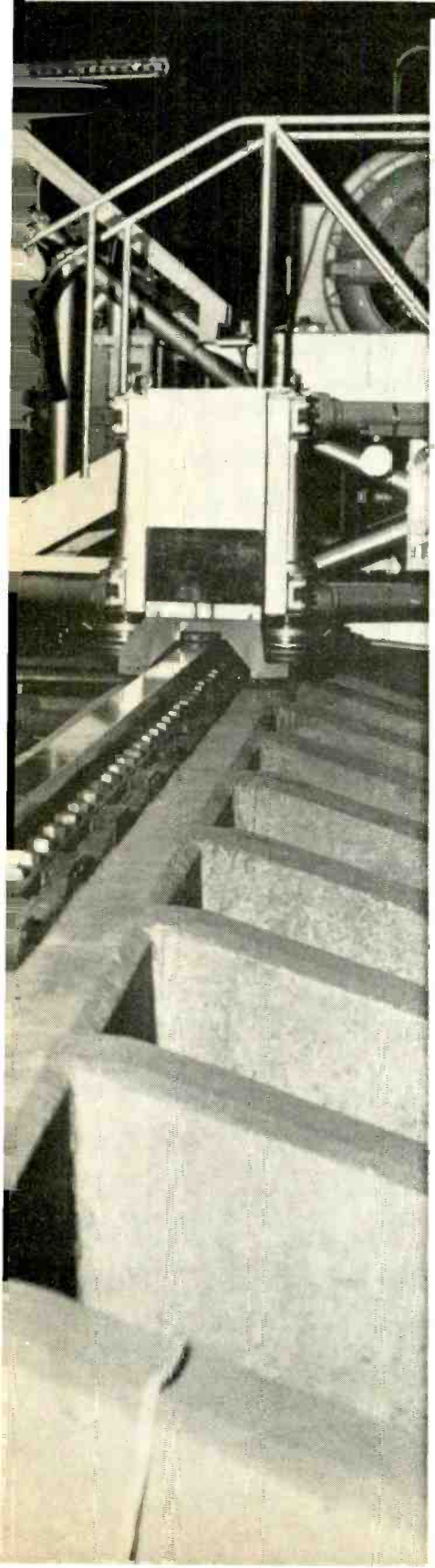

It costs millions of dollars to build modern ocean going vessels. The final design of such ships is based on extensive testing with sophisticated electronic measuring equipment using exact models as shown in the photo of the Naval Research and Development Center. The engineering technicians who check out, maintain and repair such equipment have to be experts. Their work is not only interesting and exciting, they also enjoy top pay in their field.

CREI offers Electronic Engineering Technology programs through home study. You have a choice of *eighteen* different program arrangements so you can specialize in exactly the area of electronics you want. All of the programs, except a brief introductory course, are college-level.

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CAPITOL RADIO ENGINEERING INSTITUTE
WASHINGTON, D.C.

letters

ABOUT CLOCK READOUTS

I read the article on page 35 of your February issue covering the Mostek Digital Clock on a chip with great interest. MOS/LSI chips are going to revolutionize consumer products. We have already seen this happen in electronic calculators. Clocks are a logical next step.

Sperry Information Displays is the leading supplier of electronic displays for digital clocks using MOS/LSI chips. The photograph in the article showed the Heathkit digital clock that uses the Mostek chip and Sperry advanced design planar gas discharge displays. I understand that this is one of the most successful kits ever offered by Heath. Heath also uses Sperry displays in their popular IC-2008 calculator kit.

I was somewhat disappointed that the article recommended the use of fluorescent display tubes and not the more popular Sperry displays. The choice of fluorescent display tubes for a consumer product such as a clock is a poor one since these tubes have a limited life and start to deteriorate after a year. Sperry planar gas discharge displays have a life of greater than ten years and have a much better aesthetic appearance.

Appearance, life, reliability and low cost are the major reasons for the wide acceptance of Sperry displays in consumer products such as clocks.

L. L. POND, JR.
Marketing Manager
Sperry Information Displays Div.
P.O. Box 3579
Scottsdale, Ariz. 85257

P.S. For your information, one of the newest consumer products to use MOS/LSI and Sperry displays is the new Frigidaire electric/electronic range. The Frigidaire people in Dayton, Ohio are quite excited about this new advanced design product.

A second article by Larry Sullivan of Mostek will describe other types of readouts and how they are used with the Mostek MSI clock chip—Editor

DIGITAL TACH

In your January 1973 issue in your letter section, a Mr. Robert N. Sleght, from Laramie, Wyoming was wanting to know a source of some IC to build a speedometer and a tachometer. You also said you would be running a story in

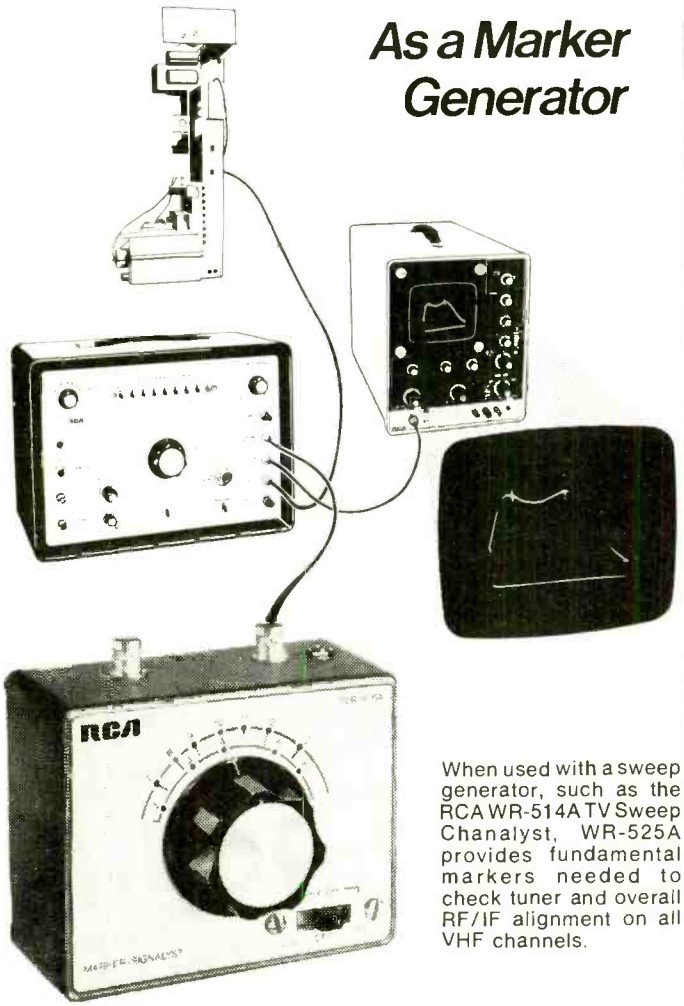
(continued on page 26)

New!
RCA WR-525A Marker/ Signalyst

$46.50

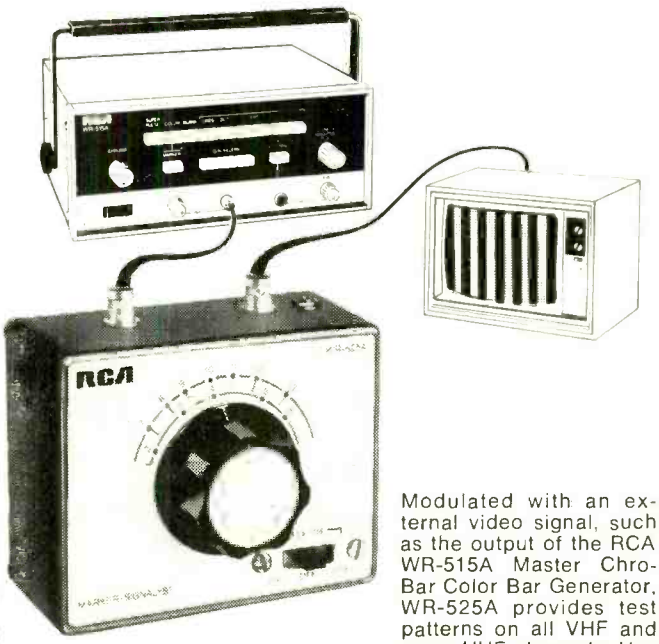
Optional Distributor Resale Price
(not including RCA VS323 or equiv. 9-V battery)

As a Marker Generator



When used with a sweep generator, such as the RCA WR-514A TV Sweep Chanalyst, WR-525A provides fundamental markers needed to check tuner and overall RF/IF alignment on all VHF channels.

As a Signalyst



Modulated with an external video signal, such as the output of the RCA WR-515A Master Chro-Bar Color Bar Generator, WR-525A provides test patterns on all VHF and many UHF channels. Use these patterns to check tuner operation and receiver performance. Also use them to check CATV and MATV systems, as well as closed-circuit RF distribution systems and their amplifiers, line-splitters, and other components.

See your RCA Distributor for more information. Or write RCA Test Equipment Headquarters, Harrison, N.J. 07029.

RCA
Electronic Components

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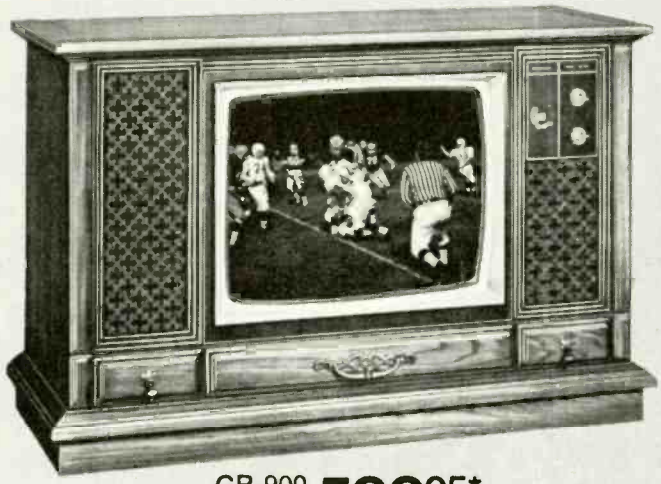
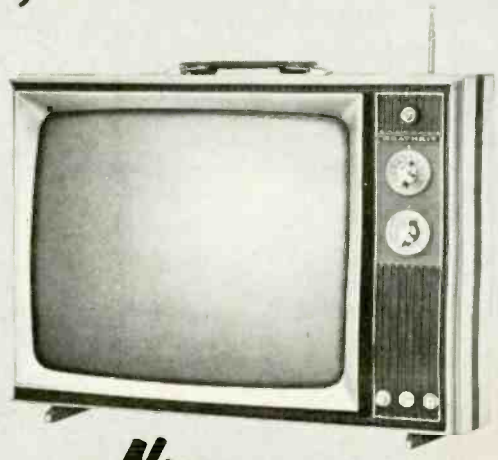


GR-900 **599.95*** (LESS CABINET)



New GR-1900 **179.95*** (INCLUDES CABINET)

...and staying out of the red.

New IC-2108 **79.95***

New IC-2009 **92.50***

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Heathkit GR-900 25V Color TV with total-tuning convenience.

It's the most advanced TV circuitry you can build. Yet everything goes together with traditional Heathkit simplicity. And the built-in convergence board and test meter for at-home maintenance and self-service add further savings over the life of the set. With the GR-900 you pre-set any 12 UHF stations for positive pushbutton power tuning, and you can scan both UHF and VHF channels in either direction. An ultra-rectangular black matrix tube, voltage controlled varactor UHF tuner, MOSFET VHF tuner and an exclusive angular tint control for consistently better flesh tones combine to produce an absolutely brilliant color picture. There are four preassembled and finished cabinets to choose from, plus the Heathkit Wall Mount and wireless remote control option. Any way you look at it, the Heathkit GR-900 is one of the most rewarding kits you can build. Mailing weight, 125 lbs.

New Heathkit Solid-State B&W 19V Portable TV — a truly extraordinary set

The new Heathkit GR-1900 is like no other B&W portable! With advanced solid-state "modular" design — most circuitry mounts on just four plug-in boards. Dependable solid-state circuitry, including 23 transistors, 13 diodes, 2 ICs, and just 2 tubes; picture & high voltage. Total detent tuning on all 70 UHF channels as well as VHF. "Instant-On" for sound and pictures at a touch — plus other "big-set" front panel control features such as VHF/UHF fine tuning; brightness; contrast; master on/off; vertical hold; AGC; and height. New Ultrarectangular picture tube for a full 184 sq. in. viewing area. Automatic Vertical Linearity for rock-steady pictures — a feature usually found only on expensive color sets. Dual-Controlled AGC for improved picture/noise ratio — another "big-set" bonus feature. Extra-wide Video Bandwidth for theater-quality black-and-white pictures. Four circuits (most sets have only 3) in the grounded base VHF tuner for superior cross modulation in dense station areas. With all this, the GR-1900 is a kit even the novice can build. Both tuners come preassembled and aligned, transistors & ICs plug into sockets, and all chassis wiring is color coded. For truly extraordinary performance in B&W TV, you've got it all in the GR-1900. Mailing weight, 56 lbs.

New Heathkit Desk-top Calculator — an outstanding kit-form value.

The Heathkit IC-2108 features a sleek, low-profile case with bright ½" readout tubes in an 8-digit display — one of the largest, most legible in the industry. The color-coded keyboard is human engineered to slope down to the desk so you can rest your arm while using. And the IC-2108 is loaded with features: Four arithmetic functions. Floating and fixed decimal. Constant key. Chain calculation capability. Clear display key. Entry and result overflow indicators. Negative number indicator. 120/240 VAC operation. In addition, the IC-2108 is amazingly simple to build. Two spare evenings will do it. **Kit IC-2108,** 4 lbs.

New Heathkit "Pocketable" Calculator — you can service it yourself

The Heathkit IC-2009 is first a self-contained portable, weighing in at 11 oz. and small enough to fit in your coat pocket, but it's a desk-top calculator too. The internal Nickle-Cadmium battery gives five to eight hours use between charges. Or, the IC-2009 can be left connected to its charger for indefinite operation. And unlike other pocket calculators, the Heathkit IC-2009 is designed to be maintained by you. Plug-in keyboard and display boards, plus a complete troubleshooting section in the manual, make it easy — and economical. Add up the features for yourself: 8-digit capacity. Four arithmetic functions. Full floating decimal. Constant key. Chain calculation capability. Clear entry key. Entry and total overflow indicators. Negative answer indicator. Battery-saver circuitry. Low battery indicator. Tactile-feedback keyboard for positive entry indication. Order your IC-2009 now. You'll have it built in two or three evenings. Mailing weight, 3 lbs.

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Heathkit 4-Channel Amplifier with Universal Decoder...359.95* (less cabinet)

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 5 Hz to greater than 45 kHz at 0.25% distortion. **Kit AA2010,** 37 lbs. **AAA-2004-1,** pecan cabinet, 7 lbs. **24.95***

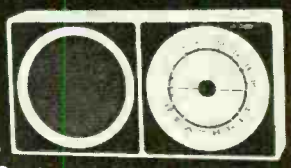
Heathkit Universal Decoder for 4-channel conversion . . . 39.95*

Reproduces all matrixed discs, plus "derived" 4-channel from conventional stereo materials. 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 looks like a book . . . 49.95*

Disguised as an ordinary library book, this novel device fits unobtrusively anywhere in the home. Transmitter disperses a 41 kHz signal which bounces off walls and returns to the receiver where it's monitored for any change in amplitude. 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. **Kit GD-39,** 4 lbs.



New

Heathkit GR-1008 AM Radio can be built in one evening . . . 14.95*

A smartly styled, great sounding solid-state radio that makes a great introduction to Heathkit building. Eight-transistor circuitry mounts on one printed board, big 3½" speaker mounts in high impact plastic case. If you've never built a kit before you can probably have this one together in one fun evening. Uses 9-volt battery (not supplied). Order the Heathkit GR-1008 for yourself or the kids. **Kit GR-1008,** 2 lbs.

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next month

MAY 1973

- **Build An Electronic Music Synthesizer**
  Modular construction makes it a snap. Start with the power supply, voltage-controlled oscillator and controller circuits.

- **4-Channel Stereo—SQ, QS, CD4**
  See how these competitive systems compare. Scope waveforms show what happens when you use one kind of matrix to decode another.

- **Heath's Digital FM Tuner**
  It's loaded with IC logic circuits. This article shows how these devices function in the FM receiver.

- **How Security Systems Work**
  Where does an ultrasonic detector work best? How do you use perimeter protection effectively? These are just two of the important questions this article answers.

PLUS:
Setting Up A PA System
Jack Darr's Service Clinic
Lou Garner's State Of Solid State
Transistor Interchangeability Directory

LETTERS
(continued from page 22)

your April issue about building an IC digital tachometer.

Harmon Electronics has been producing a digital tachometer, see enclosed brochures, Tach II for almost a year now. We are selling the unit to the Automotive Aftermarket. Although we are not selling the IC, we have a 24 pin custom IC for the tachometer. The IC has the basic circuit for the tachometer, a selector for 4, 6 or 8 cylinders and a memory to recall the highest rpm that the engine turned. By using the custom IC we had developed we were able to get our price down to $69.00 suggested retail.

We are presently working on a clock, speedometer and a 4-digit tachometer for test equipment. We also have a proposal for a complete digital dash for an automobile. Mr. Sleght could go out and buy one of our Tach II and save himself a lot of work and expense.

We also have a speedometer now, that picks up off of the front wheel and gives your speed in tenth of a mile per hour, but we do not have an IC for it yet.

JAMES P. SMITH
Automotive Marketing Mgr.
Harmon Electronics, Inc.
Grain Valley, Missouri 64029

In this issue, readers will find a complete construction article on an IC digital tachometer. Since a custom IC is not readily available, several individual IC's are used in its place—Editor

HELP A READER

I own a Doric Transistorized Organ Model or Series Number: 4528. Unfortunately I purchased this organ second hand and did not acquire a circuit service manual for it. I have attempted to communicate with the Doric Company, however, it appears that this company is no longer in business. I would appreciate it if any reader, who owns such an organ, would send me a copy of their service manual. I would be more than glad to pay for any copy of the Doric service manual sent to me by some reader of **Radio-Electronics.**

MORRIS JAGODOWICZ
622 Euclid Avenue
Syracuse, N.Y. 13210

ITALIAN PEN PAL

I am an Italian boy very interested in hi-fi systems. I am especially interested in choice, installation and regulation of hi-fi equipment.

I read a lot of technical reviews and when I can get your review in Milan, I get very interested in your articles about hi-fi and electronics.

I am writing you because I would like you to help me to solve one of my problems. The problem is this one: I would like to correspond with an American boy who has the same hobby. I want to correspond about hi-fi technical problems in the English language, preferring someone who has some personal experience in the field.

GIUSEPPE D'ANGELLA
3 Brigata Missili
Quartier Generale
30026 Portogruaro (Venezia)
Italy

FATAL FLAW?

This is in response to your article, "Setting Back The Clock," which appeared in the "Looking Ahead" section of **Radio-Electronics** in October 1972. We feel your use of the term "Fatal Flaw" was definitely misleading and gave the impression that the NBS TvTime System is not feasible. This could not be further from the truth. The NBS system was designed to provide the correct time to all users, regardless of locality. The NBS has thoroughly tested the TvTime System and the "fatal flaw" does not exist.

The facts are these:

(1) The networks would transmit NBS-controlled *precise* time signals in Greenwich Mean Time (which is correct in all time zones) to their affiliates.

(2) If the network signals are not videotaped or otherwise delayed by the affiliate, they can be rebroadcast locally. However, the home TV receiver/decoder would not be able to pick up these network-originated signals; only users with precise time decoders could receive them.

(3) If the local affiliate does tape the network program for later replay, the network time is automatically deleted.

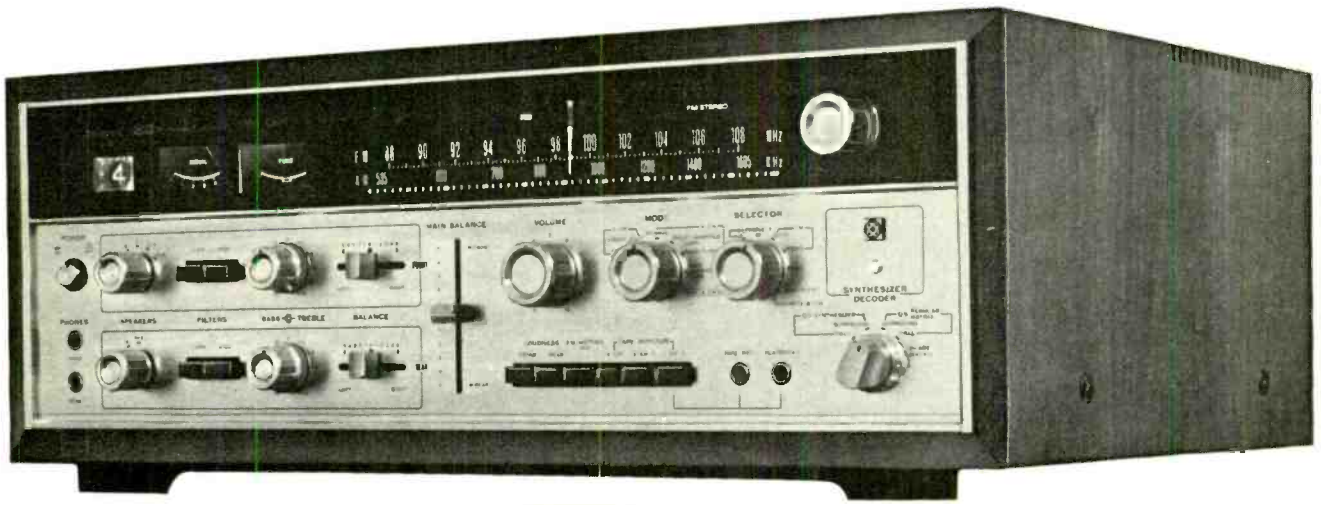
(4) The local station has the option of generating local time zone hours, minutes, and seconds signals by using his own equipment and making periodic checks against a network signal (even from another network if necessary) to keep the local clock on time. The NAB report is correct in stating that any local time signals must originate at the local station.

A home TV receiver, equipped with a decoder, will automatically decode and display the correct local time when it is available. It ignores network time signals. It will also display program captions in the same way. The system differentiates between precise time, local time, and captions because each type of message has its own signature which the home receiver-decoder interprets; i.e., the captions do not get mixed up with the time, and precise network time is not decoded.

SANDRA L. DANIELSON
Section 273.01
Time and Frequency Division
National Bureau of Standards
Boulder, Colo. 80302

R-E

All quadraphonic systems are not created equal...Sansui has created the QS vario matrix.



QRX-6500

Here at last is the development that once and for all will lay to rest the dispute over discrete vs. encoded recordings. The Sansui vario matrix—a technological extension of the QS Regular Matrix—provides unbelievable front-to-back separation, to a degree never before possible with matrix recordings—separation so great that engineers have hailed it as the "discrete matrix."

Two new units in the Sansui four-channel lineup—the QRX-6500 ($699.95) and the QRX-4500 ($599.95) contains this outstanding new decoder. These full-featured four-channel receivers have high power output (280 watts and 240 watts IHF), superb FM sensitivity, and are loaded with special features to make quadraphonic listening a totally trouble-free and fulfilling experience.

The new decoder includes a position for Phase Matrix recordings, and both "Hall" and "Surround" positions for the QS Regular Matrix and for the synthesizer section, for accurate decoding of any current matrix as well as creating enhanced 4-channel sound from two-channel recordings.

Other special features include a sound-field rotation switch, linear balance controls for front/rear and for left/right, and the capability to drive up to 10 speakers —all front-panel switch-selected.

Treat your ears to a demonstration today at your nearest Sansui dealer. Your listening will never be the same again.

QRX-4500

QS REGULAR MATRIX

Sansui

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Circle 12 on reader service card

From Cleveland Institute of Electronics

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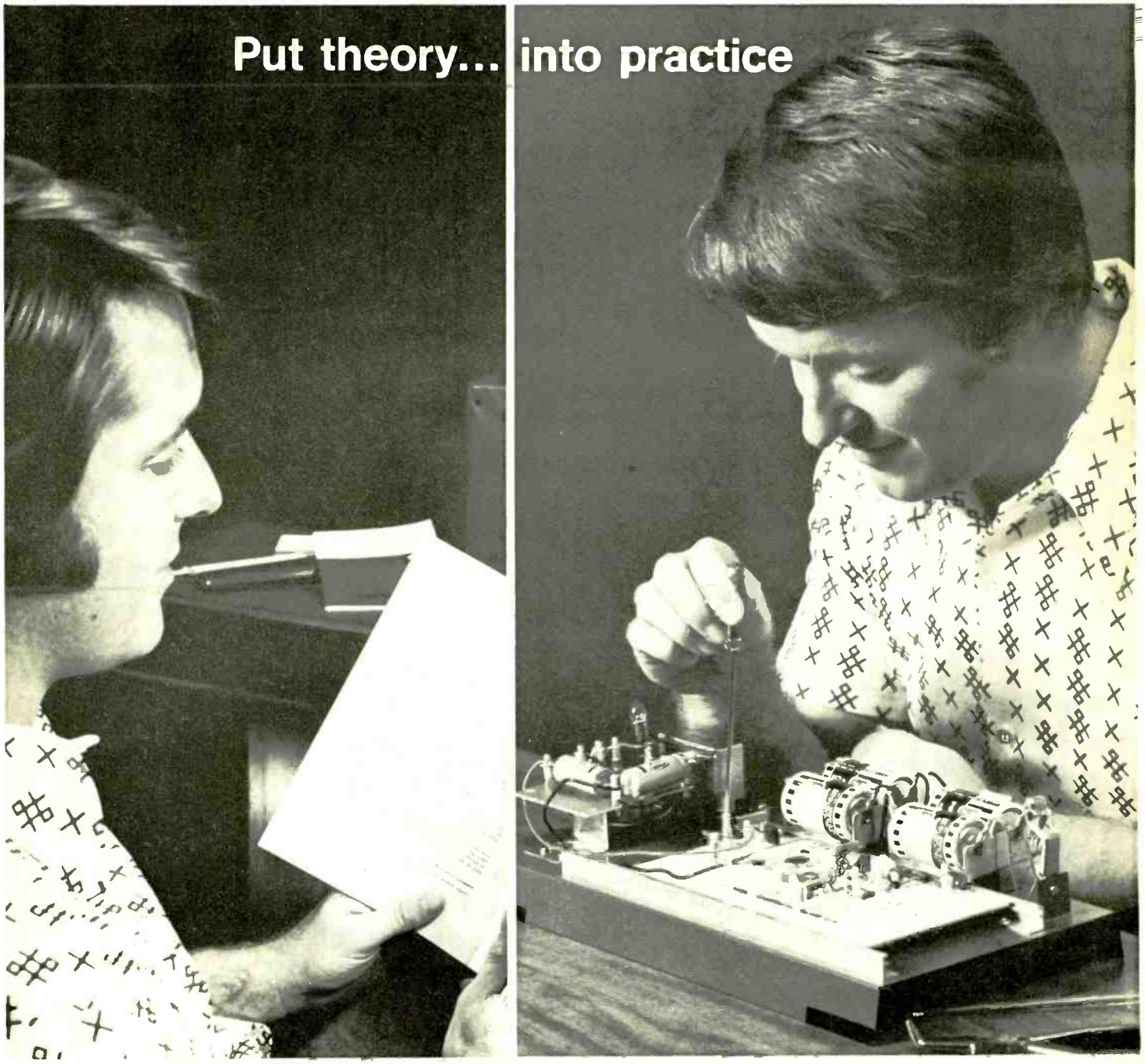
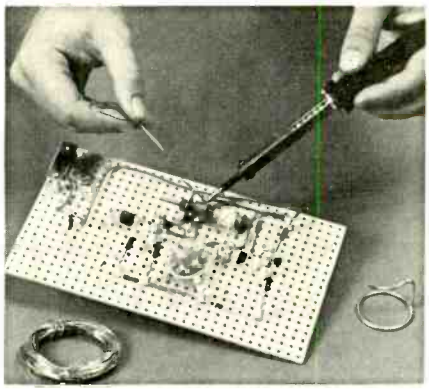
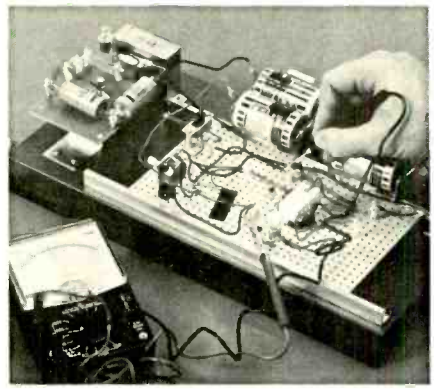


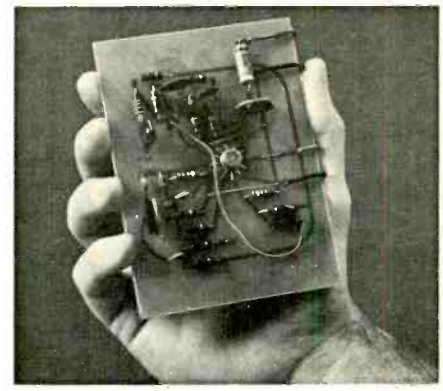
You get your own 161-piece electronics laboratory... with authentic electronic components used by industry!



You learn how to construct circuits and connect them with a soldering iron, which is part of your CIE laboratory equipment. This "hands on" experience is extremely valuable in applying what you learn.



Testing and troubleshooting are an important part of your learning experience. Included in your laboratory is a precision "multimeter" to diagnose electrical and electronic troubles quickly and accurately.



Modern space-age components like this IC (integrated circuit) are professional quality and can be used again and again in many of your projects. Lesson by lesson, piece by piece your knowledge grows!

Prepare now for a high income career in Electronics...the Science of the Seventies.

Electronic miracles are changing today's world with breathtaking speed.

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"Hands on" experience helps to reinforce basic theory. When you learn by doing, you discover the "how" as well as the "why." You'll find out for yourself the right way as well as the wrong way to use electronic components. How to construct your own circuits, to discover trouble spots and learn how to fix them. And with CIE's special Auto-Programmed® Lessons, you learn faster and easier than you'd believe possible.

CIE's fascinating course, Electronics Technology with Laboratory, teaches you Electronics by making it work before your eyes. And you do it yourself, with your own hands.

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You'll have high paying job opportunities

Electronics is still young and growing. In nearly every one of the new exciting fields of the Seventies you find electronics skills and knowledge are in demand. Computers and data processing. Air traffic control. Medical technology. Pollution control. Broadcasting and communications. With a CIE Diploma and an FCC License *you* can choose the career field *you* want . . . work for a big corporation, a small company or even go into business for yourself.

Here's how two outstanding CIE students carved out new careers: After his CIE training, Edward J. Dulaney, President of D & A Manufacturing, Inc., Scottsbluff, Nebraska, moved from TV repairman to lab technician to radio station chief engineer to manufacturer of electronic equipment with annual sales of more than $500,000. Ed Dulaney says, "While studying with CIE, I learned the electronics theories that made my present business possible."

Marvin Hutchens, Woodbridge, Virginia, says: "I was surprised at the relevancy of the CIE course to actual working conditions. I'm now servicing two-way radio systems in the Greater Washington area. My earnings have increased $3,000. I bought a new home for my family and I feel more financially secure than ever before."

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Circle 13 on reader service card

equipment report

Heathkit IB-1100 Digital Readout Frequency Counter Kit

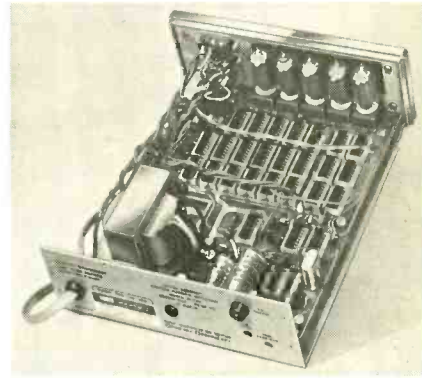
Circle 100 on reader service card

ONCE TAKING UP A FULL EQUIPMENT rack of space the frequency counter has evolved through the intermediate transistor version to the present state of the art integrated circuit form. Single IC's displace entire transistor PC boards allowing the IB-1100 to be packaged on a single board in a compact 7¼" wide by 3⅛" high by 9¼" deep case weighing only 4 pounds. Performance-per-dollar ratio is so high that for the first time the frequency counter is sure to find its way into the home workshops of many technicians, engineers and hobbyists. The only real difference between the IB-1100 and more expensive instruments covering the 1-Hz to 30-MHz range is the use of gas display tubes instead of light-emitting-diodes and the lack of a crystal oven.

It takes about seven hours to assemble the kit with the usual Heathkit ease. The sturdy printed board is well marked, making it difficult to put something in the wrong place. The counter worked when finished with only an inoperative display segment caused by a poor solder connection; not bad considering the hundreds of solder joints in this kit.

There are two calibration procedures suggested by Heath to adjust the crystal oscillator timebase. One method uses a radio receiver to beat a transmitted carrier with the radiated harmonics from the counter. A second method is to adjust the IB-1100 to read the same as another counter. A generator above 1 MHz is used so the oscillator can be adjusted to a small percentage of error.

We concocted a third method that anyone with a color receiver can adopt. It is a little more involved to set up than the first two methods but can give better results. When tuned to a color broadcast the subcarrier oscillator in a color TV receiver is phase locked to the transmitted color subcarrier frequency. The TV's oscillator is exactly at the same frequency as the highly regulated transmitter. The frequency will be within a couple of cycles of 3.579545 MHz. Using an RCA XL-100 CTC46 chassis, the counter's coaxial input cable was connected to pin 8 of the IC on the MAC001A color module through a 1000-ohm resistor. It turned out this method was more accurate than the comparison method also tried because the other



INSIDE THE FREQUENCY COUNTER. It's all solid-state except the gas-filled numeric display.

counter used was not itself well calibrated.

Most builders of this kit will have the technical capability to figure out where to pick off the color subcarrier oscillator output in their particular set. Isolation with a resistor or capacitor prevents unlocking or disabling the receiver's oscillator and the frequency readout should be entirely stable to the last cycle.

Conservatively specified the sensitivity of the counter is listed as 100 mV rms typical and 250 mV maximum. Our unit worked to 30 MHz with 80 mV or lower input. In fact

(continued on page 87)

Circle 14 on reader service card ➔

SIMPLICITY, PERFORMANCE, RELIABILITY...

what more could you ask of a dual trace oscilloscope that's selling for $550?

YOU COULD ASK FOR THE PHILIPS LABEL!

Philips is a world leader in instrumentation and the PM3110 bears that famous label. It is your assurance that it is made with the same professional precision and concern as other test and measuring devices manufactured by N.V. Philips of the Netherlands.

SIMPLICITY. Level and stability controls for triggering have been eliminated, as have the usual DC balance controls. The PM3110 performs these functions internally, automatically. Even experienced technicians are sometimes uncertain whether to display a particular signal in the "chopped" or the "alternate" mode: PM-3110 mode selection is automatic. And the PM3110 automatically chooses either line or frame sync pulses for its trigger input when displaying TV signals.

PERFORMANCE. IEC bandwidth is 10MHz at 50mV/cm sensitivity; sensitivity can be multiplied by 10X to 5mV/cm with a bandwidth of 5MHz. Maximum vertical deflection is three times screen height or 24cm. Overall accuracy from input to screen is 5%. Line voltage variations of −15% to +10% produce only 1% overall error.

The horizontal sweep can be expanded 5X to 50cm so that, for example, a color TV burst can be displayed in enough detail to permit the technician to count the cycles in the burst.

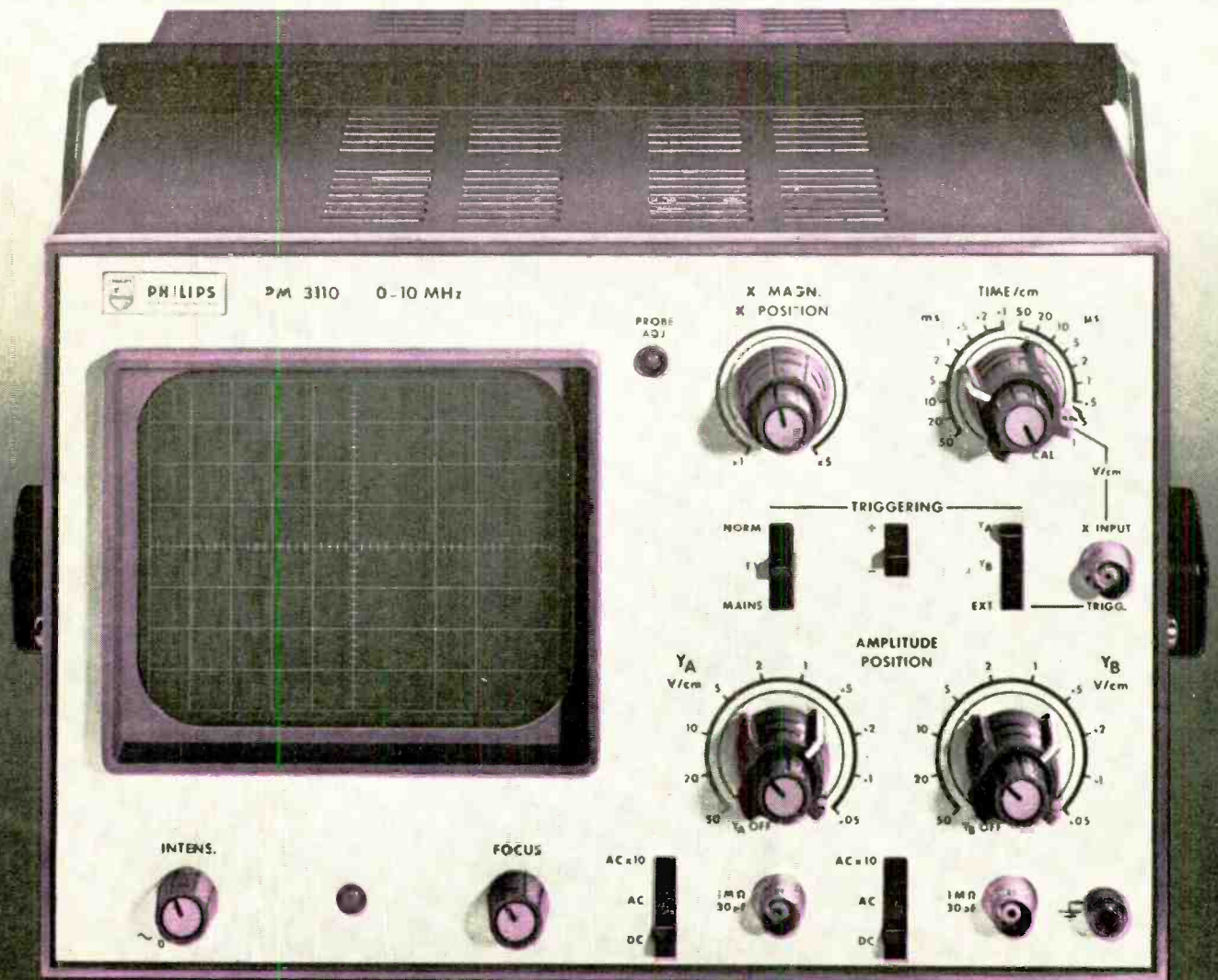
And PM3110 signals are displayed on a full 8x10cm graticule, not the usual 6x10, this permits the entire CRT surface to be used for accurate measurement.

RELIABILITY. The PM3110 can withstand input overloads up to 1,000 volts for as long as 30 seconds; inputs as high as 500 volts can be handled with perfect safety, a great advantage in TV service applications.

Although the PM3110 weighs only 19 pounds, it is both rugged and durable, having passed rigid environmental and vibration tests. Its maximum operating temperature range is from −10 to +45 degrees C.

ECONOMY. The PM3110 sells for $550. That's less than any comparable dual trace oscilloscope and is within the reach of schools, service centers, laboratories and manufacturing concerns.

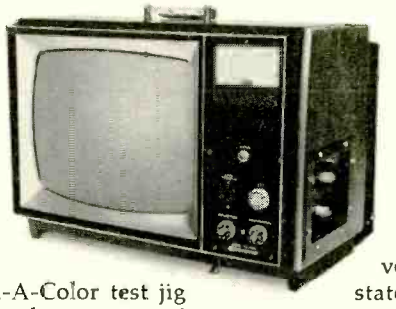
THE PHILIPS LABEL. Philips quality makes the PM3110 your best buy in a low-price dual trace oscilloscope. The PM3110 is available from Test & Measuring Instruments Inc., which provides applications engineering assistance and service everywhere in the U.S.A. For complete data on the PM3110 and for information on the entire line of Philips test and measuring instruments, contact: Test & Measuring Instruments Inc., Hicksville, New York 11802. Phone: (516) 433-8800.



MESA + MEASURING INSTRUMENTS INC.
A NORTH AMERICAN PHILIPS COMPANY

There must be an easier way...

There is: Sylvania's Chek-A-Color test jig.



TV servicemen were never meant to be movingmen.

But, that was before antique, modern and French Provincial units that included hi-fi, tape decks and record players were built around a large-screen color TV set.

Getting those units to the shop can be a big job.

