Electronics World

AUGUST, 1968
60 CENTS

w/p-p. 77

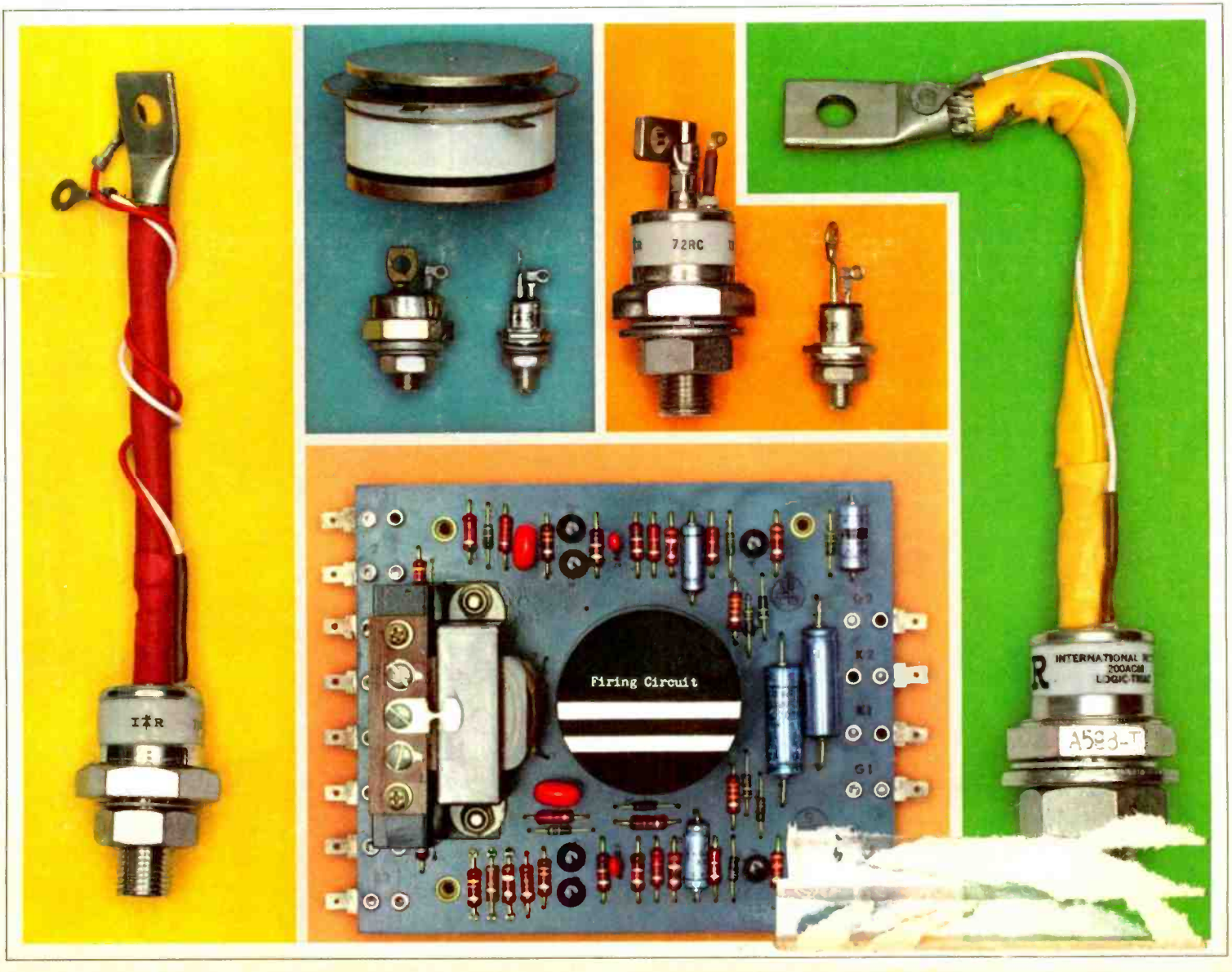
THE CO-OP ENGINEER—Partnership between Industry and Education

HOW TO SELECT THE PROPER FUSE

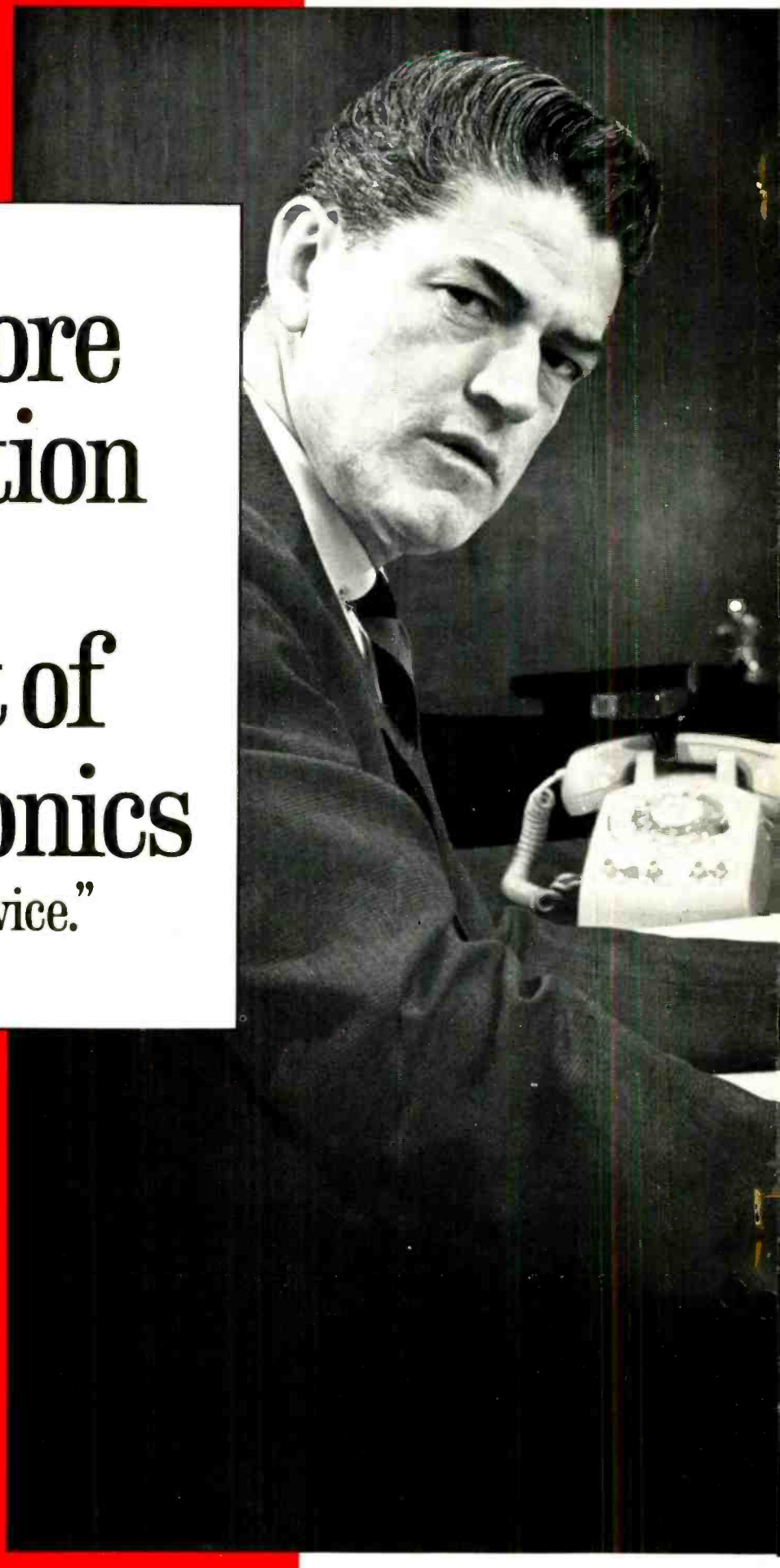
SOLID-STATE KITS—A Novel Method of Circuit Design

SCR's and TRIACS

INCLUDING PRACTICAL CIRCUIT APPLICATIONS



"Get more education or get out of electronics ...that's my advice."



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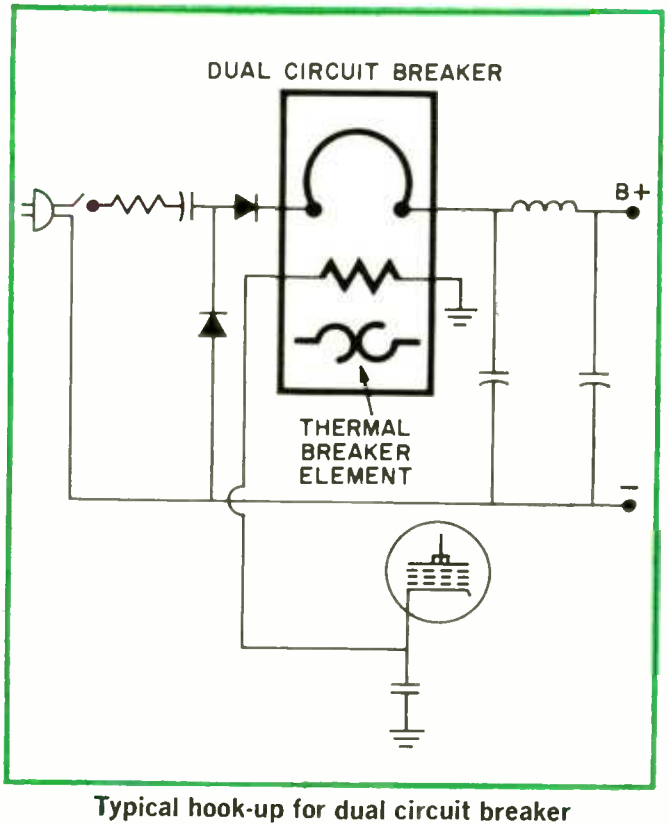
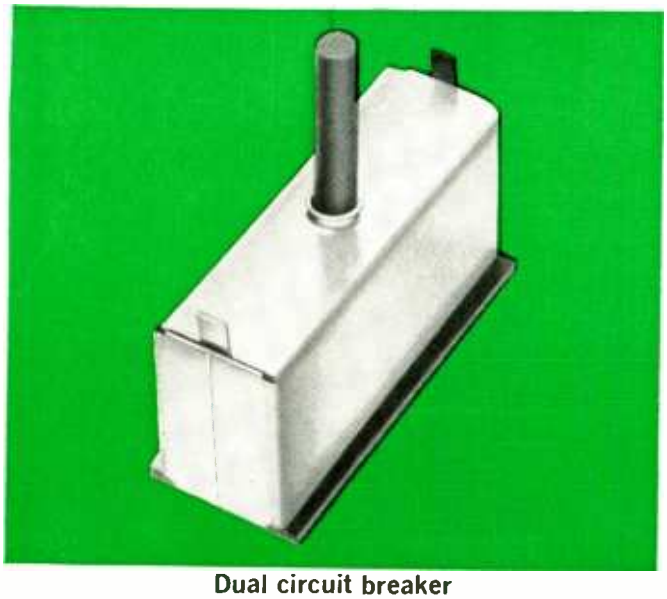
New circuit breakers for color TV



Typical hook-up for dual circuit breaker



Dual circuit breaker

Practically all the new color TV sets have a new kind of dual circuit breaker in them which you may not have run into before. Here's the story.

Remember back when black-and-white television used two fuses—one in the power supply input, and one in the horizontal output circuit? Next, in the interest of economy, the fuse in the horizontal output was eliminated. Then the designers switched to re-settable breakers, in the B+ line.

Along came color. Overload protection became necessary, because the horizontal circuits are more complicated, and more expensive components including the flyback transformer could be knocked out by a defect in the horizontal circuit.

The answer: a dual breaker which pops out from excess current in *either* the B+ or the horizontal output . . . in a single breaker case. It has two electrically isolated but thermally connected circuits, either of which can cause the B+ contacts to open.

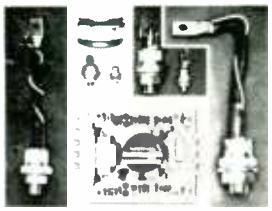
The diagram shows a basic hook-up for the breaker. The thermal breaker element goes directly in the B+ line. A resistor inside the breaker, usually about 1.3 ohms, is connected between the cathode of the horizontal output stage and ground. This resistor is located so it will heat up the thermal breaker element.

Along comes an overload in the B+. The thermal element pops the contacts open, in the usual manner. When there's excessive current in the horizontal output, the heating of the breaker's resistor has the same effect as a B+ overload, opening the contacts and removing voltage from the circuit.

Tip No. 1: breakers can fail because they get repeatedly reset into a fault. Check for gassy tubes and leaky capacitors before you replace the breaker, or you'll have the whole job to do over.

Tip No. 2: always replace with a Mallory breaker. We have three different dual breaker ratings in our line. They will replace the dual breakers in all existing color set applications. All are made to original equipment specifications. Your nearby Mallory distributor can supply you off the shelf. See him soon, or write to Mallory Distributor Products Company, a division of P. R. Mallory & Co. Inc., Indianapolis, Indiana 46206.

SCR's and TRIACS
INCLUDING PRACTICAL CIRCUIT APPLICATIONS



THIS MONTH'S COVER shows a number of new power thyristors (SCR's and triacs) manufactured by International Rectifer. A feature story on these new devices is our lead article. The large device at the left is a high-power SCR, while the unit at the right is the highest rated triac in the industry, a 200-A, 1000-V bidirectional thyristor. The hockey-puck-shaped device near the top center is a pressure-assembled SCR with a 60% greater current-handling capacity than stud-mounted units with the same junction area. Four other SCR's are shown with current ratings ranging from 5 to 100 amperes. The printed-circuit board assembly is one of the many pre-packaged firing circuits that are available for use with SCR's and triacs. It consists of a magnetic amplifier to provide the control function and to supply the basic firing pulses. These are then amplified and shaped by means of semiconductor circuitry. Cover photo: L. Heicklen Studios.

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CONTENTS

MONTHLY FEATURES

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COMING NEXT MONTH

SPECIAL FEATURE ARTICLE:

PHOTOCELLS

In this month's feature story, each of the four types of light-sensitive devices—photoemissive, photovoltaic, photoconductive junction, and photoconductive bulk effect—are discussed, but Author Rabinowitz of Clairex zeroes in on applications of the thick-film bulk effect units. He cites differences and gives the engineer down-to-earth advice on which device works best under certain conditions. A number of circuits—servos, low-level voltmeters, photometers, choppers, etc.—which use photoconductive bulk-effect devices are included.

TO THE MOON AND BACK
Spacecraft navigation is complicated; but when a space vehicle is aimed for a tiny spot on the moon's surface, the problems are astronomical. This article discusses the injection, midcourse, and terminal guidance phases.

AUDIO OP AMPS
Even though they cost more, hi-fi circuit designers will use IC's if these devices significantly increase the performance of audio systems.

IC DECIMAL COUNTERS
IC's have opened the floodgates to a torrent of new circuit applications. Decimal counters and readouts, which are in the forefront of these new uses, are discussed in depth in this informative article.

BURGLAR ALARMS
Electronic intrusion alarms may save your home or even your life. With the soaring crime rate, American businesses are spending increasingly large sums to keep burglary losses low.

TV ALIGNMENT TECHNIQUES
In Part 2 of this two-part series, the principles of alignment are thoroughly covered so that the technician is better able to interpret the service instructions for any TV receiver.

All these and many more interesting and informative articles will be yours in the September issue of ELECTRONICS WORLD . . . on sale August 20th.

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Radio & Television news

By FOREST H. BELT /Contributing Editor

Plug-In Transistors for TV

Service technicians in large numbers still shun transistor TV sets. One reason is that transistors are so hard to get at for testing. They are soldered to the circuit boards, and sometimes are damaged merely by the desoldering and resoldering. In its new line of transistor color-TV sets, *Sylvania* uses sockets. Transistors can be pulled out and plugged back in easily. Home servicing for these transistor sets can be almost the same as for tube sets: decide which stage is bad, plug in a replacement, and see if the set works. Or, pull out the transistor and check it with a portable transistor tester.

Precautions will be important. For one thing, plugging a transistor into a live circuit can damage it. The set should be off while the transistor is removed or replaced in its socket. Secondly, if a circuit fault has burned out the transistor, the new one will probably be burned out too. Technicians, with some ingenuity, can figure ways around this problem. The main thing is that in-home repair has come to the transistor-TV portion of the servicing field.

Radiation Emphasis Shifted

The television industry has insisted, as we have reported in this column, that x-radiation from color-TV sets is extremely unlikely to occur in any dosage that could have medical or genetic effects on technicians or viewers. In Congressional hearings connected with anti-radiation bills, a professor from the University of Pennsylvania and another from the University of California have suggested that non-ionizing radiation (such as the concentrated and amplified light from lasers) may be a worse problem than the ionizing kind—such as x-rays. Both told the Senate Commerce Committee that non-ionizing radiation might, in their opinion, produce physical and biological damage to humans.

This doesn't change the fact that many people are still concerned with color-TV x-rays, but it does mean that the spotlight has moved a little. There is slightly less pressure for an extreme anti-x-ray bill.

The Ubiquitous Cable

CATV marches on. The U.S. Supreme Court has just ruled that the FCC has the authority, under existing law, to regulate the growing CATV industry.

There are more than 2000 cable-TV systems in operation now, serving upward of 3 million homes. The long-standing battle with broadcasters still simmers, but it's interesting to discover that nearly one-third of existing systems or franchises are owned by broadcasters. Newspapers own about half that many. The newest strife developing is with phone companies who contend they can install CATV systems without bothering to get a franchise from their communities, since phone utilities are already licensed as common carriers; it makes no difference, they say, whether it's voice or video being carried into the home on phone-company lines.

At the 1965 convention of the National Community Television Association (now National Cable Television Association), dozens of cable operators disavowed any intention of ever originating programs. Now nearly half of them already do. Time and temperature (and other weather), plus local news and special events, comprise most of the programs thus far. But more than 10% report either using or planning to use film programs. With black-and-white and color cameras becoming less expensive, look for more live programming. Foot-in-the-door tactics include educational programs wired into schools at low or no charge.

FCC—"Big Brother" to Electronics

The Federal Communications Commission is looking into a new field: computers. They have already asserted their domain over CATV; their authority there was hotly disputed, but nevertheless became actuality with the recent Supreme Court ruling. Not long ago, new latitude was given the FCC to regulate consumer electronic products that might generate interfering radiation—such things as garage-door openers, microwave ovens, and the like. Such devices seem to fall almost within the realm of communications, particularly when actual communications or navigation might be disrupted by them. But—computers?

Computers are being interconnected over communications systems that do fall in the province of normal

FCC concern, so the FCC suggested perhaps they should also control the computers. While many computer users are anxious to maintain privacy, especially of proprietary industrial information going over the wires, not many like the idea of having the FCC riding herd on the hardware at either end of computer-communications links.

Who Pays for Warranty?

It shouldn't be the dealer or the customer, say most dealers and customers, but it's likely to be one or the other. The labor of warranty repairs is the big issue, and all sorts of plans are being put forward. Extended picture-tube warranties brought the problem into the foreground, as we predicted. Generally, manufacturers expect the dealer to foot the bill. One or two don't mind paying the dealer for warranty service provided the dealer has paid in a warranty fee—called a service contract—over and above the normal set cost. Of course, the dealer is to collect the fee, and perhaps a markup, from the customer at the time of the sale. That philosophy isn't going over too well with some dealers.

Westinghouse is including labor in its color-CRT warranty. The company will reimburse the dealer for installing an in-warranty color picture tube, at "retail" rates . . . whatever those are. Since there is nothing extra tacked onto the initial price, dealers and customers both like the sound of this kind of warranty. It will be interesting to see how many other color-set makers follow this example. There are likely to be other proposals before the summer is ended.

Distaff CET

A lady technician, Norma Blair, who works for *Daubendiek TV* in Beatrice, Neb., is the first woman to become a Certified Electronic Technician. It took three tries for her to pass the National Electronic Associations' certification exam, which is par for nearly one-third of the technicians who have taken the written test. She thus became CET Nebraska 33.

Cable-less TV

Microwave is sometimes used to pipe TV signals from distant reception points to the head end of CATV systems, but cable is always used to re-distribute the signals among subscribers. Now microwave equipment operating up near 50 GHz, which is almost infrared, is being tried in Brooklyn, N. Y. to distribute CATV signals to various apartment buildings. Past experiments with 18 GHZ in Manhattan were unsatisfactory in rain or fog.

Officials of *Laser Link Corp.*, developers of the equipment that permits operation at this extremely high frequency (e. h. f.), claim no trouble from rain or smoke, at least for short (2- or 3-mile hops). A novel modulation technique (details unavailable) is said to eliminate the need for large amounts of signal power. Installation costs in the city should be much cheaper with this beamed system.

Economy Warms, Sales Flourish

In the last month or two, consumers began spending their money for electronics goods again. Even with installment loans tougher and more expensive, sales of TV and radio sets are up. Prices of electronics goods are still not hit by the rising curve of inflation: TV sets in general show a decline in price. With more spendable income, the end result of general wage hikes, the American consumer is helping dealers recoup some of the un-met quotas of early months this year. You remember, there was a slump in April and May, following an unexpectedly good first quarter: that down-turn was disappointing.

However, there is the possibility of overheating in such a warm and humming economy as we now have. Canny dealers are avoiding inventory overloading, just in case. Another slump could be brought on by the controversial tax surcharge or by a tightening of installment credit.

Flashes in the Big Picture

Zenith color-TV sets for the 1969 model year have channel selector for all v.h.f. channels plus six detented u.h.f. channels that can be pre-set by customer. . . . Handwiring of TV sets loses another proponent as *Setchell Carlson* shifts to printed circuits: modular (called "Unit-ized") design will be retained. . . . *PlayTape* expects to introduce $300 home video tape recorder soon, using cartridge that holds ordinary ¼-inch magnetic tape. . . . Look for more aluminum wire taking place of copper; strikes cut copper supplies, and makers decided less expensive aluminum works about as well. . . . VTR is no longer only magnetic recording means for video: *Matsushita* has one called Video Sheet Recorder. . . . Radio in bathtub or pool? *RCA* has one that floats and is waterproof. ▲

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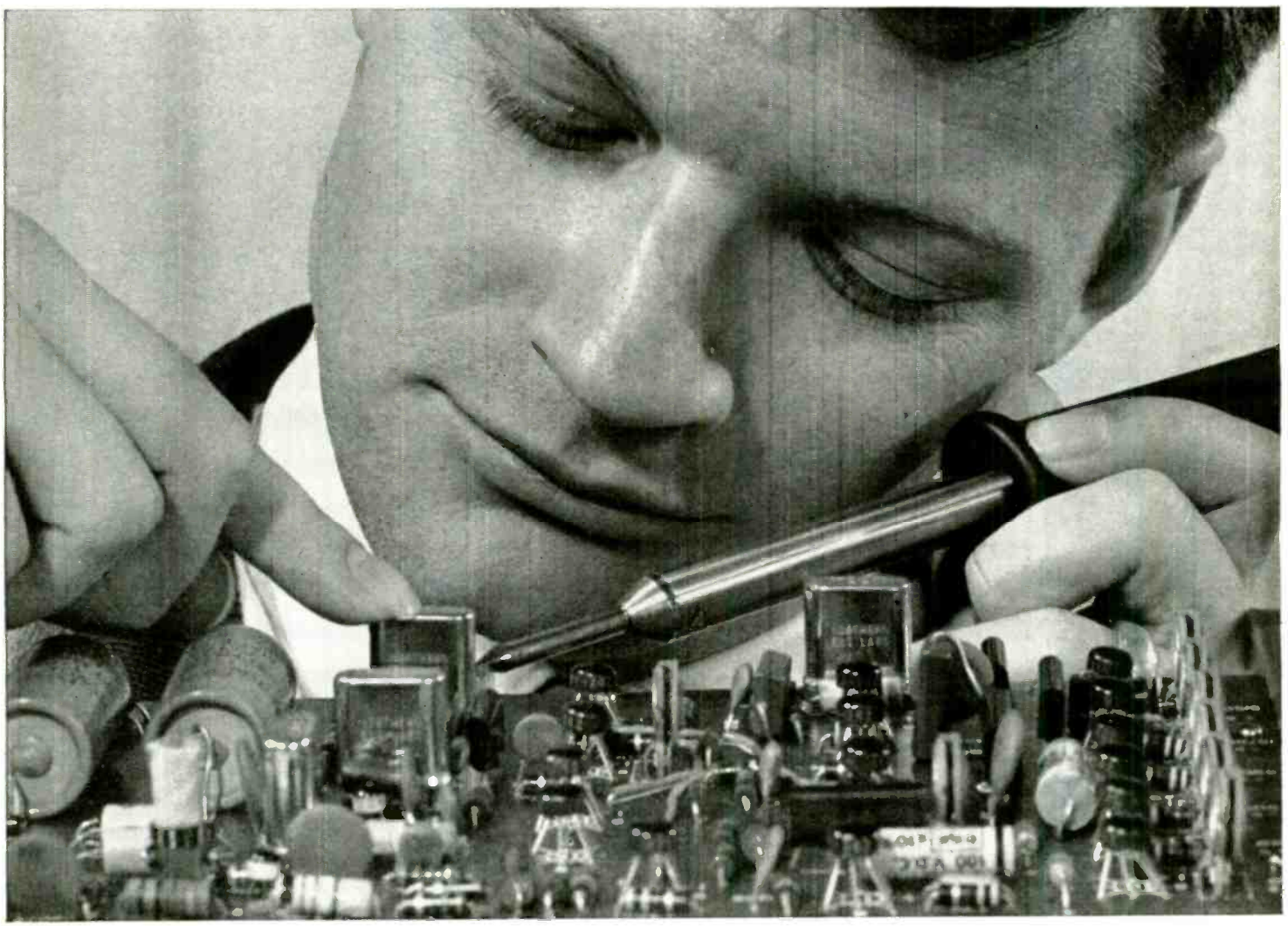

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LETTERS FROM OUR READERS

BATTERY-POWERED CARS

To the Editors:

I wish to compliment you and your magazine on the article "Battery-Powered Cars: Fact or Fantasy" appearing in the May issue. The author, Mr. W. Evanzia, skillfully handled a complex technical and timely social subject, and presented it in a simple, straightforward manner. He clearly pointed out the important areas of technological developments which will bring about an acceptable electric vehicle to the American market, in the not-too-distant future.

I would like to point out, however, several minor errors in your article. The article refers to Dr. Robert C. Shair as the head of electrochemical research at *Gulton*. The name that should have appeared is that of Dr. Harvey N. Seiger. Dr. Robert Shair is Vice President of corporate research and development and he presently guides the total research activities of *Gulton Industries*.

There are also two apparent misprints. The first acceleration in Table 1 should read: 0 to 60 mi/h and not 0 to 20. Table 2 gives 15 Wh/lb as the energy density for the Ethium battery. The correct value is 150 Wh/lb expected from the system.

I wish to assure you that these minor errors in no way detract from the quality of your fine article.

STEVEN CHARLIP, Section Head
Engineering Development
Gulton Industries, Inc.
Research & Development Division

Also, in the third paragraph at the top of p. 41, the output of the silver-cadmium cells should have been indicated as 25 rather than 2 watt-hours per lb.—Editors

To the Editors:

Mr. Evanzia's article on electric cars in the May, 1968 issue ends with the remark that "Electric cars may not be the complete answer to our traffic congestion and air pollution, but if they aren't, what is?" There is such a good answer to this one that I could not resist a reply even if it may not appeal to you electronic types.

Much to everyone's surprise, the products of combustion from a steam car boiler (even the antiques) are orders of magnitude lower in smog-producing components than are internal-combustion engine exhausts, and the modern steam car is, to say the least, competitive with present-day gas cars in range and performance.

If electronics people really want to help lick the smog problem, give us a practical control system for the temperamental monotube boilers that give the modern steamer its ten-second warm-up, light weight, and freedom from explosion hazards. The best automatic controls we have now are copies of those developed by Abner Doble in the early thirties.

If you are interested in this sort of thing, contact The Steam Automobile Club of America, Inc., 1937 East 71 St., Chicago, Ill. 60649.

DOUG GARNER
Newport News, Va.

* * *

ELECTRONICS TRAINING EDITORIAL

To the Editors:

Regarding your editorial "Electronics Training for All" in a former issue, this struck a chord of encouragement that the electronics industry may be awakening to the realization of the need for electronics training in our educational system. However, as I read and reread your article, I had the distinct feeling that your comments were directed to the college-oriented populace. While this is proper and necessary, it will not answer the "servicing and maintenance of electronic equipment [that] will continue to plague the industry" problem mentioned in paragraph five of your editorial. This problem can only be solved by considerably increasing the training of electronics technicians.

Where are we going to get our electronics technicians? Not from the college graduates, that is certain. The only source of such personnel is our vocational technical programs that should begin in the high schools and continue in our junior colleges and technical institutes or centers. It certainly takes much more training in the practical than in the abstract in order to be a good service technician.

Know why RCA's color chassis are so easy to service?

Because service men like you helped us design them.

First we got their advice, then we designed the whole assembly for easy servicing. For example, the chassis give you easy access. You don't have to pull out the chassis to get at the high-line voltage connection. Circuits and components on the circuit board are clearly marked so you can easily service them. The tuner assemblies are simplified for your convenience. And, we set up more test points. They're the kind of chassis we think you'd design yourself. Fact is, all our chassis designs are reviewed by a representative group of servicemen. And we appreciate their advice. We think you will, too—every time you service sets by RCA.

RCA

As you know, only a small percentage of our high-school graduates go on to college. Those who do not should by all rights take some kind of technical training. However, the number of non-college-bound students securing technical education is extremely small. Here at our high school of 1230 students, only 123 are enrolled in some kind of vocational program; of this number, only 25 are in the electronics technology course. This enrollment is by far too low. As I see it, there are mainly two reasons for this. First, there is the overstressing that *all* students should prepare for college regardless of their ability, desire, and/or capability. In other words, our high-school educational system is academically oriented and is not performing the educational service to the public which would meet its needs.

Second, and most important, there is the stigma that has long been attached to vocational training, be it under the guise of technical education or trade and industrial education. Too many people feel that such training is for the "numbskulls" and disciplinary problems. This has made it difficult to secure those students who do not fall in these categories but who could profit greatly by such training.

GARLAND P. KUNTZ
Electronics Instructor
Dunedin High School
Dunedin, Fla.

* * *

COMMUNICATIONS VIA TOUCH

To the Editors:

Your article "Communications Via Touch" (May issue, page 32) contains some surprising statements. I have performed a number of experiments with arrays of air-jet tactile stimulators on the fingertips somewhat similar to the ones you describe on the chest. In my experiments maximum recognition rates have never exceeded 2 letters/second with random letters or 4 letters/second with English text. This is a far cry from the 15 characters per second you report. How, when, and where was this particular experiment performed and by whom?

JAMES C. BLISS, Group Head
Bioinformation Systems Group
Engineering Techniques Laboratory
Stanford Research Institute
Menlo Park, Cal.

Mr. Bliss' concern was caused by the inadvertent omission of a decimal point. The correct transmission rate is around 1.5 characters per second, not 15. Also, on page 80, the sentence "pulses or taps of the skin contactor shorter than 0.5-microsecond duration cannot be felt by man" might invite some additional queries. In lieu of "shorter than," the word "of" would have been more appropriate.—Editors ▲

Reflections on the news

Over 125 Million Tons of Pollutants . . .

are dumped into the nation's atmosphere each year, says "Waste Management and Controls" magazine. Almost 60% of the pollutants are from vehicles—cars, trucks, and buses; manufacturing processes account for another 18%; electric generation for 12%; space heating and refuse disposal for 9%; and miscellaneous causes 1%. This huge blanket of filth which covers the country from coast-to-coast has created a market for pollution control equipment and services that could reach $105 billion by the year 2000. The 1967 anti-pollution equipment market was estimated to be more than $380 million and most of the country has yet to attack the problem seriously.

But many people responsible for pollution control do not understand the problem. There has been a tendency to separate air pollution control from water pollution control, where in fact they are part of the same problem. Many industrial companies remove contaminants from gas and vapor and dump them into streams to pollute the water. Likewise, manufacturers remove contaminants from liquid waste, burn them, and pollute the atmosphere. It appears that the only reasonable approach to the pollution control problem is a "system approach." The entire environment must be studied and monitored. Then, after sufficient data has been gathered, a system of control can be designed to nip the problem at the source. But, before a control system can be effective, a determination of what level of pollution man can stand has to be made.

Some of the larger cities such as New York, Los Angeles, and Boston have appointed agencies or set up groups to study the pollution problem. Other industrial centers are passing numerous pollution control laws. The National Center for Air Pollution (a division of the Public Health Service under the Department of Health, Education and Welfare) is employing many engineers to study industrial processes, determine pollution levels, and to recommend changes in existing techniques of pollution control. Some of the industries being carefully looked at are iron and steel plants, pulp and paper factories, and ore processing plants. It'll be another year or two before most of the present studies are completed and probably longer before much progress is made in either air or water pollution control.

Liquid Crystals . . .

may be the most important new development in display systems since the coming of the light bulb. The new technique which was disclosed by *Radio Corp. of America* scientists at a recent press conference makes use of the line-up of molecules in a "nematic" liquid crystal—where the molecules are stacked in short lengths like a pile of lumber—to form pictures and numbers that reflect light.

The revolutionary new technique is still under development, and likely to remain so for some time. However, *RCA* demonstrated its potential application to new products by showing it being used as a decade counter display and a 24-hour clock dial. The scientists see the liquid crystal as a possible thin-screen competitor to such vacuum-tube displays as the oscilloscope used in radar, the "Nixie" tube, and—way in the future—the picture tube in television sets.

Making displays, at least in this extremely primitive development phase, is a simple process. A thin film of liquid crystal 1/1000th inch thick is squeezed between two thin sheets of glass whose inner faces have been coated with a conductive tin oxide. When an electric field is impressed upon the crystal, ion flow dynamically scatters light and gives the crystal a milky white appearance. Unlike most electroluminescent displays, the liquid crystal gives off no light of its own. It is reflective in nature and the brighter the light shining on the crystal, the easier it is to see.

Electronic Surveillance Equipment . . .

has made the difference in a number of firefights in Vietnam, say Army Information Officers. Some details on a few of the newest pieces of equipment have been declassified and released to the public by the Army, perhaps in hope of impressing the Viet Cong with our technical prowess. Most of these so-called "new" devices have been in the works for years, but for one reason or another are just beginning to be used under combat conditions.

When US troops began to arrive in Vietnam in large numbers, they brought with them radars and other surveillance equipment which was representative of the state of the art of the early 1950's. Such an instrument was the PPS-4, a portable personnel surveillance radar which was almost always out of action. Even

when it worked, its performance was marginal. Few soldiers knew how to operate it and most of these men lacked the experience to tell human movement from trees, water buffalo, and the like. In addition, the weather proved to be almost as big an enemy as the Viet Cong and North Vietnamese. Heat and humidity fostered fungus growth, making radar and radios inoperative; and the extremely high temperatures ruined mountains of batteries stored in supply dumps.

It was with relief that the Army men welcomed the PPS-5, a much improved anti-personnel radar. It's more accurate, easier to use, and many times more reliable than the PPS-4. Recently American troops have received image intensifiers, a device that helps them see in the dark. The intensifiers pick up very faint light rays reflected from objects. The light rays enter a viewing tube through a set of fiber optics which has on one side a chemical film that emits electrons when light strikes it. The electrons are accelerated by an electric field and strike a fluorescent screen to paint a picture of the scene under observation.

Other personnel detection devices will probably be field-tested in the Vietnamese jungles soon. Army researchers are working on at least two smaller versions of anti-personnel radar; the AN/TPS-15 and the AN/PPS-7 for Marine use, and one that mounts on the barrel of a rifle. There is even a device that "sniffs" out the enemy by detecting, at great distances, human body odor.

Without Positive Fingerprint Identification . . .

many criminals would go free. But searching fingerprint files for matching "impressions" is a laborious, time-consuming job. Therefore, the Federal Bureau of Investigation has requested the National Bureau of Standards to develop a computer-aided method of fingerprint identification. Automating even part of the identification process, the FBI feels, will reduce the manpower required to search for matches and speed identification. Exclusive of other law enforcement agencies, the FBI has over 60 million sets of fingerprints in its civil file and about 17 million in its criminal file.

The use of fingerprints for identification purposes is impeded by the difficulty in classifying them succinctly; the Henry system, which has been in use for over 60 years, requires impressions of all ten fingers. In searching for a matching fingerprint, a hundred or more prints in the same Henry classification must sometimes be inspected. This work is done manually.

Just the first leg of developing an effective computer-aided fingerprint identification system has been completed. Joseph Wegstein of the NBS Computer Center has designed a procedure to produce compact descriptions based on the minutiae, or fine details, of the fingerprint impression. In the Henry system, identification is confirmed by the presence of pattern characteristics such as arches, loops, and whorls, and by counts of ridges between certain features. The Wegstein technique characterizes fingerprints by comparing certain groups of minutiae from among the ridge endings, bifurcations, incipient ridges, islands, and enclosures that make the fingerprint unique. Thus it is possible to make preliminary identification on the basis of one print instead of ten.

Computer programs utilizing the Wegstein characterization technique have been written. The next step of the project involves experimentation with various methods of matching fingerprint descriptors.

Some Thoughts . . .

about things going on. *Westinghouse Electric Corp.* reports it has developed the world's smallest neutron detector. The chamber, which measures less than 0.075 inch across and 2.4 inches long, will be used to measure neutron flux in reactors a billion times its size. . . . Will European railroads be automated? English railroad men are interested in the *Marconi Co. Ltd.'s* Myriad 11 computer and graphical/tabular display which automatically controls rail traffic in complex networks of crossovers and junctions. A *Siemens* 4004/45 data processor schedules the Rumanian State Railways' freight movements four weeks in advance. . . . Federal Aviation Administration predicts that the number of passengers traveling on US airlines will triple in the next decade. Where will we put the planes? . . . What will probably be the world's largest integrated computer system will be located at the Defense Logistics Services Center in Battle Creek, Michigan. When completed, the system will be able to supply "real time" logistics intelligence for all branches of the services. Thirty-four people have been working full time for more than a year to spell out the computer requirements. . . . The New York Stock Exchange has put into operation its $5 million *IBM* System 360 computer. The computerized bookkeeping system will keep track of the deposit and withdrawal of shares between clearing houses. The system, which should cost about $8 million per year to operate, is expected to eliminate up to 75% of the present handling of stock certificates by brokers. . . . Optical communications systems moved toward practical usage when *Bell Labs* scientists announced they had developed the first tunable continuously pumped coherent parametric oscillator. The system is experimental, but the *Bell Labs'* scientists say the technique can be adapted to digital data, facsimile, voice and picture transmission as well. ▲

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

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

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

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

Coming Impact of UHF

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

Opportunities in Plants

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

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

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

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

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

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Matt Stuczynski, Senior Transmitter Operator, Radio Station WBOE

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Glenn Horning, Local Equipment Supervisor, Western Reserve Telephone Company

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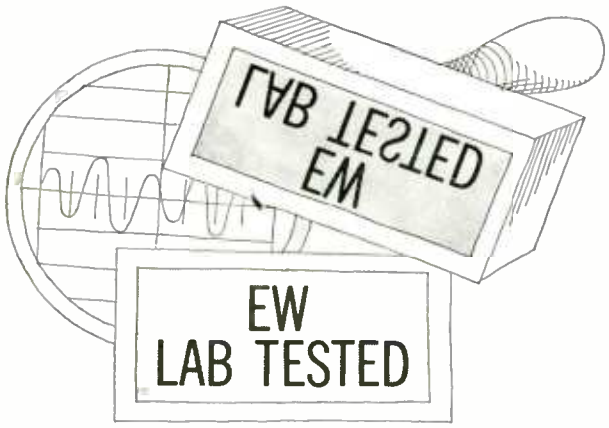


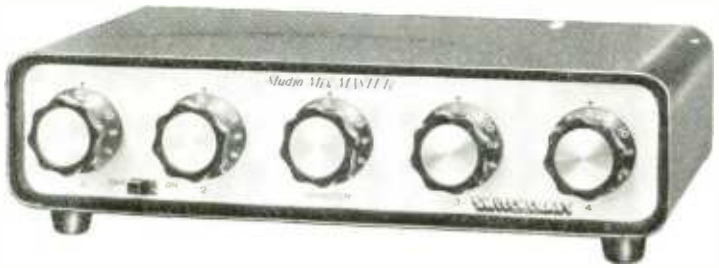
HI-FI PRODUCT REPORT

TESTED BY HIRSCH-HOUCK LABS

Switchcraft Model 307TR Mixer
KLH Model Five Speaker System

Switchcraft Model 307TR Mixer

For copy of manufacturer's brochure, circle No. 35 on Reader Service Card.



A PROGRAM mixer is an important part of any recording, broadcast, or public-address installation. It permits combining and individual adjustment of several different program sources, such as microphones, phono cartridges, tape recorders, or tuners into a single signal which can drive higher level amplifiers.

Mixers for professional applications are normally much more elaborate and costly than for amateur or simple public-address use. The new *Switchcraft* Model 307TR "Studio Mix Master" is a four-channel, solid-state stereo or (mono) mixer admirably suited to the needs of the serious amateur or for less-exacting professional requirements.

The mixer has four inputs, each with its own front-panel level control. A fifth, master volume control, affects the total output. Each input has two alternate jacks; one is a high-level Aux. standard phono jack and the other is a phone-plug microphone jack, only one of which may be used at a time. In the rear of the unit is a stereo/mono switch which combines all four inputs into the left-channel output in the Mono position. For stereo recording, the Stereo position of the switch, in effect, divides the mixer into two halves, each of which has two inputs and separate outputs.

There are also two phono-equalizer slide switches that convert two of the four microphone inputs into RIAA-equalized magnetic-phono cartridge inputs. In this mode of operation, the Model 307TR can be used as a mixer for a stereo cartridge and a pair of microphones, a cartridge and a stereo-tuner signal, and numerous other combinations of program sources.

The mixer is powered by two 1.5-volt "D" cells. This 3-volt power source operates a transistorized inverter that delivers 18 volts d.c. for powering the amplifier transistors. The batteries should last about 100 hours if used two hours a day, and somewhat less in continuous service. Since there is no pilot light to indicate that the unit is turned on, it is necessary to develop the habit of switching the mixer "off" when not in use.

With all level controls at maximum, only 100 millivolts was needed at the Aux. inputs to develop 1-volt output. At the microphone inputs, 1 millivolt was sufficient to drive the amplifier to 1-volt output. The magnetic-phono inputs required 4.6 millivolts.

The signal-to-noise ratio was about 48 dB referred to 1-volt output, at maximum gain, and slightly better at lower gain settings. The audible noise was all hiss and the noise level would be rated even lower if the bandwidth were weighted to be restricted to the audible range. Noise was inaudible under ordinary operating conditions and unmeasurably low on Phono, where the RIAA equalization de-emphasis attenuated it considerably.

The microphone inputs did not overload until a signal of 160 millivolts was applied, regardless of control settings. The phono inputs withstood 200 millivolts without overloading. In practical terms, this means that the mixer is immune to overload from its intended program sources.

The distortion was dependent on the setting of the individual level controls. At the maximum setting, distortion was about 0.5% at 1-volt output, 0.85% at 1.5 volts, and 4.5% at 2 volts. At half of maximum setting, although the maximum output conditions were not affected, the distortion at 1.5 volts was 0.25% and at 1 volt was a very low 0.13%.

The basic frequency response through the Aux. inputs was flat within +0, −0.5 dB from 20 to 20,000 Hz. The magnetic-phono cartridge equalization was accurate to within 1 dB or so over its full range.

There is little that can be said about the performance of a unit such as this, except that it worked exactly as intended, and seemed to have absolutely no vices or weaknesses. It sounded fine and was stable and quiet under all conditions of operation. It was housed in an attractive, glossy black-enamel metal case, with rubber feet.

The *Switchcraft* Model 307TR has a suggested user net price of $87. ▲

KLH Model Five Speaker System

For copy of manufacturer's brochure, circle No. 36 on Reader Service Card.

THE *KLH* Model Five bridges the gap in price and performance between the company's popularly priced Model Six and the top-of-the-line Model Twelve. Like other *KLH* speakers, the Model Five uses an acoustic-suspension woofer in a fully enclosed cabinet measuring 26″ x 13¾″ x 11½″ deep. Although it could be installed on deep, sturdy shelves, its size and weight will dictate a floor mounting in most cases of use.

The Model Five is a three-way, 8-ohm system with a 12-inch driver operating up to 600 Hz. Two 3-inch cone speakers operate between 600 and 3000 Hz, while a tiny 1¾″ dome tweeter radiates the frequencies above 3000 Hz. A pair of three-position level switches on the rear of the cabinet per-

(*Continued on page 60*)

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TYPE S54

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X10 Gain increases deflection factor to 10 mV/cm (DC to 4 MHz).

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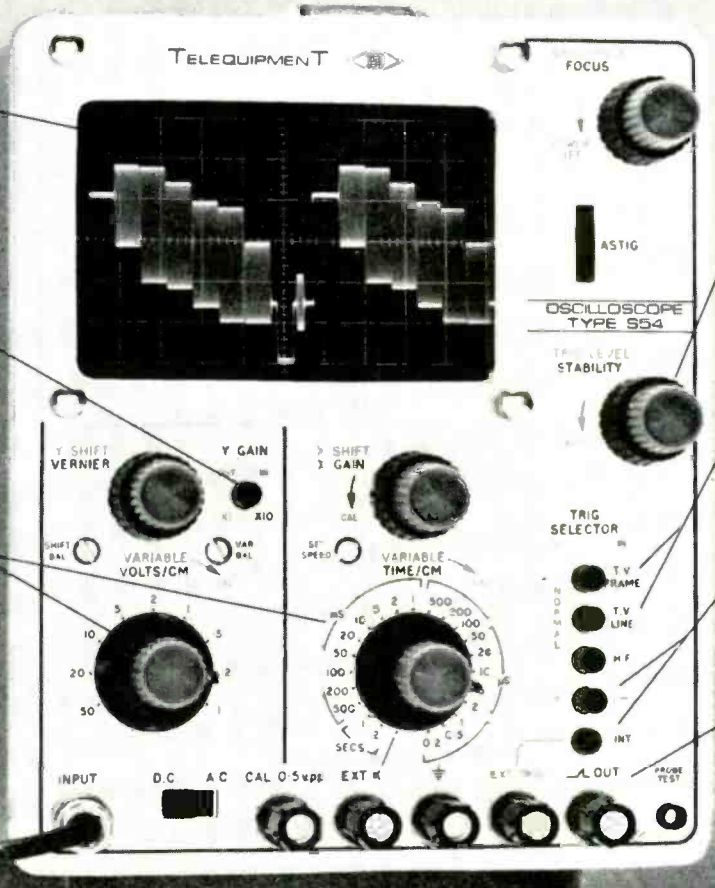

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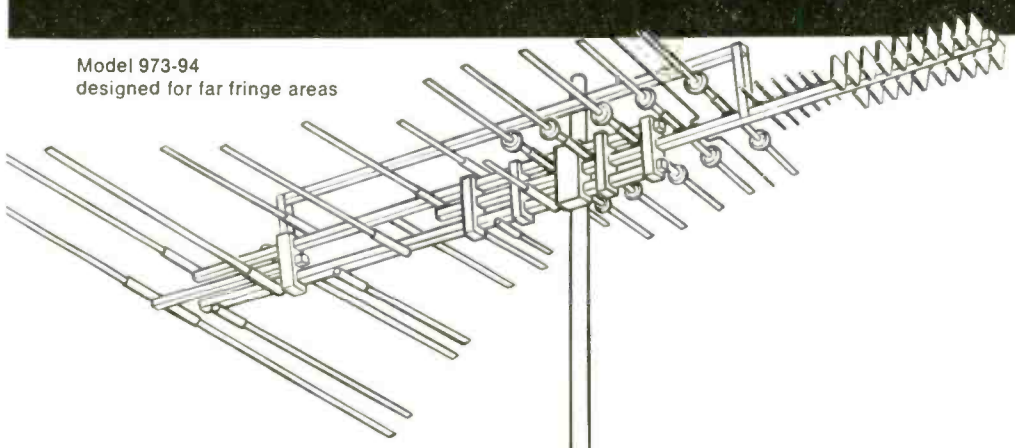

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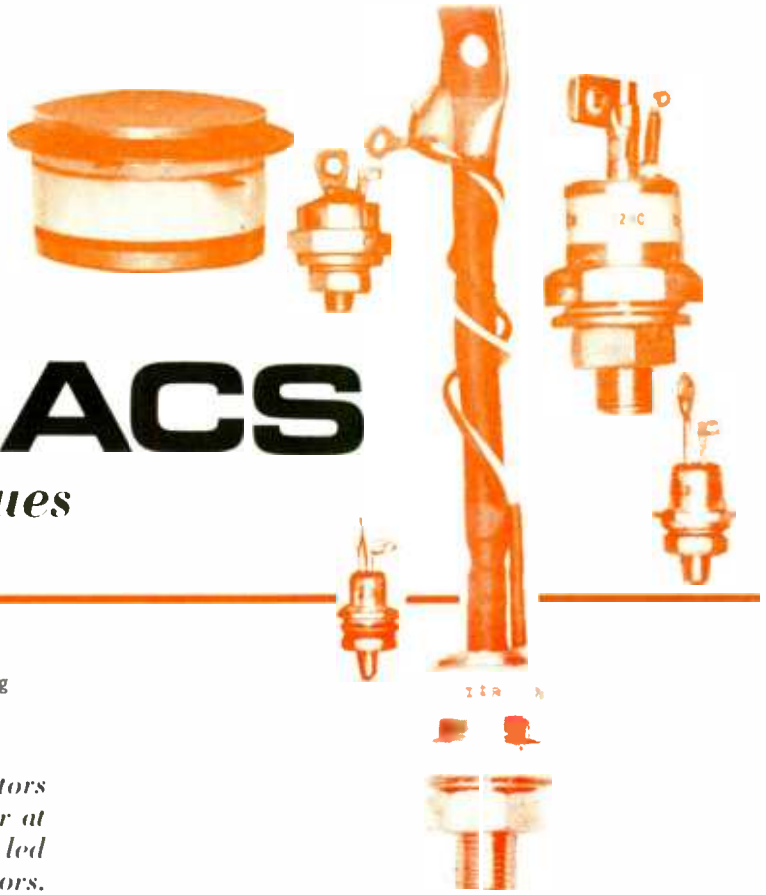


By DAVID COOPER/ Manager, Advanced Products Engineering
International Rectifier

In the past two or three years, new thyristors have been developed that handle higher power at faster speeds and at lower prices. This has led to more uses for these new semiconductors.

TWO and a half years ago, an article entitled "The SCR Revolution" appeared in this magazine (February, 1966 issue). The author described some of the many applications which had been developed using thyristors (SCR's and triacs). At the present time, the revolution is continuing and, as a matter of fact, at an ever-increasing tempo.

The challenge presented by the availability of relatively low-cost SCR's in current ranges from one ampere to more than 500 amperes has been met by imaginative circuit designers. SCR's are now being applied to literally thousands of items. They are being used in equipment ranging in power ratings from hi-fi sets to steel-mill drives and in frequency ratings from the low frequencies used in furnace-heating supplies to the high frequencies used in radar pulse modulators. Most of the emphasis in SCR development in the past two or three years has been on extending the voltage and current ratings of devices and, at the same time, making them faster in their ability to turn on and turn off.

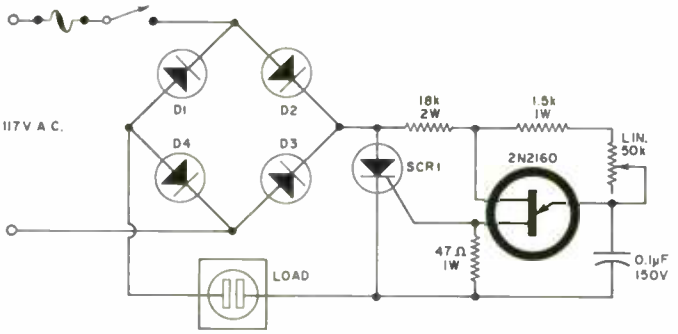
Better and Cheaper

By employing advanced design and fabrication techniques, such as shorted emitter construction and multi-gate design, and by using minutely controlled diffusion and epitaxial deposition, SCR manufacturers are now able to supply a 500-ampere device with high voltage capability and faster turn-off than the first 16-ampere devices which were introduced in 1958. More important is the manufacturers' ability to produce these characteristics on demand and in large quantities, thus maintaining a low manufacturing cost which can be passed along to equipment manufacturers. This trend toward lower costs of devices with rather sophisticated requirements is, of course, the means by which more and more SCR applications become economically practical. Another direction being taken in industry to lower the cost and also to simplify electronic equipment is to combine several distinct but related functions in one device.

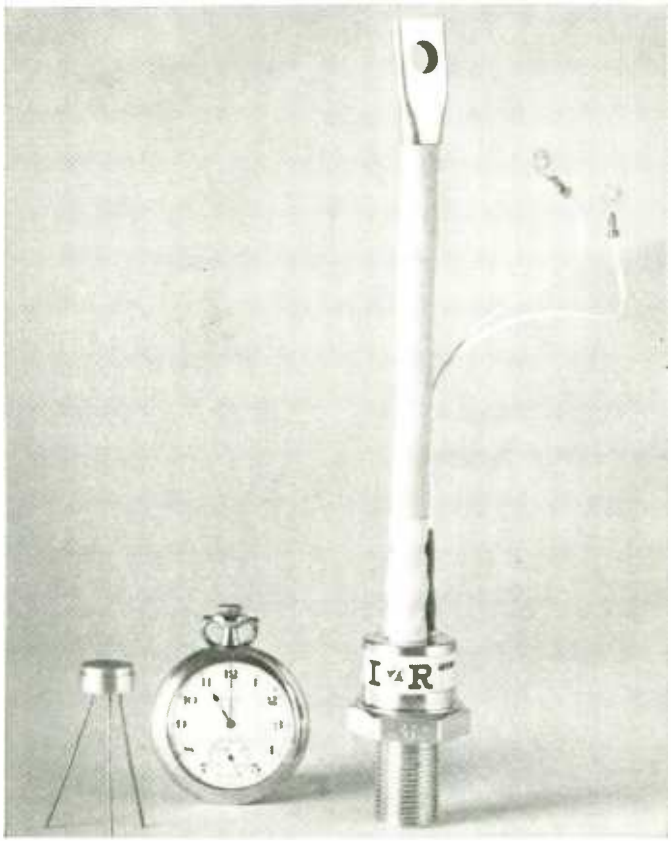
Electron-tube manufacturers have delayed the demise of the electronic tube by combining several vacuum tubes in one envelope. They are now developing tubes which also include resistors and other components within the tube envelope. Producers of solid-state devices have done the same in the form of integrated circuitry. However, most of the early progress in this field has been made at low power levels. One exception to this is the triac. The triac, or bi-directional thyristor, combines the function of two SCR's in a single silicon chip.

The progress made in triac technology in the past few years is phenomenal. In 1966 the largest triac available was rated at 10 amperes and 400 volts. A triac is now in produc-

Fig. 1. Full-wave incandescent light dimmer for lamps up to 400 or 1000 watts. Can also be used as motor speed control.



	FOR LAMPS UP TO 400 WATTS OR SMALL MOTORS (UP TO 2 AMPS)	FOR LAMPS UP TO 1000 WATTS OR LARGER MOTORS (UP TO 5 AMPS)
D1-D4 =	3F20-D	20HB20
SCR1 =	2N1774	2N685



Only two years ago, triac ratings were in the 5 to 10 amp range. Today, 200-ampere triacs, such as the one on the right, can control more than 140 kilowatts of a.c. power.

tion which is rated at 200 amperes, 1000 volts, representing 50 times the former power rating. This 200-ampere triac also possesses a "logic-gate" characteristic, which not only permits the use of simpler power circuits but also allows further simplification of the driving circuitry.

The high-power triac has provided tremendous size reduction in power-control equipment. For instance, theater light-dimming circuits of 12-kVA rating require only one triac as opposed to the two SCR's previously needed, and a three-phase a.c. motor starter can be designed in 60% of the volume formerly required using SCR's.

Another means of advancing the use of thyristors has been the availability from several manufacturers of a packaged driving circuit for various types of power control schemes. These contain all the necessary circuitry to provide smooth, accurate, and reliable control.

Recent advances in power thyristor packaging have also helped to provide more kilowatts per dollar in a smaller space. Most power rectifiers and silicon controlled rectifiers in the past have been supplied to the user in a case with a threaded stud on one end. This permitted the user to screw the stud into a metal plate (usually aluminum or copper) which serves to conduct heat away from the semiconductor to maintain a reasonable operating temperature. By designing semiconductor cases capable of being heat-sinked on both sides of the device simultaneously, manufacturers have been able to increase the current rating of the same piece of silicon by 60%. Through the use of standardized, off-the-shelf driving circuits and the newest high power density thyristor and rectifier packaging, it is possible to build extremely compact and efficient assemblies capable of controlling hundreds of kilowatts.

With the advent of large, stud-mounted junction devices in high-voltage ratings and double-sided cooling, the SCR has truly come into its own in large power applications. What was considered an innovation in motor control for vehicles came in 1964 when SCR control for golf carts was

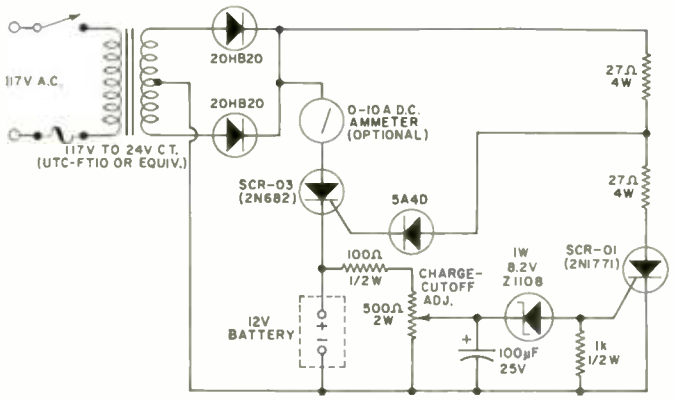


Fig. 2. Controlled battery charger delivering up to 10 amps. Charging rate is reduced to trickle at a given preset level.

introduced. Only three years later in 1967, two rapid transit cars using an SCR control capable of simultaneously driving several large d.c. traction motors rated at several hundred horsepower were added to the Chicago transit system.