That's why we developed our two Chek-A-Color test jig units. One, our full-house model, gives everything you need to test a chassis. The other is a basic unit that practically lets you design your own test jig.

All you have to take back to the shop is the electronic guts of the TV monsters.

Regardless of the size of the original picture, Chek-A-Color lets you see it on a benchtop 14-inch (diagonal) screen. It adapts to both high and low focus voltage sets and a full line of adapters lets you test over 5,000 different models.

A front-panel switch controls a yoke programming system that gives you a range of impedances and/or deflection voltages to closely match both tube and solid-state systems.

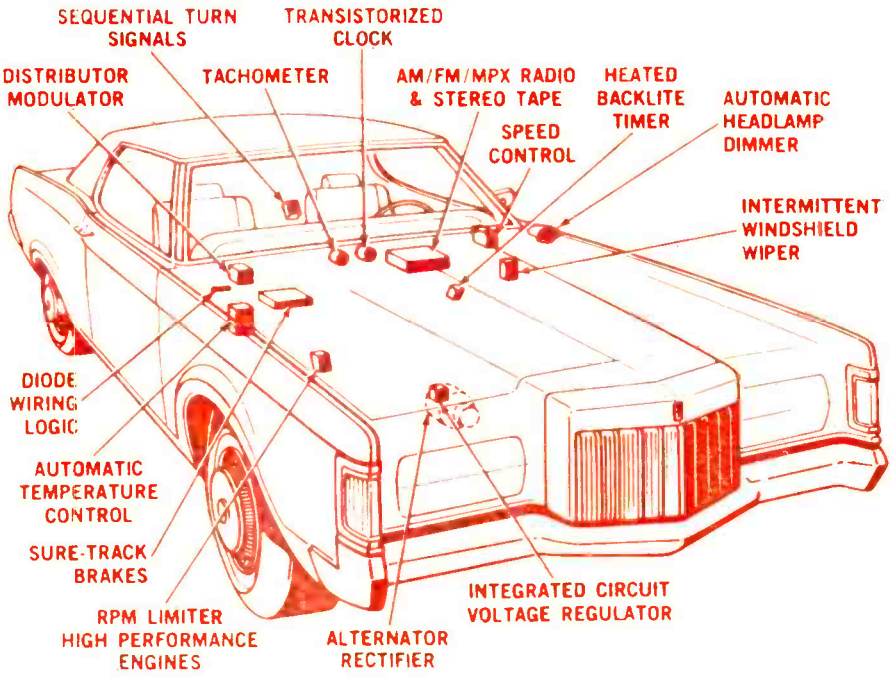
For actual testing, a convenient meter lets you measure anode voltage and a speaker lets you check sound performance.

Since Chek-A-Color handles tube, hybrid and solid-state chassis, there won't be many complete cabinets to lug.

With a Chek-A-Color test jig all you have to take is the chassis. Get the picture? Sylvania Electronic Components, 100 First Avenue, Waltham, Mass. 02154

GTE SYLVANIA

ELECTRONICS



for your car

Everything from electronic ignition to automatic headlight controls to sequential turn indicators to electronic warning systems to. . . .

by JOE SHANE

AUTOMOTIVE ELECTRONICS IS A FAR-reaching subject area. It includes everything from electronic ignition systems, to automatic headlight controls, to sequential turn indicators, to low-fuel warning devices, to anti-skid systems, to fuel injection, to radio and tape stereo systems, to. . . .

In this article we will look at the most popular add-on electronic gadgets. We will also examine some of the newest original-equipment electronics. Here we go.

Collision warning system

In an effort to avoid rear-end collisions a lot of work is being done on obstacle detectors of all sorts. One of the units being considered is a laser obstacle detector. A block diagram of such a unit is shown in Fig. 1. This diagram is provided by the Society of Automotive Engineers.

Basically the system is composed of three major units—an infrared laser (the transmitter), a receiver, and a warning unit to notify the driver when he gets too close to a possibly dangerous object. The device could be an add-on, but it is more likely that it will first appear as an option offered by the car manufacturer.

A much more common, although less sophisticated device is the electronic ignition system. Up until the appearance of the 1973 cars, this was either a very costly optional extra or an add-on. Fig. 2 shows the complete circuit of a Delta Mark 10 add-on capacitive-discharge electronic ignition system.

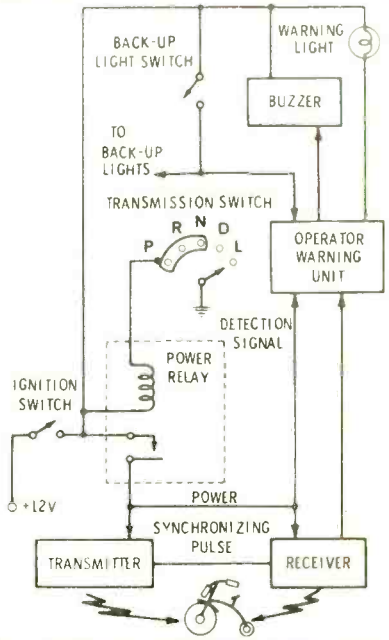


FIG. 1—LASER OBSTACLE DETECTOR is shown in block diagram form.

To briefly review the operation of this circuit, note that it consists of a dc-to-ac inverter (Q1, Q2); a bridge rectifier (diodes X1, X2 X3, and X4; a capacitor (C3), an electronic switch (the SCR) and the high-voltage coil that is already a part of the car's ignition system. This coil is not shown in this circuit.

Twelve volts from the car battery is supplied to the inverter which steps it up to about 300 volts ac. This voltage is then fed through the bridge rectifier and the resulting dc is applied to the storage capacitor. At the proper moment, the SCR discharges the capacitor into the coil and the stepped up coil voltage is applied to the appropriate spark plug through the distributor. This cycle repeats as long as the car's engine runs. A trigger pulse is tapped off the car's distributor to tell the SCR when to switch, so that the timing of the electrical impulses is correct.

Unfortunately, the 1973 cars made by Chrysler Motors (Plymouth,

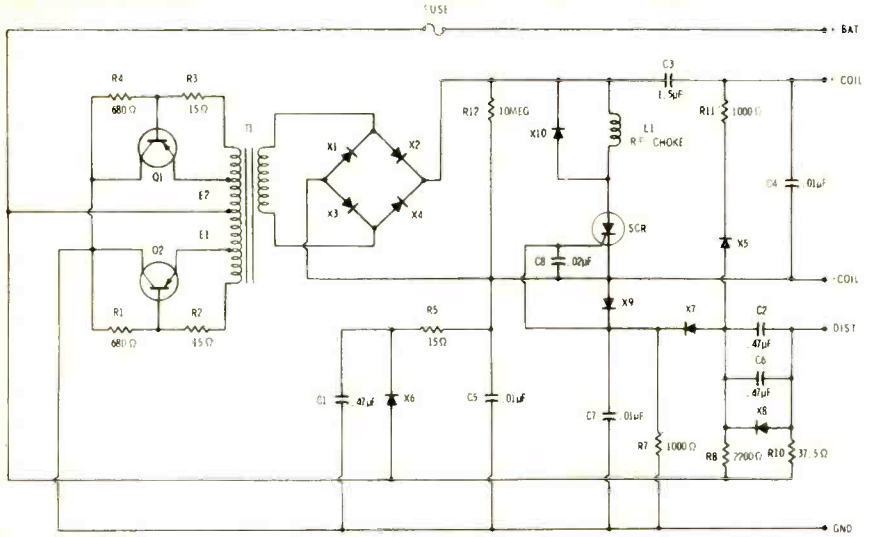


FIG. 2—ELECTRONIC IGNITION SYSTEM is a capacitive-discharge type manufactured by Delta Electronics. It's their Mark 10 unit.

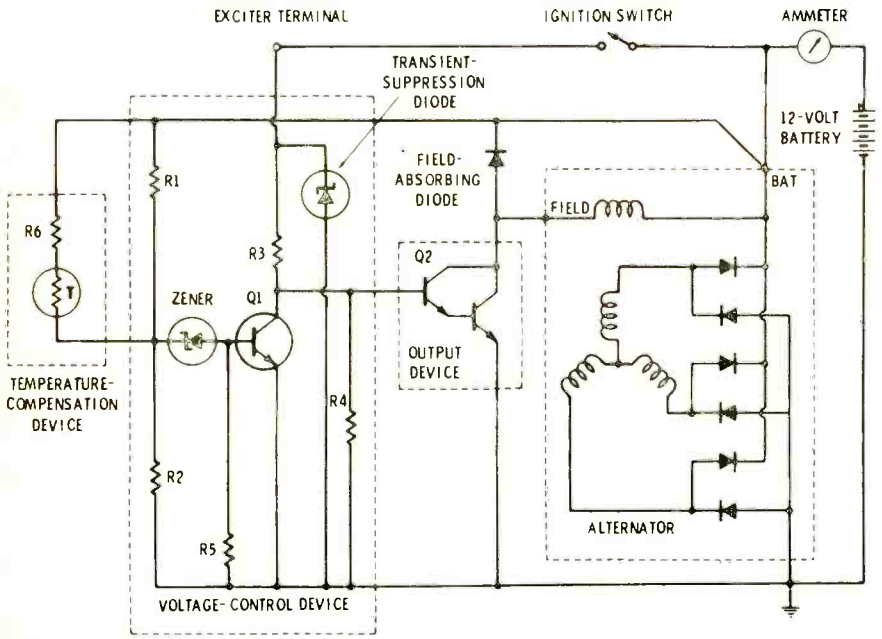


FIG. 3—ELECTRONIC IC REGULATOR uses Zener diodes and a Darlington transistor pair to keep the battery fully charged.

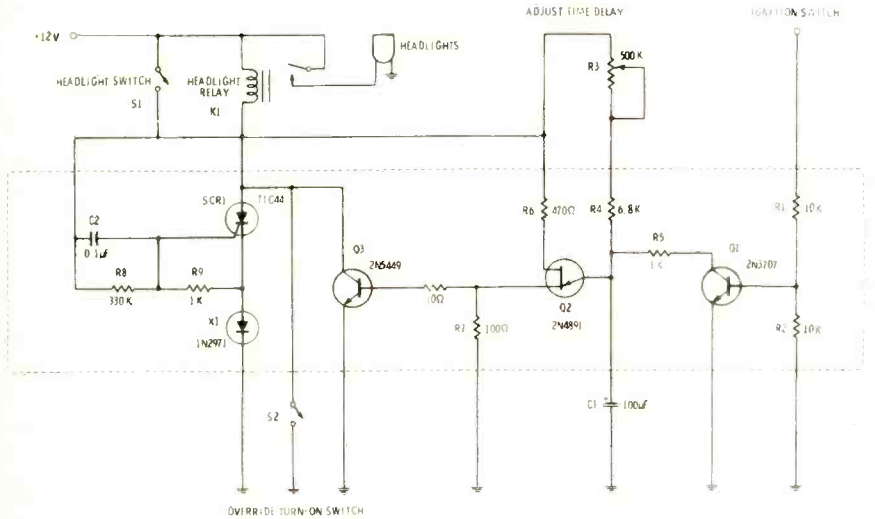


FIG. 4—HEADLIGHT TURN-OFF CONTROL automatically turns off car headlights when ignition is turned off.

Dodge and Chrysler) all include electronic ignition as standard equipment. If the other car manufacturers follow suit—and hints from Detroit indicate that they will—it won't be long before every new car comes with a built-in electronic ignition system.

The next place electronics turns up in the ignition system of the modern automobile is the regulator. This is the device that determines whether the car battery is fully charged or not. If the battery is fully charged, the regulator shuts off the charging voltage provided by the alternator. If the battery is partially discharged, the regulator feeds a charging voltage to the battery to bring it up to its proper level.

In the past this was done with an electromechanical device. However, the latest approach is an all electronic unit like the one shown in Fig. 3.

When the owner starts the car, the ignition switch is closed applying battery voltage to the exciter terminal of the regulator. This turns on transistor Q2 and battery current flows through the field winding of the alternator. Now the alternator starts to develop a charging voltage. When this voltage reaches the proper level, the Zener diode conducts and turns on transistor Q1. This reduces the voltage applied to the base of Q2 and that transistor turns off. When Q2 stops conducting no voltage is applied to the field winding of the alternator and the alternator output drops. When the output voltage drops too far the Zener diode starts to conduct again and the cycle starts all over again.

The electronic regulator keeps the battery more precisely at full charge than the electromechanical types. As a result battery life is extended.

Automatic headlight control

A device that will turn off the headlights of a car when the ignition switch is turned off is shown in Fig. 4. This circuit was developed by Texas Instruments. An SCR is used as the electronic switch, while a Unijunction transistor timing circuit provides a time delay. The result is that when you turn off the car, the headlights remain on for a short period of time (10 to 30 seconds as set by resistor R3). At the end of this period, the lights turn themselves off automatically.

While you are driving the car and the ignition switch is on, transistor Q1 is conducting, preventing the Unijunction circuit from working. The SCR is not conducting so relay K1 is not activated and the headlights are off.

When the driver turns on the headlights with switch S1, SCR1 is turned on, the relay is energized, and the headlights light.

The automatic lights-off process

starts when the ignition switch is turned off. Transistor Q1 stops conducting and capacitor C1 begins to charge. When the total voltage applied to capacitor C1 reaches the trigger voltage of the Unijunction, (Q2), the capacitor discharges through Q2 applying a pulse that turns on transistor Q3 momentarily. This, in turn, turns off SCR1, the relay opens and the lights go off. Since charging time of C1 is controlled by R3, this resistor becomes the time-delay adjustment.

Electronic Test Gear

There are many kinds of electronic test equipment for measuring the performance of a car. One not so common instrument is the electronic oscilloscope type of ignition analyzer.

A popular version of this equipment is the Heathkit CO-1015 solid-state ignition analyzer. This instrument can be built from a kit in just a few evenings and can be used to track down the most elusive auto ignition problems in just about any car engine.

The analyzer can be used with any standard, transistorized or capacitive-discharge system on three, four, six or eight-cylinder engines to detect shorted spark plugs, defective wiring, worn distributor parts, incorrect dwell time, coil, condenser or transistor or capacitive-discharge circuit problems. Some of the scope patterns that appear on the analyzer screen and what they mean appear in Fig. 5. You'll note how easy it is to spot variations in the normal pattern with this instrument.

An added feature of this unit is a built-in tachometer with 0 to 1000 and 0 to 5000 ranges to permit making carburetor adjustments while the ignition system is being checked. With an optional inverter the unit can be permanently installed in the car so you can monitor engine performance while the car is running for on-the-road testing.

An important adjunct to the ignition analyzer is an electronic timing light. This is basically an electronic strobe, triggered by the points in the distributor. The electronic timing light has one major advantage of the less costly, neon timing light, it delivers an extremely bright pulse and can be used in ambient light conditions that would preclude using the dimmer neon-type timing light.

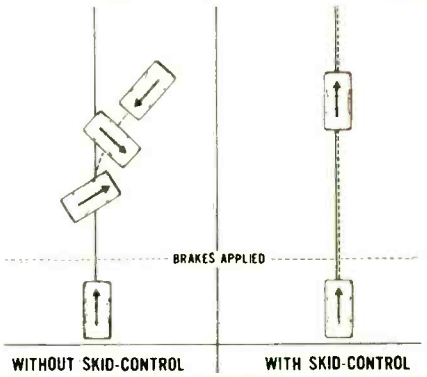


FIG. 6—CAR WITH ANTI-SKID control stops faster and remains under driver's control.

Things to come

What does the future of electronics in cars look like? We probably can't accurately predict the answer to this one. Our wildest guesses are likely to be too conservative.

But let's take a look at one of the things that *we know* are on the drawing boards. Anti-skid braking for one. Fig. 6 shows a comparison of what happens to a car without an anti-skid system as compared to a car equipped with such a system.

Anti-skid calls for a little electronic computer (like the one predicted by Arthur Halley in his new novel "Wheels") to monitor what is happening to the car as it comes to a stop and to vary the braking power applied to the wheels to keep it at maximum, but just below the point that would cause the car to skid.

Yes, the car, like everything else around us is becoming more and more involved with electronics. Or is it electronics that is becoming more and more involved with cars? Either way, for those of us who are involved in electronics it is going to be interesting to watch the developments. **R-E**

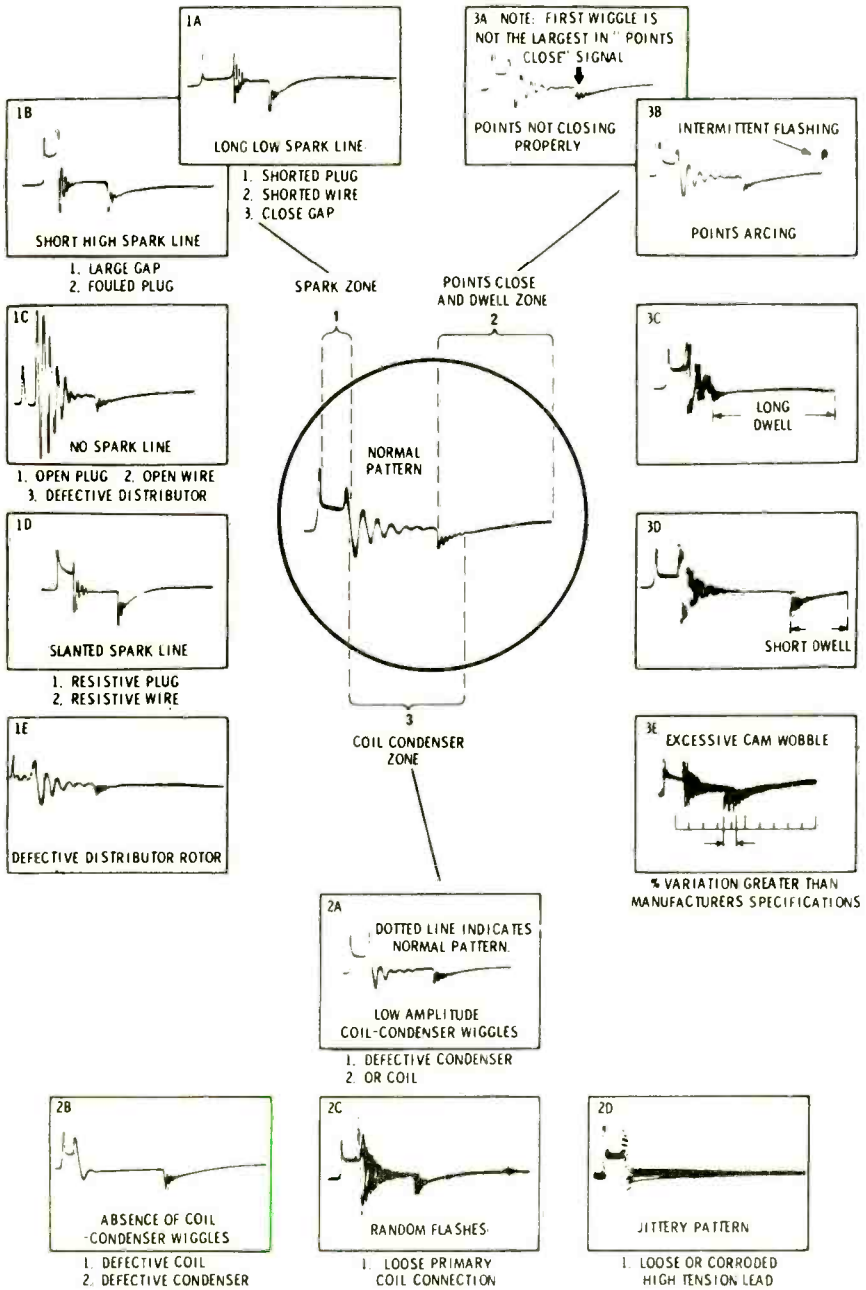
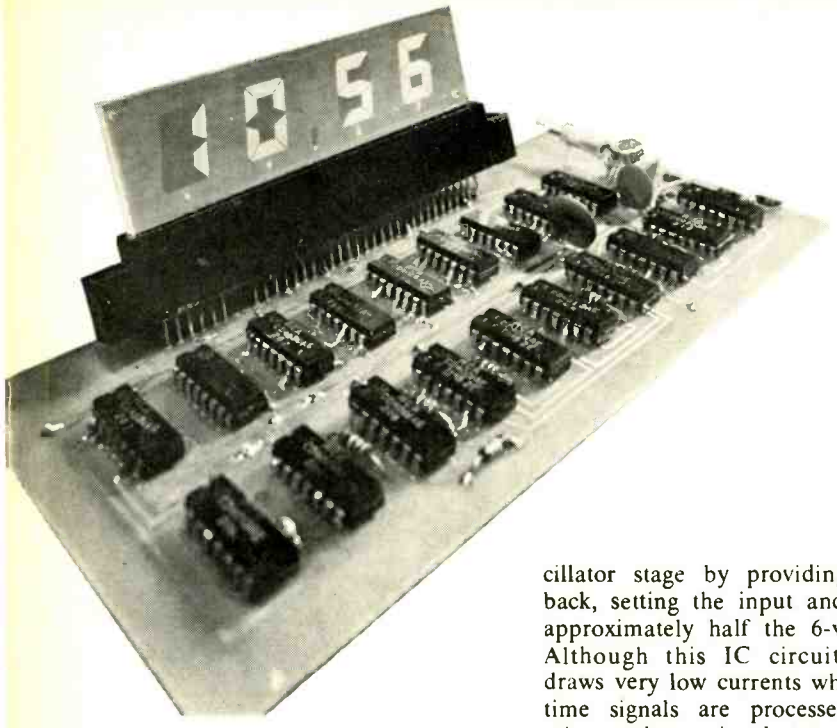


FIG. 5—TYPICAL WAVEFORMS produced using Heathkit CO-1015 ignition analyzer. A quick way to troubleshoot a car's ignition system.



BATTERY-POWERED

That Has A Liquid-

Crystal-controlled oscillator for PC board for simple assembly hand at commercial designing by

MOST INTEGRATED CIRCUITS HAVE MADE the electronic digital clock a reality. Our clock uses special low-power IC's to drive a liquid-crystal display with a total current drain of one third of a milliampere. Nineteen IC's are arranged to oscillate at 32,768 Hz and divide down to provide outputs at one-second, one-minute and one-hour rates to drive the respective display segments.

The oscillator is crystal controlled for high accuracy without a connection to the ac power line. A minute and hour display is separated by a colon, flashing at a precise one second rate. The flashing colon can be used for second timing and lets you know that the clock is running. A double-sided PC board holds all the components except for the time set switches which get mounted on the clock case.

Battery operation is possible since the accumulated microampere drains of the individual IC's is low. I recommend using the reflective type display with the R suffix unless you have a particular lighting situation which favors the transmissive type. Since the display does not generate any light it cannot be seen in the dark. There is also a simple ac supply to free you from worrying about battery life.

Circuit operation

Refer to Fig. 1 the clock schematic, for the following discussion of how the circuit works. It starts with the crystal oscillator IC19-c. This integrated-circuit section is an MOS complementary inverter that provides the gain needed to maintain oscillation. Resistor R10 self biases the oscillator stage by providing dc feedback, setting the input and output at approximately half the 6-volt supply. Although this IC circuitry usually draws very low currents when fast rise time signals are processed, in situations where signal transistions are slowed, supply current sharply increases. During a portion of the signal transistions both the p-channel and n-channel complementary devices are on and there is a current path directly between the power supply and ground. The input waveform of the oscillator has slow transistions since the crystal eliminates the high-frequency components. One of the things done to keep oscillator current down is to operate it with a 6-volt supply even though we need a higher-voltage supply in other parts of the circuit.

Digital clocks generally use oscillator frequencies that are powers of two, since each binary divider stage halves the frequency. In our case the frequency is 2 to the 15th power or 32,768 Hz, high enough so a reasonably priced crystal can be used and at the same time not so high that excessive frequency division is needed.

The oscillator feeds a buffer amplifier stage IC19-b isolating it from the 14-stage IC ripple counter that follows. The bulk of the frequency division is done in this counter with outputs at 2, 8 and 64 Hz. The 2-Hz output is divided again to form the basic 1-Hz clock tempo. The 8-Hz output is used in the hours counter, and the 64-Hz is used by the display and its drivers. All three outputs feed level-shifters to convert the nominal 6-volt swings of the ripple counter to the 15 volts required by the rest of the clock. The liquid crystal display needs high ac drive to give good contrast. The 15-volt supply is used here. The dc is chopped to drive the display with 30 volts peak-to-peak.

The 2-Hz output of the IC17-a buffer feeds IC16 a seven-stage counter. The first divider stage output of this IC is at 1 Hz and is used to give fast count inputs to the minute and hour counters for setting the clock. The 1-Hz output is also routed to the colon driver to blink the colon at a 1-Hz rate. IC15-a and IC15-b flip-flops together with NOR gates IC14-c and IC14-d are used to reset the counter so it cycles every 60 seconds. This signal drives the minutes counter. Flip-flop IC15-b is triggered by the 4- and 8-second outputs from IC16. Therefore, IC15-b is set exactly 12 seconds after its reset input is grounded. This is done by IC15-a with inputs from the 32- and 16-second outputs from IC-16. After 48 seconds IC15-a is clocked to 1 allowing IC15-b to follow 12 seconds later. Simple arithmetic tells us that 48 plus 12 is 60 and counter IC16 is reset every 60 seconds. IC16 can be held reset continuously by flipping S3 to stop the clock. Returning the switch to the normal position restarts the clock with the first pulse occurring 60 seconds later.

The 1/60-Hz output of the divider is fed through the IC13-a, 13-c, 13-d, 14-a, 14-b configuration of gates to feed IC2 of the minutes counter. The arrangement of gates either feeds through the normal 1/60-Hz signal or the 1-Hz output from IC16 when S2 is in the FAST position. IC13-a and IC13-d are connected as a binary to eliminate the effect of SET MINUTES switch S2 contact bounce. The binary does not switch states until the switch armature touches either contact. If the contact bounces open a number of times after the initial closure the flip-flop remains set or reset and the switch bounce is not seen by the minutes counter.

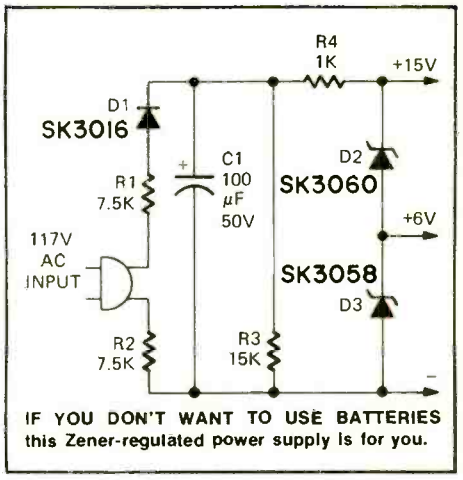
IC2 is a decade counter and divider that includes a seven-segment decoder. Each input pulse advances the counter state by one until the count of ten when a carry pulse is generated at pin 5 and the counter is reset to 0. As the counter is advanced the proper a, b, c, d, e, f, g segment outputs are on, displaying the counter's decimal state. For example

IC DIGITAL CLOCK

Crystal Readout

accuracy and COS/MOS IC's and are features of this clock. Try your designing your own case.

by STEVE LECKERTS



IF YOU DON'T WANT TO USE BATTERIES this Zener-regulated power supply is for you.

at the count of seven, outputs a, b and c are activated, which corresponds to a decimal seven. Each segment output of IC2 goes through an exclusive-OR gate to finally drive the liquid-crystal display segment.

Notice that one input to each exclusive-OR gate is fed from the segment outputs of the decode counter. The other input of each gate is driven by the 64-Hz signal generated in IC18. This 64-Hz signal also feeds the common X terminals of the display. When a particular segment output from IC2 is 0 the exclusive-OR gate has an output that is in phase with the common 64-Hz signal fed to the display. These identical 15-volt peak-to-peak 64-Hz voltages on both sides of a display segment means there is 0 volts across the display at all times and the crystal remains clear. When a segment output of IC2 is activated by producing a high dc voltage (close to 15 volts), the output of the exclusive-OR gate reverses phase. Now the phases of the 64-Hz signal across the display segment are both 15 volts peak-to-peak, but 180° out of phase. The display segment sees a voltage equal to double amplitude or 30 volts peak-to-peak. In this way the large peak-to-peak ac voltage needed by the liquid crystal display is generated.

IC2 is the units minute counter. The carry signal from this counter drives IC5 the clock input of the tens minute counter. Operation of this counter is similar to that of IC2 except it is reset externally to become a module-six counter. If there were no modifications to the reset input of the counter we would find ourselves with 100-minute hours since IC5 would count to 10 just as IC2 does. What we want is for this stage to count to 5 and then reset to 0. This is division by six, since the count sequence is 0, 1, 2, 3, 4, 5—a total of six different states. To shorten the count cycle the reset input of IC5 is driven from 'D' flip-flop IC11-b. The set input of this flip-flop is taken off the B segment output of the counter. By studying the display lettering again you will see that segment B is activated during the numbers 0 through 4. Upon reaching the count of five the B segment goes out. When the set input is 0 the clock input becomes effective. At the next clock pulse from the carry terminal 5 of IC2 at the 60th minute IC11-b is clocked to whatever the D input is set to. In this case the D is wired to ground so the 60th minute causes the flip-flop to go to its 0 state. In the 0 state the $\bar{Q}$ output becomes high, resetting IC5 and giving the required transition from 59 to 00 minutes. Pin 5 is the carry output from IC5 which is then routed through the IC12-a, 12-b, 12-c, 12-d, 13-b complex to the input of IC8, the hours counter.

These gates operate the same as the group of gates preceding the minutes counter. They allow the SET HOURS switch S1 to select either the carry output of IC5 or the 1-Hz fast update signal. With the switch in the FAST position the hour display will change at a one per second rate so the clock can be set. The hours display is considerably trickier to set up than the minutes since we must go from 1 through 12 and then reset to 1 not 0. What we do is reset to 0 and then sneak in an input pulse to IC8 stepping it to 1. This resetting and step is done very quickly, much faster than the display can respond so you cannot see the counter going through the 0 state. While IC8 drives the units hour display it is unnecessary to devote another counter to operate only the 1 in the tens hour display. This one digit is controlled instead by flip-flop IC10-a which drives the B1 and C1 display segments through exclusive-OR gate IC9-b. B1 and C1 are tied together since they are always activated at the same time for a 1 display. The other two flip-flops associated with the hours counter IC10-b and IC11-a perform the logic to do the reset and step function previously described.

The pin 13 segment output of IC8 (C segment) is used to detect the fact that the unit hours digit is a 2. This output is 0 only when a 2 is displayed. The next clock pulse at the hour of 1 into pin 1 of IC8 simultaneously clocks IC10-b, resetting IC8 to 0. Now here is where the 8-Hz output from IC17-b comes into play. At the same time the output of IC10-b resets IC8; IC11-a is set, since its pin 6 set-input is common to the reset of the counter IC. This action raises the clock enable of IC8 (pin 11) high, disconnecting the input. Now ⅛ of a second later, an 8-Hz pulse clocks IC11-a back to the 0 state in turn returning the clock enable input of IC8 to its normal 0. The disruption of clock input by the change of the clock enable from 0 to 1 and back to 0 looks like an extra input pulse to the IC, clocking it to the 1 state. When IC8 counts to ten the carry output at pin 5 clocks IC10-a to its 1 state in turn activating the 1 in the tens hour position of the display. When IC8 is reset by the thirteenth hour pulse IC10-a is reset to 0 clearing the tens position.

Construction techniques

The foil pattern for the two-sided printed circuit board is shown in Fig. 2. We did not use plated through holes. As a result, you must remember that the top and bottom foil patterns are independent and both sides must be soldered where there is circuit foil radiating from a terminal on both sides.

Before installing the display connector bend back pins 7 and 8 so they are not soldered to the board. These are the A1 and F1 display segments which are not used in the clock. The pin positions on the foil are reserved for signal routing. After the clock is operational and you are sure you have selected the right two pins, cut them off close to the connector.

Fig. 3 shows the correct positioning of the IC's, the jumpers on the bottom side of the board, the location of the discrete resistors, capacitors and

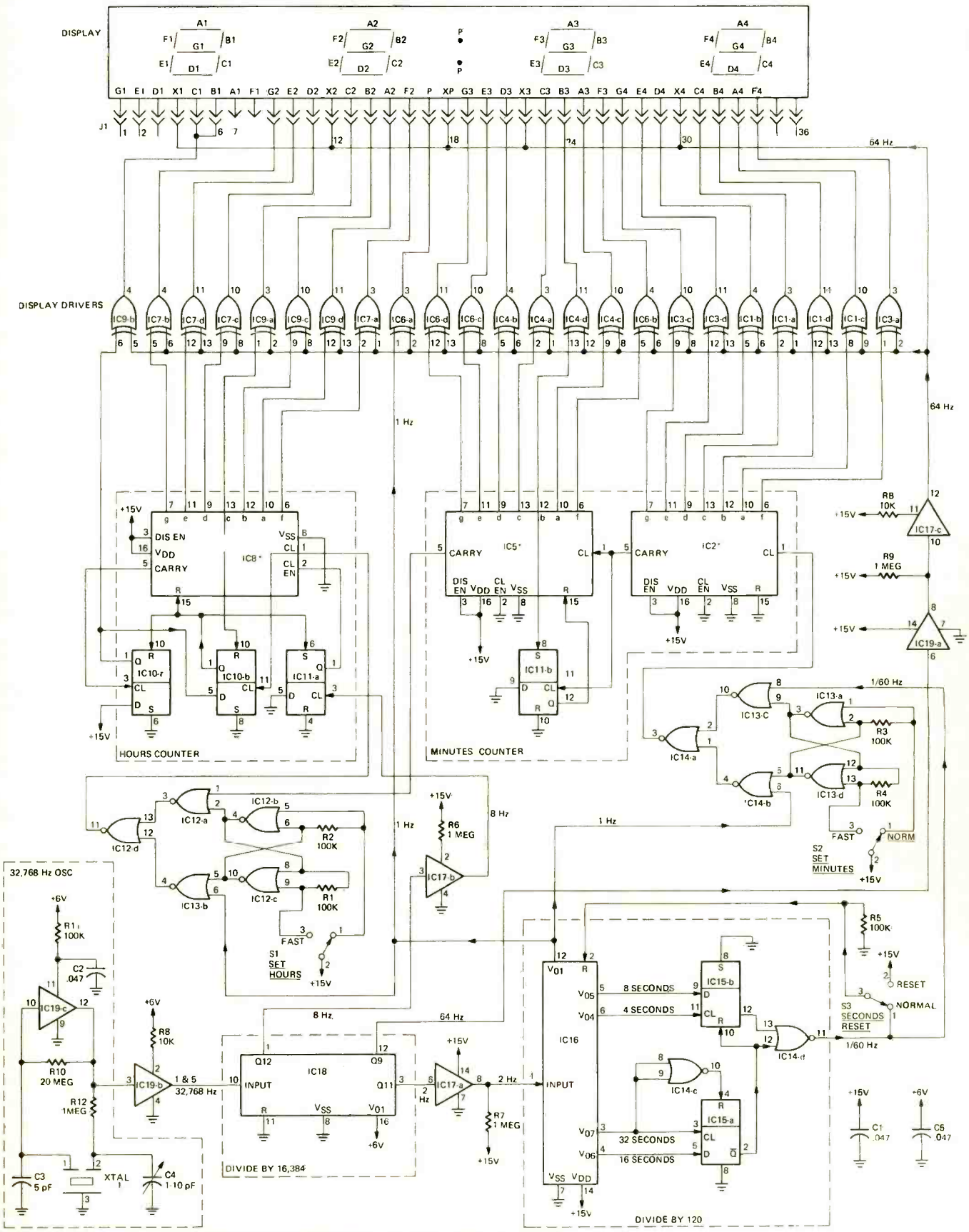


FIG. 1—SCHEMATIC OF THE LIQUID-CRYSTAL DIGITAL CLOCK. The display used here does not emit light and its segments are visible only under reflected light. Use the transmissive type if you want to supply back-light for the display panel.

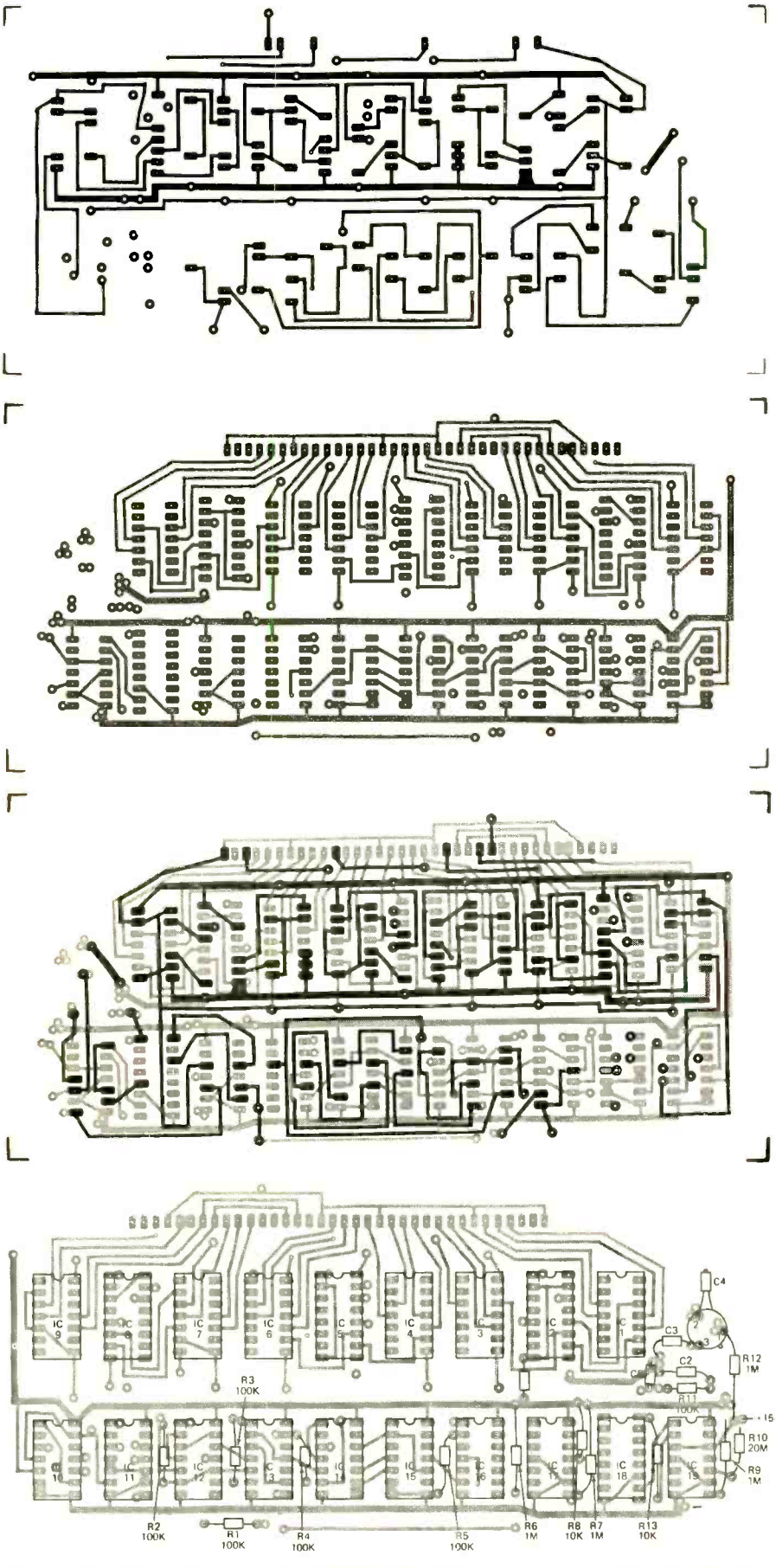


FIG. 2—THE CIRCUIT BOARD IS PLATED ON BOTH SIDES. The top and bottom foils are made from the first and second patterns, respectively. Both are exactly 6¾ inches wide between corner marks. FIG. 3— THE RELATIVE POSITIONS OF THE TWO FOILS is shown in the third illustration while the bottom illustration shows the positions of the IC's and other components.

PARTS LIST

C1, C2, C5—.047 μF 100V Sprague 225P film or equivalent
C3—5:pf 1000V MPO ceramic
C4—1-10 pF variable tubular ceramic

Display—liquid crystal cell

IC1, IC3, IC4, IC6, IC7, IC9—quad exclusive-OR gate
IC2, IC5, IC8—decade counter/divider
IC10, IC11, IC15—Dual 'D'—Type Flip-Flop
IC12, IC13, IC14—quad 2-input NOR Gate
IC16—7-stage binary counter
IC17, IC19—dual complementary pair plus inverter
IC18—14-Stage ripple-carry binary counter/divider

J1—printed circuit board connector

R1, R2, R3, R4, R5, R11—100,000 ohms ¼ watt
R6, R7, R9, R12—1 megohm ¼ watt
R8—10,000 ohms ¼ watt
R10—20,000 ohms ¼ watt

S1, S2, S3—spdt miniature toggle switch Alco 105D or equivalent

XTAL—32,760-Hz Crystal

the TO-5 cased crystal, feedthroughs and switch connections. There are one or two places where a feedthrough is situated under an IC, and so these must be soldered before installing the IC.

IC2, IC5 and IC8 are decode counters. They can have either a display enable function or a ripples blanking feature. Neither of these are used in our clock.