Plastic-encapsulation of SCR's is another fabrication technique that reduced device cost in the past few years. For example, a 40-A, 400-V SCR in a ceramic-metal case cost $30 in 1966. In its present encapsulated version, a similarly rated device now sells for about $9.

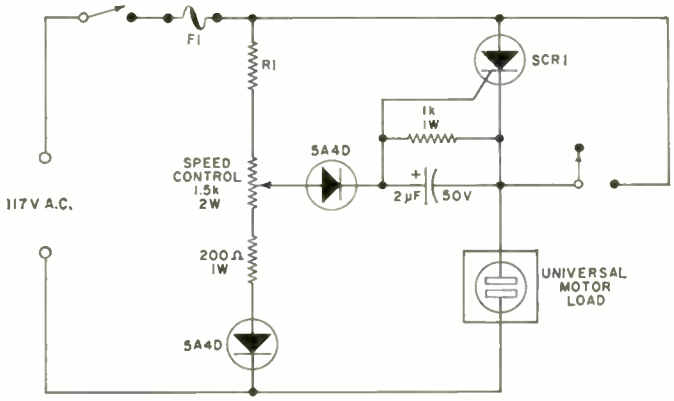
Static Power Control

The inherently fast response and controllability of the SCR and triac have truly revolutionized static power control. Digital-computer-controlled SCR heating and climate control systems for office buildings, now being designed, are so precise and maintain such high resolution that they change the power distribution to the various parts of a building, sensing a temperature change even when a cloud covers the sun. Thus only the minimum energy is required for heat. It is estimated that this highly sophisticated type of climate control system will pay for the entire installation in large office buildings in power savings accrued over a three-year period.

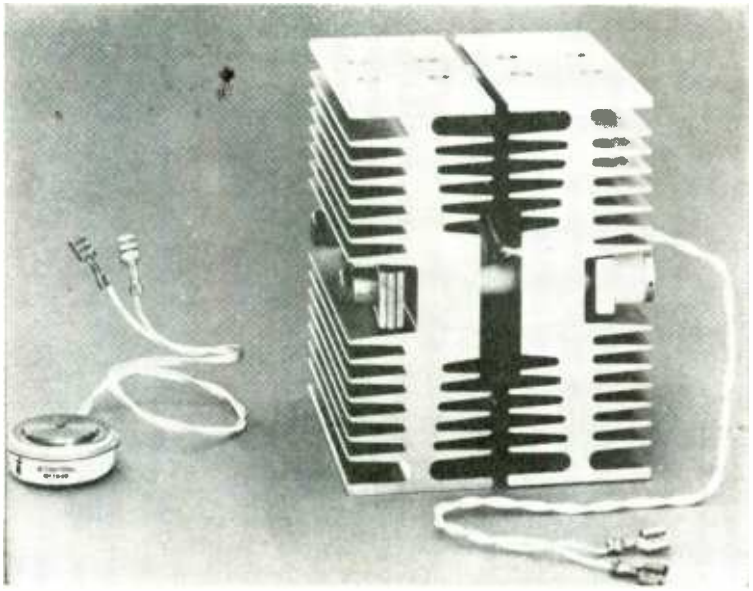
The advent of integrated circuits has also helped to increase the use of silicon controlled rectifiers. By being able to incorporate more control and logic functions in smaller and less expensive packages, the designer has been able to show the economic feasibility of many circuits which might otherwise have proved impractical.

In order to illustrate this let us consider pulse-burst modu-

Fig. 3. Variable speed control designed for universal motor.



	FOR 2A MOTOR	FOR 5A MOTOR
R1 =	10k, 2W	5k, 2W
F1 =	3A	10A
SCR1 =	SCR-02 (2N1774)	SCR-04 (2N685)



This pressure-assembled hockey-puck-like SCR can have heat sinks on both sides thus increasing the power-handling capacity. This SCR, which can carry as much as 250 amperes average, has a 60% greater current-handling ability than a conventional stud-mounted device having the same junction area.

lation and zero crossover firing control. One of the disturbing effects of SCR control has been the r.f. interference noise generated by the very fast switching of the SCR's. Where loads have relatively slow response to changes in applied energy (for instance in temperature changes in large heaters), it is now possible to use a control scheme which virtually eliminates this noise generation. By switching the SCR's on as the sinusoidal supply passes through zero, a very smooth waveshape results. If this switching continues for several cycles and is then discontinued and then repeated, the load will be subjected to "bursts" of sine-wave pulses—hence, the name, pulse-burst modulation. This concept is even more attractive when you consider the integrated circuits available to perform the logic required.

Inverters and Choppers

A very interesting application of the SCR which has come into its own in the last few years has been the static inverter. An inverter is simply a circuit which converts d.c. to a.c. Some common applications for SCR inverters are fluorescent light supplies, induction heating supplies, ultrasonic

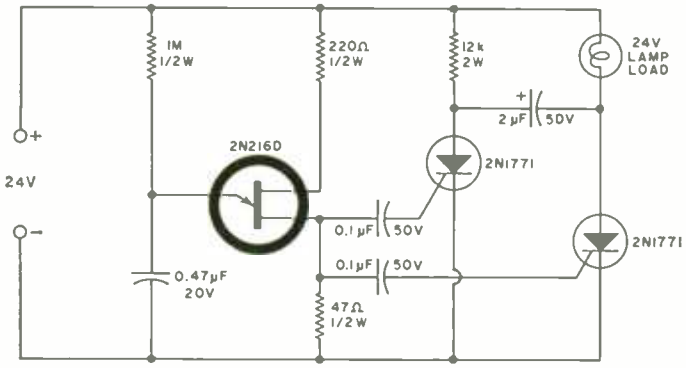


Fig. 4. Battery-powered flasher circuit producing about 60 flashes per minute. To vary flashing rate, substitute 0.5-meg resistor and 0.5-meg pot for the 1-meg resistor.

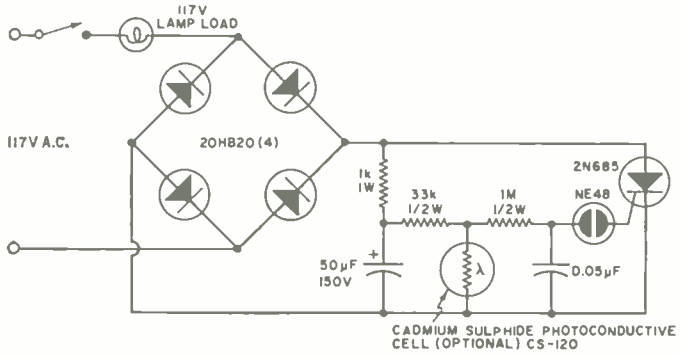
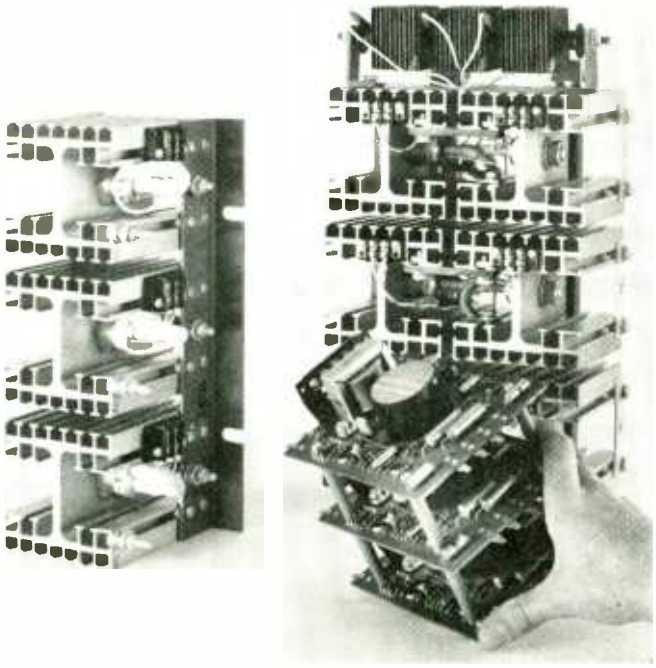


Fig. 5. Line-voltage flasher with optional PE control.

Plastic-encapsulated SCR's, such as these, are low in cost.

Table 1. Listing of typical SCR inverter applications and output capabilities.

APPLICATION	POWER RANGE	FREQUENCY	ADVANTAGES
Fluorescent-Lighting Supply	3 kW to 30 kW	400 Hz to 10 kHz	a) Increased lamp efficiency b) Allows use of fluorescent tubes where only d.c. is available
High-Frequency Induction Heating	1 kW	I kHz and up	a) Increases productivity in metal-processing industry b) Saves power over rotating machine c) Provides lower maintenance over other high-frequency sources
Ultrasonic Cleaning	500 W and up	50 kHz and up	a) Increased productivity for industrial uses b) Solventless cleaning reduces additional steps in cleaning process
A.C. Motor Speed Controls	10 hp and up	0 to 400 Hz	a) Can replace d.c. motor b) Lower maintenance, lighter, smaller
No-Break Power Supplies	10 kw to 400 kW	60 Hz	Provides uninterrupted power for computers or other equipment vital to business and national defense



Prepackaged firing circuits, such as this three-phase unit which is shown in the right foreground, can be employed with triac (left) and SCR (right) controllers.

generators, induction motor speed controls, and no-break power supplies. SCR inverters are being manufactured to provide output power ratings ranging from a few kilowatts to several hundred kilowatts. Table 1 lists the wide range of application and output capacities.

There are many types of inverter circuits now being used. (*See Special Section on "Power Supplies" in our April, 1968 issue.—Editor.*) Inverters producing sine-wave outputs can be applied to many different kinds of loads with very good results. They can also be used in multiples to form multiphase waveshapes and simulate high frequencies.

SCR's are also used in d.c. choppers. A d.c. chopper is simply a circuit used to provide unidirectional pulsations from a d.c. source to a load. By varying the chopping rate the level of d.c. from the supply to the load can be controlled. This configuration could be called a "d.c. transformer."

Motor Control

A d.c. motor requires a control capable of supplying variable-level d.c. When the available power supply is a.c., this can be accomplished by simply providing a bridge of controlled rectifiers between the a.c. source and the d.c. motor. Using this technique, d.c. drives for steel mills have been designed to drive motors of up to 12,000-horsepower ratings.

In some applications the only available supply is d.c. This is the case with fork lifts, rapid transit cars, and electric delivery trucks. In order to control the voltage to the motor with a d.c. supply, a series of resistors between the supply and the motors has been used in the past. In this type of control, as the motor is started, the amount of resistance between the d.c. source and the motor is reduced slowly until the motor speeds up. This system is cumbersome and inefficient due to the power dissipation in the resistors. An improvement on this method is accomplished by the use of SCR's. By varying the chopping rate of a d.c. supply the average voltage to the load can be varied.

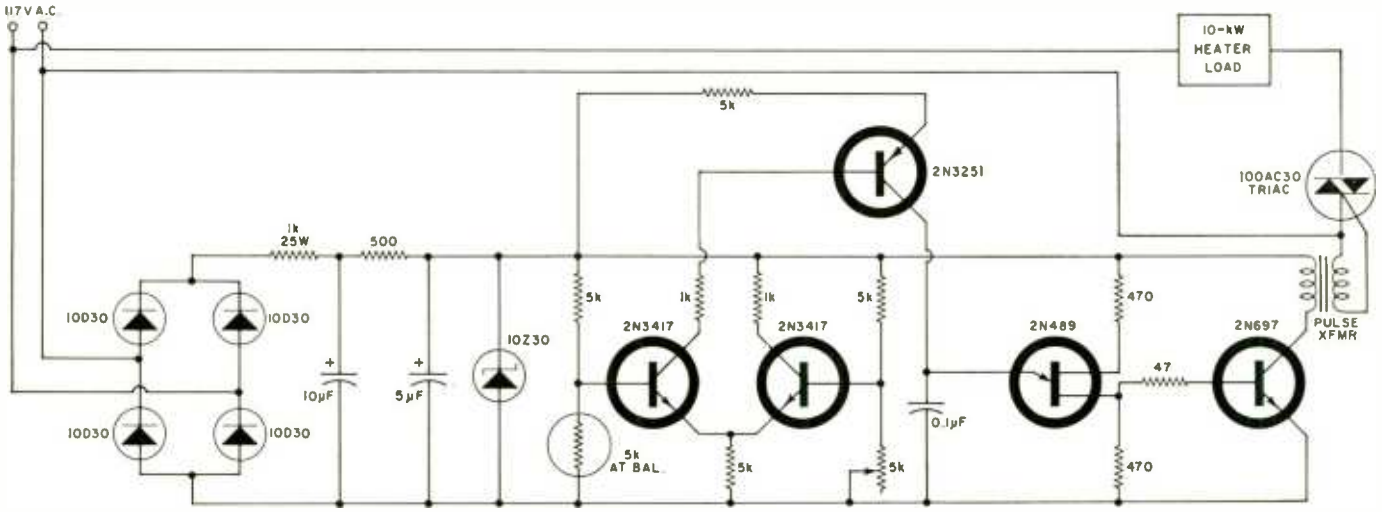
Thus, the use of heavy, slow power contactors and inefficient massive resistors is now unnecessary in large d.c. motor control. The resulting SCR replacement is not only smaller and more efficient, it is also faster-acting and more accurate, allowing the use of more sophisticated types of control.

Today the power systems controlling the motors can now effectively receive signals from command computers and respond in a few microseconds to accurately control motors. In another example, the thickness of metal produced by a rolling mill can be sensed by an x-ray gage, transmitted to a digital computer which can analyze the quality of the strip, and pass along corrective action to the SCR motor controls—all within microseconds. The same technology has allowed systems like the San Francisco Bay Area Rapid Transit System to be designed to provide completely automated rapid transit.

The widespread application of thyristor circuitry in recent years can be measured by the increase in sales of SCR's. In 1966 there were about 15 million SCR's sold in the United States, in 1968 more than 25 million is expected to be marketed.

Application of these devices has been extended to include home heating systems, estimated at 80 megawatts of new installed load each year in th United States, electric transmissions for earth-moving vehicles capable of hauling over 100 tons per load, as well as motor controls ranging from steel mills to portable mixers, and logic circuits for automatic process control to indicating lights on FM multiplexing systems. The SCR revolution continues because of the burgeoning expansion of applications. ▲

Fig. 6. Climate-controlled heater circuit using 100-A triac. Regulated filter supply feeds a differential input stage consisting of pair of 2N3417's. When temperature drops below the reference as determined by setting of pot, the left-hand transistor conducts more and turns on the 2N3251. This charges the 0.1-μF capacitor more rapidly, resulting in faster pulsing of the 2N489 unijunction transistor. This, in turn, triggers triac through output transistor and pulse transformer, increasing heater load current.



New York City bus driver is using his handset to communicate by two-way radio with his headquarters dispatcher. Hidden behind driver is a gooseneck-mounted mike for bus p.a. system.

$6 Million Two-Way Radio System For Buses

By MILTON S. SNITZER / Technical Editor

This is the world's largest commercial system with almost 5000 solid-state radios for traffic control and as crime deterrent.

PASSENGERS riding the New York City buses recently have noticed that something new has been added. Most of these buses now sport small center-loaded whip antennas along with some new radio equipment. The other day, while we were riding a crowded bus, we were surprised to hear the bus driver tell the standees to "please move to the rear of the bus." None of the passengers seemed startled—New Yorkers seem to take everything in stride—but they did do as they were told.

Over two and one-half million passengers ride on some 4200 New York City buses every day. At present, about 3000 of these have been equipped with two-way radios and p.a. systems; by the end of the year, the entire fleet will be so equipped—that is, if the present plans go along without a hitch.

To communicate with these buses, the five boroughs of the city have been divided into 19 control areas. Each area has its own base radio station located in the bus garage serving that area. Control consoles for all the base stations are centrally located in the Transit Authority's Surface Headquarters in Brooklyn. Telephone lines interconnect the control consoles with the radio transmitters. In addition, there are two high-power (350-watt) supervisory and road service vehicle control stations to reach the newly radio-equipped snow-fighting units and patrol and supervisory vehicles. Two hundred fifty-two hand portable radios, with about a 1-mile range, will be employed by the various street and yard dispatchers.

Radio communications should result in improved service, especially during emergencies, blockages due to snow storms, fires, floods, and other serious tie-ups. Buses can be re-routed instantly from headquarters and short lines can be established immediately. Serious accidents can be handled as they occur, and bus breakdowns and mechanical failures can be reported and acted upon at once.

When it becomes known that a driver can summon immediate police aid, the new radios will be an effective deterrent to vandalism, and help prevent robberies and assaults. Toward this end, the driver has a hidden foot switch that ties the gooseneck-mounted p.a. microphone into his radio transmitter so that the dispatcher can hear just what's happening on the bus.

The p.a. system uses two high-efficiency loudspeakers: one above the driver's head and the other at the very rear of the bus. A useful added touch is the installation of a flush-mounted outside loudspeaker beside the front door. When this is switched on, the driver can tell the people who are waiting for him on the sidewalk that "there's another bus just behind me."

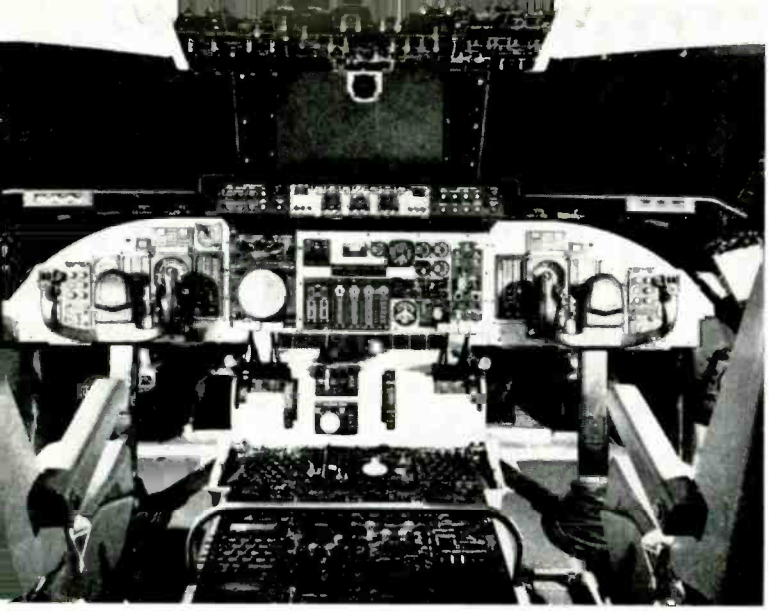
All Solid-State Equipment

All the radio and p.a. equipment used in the $6 million system is solid-state and operates from a 12-volt battery supply. The same type of equipment is used for the 19 base stations so that in the event of a power failure or other emergency the system can continue to operate. Narrow-band FM radio equipment is used and this equipment is left on all the time that the bus engine is running. Battery drain is only 0.2 amp when not transmitting. Transmitter power output is 30 watts.

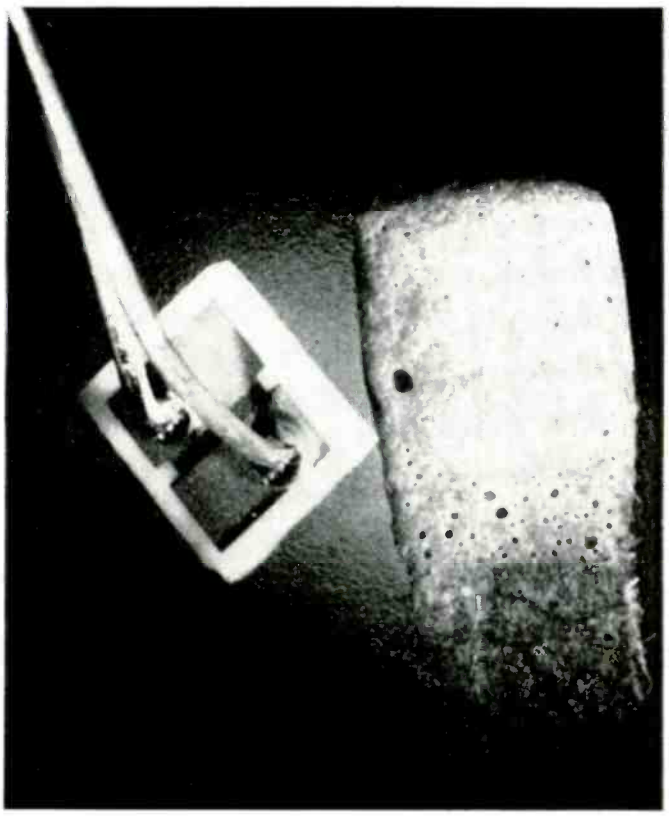
Most of the transmitters we saw operate at frequencies between 30 and 31 MHz, although a few of the sections in the city are using frequencies between 155 and 159 MHz. Buses operating on the lower frequency use center-loaded whips, while those on the higher frequency use full quarter-wave whip antennas. Antennas are mounted atop the bus roof over the driver's head.

Most of the radio equipment was furnished to the Transit Authority by *RCA* under a contract that was said to be the largest commercial award for two-way radio equipment in the public transportation field. ▲

Control center for new bus radio system employs 19 radio dispatchers for the radio base stations. Telephone lines are used to connect dispatchers' consoles to the stations that are located in Transit Authority garages in the city's five boroughs.



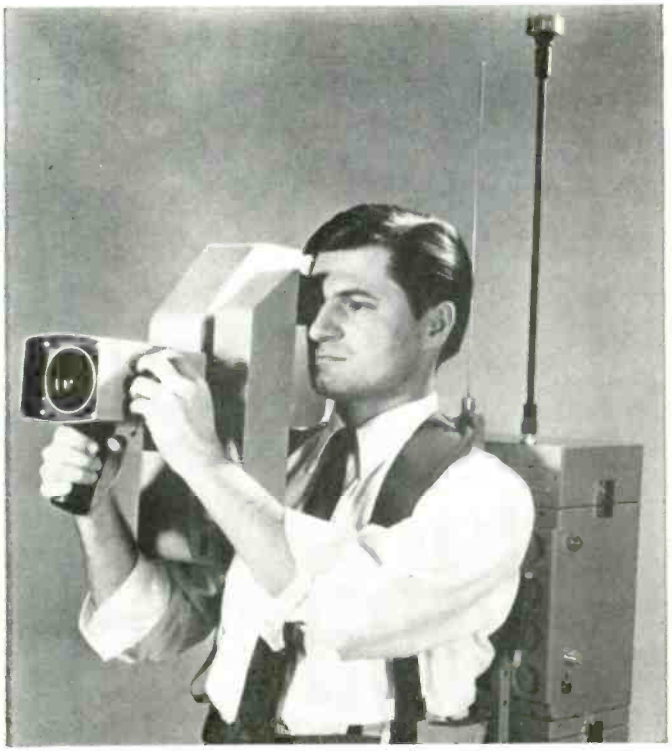
RECENT DEVELOPMENTS IN ELECTRONICS



Training Simulator for Largest Transport Plane. (Top left) Air Force pilots will be quite at home in cockpits of the new C-5's, the world's largest transport plane, thanks to this training simulator now being built. A pair of digital computers will serve as brain for the simulator, which will duplicate exactly the pilot, copilot, flight engineer, and navigator's stations. The new simulator will be the first cargo aircraft type that includes the navigator's station. And this new station has the most sophisticated engineering advance—a radar land-mass generator. The generator gives the navigator a radar-return pattern for any part of the United States. Eventually, geographic film strips may be projected onto the simulator's cockpit window to provide an even more realistic "flight." Five of these systems are being built by Conductron-Missouri under subcontract to Lockheed. The first two of these are for the transition training unit at Altus Air Force Base, Oklahoma, where pilots will learn how to fly the C-5. The other simulators will go to three military airlift command bases for use in their pilot refresher training courses.

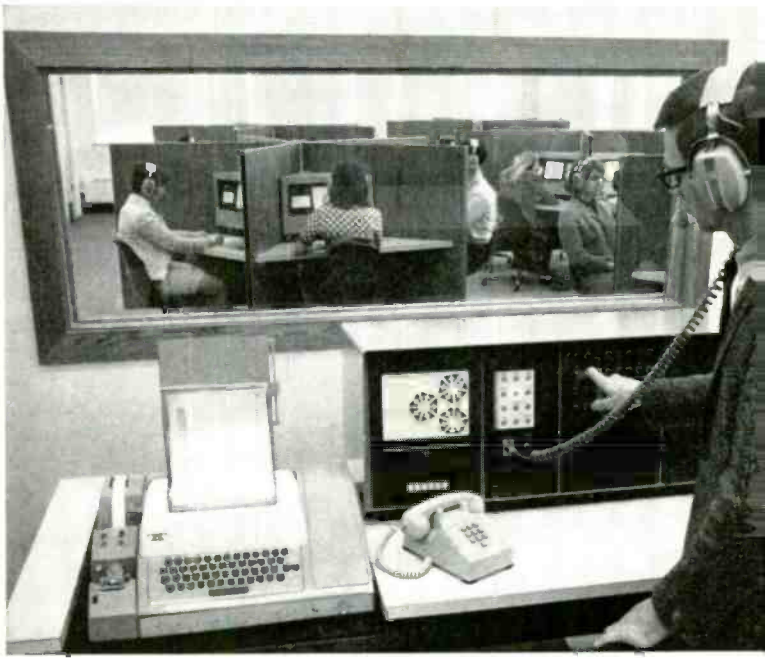
Controlled Fracturing by Laser. (Center) The large object at the right is a book match head, which shows just how small the tiny rectangular resistor next to it is. The resistor, fabricated on a ceramic base $\frac{1}{8}$-in square and $\frac{1}{32}$-in thick, was separated from a larger ceramic base by a new laser process called "controlled fracturing." The new process, being patented by Western Electric, has several advantages over presently used diamond scribing and diamond sawing. Among these are: reduced likelihood of contamination, flexibility in design as lines need not be straight, and greater speed and accuracy. Cuts or partings have been made at the rate of 120 linear inches a minute and separations can be made to within 1 mil of the desired parting line. In use, a continuously operating laser beam is focused on the work piece through an optical system that produces a very small, intense spot of light energy. The ceramic material absorbs the energy; heat and mechanical stresses are then produced, resulting in a controlled fracture of the ceramic.

Japanese Video Telephone. (Bottom left) Evidently, Bell Labs is not the only one working on a telephone that transmits pictures (see "New Picture Telephone Goes Commercial" in our March issue). This new TV-telephone, developed in Japan by Toshiba, uses ordinary inter-office and short-range dial telephone lines to handle up to ten switchable audio-video circuits on the same call. The new experimental model is an improved version of the picture telephone introduced by the company in 1964. At present, the system is installed in the manufacturer's laboratories and is slated for installation in the offices of top executives. The picture size is $3\frac{3}{8}$ by $4\frac{1}{2}$ inches; bandwidth is 500 kHz; 315 interlaced scanning lines are used for display.

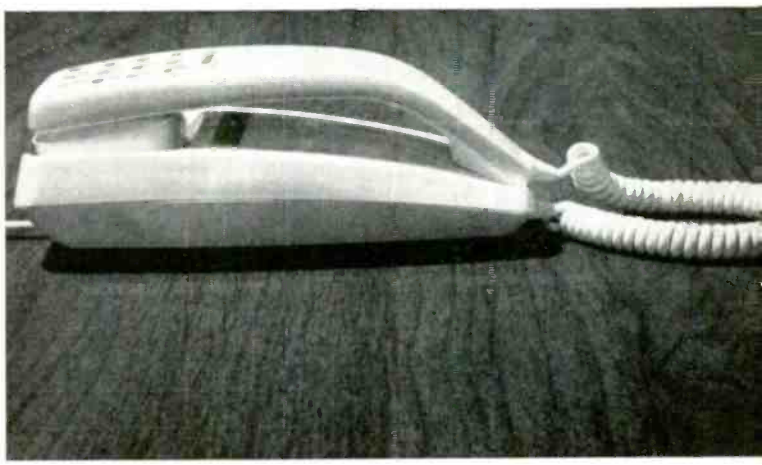


Wireless Color-TV Camera. (Top left) One of the several portable color-TV cameras that will be viewing the 1968 presidential nominating conventions is this wireless unit developed by CBS Labs. This camera will permit news teams to roam the convention floors for on-the-spot coverage. The camera uses digital remote control for focusing, color registration, and centering, thereby relieving the operator of these chores. The camera uses three one-inch Plumbicon color tubes in its head along with a zoom lens. The backpack microwave transmitter can transmit picture information up to about 3 miles.

Desk-Top Learning System. (Top right) Combining a special 7-in, 45 r/min record and 8 by 11-in printed sheets, Responsive Environments Corp. has developed a "talking page." This is a low-cost desk-top responsive learning system for use mainly in elementary schools. Operating a lever at the side of the unit, the student can set a playback stylus down at up to 53 different precise locations on the disc, producing up to 14 minutes of recorded instruction. The printed sheets show the student just where to locate the stylus in order to get a prerecorded instructor's response to the question or the direction on the sheet.



Tape System for Schools. (Center) The first true random-access audio information retrieval system in the U.S. has been installed at the Oak Park and River Forest High School, Oak Park, Ill. The system will permit students to receive any one of 224 recorded 15-minute programs in less than 30 seconds. Heart of the system, installed by Ampex, are seven master tape transports, each with 32 tracks. Programs are transferred from the master unit to the student buffer at 120 in/s and replayed for the student at 3 in/s. The $358,000 installation has 25 student learning booths plus instructor's control center.



Experimental Electronic Telephone. (Below right) The slim handset of this new experimental telephone, developed by Bell Labs, weighs less than half as much as the handset of today's phones and the new phone is getting more and more electronic. For example, it uses hybrid IC's in the push-button tone generating circuits. Also, it has an electronic tone ringer which is smaller and takes less power than the bells used now. A new electromagnetic microphone and amplifier are used which are one-fourth the weight of the present carbon microphone, occupy less space, and have better fidelity at voice frequencies.

Fig. 1. RCA's QK 2200 sampler has in a single package enough technical data and IC's to enable an engineer to test various circuits before he puts them in production format.

SOLID-STATE KITS
A Novel Method Of Circuit Design

By W. J. EVANZIA/Associate Editor

Design engineers find solid-state kits are an easy and inexpensive method of trying out circuits. Manufacturers find them good product promotional devices.

GIVE me that chip, I'd like to try it on for size. Many engineers have found that solid-state kits are an inexpensive and practical way to try out new circuits; and some manufacturers are finding them an excellent method for introducing their products to circuit designers.

Product promotion is the reason for such kit sales. Laboratory kits are simply a merchandising device, and most companies do not expect to sell them at a profit. But, as one company puts it, "our objective in all cases has been simply to make our product available to all users on as broad a base as possible . . . more broadly, of course, than our salesmen can achieve." This attitude is typical of the semiconductor manufacturers who are merchandising such kits. They feel that if enough users have a chance to try the devices and can prove to themselves that solid-state components will do a good job, chances are the kit manufacturer will be called upon to provide solid-state components for the final production models.

Such kits are available from the Electronic Components Division of *Radio Corp. of America, Motorola Semiconductor Products Inc., General Electric Co.*, and *Siliconix Inc.*, among others. Prices range from about $2 for a silicon-controlled rectifier/trigger-pair kit to about $85 for a field-effect transistor and current limiter set.

Linears by RCA

Been a digital IC man all your engineering life? *RCA* claims its new linear integrated circuit sampler is just the thing to update your technical know-how. The QK 2200 sampler has—in a single package—a linear integrated circuits manual, technical data, application notes, mounting instructions, and eleven circuits (26 devices)—two d.c. amplifiers, two r.f. amplifiers, two FM i.f. amplifiers, two operational amplifiers, three transistor arrays, two diode quad and 2-diode arrays, three "universal" audio amplifiers, two video wide-band amplifiers, three r.f. amplifiers useful at frequencies from d.c. to 120 MHz, three ultra-high-gain 3-amplifier arrays, and two dual-Darlington arrays. The sampler sells for $39.95 and is available nationwide from *RCA* distributors.

But what about the kit itself? Well, it's not a toy and it's not for experimenters; it's an engineering laboratory aid. The IC's, which are available in TO-5 cans, formed-lead TO-5 cans, 14-lead flat packs, dual-inline plastic, and dual-inline ceramic units, are bundled in styrofoam packs and carried in special compartments cut into the one-inch-thick sampler cover. A brief description of the unit's operating characteristics and a circuit diagram are printed alongside each IC pack. The manual, technical data, and application notes are in folders which fit into a special slot in the sampler box. The whole thing folds together into a neat 3½" × 11" × 11½" box.

Experienced engineers should find the IC-41 manual particularly helpful. It has been prepared to provide an understanding of the basic principles involved in the design and application of linear IC's; and can be used as a guide by circuit and system developers in determining optimum design specifications.

Neophyte IC users should be able to get good service from all of the information supplied with the sampler kit. One of the general information folders describes complete mounting and connection techniques for two of the most popular IC packages—the 14-lead flat pack, and the 10- and 12-lead TO-5 package. A very helpful table of IC sockets is

included with the data. It lists socket type, the manufacturer or supplier, the manufacturer's or supplier's part number, and a brief description of the component. Another folder, a "product guide," lists information on all linear IC's made by *RCA*.

Although the QK 2200 sampler is for the professional, experimenters and hobbyists have not been forgotten. *RCA* also sells an IC Experimenter's Kit for $10.98. It's designed for practical and educational use. The KD-2112 comes complete with a special manual and all the components needed to build a 500-milliwatt audio amplifier or variable-tone audio oscillator. For $9.95 you can also get a silicon-controlled rectifier kit (KD-2105) with which you can build a lamp dimmer, a battery charger, a motor-speed control, or an electronic synchronous switch. Two add-on kits, the KD-2106 and KD-2110 which sell for $2.75 and $2.45 respectively, enable the experimenter to build interesting light-operated switches and electronic heat controls.

A Multitude of Applications

Prototyping your new solid-state circuit designs? *Motorola's Semiconductor Products* division says it can help you with its special solid-state kits. There are SCR's, triacs, and triggers; there are silicon power transistors; there are field-effect transistor amplifier and chopper kits; there are tiny switching transistors; and a box full of plastic transistors and dual switching diodes.

Well written application notes authored by *Motorola* engineers and detailed data sheets are included in each kit. For example, in the H-960 half-wave SCR-trigger pair and F-960 full-wave thyristor kits, the application notes take a look at some fundamentals of power controls using SCR's and triacs.

Incidentally, each kit is priced at the regular 1-99 price for the thyristor alone—you get the plastic trigger free. The H-960 sells for $2.10 each and the F-960 for $3.45 each.

Motorola's 960-watt triac takes the place of two conventional back-to-back SCR's. It has symmetrical gating and holding characteristics in all modes. In addition, a 100-A peak surge capability, 50 to 400-volt V_{DOM}, and built-in transient overvoltage protection makes it a natural for a variety of cost-lowering, circuit-simplifying applications.

Another interesting kit is *Motorola's* "Micro-T Handy-Pac". This complementary pair (*n-p-n/p-n-p*) of transistors contain the same "die" found in the 2N3904 and 2N-3906 transistors and their electrical performance is identical to the larger units. However, the Micro-T packaging makes them ideal for miniaturized equipment applications.

The FET chopper and amplifier kits sell for $1.00 apiece. Each of these samplers contains two MOSFET devices which alone retail for $2.00. The application notes included in these kits parallel papers on amplifier and mixer circuit design presented by *Motorola* engineers at previous Wescon symposia.

The two most expensive solid-state kits are the "Handy-Lab" at $49.50 and the 3-30 Silicon Power Kits at from $2.75 to $12.65.

The HandyLab is a box of 300 assorted plastic transistors which are capable of being used in a variety of circuits from low-level amplifiers and switches to high-frequency oscillators and high-speed logic networks. A booklet which lists the transistor characteristics and some typical circuit applications is also provided.

The transistors in *Motorola's* Silicon Power Kit are complementary pairs. Seven pairs which have current handling capacities of 3, 4, 5, 10, and 30 amperes are offered. The company says that these transistors permit the circuit-simplifying advantages of direct-coupled symmetry plus higher frequency stability in a.c. and d.c. driven loads. Included are these informative industrial application notes: "High-Performance All Solid-State Servo Amplifiers" and "Complementary Solid-State Audio Amplifiers" which discuss at length phase-shift

Fig. 2. FET's that fit a multitude of circuit applications are available in two Motorola sampler kits. Each sampler pack contains two evaluation devices plus two application notes pertaining to their use as well as device data sheets.

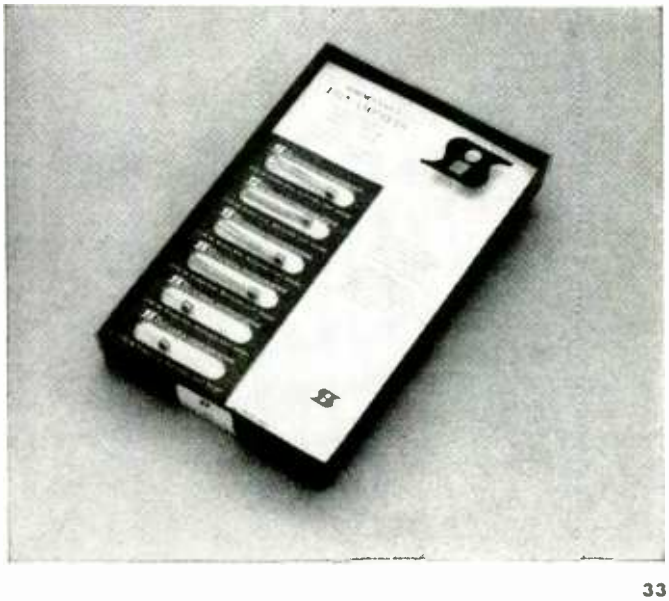
reduction and conversion of typical circuits to transformerless operation.

New on the Market

For $30, you get a box full of planar transistors from *General Electric Co. G-E's* Economy Semiconductor kits are essentially new, having recently been updated by the company. The kits, which contain 55 transistor types (338 devices) and technical data, are available from *G-E* distributors. Application notes are not included.

The purpose of the *G-E* sampler is the same as that of those previously discussed—merchandising. The main difference is in the transistor type—planar—and the categories of components available. For example, there are a number of transistors—the 2N3391, 2N3392, 2N3393, and others—for consumer-industrial use; there are general-purpose components—the 2N3402, 2N3403, and others. (These *n-p-n* passivated transistors are especially suited for high-level linear amplifiers or medium-speed switching circuits in individual control applications.) There are consumer types—the 2N3362 and 2N3363—suitable for u.h.f. oscillators and FM tuners; also included are silicon switching transistors—2N3605A, 2N3606A, and 2N3607—which are epoxy equivalents of types 2N914, 2N706, (*Continued on page* 75)

Fig. 3. Differential amplifier FET's and current limiters in the Siliconix designer kits can be used to take the guesswork out of breadboarding. Seven kit packs are available.



This comparison of a 12-inch Trinitron and a conventional 12-inch shadowmask television tube illustrates the significant reduction in neck and yoke size and color circuitry

Sony's New Single-Gun Color-TV Tube

A Breakthrough?

By W. J. EVANZIA/Associate Editor

Employs a CRT gun that can be used with Chromatron, shadow, or aperture-type masks. Makes possible simple convergence and yoke assembly, and brighter pictures.

CONVERGENCE can be a color television technician's most troublesome receiver adjustment. The convergence assembly, and its circuits, is also one of the TV receiver's most expensive parts. Therefore, the recent *Sony Corp. of America* demonstration of a new Trinitron one-gun TV tube created a flash of excitement when *Sony* engineers showed how the new tube made convergence adjustment a simple job; and how the Trinitron would shrink the assembly size and enable TV tubes to be made cheaper. Later, much of the glow of the announcement was dimmed by a report that a 7-inch *Sony* Microcolor TV would cost about $400. This is in the price range of some 23-inch American models.

Unlike conventional TV tubes, the Trinitron's single gun ejects three electron beams simultaneously. These converge and focus through an electron-optical system which consists of two large-diameter lenses and a pair of electron prisms. Conventional color tubes have three electron guns, each of which ejects an electron beam to reproduce the three basic colors on the picture-tube screen, and a small-diameter electron lens to focus each beam. The three guns are positioned in a *delta* shape.

Universal Assembly

Since Trinitron is a gun assembly, not an entire TV picture tube, it can be used with any of three available grid assemblies. The Trinitron gun can be used with a Chromatron grid (as will be used with the forthcoming 7-inch model); and it can be used with the shadow-mask grid of the conventional American color-TV tube. The newest assembly, the aperture grill, was especially developed by *Sony* for use with the Trinitron gun in a 12-inch (diagonal) TV tube. According to *Sony* engineers, the screen of a one-gun Trinitron TV tube is twice as bright as that of a delta-shaped three-gun TV tube because of the sharper focus possible with the Trinitron's in-line set-up; and because the aperture and Chromatron grids are more transparent than shadow-mask grids. In a shadow-mask tube, about 30% of the electrons in the three beams reach the screen, while 80% of the electrons pass through the thin-wire Chromatron grid. Although fewer electrons pass through the metal aperture grid than the Chromatron grid, the number of electrons that find their way to the screen is significantly greater than in the shadow-mask tube.

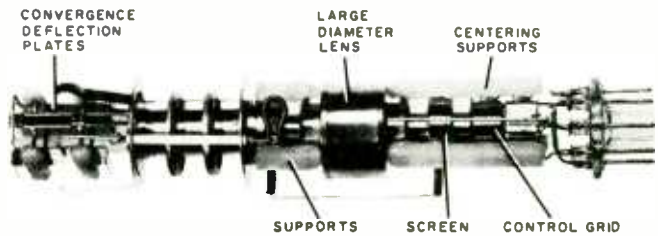
Brings Spots Together

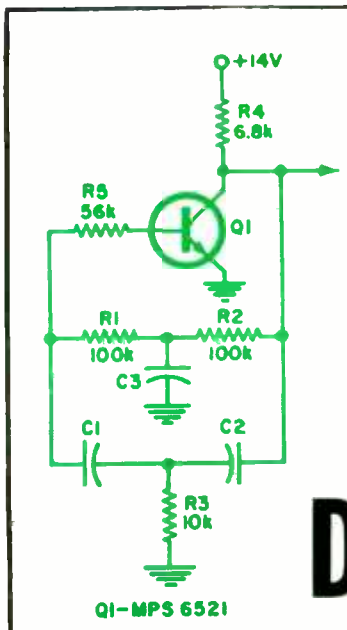
In any three-color TV system, special adjustments are required to make each of the three beams converge at the same spot. In the Trinitron tube structure, the three in-line electron beams are brought together by a pair of symmetrical electron prisms which work on the electrostatic deflection principle. Thus it is only necessary to adjust the voltage on the left and right deflection plates to position the beam properly at the center of the tube. Very few dynamic convergence adjustments are required because of the Trinitron's specially designed deflection yoke. Therefore, only one or two adjustment points are needed compared to the more than ten in ordinary three-gun systems.

Because of the single electron gun, the neck of the Trinitron picture tube can be made smaller in diameter. The result is higher deflection sensitivity; thus a smaller deflection yoke and less power is required for deflection. In addition, since the Trinitron needs no special device for color switching purposes, the construction of the color picture tube, as well as the color circuits, is simplified. A total of 16 individual adjustments—4 static and 12 dynamic (4 adjusting points each for the red, blue, and green colors) are needed with a three-gun system.

As a result, *Sony* claims that its new television sets will be more reliable, easier to adjust, have less color smear and a more stable picture, weigh less, and have greatly simplified circuits which will require less power than conventional color-TV receivers. ▲

Trinitron's large diameter lens makes sharper focusing possible.





TWIN T's: Designs & Applications

By FRED B. MAYNARD / Motorola Semiconductor Products Inc.

These circuits are probably the most useful of all designs employed in musical instruments. Some new applications are discussed here.

TWIN-T circuits are being used as voltage-stable oscillators, as ringing circuits, resonant amplifiers, and tone controls. Many new designs and applications are being developed, a few of which are described here.

Basic Twin-T Oscillator

The twin-T oscillator shown in Fig. 1 is probably the simplest of all twin-T designs, but it will work in all the new circuits to be described in this article. There may be slight modifications for different functions, such as changing resistor values, adding extra resistors or other elements, but the basic circuit does not change from one application to the next.

In Fig. 1, the basic circuit consists of a high-gain silicon transistor, Q1, and attendant *RC* networks. (The *Motorola* MPS 6521 is recommended for all the applications suggested in this article. The MPS 6521 has a *beta* of approximately 100.) The T-network which establishes the circuit's response frequency is composed of *R*1-*R*2-*R*3 and *C*1-*C*2-*C*3. *R*1 and *R*2 also provide a d.c. bias feedback path from the collector to the transistor base.

In this twin-T bridge, response frequency varies inversely with the resistive and capacitive values. This is a direct-coupled circuit and biasing is quite critical. Consequently, it is best to restrict resistors *R*1 and *R*2 to a value of about 100,000 ohms apiece. This makes *R*3 about 10,000 ohms for the median design frequency. Under these conditions (*R*1, *R*2 = 100,000 ohms and *R*3 = 10,000 ohms), the *C*1, *C*2, and *C*3 values for any audio frequency can be read directly from the nomogram of Fig. 1. The lower line, A, gives the *C*1, *C*2 value (*C*1 always equals *C*2) and the upper line, B, the *C*3 value which is twice as large as *C*1.

The load resistor, *R*4, is generally selected as 6800 ohms. In some oscillator applications where high voltage stability is desired, an *R*5 value of 10,000 to 60,000 ohms is used.

Operating Points of Twin-T Oscillators

In this explanation we will consider that all the circuit elements except *R*3 are fixed and that this component has about a 50,000-ohm maximum resistance. With no resistance, or too small a resistance at *R*3, the circuit is quiescent and inoperative. The circuit begins to oscillate when *R*3 is about 1000 to 2000 ohms. From the point where the circuit goes into free oscillations, increasing the value of *R*3 decreases the oscillation frequency until at 20,000 to 25,000 ohms all oscillations cease. The total frequency change is approximately 1⅓ to 1½ octaves.

At the point where free oscillations stopped, say at 25,000 ohms, and for some resistance beyond, the circuit may be shocked into ringing oscillations. It will act as an active filter or as a resonant amplifier to produce an enhanced output at the resonant frequency.

Whereas these effects are, in a way, the same thing, the

Fig. 1. With only slight modifications, the basic twin-T oscillator can be used for many different functions. Designers can use the nomogram to choose the values for C1, C2, and C3.

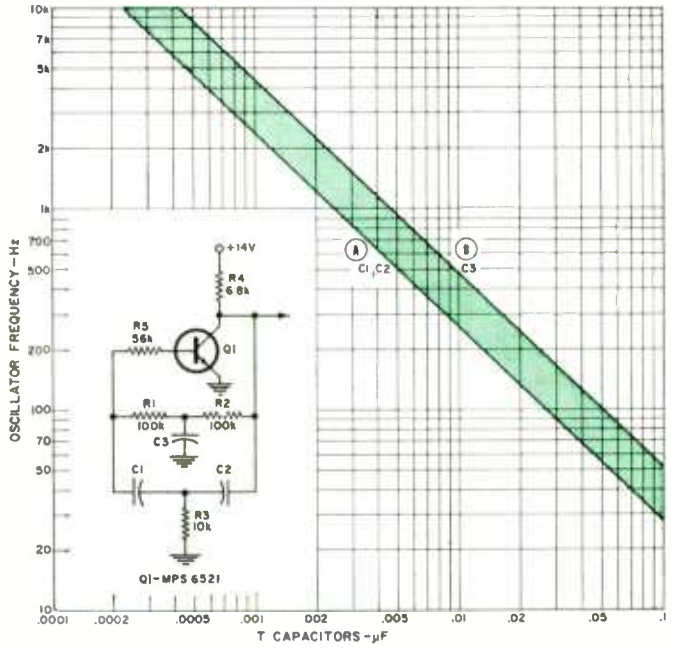
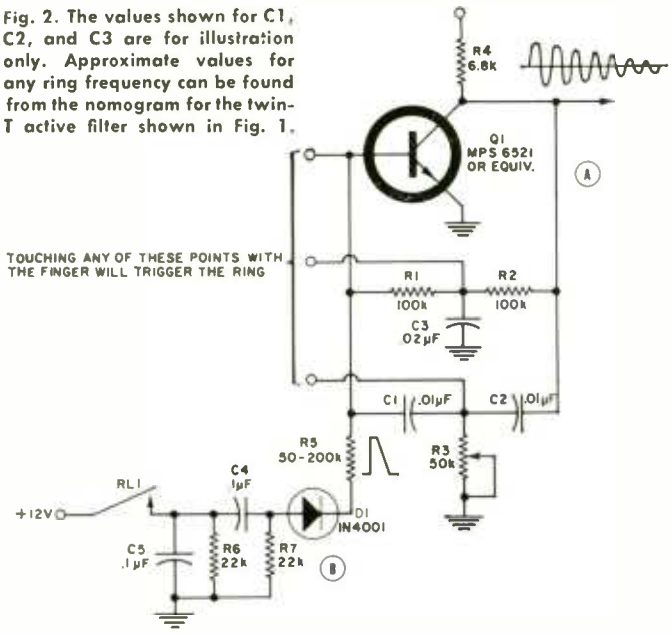


Fig. 2. The values shown for C1, C2, and C3 are for illustration only. Approximate values for any ring frequency can be found from the nomogram for the twin-T active filter shown in Fig. 1.



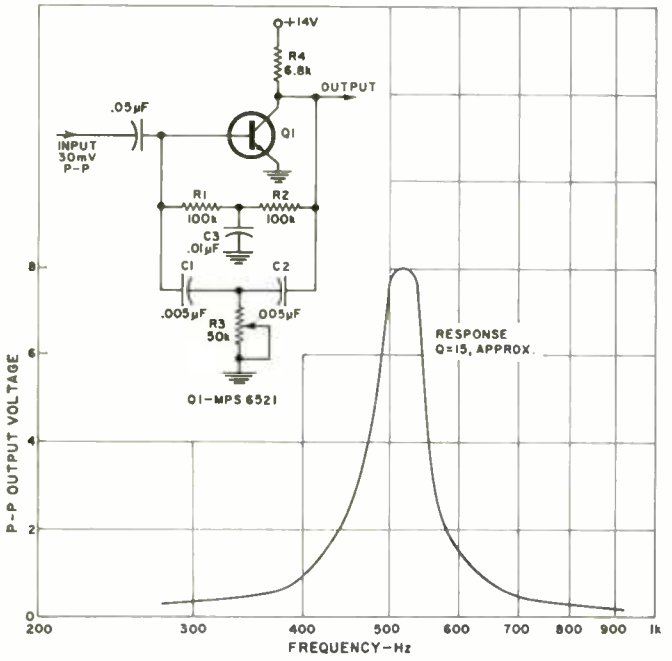
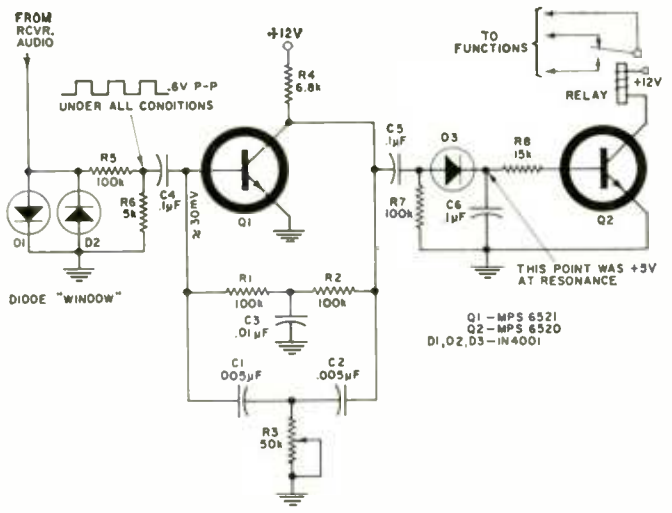


Fig. 3. Simple twin-T resonant filter peaks at 520 Hz.

Fig. 4. Part of radio remote-control system which uses twin-T resonant amplifiers. Peak response is 510 Hz.



functions are different, and will be discussed separately in the next paragraphs.

Twin-T Ringing Circuits

The ringing function is obtained when resistor *R*3 is adjusted to the point where the oscillator just becomes quiescent. If this is close to the cut-off point, the ring envelopes will be quite long, perhaps 20 to 30 sine waves in each envelope. Increasing the resistance a little farther into the quiescent region reduces the ring duration.

Any kind of shock on a sensitive part of the circuit will trigger the ringing. For example, touching the base terminal of the transistor or either of the T mid-junctions with the finger will trigger the circuit. Also, positive square waves may be used to trigger the circuit.

When the ringing outputs are amplified and reproduced in a speaker, extremely pleasant and unusual sounds are obtained. At low frequencies, about 100 Hz, the effect sounds like bass drums. At the middle frequencies, the sounds are like tom toms and bongos. At the higher frequency, 1 kHz and above, the sounds are like claves, gongs, resonant wood blocks, and the like.

The February 1967 issue of *Electronics Illustrated* carried an article which described these novel effects. It was about a group of three bongos with each set at a different pitch, and played in a realistic way by tapping touch plates with the fingers. Fig. 2 shows the basic circuit for this type of triggering. In a key-played musical instrument, the *RC* diode network can be used for injecting shock pulses.

Other uses for the very distinctive ringing sounds might be found in call bells, door bells, signaling devices, and for an audible indication of circuit and line transients.

Twin-T Resonant Amplifier

A frequency-selective amplifier can be made from a twin-T circuit adjusted into the quiescent active region. In this application the circuit has a function which is similar to *LC*, reed, and solid-state selective filters. The twin-T resonant amplifier has one advantage over some of these. It will respond only on its fundamental frequency and not on harmonics.

A simple twin-T resonant amplifier and its selectivity curve are shown in Fig. 3. This is not especially good compared to some of the other selectivity filters, but under the right conditions it can be used effectively.

For example, in an experimental radio remote-control system (Fig. 4), the transmitter was a low-power AM unit on one of the 27-MHz CB channels. It was modulated by three twin-T oscillators at approximately 300, 400, and 500 Hz.

The receiver was a superhet which fed the demodulated control signals into the twin-T resonant amplifiers. In order to make the latter work cleanly, it was necessary to insure that the input signals were always the same amplitude under all conditions. This was done by having the receiver gain high enough to assure that at the maximum transmission distance (about 1500 feet), the demodulated signals would be at least 2 volts peak-to-peak. These were passed through a diode "window" which clipped them to about ½ volt, and passed them as a constant-level signal to the resonant amplifiers. The collector outputs of the amplifiers were rectified and the d.c. output used to control relays.

In many respects, this system was probably not as good as some of the more conventional remote-control systems, but it was reliable and very interesting to use.

Twin-T Active Filters

For this function, the twin-T circuit, Fig. 5, is set deep into the active region by making *R*3 equal to *R*1 and *R*2; in this case, all 47,000 ohms. Under these conditions, the filter assumes a band-pass aspect. The specific use is in waveshaping. For example, in an electronic organ, the tone generator outputs are square waves but the organ has to produce flute

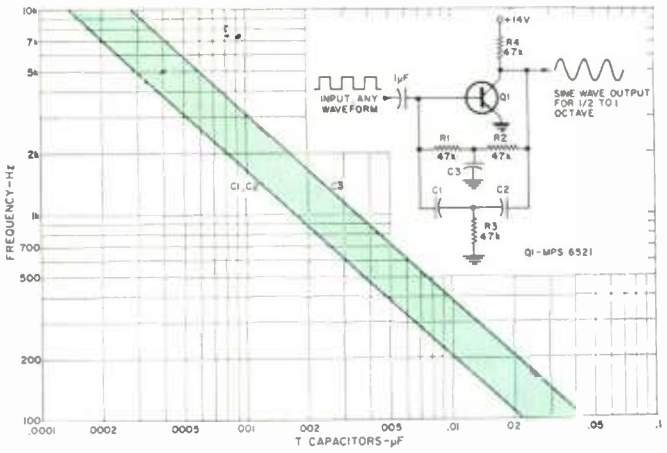


Fig. 5. The twin-T is adjusted into the active region by making R1, R2, and R3 47k. Thus filter is useful as bandpass network.

or tibia voices, which are practically pure sine waves. The conversion is very difficult with passive filtering. The active filter can accept any input waveform and produce, over its band span, reasonably good sine waveforms.

The active filters have a band-pass equivalent to about ½ to 1 octave of frequencies. After the keying, tone generator outputs are broken into 6 to 12 note segments and routed by switches to a bank of eight or nine active filter elements whose center frequencies are arranged to span the entire frequency range of the instrument. This, in an easy low-cost approach, provides the flute or tibia voicing.

Active filter elements for any center frequency can be designed from the nomogram in Fig. 5. It gives the C1-C2-C3 capacitor values for the filter when the resistive elements in the T-bridge are all 47,000 ohms.

Voltage-Stable Oscillators

The twin-T oscillator circuit shown in Fig. 6 has been used in a musical instrument. The circuit is much the same as those previously shown, but *R*5 is added to improve voltage stability. Transistor Q1 should have quite high gain (*beta* $\geq$ 200). To tune the oscillator to one frequency, capacitors C1-C2-C3 are selected in such a manner that *R*3 will have a value between 6000 and 15,000 ohms. *R*3 should be as close to 10,000 ohms as possible for maximum oscillator stability.

The object of this oscillator is to provide "sustain." Sustain is an effect heard in pianos, stringed instruments, bells, etc. in which the tone lingers and gradually decreases in intensity.