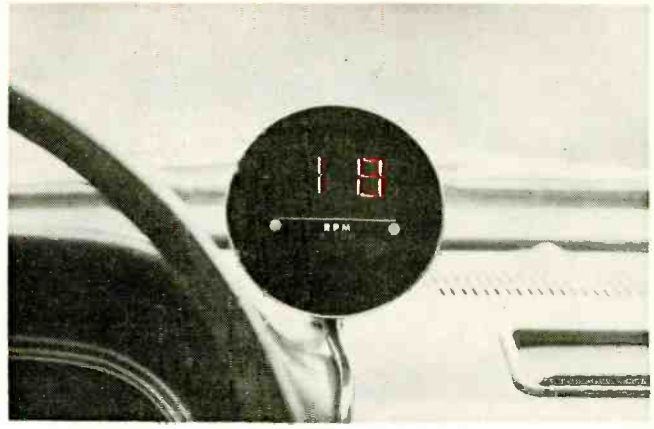
The recommended battery supply is ten alkaline C cells in series. The 6-volt supply is tapped off at the fourth cell and the plus 15-volt supply at the end of the battery string. If you want to run the clock from the ac power line use the simple rectifier Zener-regulated circuit on page 39. There are resistors in both legs of the ac line but be sure that when mounted in the case the circuit is completely insulated and cannot be physically contacted. For safety, troubleshooting should be done only with a battery supply. The power consumption of the ac supply is less than 1 watt.

The clock frequency is adjusted by variable capacitor C4. Turning the shaft clockwise increases the capacitance to lower the oscillator frequency slowing the clock. The best adjustment method is to use a time interval counter connected to the output of buffer IC19-b. The time interval is one

(continued on page 108)

PUT A DIGI-TACH On Your Dashboard

Digital readout for checking your mill's rpm's at a glance. Easy-to-read numbers promote driving safety day and night



by P. J. BUNGE

WHEN I WAS UNABLE TO LOCATE A 270° meter suitable for building a tachometer, I began to consider a digital display as a substitute. The novelty of the idea, together with the availability of low-cost readouts made this choice very attractive. How the readability would compare with a meter-type display was completely unknown. In fact, the only literature I could find on the subject seemed to be the vague mention of a digital speedometer used in an experimental car.

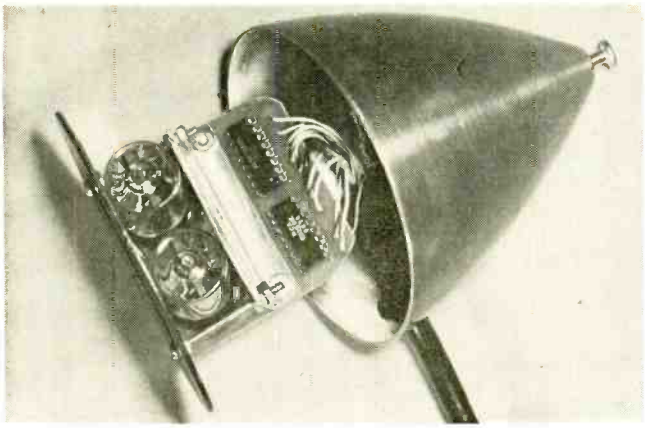
It was hard to visualize whether it would be easy, or even possible, to take a reading during the brief glimpse permitted from driving. How distracting would the constantly changing numbers be? It seemed that the only way to tell would be to build a digital tachometer and find out.

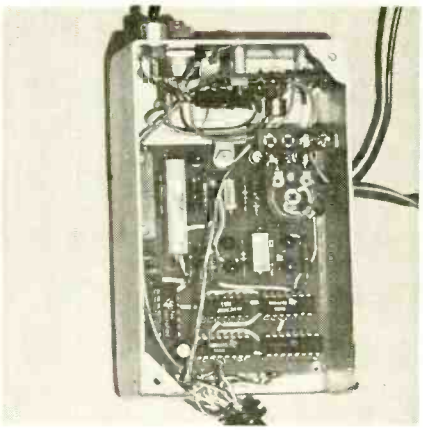
Design and construction proved to be quite straight-forward. The biggest problem was locating the correct wire in the Corvair in which the tach was installed. A quick adjustment of the SENSITIVITY control and the display registered 500 rpm. A few miles of driving soon showed that the project was a complete success and extremely easy to read. Perhaps it was psychological, or maybe a better physical location, but it did seem more convenient to read than the speedometer. For those interested in trying the idea here are the necessary details.

Circuit description

IC1 and IC2 are decade counters with BCD (Binary Coded Decimal) outputs. Their four outputs go to IC3 and IC4, quad latches or temporary

DIGI-TACH SCHEMATIC. Pulses from the car's ignition system are counted, converted to BCD signals equivalent to the car's engine speed and then displayed on two readout tubes.





DIGITAL DISPLAY (far left) makes it easy to keep an eye on the engine's rpm's.

DISPLAY TUBES and decoder/driver IC's (center) form the tachometer head. The CD2501E IC is a substitute for one of the MC7447P's.

THE SENDING UNIT (left) is on a double-sided PC board. Its housing can be any sturdy metal container.

stores. These IC's sample and hold the states of the counter outputs whenever they are strobed with a positive pulse on pins 4 and 13. IC's 5 and 6 decode this information and provide signals to illuminate the required numbers on the DR2000 displays.

To register engine RPM's the ignition pulses are counted for a fixed time, the latches are then strobed, and the counters reset for the start of another count. A D13T1 PUT (Programmable Unijunction Transistor) is used to provide the timing. It works much the same way as a unijunction with the time set by the C1-R1 time constant. D1 is for temperature compensation. The negative pulse produced discharges C2 through R5 and turns off Q4 which results in a positive strobe pulse. Termination of the strobe cuts off Q5 and produces the reset pulse which forces the counters to zero. Once C3 discharges, the reset pulse ends and a new count starts.

T1 senses the ignition coil current for each spark plug firing and turns on Q1. R16 is the SENSITIVITY contact and D3 prevents negative pulses from avalanching Q1's base. The negative pulse at the collector of Q1 triggers a monostable multivibrator consisting of Q2, Q3, C6, and the various resistors. This multivibrator prevents multiple counting, due to hash, from each plug firing.

IC7 is a prescaler to reduce flickering of the units digit. It is a D flip-flop wired to toggle as a divide by two. Other flip-flops could also be used. Q9 provides the necessary negative reset pulse.

The output from pin 5 of IC7 drives the clock input (pin 14) of the units decade, IC1. The carry from IC1 (pin 11) drives the clock input on IC2.

IC8 is an integrated voltage regulator that provides +5v from the 12–15 volts auto supply. It features protective current limiting at 1 amp. D5 protects the regulator in case the input voltage polarity is inadvertently reversed when testing or calibrating.

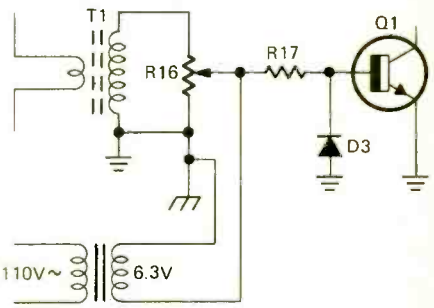
When the ignition key is on, 12 volts is applied through R12 to saturate Q7. This applies the full 5 volts to the displays and they run at maximum intensity. When the headlights are turned on, power is applied through R13 to turn on Q8. This pulls the base of Q7 down by about 2 volts, and since Q7 is an emitter follower it also reduces the voltage to the displays by 2 volts. Thus turning on the headlights dims the display for night driving.

Construction and adjustments

Many of the parts can be substituted. For example an SN7490N will replace the MC7490P and almost any silicon npn transistors will do for the 2N3646's. The 2N3055 dissipates a fair amount of power and should be mounted on the box, or preferably on a separate heat sink. I used 2N3568 for Q7 but this transistor is just barely adequate and gets rather hot. A metal T05 type with a clip-on heat sink would be preferable—a 2N2219 would do. Drill a few holes in the box for ventilation.

The displays and decoder drivers were mounted in an old fender mirror shell. Shield the ten wires and use the shielding as ground. Do not ground to the case at the display end. The only connection to the car frame should be near the ground on T1—this will prevent noise pickup and false triggering. T1 was wound on a ½-inch toroid core but a small audio transformer core would probably work just as well. The primary consists of one or two loops of the wire which goes from the ignition switch to the coil. Reverse the primary to check for highest sensitivity and adjust R16 one-quarter turn higher then the minimum trigger point.

R1-b will need to be about 400,000 ohms for a six-cylinder engine and should be selected to bring R1-a within calibration range. A six-cylinder engine fires three times per revolution or 24,000 pulses per minute at 8,000 rpm. 24,000 ppm is 400 pulses per second which is what was used to calibrate the prototype tach to read "80". The calibrating pulses are fed in on the wiper of R16 when it is ad-



CALIBRATING CIRCUIT is used to perform initial adjustments. See text for details.

PARTS LIST

All resistors ¼-watt 5% unless noted
R1-a, R1-b—Selected value (see text)
R2—1 megohm
R3—1800 ohms
R4—2700 ohms
R5, R7, R13, R15—2200 ohms
R6, R8—680 ohms
R9—2000 ohms
R10—5100 ohms
R11—1 ohm, 1 watt
R12—560 ohms
R14—4700 ohms
R16—220-ohm potentiometer
R17—220 ohms
R18, R21—1200 ohms
R19—5600 ohms
R20—10,000 ohms
C1—1 μF
C2, C3—.0015 μF
C4—390 pF
C5—.001 μF
C6—0.1 μF
C7—10 μF 20V
C8—.01 μF ceramic
C9, C10—10 μF 10V electrolytic
D1, D2, D3—1N459 or any Silicon diodes
D4—3.6V Zener
D5—-amp 50-piV silicon diode
Q1, Q2, Q3, Q4, Q5, Q8, Q9—2N3646 or any npn silicon transistor
Q6—2N3055
Q7—2N2219
PUT 1—D13T1
IC1, IC2—MC7490P
IC3, IC4—MC7475P
IC5, IC6—MC7447P
IC7—MC7474P or MC7479P
IC8—μA723
T1—See text
Two seven segment incandescent displays RCA DR2000, Luminetics Series 90 "Minitron" etc.

justed half way. 60-Hz line from a 6.3-volt filament transformer can be used if an accurate pulse generator or frequency counter is not available. In this case the tach should read "12".

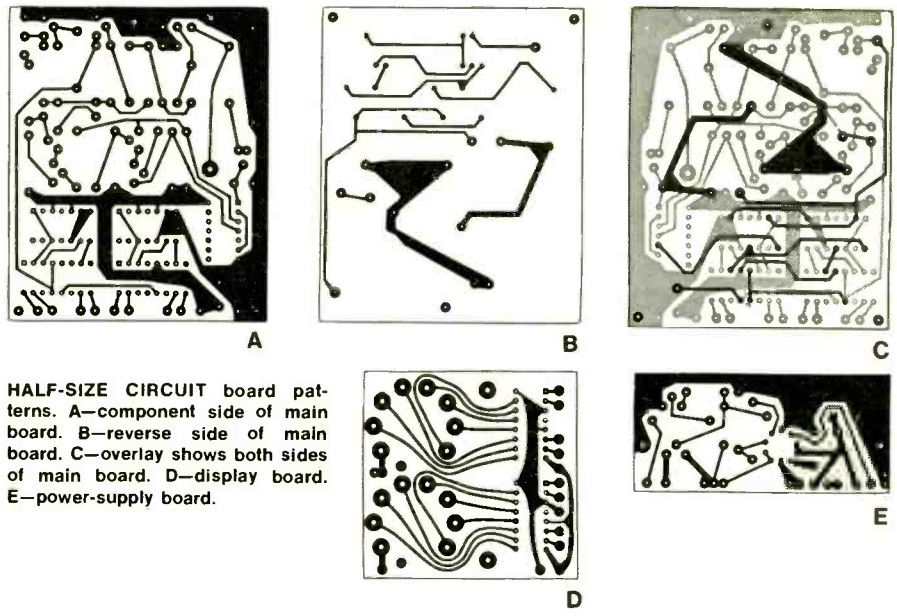
A filter may be necessary on the 12-volt input if false triggering occurs. However, the only trouble experienced was on the bench set-up using a relay and coil which was a poor simulation of an actual ignition system. In this case a .01μF capacitor cured the problem.

The prototype tachometer was road tested through winter and summer and two problems which showed up are worth mentioning. The first problem was that when the windshield wipers were turned on the tach stopped counting. The cause was traced to the fact that the wire from the ignition switch goes to the wiper motor and then to the coil. Current from the wiper saturated T1 and no pulses were counted. The problem was cured by reconnecting the wiper motor through a separate wire to the ignition switch. The second problem occurred when the weather got warm and the display went erratic over 2700 rpm. It turned out that the current pulses to the coil dropped in amplitude with increasing temperature; probably because of coil resistance increasing with temperature. They also decreased with rising rpm. The result was that the temperature increase rendered the system marginal so that it started dropping counts at higher rpm. The cure was simply to adjust the threshold setting, R16.

The more ambitious soul might want to add a high-limit indicator. The easiest way is to AND a couple of segment signals off the tens display which would trigger a one-shot controlling a light or Sonalert beeper. The ultimate would be to compare the eight 7490 outputs with the outputs of two BCD switches.

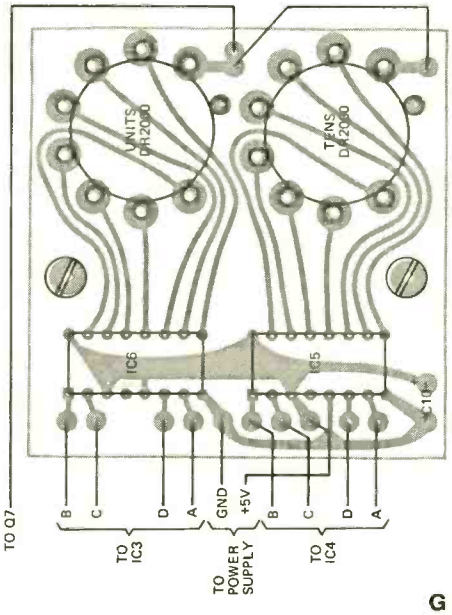
A digital speedometer is also possible, as well as a solid-state odometer. A few calculations and measurements might be of interest: a 775/14 tire has an approximate diameter of 27 inches and a measured circumference of 85.25 inches. This works out to 746.7 revolutions per mile. At 10 mph this is only 2 revolutions-per-second which means a long gate time and sluggish response due to slow updating. An 8-hole disc, light and photocell gets around this problem and gives 16 pulses-per-second at 10 mph. The gate time to read mph in this case is then 625 ms. (assuming a 1:1 ratio between speedometer cable and wheels).

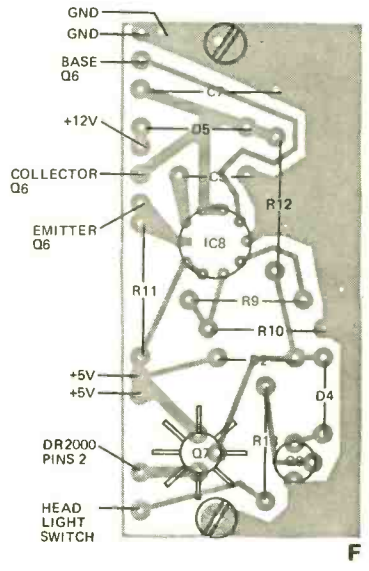
The circuit also offers possibilities for those not interested in digital tachometers. Slight modifications to the input signal conditioning circuit and you have a frequency counter. Any number of decades can be added and a crystal time base could replace the PUT. **R-E**

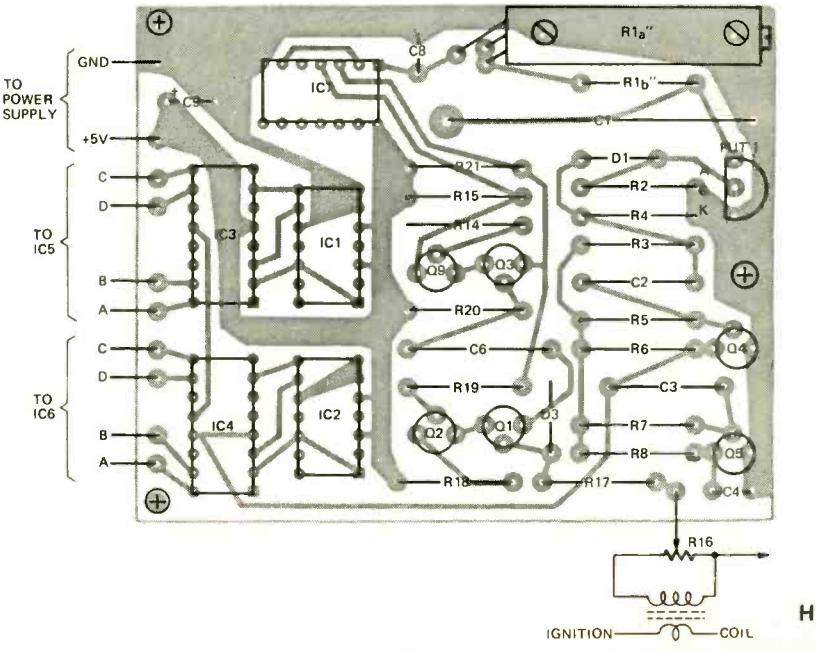


HALF-SIZE CIRCUIT board patterns. A—component side of main board. B—reverse side of main board. C—overlay shows both sides of main board. D—display board. E—power-supply board.

PARTS PLACEMENT on circuit boards. F—power supply board. G—display board. H—main board.







step-by-step

TV TROUBLE SHOOTER'S GUIDE

The solid-state horizontal output and high-voltage circuit differs vastly from its vacuum-tube counterpart. Troubleshooting is easy when you know how.

by ART MARGOLIS

WHEN SERVICING A VACUUM TUBE TV if the high voltage quit and the picture blacked out, the technician reached for a piece of test equipment like the B & K Analyst. The trouble was somewhere between the horizontal afc and the high-voltage rectifier. From the analyzer he extracted a 15,750-Hz wave form and began injecting it into control grids and plates to isolate the seat of the trouble. Working from afc to the picture tube, as soon as the injected waveshape restored the brightness, he had just passed over the bad component.

The solid-state horizontal sweep system is considerably different than its vacuum-tube counterpart. The sawtooth injection procedure cannot be used on transistor circuits easily. Instead there are other servicing techniques we must use. Dc voltage tests and a scope are required.

How it works

The horizontal output transistor frequently operates like a switch. It is fed a 20-volt peak-to-peak square wave by the driver. An impedance-matching transformer couples the square wave into the base of the output transistor. Because of the step-down windings, the wave enters the base at about 5 volts peak-to-peak.

The pnp germanium horizontal output transistor has a very low emitter-to-collector resistance when it is saturated.

The most negative portion of the square wave on the base drives the transistor into saturation. This happens because of the dc voltage setup. Both the base and emitter are fed 12 volts dc. The collector is grounded. As the negative portion of the square wave arrives at the base, it drops the base voltage about 5 volts to about 7 volts and the transistor saturates. Since the collector-to-emitter resistance is very low, for all practical purposes the conduction takes place with no resistance.

The horizontal yoke winding is in series with a 6.8-μF filter to ground, in the emitter circuit. With zero transistor resistance, the yoke is a pure inductance. When a square-wave voltage is applied to a pure inductance, a sawtooth current flows through the inductor.

The horizontal yoke windings are wrapped around the neck of the picture tube. An electron beam passes through the center of the picture tube neck and impinges on the center of the TV screen. As the sawtooth of current in the yoke starts a linear rise when the output transistor turns on, the beam is magnetically deflected by the yoke, from the center of the screen to the right-hand side.

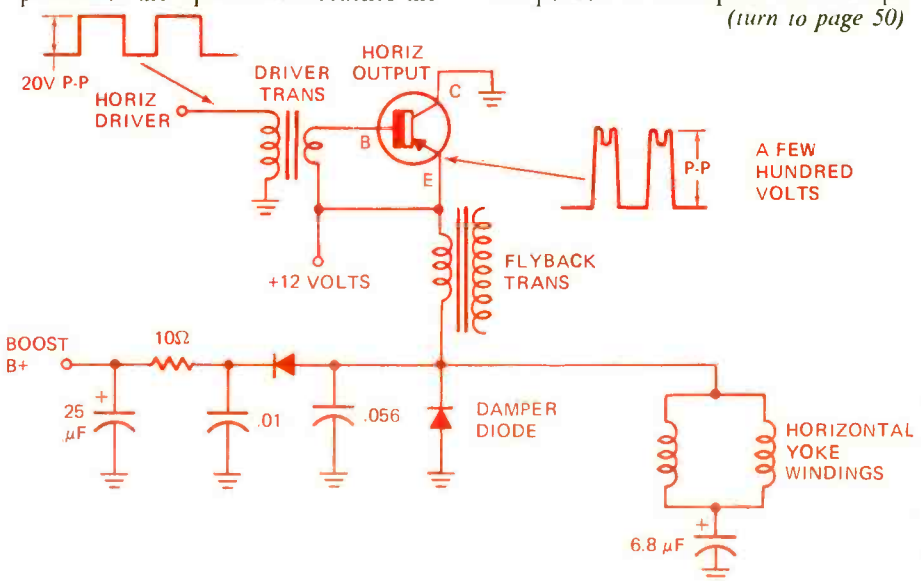
When the end of the negative portion of the square wave reaches the transistor's base, its voltage suddenly rises. This makes the base return to 12 volts or more and the transistor cuts off. Since both the base and emitter now have the same voltage, the transistor turns off.

Current through the yoke stops and the magnetic field induced around the yoke collapses causing a large current flow in the other direction. The collapse is much faster than the linear growth of the field that occurred when the transistor was on. The picture tube beam is whipped to the left side of the screen.

The current sawtooth that occurs during the trace from center to the right side builds from zero to about 5 amps. As the retrace occurs, the current slows down, stops; turns around and then builds to 5 amps in the opposite direction.

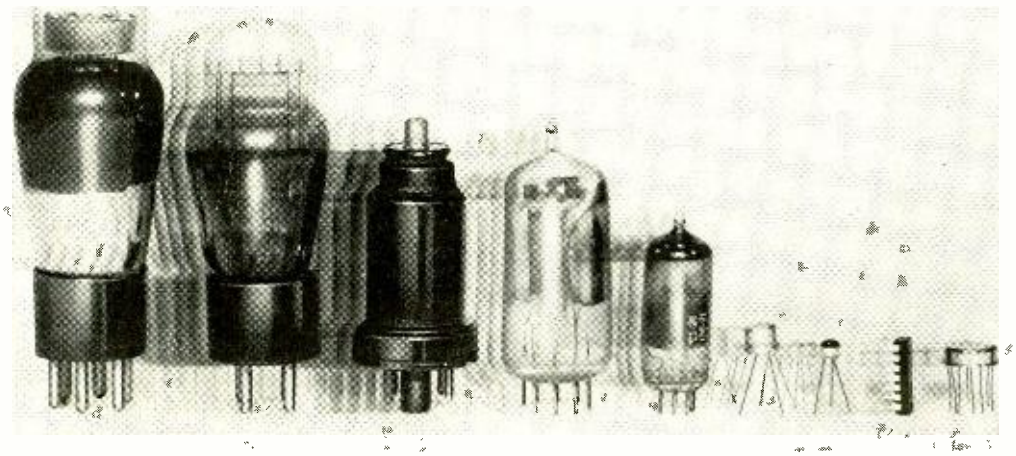
All this happens while the positive portion of the square wave keeps

(turn to page 50)



TYPICAL SOLID-STATE HORIZONTAL OUTPUT and deflection circuit. The flyback is used only to develop the high voltage. The horizontal yoke coils are driven directly from the output collector.

Changes come fast in electronics.



From tube to LSI

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!

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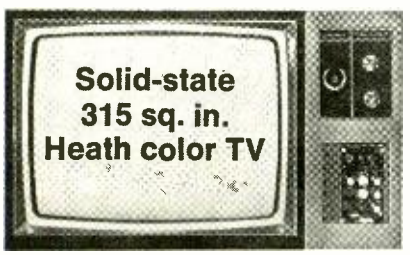

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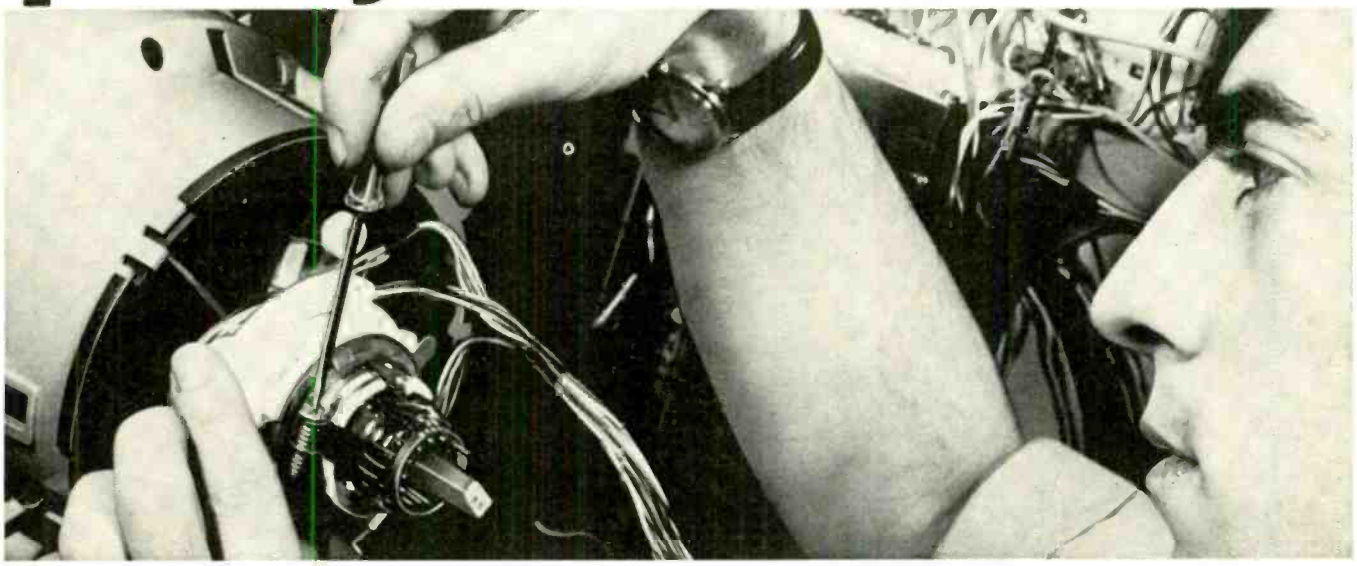

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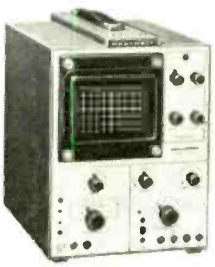

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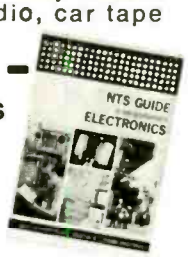

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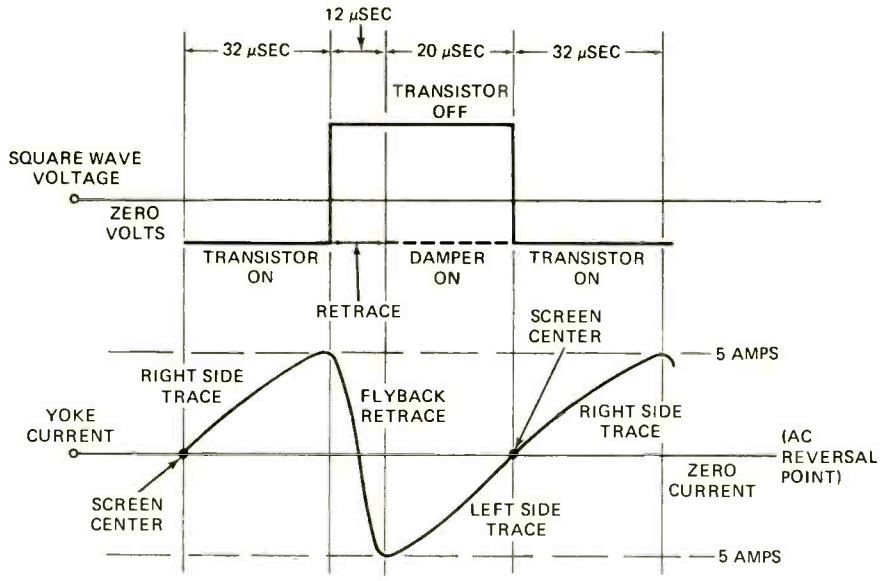


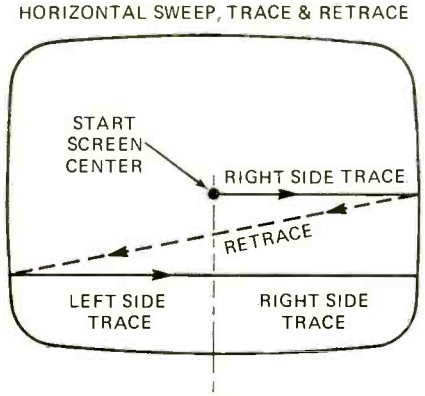
HOW ENERGIZING CURRENT FOR HORIZONTAL YOKE COILS IS FORMED. The horizontal output transistor acts as a switch opened and closed by a squarewave signal applied to its base.

the output transistor turned off.

The sudden current collapse during retrace develops a large voltage pulse; a few hundred volts peak-to-peak. This pulse has a frequency of about 70 kHz. During the positive part of the pulse the damper diode is reverse biased. When the pulse goes negative the voltage forward biases the damper and it starts conducting.

The yoke current gradually decreases to zero. This causes the magnetic field that had built up during retrace to subside, allowing the picture tube beam to return to its neutral position at the center of the screen.

At that point the square wave in the output goes negative again, turning on the transistor and the cycle repeats itself.



HORIZONTAL SCANNING LINES are formed by actions of horizontal output and damper.

To sum up, the electron beam begins its scan at the center of the screen. It is drawn from center to right side by the sawtooth developed by the saturating transistor. It retraces from right side back to left side as the transistor turns off. Then the beam is drawn from left side to center as the damper diode rectifies and dampens the 70 kHz pulse.

HV byproduct

During retrace a very large voltage pulse develops at the emitter. This 70 kHz pulse is rectified and relieved of its negative rings. The positive rings remain and have a peak signal amplitude of a few hundred volts.

In the damper diode leg, there is a winding of the flyback transformer. The winding steps up the few hundred volts to the required picture tube anode voltage, near 25 kV. The high voltage is then rectified by the high-voltage rectifier and sent on to the picture-tube anode.

Boost B-plus

Another by-product of the horizontal output stage is boost B-plus needed to power the other output stages. It is a simple little power supply. The anode of a boost rectifier is attached to the cathode of the damper diode. When a positive ringing pulse reaches the damper, it reverse biases the damper and at the same time forward biases the boost rectifier. Current flows from the boost powered circuits, through a two-stage smoothing filter supplying up to several hundred volts to circuits that require it. The boost circuit must be considered during troubleshooting. A defect in this circuit can kill the horizontal output.

Troubleshooting the circuit

Unlike its vacuum-tube counterpart, the solid-state horizontal output amplifier will not burn up when it loses its input signal. The transistor has the same voltage on emitter and base. Without drive it simply does not conduct. (In the same no-signal situation the horizontal output tube conducts wide open without drive, rapidly destroying itself.)

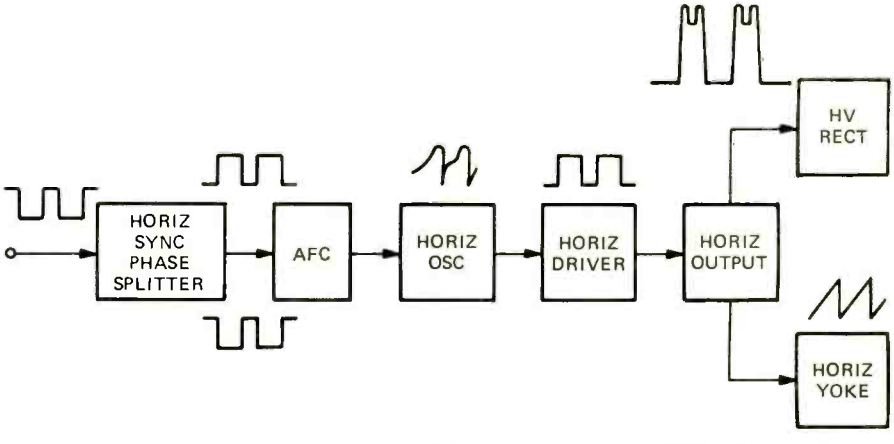
As a result, the output stage can be operated safely most of the time. This allows the simpler voltage and scope tests to replace the signal injection techniques used for vacuum tube sets.

The most common symptoms of output trouble are no raster or no high voltage. Sound, of course, is OK.

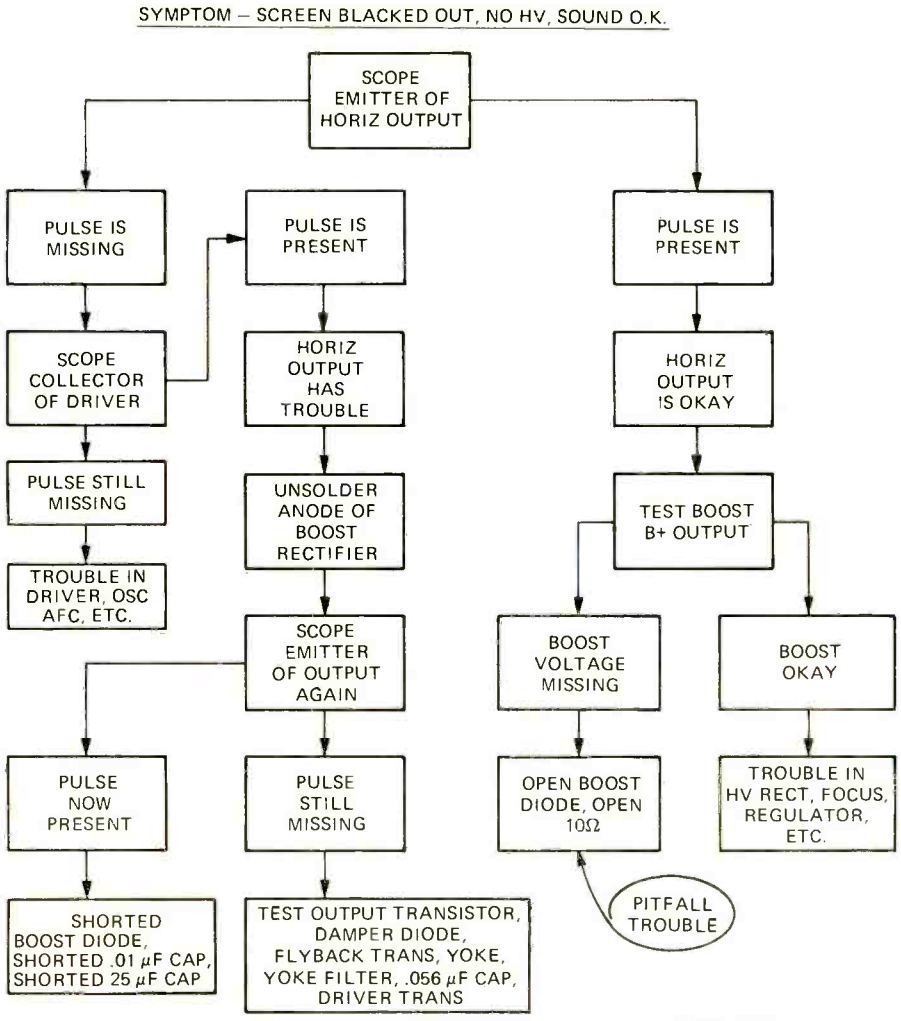
The first step is to isolate the trouble to the output stage. This is done by eliminating the afc, oscillator and driver as suspects. The first step is to scope the emitter of the output stage. If the pulse is there, the output stage is good and the trouble is in the rectifier, focus, regulator etc.

When the pulse is missing, the preceding stages including the output stage are suspect. Scope the collector of the driver stage. If the square wave is missing, the trouble is in the driver, oscillator or afc. When the square wave is present, the horizontal output stage is at fault.

When the output stage becomes the prime suspect, disconnect the anode of the boost rectifier. Then scope the emitter again. If the pulse is now present the boost B-plus is at fault. Test the rectifier and the other three components. One of them has shorted,



BLOCK DIAGRAM OF A SOLID-STATE HORIZONTAL DEFLECTION CIRCUIT. The circuit operates differently and is more complex than a vacuum-tube equivalent.



TROUBLESHOOTING CHART for typical solid-state horizontal deflection and high-voltage circuit.

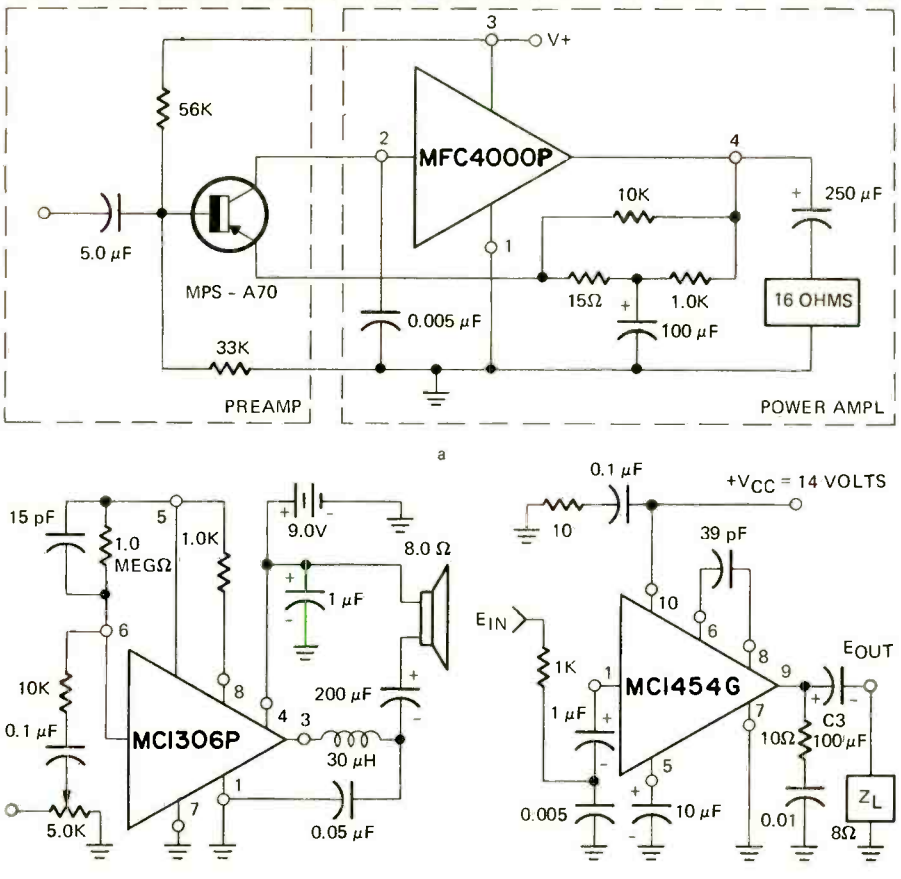
probably the diode.

If the emitter pulse is still missing, then the output stage itself is at fault. Remove the output transistor and test it, preferably by comparison with a known good replacement.

The rest of the components; the flyback transformer, the yoke, yoke filter, damper diode and its companion capacitor, all have to be tested individually.

Pitfall trouble

If you scope the entire circuit and all the waveshapes are present, yet there is still no high voltage to speak of, look to the boost B-plus circuit. If the boost rectifier and/or its series resistor are open, the effect could be lowered high voltage. This happens because the boost voltage is missing and is not there to power a stage concerned in the raster production. The only clear indication is the raster won't light up. Be sure to test those two components. **R-E**



3 IC AMPLIFIERS

All three circuits were abstracted from *Semiconductor Supermart*, a 92-page catalog issued by the Circuit Specialists Co. (P. O. Box 3047, Scottsdale, Ariz. 85257).

Featuring a 99-cent IC, the ¼ watt amplifier circuit in Fig. a uses a separate preamp stage using a single pnp transistor. Designed to drive a 16-ohm load, it may be used in pocket-sized receivers, hearing aids, and hand-held signal tracers.

Suitable for use in AM/FM portable radios, tape recorders, small phonographs, and low-power intercoms, the amplifier circuit shown in Fig. b will deliver ½ watt into an 8-ohm loudspeaker when driven by a 3 mW (rms) signal. It has a zero-signal current drain of only 4.0 mA at 9 volts and features only 0.5% distortion at 250 mW output.