The sustain function in an organ is probably second in importance only to the tone generator itself. A typical "sustain" circuit is shown in Fig. 6. Much of the organ's character is basically developed in this function. In this case, the keying is done by closing a contact (on an organ key for example) which completes a circuit from the oscillator collector to the "B+" supply. As this contact is made, C4 charges very rapidly to the "B+" potential. This starts the oscillator. When the key is opened, the charge stored in C4 keeps the oscillator going. As the charge leaks off, the amplitude of the output signal decreases to zero.

The oscillator must be maximally stable so that the output frequency does not change appreciably during the decay. In the circuit of Fig. 6, the voltage stability is sufficiently good to make the circuit useful. Maximum deviation from a constant frequency is, at most, about 18% of a semitone. Most ears cannot distinguish a deviation this small.

In some electronic musical instruments it is desirable to provide key-shift and gliding-tone effects. Many conventional musical instruments are played with these effects. The Hawaiian guitar and Hawaiian music, for example, are strongly dependent on the gliding-tone effect.

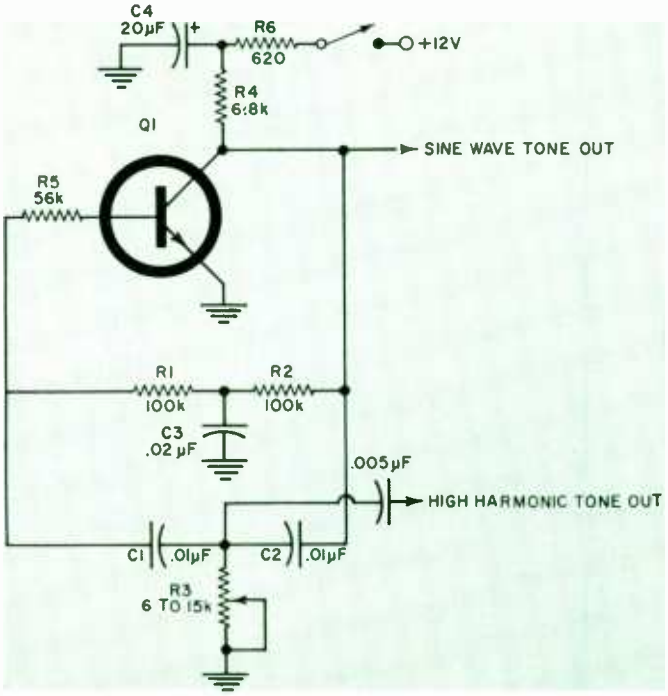


Fig. 6. Use the nomogram in Fig. 1 to find capacitor values for this twin-T stable tone generator with "sustain" feature.

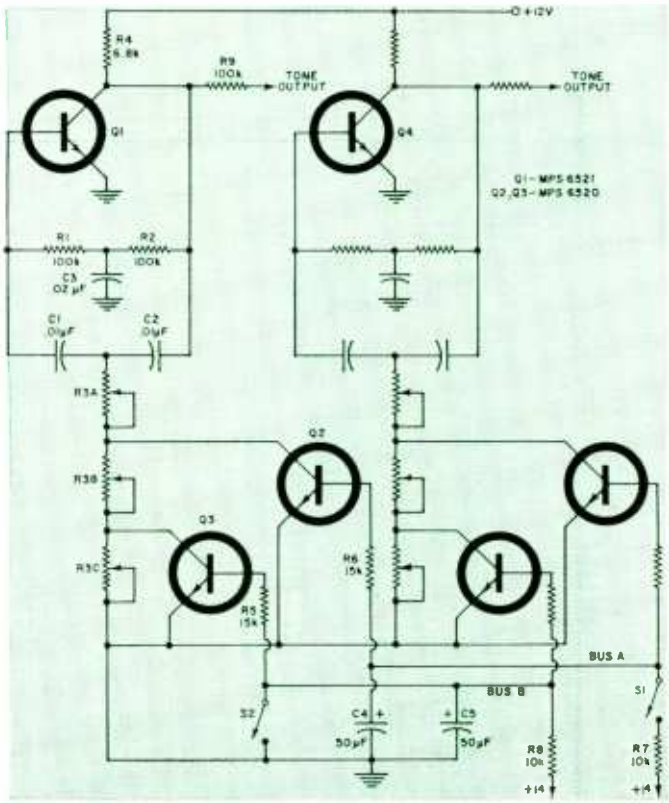
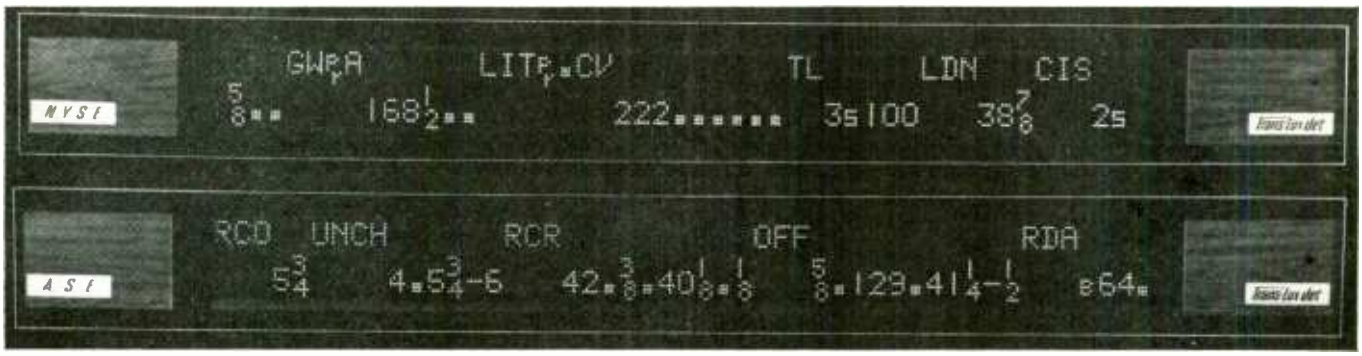


Fig. 7. This is part of a key shift and gliding tone system which was built into an experimental musical instrument.

Twin-T Gliding-Tone Circuit

Fig. 7 shows part of a key-shift and gliding-tone system built into an experimental musical instrument, in which a multiplicity of such oscillators were simultaneously controlled by key-shift and gliding-tone systems. The oscillators are very similar to those already described. The key-shift and gliding-tone effects are controlled by electronically manipulating segmented tuning resistor elements in the *R*3 branch of the twin-T bridge. (*Continued on page* 64)

Market Quotations—By Electronics



This 10-foot long display combines electronic and pneumatic components to exhibit stock quotations in brokerage offices.

By EDWARD A. LACY

New computerized electronic desk and board displays put latest market quotations at the broker's fingertips. They are his direct wire to the Wall Street exchanges.

BY punching a few push-buttons on a desk-top terminal unit, a broker in any part of the country can now obtain just about any information he needs on a particular stock within a few seconds—a very nice feature to have when the conventional ticker may be running 20 minutes or more behind. And for a panoramic view of the market, the broker can sit back and watch new automatic displays that show trends, most active stocks, and other key market indices.

Needless to say, the effect of these new systems on brokerage office procedures has been revolutionary. Time-consuming telephone calls to get quotations, for example, are on the way out—as is the ticker tape machine.

With over 15 million shares being traded each weekday, and 20-million-share-days expected in the very near future, it's no wonder that most of the nation's 3800 or so brokers have turned to electronics to keep tabs on all these transactions. The first electronic stock information device was introduced in 1959. Since then, more than 22,000 of these units have been placed in broker, bank, mutual fund, and other financial business offices.

Business Week estimates that more than $30 million will be spent on stock information devices and their services this year.

Four manufacturers dominate the field: *Ultronic Systems Corp.* (a division of *Sylvania Electric Products Inc.* which, in turn, is a subsidiary of *General Telephone & Electronics Corp.*); *Scantlin Electronics, Inc.*, *The Bunker-Ramo Corp.* (formerly *Teleregister Corp.*); and *Trans-Lux Corp.*, long a leader in photographic-type projection systems for stockbrokers, which has recently introduced some electronics systems for displaying ticker and stock news information.

While the systems made by these companies have several major differences, they nevertheless have a common basic philosophy: extensive use of computers and leased circuits to provide instant information to their subscribers (Fig. 1).

Bunker-Ramo uses four computers at its TeleCenter (in New York) which supply data to ten satellite computers, one in each major population center. *Ultronic's* master computer in Cherry Hill, New Jersey feeds data to 24 satellite computers, for regional information distribution. *Scantlin's* Wall Street Computer Center, on the other hand, is connected directly to its subscribers' terminal units.

All of these computers are tied electronically to the ticker systems operated by the New York Stock Exchange (NYSE) and the American Stock Exchange (AMEX). In addition, the computers receive information on commodities and Over-the-Counter stock transactions.

Over 70,000 miles of leased circuits are used by *Bunker-Ramo* to tie in its subscribers. *Ultronic's* data network is almost world-wide, stretching from Hong Kong to Hawaii,

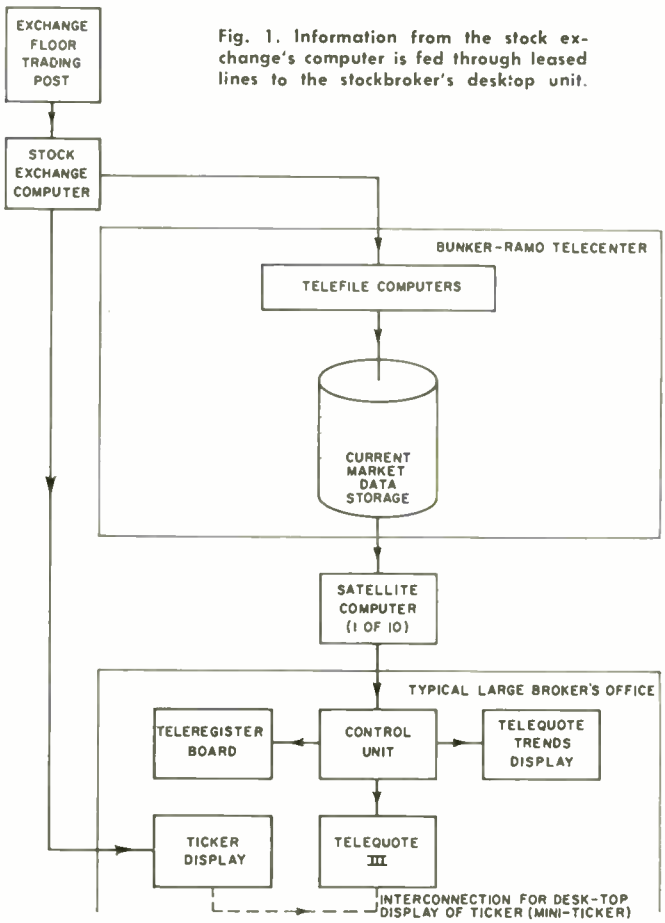


Fig. 1. Information from the stock exchange's computer is fed through leased lines to the stockbroker's desktop unit.

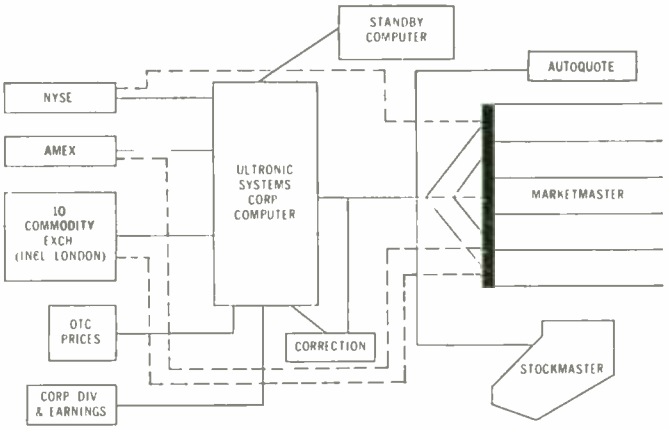


Fig. 2. In the Ultronic system, stock information from the NYSE, AMEX, and Commodity exchanges can be transmitted directly to the broker, or processed through the system's computer center.

throughout the United States, and into Canada, England, and Western Europe.

Data from the computers is supplied to three basic types of stock-market information systems: Desk inquiry units, individual-stock quotation boards, ticker displays (Fig. 2).

Desk Inquiry Units

Scantlin, the pioneer in the field, introduced its Quotron® I unit in 1959. The Quotron I was a small desk-top unit that looked like an adding machine with a tape output. Its present unit, Quotron II, provides the option of a printed tape or a visual display in the same desk console. The tape prints up to 10 characters per second. The visual display uses white digits on a black background to present information in 3 digits plus whole fractions and an indicator showing price movement up or down. Information available includes: Last sale, high and low for the day, opening price, dividend rate, etc. *Scantlin* also has a Quotype® service in which a teletypewriter is used as an input/output machine.

Ultronic introduced its 3-digit display unit, the Stockmaster® in 1961. Over 13,000 such units are now in operation. Information on more than 8000 stocks and commodities is available through the Stockmaster. A brokerage firm's remote branches can interrogate the central office's Stockmaster *via* the existing Teletype network through *Ultronic's* Autoquote system. The newest of the *Ultronic* brokerage display systems, the Videomaster, is shown in Fig. 3.

Bunker-Ramo's Telequote® III units were first installed in 1964; over 13,000 are now in use. Using a 3-inch cathode-ray tube, this device can display up to 700 characters per second. Each displayed character is composed from a 7×5 dot pattern. If a price is superseded during viewing, the new price is posted as you watch. In addition to displaying specific information that has been requested, Telequote III can display "Mini-Trends", a continuously changing display of key market indices. (Telequote III is also available with a printed tape output.)

The newest and most sophisticated of the display units is *Bunker-Ramo's* Telequote 70, introduced in January 1968 (Fig. 4). This unit has two separate 6-inch cathode-ray tubes, which allow information from two market-information services to be displayed at any given time. Four standard services are available: NYSE ticker, AMEX ticker, a business news wire service, and *Bunker-Ramo's* own computerized quotation service.

In addition, with Telequote 70, a customer's record can be retrieved from the broker's own computer storage and displayed on one of the dual screens for rapid determination of margin status. Another function enables the user to retrieve computer-stored research reports on given stocks, displaying them graphically or in text in a few seconds. Telequote 70 can also be used for direct transmission of a buy or sell order.

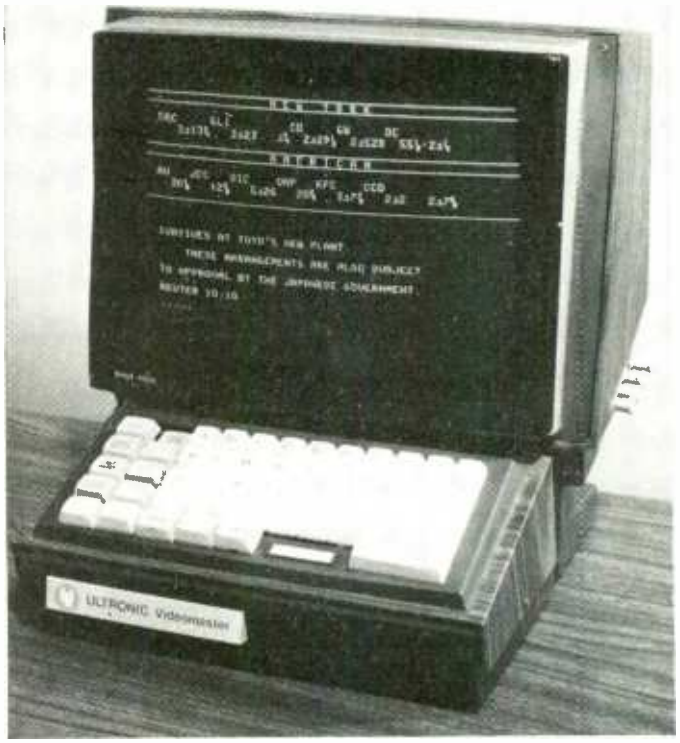


Fig. 3. At the touch of a finger, this unit calls up an array of stock data or advice on any one of 8000 individual securities.

The message appears on the screen to be checked visually and corrected before it is sent.

Stock Quotation Boards

Whereas the desk inquiry units allow pertinent information to be retrieved on one specific stock, the stock quotation boards provide continuous sales information on several hundred stocks simultaneously. *Ultronic's* InstantQuote® board at the Philadelphia-Baltimore-Washington Stock Exchange, for example, is capable of providing the trading range on 600 stocks.

With the InstantQuote board, a listing can be quickly changed by dialing the symbol for the desired new stock. All stocks carried by the Stockmaster system can be displayed on this board.

Scantlin's electronic stock quotation board, the Quotron Board, also allows easy change so that whenever market interest develops in a particular stock, the stock can be immediately placed on the board. A stock on the Quotron Board is changed by removing the symbol tags for the old stock from the electronic selector panel and inserting tabs for the new stock.

The Teleregister® boards supplied by *Bunker-Ramo* to 450 brokers' offices were first installed in 1929. The average board today is much smaller than before the introduction of the interrogation system.

Tickers

In the mechanical type ticker projection display, built by *Trans-Lux*, information on the ticker tape is transferred to a moving plastic film which, in turn, is projected onto a screen. Unfortunately, this system requires frequent replenishing of the film and it provides less than optimum viewing.

Trans-Lux now has a stock quotation device, called the *Trans-Lux* Jet, which uses jets of air, controlled and regulated by a built-in computer, to activate small discs on a moving matrix to create letters and numbers. "Black light" causes the fluorescent material on the discs to glow, thus creating characters with extremely high visibility. The symbols move across the face of the unit from right to left and,

upon reaching the end of the display, are flipped back to their original position where they return to the computer-controlled air streams to record another transaction.

The Jet unit is approximately 10 feet long and displays 49 characters (letters, numbers, and full fractions) simultaneously. (There is also a Long Jet which is approximately 15 feet long and displays 79 characters.) The unit operates at varying speeds up to the present high-speed ticker rate of 900 characters a minute and can be made to flow at greater speeds.

Ultronic's Lectrascan®, introduced in 1963, is a self-contained solid-state device which displays transactions broadcast by the stock exchanges' ticker wire networks. Lectrascan presents exchange transactions in a normal reading sequence (from left to right), with characters and numbers remaining at rest.

In contrast to Lectrascan, *Bunker-Ramo's* Teletrade® stock ticker display, being installed this summer, is a traveling character display with letters and numbers that flow from right to left. Teletrade uses cold-cathode lamps and integrated circuits with an estimated average life of 50,000 operating hours. Tests indicate that the display is legible at speeds even as high as up to 1800 characters per minute.

The luminance of the panel characters on the Teletrade can be adjusted to suit room lighting conditions. Illumination is automatically dimmed during pauses in transmission, to maintain constant ease of readability.

CRT Ticker Displays

Bunker-Ramo's current ticker system, Telequote Ticker, is a wall-mounted unit using a 27-inch CRT and solid-state circuits. Reports are displayed in a tabulation like a page of print. Twelve lines are available, 11 of which are normally used. The Telequote Ticker "prints" a line at a time with each line being held in place for six seconds after it is written. While the bottom line of the screen is being filled, the top line is erased electronically to provide space for the next sale. As the top line is filled, the second line is erased, and so on, down the screen.

Trans-Lux's VidiQuote, a 1967 development of *Trans-Lux* and *CBS Laboratories,* is a solid-state Teletype-to-video display generator which converts ticker-tape stock information to a television signal for display on a conventional television monitor or a group of monitors.

The display generator provides a continuous video simulation of the usual ticker-tape movement of stock exchange transactions from right to left on the monitor. By using appropriate buffers and control logic, the display movement is made smooth even when the exchange's ticker rate is erratic.

Information received from any two separate stock ticker lines is converted to a 6-bit digital code and fed into two recirculating buffers. The contents are then advanced periodically by a timing generator.

Video ticker-tape display bands for both NYSE and AMEX use identical 5 × 23 character matrix formats. A single character generator is time shared for both exchanges. The information in the recirculating buffers is sequentially applied to the character generator, whose output is converted into a television signal.

As new information is received on the ticker lines, it is automatically inserted into the proper location in the recirculating buffers. At the same time, all previous characters are advanced by one space and the oldest character is dropped. This movement, however, appears continuous to the eye.

Scantlin's solid-state Quotevue system also uses CRT's from 7 to 23 inches. Quotevue can accommodate multiple tickers and news wire data simultaneously. In a typical display, the NYSE and AMEX tickers and the *Dow-Jones* News Service can be displayed at the same time on one unit.

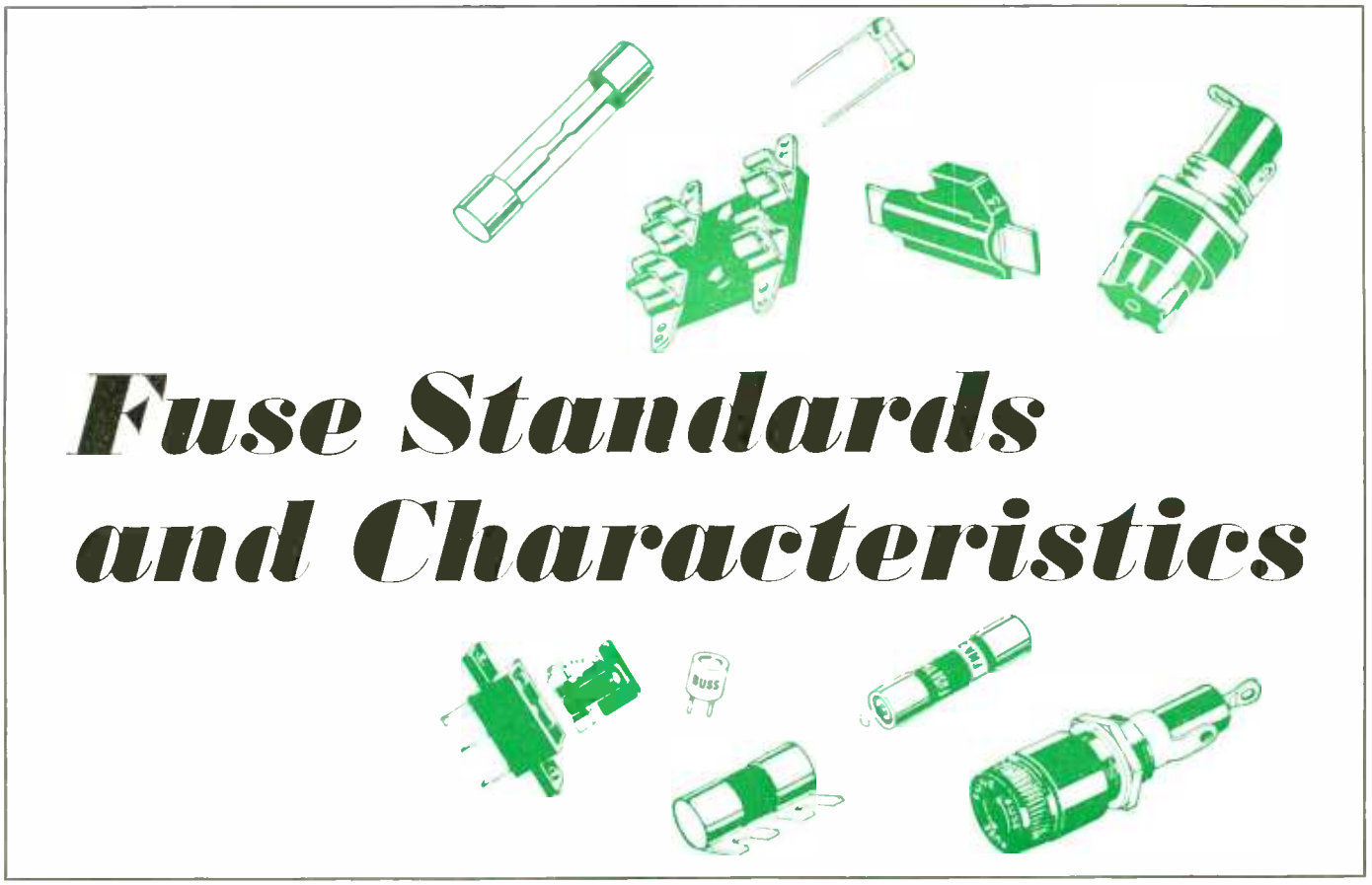
In Quotevue the newest information is written on the bottom line assigned to the input source. Writing is always on a blank line, that is, on the completion of a line, all lines crawl up one line width and the top line disappears. A new blank line appears at the bottom and is written from left to right.

Each input source for Quotevue may have writing suppressed on the active display line. This technique is desirable for news wires and messages as the character-by-character printing tends to be distracting if displayed. If writing is suppressed, the whole line appears in a vertical crawl when it is full. Ordinarily, writing is not suppressed for stock tickers since the character-by-character printing is of interest to the viewer.

Ultronic's video monitor, which is available in sizes from desk top to 23 inches, displays NYSE and AMEX transactions on the top half of the viewing screen and the *Reuter-Ultronic Report,* said to be the first new high-speed financial news service in 20 years, on the lower half.

While these video monitors, stock quotation boards, and desk inquiry units are revolutionary instruments for stockbrokers, they may be just the beginning of an all-electronic stock market. Through electronics it's just possible that the stock-market information companies may some day be able to keep tabs on even the thousands of Over-the-Counter or unlisted stocks. When that day comes, it will be a simple matter for the computers to match orders, etc. and, in effect, become the third nation-wide stock exchange, the Computer Stock Exchange. ▲

Fig. 4. The Telequote 70 brings quotations, stock and news tickers directly to the broker's desk on a dual CRT type tube display.



Fuse Standards and Characteristics

By WALTER A. MATHEWS/Chief Engineer
Bussmann Mfg. Div., McGraw-Edison Co.

In order to select the proper fuse for electronic circuit protection, a knowledge of the important standards and parameters covered here is required.

Editor's Note: Although there are Underwriters' Laboratories and MIL-Spec standards for fuses and fuse characteristics, the identification of fuses is still not standardized. Some manufacturers still use the old "3AG"-"8AG" fuse-size designations along with some added description. Others, including the company with which our author is associated, prefer to use their own catalogue designations to identify their fuses. This is done because of the very large variety of fuse types that are available in a given fuse size. In showing the parameters of some of the fuses covered in this article then, we have employed the Bussmann designations. Readers should realize, however, that other makers may offer fuses with similar characteristics but with different type designations.

AROUND the turn of the century, electrical circuit "protection" consisted of a piece of undersized wire which was designed to be the first component to break down in case of overcurrent. With higher currents, this piece of wire would sometimes explode and damage the equipment it was designed to protect. It wasn't long before the enclosed fuse was developed. It was designed to contain the products of volatilization caused by the overcurrent and interrupt the current safely and within predetermined time limits. Such enclosed fuses were subsequently mass-produced for uniformity and low cost.

Today, there are many types of enclosed fuses. In this article we will discuss what are commonly called "small-dimension fuses," which are normally associated with electronic circuits. Some large fuses find their way into electronic circuits, but these fuses are mainly confined to the power supplies that feed the electronic portions of the system.

There are two principal sizes for small-dimension fuses: those that measure ¼" in diameter by 1¼" long, and those that have a diameter of $^{13}/_{32}$" and are 1½" long. Within these size limitations there is a great variety of fuse types to meet the requirements of most applications. Most fuses in electronic circuits are of the smaller size.

Recently, even smaller fuses have gained popularity but their electrical characteristics are limited by their dimensions. Typical subminiature fuses measure 0.15" in diameter by 0.300" in length with pigtail leads. Another type is 0.25" in diameter by 0.27" high, and is a plug-in type.

What Standards Govern Performance?

There are several standards which govern the manufacture and performance of fuses. The principal one is the *Underwriters' Laboratories* "Standard for Fuses."Almost all performance specifications are based on this standard which is also the basis for other fuse standards. The *UL* Standard calls for the fuse to meet certain constructional and performance requirements before being submitted for testing. It must also pass periodic "follow-up" tests to insure the same level of performance throughout subsequent production runs.

The *UL* Standard test makes no attempt to simulate actual operating conditions. This would be impractical because of the thousands of different types of circuits in which fuses are used. Instead, the test insures that the fuse meets certain quality standards and maintains that level.

The *UL* Standard calls for a definite circuit with a known

Ampere Range Available	Voltage Rating	Characteristic	Dimensions (Inches)	Catalogue Symbol
1/500 to 2	250 or less	Fast Acting	1/4 x 1	AGX
1/500 to 3	250 or less	Fast Acting	1/4 x 1 1/4	AGC
4 to 30	32 or less	" "	"	
1/4 to 20	250 or less	" "	"	ABC
25 to 30	125 or less	" "	"	
1/100 to 1	250 or less	Time Delay	"	MDL
1 2/10 to 2 8/10	125 or less	" "	"	
3 to 30	32 or less	" "	"	
1 1/4 to 2	250 or less	" "	"	MDX
3 to 7	125 or less	" "	"	
1 to 15	250 or less	Fast Acting	13/32 x 1 1/2	BAF
20 to 30	125 or less	" "	"	
1 to 30	250 or less	" "	"	BAN
1/10 to 10	250 or less	Time Delay	"	FNM
12 to 15	125 or less	" "	"	
20 to 30	32 or less	" "	"	
0 to 30	600 or less	Fast Acting	"	FTK

Table 1. Typical small-dimension fuses. Although Buss catalogue symbols are shown, other makers have similar types.

thermal capacity. The ambient temperature is controlled and various measurements are made to see if performance matches that of previous tests. Thus, a comparison can be made between a new production lot of fuses and fuses made a month or a year or more ago. This insures that the user will always obtain fuses of uniform quality.

The *UL* Standard is the same for all types of fuses whether they are small-dimension fuses for electronic circuits or types used in industrial and commercial equipment. In general, performance levels are the same whether a small glass-tube fuse or a large service-entrance fuse is being tested.

The Standard requires that the fuse be able to carry 110% of its rated (name-plate) amperage, when tested in the prescribed circuit, until the temperature rise on the fuse stabilizes. This rise in temperature is limited to a maximum of 50 degrees centigrade on the fuse tube. The test circuit consists of open fuse clips mounted on an insulating base so that the fuse is in a horizontal position. At least two feet of wire of the specified wire gauge for that fuse rating are attached to each end of the fuse mounting. Thus, the thermal capacity of the test circuit is completely prescribed.

This 110% carry requirement has served well through the years, insuring adequate current-carrying capacity when the fuse is used in an actual circuit. This safety factor is required to prevent needless opening of the fuse. *Underwriters'* is aware of the possibility of "over-fusing" and the potential fire hazards associated with such practice. *UL* wants the properly rated fuse to carry as much current as possible so that users will not be tempted to resort to overrated fuses.

It is good practice to load a fuse continuously to no more than 80% of its rating. The reason for this is that circuit wiring usually has at least 25% more current-carrying capacity than the load current. The fuse rating will then equal the wire's carrying capacity, hence, the fuse will protect the wiring.

The minimum opening current specified in the *UL* Standard is 135% of rated current. This is the lowest current at which some consistent measurement of time can be made. The Standard requires that the fuse open within one hour at this current when operating in the test circuit described previously. In addition, a fuse is tested at 200% of rated current and must open within two minutes.

The tests described are "calibration tests." Fuses must not only meet these requirements but must do so in a safe manner.

Besides these tests, *UL* requires that the fuse prove its interrupting capability. Generally, the requirement is that the fuse be capable of interrupting a short-circuit current of 10,000 amperes at its rated voltage. Again, this interruption must be made without danger. This insures quiet, efficient extinguishing of major fault currents so that hazards are eliminated. This is quite an achievement for a "simple" fuse which costs only a few pennies.

Military Specifications, such as MIL-F-15160, use the *UL* "Standard for Fuses" as a basis. The only major difference between fuses meeting MIL Specs and those conforming to *UL* standards is the nomenclature. Fuses meeting the *UL* Standard are marked with a manufacturer's catalogue number, while those supplied for MIL Spec applications carry a military type designation.

In addition to these formal standards, there may be additional requirements imposed by the user. These are requirements for a specific application and generally call for a much higher performance level. Most of the time, however, the standard fuses which meets MIL Spec and *UL* requirements will meet these higher performance levels.

Table 2. Former standard designations and sizes of glass cartridge fuses. Some makers still uses these designations.

ELECTRONIC & INSTRUMENT FUSES

Type	Size (in)
1AG	1/4 x 5/8
3AG	1/4 x 1 1/4
4AG	9/32 x 1 1/4
5AG	13/32 x 1 1/2
7AG	1/4 x 7/8
8AG	1/4 x 1
9AG	1/4 x 1 7/16

Above fuses are available in a wide variety of current ratings.

AUTOMOTIVE FUSES (32 V Max.)

Type	Size (in)	Current (A)
SFE4	1/4 x 5/8	4
SFE6	1/8 x 3/4	6
SFE7 1/2	1/4 x 7/8	7 1/2
SFE9	1/4 x 7/8	9
SFE14	1/4 x 1 1/16	14
SFE20	1/4 x 1 1/4	20
SFE30	1/4 x 1 7/16	30

How About Reliability?

A "reliable" fuse is one that opens promptly in the event of excessive current, but does not open needlessly if the current is not excessive. Opening when safe conditions exist is a nuisance. How can we protect against nuisance openings?

We all know that a lead wire which is improperly soldered to a terminal may cause intermittent operation and local heating. Also, loose clip connections and inadequate spring pressure in the fuseholder can lead to excessive heat generation and possible subsequent opening of the protective device.

Remember that the fuse itself generates a certain amount of heat and this heat must be dissipated. If a means for dissipating this heat is not provided, the internal temperature of the fuse will rise, melting the fusible element and opening the circuit.

Also, as stated previously, keeping the loading to 80% or less of the fuse rating will eliminate most of the trouble associated with slight overcurrents and transient currents.

The cost of a fuse is extremely low considering the high degree of reliability it offers. One reason is that commercial and military standards are almost identical, permitting the manufacturer to make the same fuse for both. Volume production, along with repetitive quality control imposed by both standards, assures the user of high quality at low cost.

How to Specify

To specify a fuse, you must know the ampere rating, the voltage rating, and whether the fuse is to be a normal-opening or time-delay type. The ampere rating is easy to specify if you keep in mind the Standard requirements.

The voltage rating requires some searching of catalogues to determine which catalogue designation to use. There are

many small-dimension fuses with various voltage ratings and it is imperative that the fuse have a voltage rating equal to or higher than the circuit voltage. The voltage rating of a fuse is always the maximum rating and the fuse can be used on any lower voltage. However, this maximum should never be exceeded in a higher voltage circuit unless special tests are run. The problem is that the fuse may not be able to interrupt safely in a higher voltage circuit.

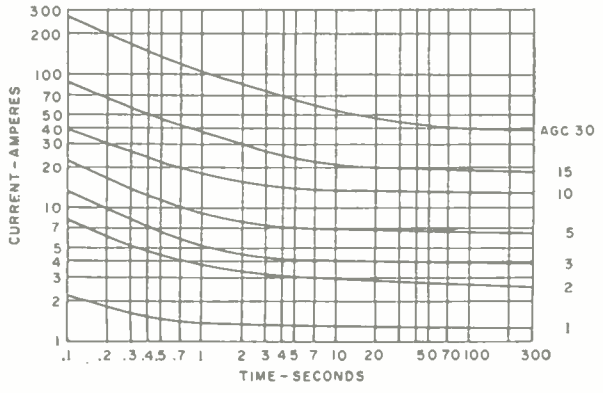
Table 1 shows the voltage ratings for typical small-dimension fuses. These fuses are identified by catalogue symbol and physical dimensions. Table 2 shows the former standard size designations for fuses along with the currently used automotive types.

Interrupting capacity is another rating of the fuse. Fortunately, the small-dimension fuses listed by *UL* have more than adequate interrupting capacity. As mentioned before, *UL* requires that the fuse be capable of interrupting a short-circuit current of 10,000 amperes at its rated voltage. Naturally, the same interrupting capacity will be maintained at lower-than-rated voltages.

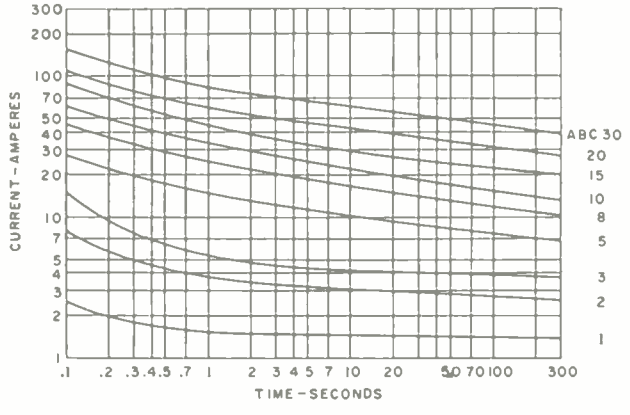
Many small-dimension fuses have ratings of five amperes or less. Hence, the associated circuit has relatively high impedance which limits the fault current to tens or hundreds of amperes rather than thousands of amperes.

After the ampere and voltage ratings have been decided, it can be determined whether the fuse should be a normal-fast opening or time-delay opening type. Normal-fast opening fuses have a single element made of wire or a punched-out metal link. This type of fuse has a smooth time-current characteristic curve with no inflections (Fig. 1). For any given amount of overcurrent, the curve shows how long it will take for the fuse to open. Normal-fast acting fuses are used in electronic equipment that is basically resistive in nature.

Fig. 1. Time-current curves for (A) type AGC and (B) type ABC normal-fast acting fuses. The first type, formerly called 3AG, employs a glass tube while the second type, formerly called 3AB, employs a ceramic tube to enclose the element. Numbers after catalogue types indicate current rating of fuse.



(A)



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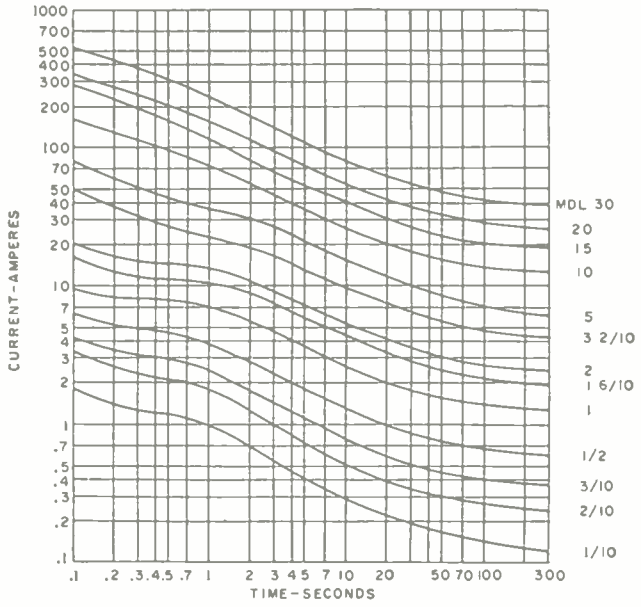
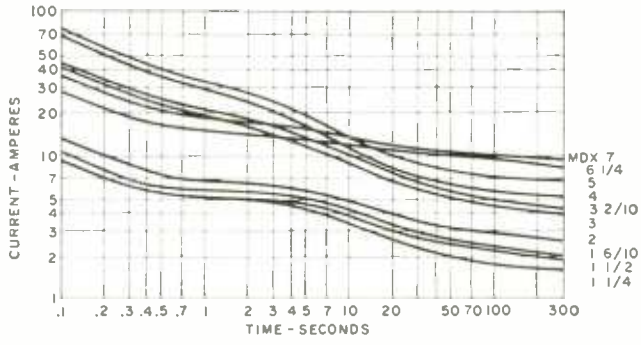


(A)



(B)

Fig. 2. Time-current curves for (A) type MDL and (B) type MDX dual-element time-delay fuses. Because of the somewhat different construction, MDL has longer time-lag than MDX. Numbers after catalogue types indicate current rating of fuse.

The time-delay type (sometimes called "slow-blow" or "slow-blowing") has a more complicated element. It uses two or more elements connected in series. Each element has a separate function: all must be connected for the fuse to be intact, but each reacts to overcurrents in a different way.

The time-delay fuse has a short-circuit element just as the normal-fast opening fuse. Its function is to melt and open on current in excess of approximately six times the rating of the fuse. On overcurrents just above this rating, the "overload" or thermal section of the element takes over. This overload section is made heavy deliberately so that it will not open immediately on low overcurrents. Thus, a typical time-delay fuse consists of a massive thermal section in series with the short-circuit elements. Typical time-current characteristic curves are shown in Fig. 2.

As the physical dimensions of the fuse increase, proportionately more time delay can be built into the fuse. A comparison of the two time-delay types, MDL and FNM for example, shows that at 200% of rated current, the MDL 10 opens in 20 seconds while the FNM 10 takes almost 30.

Time-delay fuses are used in circuits where transient and overload currents of safe duration occur. For example, a circuit feeding a motor or a transformer will have turn-on overcurrents which normally subside in a few cycles or seconds. These are entirely safe unless they continue to flow. A locked rotor in a motor or failure of a solenoid to seal-in will cause the motor and possibly the wire feeding it to burn if current is not interrupted. The proper size time-delay fuse will not open under normal conditions; however, if the overcurrent continues, the fuse opens before damage can be

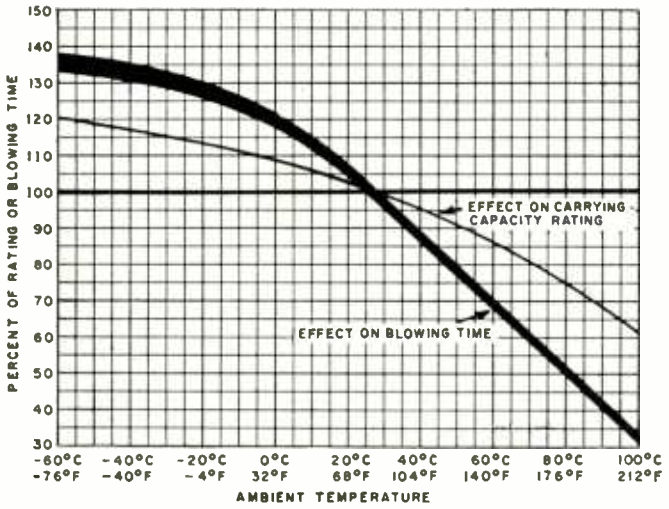


Fig. 3. Effect of ambient temperature on dual-element fuses. Normal ambient is 70° F to 80° F. Note that at higher temperatures fuse will carry less current and will open more quickly.

done. Generally, a time-delay fuse rated between 125 and 140% of the full-load current is proper.

Very fast acting fuses are used to protect meters and semiconductor devices such as silicon diodes, thyristors, and transistors. All of these devices have the common characteristic of very low overload capacity. In other words, when subjected to an overload current of relatively small magnitude, even for a very short period of time, they will burn out. Time-delay fuses are too slow for them because of the deliberate time-lag built into them. They must be protected by a fuse which has a similar characteristic—that is, the fuse must carry current up to its rating and then open very quickly when a slight overload exists. Fortunately, most meters and transistors have low ampere ratings and can be protected by low-current fuses.

Fractional-ampere-rated fuses exist and several physical dimensions are available. The glass tube fuse, either in the 1- or 1¼-inch length, are frequently satisfactory for the job.

More recently, subminiature types of plug-in and the pigtail-lead varieties have become available. These are designated as type GMW and GFA. They can be furnished with ratings between 1/200 and 5 amperes at 125 volts. Interrupting capacities of 50 amperes or better are adequate for the circuits in which these fuses will see service. The pigtail-lead fuses, which are soldered into the circuit, lend themselves to automatic insertion in a printed-circuit board and to automatic soldering using wave or dip soldering techniques.

The time-current characteristic curves of both the GMW and GFA fuses are relatively flat in the low overload range. Such a curve is characteristic of a very fast acting fuse. A slight overload is on the flat portion of the curve, which is almost asymptotic with the ampere rating. A little more current will open the fuse in a matter of milliseconds. Compare this with the action of the slow-blowing fuses, which may take as much as 20 seconds to open at 200% of the fuse rating.

The closer the fuse rating is to the normal load current, the closer is the protection obtainable. However, if harmless low-overcurrent surges or transients are present, one must be ready to accept nuisance openings of the fuse. Generally, a happy compromise can be obtained by selecting the fuse rating between 20 and 50 percent greater than the normal load current value.

Semiconductor diodes and thyristors with ampere values of five or less can be protected with the types of fuses described above. However, diodes and thyristors are now available with ratings ranging into the hundreds of amperes. Fuses are available for these devices but such fuses are much larger because of the thermal requirements needed just to make them carry rated current and to provide the higher interrupting capacities. Information on these higher current fuses can be obtained directly from fuse manufacturers.

Temperature and Vibration Effects

Fuses are very resistant to vibration, shock, and linear acceleration. This does not mean that environmental conditions can be ignored and a fuse selected indiscriminately.

Generally, a normal-fast opening fuse is excellent in environments of vibration, shock, acceleration, temperature shock, and in temperature extremes ranging from −65° C to +85° C. Some miniature fuses will operate well in ambient temperatures up to 100° C. Check with the manufacturer for fuses to be used in ambients above 100° C.

Dual-element fuses are also excellent in these same environments except that it must be remembered that they are made to be ambient-temperature sensitive. The effect of ambient temperature on dual-element fuses is shown in Fig. 3. This effect of temperature is useful because it permits the fuse to sense extraordinary thermal conditions that can be damaging to the circuit or equipment. The dual-element fuse opens to prevent thermal runaway, thus giving added protection.

Some low-ampere, dual-element fuses do not have the resistance to vibration and shock that those of higher rating (3 amperes and above) have. Vibration of 0-2000 Hz with forces of 15 G's are readily resisted by normal-fast opening fuses. Shocks of 15 G's and 11-millisecond duration are no problem. Linear acceleration of 200 G's can be tolerated.

Fuse Mountings

The best fuse is no better than the mounting used to connect it into the circuit. A bad connection between the fuse terminal and its mounting upsets the thermal path so that the fuse cannot dissipate its internally generated heat properly. Such a bad connection will cause a higher-than-normal resistance thereby adding to the heat and inducing a runaway condition.

There are three basic methods of installation. These are open fuseblocks with clips; panel-mounted fuseholders (sometimes called "fuse posts"); and direct attachment of the pigtail lead-in by soldering or by binding screws.

There are hundreds of variations of open fuseblocks from which to choose. The fuse clip is the heart of this type of mounting and is usually made from a spring bronze or beryllium copper. The latter material is the better type.

Although panel-mounted fuseholders are not available in as many varieties, there are plenty from which to choose. The most common such fuseholder has a rating of 30 amperes and 250 volts, which is adequate for the ¼" x 1¼" fuses that it accomodates. It fits into a ½" hole and is secured by means of a metal nut. Variations to make it dripproof and waterproof are available as is a version using ¼" wide male quick-connect terminals.

Lamp-indicating fuseholders are popular. These accept ¼" x 1¼" fuses and include blown-fuse indication. A lamp in parallel with the fuse glows when the fuse opens or when there is no fuse in the holder. Such holders are available for circuits with voltages between 90 and 250, and between 22 and 33.

The voltage ratings of these fuseholders are determined by the lamps used with them. The lower voltage indicates the minimum at which acceptable lamp glow is obtained, while the higher figure indicates the maximum voltage at which operation can be obtained without impairing lamp life.

The fuse is a device whose performance affords one of the highest returns for its cost. This cost, frequently only pennies, is insignificant compared to the cost of the equipment which it is protecting. ▲

NEW INSTRUCTIONAL TV SYSTEM GOES TO WORK

By JEFF MYLES/Systems Consultant, Lake Systems Corporation

New television system is helping Boston Archdiocese solve its teacher shortage problem while upgrading educational facilities and enriching the curriculum.

Fig. 1. Instructional television program signals are transmitted in omnidirectional pattern from tall antenna at left.

TODAY, when you are lucky enough to have an outstanding teacher on your staff, you make every attempt to see that as many students as possible are exposed to his lectures. But rather than saddle him with an impossible teaching load and oversize classes, you now put him on closed-circuit TV where his lectures and laboratory demonstrations can be witnessed by the maximum number of students.

More and more school systems—parochial as well as public—are finding instructional television the answer to the critical shortage of qualified teachers and a means of coping with the information explosion.

One of the largest parochial school systems in the country is now in the process of expanding its instructional television program which will eventually reach 400 receiving sites in the Greater Boston and Commonwealth areas. The Archdiocese of Boston, which has been active in educational television since 1953, has in the past used ETV channel 2 in Boston and commercial channel 38 for instructional purposes. Now with the installation of its new ITFS (a 2500-MHz instructional television fixed service) system, the Archdiocese will be able to reach schools, rectories, convents, seminaries, hospitals, homes for the aged, recreation halls, nursing and health service centers, adult education centers—an audience of almost two million persons.

This new four-channel ITFS system operates in the 2500-MHz microwave band and is thus not receivable on home sets without special antennas and converters. Programs originating from the school district's studios are transmitted in an omnidirectional pattern from an antenna located atop the 831-foot Prudential Center Building in Boston's Back Bay area. These signals are received at the various locations by dish-type (parabolic) antennas, then converted to v.h.f. by special receiver-converter units, and delivered to the TV receivers *via* a coaxial cable distribution system.

The new ITFS system is developed around completely solid-state hardware made specifically for the 2500-MHz service by *Jerrold*. It consists of an omnidirectional transmitting antenna, transmitters, receiver-converter units, and receiving antennas.

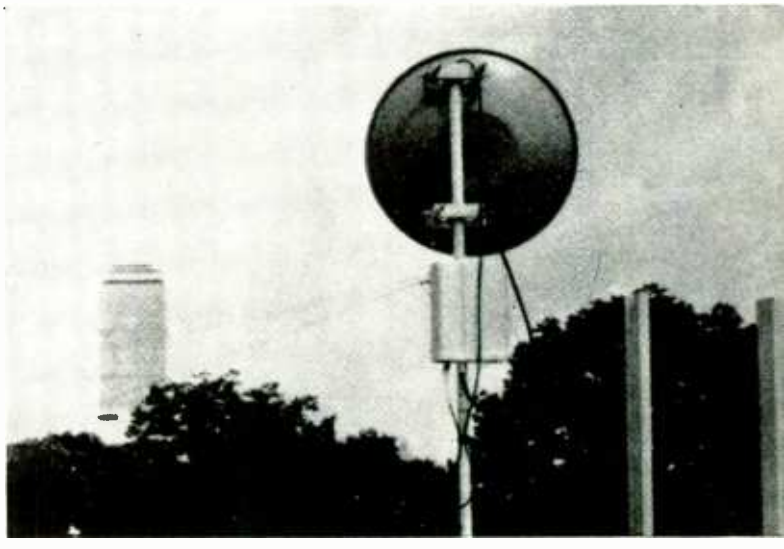
The transmitting antenna, developed by the firm's *Taco* subsidiary, provides the required radiation pattern coverage from the roof of the Prudential building. Unlike previous omnidirectional 2500-MHz antennas, which concentrate their energy at the horizon, the new antenna assures uniform coverage at all receiving locations within a 360-degree azimuth—without the need for oversize dishes at close-in locations—by efficiently distributing energy in the vertical plane accompanied by a 10-dB gain at the horizontal. It has excellent circularity with gain variations no greater than ±1.5 dB throughout the entire vertical pattern from horizontal to −15 degrees.

The transmitters are special, too, in that they can transmit both monochrome and color signals. The receiver-converter units mount on the antenna mast at the school and convert the 2500-MHz signals to v.h.f. receivable on TV channels 7, 9, 11, and 13.

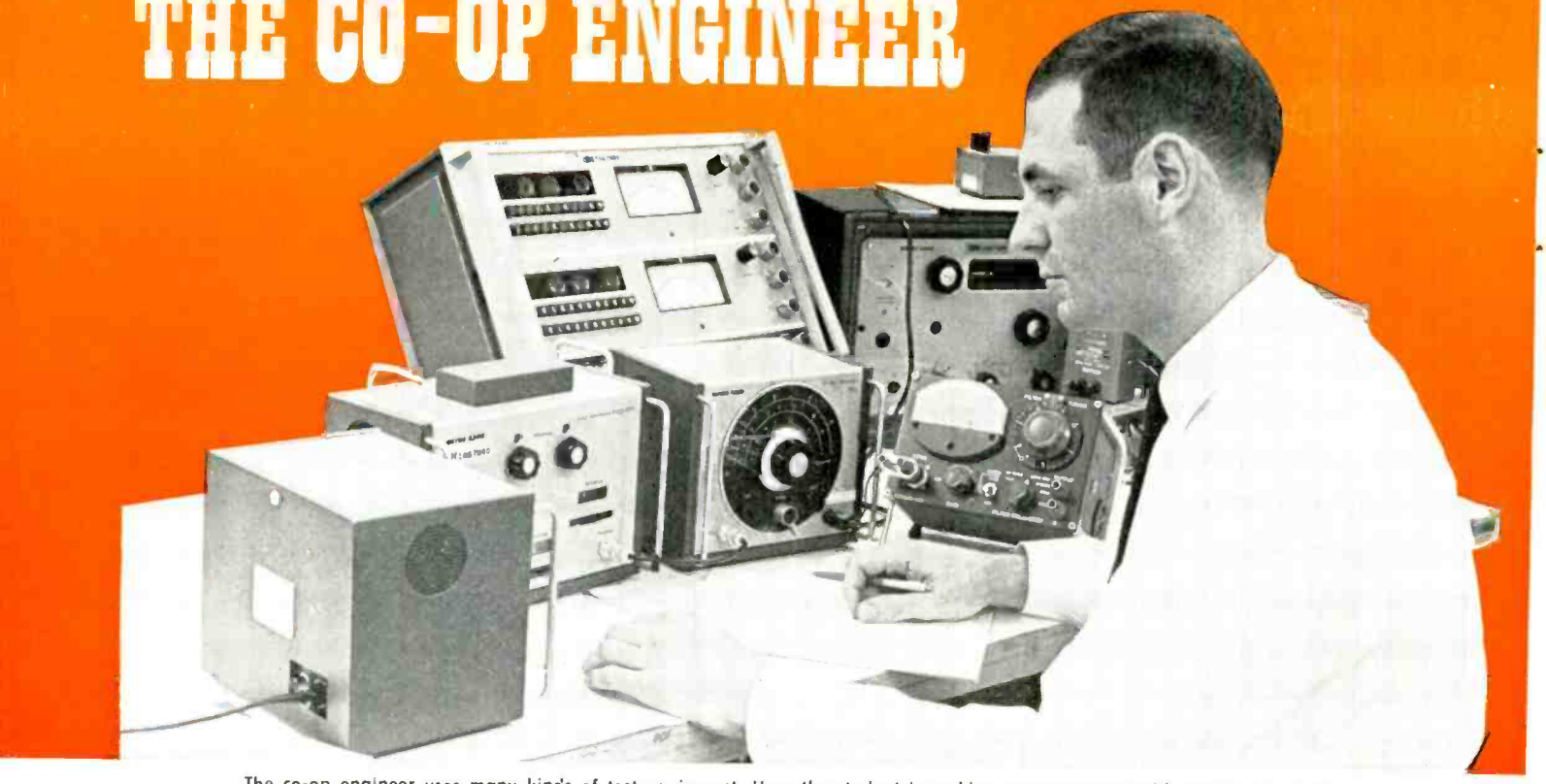
The new system is being installed by *Lake Systems Corporation* of Newton, Mass. which is serving as the engineering-contractor for *Jerrold* on the job.

When completed, according to Msgr. Flaherty, director of the Boston Catholic Television Center, an estimated 172,000 students and 6000 teachers can be reached—with an enlarged and enriched curriculum. ▲

Fig. 2. Signals from antenna atop Prudential Center Bldg. (background) are received by parabolic antennas at schools.



THE CO-OP ENGINEER



The co-op engineer uses many kinds of test equipment. Here the student is making measurements with Wayne-Kerr bridge.

—partnership between industry and education

By S. M. GREENWALD, Director of Cooperative Education
and A. H. SEIDMAN, Associate Professor of Electrical Engineering, Pratt Institute

These well-trained engineers, who alternately work one semester and study the next, are playing an ever-increasing role in the electronics industry.

AS AN employer, how would you like to cut engineer recruiting costs? As a student, what do you think of an engineering education that combines industrial work experience with classroom theory and allows you to earn money to help pay for your education? Both of these things are possible through Cooperative Education, a joint effort by industry and education to produce a well-trained, superior engineer. The co-op engineer generally spends the time starting with his sophomore year alternately working one semester and studying the next.

A number of schools like Pratt Institute, Northeastern, Drexel Institute, Purdue University, and Virginia Polytechnic Institute offer co-op programs. Employers of co-op engineers in electronics reads like a "Who's Who" of industry and government. In the private sector they include *IBM*, *General Electric*, *Varian Associates*, *Grumman*, and *Ling-Temco-Vought*; NASA and the Army Electronics Command are examples of governmental agencies employing co-op engineers.

The chief objective of an employer participating in a co-op program is to provide a flow of talent into his organization. The employer has a chance to train students in the engineering procedures of his organization and to observe their performance over a period of time. This enables the company to select the most promising students for permanent employment. Data from co-op employers indicates that upon graduation approximately 55 percent of the co-op students return to the companies where they worked as students. Employers who are selective with respect to the student's academic potential, personality, and location preference report co-op retention rates of upwards to 100 percent.

How does the co-op program benefit the student? Theory and practice are more closely integrated and the student is motivated by the challenge of industrial experience. The co-op student gains industrial experience beginning with his second year in college, rather than having to wait until he graduates before becoming exposed to a work situation. As he gains knowledge and skill, his employer gives him progressively more challenging assignments, usually directly related to his engineering and science major.

Table 1. The type of firms that employ co-op engineers.

Electronics Firms	30%
Electrical Equipment Manufacturers	20%
Research Firms	11%
Public Utilities	11%
Federal Government Agencies	7%
Aerospace Firms	5%
Consulting Engineering Firms	3%
Electro-mechanical Equipment Mfrs.	3%
Miscellaneous (1% or less each): Total	10%
Mechanical equipment manufacturers, medical electronics, radio-TV stations, etc.	

From the second year on, the co-op student has a chance to evaluate his choice of major. If he decides his interests and aptitudes are stronger in another area, he can adjust his courses in time to meet degree requirements. He finds there is considerably more to a satisfying career than technical skills; the co-op engineer learns quickly to adapt to a job, relate to his fellow employees, and get along with all kinds of people.