The 1-watt amplifier circuit in Fig. c furnishes an overall voltage gain of 9. With a total harmonic distortion of less than 0.75%, the design has an input impedance of 10 k and can drive an 8-ohm load. A "TO-5" type heat sink is recommended for optimum performance at maximum output. **R-E**

the state of SOLID STATE

This month's selections are diverse and interesting. Among these is a new logic-type IC whose introduction is most timely.

by LOU GARNER
SEMICONDUCTOR EDITOR

IN JANUARY, I PREDICTED A NEW solderless breadboarding *system* would be introduced during 1973—one involving components as well as a breadboard chassis. That prediction has now been fulfilled by a well-known mid-western manufacturer, Kurz-Kasch, Inc. (1421 South Broadway, Dayton, Ohio 45401), with their introduction of a series of powered breadboards and a complementary series of unique and versatile component substitution devices dubbed *Substicomps*. Used together, the powered breadboards (POWRBOARDS?) and *Substicomp* devices permit even relatively complex system circuits to be assembled, modified and tested in minutes rather than hours, and without soldering. Once proven and optimized, the circuits can be easily duplicated using conventional construction techniques.

The *Substicomp* system's basic breadboard is assembled in a uniquely styled calculator-like, molded enclosure (see Fig. 1). The first unit in the planned series of breadboards, intended primarily for digital design applications, offers a fixed 5-volt dc, 1A, regulated, short-circuit proof power supply, and an integral function generator, together with a solderless plug-in type "super-strip" breadboard. The "super-strip" will accommodate the latest LSI and MSI circuits as well as standard IC's and discrete semiconductor devices such as transistors, diodes, Triacs and SCR's. Other models in the line will include one with a variable voltage, 0-15 volts dc. 0.5A, metered power supply for general purpose and linear circuit work, and also a model with built-in battery holders for low-cost experimenter, student and hobbyist applications. Powered breadboard prices range from $34.95 to $99.95, depending on type.

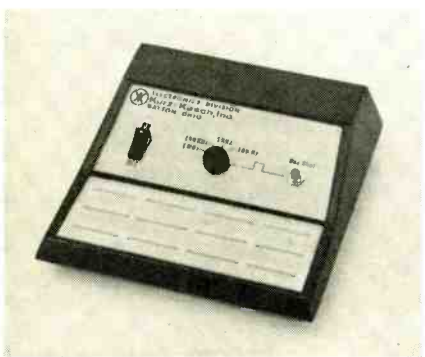


FIG. 1—POWERED BREADBOARD by Kurz-Kasch—digital model.

Offering the switch selection advantages of the familiar substitution box, but *without* the disadvantages of high cost, long feedback-prone leads, bulky cabinetry, expensive switches and knobs, and limited areas of application, the *Substicomp* devices are compact circuit boards containing selections of various standard components, such as resistors and capacitors, together with unique integral slide selector switches, as shown in Fig. 2.

In practice, they can be inserted directly into wired equipment as well as experimental breadboard circuits using self-supporting leads no longer than those of standard individual components. Once installed, optimum component values are selected simply by shifting the selector switch slider.

Their small size and relatively low cost allow several different types to be used simultaneously in a single circuit, thus permitting rapid optimization of component values. The devices net for approximately the same price as the individual components included on each device, if purchased separately.

A broad range of models will be offered, including, low-, medium- and high-wattage resistors in various value ranges, different types of capacitors, and other standard components.

Although designed specifically for use in Kurz-Kasch's breadboarding system, *Substicomp* devices may be used with any breadboard, either solderless or semi-permanently wired. In fact, after examining prototype units, I suspect that many radio-TV service technicians will adopt these for their field and bench service work—a handful of these in the toolbox would be equivalent to a basic inventory of standard components!

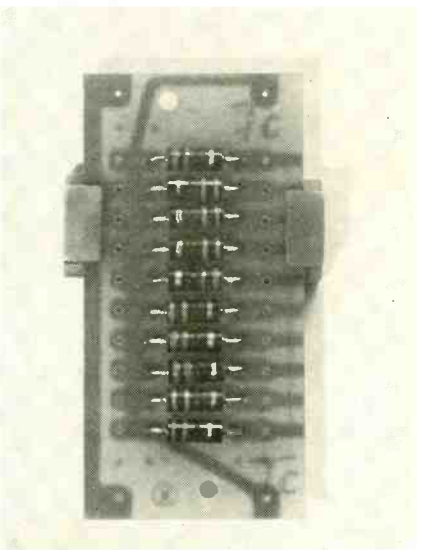


FIG. 2—A TYPICAL SUBSTICOMP substitution device.

Both the powered breadboards and the *Substicomp* devices are available individually as well as in espe-

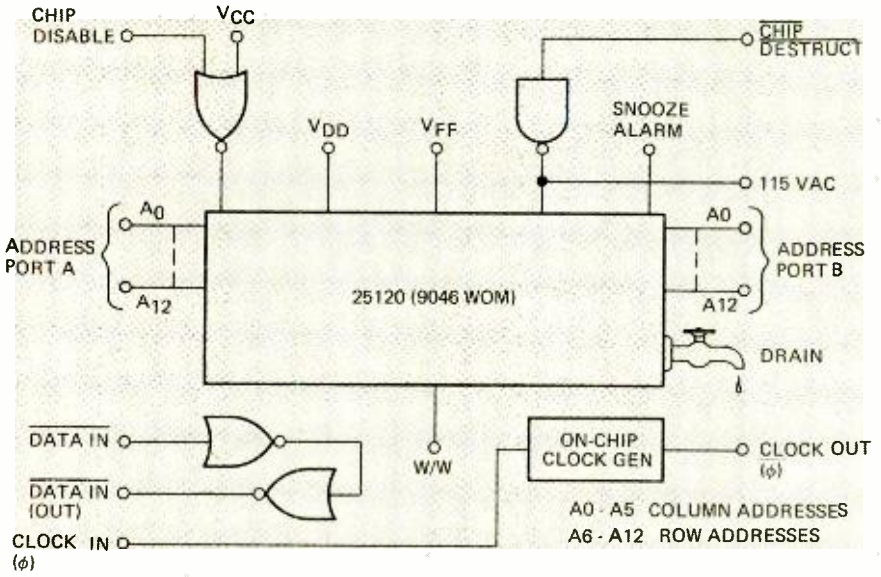


FIG. 3—SIGNETICS' AMAZING 25120 IC—basic block diagram

cially priced "system kits," comprising a selected breadboard and suitable assortment of applicable devices.

Availability is through regular distributor outlets. If these are not yet available in your area, contact Mr. Tom Barth, Marketing Manager, Kurz-Kasch, Inc.

A nugatory device

Generally, I try to report on new solid-state devices as soon as they are introduced. On occasion, however, a new device will be introduced by a major manufacturer that is so far-reaching in its implications that a detailed study is required before a formal announcement is made. Such is the case with the type 25120 IC developed last year by the Signetics Corporation (811 East Argues Ave., Sunnyvale, Calif. 94086). Our study has delayed a formal presentation until this month, which, we feel, is especially appropriate because of the unit's unique capabilities.

The 25120 is a fully encoded, 9046XN, random access write-only-memory. The device's basic block diagram is in Fig. 3. The 25120 is fabricated using both enhancement and depletion mode p-channel, n-channel, and neu-channel MOS devices. Although a static unit, a single TTL level clock phase is required to drive the on-board multi-port clock generator. Data refresh is accomplished during CB and LH* periods. Quadri-state outputs (when applicable) allow expansion in many directions, depending on organization. The static memory cells are operated dynamically to yield extremely low power dissipation. All inputs and outputs are directly TTL compatible.

According to the data sheet published by Signetics, the 25120 features fully encoded multi-port addressing, a write cycle time of 80 ns (typical), a non-applicable write access time, a power dissipation of 10 μW/BIT (typical), a cell refresh time of 2 ms (typical), "n" available outputs, and non-hermetic silicon DIP packaging. The required V_{CC} is +10 volts, V_{DD} is 0 volts, ±2%, while V_{FF} is a standard 6.3 volts ac.

Signetics claims that their use of a proprietary Sanderson-Rabbet Channel permits the 25120 to provide 50% higher speed. Fig. 4 is a photograph of the new device.

Full applications notes are not yet available on the device, but Signetics indicates that the recommended cooling is by use of a six-foot high-speed fan, mounted not more than ½" from the package. If overheating occurs, more air is recommended.

Pending the availability of specially designed commercial hardware for the 25120, I recommend using an old-fashioned vacuum tube grid leak drip pan under the drain terminal.

Unfortunately, Signetics has not released full price and availability data on the 25120. However, I have received unofficial word from an impeachable source that the device will be priced at a nominal one megabuck each in large quantities, with orders accepted *only* at high noon on **APRIL 1,** and delivery scheduled on (exactly) **February 31st** of the following year. Should, by some misfortune, there be no February 31 in the following year, delivery will be rescheduled for the first available year in which February 31 occurs.

*CB and LH—Coffee Breaks and Lunch Hours, clock watching time excluded if in excess of 1 nanosecond.

Product/device news

A family of four new, low-cost LED numeric displays designed for portable instruments and desk-top calculators has been introduced by Litronix (19000 Homestead Road, Cupertino, Calif. 95014). These new devices utilize a "bubble top" integrated lens construction to magnify the LED image, thus permitting a minimum use of gallium arsenide phosphide material. As shown in the side view of Fig. 5, the lens is molded as part of the

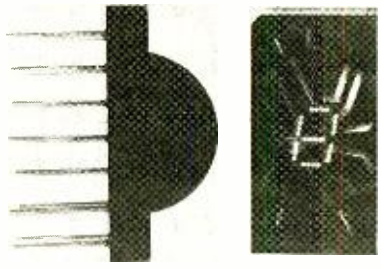


FIG. 5—"BUBBLE TOP" LED numeric display developed by Litronix.

device package. The devices offer 0.19" high digits with 300 ft-L brightness at only 5 mA per segment. Types Data-Lit 4 and 402 have a common cathode; types DL-410 and DL-411 a common anode. The DL-411 has an electrically isolated decimal point. All four types sell for only $3.90 each in 100-up quantities.

The National Semiconductor Corporation (2900 Semiconductor Drive, Santa Clara, Calif. 95051) has introduced a new series of precision preamplifier IC's designed specifically for use with operational amplifiers to achieve greatly increased DC accuracies.

Offered in standard "TO-type" packages, as illustrated in Fig. 6, the

FIG. 6—PRECISION PREAMP IC, a LM121 from National Semiconductor.

new devices, identified as the LM121/LM121A series, have a high common mode and supply rejection—typically, 135 dB.

The LM121 features easy offset voltage adjustment and, with offset nulled, a drift guaranteed to be less than 1 μV/°C. The LM121A is even better, guaranteed to have less than

0.2 μV/°C drift. All devices in the new series are compatible with virtually all standard IC op amps, including the LM108, LM101A, LM741 and LM118. Pricing in 100 lot quantities range from $3.95 each for the LM321H to $39.95 each for the LM121AH.

A new MOS/LSI calculator circuit set complex enough for business applications, yet inexpensive enough for most consumer products has been introduced by Electronic Arrays, Inc. (501 Ellis St., Mountain View, Calif. 94040). All the calculating logic, the clock, and a good portion of the interface circuitry of a 12-digit 4-function memory calculator are on just two MOS circuits, the EA 7022 in a 28-lead DIP and the EA 7023 in a 40-lead DIP.

These two packages, which make up the EA S-129 set, shown in Fig. 7,

FIG. 7—MOS/LSI CALCULATOR circuit IC's introduced by Electronic Arrays, Inc.

contain an arithmetic/algebraic processor with 12-digit entry and display capacity, an accumulator memory, the keyboard scanning and display control logic, an internal clock generator, and power-on clearing circuitry.

The EA S-129 has push-pull outputs, and in a typical machine with a 27-key input and a 12-digit display, only a sum total of about 50 resistors, capacitors, and diodes are needed for input pullup, display current setting, frequency control, and so forth; no additional transistors or logic circuits whatever are required. The list price for small quantities is $32.50 for 100 sets.

Designated type SN72440, a new combined threshold detector and zero-crossing trigger IC has been announced by Texas Instruments, Inc. (P. O. Box 5012, Dallas, Tex. 75222). Intended for ac power control applications, the new IC device, Fig. 8, allows a triac or SCR to be fired when the ac input signal crosses through zero volts, thereby minimizing undesirable electromagnetic interference and permitting the load to use full cycles of line voltage, as opposed to the partial cycle use typical with SCR phase-control power circuits.

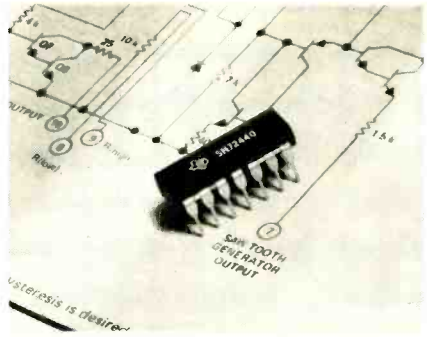


FIG. 8—TI'S SN72440 zero-voltage switch.

The unit includes a zero-voltage detector, a differential amplifier that may be used in conjunction with a resistance bridge to sense the parameter being controlled, the active elements of a saw-tooth generator, and an output section. Also included are resistors which may be used as a voltage divider for the reference side of the resistance bridge; an external sensor suitable for the application and an external potentiometer form the input side of the bridge. Offered in either a 14-lead plastic or ceramic DIP, the SN72440 sells for $2.24 or $2.44 each in 100-lot quantities, depending on package type.

The Burr-Brown Research Corporation (International Airport Industrial Park, Tucson, Ariz. 85706) has introduced a new series of instrumentation amplifiers. Models 3625A, 3625B, and 3625C feature input voltage drifts of 3.0 μV/°C, 1.0 μV/°C, and 0.5 μV/°C, respectively, at gains of 1000. Bias current is only 100 nA and dc gain linearity is ±0.02%.

Small differential signals can be amplified, with gains of 10 to 1000 selected by the use of a single external resistor, in the presence of ±10V common mode voltages. Using matched IC op amps and high stability wire-wound resistors, the 3625, Fig. 9, offers an input impedance of 1000

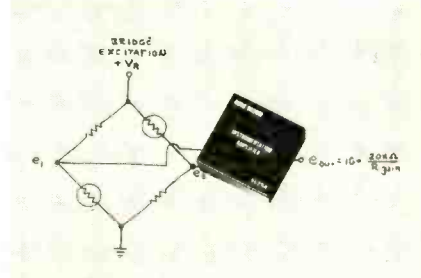


FIG. 9—LOW-COST MODEL 3625 instrumentation amplifier now available from Burr-Brown Research Corporation.

Megohms, the CMR at G = 1000 is 100 dB; output is ±10V at ±5 mA; input noise level at G = 100 is 5 μV rms from 10 Hz to 10 kHz.

Intended for use as transducer amplifiers for low-impedance signal sources, such as strain gauges and load cells, the new units are priced at from $29.00 to $59.00 each, depending on type. Small quantities of these amplifiers are available from stock.

Four new lines of microwave diodes for communications and other commercial applications have been announced by the Amperex Electronic Corporation (Hicksville Division, Hicksville, N.Y. 11802), a wholly owned subsidiary of the North American Philips Corporation. The four lines include 11 Schottky barrier devices, four tuning varactor diodes, 23 Gunn-effect devices, and 5 IMPATT devices, for applications in C, X and Ku band microwave systems. Several of these new devices are illustrated in Fig. 10. All feature conservative ratings; some of the devices are available in matched pairs.

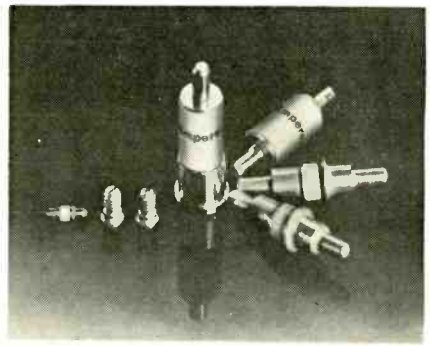


FIG. 10—NEW MICROWAVE DIODE line introduced by the Amperex Electronic Corporation.

Another MSI logic circuit has been added to the MECL 10,000 logic family by Motorola's Semiconductor Products Division (P. O. Box 20912, Phoenix, Ariz. 85036). The new circuit, Fig. 11, designated type MC10165, is

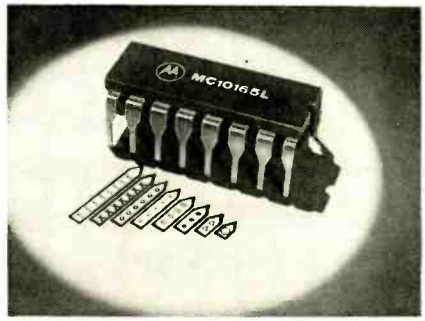
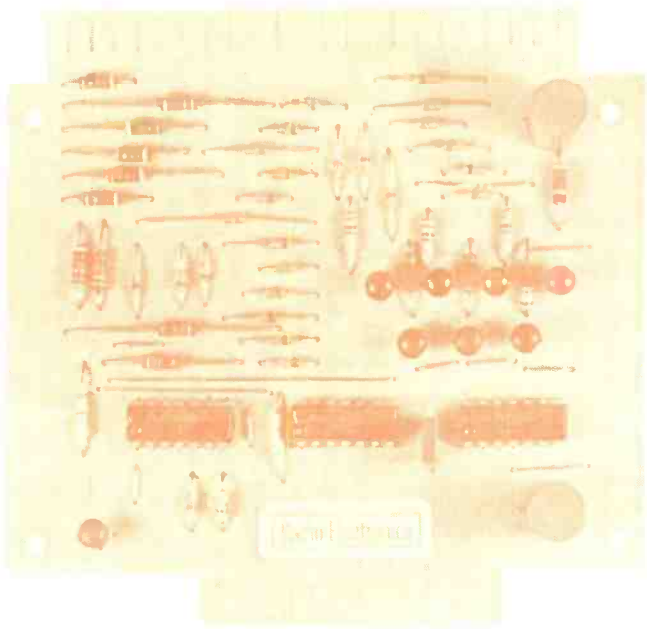


FIG. 11—MOTOROLA'S MC10165 8-input priority encoder.

an 8-input Priority Encoder which operates with a typical propagation delay from data-input to coded-output of only 7 ns.

That concludes our solid-state story for April . . . but, lest we forget, if, by some happenstance, you didn't get the "message" on the Signetics 25120—**APRIL FOOL!** **R-E**



build an ASCII keyboard encoder

Here is what you need to couple the keyboard you built in February to a computer, teletype, or teaching machine.

by DON LANCASTER

THE LOW-COST KEYBOARD, LIKE THE majority of other typewriter style keyboards, provides only a single "make" contact for each key depressed (see **Radio-Electronics**, February 1973). Computer terminals, teaching machines, etc., cannot directly use a single-contact operation, and a device called an *encoder* must be placed between the keyboard and the computer. The encoder converts the single contact closure into a seven- or eight-bit IC logic compatible parallel code, usually following the ASCII encoding scheme, and allowing for *shift* and *control* key operations. After parallel encoding, there may follow a *parity* generator for error detection, and a 100-word-per-minute *parallel* to *serial* converter that allows the signals to be sent down a single wire or phone line.

The keyboard encoder described here costs only a tiny fraction of commercial equivalents. It uses three "dollar" integrated circuits and a small handful of surplus computer diodes. While this encoder was designed as a companion to the low-cost keyboard, it may be used with *any* keyboard, provided the make contacts are less than 2000 ohms when ON and provided that the keys *do not* have a common ground terminal. The encoder generates all the codes shown in Table I. This includes all the capital letters, all the often used punctuation, all numerals, and all of the transparent or control functions. Often used control functions such as DELETE, SPACE, LINE FEED, ESCAPE (ALT MODE), CARRIAGE RETURN, etc. are brought out to separate keys. The output is RTL, TTL, DTL and MOS compatible, and a single 10-volt, 25-mA power source is needed. If an ASCII code is not desirable, the same encoder may be used, through suitable rewiring, to generate EBDIC, SELECTRIC, BAUDOT or MORSE codes. Parity and the 100-wpm (words-per-minute) serial converter are easily added to the basic encoder.

What is the ASCII code?

Many years ago, the American Standards Association decided to adopt a standard code that computers could use to talk to each other, to their input/output devices, and to allow standardized connections between different brands of computer machinery. The resultant industry wide code is called ASCII, short for *A*merican *S*tandard *C*ode for *I*nformation *I*nterchange. This code is a sequence of six, seven, or eight *bits* (ones or zeros). It may be sent either in *serial* (bit by bit, least significant bit first) form, or in *parallel* (all bits at once, on 6, 7, or 8 lines) form. Usually, parallel words are used *inside* machines, while serial words are used *between* machines. Serial words are obviously slower, but they take far less wire and interconnections.

The basic code consists of *seven* bits. If we look at all possible combinations of seven ones and zeros from 000-0000, 000-0001 . . . through to . . . 111-1111, we'd find a total of 128 different sequences. Each of these may be used to represent something distinct. 64 of these code sequences are used for alphanumeric capital letters, numbers, a blank, and punctuation. 32 more sequences are used for *transparent* or *control* commands that never appear on a screen or in print. These commands tell the machinery on the other end what to do—things like returning carriages, clearing, line feeds, bell ringing, and other control functions. A final 32-code sequences are reserved for lower case alphabet and some little used punctuation. This last group is very seldom used as most computer communications can be handled with only capital letters, numerals, control commands, and common punctuation.

The complete code appears in Table II. It is arranged in a *matrix* form to make it compact and easy to read. For instance, the transparent command "Carriage Return", or "CR" has a code of 000-1101, starting with bit 7 on the left and going to bit 1 (the least significant) on the right. A numeric "6" has the code 011-0110. Note the right half of this code is the same as a binary or a binary-coded-decimal six. A capital L has the code 100-1100, while the lower case L is a 110-1100.

There are several ways to use the code, depending on how much you want the code to do. If we are *only* interested in upper-case alphabet, numerics, and punctuation, we can use the middle of the code and get by with a six-bit code, sometimes called ASCII-6. This is useful in character generators and displays that do not need transparent commands or lower case alphabets. Many MOS integrated circuits are now available that convert the six-bit subset into a recognizable bunch of dots on a TV screen or a line printer; these are called ASCII Character Generators.

Or, we can use all seven bits, either with or without the lower case stuff, picking up both alphanumerics and control commands. This is often called the ASCII-7 code. Finally, if we

TABLE I OUTPUT CODES

The output codes below are shown in HEXADECIMAL notation to conserve space. Thus "3D" is an ASCII 011-1101, or output $a_1 = 1$, $a_2 = 0$, $a_3 = 1$, etc. . . . The "Key Depressed" output does *NOT* appear for the SHIFT or CONTROL buttons depressed separately. All other keys, whether or not they are used with SHIFT or CONTROL, produce a *Key Depressed* output.

KEY	NORMAL CODE	SHIFTED CODE	CONTROL CODE
@	40	40	00 (null)
A	41	41	01 (soh)
B	42	42	02 (stx)
C	43	43	03 (etx)
D	44	44	04 (eot)
E	45	45	05 (eng)
F	46	46	06 (ack)
G	47	47	07 (bell)
H	48	48	08 (bs)
I	49	49	09 (ht)
J	4A	4A	0A (Lf)
K	4B	4B	0B (vt)
L	4C	4C	0C (FF)
M	4D	4D	0D (cr)
N	4E	4E	0E (so)
O	4F	4F	0F (si)
P	50	50	10 (dle)
Q	51	51	11 (DC1)
R	52	52	12 (DC2)
S	53	53	13 (DC3)
T	54	54	14 (DC4)
U	55	55	15 (NAK)
V	56	56	16 (SYN)
W	57	57	17 (ETB)
X	58	58	18 (CAN)
Y	59	59	19 (EM)
Z	5A	5A	1A (SUB)
0	30	20 (space)	10 (dle)
1	31	21 (!)	11 (DC1)
2	32	22 (")	12 (DC2)
3	33	23 (#)	13 (DC3)
4	34	24 ($)	14 (DC4)
5	35	25 (%)	15 (NAK)
6	36	26 (&)	16 (SYN)
7	37	27 (')	17 (ETB)
8	38	28 (()	18 (CAN)
9	39	29 ())	19 (EM)
:	3A	2A (*)	1A (SUB)
;	3B	2B (+)	1B (ESC)
<	2C	3C (,)	0C (ff)
-	2D	3D (-)	0D (cr)
>	2E	3E (.)	0E (so)
?	2F	3F (/)	0F (si)
↑	5E	5E	1E (rs)
—	5F	5F	1F (us)
SPACE	20	20	00 (null)
LINEFEED	0A	0A	0A (Lf)
C. RETURN	0D	0D	0D (cr)
ESCAPE (ALT)	1B	1B	1B (esc)
DELETE	7F	7F	1F (si)

like, we can add an eighth bit and use it for error detecting. It is called the *parity* bit. In an *even parity* system, the parity bit makes the total number of *ones* in the word *even*. If there are 1, 3, 5, or 7 ones in the word before the parity bit is added, the parity bit is a one. If there are 0, 2, 4, or 6 ones, the parity bit is a zero. This way, there is always an *even* number of ones sent. At the receiving end, parity is once again tested. If an odd number of ones shows up, a mistake has been made, and the receiver can substitute a "?" or ask for the information over again. We could also use an odd parity system just as well, provided both ends are playing the game with the same rules. This is called the ASCII-8 code.

Seven bits are rarely sent between machines. An eighth wire or bit space is usually added, so that if parity is added later, it doesn't take a bunch of rework. Similarly, most paper tape punches and magnetic tape is in an eight-track code; if parity isn't used, the eighth bit is usually all ones.

You may wonder what all those transparent commands stand for. Actually, a lot of them are only used on very big and very complicated machines, and thus aren't really very common. The ones you'll probably use are few in number. For instance, **CR** is a carriage return that starts a new line on a typewriter. **LF** is the line feed, used to skip a line. **BEL** rings a bell or signals an operator. **BS** is backspace. It can only be used in some systems, for many CRT terminals and teletypes cannot back up. The direct control commands are labeled *DC1*, *DC2*, *DC3*, and *DC4*. These are usually yours to do anything you want with, such as turning on and off equipment, remote signalling, etc. **NUL** is a do-nothing command that everything sits in while not

ASCII ENCODER PARTS LIST

R1—390 ohms, ¼ watt (sets operating force—see text)
R2, R3, R4—100,000 ohms, ¼ watt
R5, R7, R10, R16—4700 ohms, ¼ watt
R6, R8, R9, R11, R12, R13, R14—9100 ohms, ¼ watt 5%
R15—470 ohms, ¼ watt
R17, R18, R19—100 ohms, ¼ watt
R20—2200 ohms, ¼ watt
R21, R22, R23—10,000 ohms, ¼ watt
C1—0.1-μF disc ceramic capacitor
C2, C3—100-μF 10V electrolytic
D1 thru D26—1N914 or similar silicon computer diode
D27—1N4736 or similar 6.8-V Zener diode
IC1, IC2, IC3—MC 9818P mwrtl hex inverter
Q1, Q5, Q6, Q7—2N5139 pnp transistor
Q2, Q3, Q4, Q8—2N5129 npn transistor
MISC: PC board, jumpers, sleeving, solder, hardware.

in use. Finally, **ESC** is called Escape or Alternate mode. This lets you break out of the ASCII code if you ever need a longer sequence or something else special. The technique is called *code extension*. One common use is on a timesharing terminal, where you can switch back and forth between BASIC, FORTRAN, and EXECUTIVE MODE languages using the **ESC** or exactly equivalent **ALT** key.

DEL is a 111-1111 code that's used to delete a previous command or fill a paper tape full of holes.

Construction steps

The schematic and parts list is shown in Fig. 1. The keys are arranged electrically to form an "8 x 8" array, and pnp transistors translate the positive end of the array back down to logic levels. This technique requires far fewer diodes than a direct encoding does. The *control* and *shift* keys suitably alter the code of only those keys they're supposed to change.

A printed circuit board is used for

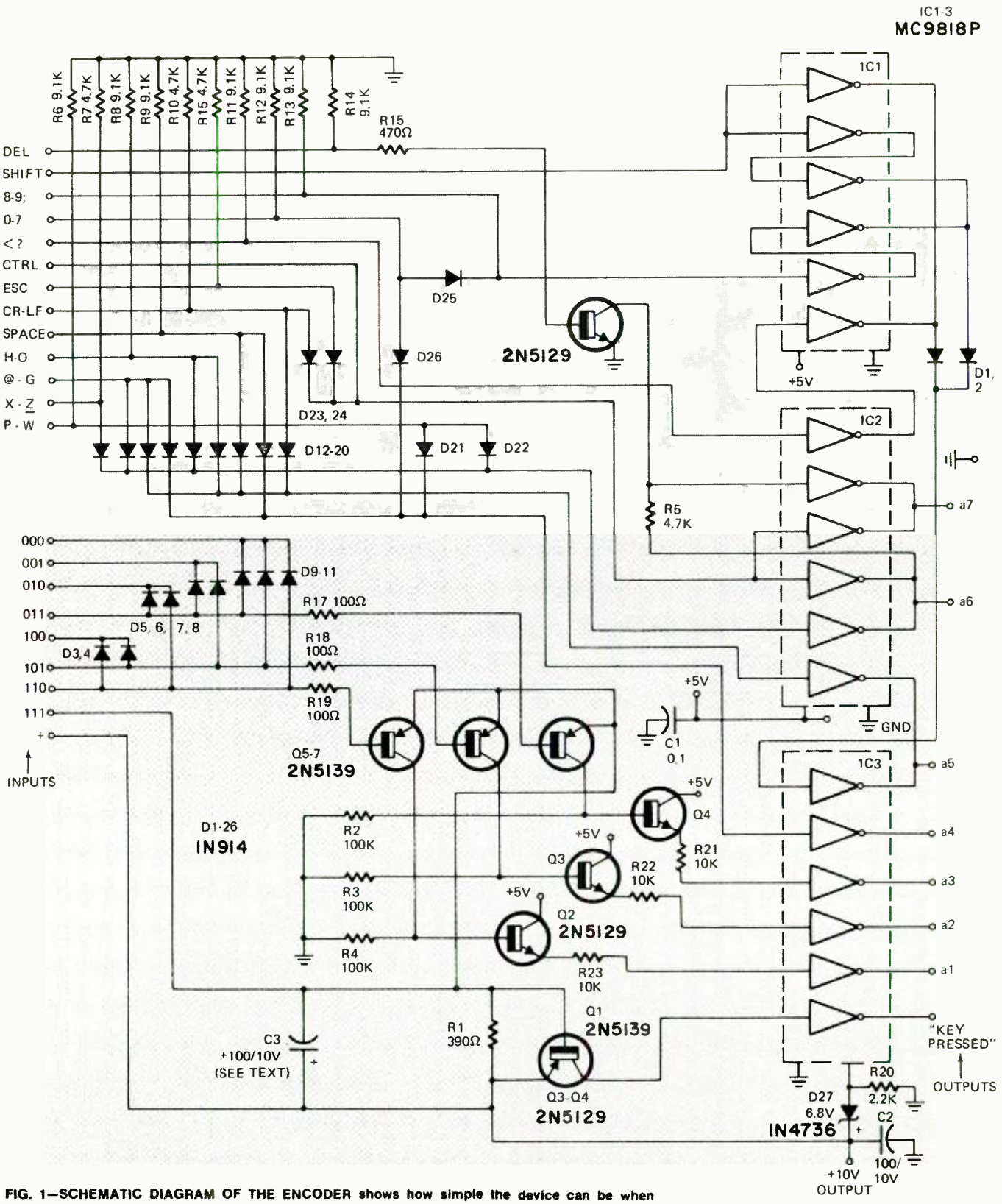
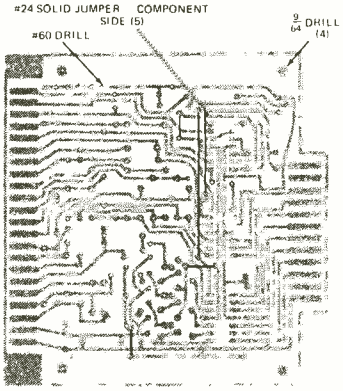


FIG. 1—SCHEMATIC DIAGRAM OF THE ENCODER shows how simple the device can be when three inexpensive IC's are used.

assembly. It's available commercially (see Fig. 1 parts list) or you can make your own using the pattern in Fig. 2 and following the drilling and assembly guides of Figs. 3 and 4. Use a small iron and fine solder for assembly, and be careful to observe the code notch and dot on the IC's and the polarity bands on the diodes and capacitors.

Resistor R1 determines the operating force required on the keyboard. It is chosen to be low enough in value that each key's output code is set up and correct at ⅓ to ¼ the pressure required to get the "key pressed" output command. This way the code is set up and stable before it is sent. Capacitor C3 further delays the "go" command to insure reliable operation. Be sure you use only the *leading edge* of the "key pressed" command, for it lasts longer than the rest of the code does. Should a second key be pressed before the first one is released, it will not be sent, giving a form of "2 key rollover" protection.

The PC board mounts on short spacers directly below the keyboard, and connects to the keyboard with a double connector, a flat cable, or direct jumpers. An Amphenol 143-012-01 connector may be used as an output. A 12-volt supply may be used by going to an 8-volt Zener diode. Operation at 5 or 6 volts may be obtained by lowering all the resistors, but the required keyforce will be



1 REQ'D 1/16 P.C. MAT'L

FIG. 3 (left)—DRILL GUIDE for the PC board. Solid-wire jumpers are on the component side.

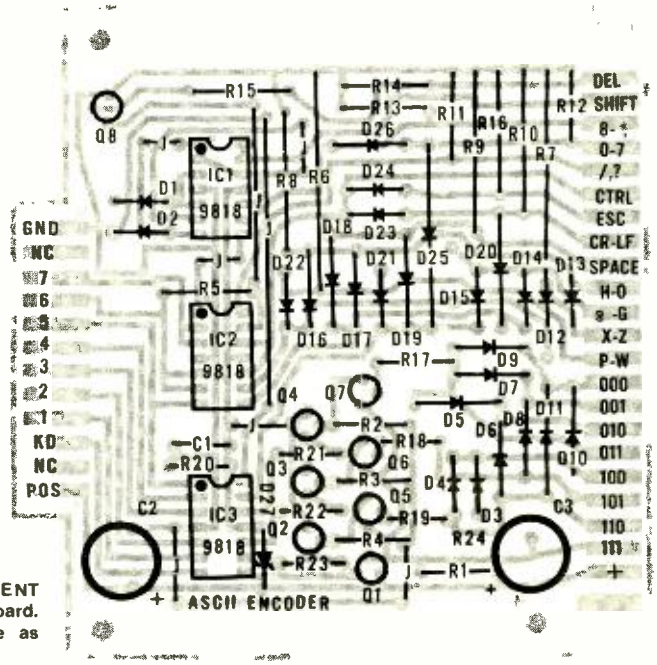


FIG. 4 (right)—COMPONENT SIDE of the encoder board. Jumpers are shown here as well as in Fig. 3 at left.

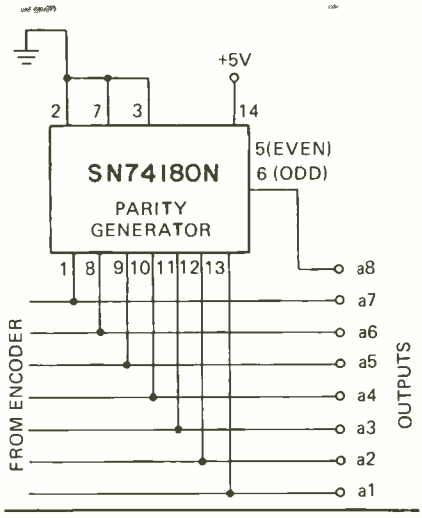


FIG. 5—PARITY GENERATOR for the eighth bit (a8) needs only one IC for odd or even parity.

TABLE II COMPLETE ASCII CODE

To read the matrix, choose your character. Then read the three high order bits off the top and the four low order bits off the left side. For instance, a small alphabet "f" is a binary 110-0110, otherwise known as a hexadecimal 66. Each control function has a specific meaning. For instance "LF" stands for a line feed, "CR" is a carriage return, "BEL" is a bell to attract an operator's attention, "ESC" is an escape for complicated control instructions, etc.

	b_7					0	0	0	0	1	1	1	1
	b_6					0	0	1	1	0	0	1	1
	b_5					0	1	0	1	0	1	0	1
BITS	b_4	b_3	b_2	b_1	Row / Column	0	1	2	3	4	5	6	7
	0	0	0	0	0	NUL	DLE	SP	0	@	P	'	p
	0	0	0	1	1	SOH	DC1	!	1	A	Q	a	q
	0	0	1	0	2	STX	DC2	"	2	B	R	b	r
	0	0	1	1	3	ETX	DC3	#	3	C	S	c	s
	0	1	0	0	4	EOT	DC4	$	4	D	T	d	t
	0	1	0	1	5	ENQ	NAK	%	5	E	U	e	u
	0	1	1	0	6	ACK	SYN	&	6	F	V	f	v
	0	1	1	1	7	BEL	ETB	'	7	G	W	g	w
	1	0	0	0	8	BS	CAN	(	8	H	X	h	x
	1	0	0	1	9	HT	EM	)	9	I	Y	i	y
	1	0	1	0	a	LF	SUB	*	:	J	Z	j	z
	1	0	1	1	b	VT	ESC	+	;	K	[	k	{
	1	1	0	0	c	FF	FS	,	<	L	\	l	|
	1	1	0	1	d	CR	GS	-	=	M	]	m	}
	1	1	1	0	e	SO	RS	.	>	N	↑	n	~
	1	1	1	1	f	SI	US	/	?	O	—	o	DEL

100-WPM ADAPTOR PARTS LIST

R1—1000 ohms, ¼ watt
R2—2200 ohms, ¼ watt
R3—10 ohms, ¼ watt
R4—10,000 ohms, ¼ watt
R5—potentiometer, 1000 ohms, linear
C1—0.1-μF 10V disc ceramic
C2, C3—100-μF 6V electrolytic
C4—4-μF 10V tantalum, 10%
D1—1N4002 silicon power diode or equal
IC1—MC4024 TTL multivibrator
IC2—SN74165 TTL 8-bit shift register, PISO
IC3—SN7474 TTL dual-type-D flip-flop
Q1—2N1613 npn silicon transistor
MISC: PC board, jumpers, sleeving, mounting adaptor hardware.

greater and less uniform from key to key. TTL (*T*ransistor *T*ransistor *L*ogic) fanout is 1 standard load. RTL (*R*esistor *T*ransistor *L*ogic) fanout is one medium-power gate.

The unit is tested by noting the proper codes in Table I. It's particularly important to watch all the bits at once with lamp drivers, IC testers, or something similar during initial checkout to be sure the code is up and stable before the keypressed command is sent for each and every key.

An optional parity generator for the eighth bit is shown in Fig. 5 and may be used for even or odd parity. A 100 word per minute teletype adaptor is shown in Fig. 6. The 100-wpm adapter consists of an oscillator whose period must be exactly 9.09 ms. Upon the Key Pressed command, an ASCII code, a START bit and a SYNCHRONIZING bit are loaded into a parallel-load shift register. After loading is completed, the oscillator marches out the code bits in proper sequence to be teletype and computer compatible. The circuit may accept a second character anytime after the 110-ms transmission time. The output consists of a transistor that normally shorts the teletype line. It *breaks* the line anytime a "1" is to be transmitted. The proper polarity must be observed on the output, and the 20 or 30 mA loop current source is located elsewhere. **R-E**

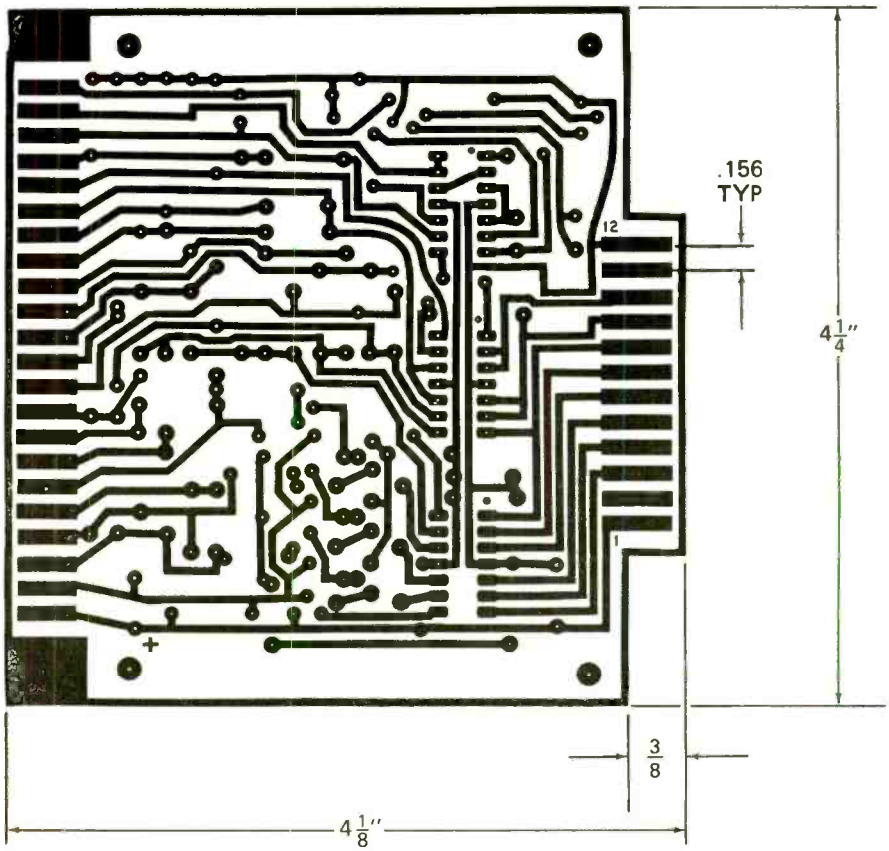


FIG. 2—FOIL PATTERN FOR THE ENCODER PC BOARD. This board mounts just below the keyboard and connects to it through flat cable, PC connectors or direct wired jumpers.

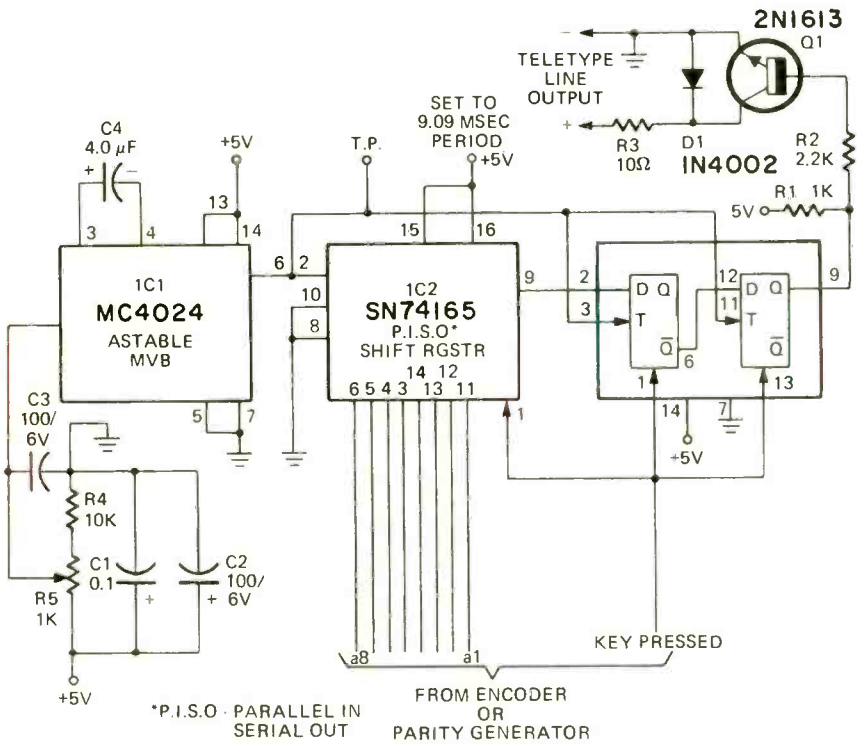


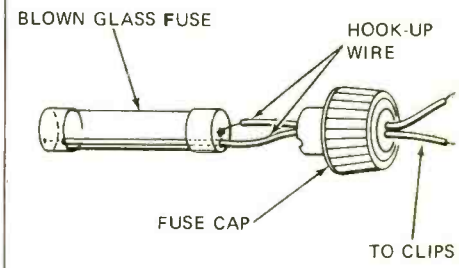
FIG. 6—TELETYPE FEED is through a special adapter circuit. This one handles up to 100 words per minute. A precision oscillator controls the storage and output from the shift register.

CIRCUIT BREAKER SUBSTITUTION BOX

A substitution box with circuit breakers selected by a switch is one of the handiest gadgets on my service bench. With breakers of different ratings, I'm ready to check radios, amplifiers and TV's with blown fuses and questionable circuit breakers.

Generally, I can clip onto the fuse or circuit breaker if the chassis has been pulled. I've rigged up a handy adapter that lets me jump fuses without pulling the chassis when the fuse holder is a post type on a panel or chassis skirt. The drawing shows its construction.

Drill a ⅛ inch hole through the



center of a spare fuse-holder cap. Drill small holes slightly off center in the ends of a blown cartridge fuse. Drill a second hole, just large enough to pass a piece of thin insulated hook-up wire, in the center of one end of the fuse. Strip about ⅛ inch of insulation off one end of a piece of hook-up wire and pass it through the center of the fuse so the short exposed wire goes through the hole in the far end. Solder. Solder a second piece of hook-up wire to the other end and then thread both leads through the fuse-post cap and then add clips for connecting to the breaker substitution box.—*Arthur M. Padmore* **R-E**

build a precision

Devices designed for electronic organs are excellent for radio-frequency use

ALL HAMS AND ALL EXPERIMENTERS at radio frequencies need a marker generator. A crystal oscillator followed by a few dividers can provide convenient markers for calibrating receivers, instruments and transmitters. This one uses inexpensive IC's and a field-effect transistor to obtain marker frequencies every 100, 50 and 25 kHz up to the vhf range.

Perhaps the most common arrangement in modern marker generators is a 100-kHz crystal oscillator using cross-coupled gates, followed by either divide-by-two or divide-by-ten stages. Plastic-cased resistor-transistor logic (RTL) is most popular because it is inexpensive and compact.

One small problem with conventional RTL is that it requires fairly high current at 3.6 volts; a more convenient requirement for most applications would be lower current at a higher voltage. Recent development of IC frequency dividers for electronic organs has made this possible.

History of a divider

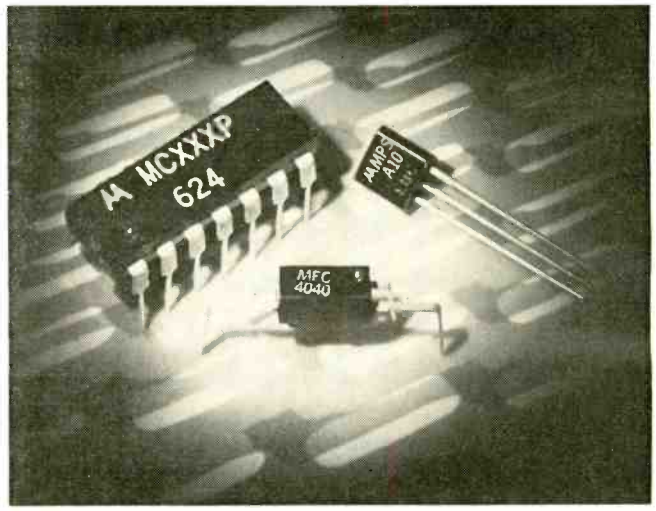
A popular method of generating organ notes is by dividing down by two's from twelve master oscillators. If these dividers could be converted to use IC's instead of the transistors or electro-mechanical devices now used, the market would be very large. So quite a bit of effort has gone into trying to develop an inexpensive, satisfactory IC divider.

Among the people working on the problem is a group at Motorola Semiconductor Products that has also been developing other simple, inexpensive consumer IC's such as audio and i.f. amplifiers. The approach they took was to use well-proven, trouble-free resistor-transistor logic and adapt it to meet the requirements of the organ manufacturers. This resulted in a number of changes in the circuits.

Conventional IC flip-flops divide well, but are more complex than necessary for simple frequency division. For example, a standard J-K flip flop has eight terminals, including four outputs and inputs not needed for division by two. These terminals require extra space both on the silicon chip and in the package, and they also must be bonded, an expensive operation. If the unneeded terminals were eliminated, the IC could be smaller, cheaper (in quantity) and easier to use.

So this was done. A new four-lead package with staggered pins had been developed for other consumer ICs, and it was used. This package is actually narrower than the popular D-shaped plastic TO-92 case. In the photograph, the new package is compared with a conventional transistor and IC. The staggered pins have a 160-mil (0.16-inch) lead spacing to permit the use of low-cost, noncritical circuit boards. The four terminals are INPUT, OUTPUT, POSITIVE SUPPLY and negative supply (or GROUND).

Having decided on improved, lower-cost packaging, the engineers next tackled the problem of inconvenient power requirements. Since an organ contains about 100 dividers, conventional RTL would require about 4.5 amperes at 3.6 volts, a hard-to-regulate supply. An obvious way to improve on this would be to increase the values of all resistors in an RTL divider, permitting higher voltage with attendant lower current. There's only one problem: high-value monolithic resistors take up considerable space. Hence most IC's use relatively small resistances, such as the 225-to-640-ohm resistors in the MC816 flip-flop shown in Fig. 1. To increase these resistors significantly would mean a very large—and expensive—chip of silicon. So a new approach was taken. The high-resistivity epitaxial layer deposited on silicon in making IC's is nor-



MOTOROLA MFC4040 FREQUENCY DIVIDER compared to in-line package and transistor.

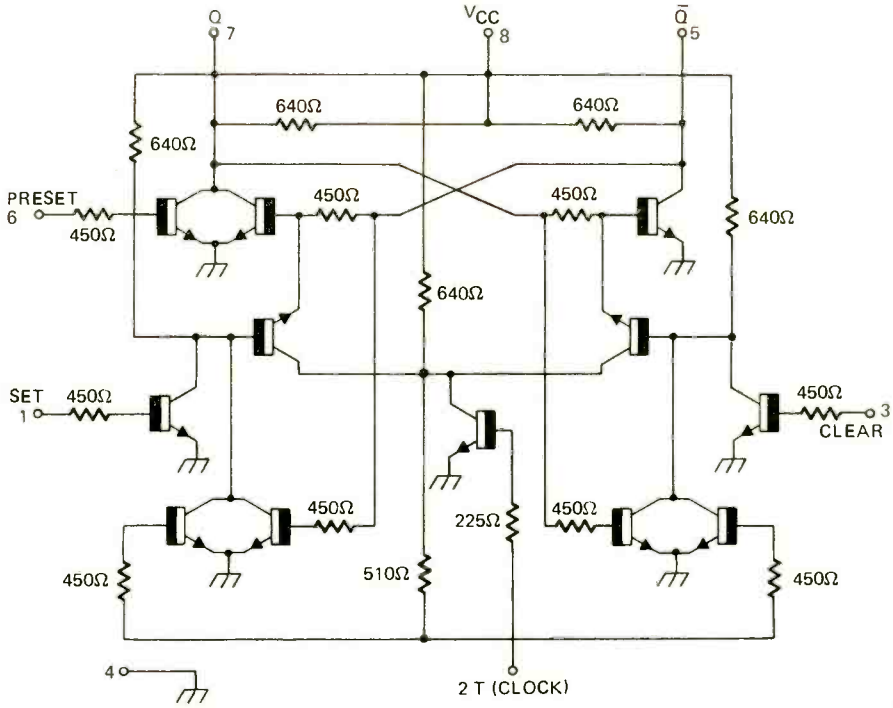


FIG. 1—RTL FLIP-FLOP (MC816) uses low-value resistors because of the high currents.

mally used as an insulator in the areas where no transistors and resistors are diffused into it. In the new frequency dividers, this epitaxial material was used for high-value resistors, solving the problem. These resistors have loose tolerances, but that's not significant in this use, where +80, -30 per cent values are fine. Where closer tolerance is needed, conventional diffused resistors are used.

So the conventional flip-flop of Fig. 1 was modified to form the frequency divider shown in Fig. 2 by increasing all resistance values. Note that a few additional changes were made: the transistors associated with the unneeded PRESET, SET, and CLEAR inputs were eliminated. One output (Q) was also deleted, a buffer stage was added to the output, and a resistive input divider was added. The resulting device, the MFC4040, makes an excellent divider for organs. It uses only about 12 mA at 12 volts, operates reliably from 4 to 16 volts, costs only 77¢ in small quantities and provides a high output voltage swing (slightly less than the supply voltage). Note that it contains ten transistors and 6 resistors in about the space a conventional transistor requires—about one-third the volume of a dual-inline package. A 4-volt (peak-to-peak) trigger input is required, and the MFC4040 seems to trigger well from sine waves to over 5 MHz. For low frequencies (below 50 kHz), a sharper trailing edge is needed (it triggers on a negative-slope wave form).

crystal calibrator

by PAUL FRANSON*

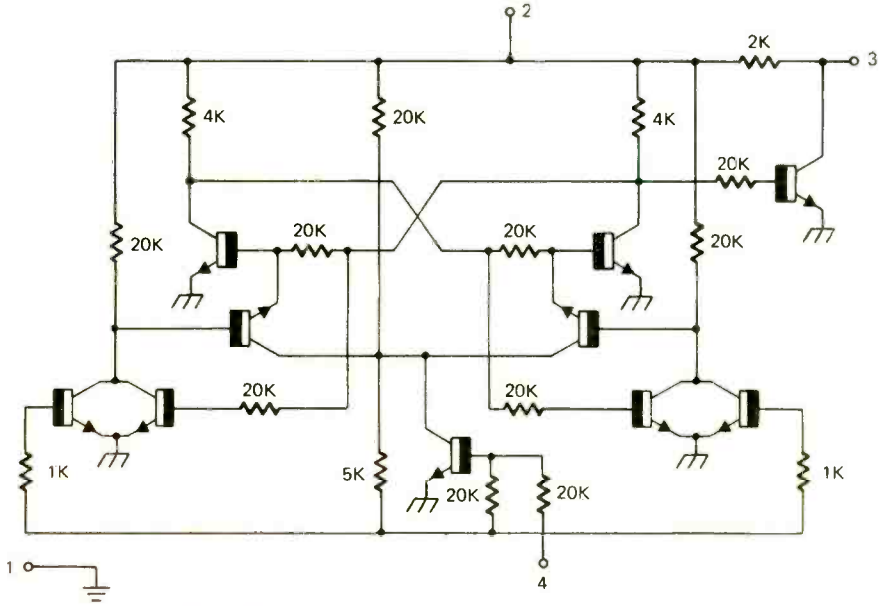


FIG. 2—MFC4040 FREQUENCY DIVIDER is designed for higher voltage and low current.

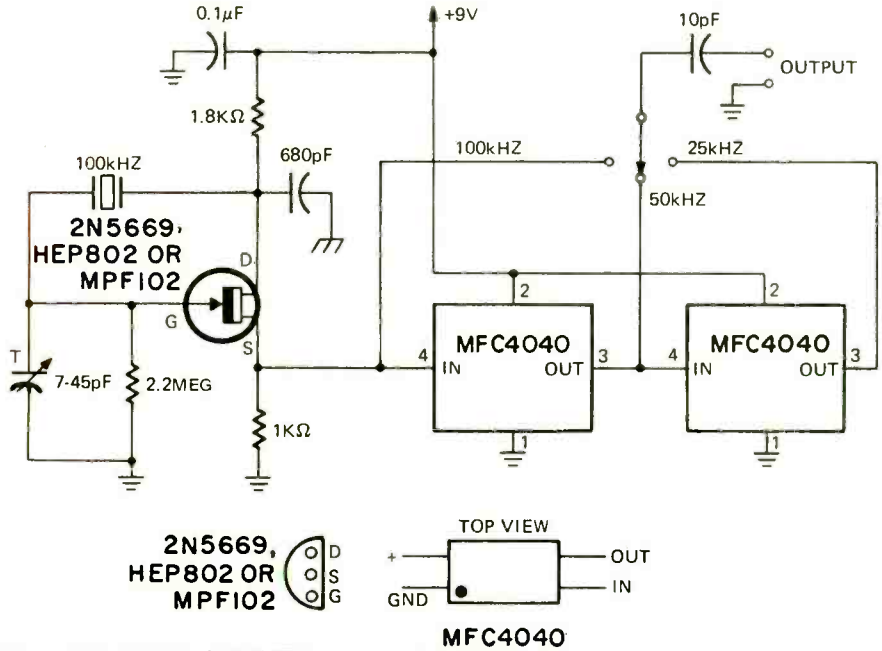


FIG. 3—THE MARKER GENERATOR uses two MFC4040's, a crystal and an FET transistor.

The marker generator

The MFC4040 thus becomes a natural candidate for a marker generator. In the circuit shown in Fig. 3, a field-effect transistor oscillator is followed by two MFC4040's, providing markers at 100-, 50-, and 25-kHz and their harmonics through at least 60 MHz. It operates from 6 to 16 volts and draws 14 mA at 9 V. The relatively high voltage makes it possible to use a simple FET crystal oscillator.

The oscillator is conventional; it is a solid-state analog of the once-popular vacuum-tube Pierce crystal oscillator. It uses an inexpensive (99-cent) 2N5669 plastic-encapsulated n-channel junction FET. The MPF102 or HEP802 can also be used.

The component resistors are not overly critical. The trimmer capacitor permits adjusting the oscillator to exact frequency by comparing a harmonic with WWV at 5, 10, or 15 MHz. Choose a time when the signal is not modulated then tune the marker generator to zero beat.

The two MFC4040's require no explanation. Each simply divides its input frequency by two and provides a square-wave output rich in harmonics. (A dual MFC4040 called the MFC6020 is also available. It has six pins and costs $1.26.)

Construction is straightforward. Perhaps the easiest approach is 100-mil spaced Vector board with a diagonal pattern. The MFC4040's fit almost perfectly into the holes. I used small rivets for mounting to avoid the possibility of pulling on the leads and deforming them. The board can then be mounted in a convenient cabinet with the battery. The unit draws about 15 mA, so a good 9-volt battery should last quite a while in the intermittent service typical of a crystal calibrator. It also could be mounted in a communications receiver. In vacuum-tube receivers, enough power for proper operation can generally be obtained from the cathode of the audio output tube.

For calibrator use at high frequencies, a small capacitor should be used between the marker generator and the receiver. **R-E**

*Motorola Semiconductor Products, Inc.

BUILD POWER

Exceptionally low quadraphonic amplifier. story with additional

THE TIGER *.01* AMPLIFIER IS THE RESULT OF MY LATEST *efforts to produce a better power amplifier by reducing distortion to a new low. It is a 4-channel unit with four completely separate power amplifiers, each delivering up to 60 watts sinewave continuous power into an 8-ohm load. This story began in last month's issue.*

It would be well to mention at this point that although the circuit is well supplied with limiting resistors and volt-amp protection in the output stage, it is still quite possible to "zortch" the outputs if rf signals are allowed to get into the amplifier. To provide good square-wave response out to 20,000 Hz, the bandwidth of the amplifier must be made 300 to 500,000 Hz. This is all well and good, but the output transistor efficiency becomes very poor after about 30,000 to 50,000 Hz due to storage-time effects in these devices.

As long as the input is an audio-range frequency there is no problem, but if higher frequencies are fed into the amplifier the output transistors will *both* be on to some extent for a considerable portion of each cycle. This is just like shorting the positive supply to the negative supply by turning on both output transistors. The effect is called "mutual conductance" and as you can imagine it causes considerable heating of the output transistors. If you want the superior transient response that you get with this kind of bandwidth, you just have to be careful about this kind of thing.

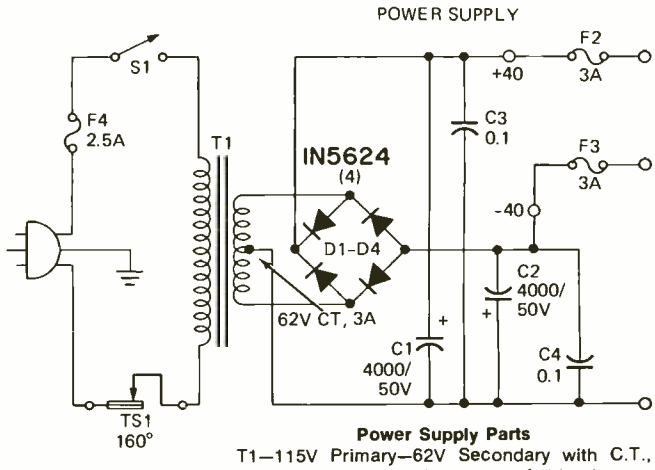
Packing and construction

Since stereo is now almost universal in home music system and the trend seems to be to four channels, the *Tiger .01* package is designed to be used in anything from a single unit to four or more channels by simply adding the new channels as needed and replacing the outer trim portion of the case. The front panel is quarter-rack size, so four of these can be mounted side by side in a standard 19-inch relay rack. Each amplifier is complete with it's own separate power supply, so there is no reduction in power when all channels are driven to full output and absolutely no interaction, or crosstalk. The meter to monitor output level makes it very simple to balance the complete system and gives you a good idea of what level you can operate at before you are likely to begin clipping peaks and running into excessive distortion, no matter what the speaker efficiency may be.

The majority of the parts are mounted on circuit boards to insure proper operation, and make construction simple. The rectifiers are mounted on a small circuit board that attaches directly to the lugs on the filter capacitors. The meter circuit parts are mounted on another small circuit board that attaches to the meter terminals. The amplifier parts are mounted on the main circuit board in the positions shown on the board layout. The output transistors are of course mounted to the heat sink along with sensing diode D/4.

The heat sink consists of two "Wakefield" type 641K sinks drilled so that they may be mounted back-to-back. In this way enough square inches of heat sink can be obtained to safely operate the circuit at full rated power continuously with no overheating problems. A 160° thermostat is mounted just below the heat sink just in case the amplifier is used in a cabinet, or location that does not have sufficient air circulation. This thermostat turns off the amplifier and turn on the overheat indicator lamp on the front panel if the amplifier gets too hot for further safe operation.

Construction should be no problem if the layout system shown in the photographs is used. The various parts that mount on the chassis should be installed first and the supply wired. The power supply can be tested for proper output voltage at this point. The no load dc output voltage should be in the order of ±45 volts with normal line voltage. The meter and its circuit board and the meter illumination lamps should be installed next. The heat sinks are attached to the mounting bracket with the same screws that hold the power transistors in place. Use an insulating mica, or similar washer under the transistor cases and insulating washers under the nuts on the mounting screws. Use a thin coat of heat sink compound on each side of the washer



POWER SUPPLY for one channel. Individual supplies contribute to the overall performance of the amplifier.

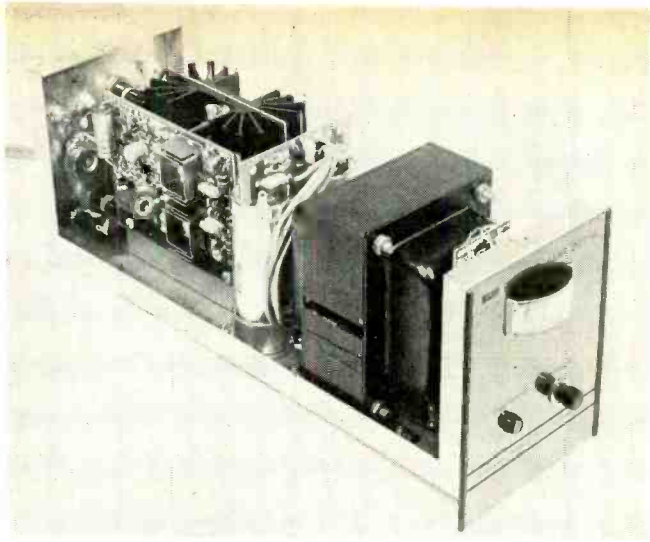
Power Supply Parts

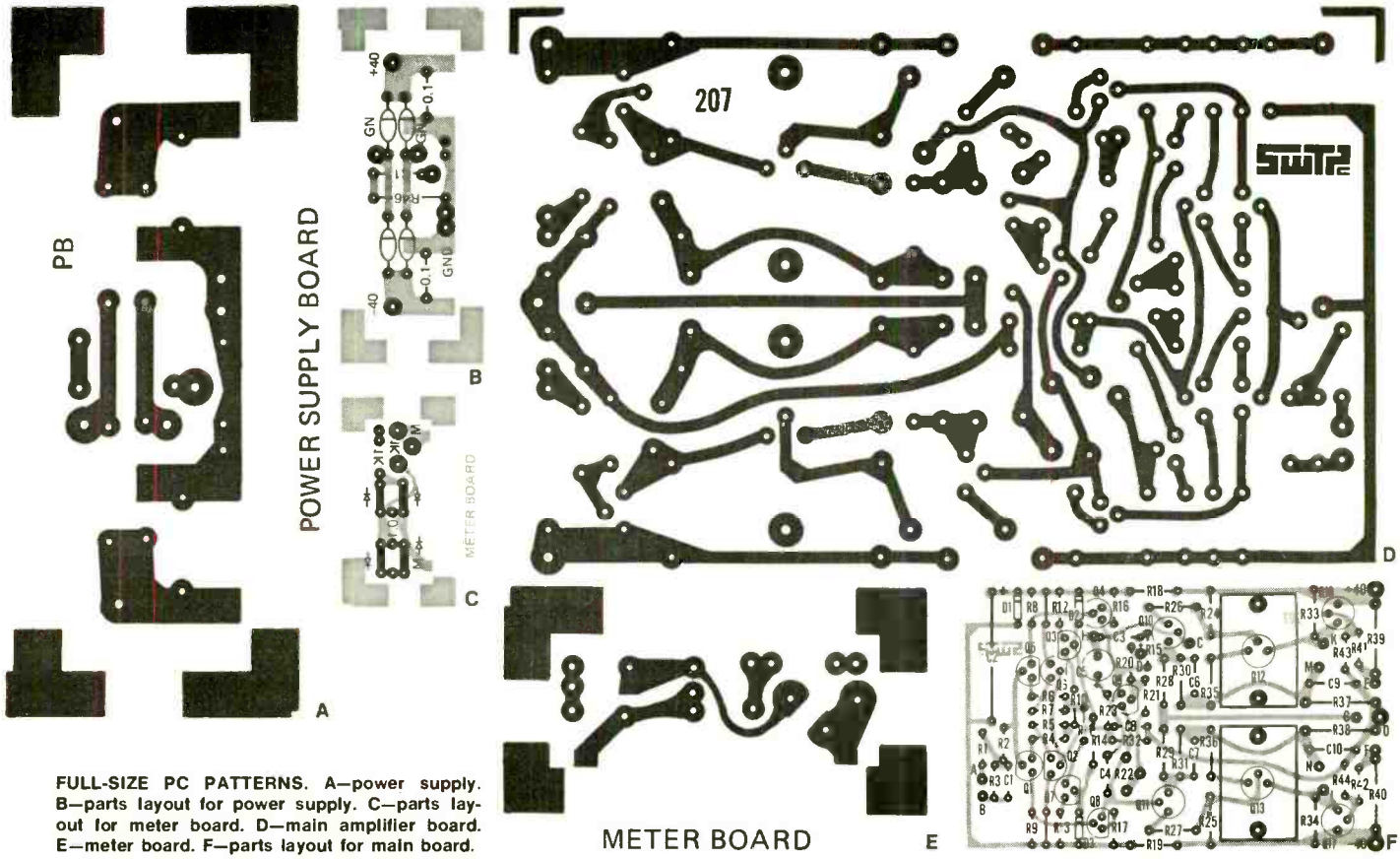
T1—115V Primary—62V Secondary with C.T., 3A rms, 5% regulation zero to full load
C1, C2—4,000 μF, 50 Vdc
D1 thru D4—200V 3.0A 1N5624 or equal
S1—Push-push switch, 6.0A 125 Vac
TS1—160° Thermal Cutoff "Elmwood Sensors"
C3, C4—0.1-μF 250-V film

4-CHANNEL AMPLIFIER

distortion is a feature of this
This month we conclude the
construction details.

by DANIEL MEYER





FULL-SIZE PC PATTERNS. A—power supply. B—parts layout for power supply. C—parts layout for meter board. D—main amplifier board. E—meter board. F—parts layout for main board.

and on the heat sink surfaces where they contact the mounting bracket.

Base and emitter connections are made to the output transistors with pins removed from a miniature tube socket with insulating tubing over the pins. Mount the bracket with the sink and output transistors in the chassis. Install the parts on the main circuit board and solder them in place. Pull everything except the plastic transistors down firmly against the circuit board before soldering and trim the excess lead length on the etched side. Mount the board on the bracket after all input connections and connecting point **"O"**.

Do not connect the output transistors to the board yet. Connect the bias diode leads to points **"C"** and **"D"** after the board is mounted to the bracket. Attach your voltmeter to the output terminals and put it on the 10 to 15-volt scale dc, whatever is close. Install the positive and negative supply fuses and the output fuse. Plug in the line cord and turn on the switch. If there is any noticeable reading on the meter after the initial turn-on transients, or any obvious overheating of a part turn the amplifier off and start troubleshooting. If all looks normal so far you can apply an input signal and check for proper amplification.

Q12 and Q13 can provide a few hundred milliwatts of power without the output transistors which should be enough to tell if operation is correct. If it is going right so far, turn off power and connect the output transistors. Turn the bias trimmer to *maximum* resistance, connect an 8.0-ohm load and apply power again. Connect A dc voltmeter across either R37 or R38 and adjust the bias trimmer for a reading of slightly less than 20 mV. This will set the output stage for an idle current of around 50 mA. which is close to optimum.

If you have a sensitive IM analyzer with a .1% full scale range, you can adjust the bias for minimum distortion with a power output of 1 to 3 watts. Watch the meter on the front panel while testing and adjusting and if at any time the reading jumps up, or shows an output when you

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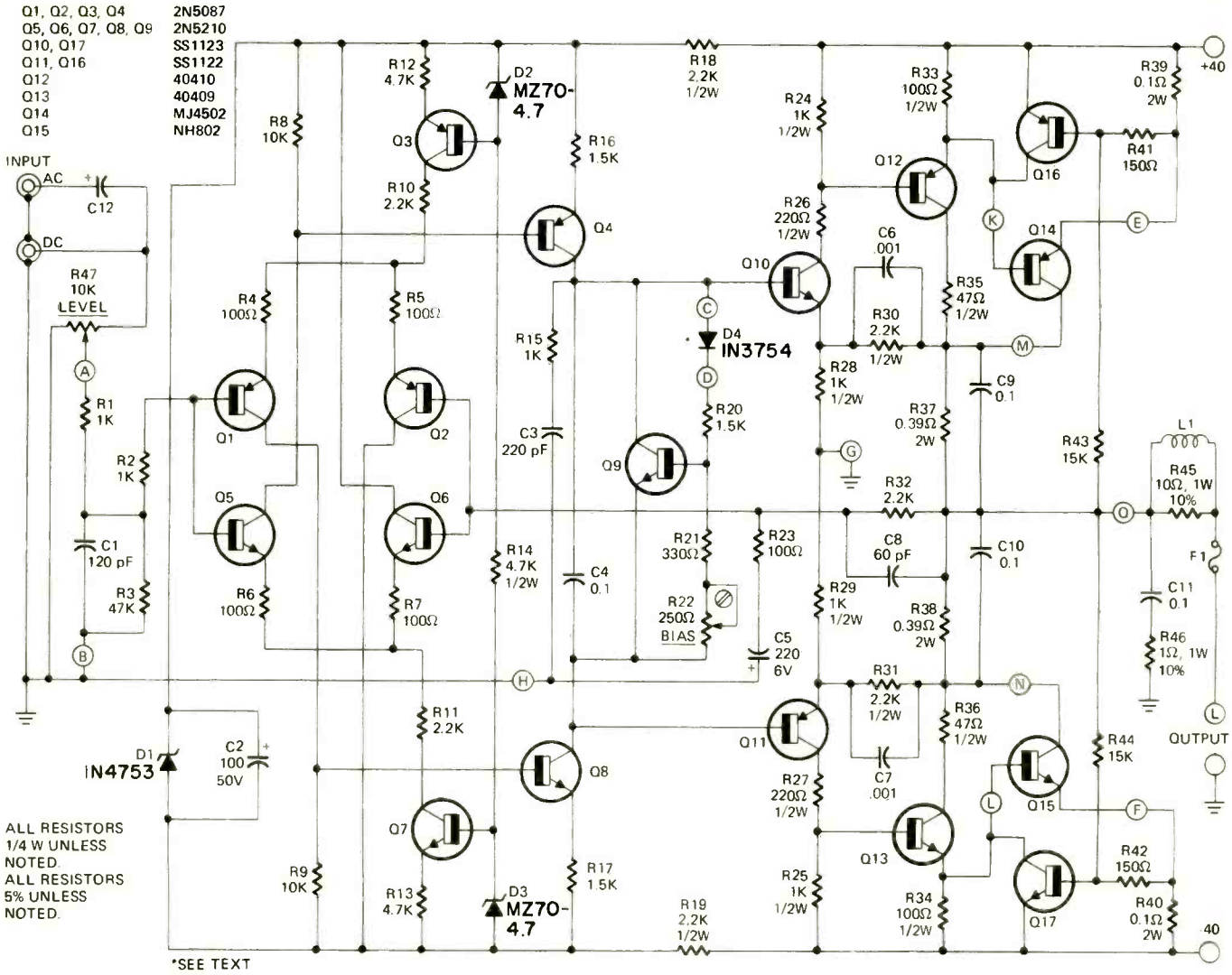

PARTS LIST—POWER AMPLIFIER

All resistors 5%, unless noted:
R1, R2, R15—1000 ohms ¼ watt
R3—47,000 ohms ¼ watt
R4, R5, R6, R7, R23—100 ohms ¼ watt
R8, R9—10,000 ohms ¼ watt
R10, R11, R32—2200 ohms ¼ watt
R12, R13—4700 ohms ¼ watt
R14—4700 ohms ½ watt
R16, R17, R20—1500 ohms ¼ watt
R18, R19, R30, R31—2200 ohms ½ watt
R21—330 ohms ¼ watt
R22—250 ohms, trimmer
R24, R25, R28, R29—1000 ohms ½ watt
R26, R27—220 ohms ½ watt
R33, R34—100 ohms ½ watt
R35, R36—47 ohms ½ watt
R37, R38—0.39 ohms 2 watt
R39, R40—0.1 ohms 2 watt
R41, R42—150 ohms ¼ watt
R43, R44—15,000 ohms ¼ watt
R45—10 ohms 1 watt 10% resistor
R46—1 ohm 1 watt 10% resistor
R47—10,000 ohms linear potentiometer

Miscellaneous parts
L1—Single layer of wire close wound on body of resistor R45
F1, F2, F3—3-amp standard fuse
F4—2.5-amp slow-blow fuse
T1—62 Vac C.T. 3A secondary 117 Vac primary
LM1—NE-2 neon lamp
The following are available from: Southwest Technical Products Corp. Box 32040, 219 W. Rhapsody San Antonio, Texas 78284
No. 207-b Circuit board for single channel of the "Tiger .01" Amplifier $2.65 postpaid
No. 207-C Complete Kit of parts for single channel of the "Tiger .01" Amplifier including chassis and cover. $75.00 plus postage for 15 lbs and insurance if desired

Meter Parts
0-20 mA meter
1N914 Rectifiers (4)
.1-μF capacitor
1000 ohms trimmer resistor
1000 ohms ¼-watt resistor

Capacitors
C1—120-pF polystyrene
C2—100-μF 50Vdc electrolytic
C3—220-pF polystrene
C4, C9, C10, C11—0.1-μF mylar
C5—220-μF 6Vdc electrolytic
C6, C7—0.001-μF 10% discap
C8—60-pF polystrene
C12—4.7-μF tantalum

Semiconductors
D1—36-volt 1-watt Zener 1N4753 or equal
D2, D3—4.7-volt 400-mW Zener MZ70—4.7 or equal
D4—1N3754 compensating diode
Q1, Q2, Q3, Q4—2N5087 silicon
Q5, Q6, Q7, Q8, Q9—2N5210 silicon
Q10, Q17—SS1123 silicon
Q11, Q16—SS1122 silicon
Q12—40410 silicon
Q13—40409 silicon
Q14—MJ4502 silicon
Q15—MJ802 silicon

have no input; **STOP** quickly and check for circuit oscillation. With luck such a condition may blow the fuses, but it can also fry the outputs so don't allow such a condition to continue if it is found. The *Tiger .01* should be quite stable if built and wired as shown, but any amplifier with this kind of gain, feedback and bandwidth can cause you lots of ulcers and heartburn if wire routing and grounding are not properly done.

Using your amplifier

Listening test show that builders of this amplifier will need systems in which all other components are the best available to really appreciate the quality of this amplifier. If possible, listen to some recordings with extended high-frequency response on a wide-range electrostatic speaker system. The beautiful transient response and the smooth, effortless way in which highs are reproduced with no sign of strain, or roughness is unreal. The bass response is limited by the speaker system characteristics. The amplifier will handle material far lower than any known speaker will go. Only time will tell, but all indications are that the *Tiger .01* circuit will be another of those large steps forward in the development of quality audio amplifiers. Try it, you'll like it! **R-E**

R-E's Substitution Guide for replacement transistors

compiled by ROBERT & ELIZABETH SCOTT

R-E's Transistor Substitution Guide is a compilation of material abstracted from the substitution guides of eight leading semiconductor manufacturers and distributors. These are:

ARCH—Indicates the Archer brand of semiconductors sold only by Radio Shack and Allied Radio stores. Allied Radio Shack, 2725 W. 7th St., Ft. Worth, Texas 76107

G-E—General Electric Co., Tube Product Div., Owensboro, Ky. 42301

IR—International Rectifier, Semiconductor Div., 233 Kansas St., El Segundo, Calif. 90245

MAL—Mallory Distributor Products Co., 101 S. Parker, Indianapolis, Ind. 46201

MOT—Motorola Semiconductors, Box 2963, Phoenix, Ariz. 85036

RCA—RCA Electronic Components, Harrison, N.J. 07029

SPR—Sprague Products Co., 65 Marshall St., North Adams, Mass. 01247

SYL—Sylvania Electric Corp., 100 1st Ave., Waltham, Mass. 02154

Radio-Electronics has done its utmost to insure that the listings in this directory are as accurate and reliable as possible; however, no responsibility is assumed by Radio-Electronics for its use. We have used the latest manufacturers material available to us and have asked each manufacturer covered in the listing to check its accuracy. Where we have been supplied with corrections, we have updated the listing to include them. The first part of this Guide appeared in March 1973.