There is less tendency for co-op students to drop the study of electrical engineering because of lack of motivation or for financial reasons. Earnings can help offset college expenses; students get an average starting salary of $80 to $110 per week with about a $10 per week increase for each succeeding work period. This totals $8000 to $10,000 for 85 weeks of employment. Although tax deductions and living expenses can reduce this amount by as much as 45 percent, net income is usually adequate to meet the cost of tuition and fees after the freshman year.

The Background

Cooperative Education, established at the University of Cincinnati in 1906, grew only moderately until World War II. After the war, rapid technological changes and the great influx of students accelerated the growth of co-op education. During the past five years, co-op education has grown impressively; thanks to the help furnished by foundation and government grants, over 56,000 students are currently enrolled in co-op programs at 115 institutions of higher learning encompassing 29 areas of professional study. The majority of students study engineering, with the largest percentage enrolled in electrical engineering courses.

Electrical engineering includes electronics, communications, computers, as well as power generation and transmission. A recent survey conducted by Northeastern University indicates that electronics-based firms and electrical equipment manufacturers employ 50 percent of all co-op students. Such employers, as shown by the study, offer a fine cross-section of employment opportunities and can also serve as a stabilizing influence in case of a recession in a particular industry or geographical area.

The study made by Northeastern also indicates that senior work assignments reflect more responsibility and challenge than the sophomore assignments. This tends to reinforce the theory that as the student approaches his senior assignments he combines practical on-the-job experience with academic-oriented theory courses. For example, over 50 percent of the senior students work as research technicians and design engineers, where theory and experience are combined. Tables 1 and 2 summarize the types of electronics companies and jobs available to the co-op engineer.

Industry's Role

A company planning to initiate a co-op program must be understanding and have a firm commitment from its engineering department. Types of work assignments, remuneration, and benefits have to be explored and evaluated, always keeping in mind the company's objectives. At the start, it is worthwhile for management to contact schools offering co-op education and employers of co-op engineers to learn of their experiences.

The three vital ingredients of any successful program are qualified students, challenging assignments, and interested technical supervisors. Proper student selection is achieved only after work assignments have been defined. A Dean's-List student will not necessarily fit into every area of engineering to the complete satisfaction of student or company. Because most co-op coordinators interview and counsel their students during the year, selection based on their recommendations ordinarily suffices; interviews by the employer can, however, also be included.

Interviewing a sophomore co-op student is a unique and revealing experience for those who are accustomed to hiring graduate and experienced engineers. The average neophyte co-op student has the ability and desire to learn, a reasonable personality, and some technical exposure. He may also have acquired experience through ham radio, kit building, or part-time work in an electronics company. The employer must be aware that the initial work assignment can be a fairly traumatic experience for the co-op engineer and a period of adjustment in his new environment may be required.

Challenging work assignments are essential to the success of any co-op program. A student who is motivated by the knowledge that his assignments are contributing significantly to his professional growth and academic performance will almost always return to his employer on graduation and influence other students to consider employment in the company. Assignments should be commensurate with his ability and academic progress in school, with new assignments for each work period reflecting the professional growth and responsibility expected of the student.

A typical co-op training program based on five work periods and beginning after the freshman year, can include:

Test and instrumentation. This permits the co-op engineer to become familiar with a variety of electronic test equipment and production methods.

Development test. Junior engineering level work in a development group.

Design and development. Design of instrumentation and subsystems.

Research and development. Original work in devices and systems.

Student's choice. This assignment grooms the student for full-time employment after graduation. A professional-level assignment that combines challenge and responsibility with a minimum amount of supervision is most desirable.

The technical supervisor is perhaps the only responsible individual who is constantly in touch with the student. Work assignments, student motivation, and discipline should be

Computers are being used in great numbers in the analysis and design of electronic devices and systems. Shown is a co-op engineer recording analog-computer data on plotter.

his responsibility. He should enjoy working with the co-op engineer, be able to communicate, and be well informed about the company's over-all policy regarding the co-op program, the student's academic background and ability, and the length of the work assignment.

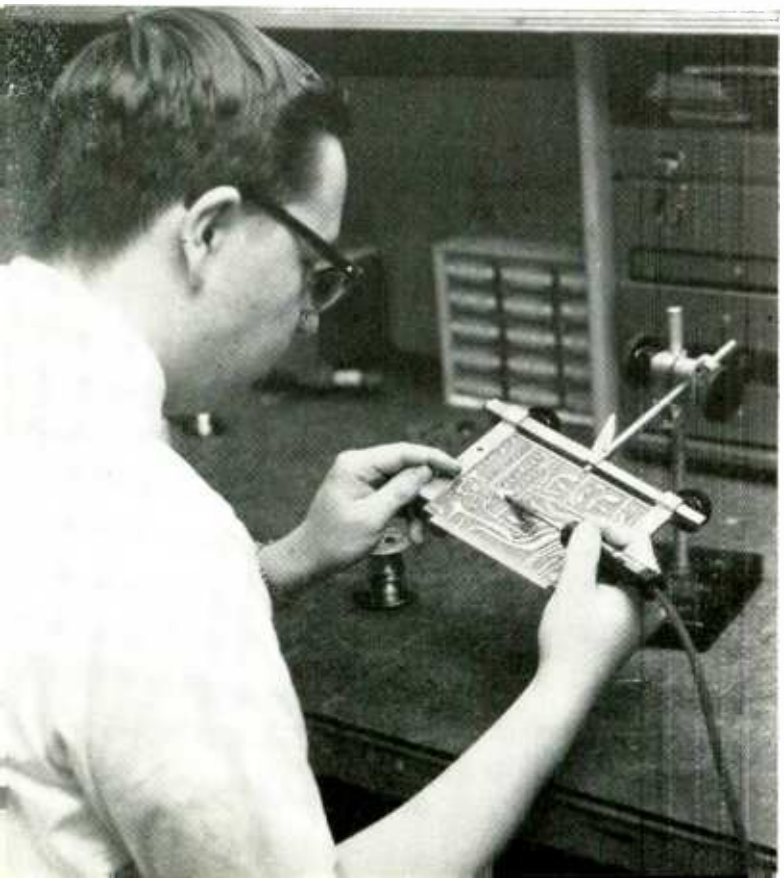
To convince a recalcitrant supervisor of the merits of the co-op program, there are two approaches which can be used. In the first, only the best qualified and most mature students are selected, thereby avoiding an initially poor relationship that may work against all co-op engineers. The second approach is to charge off all or some of the co-op engineer's salary against the training budget; the supervisor therefore obtains "free" help. This is a good tactic with a cost-conscious group.

The student's performance on the job is a very complicated question that cannot be described in a single statement. However, comments from management, students, educators, and gleaned from various surveys, indicate a definite trend. The student who is motivated by challenging assignments and personal contact with interested technical managers and college coordinators will never achieve less than a non-co-op student, but will almost always outperform a regular student in a similar work experience. A recent study presented before the Cooperative Education Association Conference backs this up. This survey compares regular and co-op students who have accepted full-time employment with the same employer.

Seventy percent of the supervisors stated that a Cooperative Education program provides a much better transition to industry; the co-op graduates are superior to non-co-op graduates in knowledge of actual operations and engineering practices. The majority of the co-op graduates agreed that the extra year needed to obtain a bachelor's degree didn't put them at a competitive disadvantage with non-co-ops. It is highly significant that 93 percent of the co-op graduates would again select a co-op program of undergraduate education. A supervisor who participated in this survey offered these reasons for supporting a co-op program in his plant:

"A co-op education is more geared to a practicing engineer and provides the necessary theory and mathematical foundation and then builds upon this with considerably more emphasis on application. Coupling this with plant experience results in a graduate who is initially better trained to cope with real engineering problems and their applications and in long term provides a better foundation for future growth."

Putting the finishing touches on a printed-circuit board that has been designed and fabricated by co-op student.



Sophomores		Seniors	
Testing Technician	34%	Research Technician	30%
Draftsman	18%	Design Engineer	22%
Utility Engineering Trainee	13%	Testing Technician	14%
Production Technician	8%	Utility Engineering Trainee	7%
Quality Control Technician	6%	Design Draftsman	4%
Engineering Trainee	6%	Development Technician	4%
Development Technician	5%	Research Assistant	4%
Oceanographic Technician	2%	Applications Engineer	3%
Miscellaneous (1% or less each): Total	8%	Interfacing Engineer	3%
Design draftsman, applications engineering trainee, data evaluation assistant, etc.		Quality Control Technician	3%
		Administrative Trainee	1%
		Estimator	1%
		Production Engineer	1%
		Programmer	1%
		Quality Control Inspector	1%
		Sales Trainee	1%

Table 2. Types of job assignments for the co-op engineer.

Student Achievements

Student assignments vary, depending upon the nature of the employing company and the student's ability to learn. Besides performing routine engineering-aid work, many co-op students are given a chance to develop and demonstrate the feasibility of a specific circuit or system. The co-op engineer may work with digital systems, integrated circuits, servos, computer-aided design, solid-state devices, modulation, etc.

One Pratt student spent his time in the power-supply section of a government agency investigating the different properties of d.c. converters, inverters, and other power regulators. Problems such as efficiency, reliability, and performance under abnormal operating conditions were analyzed and methods for improving performance were developed.

Another student was assigned to a computer manufacturer where his group was designing a monitor program to permit one computer to test and debug another computer. Initially, most of his time was spent in learning the operation of both computers and then preparing the monitor program. One student spent his first tour with an analytic group doing computerized studies of various missile systems and checking the performance of circuits.

The fourth and fifth work periods usually reflect the student's professional growth as well as his progress through academic courses. An upper junior spent this fourth work period investigating microwave phase-shifting devices. A major portion of the work resulted in the development of an improved sweep-frequency dielectrometer. Another co-op engineer evaluated the microwave properties of ferrites. One co-op student authored a technical report on the graphical design of comb line filters that proved to be invaluable to his organization. One can cite many more examples that demonstrate the value and usefulness of the co-op engineer to his employer.

Academic Aspects

The co-op plan is flexible, varying from institution to institution. The program at Pratt Institute and many other schools spreads the normal fully accredited four-year curriculum over a period of five years. The student spends his freshman year on campus at full-time study. During the next three years, he alternates work periods with study, returning to the campus for his fifth year as a full-time senior. The lengths of work and study periods (*Continued on page* 63)

TV ALIGNMENT TECHNIQUES

PART 1. The Test Equipment

By FOREST H. BELT /Contributing Editor

After you read and heed this simplified two-part explanation, you should be able to handle just about any r.f./i.f. alignment job.

Editor's Note: Our author has spent years studying why service technicians avoid television receivers that need aligning—some slightly, some badly. From countless observations and conversations, he has concluded that this aversion arises from four causes: 1. A mystique grew up around alignment in the early days of TV, and still persists. 2. Technical schools for some reason skip lightly over this important part of bench servicing. 3. Because so few technicians know how, alignment is scoffed at as unnecessary. 4. Books and articles that try to explain alignment use words, sentences, and concepts that are hard to understand. In these two articles, he concentrates on the two facets of alignment he has found most misunderstood among technicians who don't do alignment work. At the same time, the material is organized and written in a clear, direct way that makes it easy to read and understand. We think you'll like this answer to one of television servicing's continuing bugaboos.

DO YOU dread every television alignment job, or perhaps leave it for someone else? If so, you have plenty of company. A lot of TV technicians avoid alignment whenever they can. A set that really needs alignment may be left operating poorly because the technician doesn't want to get involved aligning it. Sometimes time is wasted trying to align a set without really knowing how, or profits are lost taking the set to a technician who is equipped to handle the job and knows how to do it.

The myth also persists that TV sets almost never need alignment. That's not true. Many a black-and-white set would work much better if given a very quick and simple (but accurate) touchup. Furthermore, color-TV signals demand that the i.f. strip and tuner be in good alignment. Such a number of things affect alignment—aging components, jarring, changing tube or transistor characteristics—that almost any receiver more than a year old could benefit from alignment.

Fear of alignment is unfounded. It isn't a job for the beginner, but if you know enough to do a good job of servicing, you know enough to learn alignment.

There are two main problems service technicians have with TV alignment. One is that they don't understand the test equipment. The other is that they don't understand the procedures. Either problem, left uncorrected, can make the job difficult or even impossible. You'll be pleased with how easy these problems are to solve.

But there is the repeated question: why align? For several reasons.

Fig. 1 shows screen symptoms that suggest a need for alignment. Smears and lack of detail (A) usually indicate poor frequency response in the i.f. strip. On the other hand, multiple ghosts (B) suggest ringing, caused by an overpeaked i.f. response. Poor color can often be traced to misalignment; in bad cases, the color burst may not even get through the i.f. strip. A color set with some of the symptoms of Fig. 1 will often exaggerate them whenever a color program is on.

The most definite and recognizable sign of misalignment is poor fine tuning. Normally, when the i.f. strip and tuner are in alignment, the i.f. bandpass is wide enough so that the video and sound i.f. carriers both get through okay. At one end of the fine tuning you find good sound with the picture full of "worms" and beat interference. At the other end, the picture is not too sharp—and sound may be weak.

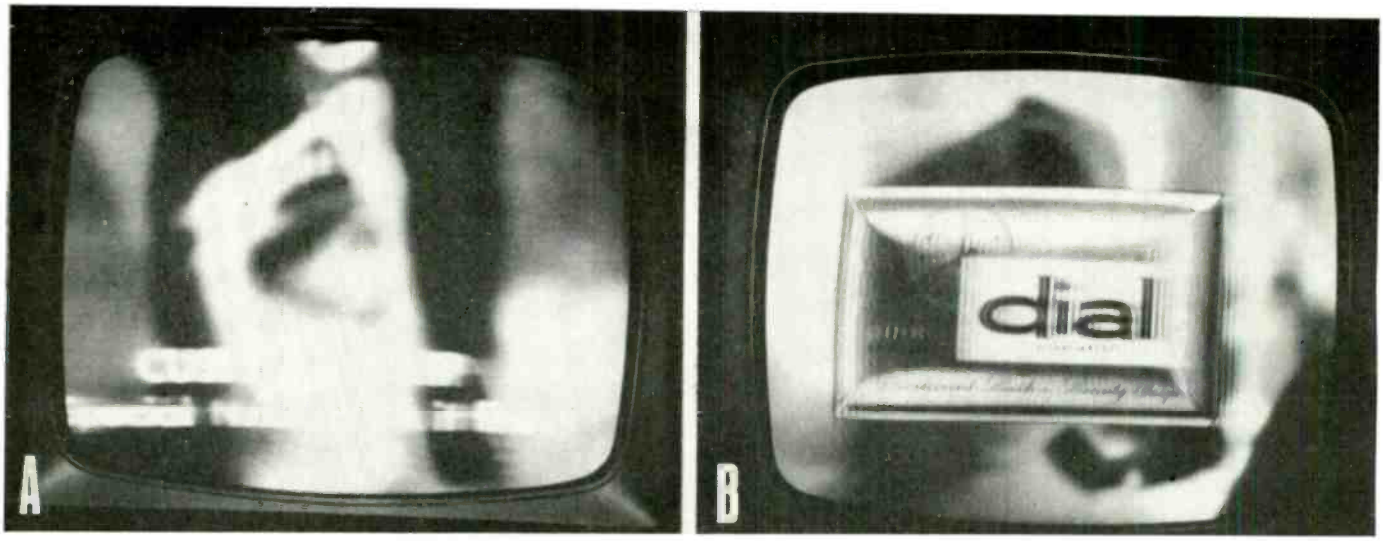


Fig. 1. Screen symptoms that indicate need for TV alignment. (A) Smear, poor definition. (B) Multiple ghosts and ringing.

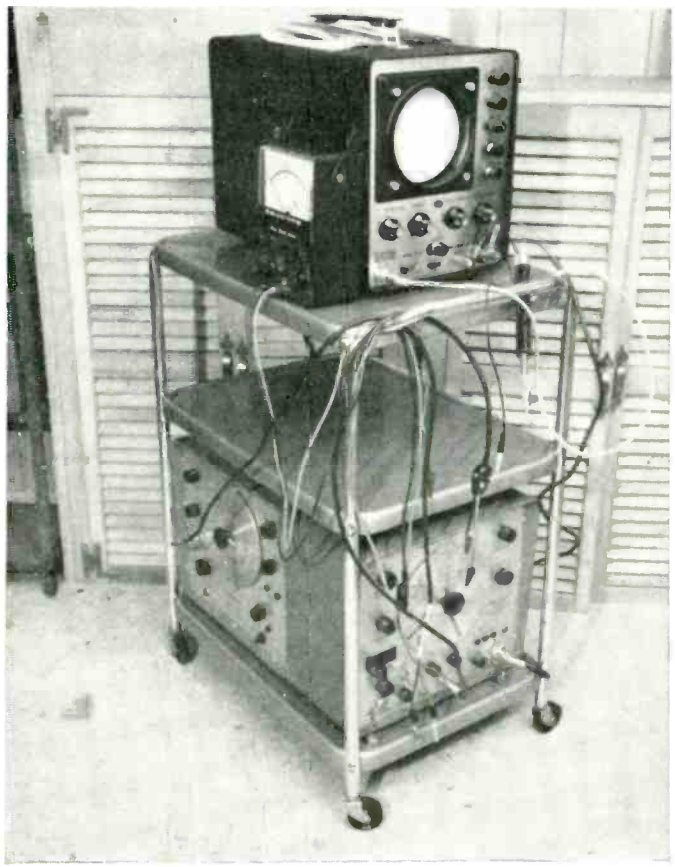
Halfway between is best picture *and* sound. With a misaligned i.f. strip you may find two or three sound peaks as you turn the fine-tuning control. The picture may have multiple ghosts at some points. These symptoms mean the set needs alignment—not oscillator adjustment, but over-all alignment, in order to correct the bandwidth of the tuner or i.f. strip.

(*Editor's Note: There are many component defects that may produce picture symptoms resembling misalignment. The technician should be certain that other troubleshooting has been completed and that alignment is actually required before proceeding.*)

Make It as Easy as You Can

There are several tricks to making alignment easy. Some of them may seem overly obvious to anyone who has already used them, yet some technicians haven't even given them a try.

Fig. 2. Alignment generators, scope, and v.t.v.m. all on cart that rolls around easily from technician to technician.



The reason voiced most often for not aligning a TV set is: "It takes so much time to get the stuff out and set it up." This may be true; it is in many shops. Technicians stack the oscilloscope, sweep generator, and marker generator away somewhere to gather dust until a TV set comes in that absolutely won't operate without alignment. Then they drag the equipment out, find that some of it doesn't work, waste time troubleshooting it, get dirty from brushing off the dust, and are generally licked before they even start. No wonder they don't like alignment.

The cure is easy: Keep the equipment connected together and set up. One uncomplicated arrangement is on a small rollabout cart (Fig. 2). This one is used in a shop with four bench technicians, and is rolled from bench to bench whenever alignment seems advisable. In fact, the technicians use the setup for quick troubleshooting in i.f.'s and tuners; since everything is already connected, getting a sweep-alignment curve takes less than a minute. When the equipment is not in use, the rollabout stands back against a wall, plugged in to keep the equipment warmed up and ready to go to work immediately.

That solves the strongest objection to regular alignment. There are so many other shortcuts and simplifications, you may soon be wondering why you've been avoiding alignment for so long. Try using these shortcuts as they crop up further along. Make alignment as easy as you can.

The Instruments to Use

Some shops don't do alignment because of the investment in equipment. You need a v.t.v.m., a sweep generator, a scope, a signal generator that's fairly accurate, and some small alignment jigs you can make in the shop. Your test equipment doesn't have to be the most expensive, but quality is important. Trying to align with shoddy test instruments is worse than not doing it at all. The poor results won't help your reputation any. If you care enough about the servicing business to do it right, find a way to finance the equipment you need.

Next, be sure you understand your equipment, and can use it with ease and assurance. A good way to start is to examine what each piece is used for.

So, let's take the v.t.v.m. first. (*Newer versions of this instrument are solid-state, so perhaps we should use the terms "solid-state voltohmmeter" or "transistor voltohmmeter," or better still, just "high-impedance voltohmmeter".—Editor*) You'll use its d.c. function as an indicator in what we'll later call prealignment. In most TV sets, the video

detector diode develops a negative d.c. output voltage, so you set the v.t.v.m. for "D.C.−" and connect it to the output side of the diode. Sometimes the diode is hidden inside the shield of an i.f. coil. When it is, the schematic will probably show d.c. continuity through a peaking coil which is more accessible.

With normal station signal, d.c. voltage at the video diode is usually between 1 and 10 volts. Almost any v.t.v.m. will do. It needn't even be accurate. Don't use a v.o.m., however, because its low input impedance will load down the circuit.

An oscilloscope is a must. You'll want a wide-band scope, with sensitivity about 0.025 volt (25 mV) per inch. With that sensitivity, the input control won't always be wide open—it is good to have a little reserve. You may need it for setting individual traps or for adjusting sets that have been badly misaligned by an inept technician or by some customer's twiddling.

The scope is used as an indicator for sweep alignment, connected directly (no low-capacitance probe) to the output of the video detector. Don't clip to the "other" side of a peaking coil; find a way to reach the diode with the scope test lead clip. If you can't, use a demodulator probe and connect across the output of the last i.f. transformer. The demodulator probe may load down the i.f. coil and throw its alignment off slightly, but the error will be minor.

Sweep and Marker Generators

Next on the list are the *sweep generator* and the *r.f. signal or marker generator*. Sometimes these two functions are combined within a single instrument called a "sweep/marker generator," but let's discuss them separately here. The r.f. signal generator should, first of all, be an accurate one. Second, it should be stable—that is, once the dial is set, the output should stay on frequency. A generator whose frequency wanders makes accurate alignment almost impossible.

You'll find two uses for a signal generator in alignment. You'll use it sometimes in conjunction with a v.t.v.m. for presetting traps and coils. This is a good way to bring adjustments close to frequency when someone has fouled them up. Often, too, it isn't easy to set traps by merely watching the sweep response curve.

The second use, and the one mentioned most in manufacturers' alignment instructions, is as a marker generator. Stability is necessary. You see, if the *shape* of the response curve is correct, the curve may be several kilohertz off-frequency without upsetting receiver operation. You make up for it, almost without knowing, when you adjust the tuner oscillator. Therefore, the stability of the generator is more important than exact frequency calibration. (Of course, there's a limit to how far off it can safely be, because of limits to just how far you can turn the coil slugs in the i.f. strip.)

You'll usually feed the generator signal into the receiver at the mixer test point on the tuner. Unless the receiver is far out of alignment, this is fine for presetting i.f. coils or trap adjustments. Occasionally, you may feed the signal into the i.f. strip at a point just preceding a coil you want to prealign. Never connect directly across the coil; be sure there is a tube or transistor stage between the generator connection and the coil to be tuned. The stage will isolate stray capacitance in the generator's output cable and prevent detuning.

Check the schematic diagram of your generator. If there is no capacitor in series with the output cable, make a habit of using one (0.001 μF) externally between the probe tip and the circuit. That way, "B+" in the set can't burn up the output control in the generator. Designers of most modern generators recognize this possibility and include a 1000-volt protective capacitor.

Next, let's consider the sweep generator. There are several different models of sweep generator available. Yours should be stable and have sufficient output to "push" a signal through a badly misaligned i.f. and make a usable display on the scope. You may want to check whether the vertical gain of your scope and the output of your sweep generator are adequate for each other. Feed the sweep generator output directly into the vertical input of the scope. Turn the generator output control and the scope vertical input gain control wide open. Set the generator for the lowest possible center frequency—usually 3.5 or 4 MHz. Turn the sweep width of the generator as wide as it will go. What you should see on the screen of the scope is a blur (Fig. 3) about an inch or so high, representing the video frequency response of the scope. If the display is much smaller, the output of your generator or the input sensitivity of your scope is insufficient. If there's no fault in the generator, you'll want one with more output or else a more sensitive scope. (Make sure the scope is up to snuff.)

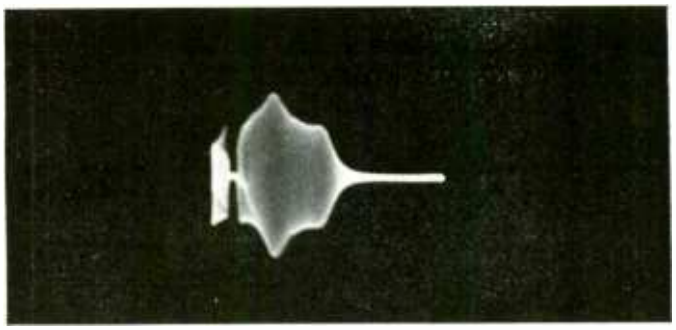


Fig. 3. R.f. from sweep generator looks like this when fed into scope. With electronic sweep, the deep notch is missing.

Inside the sweep generator, there are two ways frequency is swept. One is electronic, using a saturable inductor. The tuning coils for all the frequency bands are wound on a single core. A 60-Hz signal is fed to a "sweep" winding, saturates the entire core, and swings the inductance of all the coils up and down. That in turn shifts the output frequency above and below center 60 times each second. A generator with this system of sweeping has very little sweep width at the extreme low end of its frequency range. This is bad for certain types of alignment—as in video and chroma stages—but is no detriment to ordinary i.f. and tuner alignment.

The other way of sweeping is electromechanical. A capacitance that is common to all the bands is mounted on a device resembling a loudspeaker voice coil and spider. A 60-Hz signal applied to the voice coil pulls one plate of the capacitance back and forth, thus swinging the frequency up and down 60 times per second. As with the electronic sweep, the *amount* of 60-Hz signal is controlled by the Sweep Width control, which thus determines how far above and below center the frequencies are swept. With the electromechanical arrangement, the low-end center frequency—say 4 MHz—can be swept wide enough to reach "zero." The sharp dip at the left end of the curve in Fig. 3 is caused by this characteristic. (*Still another technique that can be used is to employ a varactor or voltage-variable capacitance semiconductor diode.—Editor*)

To view the i.f. response curve, you connect the sweep generator to a "mixer test point" on top of the tuner. This isolates the tuned circuits from the loading effects of the generator's output cable. For an over-all alignment curve that includes the tuner, the sweep generator is connected to the antenna terminals. Most sweep generators have a 75-ohm unbalanced output (one side grounded) but the "bug" on the end of the cable contains resistors (Fig. 4) that match it to 300 ohms, balanced. Whenever you feed the signal into an unbalanced circuit, the black lead must go to ground; the red lead is the "hot" one.

This brings to mind another caution: Use a capacitor

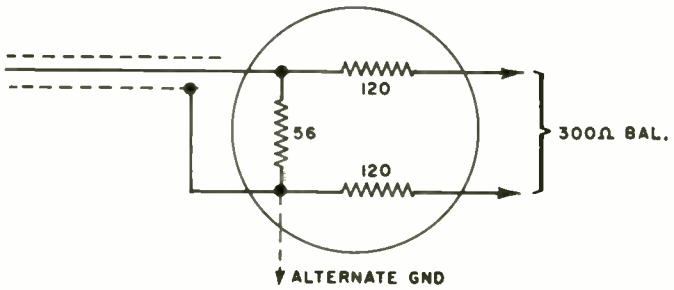


Fig. 4. Matching device at the end of generator output cable.

(0.0005 μF) in series with the hot lead if you're probing inside the set. When you are connected to the antenna terminals, the mixer test point, or a point you are sure is isolated from "B+", you won't need the capacitor. (It is more important to keep the output leads short and direct.) The d.c. voltage in plate circuits can burn up the matching resistors in the "bug."

The Truth About Markers

Markers, and the techniques used to develop them, are sometimes not thoroughly understood. They will be explained here.

First of all, why bother marking the curve? If you display a sweep response curve alone, there is no way of knowing at what frequency the skirts begin, at what frequencies they peak, and how wide the top of the curve is. It is the job of the marker to indicate the frequencies of these important points on the curve.

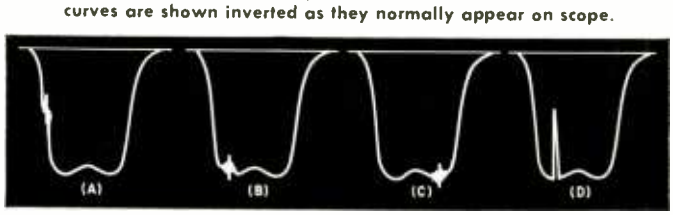
A marker is merely a signal of known frequency from an r.f. generator that is mixed with the special signal from the sweep generator. When the two of them are demodulated by the video detector (or by the demodulator probe), a "squiggle" is developed somewhere along the curve displayed on the scope. (This squiggle is actually a beat with the frequency of the sweep generator as it sweeps through the frequency of the marker generator.) The marker frequency is determined by the marker-generator dial. The position of the squiggle pinpoints that particular frequency on the curve display.

For example, in Fig. 5A, the marker is halfway up the left skirt of the curve. (The curves are shown inverted as they normally appear when the video detector anode is on the output side.) You know by looking at the r.f. generator dial exactly what frequency falls at that point on the curve. If you want to know at what frequency the top of the left skirt begins, twist the signal-generator dial until that marker is at that point (Fig. 5B); the generator dial tells the frequency.