	ARCH	G-E	IR	MAL	MOT	RCA	SPR	SYL
2N226	RS276-2005	GE-2	IRTR-85	PTC 135	HEP-254	SK 3004	RT-121	ECG 102A
2N227	RS276-2005	GE-2	IRTR-85	PTC 135	HEP-254	SK 3004	RT-121	ECG 102A
2N228	RS276-2001	GE-8	TR-08	PTC 108	HEP-641	SK 3010	RT-122	ECG 103A
2N229	RS276-2001	GE-8	TR-08	PTC 134	HEP-641	SK 3010	RT-122	ECG 103A
2N230	RS276-2006	GE-3	TR-01	PTC 102	HEP-232	SK 3009	RT-124	ECG 104
2N231	RS276-2005	GE-9	IRTR-89	PTC 107	HEP-636	SK 3008	NA	ECG 126
2N232	RS276-2003	GE-9	IRTR-89	PTC 107	HEP-3	SK 3008	NA	ECG 160
2N233	RS276-2002	GE-5	TR-08	PTC 108	HEP-641	SK 3011	RT-122	ECG 103A
2N234	RS276-2006	GE-3	TR-01	PTC 105	HEP-230	SK 3009	RT-127	ECG 121
2N235	RS276-2006	GE-3	TR-01	PTC 105	HEP-230/232	SK 3009	RT-127	ECG 121
2N236	RS276-2006	GE-3	TR-01	PTC 114	HEP-232	SK 3009	RT-127	ECG 121
2N237	RS276-2005	GE-2	IRTR-85	PTC 109	HEP-254	SK 3004	RT-120	ECG 102
2N238	RS276-2007	GE-2	IRTR-85	PTC 107	HEP-631	SK 3003	RT-121	ECG 102A
2N240	RS276-2003	GE-9	IRTR-89	PTC 107	HEP-3	SK 3008	NA	ECG 160
2N241	RS276-2003	GE-2	IRTR-85	PTC 109	HEP-632	SK 3004	RT-120	ECG 102
2N242	RS276-2006	GE-3	TR-01	PTC 105	HEP-230/232	SK 3009	RT-124	ECG 104
2N243	NA	GE-18	IRTR-63	PTC 125	NA	NA	NA	NA
2N244	NA	GE-18	IRTR-63	PTC 125	NA	NA	NA	NA
2N245	NA	GE-63	IRTR-63	PTC 117	NA	NA	NA	NA
2N246	NA	GE-63	IRTR-63	PTC 117	NA	NA	NA	NA
2N247	RS276-2005	GE-1	IRTR-89	PTC 107	HEP-638	SK 3007	NA	ECG 126
2N248	RS276-2003	GE-9	IRTR-89	PTC 107	HEP-3	SK 3007	NA	ECG 126
2N249	RS276-2004	GE-2	IRTR-85	PTC 102	HEP-253	SK 3005	RT-118	ECG 100
2N250	RS276-2006	GE-3	TR-01	PTC 105	HEP-230/232	SK 3009	RT-124	ECG 104
2N251	RS276-2006	GE-3	TR-01	PTC 114	HEP-232	SK 3009	RT-127	ECG 121
2N252	RS276-2014	GE-1	IRTR-89	PTC 107	HEP-639	SK 3005	NA	ECG 126
2N253	RS276-2001	GE-7	TR-08	PTC 108	HEP-641	SK 3011	RT-119	ECG 101
2N254	RS276-2001	GE-7	TR-08	PTC 108	HEP-641	SK 3011	RT-119	ECG 101
2N255	RS276-2006	GE-3	TR-01	PTC 122	HEP-230	SK 3009	RT-124	ECG 104
2N256	RS276-2006	GE-3	TR-01	PTC 122	HEP-230	SK 3009	RT-124	ECG 104
2N257	RS276-2006	GE-3	TR-01	PTC 122	HEP-230/232	SK 3009	RT-124	ECG 104
2N262	RS276-2004	GE-1	IRTR-85	PTC 102	HEP-253	SK 3005	RT-118	ECG 100
2N263	RS276-2009	GE-17	IRTR-95	PTC 132	HEP-53	SK 3039	RT-113	ECG 108
2N264	RS276-2009	GE-11	IRTR-95	PTC 132	HEP-53	SK 3039	RT-113	ECG 108
2N265	RS276-2003	GE-2	IRTR-85	PTC 109	HEP-632	SK 3003	RT-120	ECG 102
2N266	RS276-2004	GE-2	IRTR-85	PTC 102	HEP-253	SK 3004	RT-120	ECG 102
2N267	NA	GE-1	IRTR-89	PTC 109	HEP-2	SK 3005	NA	ECG 160
2N268	RS276-2006	GE-3	TR-01	PTC 105	HEP-232	SK 3009	RT-127	ECG 121
2N269	RS276-2003	GE-1	IRTR-89	PTC 109	HEP-3	SK 3005	NA	ECG 160
2N270	RS276-2006	GE-2	IRTR-85	PTC 135	HEP-632	SK 3004	RT-120	ECG 102
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2N277	NA	GE-4	TR-03	PTC 106	HEP-231	SK 3012	NA	ECG 105
2N278	NA	GE-4	TR-03	PTC 106	HEP-231/233	SK 3012	NA	ECG 105
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2N283	RS276-2005	GE-2	IRTR-85	PTC 109	HEP-254	SK 3003	RT-121	ECG 102A
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2N286	RS276-2005	NA	IRTR-89	PTC 131	HEP-636	NA	NA	ECG 160
2N289	NA	NA	IRTR-89	NA	NA	NA	NA	NA
2N290	NA	GE-4	TR-03	PTC 106	HEP-233	SK 3012	RT-124	ECG 104
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2N297	RS276-2006	GE-3	TR-01	PTC 122	HEP-232	SK 3009	RT-127	ECG 121
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2N300	RS276-2003	GE-9	IRTR-89	PTC 107	HEP-3	SK 3006	NA	ECG 160
2N301	RS276-2006	GE-3	TR-01	PTC 114	HEP-230/232	SK 3009	RT-127	ECG 121
2N302	RS276-2005	GE-2	IRTR-85	PTC 102	HEP-254	SK 3003	RT-118	ECG 100
2N303	RS276-2005	GE-2	IRTR-85	PTC 102	HEP-254	SK 3003	RT-120	ECG 102
2N306	RS276-2001	GE-8	TR-08	PTC 108	HEP-641	SK 3010	RT-122	ECG 103A
2N307	RS276-2006	GE-3	TR-01	PTC 114	HEP-230	SK 3009	RT-127	ECG 121
2N308	RS276-2005	GE-1	IRTR-85	PTC 107	HEP-638	SK 3007	RT-118	ECG 100
2N309	RS276-2005	GE-1	IRTR-85	PTC 107	HEP-638	SK 3007	RT-118	ECG 100
2N310	RS276-2005	GE-2	IRTR-85	PTC 109	HEP-636	SK 3007	RT-120	ECG 102
2N311	RS276-2003	GE-1	IRTR-85	PTC 109	HEP-2	SK 3005	RT-118	ECG 100
2N312	RS276-2002	GE-6	TR-08	PTC 108	HEP-641	SK 3011	RT-119	ECG 101
2N313	RS276-2002	GE-7	TR-08	PTC 108	HEP-641	SK 3011	RT-119	ECG 101
2N314	RS276-2002	GE-7	TR-08	PTC 108	HEP-641	SK 3011	RT-119	ECG 101
2N315	RS276-2004	GE-1	IRTR-85	PTC 109	HEP-253	SK 3005	RT-118	ECG 100
2N316	RS276-2003	GE-1	IRTR-89	PTC 109	HEP-2	SK 3005	RT-120	ECG 160
2N317	RS276-2003	GE-1	IRTR-85	PTC 109	HEP-2	SK 3005	RT-118	ECG 100
2N318	NA	NA	IRTR-89	PTC 109	NA	NA	NA	ECG 126
2N319	RS276-2007	GE-2	IRTR-85	PTC 109	HEP-631	SK 3003	RT-120	ECG 102
2N320	RS276-2004	GE-2	IRTR-85	PTC 109	HEP-250	SK 3003	RT-120	ECG 102

Note: NA = Not Available

	ARCH	G-E	IR	MAL	MOT	RCA	SPR	SYL
2N321	RS276-2005	GE-2	IRTR-85	PTC 109	HEP-254	SK 3003	RT-120	ECG 102
2N322	RS276-2005	GE-2	IRTR-85	PTC 102	HEP-254	SK 3003	RT-120	ECG 102
2N323	RS276-2005	GE-2	IRTR-85	PTC 102	HEP-254	SK 3004	RT-120	ECG 102
2N324	RS276-2005	GE-2	IRTR-85	PTC 109	HEP-254	SK 3003	RT-120	ECG 102
2N325	RS276-2006	GE-3	TR-01	PTC 122	HEP-230	SK 3009	RT-124	ECG 104
2N326	NA	NA	IRTR-91	NA	NA	NA	NA	NA
2N327	NA	GE-2	IRTR-85	PTC 103	NA	SK 3005	RT-118	ECG 100
2N328	NA	GE-2	IRTR-88	PTC 103	NA	SK 3025	RT-115	ECG 129
2N329	RS276-2021	GE-2	IRTR-88	PTC 103	HEP-739	SK 3025	RT-115	ECG 129
2N330	NA	GE-2	IRTR-88	PTC 103	NA	SK 3025	RT-115	ECG 129
2N331	RS276-2005	GE-2	IRTR-89	PTC 102	HEP-254	SK 3008	NA	ECG 160
2N332	RS276-2009	GE-20	TR-21	PTC 132	HEP-53	SK 3020	RT-100	ECG 123
2N333	RS276-2009	GE-20	TR-21	PTC 132	HEP-53	SK 3020	RT-100	ECG 123
2N334	RS276-2009	GE-20	TR-21	PTC 132	HEP-53	SK 3020	RT-100	ECG 123
2N335	RS276-2009	GE-20	TR-21	PTC 132	HEP-53	SK 3020	RT-100	ECG 123
2N336	RS276-2009	GE-20	TR-21	PTC 132	HEP-53	SK 3020	RT-100	ECG 123
2N337	RS276-2009	GE-17	IRTR-95	PTC 132	HEP-53	SK 3039	RT-108	ECG 107
2N338	RS276-2009	GE-20	TR-21	PTC 132	HEP-53	SK 3020	RT-100	ECG 123
2N339	NA	NA	TR-25	PTC 117	NA	NA	NA	NA
2N340	NA	NA	IRTR-87	PTC 117	HEP-713	SK3122	NA	NA
2N341	NA	NA	IRTR-87	PTC 117	HEP-712	SK3104	NA	NA
2N342	NA	NA	IRTR-87	PTC 117	HEP-S0007	SK3122	NA	NA
2N343	NA	NA	IRTR-87	PTC 117	HEP-S0007	SK 3024	RT-114	ECG 128
2N344	RS276-2003	GE-9	IRTR-89	PTC 107	HEP-3	SK 3006	NA	ECG 126
2N345	RS276-2003	GE-9	IRTR-89	PTC 107	HEP-3	SK 3006	NA	ECG 126
2N346	RS276-2003	GE-9	IRTR-89	PTC 107	HEP-3	SK 3006	NA	ECG 126
2N347	NA	NA	NA	NA	HEP-713	NA	NA	NA
2N348	NA	NA	NA	NA	HEP-713	NA	NA	NA
2N349	NA	NA	NA	NA	HEP-S0007	NA	NA	NA
2N350	RS276-2006	GE-3	TR-01	PTC 122	HEP-230/232	SK 3009	RT-127	ECG 121
2N351	RS276-2006	GE-3	TR-01	PTC 114	HEP-230/232	SK 3009	RT-127	ECG 121
2N352	RS276-2006	GE-3	TR-01	PTC 114	HEP-232	SK 3009	RT-127	ECG 121
2N353	RS276-2006	GE-3	TR-01	PTC 114	HEP-232	SK 3009	RT-127	ECG 121
2N354	NA	NA	NA	NA	HEP-635	SK 3118	NA	NA
2N355	NA	NA	NA	NA	NA	SK 3118	NA	NA
2N356	RS276-2001	GE-7	TR-08	PTC 108	HEP-641	SK 3011	RT-119	ECG 101
2N357	RS276-2001	GE-6	TR-08	PTC 108	HEP-641	SK 3011	RT-119	ECG 101
2N358	RS276-2001	GE-6	TR-08	PTC 108	HEP-641	SK 3011	RT-119	ECG 101
2N359	RS276-2005	GE-2	IRTR-85	PTC 135	HEP-254	SK 3004	RT-120	ECG 102
2N360	RS276-2005	GE-2	IRTR-85	PTC 102	HEP-254	SK 3004	RT-120	ECG 102
2N361	RS276-2005	GE-2	IRTR-85	PTC 102	HEP-254	SK 3004	RT-120	ECG 102
2N362	RS276-2004	GE-2	IRTR-85	PTC 102	HEP-250	SK 3004	RT-120	ECG 102
2N363	RS276-2005	GE-2	IRTR-85	PTC 102	HEP-254	SK 3004	RT-120	ECG 102
2N364	RS276-2002	GE-8	TR-08	PTC 108	HEP-641	SK 3010	RT-122	ECG 103
2N365	RS276-2002	GE-8	TR-08	PTC 108	HEP-641	SK 3010	RT-122	ECG 103
2N366	RS276-2002	GE-8	TR-08	PTC 108	HEP-641	SK 3010	RT-122	ECG 103
2N367	RS276-2004	GE-2	IRTR-85	PTC 109	HEP-253	SK 3004	RT-120	ECG 102
2N368	RS276-2004	GE-2	IRTR-85	PTC 109	HEP-253	SK 3004	RT-120	ECG 102
2N369	RS276-2005	GE-2	IRTR-85	PTC 109	HEP-254	SK 3004	RT-120	ECG 102
2N370	RS276-2003	GE-9	IRTR-89	PTC 107	HEP-3	SK 3007	NA	ECG 126
2N371	RS276-2003	GE-9	IRTR-89	PTC 107	HEP-3	SK 3007	NA	ECG 126
2N372	RS276-2003	GE-9	IRTR-89	PTC 107	HEP-3	SK 3007	NA	ECG 126
2N373	RS276-2003	GE-9	IRTR-89	PTC 107	HEP-3	SK 3007	NA	ECG 126
2N374	RS276-2003	GE-9	IRTR-89	PTC 107	HEP-3	SK 3007	NA	ECG 126
2N375	RS276-2006	GE-3	TR-01	PTC 105	HEP-232	SK 3009	RT-124	ECG 104
2N376	RS276-2006	GE-3	TR-01	PTC 114	HEP-230/232	SK 3009	RT-124	ECG 104
2N377	RS276-2001	GE-5	TR-08	PTC 108	HEP-641	SK 3011	RT-119	ECG 101

	ARCH	G-E	IR	MAL	MOT	RCA	SPR	SYL
2N378	RS276-2006	GE-3	TR-01	PTC 105	HEP-230/232	SK 3009	RT-124	ECG 104
2N379	RS276-2006	GE-3	TR-01	PTC 105	HEP-230/232	SK 3009	RT-127	ECG 121
2N380	RS276-2006	GE-3	TR-01	PTC 105	HEP-230/232	SK 3009	RT-124	ECG 104
2N381	RS276-2005	NA	IRTR-85	PTC 135	HEP-254	SK 3004	RT-120	ECG 102
2N382	RS276-2005	GE-2	IRTR-85	PTC 135	HEP-254	SK 3004	RT-120	ECG 102
2N383	RS276-2005	GE-2	IRTR-85	PTC 135	HEP-254	SK 3004	RT-120	ECG 102
2N384	RS276-2003	GE-9	IRTR-89	PTC 102	HEP-639	SK 3007	NA	ECG 160
2N385	RS276-2002	GE-7	TR-08	PTC 108	HEP-641	SK 3011	RT-119	ECG 101
2N386	RS276-2006	GE-3	TR-01	PTC 114	HEP-232	SK 3009	RT-124	ECG 104
2N387	RS276-2006	GE-3	TR-01	PTC 114	HEP-232	SK 3009	RT-124	ECG 104
2N388	RS276-2001	GE-7	TR-08	PTC 108	HEP-641	SK 3011	RT-119	ECG 101
2N392	RS276-2006	GE-3	TR-01	PTC 105	HEP-232	SK 3009	RT-124	ECG 104
2N393	RS276-2003	GE-9	IRTR-89	PTC 107	HEP-3	SK 3008	NA	ECG 126
2N394	RS276-2005	GE-1	IRTR-85	PTC 109	HEP-254	SK 3005	RT-118	ECG 100
2N395	RS276-2005	GE-1	IRTR-85	PTC 109	HEP-254	SK 3005	RT-118	ECG 100
2N396	RS276-2005	GE-1	IRTR-85	PTC 109	HEP-254	SK 3005	RT-118	ECG 100
2N397	RS276-2003	GE-2	IRTR-85	PTC 102	HEP-2	SK 3005	RT-118	ECG 100
2N399	RS276-2006	GE-3	TR-01	PTC 114	HEP-230/232	SK 3009	RT-124	ECG 104
2N400	RS276-2006	GE-3	TR-01	PTC 114	HEP-230/232	SK 3009	RT-124	ECG 104
2N401	RS276-2006	GE-3	TR-01	PTC 114	HEP-230/232	SK 3009	RT-124	ECG 104
2N402	RS276-2004	GE-2	IRTR-85	PTC 102	HEP-253	SK 3003	RT-120	ECG 102
2N403	RS276-2004	GE-2	IRTR-85	PTC 102	HEP-253	SK 3003	RT-120	ECG 102
2N404	RS276-2021	GE-2	IRTR-85	PTC 135	HEP-739	SK 3004	RT-120	ECG 102
2N405	RS276-2004	GE-2	IRTR-85	PTC 109	HEP-250	SK 3003	RT-120	ECG 102
2N406	RS276-2004	GE-2	IRTR-85	PTC 109	HEP-250	SK 3003	RT-121	ECG 102-A
2N407	RS276-2004	GE-2	IRTR-85	PTC 109	HEP-250	SK 3003	RT-121	ECG 102-A
2N408	RS276-2004	GE-2	IRTR-85	PTC 109	HEP-250	SK 3003	RT-121	ECG 102-A
2N409	RS276-2003	GE-1	IRTR-85	PTC 107	HEP-3	SK 3005	NA	ECG 126
2N410	RS276-2003	GE-1	IRTR-85	PTC 107	HEP-3	SK 3005	NA	ECG 126
2N411	RS276-2003	GE-1	IRTR-85	PTC 107	HEP-3	SK 3005	NA	ECG 126
2N412	RS276-2003	GE-1	IRTR-85	PTC 107	HEP-3	SK 3005	NA	ECG 126
2N413	RS276-2004	GE-1	IRTR-85	PTC 109	HEP-253	SK 3005	RT-118	ECG 100
2N414	RS276-2003	GE-1	IRTR-85	PTC 109	HEP-635	SK 3005	RT-118	ECG 100
2N415	RS276-2003	GE-1	IRTR-85	PTC 109	HEP-2	SK 3005	RT-118	ECG 100
2N416	RS276-2003	GE-1	IRTR-85	PTC 109	HEP-2	SK 3005	RT-118	ECG 100
2N417	RS276-2003	GE-1	IRTR-85	PTC 109	HEP-2	SK 3005	RT-118	ECG 100
2N418	RS276-2006	GE-16	TR-01	PTC 105	HEP-232	SK 3009	RT-127	ECG 121
2N419	RS276-2006	GE-3	TR-01	PTC 114	HEP-230/232	SK 3009	RT-124	ECG 104
2N420	RS276-2006	GE-3	TR-01	PTC 105	HEP-232	SK 3009	RT-127	ECG 121
2N422	RS276-2005	GE-2	IRTR-85	PTC 109	HEP-254	SK 3003	RT-120	ECG 102
2N425	RS276-2004	GE-1	IRTR-85	PTC 135	HEP-253	SK 3005	RT-118	ECG 100
2N426	RS276-2004	GE-1	IRTR-85	PTC 135	HEP-253	SK 3005	RT-118	ECG 100
2N427	RS276-2004	GE-1	IRTR-85	PTC 102	HEP-2	SK 3005	RT-118	ECG 100
2N428	RS276-2004	GE-1	IRTR-85	PTC 109	HEP-2	SK 3005	RT-118	ECG 100
2N431	RS276-2009	GE-20	TR-21	PTC 123	HEP-50	SK 3124	RT-100	ECG 123
2N432	RS276-2009	GE-20	TR-21	PTC 123	HEP-50	SK 3124	RT-100	ECG 123
2N433	RS276-2009	GE-20	TR-21	NA	HEP-50	SK 3124	RT-100	ECG 123
2N435	NA	NA	NA	NA	HEP-2	NA	NA	NA
2N438	RS276-2001	GE-7	TR-08	PTC 108	HEP-841	SK 3011	RT-119	ECG 101
2N439	RS276-2001	GE-7	TR-08	PTC 108	HEP-641	SK 3011	RT-119	ECG 101
2N440	RS276-2001	GE-8	TR-08	PTC 108	HEP-641	SK 3011	RT-119	ECG 101
2N441	NA	GE-4	TR-03	PTC 106	HEP-231/233	SK 3012	NA	ECG 105
2N442	NA	GE-4	TR-03	PTC 106	HEP-231/233	SK 3012	NA	ECG 105
2N443	NA	GE-4	TR-03	PTC 106	HEP-233	SK 3012	NA	ECG 105
2N444	RS276-2001	GE-7	TR-08	PTC 108	HEP-641	SK 3011	RT-119	ECG 101
2N445	RS276-2001	GE-7	TR-08	PTC 108	HEP-641	SK 3010	RT-119	ECG 101
2N446	RS276-2001	GE-7	TR-08	PTC 108	HEP-641	SK 3011	RT-119	ECG 101

(continued next month)

R-E's Service Clinic

The Full Treatment

Logical troubleshooting is seldom a one-step affair

by JACK DARR
SERVICE EDITOR

THIS IS THE TALE OF A SERVICE job. Nothing really unusual about it, except for one mildly odd reaction. That's not why I want to talk about it. Rather, I want to use this to illustrate how the most "unusual" problems can be tracked down by the use of a logical series of tests, a good knowledge of the circuit actions and reactions (some of them exceedingly basic) and a plentiful supply of that quality known as "admirable determination" in our own kids and "damned bullheadedness" in those of the neighbors. Ordinarily, you won't have to go all the way through this whole series of tests. In this case, I did. That's the interesting part.

The subject was an RCA CTC-31 color TV. The raster came on, perfectly focused, good color, and plenty of brightness. It stayed on for *exactly* one minute from the time the picture appeared. Then, it dimmed, lost focus, pulled in from the sides, and disappeared. Turned off for not more than 30 seconds, it would faithfully *repeat* this, indefinitely.

Now here we go. Preliminary readings showed that both high-voltage and focus were dropping about 40% when the raster went out. Monitoring the 6JE6 cathode current showed it stayed normal at 200 mA with raster, but it dropped only about 10 MA when the raster went out. The scope showed full drive on the 6JE6 grid, and the grid voltage was fine. Neither of these changed at all when the trouble occurred.

Taking the easiest and most likely things first, I changed the horizontal output, damper, high-voltage rectifier, focus rectifier, and high-voltage regulator tubes. No help. Then I substituted deflection yoke and picture tube, with a test jig. Same thing. From here on, I went through a series of tests that would take too long, in detail. You'll find them listed in the table. In each one, the result was exactly the same; no change in the symptoms or the timing of the raster fading. Very uncanny!

1. **Replace** tubes; horizontal output, damper, high-voltage rectifier, high-voltage regulator, focus rectifier.
2. **Monitor** 6JE6 cathode current.
3. **Substitute** deflection yoke and picture tube using a test jig.
4. **Check** deflection yoke socket, wiring, plug.
5. **Scope** 6JE6 grid-drive waveform, read dc grid voltage.
6. **Disconnect** focus transformer from flyback.
7. **Substitute** horizontal efficiency coil, capacitors.
8. **Read** 6JE6 screen-grid voltage.
9. **Read** high-voltage regulator cathode current.
10. **Substitute** B + + rectifier.
11. **Substitute** .0022-μF capacitor in B + + .
12. **Check** screen controls, picture tube.
13. **Read** screen current.
14. **Check** vertical linearity control, on B + + .
15. **Disconnect** VDR in pincushion circuit.
16. **Check** arc-gap capacitors, screen circuits.
17. **Spray**-cool *everything* in sight.
18. **Read** picture tube cathode voltages.
19. **Read** picture tube grid voltages.
20. **Read** color difference-amplifier tube plate voltages.
21. **Read** dc voltage on kine-bias control.
22. **Check** difference-amplifier tube heaters.
23. **Read** blanker tube plate voltage.
24. **Read** blanker tube cathode voltage.
25. **Check** blanker tube.

Substituting a new 6GH8 for the blanker tube stopped the trouble. Putting the old one back made it go back to its one-minute dropout. I put the tube in the tube-tester. It would go up to full emission; in one minute it

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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.

dropped to zero. I repeated this test four or five times. This thing would make a marvelous electronic egg-timer. In the meantime, the set was playing merrily away without a bobble.

A very close examination of the tube, with a high-powered glass, showed an almost imperceptible lump on the cathode ribbon, from the base pin to the lower end of the cathode cylinder. Another tube didn't show this lump. It didn't look like a bad weld; I decided that it was a fatigue-crack in the ribbon, which opened up when the cathode had been heated for precisely that amount of time! Cooling, it closed again.

So, there it was. Elapsed total time, something like 2.5-3 hours. (With, I will admit, numerous coffee breaks!) Explanation: when the blanker cathode opened, it opened the dc path to ground for the circuit which determined the picture-tube grid voltages. When they went highly positive, the picture tube drew far more than normal beam-current. This overloaded the HV supply and pulled the voltages down to the point where the screen went dark.

This was a good fight, and I enjoyed it. It was also a lot of good practice in diagnosis! The checklist might be useful. If you want to clip it out and pin it up over the bench, it could help novice technicians remember how many things you have to check, to give a TV set "The Full Treatment"! Just remember what each action and reaction *means*, and what it's trying to tell you. With a large supply of patience, that's all you need!

R-E

reader questions

NO BLUE

I can't get any blue, in a Motorola TS-908 chassis. Green and red OK. Blue video drive checks out, picture tube seems to be OK. Tubes OK. How can I find what causes this? J.M., Detroit, Mich.

Well, "leave us analyze" for a bit. For one thing, let's see what *is* working! Your demodulators are OK, since you must have both red and blue to develop the green signal. So the trouble must be in some stage *after* the demodulators. This narrows it down considerably. In fact, there's only one stage left; the triode section of the 6BL8, the blue difference amplifier.

Since your voltages aren't too badly off, this trouble must be something that is breaking the *signal-path* for the blue, between the demods and the pix tube grid. Put a color-bar signal on the set, and then simply *follow* the characteristic blue signal waveform from the demods to the pix tube. Somewhere along the line, it'll stop!

ONE CHANNEL DEAD, RECORD ONLY

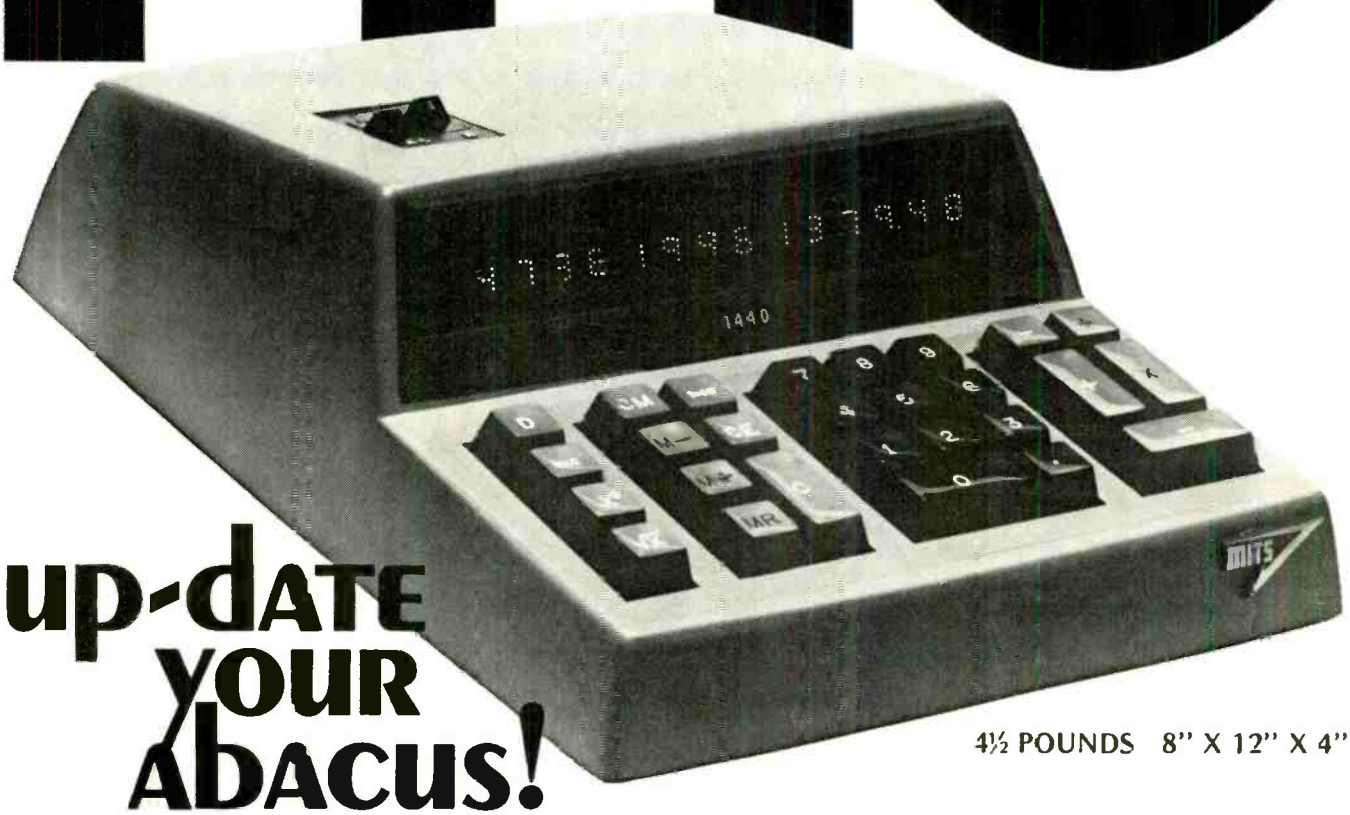
I've got an odd one on a Lafayette RK890A 8-track cartridge recorder. Playback and recording on the first 3 tracks, fine. However, when I record on the 4th track, the left channel is normal but the right channel is very low. The VU meter shows a low level on the bad one, while the other is OK. For a final weirdo, pre-recorded tapes play normally on the last track.—C.V., Bronx, N.Y.

OK: Wait'll I dust off the crystal ball, and here we go. To change tracks, you *move the heads* up and down, right? There is no electrical switching as far as the signal is concerned. Track 4 would probably be the one with the heads in the lowest position, or closest to the chassis.

From all of the symptoms, and especially the reaction of the *VU meter* (which is right across the head, in RECORD, and works normally on all of the other three channels) it looks very much as if you have a *short* to chassis

(continued on page 78)

1440



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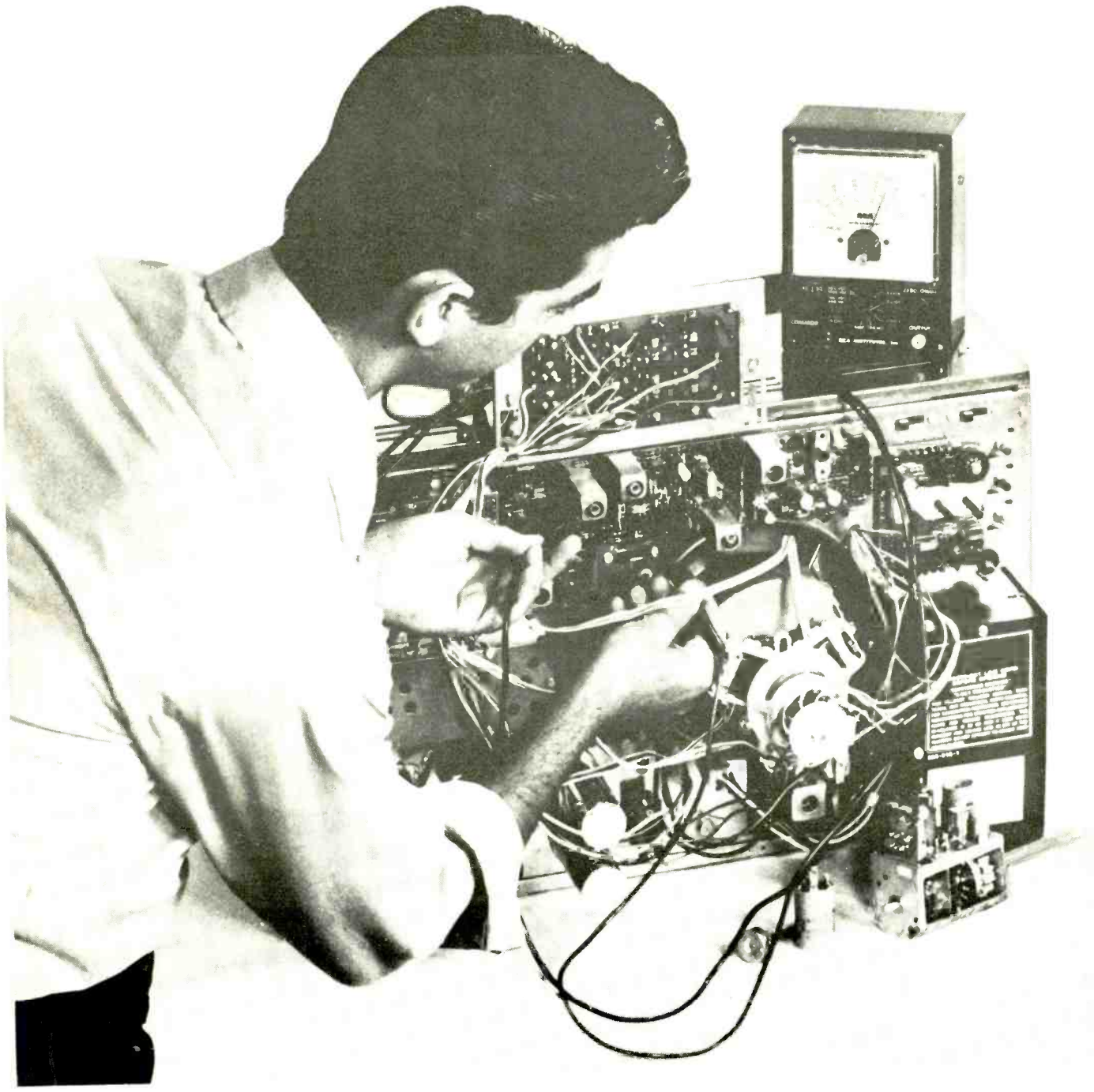

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when the head is in Ch. 4 position. The very small wires to the head may be rubbing on a sharp edge, or something.

Get a big magnifying glass and a strong light, and see if you can tell where this is taking place. You might try putting bits of plastic tape across any sharp metal edges near the wiring to the heads. Might even be able to verify this crystal-ball diagnosis with an ohmmeter on the head, moving it into Ch. 4 position manually.

HORIZONTAL JITTER ZENITH 25MC36

***I have an odd problem in a Zenith 25MC36. It has a distinct horizontal jitter; picture good, horizontal sync good, color fine, and everything else, but it jitters. By accident, I discovered that if the sound* was turned off, the jitter disappeared.—P.G., Mobile, Ala.**

Most likely cause, a loose *core* in the horizontal hold coil. I ran into one just like it quite a while ago. You can replace the coil, but you may be able to fix it by running the core all the way out, cutting a thin rubber band in two, and slipping it through the coil. Now, run the core back in, and the rubber-band will hold it tightly.

There is no electrical connection with the sound circuits. The actual sound (air movement) is making the coil vibrate, changing the horizontal frequency very slightly when the core moves.

REPLACEMENT TRANSISTORS

I need a set of output transistors, and a driver, for a Wards GHJ-949B stereo. The outputs are marked "SPS-0122" and "SPS-0121". The driver is "036-09800". There's some confusion in the parts list. The outputs are the flat-pack Case 152 types, but the replacements listed are TO-5. Do you have any data on these?—K.J., St. Paul, Minn.

RCA SK-3083 and SK-3054 would work for the output pair, and an SK-3025 would probably make a good driver. Cases match the originals. When you put in the new outputs, be sure to check the emitter resistors, bias diodes, and anything else that could have been damaged when the originals went out.

WEAK SYNC

I've got a sync problem in a Motorola TS-934A. Both vertical and horizontal sync are poor, and I don't have a heck of a lot of color sync, either. Waveforms around the sync-separator don't look too bad, but the collector voltage on the sync-separator transistor

(continued on page 80)

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Circle 18 on reader service card

(continued from page 78)

is only about half of what it should be. Agc action is funny, too.—J.S., Tyrone, N.Mex.

You may have "double trouble" here. First, check out that sync-separator stage. The collector voltage on this transistor is *developed* across the emitter resistor of the horizontal sync pulse shaper transistor. So, if this voltage is low, the sync-separator isn't drawing normal *current*. This could mean incorrect bias or a leaky transistor.

No. 2: note that you have a *set of symptoms* which could point to some trouble in the *video* signal; i.e., poor sync, poor color sync, poor agc. Since all of these stages rely on getting the correct video signal, as well as their dc voltages, this could be a "common cause".

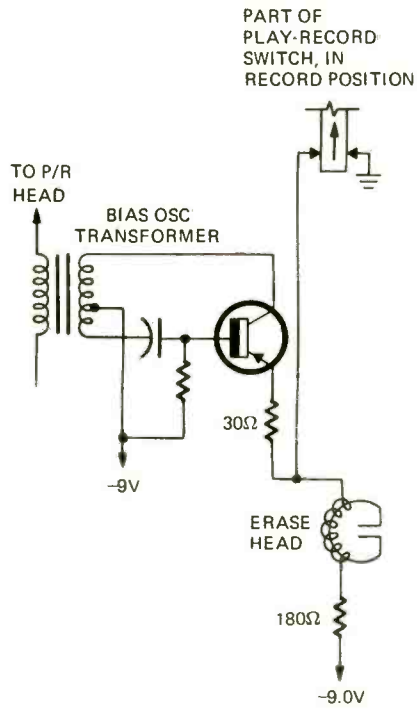
Check the peak-to-peak amplitude of the video signals on each of these stages. Then, if it isn't high enough, follow it back to the takeoff point. This is the collector of the chroma sync amplifier stage on the SA panel. If your *picture* is OK, the video stages themselves should be OK; then, there's only one stage between this and the sync-agc circuitry on the FA panel. (Check the No. 9 pin on the SA panel, and the interconnecting wiring to pin 6 of the FA panel, too.)

GARBLED RECORDING, PLAY OK

This Craig 2108 recorder will play pre-recorded tapes very well. On record, it garbles so badly that you can't use it. It won't erase, either. What could cause this?—J.B., Taylorville, Ill.

In this machine, they use dc bias for the erase head. The switch for this also grounds the emitter of the record-bias oscillator. Since the playback head is also used for recording, it would seem that this is OK: also the amplifier.

Check that part of the PLAY-RECORD switch. You can tell whether



it is working properly or not by reading the dc voltage on the bias-oscillator transistor emitter (see diagram). This should go down to -0.6 volt in RECORD if the switch is working properly. Check for bent contacts, etc or broken lugs or wires.

VIDEO DETECTOR BLOWS

I'm having trouble holding video detector diodes in a Motorola 551. They blow out about once a month. We've checked the i.f. transformer, and the whole circuit, and can't find any leakage which could cause this.—E.C., Milton, W.Va.

We went around once before with this problem, in a certain model of an old set. The answer in that case was the same as this; use a detector diode with a higher reverse voltage rating. We replaced the tiny glass diodes with a good old 1N34 or 1N70, which have

(continued on page 84)

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Circle 20 on reader service card

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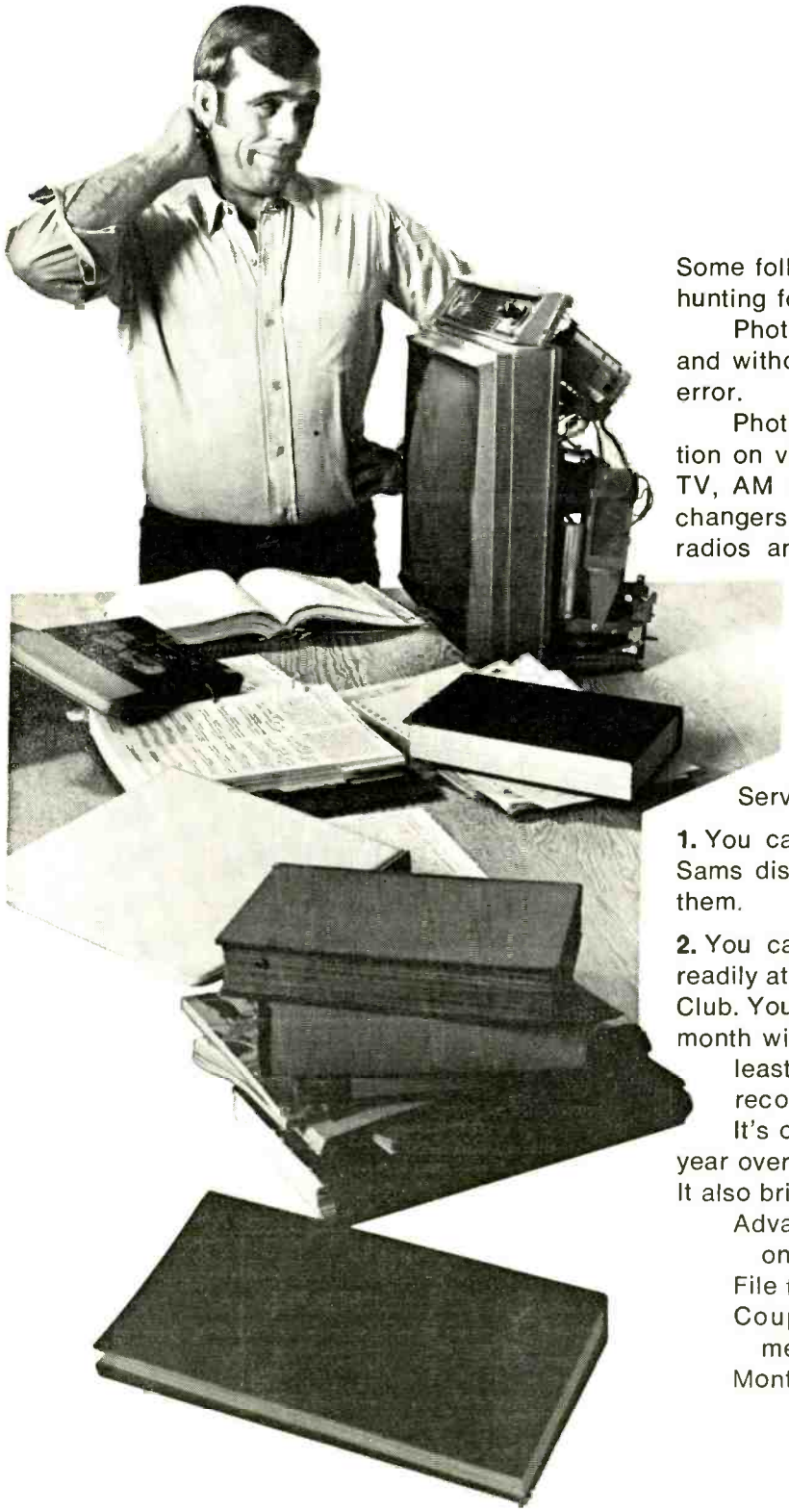

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Circle 21 on reader service card

a prV rating of 60 volts or more. These held up.

I have run into the same problem in some sets made for different companies by Sharp. Same cure. In these, the diode is in the last i.f. transformer can; a tight fit, but possible.

REALLY HIGH VOLTAGES

I've got an odd problem with a Zenith 23XC36. Boost-boost rectifier was burned out, and the 6HS5 tube dead. Replaced these, and got a picture. No color, but good picture. Now, when I checked voltages, I found that I was reading 2200-2400 volts on the 1200 volt B++ line, and 1200-1300 volts on the raw boost terminal. Everything I've checked so far in this area is good. What causes this?—J.S., Alhambra, Calif.

I know what I'd check first; my *voltmeter*. (That's not intended to be insulting; I've had the same thing happen to me.) Seriously speaking, if you really had voltages this high on the boost and boost-boost, your picture would *not* be good. It would probably be flaring so brightly that you couldn't even turn the brightness down enough. You'd have 2400 volts on the screens, for example.

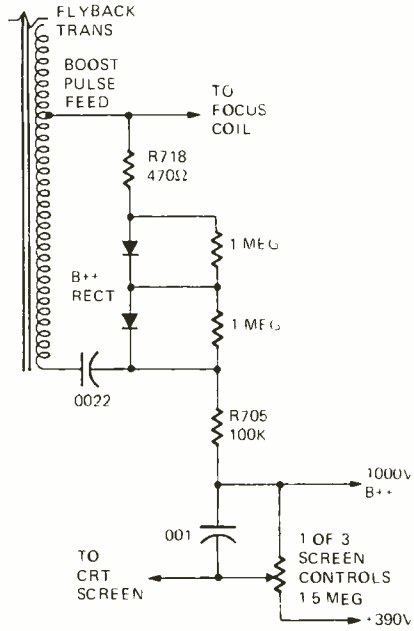
It *is* quite possible to get readings like this in certain cases. If you are using a very sensitive FETVM, or even vtvm, with an *unshielded* "hot lead", these instruments can pick up *pulses*, rectify them, and then add this to the actual dc voltage on the test point. There is a very high-intensity field all around the area where you were taking the readings: this is normal, around the base of the damper tube, yoke leads, and so on. I checked out a similar meter not too long ago, and got the same thing. By using a shielded lead to the hot probe, the problem was cleared up.

Try reading these voltages with a different voltmeter. I think things will look better.

NO BOOSTED BOOST

The boosted boost is very low on this Heath GR-295 color TV. I'm only reading about +700 volts instead of +1,000 volts. I've tried new rectifiers and the capacitors. R718 burned out; I replaced it and the new one gets hot and drops in value. I think this might be something in the flyback.—F.B., Lemoore, Calif.

Nope. Look at your major symptoms. You do have *normal input* to this circuit: the boost (with pulse). If



you did not, you wouldn't have enough power to burn up that resistor. So, from the symptoms, and the fact that the rectifiers and capacitors have been (rightly) replaced (see diagram), you've got an *overload* on the 1,000 volt line. *This* is burning up the 470-ohm resistor! Normally, there is very little current-flow in this circuit.

Check the bypass capacitors on the screen controls, and all wiring on the 1,000-V. line. These are the only load on it. **R-E**

appliance clinic

CLEAN UP THE CLEANER

by JACK DARR
SERVICE EDITOR

THE HOME VACUUM CLEANER IS A SIMple thing. Let it get out of order, though, and you've got troubles. So, let's see how to check one for proper operation.

All vacuum cleaners are alike. They have a fan, an electric motor to turn it, and a system of hose, ducts, a dust-bag, and a case to hold the thing together. That's all. To work as they should, they must have a free flow of air through all of these parts. Let it clog up, and you lose suction.

For a quick-check, turn it on and put the palm of your hand over the end of the hose. It should pull your hand against the hose with a solid "Thunk"! The motor will normally slow down just a little. The sound of the motor is a dandy clue; it should have a healthy howl. If it grunts and groans, and sounds as if it were pulling a heavy load, look out. Something is at least partially blocking one of the air-passages.

You've got several possibilities; the hose and staff (the long metal tube), the bag, and the housing itself. Eliminate the hose first; with the motor running, pull it out of the housing. If the motor suddenly speeds up and sounds free, the hose is clogged. You can plug it into the BLOW outlet on the other side of the housing. *Don't do this in the house!* If the dirt comes loose, you'll blow it all over the place and your name will literally be "Mud." Do it outside or in the garage.

If the hose is OK, check the bag. These are cloth or paper, but they must be porous so that the air can get out, while trapping the dust. If they have been used too long, the tiny pores may be stopped up. Try a new bag. If it's a cloth bag, turn it inside out, dump the dust, and then beat it as clean as possible.

If this doesn't get it, open the cleaner housing and check the filters, there will be at least one. These are small porous "discs" made of paper, cloth, or fine wire mesh, that are placed over the motor to stop fine dust that may get through the bag. If they're loaded with dust, either clean them or put in a new one. You may find another one, at the outlet opening of the housing. Same here; be sure that air can get through it.

In practically all modern cleaners, the air-flow goes *through* the motor itself. This is done to help cool it. The incoming air goes through the bag and the filter first, of course. In time, enough fine dust can get through and stick to the motor, to partially clog the air flow.

This can get worse, of course. In the "inside-bag" or tank cleaners, if the bag comes off the mounting clamp, all of the dirt will promptly go to the motor. This makes quite a mess, and stops the flow of air almost completely.

The cure is a thorough cleanup. The easiest way is to take the thing to the nearest filling-station and blow the dirt out with their high-pressure air-hose. Of course, if you have another cleaner, or a Shop-Vac, you can use it to clean this one up. A dry paint-brush is a good tool to get the dust out. If some of it has solidified, it can be very carefully dug out with a stick or small screwdriver. Be very careful not to gouge the motor windings, leads, etc. since these are exposed.

Most of the tank or canister-type cleaners have the motor mounted on a sheet-metal plate in the housing. If the motor isn't accessible when you open the case to change bags, you can get it out by taking out three or four small screws around the edge of the mounting plate. These are usually visible. If they're not, and the cleaner has a thick soft rubber gasket around the lip, lift the edge of this gasket and look under it; the mounting screws may be hidden under there.

'The older models needed oiling at infrequent intervals. Most of the newer ones have permanently-sealed bearings. Check the instruction book to make sure. Of course, if you can see a tiny hole in each end-bell of the motor, marked "Oil," that should tell you! About two drops of oil every six months is plenty. Don't over-oil; excess oil around the motor and fan will pick up dust and cake it everywhere.

(turn page)

Many units have enclosed fans; the air will come through the motor, then into the center of the impeller-type fan, and out of a duct on the rim. If you hear a clattering noise as the motor runs, take the cover off the fan, and see if the impeller is hitting the case, or what else may be wrong. Once in a while, dust will cake on the blades, and some of it may be thrown off, hitting the cover. If there is any accumulation on the blades, scrape it off. The dirt throws the fan off-balance.

As with everything else, I have a favorite prop story about vacuum cleaners. In the early '20's, I worked in St. Louis for an appliance dealer. I got a call to go see a little old German lady. When I got there, I found that she spoke practically no English. However, like all of us there at that time, I had a smattering of PlattDeutsch so we got along.

"Was ist los, Fran Schmitt?" I asked (1). "Meine Staubsanger is ausgeschpielten!" she said. (2) "Das is alles recht" I said. "Ich willst begebenst es." (3) She went to the closet and wheeled out a "stick" type vacuum cleaner, a Hoover, I think. One of the kind with a handle, and a large cloth bag. The bag looked suspiciously fat. I felt it—just like a sandbag!

With some difficulty, I lugged it out into the back yard, and got it off. There must have been 40 pounds of dust in it! I emptied it into the ashpit and went back. I hooked it up, and it howled happily. I cleaned up the dirt I'd spilled on the floor, and she beamed at me. "Ach, das is wunderbar!" (4)

I showed her how to take the bag off and empty it. She looked puzzled. I said "Was ist? Die verkaufer sollte gezeigt du" (5) "Nein, nein! Er zahlenst mir nichts!" (6) At any rate, now she was happy, and so was I. I went off happily munching on a big handful of Springerle. (It was near Christmas).

The moral of this, of course, is "read the instruction book", if the salesman doesn't show you how to run things. That's about all there is to it. Just make sure that the air going through it is truly free as the air, and you've got it made. **R-E**

Glossary:
1. What's the matter, Mrs. Smith?
2. My Vacuum cleaner is played out!
3. That's all right. I'll fix it.
4. Oh, that's wonderful!
5. What is this? Didn't the salesman show you how to do this?
6. No, no. He showed me nothing!

EQUIPMENT REPORT

(continued from page 32)

120 mV got us up to 42 MHz reliably.

Above 40 MHz sensitivity drops rapidly and that frequency represents the end of the usable range. We made our measurements driving the counter from a 50-ohm generator. If the counter is driven from higher impedances there will be an apparent decrease in sensitivity due to loading. The 1 megohm shunted by 20 pF input impedance along with the input cable capacitance becomes significant at the higher frequencies as the capacitive impedance gets lower.

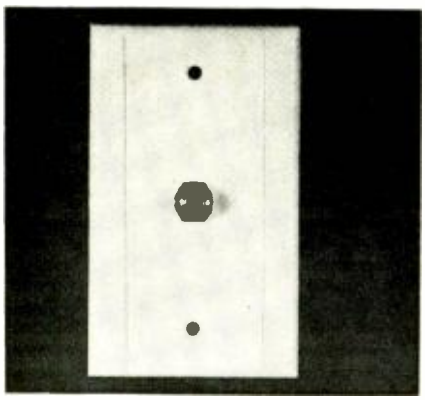
The stark simplicity of the front panel containing only an input connector, the on-off switch and the frequency range switch disguises the true power of the instrument. When switched to the kHz range a neon over-range indicator tells you the measured frequency is too high nudging you to switch to the higher scale. It does not mean that the readings are meaningless though since up to ten digit resolution is possible using only the five readout tubes when the frequency is above 100 kHz. The rightmost five significant digits can be read in the kHz position when the over-range lamp is lit.

Twenty-seven integrated circuits and 13 transistors are used to divide down from the 1-MHz temperature compensated crystal to generated the needed gate waveforms. Popular 7400 TTL series devices are used giving the builder assurance that inexpensive replacements are available. The transistors are used in the input shaping and amplifier circuitry, in the regulated power supply and for some of the gating functions. Two back-to-back diodes protect the input FET from large input swings with the maximum input limited to 150 volts rms below 100 kHz. Above 100 kHz derating of 48 volts per decade is specified. Three supply voltages of 5, 15.5 and 100 volts are used. 5 volts is used to power all of the IC logic and some of the transistors with the 15.5 volts reserved for the remaining transistors with the exception of the over-range lamp driver. This transistor is powered from the 100-volt supply through the indicator. Jumpers on the power transformer primary taps can be changed to allow a choice of 120 or 240 volts ac operation. Wire bail foldable legs are mounted on the case so the front can be tilted up for bench use.

The counter was a real convenience replacing make-do techniques previously used. The IB-1100 was put right to work to set the 32,768-Hz crystal oscillator frequency of the liquid-crystal digital clock that appears on page 38 in this issue. **R-E**

new products

82 CHANNEL TV OUTLET, *T-77A & T-77AB.* A no-loss feed-thru connector is attached to a telephone-type wall plate. Input and output connections are 75 ohms. Packed one to a preprinted bag



with 24 in a carton, plaster straps included; connectors and ferrules are not included.—**Winegard Company,** 3000 Kirkwood Street, Burlington, Iowa 52601.

Circle 31 on reader service card

TWO-WAY RADIO, *model 2000-35* is a type accepted 3-watt, 6-channel AM transceiver covering 25 to 30 MHz and is approved for both business and citizens services.

As the operator's needs grow, he

can add on one of the building blocks that consist of *P5900* tone calling accessory, *PX100* transmitter amplifier and *CB 9* monitor and *P5804A* power supply.—**Pathcom Inc.,** 24049 South Frampton Avenue, Harbor City, Calif. 90710.

Circle 32 on reader service card

STEREOTAPE HOME CONVERTERS *Model 12R900* is designed specifically for use with RCA's Q-8, 4-channel car tape player and makes it possible to use the unit in the home. The *Model 12R800* features a quick release mounting bracket as standard equipment. *Model 12R1000* can accommodate all other RCA car stereo players when they're equipped with the optional quick-release mounting bracket.

There are optional matching speaker sets, *Model 12R410* that feature a distributed port-reflex design and are internally damped. Two speaker sets are required

for the Q-8 12R800.—**RCA Parts and Accessories,** 2000 Clements Bridge Road, Deptford, N.J. 08096.

Circle 33 on reader service card

NOISE ELIMINATOR KIT helps eliminate alternator whine and ignition noise from car stereo tape players or FM radios. It is also effective for eliminating noise on CB radios, monitors and other auto radio installations.

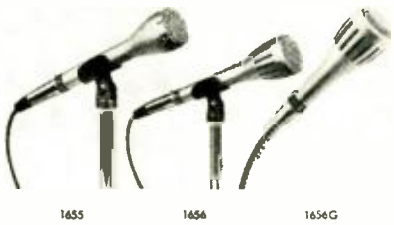
No special tools are needed to install the kit, which consists of a choke coil and capacitor. $1.69.—**Radio Shack,** 2617 West Seventh Street, Fort Worth, Texas 76107.

Circle 34 on reader service card

MICROPHONES. *Model 1656* cardioid dynamic microphone is ideally suited for live performances, broadcast and recording as well as general public address usage. The unit has a frequency response from 60 to 15,000 Hz. On-off switch is built into the handle. Unit mounts on a swivel stand adapter that is supplied.

Model 1656G cardioid dynamic microphone is designed for paging, cueing or talkback from control stations. It has a frequency response from 60 to 15,000 Hz and is internally threaded for mounting on a flexible gooseneck stand.

Model 1655 is a professional dynamic microphone with amni-directional pattern for outdoor applications. It has a



frequency response from 50 to 15,000 Hz.—**Altec Corporation,** 1515 South Manchester Avenue, Anaheim, Calif. 92803.

Circle 35 on reader service card

ANTENNA HARDWARE includes masts, chimney mounts, roof mounts, wall mounts, stand-off insulators, guy wires, anchor hooks, eye bolts, turnbuckles, lead-in clips lightning arrestors, ground rods, ground wire and twinlead. Except

for masts, the line is mounted on pegboard cards that provide complete installation instructions.—**Jerrold Electronics Corp.,** 401 Walnut Street, Philadelphia, Pa. 19105.

Circle 36 on reader service card

ALPHA CYANCACRYLATE ADHESIVE, *Instant Weld,* has a tensile strength up to,

5,000 lbs/in^2 in each drop.

Four formulas are available. *Red Label—101* for use when bonding any combination of plastic, rubber, ceramic or

glass; sets in 10-20 seconds. *Blue Label—102* for use when bonding same; sets in 45-60 seconds. *Yellow Label—747* for use when metal is one or both of the bonded components such as metal to plastic or metal to rubber, glass, etc.; sets in 30-45 seconds. *Green Label—240* holds porous and non-porous materials; sets in 60-120 seconds. Kit—$7.95.—**Oneida Electronics Mfg., Inc.,** 843 North Cottage Street, Meadville, Pa. 16335.

Circle 37 on reader service card

PORTABLE COLOR TEST JIG KITS includes cabinet and necessary components, but not picture tube. A patented yoke adapter is available for use in servicing various makes.

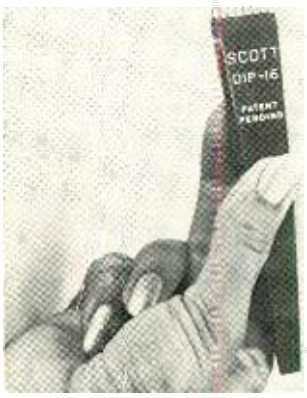
With color picture tube added and proper yoke adapter connected, each kit may be used to check any U.S. television set in the home. Enables rapid diagnosis of whether trouble is caused by picture tube, convergence board or chassis. It enables the technician to show the customer when a new picture tube is needed.

The new kit line includes four 15" models and one 19" model.—**Pix-O-Scope, Inc.,** 3311 Shelby Street, Indianapolis, Ind. 46227.

Circle 38 on reader service card

DIP IC TOOL *DIP-SERT/16* facilitates and speeds the manual insertion of 8- to 16-pin dual in-line packages in sockets and PC board mounting holes.

Unit is precision-molded of tough, durable plastic, weighs less than 1 oz. It grasps the DIP leads firmly, compresses



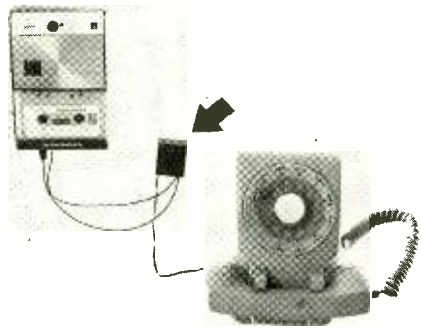
them uniformly to align with socket or PC board holes and provides firm, even insertion pressure.

(continued on page 96)

Can be used for mounting IC's, relays, resistors and other components housed in dual in-line packages. $2.98.—**Scott Industries,** Paramount Building, North Chelmsford, Mass. 01863.

Circle 39 on reader service card

TELE-SECRETARY is a telephone accessory that can be used with any telephone and standard portable tape recorder. It will start and stop your tape recorder every time your telephone is used. You have a permanent record of all telephone conversations. Is com-

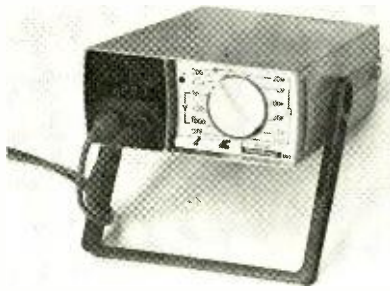


pletely self-contained, needs no batteries and connects to any point on your telephone line and will not interfere with normal telephone operation. $29.95.—**International Marketing & Manufacturing,** P.O. Box 1413, El Cajon, Calif. 92022.

Circle 40 on reader service card

PORTABLE DIGITAL MULTIMETER, *4442DMM* provides up to 12 hours of continuous operation and has an accuracy of .05%.

Twenty ranges cover 200 mV (100 μ V resolution) to 1,000 volts ac/dc, 200 ohms (0.1 ohm resolution) to 20 megohms, plus ac and dc current. Accessory plug-in shunts extend the ac and dc current ranges. Features include LED read-



outs, dual-slope high-impedance bipolar A/D converter, single MOS LSI plug-in chip for all of the logic circuitry, autopolarity, automatic blanking of unused digits, and overload protection. Unit comes with 4 nickel cadmium C cells and battery charger. $325.00.—**Weston Instruments, Inc.,** 614 Frelinghuysen Avenue, Newark, N.J. 07114.

Circle 41 on reader service card

WALL MOUNTED MATCHING TRANSFORMER *T-383* is ideal for MATV and home TV antenna systems where there are no strong local TV channels. Mounts in any electrical outlet box. It matches 75-ohm TV (or FM) receivers. Twinlead can be easily attached to convenient 300-ohm output terminal screws.

Insertion loss is only 0.6 dB at vhf and less than 1.0 dB over entire uhf spectrum. Vhf match is 14 dB and uhf match is 11 dB. Provides ac and dc blocking up to 500 volts.

Uses patented universal 659 bushing, capable of accepting any RG-59 or RG-6 size cables. $3.95.—**Jerrold Electronics Corp.** 401 Walnut Street, Philadelphia, Pa. 19105.

Circle 42 on reader service card

TELEPHONE RECORDER, *Tel-O-Cord* monitors two-way telephone conversations. The unit automatically records conversations by two parties on standard tape cassettes, but is activated only when the telephone receiver is manually removed from the hook. A beep tone sounds every 15 seconds to alert both

parties that the conversation is being recorded.

It can also be used as a tape recorder by using an external microphone.—**Craft Electronics, Inc.,** 830 Hempstead Turnpike, Franklin Square, N.Y.

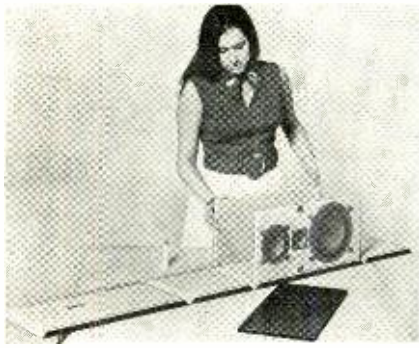
Circle 43 on reader service card

PREFABRICATED SPEAKER ENCLOSURES are designed to fold together in less than 12 minutes without tools, cutting, screws or nails. Will provide frequency response through the 10 to 25,000 Hz range.

The enclosures are assembled by laying out a single piece that forms the four sides. The speaker and rear terminal boards are then inserted into the grooves cut into these side panels and the sides are wrapped around the panels with the panels being held by matching

grooves on all four sides. The speakers are then mounted on the speaker board and the front grille pushed into place.

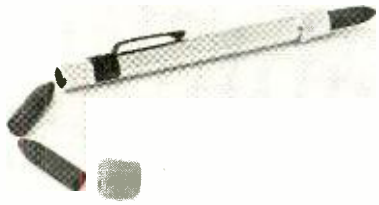
CK 20-2 is a 2-way system and has a speaker board fabricated to hold a 2-½"



tweeter and an 8" woofer. *CK 20-3* is a 3-way system that holds a 2½" tweeter, 5" midrange and an 8" woofer.—**National Tel Tronics,** 98 Cutter Mill Road, Great Neck, N.Y. 11021.

Circle 44 on reader service card

3-IN-1 ERASER has three interchangeable rubber heads impregnated with a special abrasive. (1) Fine for micro-deburring and cleaning of thin, hard coatings and residual chemicals on PC board connections; (2) Medium for erasing solder spots and heat marks on PC boards and components; (3) Coarse for



quick cleaning of rust, corrosion and stains on metal, plastics, glass or ceramic surfaces. Precision-made of solid brass and plated for longer life. 5" long x ⅜" diameter; $2.50.—**Fancort Industries, Inc.,** 150 Broadway, New York, N.Y. 10038.

Circle 45 on reader service card

PORTABLE UHF-VHF-AM RADIO, *Realistic Patrolman-3,* tunes AM, 450-470 MHz uhf and 144-174 MHz vhf for police, fire, public utilities, business radio, weather

broadcasts, 2-meter amateur radio and other 2-way radio services.

Separate tuning controls are provided

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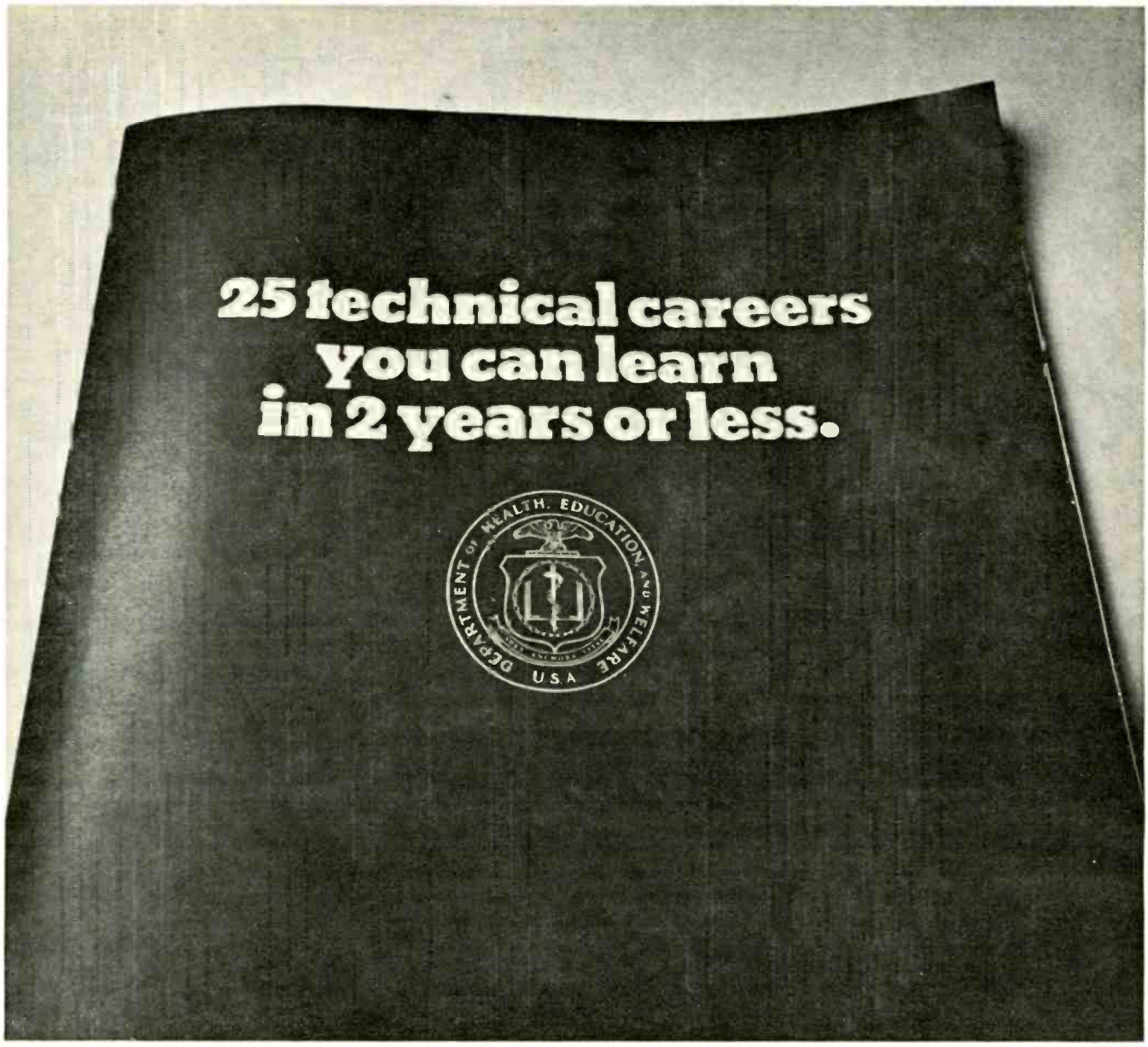


How far can you go without four years of college? Here's what the U.S. Government says about it in a booklet published by the U.S. Office of Education:

"A lot of people think that careers are meant for college graduates—jobs are for everybody else.

"Ten years ago, they may have had a point.

"But something's happened recently to change all that. A revolution in science and technology...

"You no longer need four years of college to start out on a scientific or technical career.

"You can break into any field—from medicine to computers to engineering to the space program—with only a year or two of education. Just become a technician."

Free Guidance Materials

To help you select the technical career field that's right for you, we've listed opportunities on the attached postpaid card and in the special coupon, at right. And you can find out what you should know about the field you like best by simply checking off your choice and mailing the card or coupon today.

Free Guidance Booklet

By return mail, you will receive a free ICS Career Guidance Booklet that describes the opportunities, income and job security you might expect in your newly-chosen field. It will also explain how ICS can help you get the training you need to break into this new career field...right in your home...during your spare time...without losing a single day's pay from your present job ...and without ever setting foot in a classroom.

Free "Demonstration Lesson"

In addition, you'll receive a free "Demonstration Lesson" that lets you see for yourself why picking up the job skills you need—the ICS way—may be easier than you think.

More than 8,500,000 men and women have turned to ICS for career training since 1890. Some 2,000 American firms and government agencies are using ICS training programs to upgrade their employees. (Among these firms are such names as Ford, U.S. Steel, Chrysler, Mobil, 3M Company,

Take advantage of this U.S. Government booklet and get started in a big-income career.

"...you no longer need four years of college to start out on a scientific or technical career.

"You can break into any field — from medicine to computers to engineering to the space program — with only a year or two of education. Just become a technician." *U.S. Office of Education*

Alcoa, Pan Am, GE, Motorola and RCA.)

ICS career training is approved for veterans training, and is Accredited by the Accrediting Commission of the National Home Study Council. Just mail the card or coupon for your free guidance materials.

(If card is missing, use coupon and mail to: ICS, Scranton, Pa. 18515) ©1973 I.C.S.

ICS International Correspondence Schools
Scranton, Pennsylvania 18515

RA727Z

Please send me free ICS Career Guidance Booklet and a free "Demonstration Lesson" for the field I have checked below. I understand I am under no obligation.

- ☐ Electronics Technician
- ☐ Air Conditioning, Refrigeration & Heating
- ☐ Automotive Mechanics
- ☐ Auto Body Rebuilding Specialist
- ☐ Engineering (Civil, Electrical, Mechanical, Chemical)
- ☐ Communications/ Broadcasting
- ☐ Computer Servicing
- ☐ Diesel, Gas Mechanic
- ☐ Surveying & Mapping
- ☐ Drafting (Mechanical)
- ☐ Electrician
- ☐ Architecture
- ☐ Engineering Technician
- ☐ FCC Licensing
- ☐ TV Servicing & Repair
- ☐ CATV Tech.

☐ Check here for special information, if age 16 or under.

NAME _____ AGE _____

ADDRESS _____ APT. _____

CITY _____ STATE _____ ZIP _____

NEW PRODUCTS

(continued from page 91)

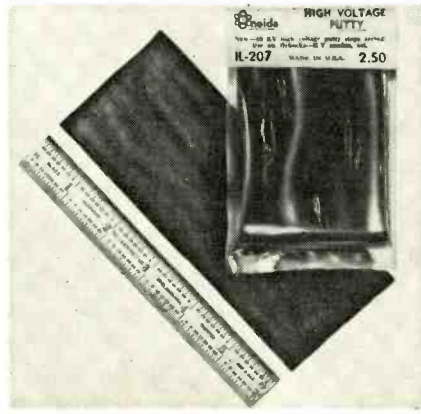
for AM and for uhf/vhf, and each band has a window-type rotary dial for accurate frequency selection. An adjustable squelch control reduces background noise while monitoring vhf and uhf.

$49.95 includes 4 penlight cells and earphone. High-impact case with carrying handle, 8-½"x5-½"x2-¼", ac adapter $4.95.—**Radio Shack,** 2617 West 7th Street, Fort Worth, Tex. 76107.

Circle 46 on reader service card

HIGH VOLTAGE PUTTY easily molds around uneven objects. Eliminates arcing in high voltage television transformers, anodes, tube sockets and filament wire.

It replaces corona dope. Service technicians can make a variety of television repairs right in the home. Packaged in 6" lengths.—**Oneida Electronic Manufacturing, Inc.,** Meadville, Pa. 16335.



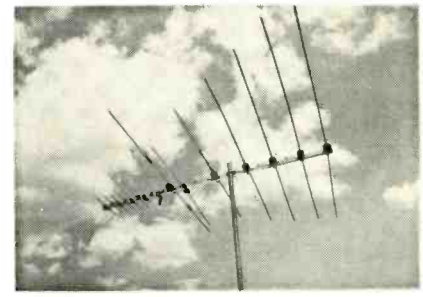
Circle 47 on reader service card

2-SET COUPLER, *Model SC42-730,* is designed to distribute two TV or FM signals from the one standard MATV or CATV coaxial cable output to two television sets. It splits one 75-ohm coaxial output into two 300-ohm outputs.

Includes an insta-mount adhesive strip for press-on indoor installation. Sawtooth washers eliminate the need for stripping or cutting twinlead insulation. An "F" connector is included for use with coaxial cable $4.70.—**JFD Electronics Corp.,** 1462 62nd Street, Brooklyn, N.Y. 11219.

Circle 48 on reader service card

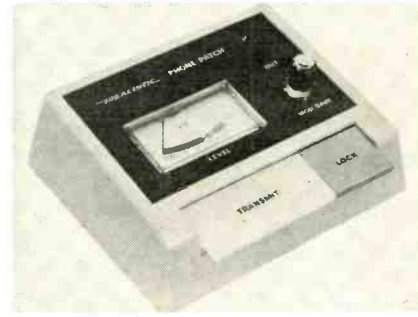
TELEVISION ANTENNAS. *Color Whiz* uses cross-phased dual band elements that deliver the same gain, directivity and front-to-back ratio of conventional antennas up to 20% larger in size. Elements slip into precise receiving position with minimum effort yet are retained rigidly in place by the new bracket mechanism. Director section features new flat planar construction that results in a larger signal gathering area which produces pictures with sharper detail and more intense color.



All elements are reinforced with external sleeves and internal dowels at their base. A vhf/uhf signal splitter is included with each antenna. Over eight models; $8.60 to $49.95.—**JFD Electronics Corp.,** 1462 62nd Street, Brooklyn, N.Y. 11219.

Circle 49 on reader service card

PHONE PATCH, *Realistic No. 21-514* provides interconnection between amateur-radio or citizens-band station's equipment and the telephone system, making it possible to place or receive telephone calls through a base station and relay them to a mobile unit in a car, truck or boat, or to another station that does not have access to a telephone. Phone patches have been used during civil emergencies, to provide communications in disaster areas, and often as a means for servicemen overseas to talk with relatives in the U.S.



Comes complete with 15-foot telephone leads, 3-foot transmitter lead and installation instructions. It features a built-in VU meter, gain control and locking push-to-talk bar. Not for use with transceivers using electronic switching. $19.95.—**Allied Radio Shack,** 2617 West Seventh Street, Fort Worth, Texas 76107.

R-E

NEXT MONTH

Been wanting to build an electronic music synthesizer? Stop wishing and start looking for the May issue of Radio-Electronics. You'll find just what you've been looking for. By the way, the May issue goes on sale April 19.

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.

ELECTROLYTIC CAPACITOR GUIDE. 32-page brochure tells how to find a good capacitor replacement for an original equipment capacitor of a given rating, size and shape. Over 4500 capacitors include singles, duals, triples and quad types.

Complete information on how to use this guide is included. All capacitor replacements are listed by microfarad and voltage ratings and physical case sizes.—**Mallory Distributor Products Company,** 101 South Parker, Indianapolis, Ind. 46201.

Circle 51 on reader service card

WHO'S WHO IN ISCET shows a total of 198 CET examination sites where electronics techs may take the certification examination. 45 states plus Canada have Certification Administrators listed that provide test locations quarterly on national "T" dates—usually March 15th, June 15th, Sept. 15th and Dec. 15th. This directory also lists the national serviceability committee—a 20-man technician group from which 6-man teams of independent servicers are chosen to perform in-plant inspections of electronics products.—**National Electronics Associations,** 1715 Expo Lane, Indianapolis, Ind. 46224.

Circle 52 on reader service card

ANTENNA & ACCESSORIES CATALOG. 48-page book provides data on several hundred different models of indoor and outdoor antennas for vhf, uhf and FM; antenna kits; mounts and mounting hardware; guy wire; transmission wire; masting; chemicals; rotators; uhf converters; antenna amplifiers; color boosters; home system amplifiers and distributor systems; couplers; and passive networks.—**Channel Master,** Ellenville, N.Y. 12428.

Circle 53 on reader service card

ELECTRONIC EQUIPMENT *Winter 1972-73 catalog.* 12-page book contains dozens of digital circuit design and breadboarding aids.—**EI Instruments, Inc.,** 61 First Street, Derby, Conn. 06418.

Circle 54 on reader service card

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

EDUCATIONAL MATERIALS CATALOG. 48-page catalog features textbooks, student's workbooks, instructor's guides, laboratory manuals, supplementary and reference materials, audio-visual aids and training devices for use in industrial education programs. Over 300 selected titles are supported by descriptions, illustrations and prices.—**Howard W. Sams & Co., Inc.,** 4300 West 62nd Street, Indianapolis, Ind. 46268.

ELECTRONIC PARTS AND EQUIPMENT *Catalog 730* is a 420-page catalog that lists over 50,000 separate stock items from more than 400 manufacturers.

Detailed specifications, descriptions and illustrations cover a vast array of components including: semiconductors, integrated circuits, LED's, tubes, relays, timers, transformers, resistors, capacitors, connectors, coils, chokes, sockets, plugs, jacks, switches, fuses, batteries, clips, lamps, wire and cable and much more. Other major sections include: test equipment, intercoms, power supplies, electronic counters, sound equipment, chemicals, and hardware. **$5, Free with $10 order.—Allied Electronics,** 2400 West Washington Blvd., Chicago, Ill. 60612. **R-E**

SPEED TROUBLESHOOTING

Rapid troubleshooting and repair technician. Here is a new that requires only common sense and

by JONATHAN L. TURINO

TROUBLESHOOTING IS BOTH AN ART and a science. Some people seem to have a natural talent for the art of speedy and logical troubleshooting, while others must study and apply the science of logical troubleshooting. This article is devoted to the science of "logical troubleshooting" with the hope that through a little study and application of this theory, our science will approach the art!

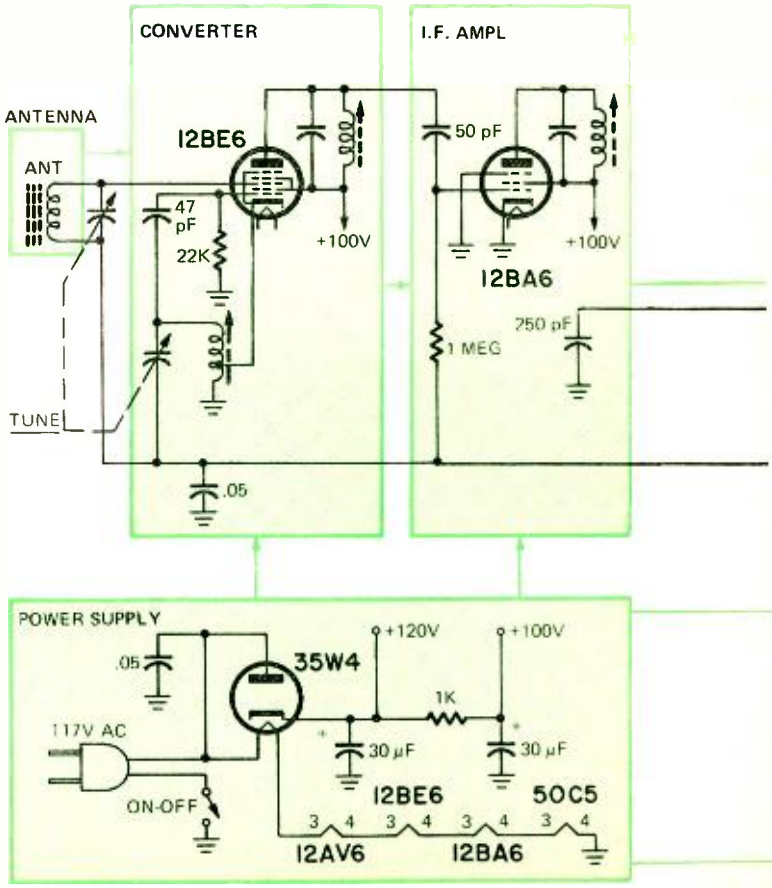
Before we begin to troubleshoot, we need some basic tools. These fall into two main categories: hardware and software.

The test equipment (hardware) you use must fit the job. Troubleshooting a defective superhet radio with a pocket vom is possible, but it is just a little difficult because you don't get enough useful information at each measurement. For the same reason you would wreak havoc with your nerves trying to troubleshoot a digital frequency counter with an audio signal tracer.

Probably the handiest single piece of test equipment you can have is a general-purpose dc to 5-MHz oscilloscope. It is your "window" into the world inhabited by those electrons that are causing the troubles you are out to shoot.

In general, however, the two pieces of test equipment you need for any troubleshooting job are: one piece to put a known good signal into the equipment you are testing, and one piece to observe the output indications at various points in that equipment. The second of these two items is by far the most important since much electronic gear has its own signal source, and if it does not, you can usually improvise a little to create one.

One of the necessities of course, when you get down to component isolation, is a vom (or vtvm, tvm, etc.). Without this essential piece of test gear, the job of finding one bad component among several is next to impossible. For localizing a defective stage in most equipment, an af–rf sig-



With A Logical Approach

techniques are vital to the modern speedy approach to troubleshooting a minimum of equipment.

nal tracer will do the job; but if you have a scope, you are in great shape when you use it logically while troubleshooting.

Work with a block diagram

The "software" category of tools is extremely broad. It includes the schematic, any theory of operation and operating instructions, all of your knowledge, and most important of all, a block diagram of the piece of gear you are troubleshooting. For rapid and logical troubleshooting, a block diagram is a must. You have to isolate the defective "stage" before you get involved with the individual resistors, capacitors, transistors, and diodes or the job will take forever.

The next question is where do you get a block diagram for most equipment, since it is not usually supplied. The answer: Create one. Whether you actually draw a block diagram, mark up the schematic as we have done in the diagram, or simply create the blocks in your mind's eye, you need the block diagram. As you probably deduced, the diagram is the schematic of a simple five-tube radio with the stages "blocked out" and arrows added to show signal flow.

The technique for creating a block diagram is rather simple. All that is necessary is to define the function of each stage. In the case of our radio, this is rather easy since we have several easily identifiable pieces: oscillator-mixer, i.f. amplifier, detector and audio amplifier. Although some pieces of gear are more complex and take longer to block diagram, each and every one can be blocked. The only rule you must remember is that each "function" gets a block. There will be more examples of block diagrams and their creation as we go along.

The second big piece of software you need is information regarding the correct output with the proper input and control settings. If you do not know what a piece of equipment is supposed to do, you will have a hard time deciding whether it is doing what

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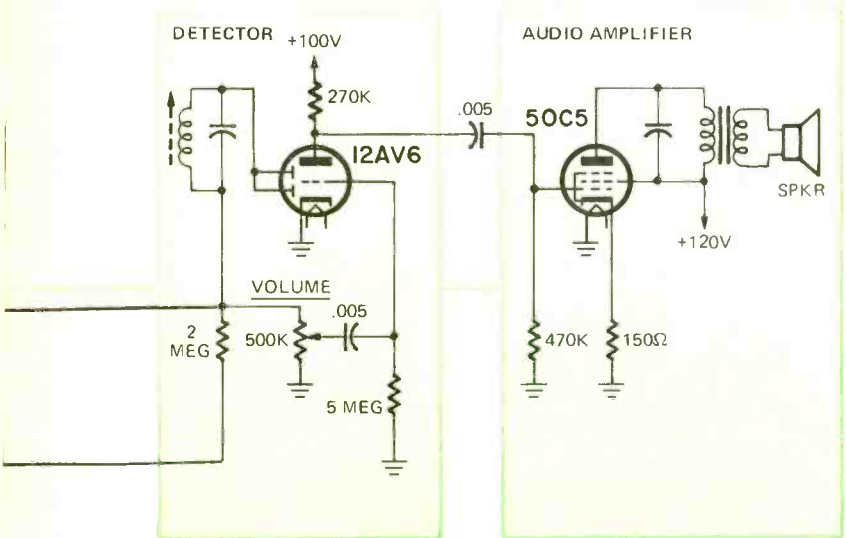


HOW SCHEMATIC IS CONVERTED TO A BLOCK DIAGRAM for use with the author's cut-it-in-half troubleshooting tricks.

it is supposed to do correctly. In the case of our five-tube radio, we know that it should provide music when tuned to a station (if it is plugged in, if it is turned on, if it is working properly, if . . .) so we are halfway to fixing it when it becomes inoperative.

We are now ready to start troubleshooting, so let's pause for a moment to take stock of what we have:

1. A defective piece of equipment.
2. The proper test equipment.
3. A block diagram and schematic.
4. The operating instructions and a good idea of what the defective equipment is designed to do.

Organization is important for rapid troubleshooting. You should have all necessary items handy (including hand tools, a soldering gun or iron, etc.) so that you don't have to waste time getting up to search for something like a smaller nutdriver. We are going to troubleshoot logically, so let's organize efficiently and logically from the beginning to avoid having to ask, "Now where was I?" Answering yourself takes much more time than simply talking to yourself (which is quite acceptable when troubleshooting).

Now let's begin. How? There are two very basic rules to follow in the initial troubleshooting phase: **observe the front-panel indications** and, most important of all, **check the simple things first.** Overlooking that second rule (something even experienced technicians do, much to their chagrin) is costly and time consuming. The old cliche that goes, "try plugging it in" is actually a much more common occurrence than you might imagine.

Observe the symptoms (front panel indications). Does the power lamp light? Is the equipment completely dead or is there hum from the speaker? Is the speaker switch on EXTERNAL? Is the LOCAL-REMOTE switch set to REMOTE? Is the fuse the proper size? What happens if you turn this knob that way? In other words, glean all the information from the front (and rear) panel controls and indicators that is obtainable so you will have some idea regarding where to look first or how to proceed. Make some educated guesses about the possible defective stages from the symptoms you observe, and be ready to abandon any (or all) of your guesses if later information points to a different area.

Do not be stubborn. Update your guesses as you go. When your first symptom is a completely dead piece of gear, check the cord and the plug (is the socket live?), the fuse and then the power supply. If all portions of the equipment are dead the power supply is most likely the problem area. If you get "weird" symptoms you might check the power supply first also, since many supplies use resistor voltage dividers. If one leg of a voltage divider opens, you can have some "illogical" happenings.

Up to this point we have been very general about what we are trying to fix and how to go about it. These basics are important though and should not be overlooked. Just because they are "simple things" they bear repeating. But the moment of truth that separates the troubleshooters from the tube-jockeys is here. The equipment is plugged in, the fuse is OK and the power supply is putting out the proper voltages. The gear is still broken. You have to find the bad stage, isolate the defective component and replace it.

Our first example (which will appear next month) is an AM-FM stereophonic receiver in block diagram form. We will describe, analyze and apply what is possibly the most efficient method that exists for logically localizing a defective stage in any piece of equipment, no matter how complex. It is called "cut-it-in-half" and we will apply it to quickly pinpoint a host of troubles. **R-E**

first co-op tv repairs

A young man applied the idea of the cooperative to a service business—with surprising results

by F. ROY KEMP

WILLIAM KING, 32, A RECENT GRADUate of an accredited TV repair school, had the problem that plagues every newcomer to the field: do you work as an employee or do you go for the big one and become the owner of your own business? Both alternatives have special advantages—and disadvantages.

Bill had had a considerable background in electronics and felt that he was ready for a managerial position.

WILLIAM KING hands repaired radio to a customer in The Co-Op TV/Radio Service Center.

He also knew how cooperatives work—he lives in a co-op apartment building. He had the idea of extending the cooperative to a TV service center where he would be the manager and the consumers the owners.

So he worked out a prospectus for a year's operating budget, went to the Grand Street Consumers Cooperative Society with it, and sold the idea. He got the financing necessary. Now he's in business as manager of the nation's first Co-Op TV and Radio Service Center, in New York City, is doing fine, thank you, after three

(turn page)

months in business. Here's the way it works:

"We provide the service," says King, "the people provide the money. Our rates are figured out on a basis of operating costs plus a reasonable percentage of profit. There is a rebate to the customer-shareholder in proportion to what he has spent. In effect, the business is owned by the shareholders. A consumer becomes a shareholder by buying one share in the Co-Op Supermarket in the same building, under the same Grand Street Co-Op. And that costs $25.00. But you do not have to be a shareholder to have your TV repaired.

Bill is enthusiastic about the results of his service center, so far. He has 30 to 40 telephone enquiries, daily. The rates are: $12.50 per hour for labor plus the cost of parts. This fee is acknowledged to be less than that charged by most private repair shops. He encourages customers to bring their TV sets to the shop to take advantage of his $3.00 per 15 minute in-shop repairs. And this they are doing in increasing numbers. Very often the trouble with a malfunctioning

CO-OP TV AND RADIO SERVICE CENTER MANAGER works on television receiver while a sales representative of a parts supplier looks on. The center services all consumer electronics.

TV set can be quickly spotted and quickly repaired. When this happens, a service has been rendered and everybody is happy.

Common problems are with tuner regulation or high voltage or of course, worn out tubes that need replacing. Free estimates are given on all repairs, verbal authorization is secured before the work is done. After repairs are made, all the old parts go back and the set is guaranteed for 90 days.

"There is a stereotype about the TV service technician being an unscrupulous person," says King. "I'm trying to change that image." And word has got around that here is a place where service really means service at reasonable rates. People are lugging their TV sets all the way from the Bronx and Queens. Though the shop has two field men, house calls are limited to the neighborhood.

WILLIAM KING in his shop. Already, the shop is outgrowing its 3500 square feet of space.

PARTS INVENTORY is continuous. Secretary checks work sheets for replacement parts.

"There are problems in this type of business as in any other. One of them: giving an estimate on a TV that needs extensive repairs after being inadequately repaired by someone else. Or looking after dear old Mrs. Berger

(turn page)

who keeps bringing in a battered old radio for repairs. It would cost $15 to fix her set, and she could get a $5 transistor radio that would work better. But I think she is just lonely and wants someone to talk to. Anyhow, she says she is too old to travel to Canal Street to buy another one. So we do the best we can."

NORMAN PHARR, field service technician, checks his tube caddy before leaving on job.

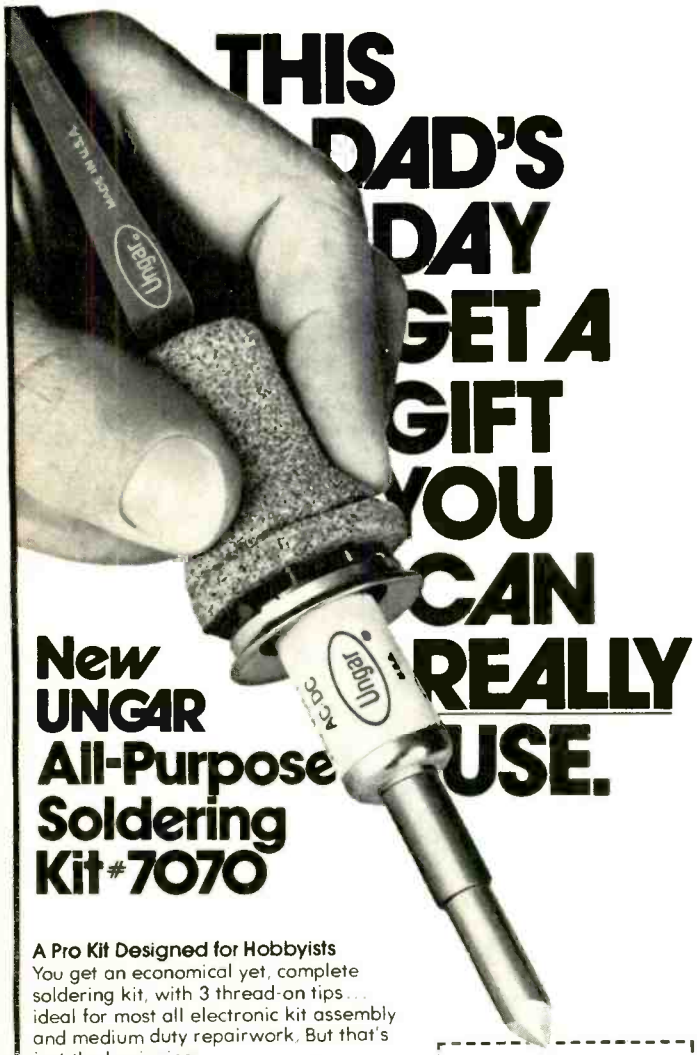
"Customers do get impatient when we have to order parts from a manufacturer," King went on. "And that can be a bottleneck, because we cannot keep an inventory large enough to fit every situation. But we try to explain, and most of our customers understand. We have won their confidence and that is a major step forward."

KING AT WORK inside a television set about to clean the vhf tuner.

Convinced of the value of the cooperative as a method of business operation, Bill enjoys his day-to-day relationships with his customers. "The individual becomes a shareholder with a small investment. He's helping us, we are helping him."

SATISFIED CUSTOMER writes a check as King gives the TV set a last-minute once-over.

Bill has one special instrument that he uses on all TV sets. Maybe it is his "secret weapon." And that is a can of spray-on window cleaner to make spotless the viewing screen of the picture tube. This screen cleaning greatly improves the visibility of the image—just like looking through a clean window. Best of all, for this final service, the price is right: it's for free. **R-E**



THIS DAD'S DAY GET A GIFT YOU CAN REALLY USE.

New UNGAR All-Purpose Soldering Kit #7070

A Pro Kit Designed for Hobbyists
You get an economical yet, complete soldering kit, with 3 thread-on tips... ideal for most all electronic kit assembly and medium duty repairwork. But that's just the beginning.

Versatility; A Modular System
Only Ungar gives you this *Maximized Versatility*: Tips—heater units—even handles are interchangeable and available in an optimum variety of configurations. "Custom-make" your iron: for PC work just add a #537 heater to your kit. Tackle virtually every soldering job by simply changing components—not the whole tool. (Our brand new catalog #513 has all the details plus handy application selector...at your local electronic retailer).

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You get a perfectly balanced handle of hi-strength plastic, comfort-cork grip, stainless steel heat deflector and flexible 2 wire, integral cord—all UL listed and backed by Ungar's guarantee of excellence.

Get the Finest Tool Available!
Maximum versatility, high quality, low cost plus a complete selection of accessories and production aids... it's the reason more pros in service, repair, R&D and on-line production demand Ungar every time. Your kit is at your local electronic retailer, right now, for only about $6...all accessories and our new catalog are there too. HAPPY DAD'S DAY!

Honey, I could sure use a Father's Day gift like the Ungar #7070 Soldering Kit. Hint! Hint!

Only about $6 too!

Argyle socks and wild ties you may still get. This hint coupon may help. Let us know where you put it and what the results were. Ungar

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Circle 11 on reader service card

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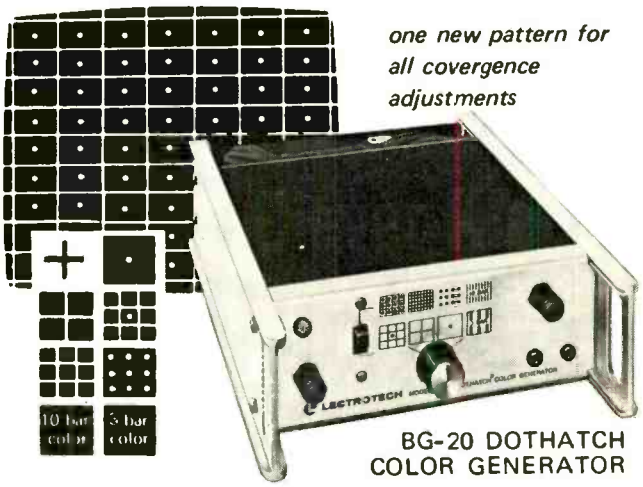
an exclusive Lectrotech development



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Now you can get a high performance Model 8000A Digital V.O.M. from Fluke, America's foremost maker of quality digital mutimeters, especially designed for TV, radio, stereo and audio service. No other digital V.O.M. gives you the resistance range to check breakers and switches, the high resolution voltage to look at emitter base and other transistor voltages, excellent ac accuracy and full accuracy with a 30 second warm-up.

Measures in 26 ranges 100 μV to 1200 V, 0.1 μA to 2A, and 100 milliΩ to 20 megΩ with a basic dc accuracy of 0.1%. Full year guarantee. Low cost options include rechargeable battery pack, printer output, deluxe test leads, HV, RF & 600-amp ac current probes, carrying case, and rack mount. Unique self zero eliminates offset uncertainty. Electronics securely mounted in high-impact case. Service centers throughout U.S., Canada, Europe and Far East for 48-hour turnaround repair.

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Circle 80 on reader service card

new books

World Radio And TV Handbook, 1973. Gilfer Associates, Inc. P.O. Box 239, Park Ridge, N.J. 07656. 400 pages, 6" x 9", $6.95.

This is the 27th annual edition of this encyclopedic handbook. It contains more pages and is more comprehensive than the earlier editions. Its pages are packed with a wealth of detailed information on all types of broadcasting stations (AM, short wave, FM and TV), times on the air, languages and frequencies in use, power, specific addresses. The additional pages in this 1973 edition reflect the expanding broadcasting activities in Africa and South America.

1-2-3-4 SERVICING STEREO AMPS, by Forest H. Belt. Howard W. Sams & Co., Inc., 4300 West 62nd Street, Indianapolis, Ind. 46268. 5½ x 8½ in. 240 pp. Softcover, $4.95.

A new easy-to-understand troubleshooting procedure that drastically cuts callback rates and repair time. The book begins with a basic discussion of the fundamentals of the 1-2-3-4 servicing method. The author shows how to service electronic equipment by dividing it into four distinct divisions—sections, stages, circuits and parts. Then he analyzes the four important servicing steps—diagnose, locate, isolate and pinpoint. This book will give a complete understanding of servicing both two-channel and four-channel stereo amplifiers.

COMPUTER CIRCUITS & HOW THEY WORK, by Byron Wels. TAB Books, Blue Ridge Summit, Pa., 17214. 192 pp. 5½" x 8½". Hardcover, $7.95; Softcover, $4.95.

In step-by-step fashion, the author explains how the various parts of a computer work and the terminology associated with each part and function. Section one discusses the principles of the central processor, the memory, control section, registers, instruction decoders, timing circuits, serial and parallel operation, phase counters, input-output sections, etc. Section two deals with comparators, error detection, and parity checking. Section three provides a comprehensive treatment of memories, the various operating modes and performance criteria and data storage and retrieval. Section four is devoted entirely to circuits and applications, actual circuits designed to perform a wide variety of functions.

FIRE & THEFT SECURITY SYSTEMS, by Byron Wels. TAB Books, Blue Ridge Summit, Pa. 17214. 5¼ x 8¼ in. 174 pp. Hardcover, $7.95; Softcover, $4.95.

A handy guidebook that completely covers the selection, installation and general maintenance of home and business security systems. Contents include personal and property security systems, selling protection, "rolling your own", service and maintenance, detectors, control units and system considerations, how much must you pay and devices and systems, which is a fairly large section which includes data on virtually all devices known to the security industry and tells where to find the components needed for assembling a fire and theft system or surveillance set-up.

ABC'S OF LASERS & MASERS, by Allan Lytel and Lawrence Buckmaster. Howard W. Sams & Co., Inc., 4300 W. 62nd St., Indianapolis, Ind, 46268. 128 pp. 5½" x 8½". Softcover, $3.50; in Canada, $4.40.

This book introduces the reader to two devices that play a vital role in science—the laser which produces light radiation and the maser which produces microwaves. Quantum theory is used to explain the emission of coherent light and a number of emitting materials are discussed, from ruby crystals, through certain gases, to solid-state materials. Modulators, detectors, laser frequencies, power supplies, power output and communications are studied as is the history and development of the laser and maser and many of their present-day applications.

MODERN SOUND REPRODUCTION, by Harry F. Olson. Van Nostrand Reinhold Co., 450 West 33 St., New York, N.Y. 10001. 328 pp. 6" x 9". Hardcover, $17.50.

This book describes elements, systems, accessories, methods and applications that help achieve high levels of excellence and performance in sound reproductions. It highlights such aspects as effects of electrical and acoustical noise, theory, action and performance of transistor and integrated circuit audio amplifiers, and electronic modifications used to heighten the emotional impact and artistic embellishment of recorded sound. The text covers monaural, monophonic, binaural, stereophonic and quadraphonic sound reproducing systems, and includes a study of room design in relation to sound reproduction. It also explains the characteristics of the human ear relating to sound reproduction systems.

BASIC ELECTRONICS COURSE, by Norman H. Crowhurst. TAB Books, Blue Ridge Summit, Pa. 17214. 368 pp. 5½" x 8½". Hardcover, $8.95; Softcover, $5.95. Illustrated.

This is a self-study text for the novice, hobbyist, student; a reference and "brushup" on the basics of electronics; a guide for technicians and others who want to advance their knowledge of electronics. In a clear, easy-to-understand manner subjects covered range from electricity and magnetism to semiconductors and microelectronics. The basic roots of electricity are discussed, covering early discoveries that led to the present theories of current and voltage, continuing to the properties of resistance. Ohm's laws, Kirchoff's laws and power calculations. Study questions are included at the end of each chapter.

QUESTIONS & ANSWERS ABOUT CB OPERATIONS Second Edition, by Leo G. Sands. Howard W. Sams & Co., Inc., 4300 W. 62nd St., Indianapolis, Ind., 46268. 114 pp. 5¼" x 8¼". Softcover, $2.95.

This book is a handy guide and reference source for prospective and existing users of Citizens-band radio. It covers CB operating procedures, licensing, rules and equipment selection. It is written in non-technical language to make its contents understandable to everyone.

99 WAYS TO IMPROVE YOUR SHORTWAVE LISTENING, by Len Buckwalter. Howard W. Sams & Co., Inc., 3 W. 57 St., New York, N.Y. 10019. 144 pp. 5½" x 8½". Softcover, $3.95; in Canada, $4.95.

Divided into ten sections, the guide deals with particular phases of shortwave listening; includes antennas and their installation, receivers, accessories, listening techniques, special signals and frequency bands, interference sources, troubleshooting tips, etc. Only a few simple tools are needed to construct the suggested improvement devices. A valuable source of information for the newcomer to the SWL hobby, the established hobbyist, or the technician. **R-E**

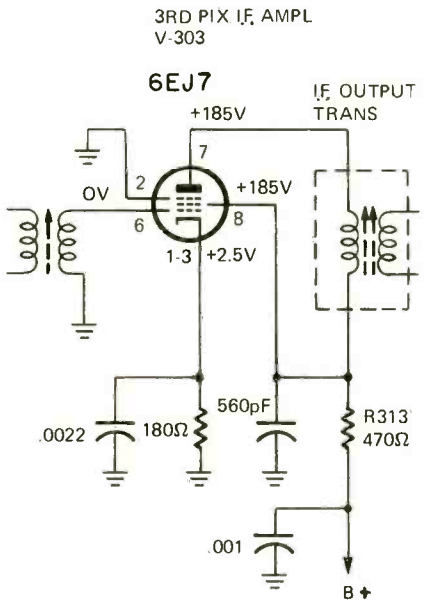
technotes

MAGNAVOX T952 CHASSIS

Vertical jitter or slight bending at the top of the picture on weak uhf channels can be cured by changing C156 (in series between the output of the video amplifier and input to the base of the sync separator) from .01 to .02 μF and changing R213—the vertical sync driver base resistor—from 4700 to 3300 ohms.—*Magnavox Service News Letter*

ADMIRAL 25G6 CHASSIS

The symptom was no picture, just a blank raster with birdies in the sound. This condition can be caused by bad tubes or other defects in the oscillator and i.f. amplifier circuits. In a recent case, the 6EG7 third pix i.f. amplifier tube had shorted. This overloaded the 470-ohm plate dropping resistor (R313) so it had to be replaced.—*Homer Davidson*



ADMIRAL M20 CHASSIS

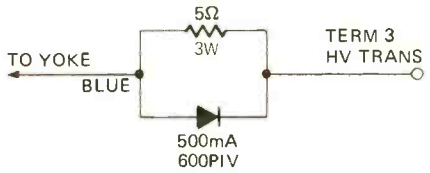
Excessive brightness, washed-out video and no control of brightness can be traced to an open fuse in the low-voltage power supply. This 0.5-ampere pig-tail fuse, F904, part No. 84A7-16, is in the secondary of the power transformer supplying ac to the 400-volt B-plus circuit. Because of the power-supply circuitry, 285 volts remains on the 400-volt line when this fuse opens. The reduced voltage on the picture-tube cathode results in excessive brightness.

Check the circuits supplied by the 400-volt line and then replace the open fuse.—*Admiral Service News Letter*

ADMIRAL FLYBACK REPLACEMENT

When you install a 98A131-5 replacement flyback transformer kit (79A148-1 transformer) in the G11 chassis, you may find a need for horizontal centering.

Horizontal centering can be accomplished by adding a centering diode, with parallel resistor, in series with the BLUE lead to the deflection yoke at terminal 3 of the flyback (see diagram). The polarity of the diode determines the direction that the picture shifts. Diode polarity shown in the diagram shifts the picture to the left. The amount of picture shift is determined by the value of the resistor. A 5-ohm resistor shifts the picture approximately 1 inch. Do not exceed 10 ohms. Any 500-mA, 600-piV diode is satisfactory.—*Admiral Service News Letter*



ADMIRAL K20 CHASSIS

If the audio is dead and the 57C29-2 audio IC has failed, check the ground point of the tone-control capacitor (.022 μF, C134) before replacing the IC. This capacitor **must** be grounded to the shield braid at the volume control. If, instead, it is grounded on the tuner cluster bracket, change it before installing the new IC.—*Admiral Service News Letter*

(continued from page 41)

over the frequency or 3.051757813 x 10^{-5} second. Next best is to use a frequency counter and adjust the oscillator frequency to 32,768 Hz. If neither instrument is available the clock should be set by very small adjustments until you have zeroed in.

To set the time, the SECONDS RESET switch is first toggled to RESET and returned to NORMAL exactly on the minute. The minutes counter is then set by advancing rapidly with the SET MINUTES switch. Finally the hour is set with the SET HOURS switch. The minutes and hours switches should be set back to normal as soon as the desired display is reached since the display delay time may cause you to overrun the correct setting.

When the battery or the ac supply is first connected to the clock, the display segment may be activated erratically. Initially the counters may set up in unused states causing this improper display. Don't worry about it. When the clock is set to the correct time it will quickly step out of these unused states. **R-E**

NOTICE

As we were going to press RCA Components Division notified **Radio-Electronics** that they expect to offer a complete kit of parts for an ac-powered version of this liquid-crystal clock. The kit will contain all parts: including printed-circuit board, IC's, readout, and case. It will be available from RCA distributors about September 1, 1973.

Visiting the New England area? Come in and browse through our showroom! Our customers call us an experimenters paradise. Our two buildings at 119 Foster Street, Peabody, Mass., contain over 35,000 square feet of surplus bargains, all packed to the ceiling. Over 3,000 different items in stock, truly super values at super savings! However, if you can't stop by to visit us, make sure you request our catalog.

WAVEFORM GENERATOR, BF-5

Just one of these BF-5 devices produces sine, square, triangle, 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, which cost 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

Introducing... The Super Clock!!!

SUPER TIME, FREQUENCY STANDARD (KIT)

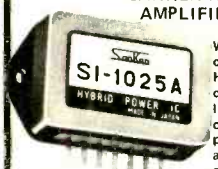
This is for nuts only! A clock with a deviation of less than one second per month. We have obtained a lot of surplus high stability 1 MHz crystal oscillators made by Cts Knight for Computer Measurements Corporation. The oscillator uses a special proportional control oven, and a glass enclosed aged crystal to obtain super stability. The specifications are one part change in 10^9 for 1% change in input voltage, 4 parts in 10^{10} per degree C from 0 to 55C, with aging of less than 5 in 10^7 cycles per year or 2 in 10^8 per week after warmup. This oscillator requires only 28V DC at 4.2 Watts (12 Watts during warmup). Output is 1 Volt RMS into 1K ohm, completely solid state. Value in excess of $300.00.

The oscillator is available separately, or in combination with the Aries AR-720K Quartz Chronometer, in lieu of its regular crystal. Outputs are available in the combination kit for 1 MHz, 100 KHz, 10 KHz, 1 KHz, 100 Hz, 10 Hz, and 1 Hz. Power input is 115V AC, 60 Hz, with provision for automatic battery take-over (battery external, not included), in the event of a power failure.

☐ Crystal Frequency Standard Only Ready to Operate . . . $39.50

☐ Complete Kit, with Modified AR-720K and Power Supply . . . $198.00

SANKEN HYBRID AUDIO AMPLIFIER MODULES



We have made a fortunate purchase of Sanken Audio Amplifier Hybrid Modules. With these you can build your own audio amplifiers at less than the price of discrete components. Just add a power supply, and a chassis to act as a heat sink. Brand new units in original boxes, guaranteed by B and F, Sanken, and the Sanken U. S. distributor. Available in three sizes: 10 watts RMS (20 watts music power), 25 watts RMS (50 watts M. P.), and 50 watts RMS (100 watts M. P.) per channel. 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.

☐ S I 1010Y 10 watts RMS amplifier, industrial grade . . . $ 4.75

☐ S I 1025A 25 watt RMS amplifier, industrial grade . . . $14.75

☐ S I 1050A 50 watt RMS amplifier, industrial grade . . . $22.50

☐ S I 1025E 25 watt RMS amplifier, economy grade . . . $14.00

☐ S I 1050E 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) 3100 mfd 75V capacitors for 10, 25 or 50-watt stereo amplifiers . . . $ 5.00

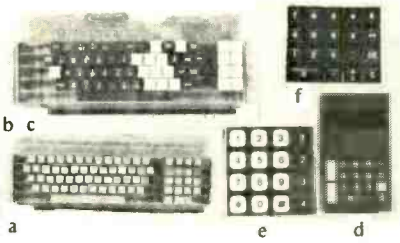
☐ SGS4 4-watt RMS amplifier . . . $ 2.00

☐ 6 Amp Bridge Rectifier, suitable for all amplifiers. . . . $ 1.50

☐ 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 amplifer, includes two 10 watt Sankens, etc. . . . $38.00



KEYBOARDS

B and F has accumulated a wide selection of surplus keyboards, which we are now offering at low prices. With this selection, you should be able to find something to fill your requirements, no matter how complex.

1) Figure "A", ASCII coded full alphanumeric, using solid state decoding. Manufactured for Tektronix by Honeywell or Controls Research. Complete with schematics, brand new. KB-1 . . . $55.00

2) Figure "B", similar to above, but slightly different key layout. KB-2 . . . $40.00

3) Non-decoded alphanumeric keyboard, Figure "C", single form, SPST contact on each key. KB-3 . . . $24.50

4) Figure "D", calculator keyboard in calculator case, pressure sensitive elastomer contacts, manufactured for Aries. KB-4 . . . $9.50

5) Touch-tone keyboard, Figure "E", manufactured by Chromerics. No electronics included. KB-5 . . . $9.00

6) Desk calculator keyboard, Figure "F", manufactured by Controls Research. KB-6 . . . $15.75

ROTARY THUMBWHEEL SWITCH

Brand new, subminiature size digital switch, available with output in straight decimal form, or BCD. Widely used to set up predetermined counts or intervals, digital values or digital-to-analog values. Prices quoted are per section, or decade.

☐ Decimal Output (10 position) RTSDCO . . . $2.35

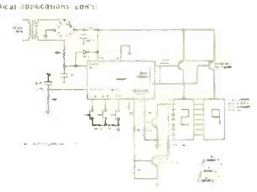
☐ Binary Coded Decimal Output RTSBCD . . . $2.35

☐ Pair of End Plates . . . $ .50

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



DIGITAL CLOCK CHIP

These large scale integrated (LSI) chips eliminate 14 to 20 MSI TTL chips in the design of an electronic clock. Features 12 or 24 hour operation, 6 digits, internal multiplexing, operates on 50 or 60 Hz input, or a schematic is provided for crystal control. Logic gates between the counter allow setting at the rate of one hour digit per second, or, one minute digit per second. A "hold" input allows stopping the chain. The multiplexer samples the outputs of the hours, minutes and seconds counters (in the six digit mode), routing this data to a programmable read only memory (ROM), which is programmed to provide BCD and seven segment outputs. All outputs are compatible with bipolar devices, necessitating few external components for the display interface. Only one power supply is required for operation.

1) 5314 chip (24 pin plastic) used for 7 segment displays such as LED's, numitrons, minitrons and Sperry displays. . . . $9.95

2) 5311 chip (28 pin ceramic) includes BCD output to above for interface to nixies, computer inputs, etc., in addition to 7 segment outputs. . . . $14.95

COMPACT BRIDGES – BY VARO & G. I.

2 Amp 100 Volt	$ .50
2 Amp 200 Volt	$ .60
2 Amp 400 Volt	$ .80
2 Amp 600 Volt	$1.40
2 Amp 800 Volt	$2.00
6 Amp 50 Volt	$ .80
6 Amp 100 Volt	$1.00
6 Amp 200 Volt	$1.20
6 Amp 400 Volt	$1.50
6 Amp 600 Volt	$1.80

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 really 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. 1 lb./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.

SOLID STATE POWER SUPPLIES

The following listed supplies are recent production, entirely solid state regulated supplies. Inputs are 115V, 60 Hz. All feature ultra-low ripple, high regulation, and short circuit current limiting. Quantities are limited. Manufactured by Transistor Devices and Elcom.

☐ PSTD 12, Fig. A, ± 12 volts @ 0.75 Amps each output . . . $30.00

☐ PS 12-5-2, Fig. B, ± 12, ± 5, + 28 at 1.25, 0.5, 7.2, 0.6, 3.0 Amperes, respectively . . . $45.00

☐ PS 12-5-1, Fig. B, - 12, ± 5, + 28 at 0.5, 7.2, 0.6 and 9 Amperes, respectively . . . $40.00

☐ PS 932, Fig. C, + 5 volts @ 1.0 Amps, ± 15 volts @ 0.1, 0.1 Amps . . . $19.75

☐ PS 931, Fig. D, 12 volts, 1.0 Amps, uses new Fairchild Regulator . . . $11.75

☐ PS 930, Fig. D, 5 volts, 1.0 Amps, excellent for TTL-logic, up to 50 7400 chips, uses new Fairchild Regulator . . . $ 9.75

NOT Postage Paid; shipped Frt. Collect

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

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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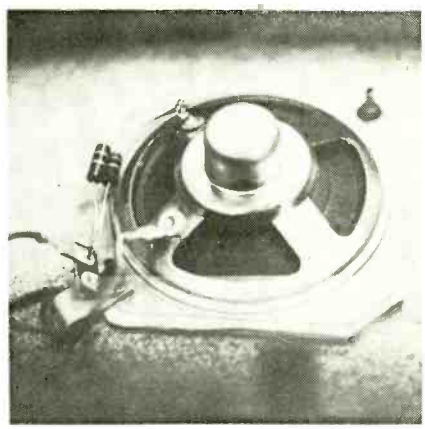
Circle 85 on reader service card

service aids

REPLACING HIGH-IMPEDANCE SPEAKERS

Finding a replacement for a speaker with an odd-value of voice-coil impedance can be a problem. Sure, you can order one—and wait weeks for it to come. Or, if the enclosure has room—and you have the tools and the time—you can make the opening for the speaker larger and mount one of those multi-impedance speakers in the box.



LOADING RESISTORS may be supported at one end by an insulated terminal strip.

A quick and low-cost repair for most solid-state portable radios and record players is to substitute a speaker that fits the existing opening and mounting screws. Then solder in enough series resistance to equal the approximate impedance of the original speaker. Be sure to use high-wattage resistors—2 watts at least.

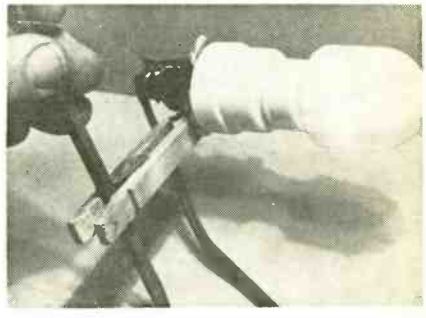
(This repair will not work with walkie talkies or intercoms that use high-impedance speakers that double as microphones.)

Using this method there is little noticeable loss in speaker volume and the lighter-weight voice coil seems to improve the frequency response somewhat.

For a permanent repair on a stereo system replace both speakers even if only one is defective. It keeps quality and volume balanced.—*Elmer Carlson*

MINIATURE EXTENSION LIGHT

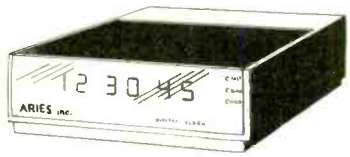
A handy extension light for working in close places can be quickly devised at small cost. To the finger-end of a spring-type clothespin bolt a single 117-volt outlet with attached cord. Tape any exposed connections and the device



HANDY TROUBLE LIGHT made from clothespin, nightlight and a short extension cord.

is complete. Plug a 7-watt night light in the receptacle and you are in business. The clothespin, of course, is used as a spring clamp to hold the light in any desired position.—*Glen F. Stillwell*

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:

- Decorator solid walnut case. A Striking addition to even the most luxurious living room. Our sketches just don't do it justice.
- 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

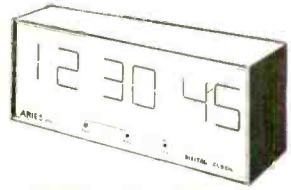
This brand new calculator from T.I. promises to revolutionize engineering calculations! Use scientific notation, i.e., 4235.7867 is expressed as 4.2357867×10^3. Does squares, square roots, reciprocals, adds, subtracts, multiplies, divides. If you have been looking at electronic slide rules you know what 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

FUNCTION GENERATOR KIT IMPOSSIBLE?

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.

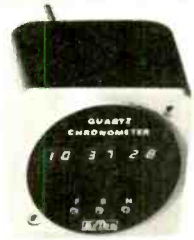
Sh.Wt. 15 lbs.

☐ 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 possibie 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.

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Several unfortunate circumstances have forced us to temporarily stop taking orders for our pocket calculator and delayed the filling and shipping of purchase orders. The overwhelming demand for these calculators rapidly ate up our off-the-shelf inventory. Now we are experiencing a lot of difficulty in procuring the LSI chip from the vendor, and this slow and dwindling delivery has all but halted production on the calculator.

Although we are unable to fill orders or deliver at this time, we plan to be able to again enjoy your patronage in early April. We are making every effort to resume production, replenish our stock and accept orders for our pocket calculator at the earliest possible date, as soon as parts become available to us. In the meantime, we welcome any requests for information regarding the calculator, and thank you again for your continued interest.

Sincerely, Arthur J. Pennell

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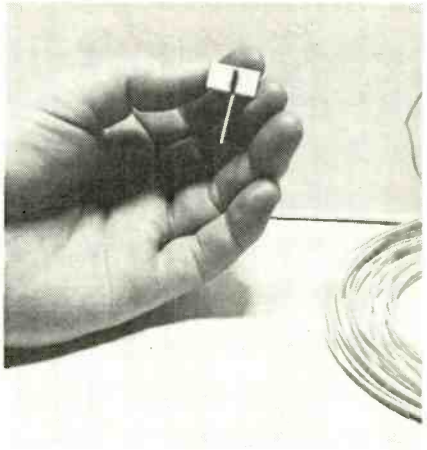
(617) 532-0450

Circle 88 on reader service card

try this

BROKEN DIAL POINTER

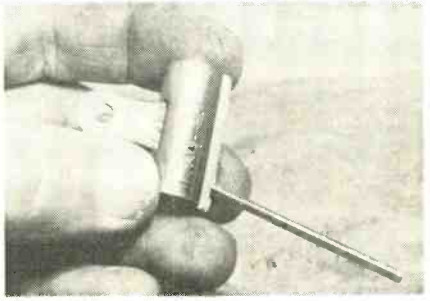
Many times, a plastic dial pointer breaks off so you can't see what station you are dialing. To repair it, all you need is a piece of solid hookup wire—number 22 or larger. Strip the insulation off one end and solder this to the part of the assembly that rides along the dial cord. (The insulation left on the wire gives you a colored pointer so select a color such as red, yellow or white for a good contrast between the pointer and the dial.)



If the dial pointer assembly is all plastic, heat the bare end of the wire with a soldering iron and push it into the plastic piece.—*Homer L. Davidson*

ALLEN WRENCH HANDLE

Certain small sizes of Allen (and spline) wrenches are used most frequently. These are the ones most frequently lost or misplaced. To prevent this and save time and trouble in using such a tool, provide it with a handle improvised from a spring-type paper clip. This will serve as a handle and also provide a means to keep the tool on a pegboard hook when not in use.—*Glen F. Stillwell* **R-E**



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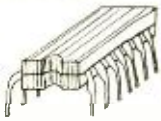

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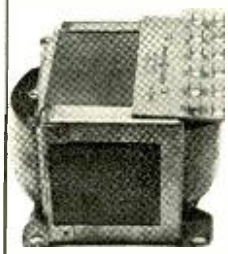

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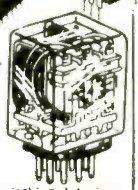

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PRV	1A	10A	15A	20A
100	.30	.60	.85	1.05
200	.65	.85	1.25	1.45
300	.75	1.10	1.45	1.65
400	.90	1.35	1.75	1.90
500	1.20	1.50	2.50	2.20

*Press fit

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200	.07	.12	.20	1.25
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600	.11	.20	.50	1.80
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5556 oper amp	$ .75
101 oper amp	$ .75
7410 V oper amp	$ .55

Silicon Control Rectifiers

PRV	6A	10A	20A	70A
50	.25	.32		
100	.30	.45	1.00	3.50
200	.50	.75	1.25	6.50
300	.60	.90	1.50	
400	.70	1.10	1.75	9.50
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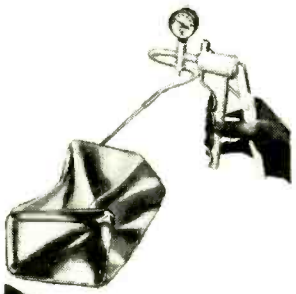

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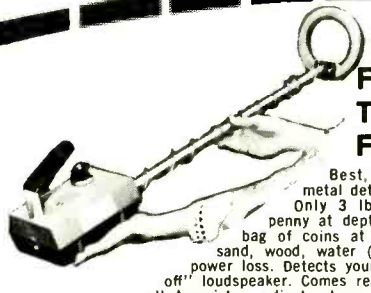

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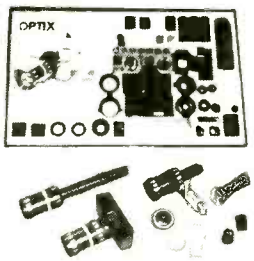

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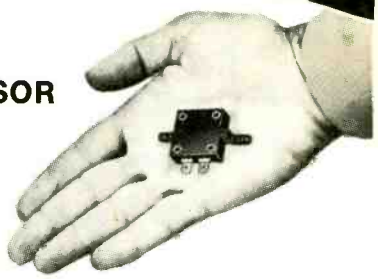

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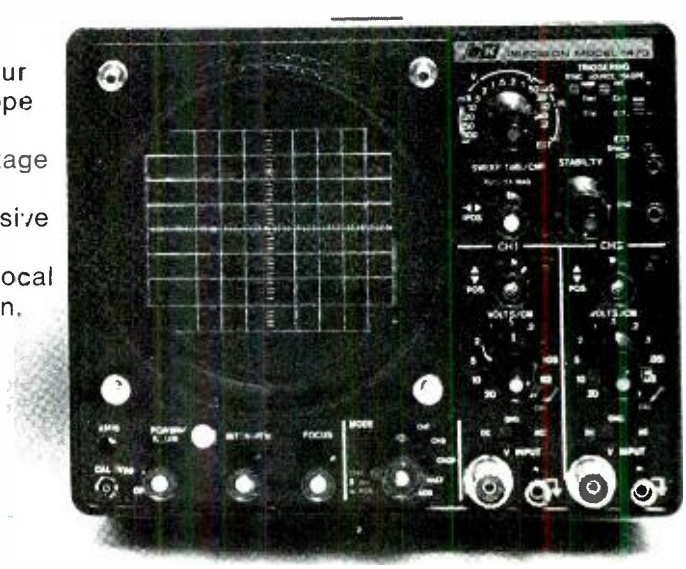

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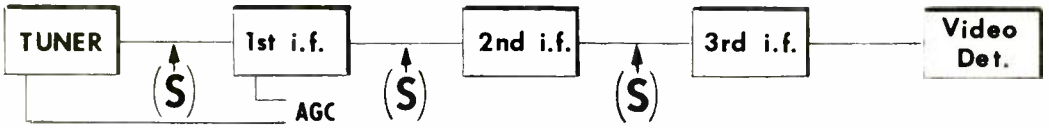

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