In Fig. 5C the marker has been moved to the right-hand side of the top of the curve. Again, you identify the frequency there by looking at the signal generator dial. If you remember the frequency at the top of the left skirt, you can subtract one from the other and find the bandwidth across the top of the curve. Often this is important, especially in color-TV and in FM-stereo receivers.

Another kind of marker, recommended by some manufacturers for color-TV alignment, is the absorption type. Instead of a squiggle, the absorption marker produces a *slot* along the curve, as shown in Fig. 5D. This type of marker is used mainly for alignment in the chroma section of color sets. It is mentioned here only for reference.

Fig. 5. Marker "squiggles" on response curves. (A) Halfway up left skirt. (B) At left top. (C) At top of right skirt. (D) Response curve with an absorption or "notch" marker. Note that curves are shown inverted as they normally appear on scope.



The Marker Adder

One trouble that always plagues service technicians trying to align TV receivers is that mixing the marker with the sweep signal can upset the true response of the tuned circuits. The usual method of keeping the marker from distorting the curve is to inject only a very weak r.f. marker signal. All too often, the squiggle on the response-curve is then so small it is barely visible, especially down near the bottom of the skirts. That makes it difficult to identify frequencies at those points.

One answer to this is an instrument called a "marker adder," or sometimes "post marker adder." The sweep generator signal is fed into the television receiver as usual. A "sample" of the sweep signal is coupled to the marker adder. At the same time, the marker signal is also fed to the marker adder. The demodulated response curve of the receiver, taken from the video detector, goes to the marker adder instead of to the oscilloscope. The marker adder therefore receives three signals: the response-curve signal from the video detector, the marker signal at whatever frequency the signal generator is set, and a sample of the sweep signal that is being fed into the receiver.

Inside the marker adder, the marker-frequency signal is mixed with the sample of sweep generator signal to form the regular "squiggle" signal. However, as you can see, the marker r.f. signal has not gone through any of the stages of the receiver. The squiggle signal can now be added to the response-curve display without affecting the receiver circuits, since it is added after the response of the tuned circuits has already been determined. Most important, the marker squiggle can be made large and easy to view, without distorting the curve.

Some sweep generators now available include a marker adder. The "sampling" connection between sweep generator and adder is internal. The marker signal is fed in through an input jack, except when—as in at least one model—the marker generator is also part of the same instrument. A test lead is provided which connects to the video detector of the receiver and two output leads go to the oscilloscope vertical and horizontal input terminals.

You'll find, in using a marker adder, that it takes some practice to get the best setting of the scope's Vertical Gain and the adder's Pattern Size control. It isn't really difficult, however, and a little experimentation with both makes it easy.

(*Before leaving the marker generator we should note that most of them have provision for producing one or more fixed-frequency, crystal-controlled—hence highly accurate and stable—marker signals. As a matter of fact, one such instrument does not use a variable-frequency oscillator at all; instead it has a large number of crystal-controlled, fixed-frequency marker oscillators.—Editor*)

Connecting the Instruments Together

Sometimes, it's the interconnection of equipment that confuses a service technician. When you don't understand what the various connections are for, it can be hard to remember how to make them. The only sure-fire solution is to become familiar with them. And, to do that, you have to practice them a few times.

Instruction manuals for your instruments usually show the connections. Service data for the TV receiver is also likely to offer some help. Small matching devices are often suggested to connect the equipment properly to different receivers. Many of these "jigs" are interchangeable; once you have built a few, you can use them with almost any television set.

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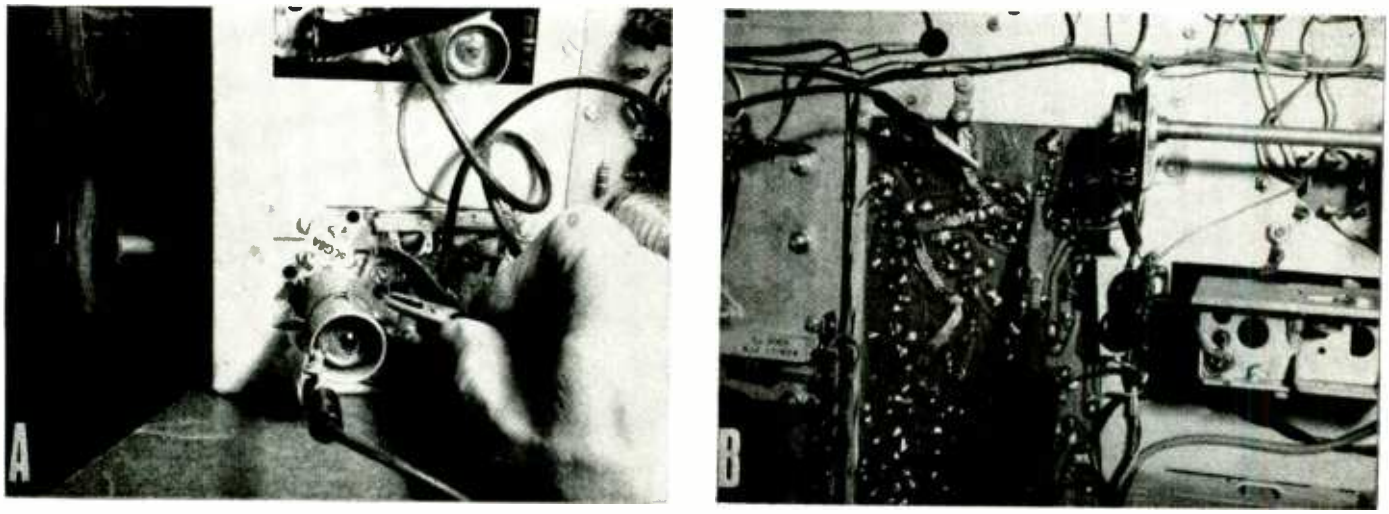


Fig. 6. Prealignment connections. (A) Clipping to mixer test point on tuner. (B) V.t.v.m. connection to the video detector.

Fig. 6 shows how to connect your r.f. signal generator and v.t.v.m. for prealignment or for adjusting traps. The generator goes to the mixer test point on top of the tuner—a small wire sticking up through an insulated hole. The v.t.v.m. probe is clipped to the video detector output. The hookup is uncomplicated. Make sure both instruments have good grounds to the chassis. The tuner mounting bracket is usually handy in case a ground lead won't reach the chassis pan.

When an early stage is so badly misaligned that the desired signal can't get through, the signal generator connection can be moved to other points in the i.f. strip. Also, it is sometimes helpful in aligning a trap to inject the signal nearer the trap. In most cases, however, the mixer test point is the best injection point.

Fig. 7A shows how to connect your sweep generator, marker-signal generator, and scope to display a sweep response curve of the i.f. section in a receiver. In (A) only the connections between sweep generator, signal generator, and scope are shown. The scope horizontal input is switched to External Input and a cable is run from the Horizontal Output jack of the sweep generator. This is the same signal that drives the sweep device inside the generator, so the horizontal sweep of the scope pattern coincides exactly with the swings of signal frequency up and down. Unless they are synchronized, there is no way of telling where the response-curve display might start each time it's swept.

In Fig. 7A, the marker generator is connected directly to the sweep generator. A number of modern sweep generators include this input connection to give a better marker without distortion. However, the marker generator may not put out enough signal to make a distinct marker, particularly near the bottom of the skirts. In those cases, you must resort to the connection you will examine later in Fig. 7B.

The output of the sweep generator in Fig. 7A is usually connected to the mixer test point. Sometimes alignment instructions for a receiver indicate a different connection. That's fine; make it where the manufacturer suggests. The output of the receiver's video detector is connected directly to the vertical input of the scope.

Make sure the instruments are all well grounded to the chassis. You may even have to run an extra braided shield between the ground terminals of the several instruments. If touching the case of an instrument affects the response curve, a better ground is needed.

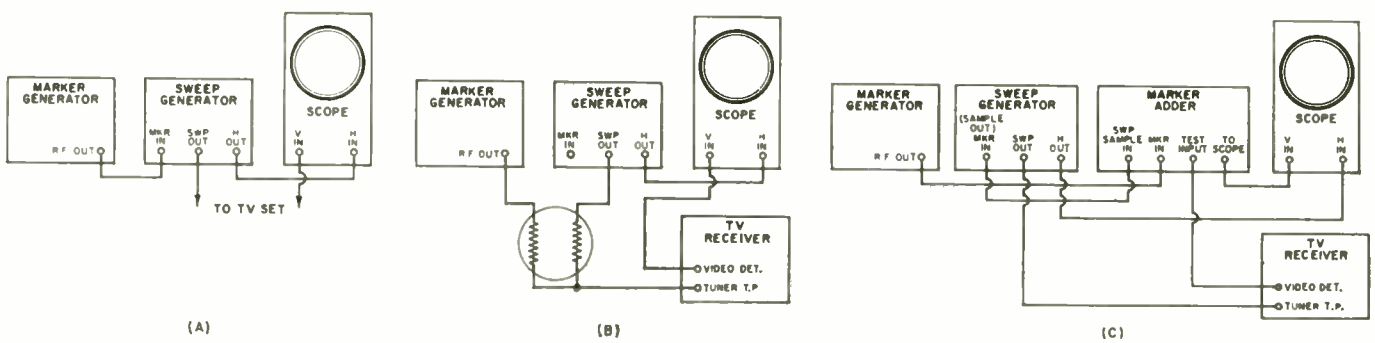
Fig. 7B shows the equipment connected to a TV receiver. The sweep and signal generators both feed the mixer test point. The resistive matching jig isolates the two instruments and helps prevent the marker signal from "swamping" the tuned circuits.

Fig. 7C includes the marker adder. Notice that the test lead from the receiver's video detector is connected to the marker adder Response or Test Input rather than to the scope. It was mentioned earlier that a scope demodulator probe could be used and the response signal taken prior to the video detector. This isn't a good idea with the marker adder; its input circuit isn't designed to work with a demodulator probe.

Interconnecting the equipment properly is the first step in intelligent alignment. Now that you understand the purpose of each item, it's easier to go ahead with the work. Nevertheless, the work itself is often misunderstood. In next month's installment, you'll find considerable detail on how to go about an alignment. The whole procedure is divided into parts, with explanations of how and why for each. When you are through, you will be able to align any TV receiver with minimum expenditure of time and trouble. Best of all, you'll probably find that you are actually enjoying it!

(Concluded Next Month)

Fig. 7. Instrument interconnections for TV alignment. (A) The basic setup. (B) Showing connection to the receiver, and the alternate marker/sweep connection. (C) How a marker adder is to be used is shown here.



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KHAN: Raga Chandranandan (excerpt) Connoisseur Society • This classical Indian music provides some of the most exciting musical experiences imaginable. Directionality between vastly different instruments is the point here, as well as the sheer sound of the instruments themselves.

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MARCELLO: (arr. King): Psalm XVII "The Heaves are Telling" (complete) Connoisseur Society • This arrangement of the brief Marcello Psalm is for brass, choir and organ, who answer one another antiphonally.

PRAETORIUS: Terpsichore: La Bourrée XXXII (complete) DGG Archive • A musical gem played by a raft of renaissance instruments including recorders, viols, lutes, harpsichord, small kettle drums, chimes, bells, and triangle.

BERG: Wozzeck (excerpt from Act III) Deutsche Grammophon Gesellschaft • The acknowledged masterpieces of modern music incorporating the use of many unusual and extraordinary musical devices, including dramatic crescendos for full orchestra.

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JOHN FRYE

Modern electronic equipment can help many physically handicapped people lead productive, independent lives.

ELECTRONIC AIDS FOR THE HANDICAPPED

THE sweltering August day kept the air-conditioner in Mac's Service Shop humming busily, but Mac and Barney were feeling no pain as they sat side by side on the service bench sipping frosty glasses of lemonade that Matilda, the office girl, had prepared and was sharing with them.

"Last night I spent an interesting four hours helping a crippled guy in the East End install the new *Heath* Home Protection System he had just put together," Barney volunteered. "He lives all by himself and can't walk or even stand. Since he can't go scampering around checking for trouble and needs more time to get out of its way or to summon help, he decided a Home Protection System would be a good investment."

"I've seen that new *Heath* system advertised, but I don't know anything about it," Mac said. "How does it work?"

"I didn't have time to study fine details of its operation myself, but I know it consists basically of a receiver that sounds a Sonalert alarm whenever a special type of signal is received *via* the power lines, and of two different and separate transmitting units. One is a specialized unit that sends the proper signal for triggering the receiver into the power line whenever the ambient temperature goes above 133° F or whenever the ambient smoke concentration at the unit exceeds an adjustable pre-set level.

"The other is a general purpose transmitter that feeds the receiver-triggering signal into the light lines when actuated by any one of various types of external sensors connected to it. It has separate inputs to accommodate normally open or normally closed sensors, or sensors that either increase or decrease in resistance with activation, and it provides latching or non-latching activation of the transmitter by a sensor. Fail-safe features cause the alarm to sound if power is lost at the receiver or if certain critical components in either transmitting unit fail."

"I don't see why a separate heat and smoke-detecting unit is necessary," Mac observed. "Why not just connect a simple heat-detecting sensor to the general purpose transmitter and depend on it for a fire alarm?"

"I asked the same question, and George—that's the crippled guy's name—was ready for it. He says a fire ignites in some house in the nation every fifty seconds, and a death results from a fire every forty-four minutes in the U.S. While the old and physically handicapped understandably account for a large percentage of these victims, a surprising number are young and vigorous. The answer lies in the fact the inhalation of smoke and fire-generated gases often renders a sleeping person unconscious before the discomfort of mounting heat can awaken him. In the great majority of cases, smoke gives an earlier warning of fire than does heat; and a physically handicapped person, especially, needs all the extra time he can muster to escape and summon help."

"I see George is in there thinking."

"I was more and more convinced of that as the evening wore on. Anyway, I mounted the smoke-detection unit at the ceiling just outside his bedroom. The general purpose transmitter was located in the kitchen. A water-detecting sensor mounted at the top of the sump-pump pit in the basement was connected so it would sound a warning if the pump failed and the pit filled with water. An old but serviceable thermostat was connected to the transmitter to give warning if the furnace quit and the house temperature fell to 60°. Another sensor was connected in the deep-freeze to warn of rising temperature.

"Two normally open magnetic reed switches were installed on the jambs of the front and rear combination screen-and-storm doors and magnets were cemented to the door edges so their influence held the switches closed as long as the doors were shut. The switches, in series, were connected to the normally closed input of the transmitter so an alarm sounded if either door were opened. George isn't so much looking for intruders as he is wanting to be sure the doors are closed before he goes to bed. Because of his wheelchair, the doors can't be equipped with springs or door-closers; and he hates to be awakened on a cold winter night by the sound of the wind banging an unlatched door around and have to climb in his wheelchair and go shut it."

"Where does he have this protection system receiver?"

"On a table right by his bed. Also on this table is one of those two-channel wired/wireless remote-control transmitter units. The living room TV set, which he can see from his bed through the open bedroom door, is plugged into the remote-control receiver for one channel, and a living room floor lamp is plugged into the receiver for the other channel. That way he can leave the light and TV both on while he gets into bed; then he can turn either or both off and back on whenever he wishes.

"One of two master intercom units is on this table, too. The other is out in the combination garage and workshop on the rear of the lot. Slave unit speaker-microphones are mounted just outside the front and rear doors. When an early-morning caller pushes the button on the front door bell or the back door buzzer, George, without getting out of bed, can use the intercom to ask what he wants. He can also listen in on things out in the garage and shop to be sure everything is okay out there.

"When in the shop, he can hear the doorbell or the telephone over the intercom there from the other unit by his bed. If it's the doorbell, he can invite the person at the door to come on back to the shop. Or if it's the telephone, he can answer it on a self-installed extension from which the ringer circuit has been thoughtfully disconnected so as not to change the normal impedance of George's private line! Finally, if something should happen to George in bed or out in the shop and his telephone would not work, he could still call for help over these two outside speakers."

"I have the feeling George has a radio-controlled garage door."

"Natch! We had to run out to the shopping center to get some wire, and he insisted we use his car. It's hand-controlled, of course, with all power features, and he handles it smoothly and easily. His radio control for the garage door is one of those high-frequency jobs that get no static from CB

transmitters. But he does have a CB transceiver in his car, which surprised me because he's a ham, and I expected him to have a powerful amateur installation.

"But he says the only reason he has a two-way radio of any kind in his car is purely for convenience and safety. He believes a handicapped person should devote his entire attention to his driving and not be noodling around with a hobby radio. And for getting essential information or help while driving, CB is far superior to ham radio simply because of the greater number of CB operators who have their receivers turned on almost continuously. Being able to talk halfway around the world doesn't do you much good when you need local information or help as quickly as possible.

"I was interested in his reasons for selecting the very compact, solid-state, 23-channel receiver with a p.a. feature he was using. He said he chose the transistorized version for compactness, low battery drain, dependability, and ability to withstand shock. It had to be small so as to take up minimum room in the driver's compartment already occupied by the hand controls. Low battery drain was important because in some situations you might have to call for help for hours without being able to run the motor. Transistors were much less likely to fail than tubes, especially under the shock of a crash."

"Old George sounds kind of pessimistic. He's always expecting trouble."

"He explained that, too. He says a non-handicapped person is much better able to work his way out of any trouble he gets into than is the physically handicapped. The latter, to the best of his ability, must use his imagination to anticipate trouble and provide a means of handling it before it happens."

"Makes sense. But why a 23-channel job and why the p.a. feature?"

"I thought, too, a transceiver to be used only for talking to other CBer's would need, at most, only the seven channels authorized for contacts between stations with different calls, but George says in an emergency he would contact a station wherever he found it, and that might well be a business station using a channel outside the Sacred Seven. If he really needs assistance, he wants to be able to yell 'Help' on all 23 channels.

"The p.a. feature enables him to switch the output of the transceiver modulator into a little paging-type horn speaker mounted under the hood. In some situations, he could get attention and help vocally where the radio would be useless. Also, when stopping outside a motel office, he can use the speaker to explain he can't walk and persuade the manager to come to the car. There are other situations where it's handy to be able to send your voice in to where you can't go yourself."

"Sounds to me as though George is putting CB to the use for which it was intended."

"Yeah, and he also has a watt-and-a-half hand-held transceiver with nickel-cadmium batteries that he carries with him when he is away from home in his wheeled cart. He often goes to town in this thing, and that is a round trip of about four miles. He says with the transceiver along, he knows he can get help if he gets a flat tire on the cart or something else happens. When traveling, he takes this into the motel with him—just in case!"

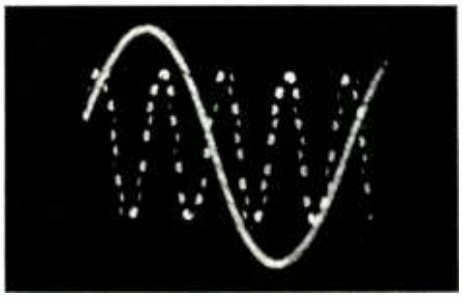
"He certainly sounds like the kind of cautious fellow who wears both a belt and suspenders, but I admire him for his foresight," Matilda said, starting to gather up the empty glasses. "Working in this shop where all we usually see are radios, hi-fi's, and TV sets, I sometimes feel that all electronics can do is amuse and entertain. It makes me feel good to know how much more this field in which we are working can do for a person such as George. Electronics enables him to lead an interesting, active, independent life and to do it safely without taxing his limited physical ability too much. The great pity is that so few people, handicapped like George, know of the existence of these electronic devices or have the technical know-how to adapt them to their peculiar needs." ▲

PHOTOGRAPHING SCOPE TRACES

By E. J. ERWOOD
Dept. of E.E., The Technological Inst.
Northwestern University

WHEN several waveforms are to be photographed at the same time during an experiment, it is sometimes confusing as to which trace is which variable. By interposing light filters made from perforated metal or plastic, open-pore sponge sections, or ruled grid patterns, it is possible to identify one of the traces.

The high-frequency waveform in the photo, for example, was photographed through a perforated metal mask placed on the face of the CRT. The low-frequency waveform was photographed through a 45-degree angled grid pattern. (It is difficult to see the grid lines in our reproduced photo.—Editor) The film used is Polaroid Type 47, black and white speed 3000. ▲



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CIRCLE NO. 112 ON READER SERVICE CARD

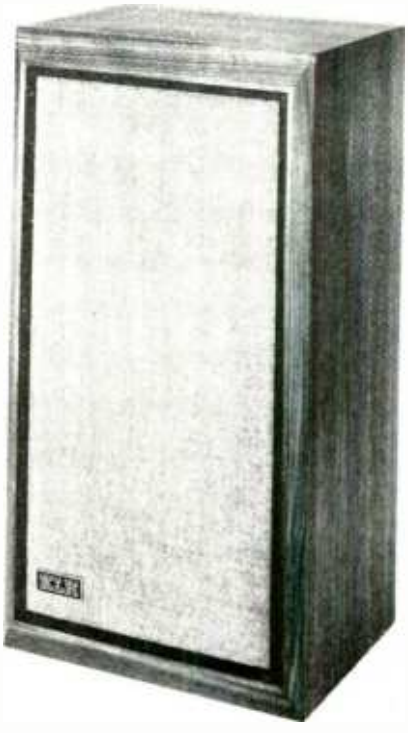
(Continued from page 22)

mit an increase or decrease of 2 to 3 dB in the level of the mid-range and high-frequency speakers, to suit the specific listening environment or personal taste.

Our tests of the speaker system were made in the same indoor environment used for all our other speaker measurements. However, this was one of the first speakers that we tested using a number of microphones simultaneously, with their outputs electrically averaged rather than with a single microphone located successively in different parts of the room. The final response curves from the two techniques are very similar. However, the newer method appears to be less subject to the effects of room resonances, except at very low frequencies. Below 150 Hz, it becomes increasingly difficult to separate the characteristics of the room from those of the speaker. Only continued experience with the new test method will let us identify the inherent response of the room.

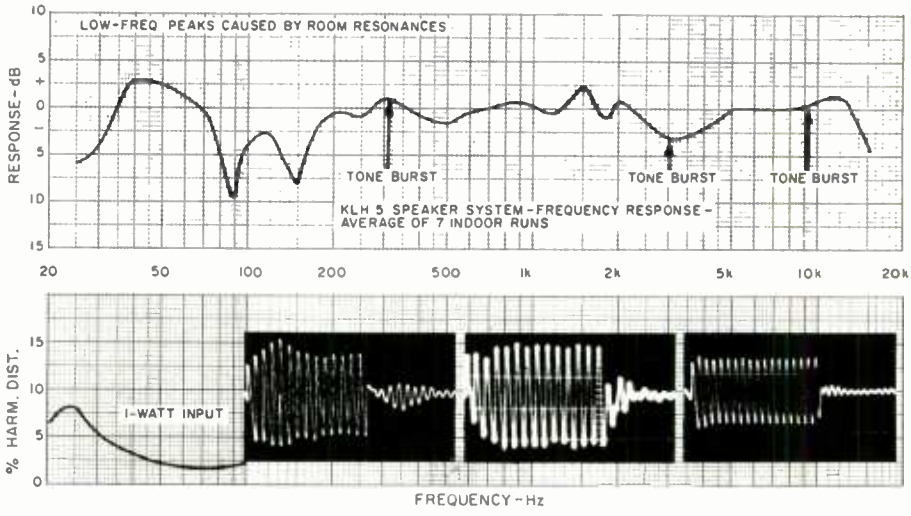
At any rate, the average of seven microphone responses throughout the room shows the Model Five to be a remarkably smooth speaker. From 170 to 14,000 Hz, the averaged response does not vary more than ±2.5 dB. Aside from some irregularities which may well be caused by room resonances, the response remains smooth and strong down to 20 Hz. Because of the very low harmonic distortion of the woofer, it is a genuinely useful low-frequency response. At a loud 1-watt drive level the distortion was only 5% at 30 Hz, 8% at 25 Hz, and down to 6% at 20 Hz. At 50 Hz and above, the distortion was typically less than 1.5%.

The tone-burst response was very good throughout its full range. Although we have seen a few other speakers that have better tone-burst response at one or two specific frequencies, we cannot recall having tested a dynamic



speaker system with better over-all transient response.

An inexperienced listener when first exposed to this speaker might have a slightly "let-down" feeling. It does not inundate one with sparkling highs, project the performance into the listening room, or shake the walls with its bass. In fact, it was remarkably free from any particular sonic characteristic or coloration. Of course this is just the way a speaker *should* sound. In fact, the term "coloration" is anathema to speaker designers. As we listened to the speaker, we became increasingly aware of its special virtue—a deceptively easy, unobtrusive quality. When called upon to deliver a palpable bass, or the airy quality of strings, it does so effortlessly. It is a fine speaker, in every way worthy of the manufacturer's name. The *KLH* Model Five speaker system, attractively finished in oiled walnut, sells for $179.95. ▲



Midget Signal Generator

By LESTER L. SCHROEDER

Sometimes a signal generator could make field servicing easy, but often it is too big to carry. Here is a hand-held unit that will do the job.

IN almost all phases of electronics servicing, the signal generator or signal injector is a very useful device. Generally, audio sine-wave generators are used as signal sources but they are usually big and heavy and the electronics technician needs a tool that is easy to carry.

There are some small signal generators on the market but usually they lack either an output signal amplitude control or a frequency control, or both.

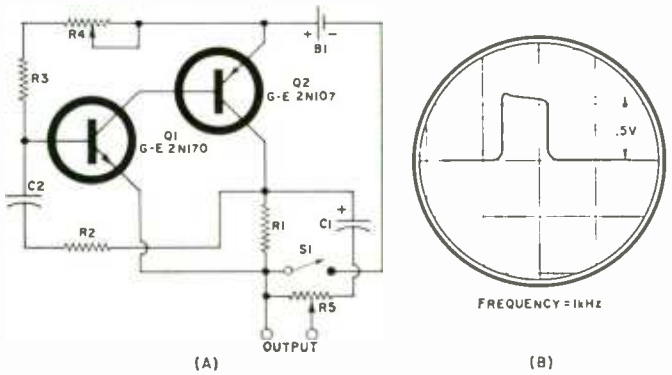
This article describes the design and construction of a small signal injector that overcomes such problems. It can be hand-held and is very useful for troubleshooting audio circuits. The complete instrument is only six inches long and ¾ inch in diameter. It has an output level control behind the pin-jack probe and the frequency control is located just above the center of the tube-body housing.

Circuit Design

Because cost and size are prime considerations in this circuit design, a minimum number of components is used. Basically, the circuit is a modification of the code-practice oscillator described in *G-E's* 1964 "Transistor Manual." It is a simple bistable two-transistor unit that utilizes complementary *p-n-p* and *n-p-n* components. Variable resistor *R5* was added to prevent circuit overloading while capacitor *C1* was included to keep the d.c. in the tested equipment out of the generator. Its value may be increased to 20 μF for audio circuits or decreased to a minimum of .05 μF for r.f. circuits. Capacitor *C2* was changed from 0.47 μF to 0.1 μF to increase the oscillator frequency.

The printed-circuit board must be designed carefully and the component layout must be exact because all the parts have to fit into a ¾" diameter Bakelite tube. The complete

Fig. 1. (A) Complementary "p-n-p" and "n-p-n" transistors form bistable oscillator. (B) Frequency is continuously variable from 600 to 1200 Hz, with a maximum amplitude of 0.5 V p-p.



(A) (B)

R1—5 ohm, ½ W res.
R2—100 ohm, ½ W res.
R3—1000 ohm, ½ W res.
R4—50,000 ohm subminiature pot.
R5—5000 ohm subminiature volume control, with "on-off" sw., S1
C1—2 μF, 10 V elec. capacitor
C2—0.1 μF, 3 V ceramic capacitor
B1—1.5-V "AA" battery
Q1—"N-p-n" transistor (G-E 2N170)
Q2—"P-n-p" transistor (G-E 2N107)
1-6" length, ¾" dia. Bakelite tubing
1-Copper or aluminum battery holder
1-Pin plug

Fig. 2. Components are mounted on a phenolic board and then slipped into a plastic tube of ¾" Bakelite. Refer to text.

circuit assembly is shown in Fig. 2. The 5000-ohm volume control, *R5*, is attached to one end of the printed-circuit board and the battery, *B1*, to the other. The pin jack, which serves as a probe, is fastened directly to the shaft of the volume control and doubles as the "on-off" switch and signal amplitude controller. For convenience, the 50,000-ohm frequency control (*R4*) is mounted near the battery holder. The tube has machined brass ends.

Operating Characteristics

Output of this palm-sized generator is a continuously variable frequency of from 600 to 1200 Hz, with a maximum amplitude of 0.5-volt peak-to-peak (see Fig. 1B). The output is basically a square wave with a relatively fast rise time. Consequently, many harmonics of the base frequency are present. The square-wave pulses are positive, with some distortion, but this is not a problem when the output is used for signal tracing.

Although the instrument was built to test transistor and tube audio amplifiers, the signal injector can also be used as an emergency radio-frequency signal source. ▲

"What sort of attitude on the part of our employees bugs you, Baby?"

The Co-op Engineer

(*Continued from page 48*)

vary from school to school. It may be 13 weeks of work or study (quarter system), 17-week periods (trimester system), or 18-week semesters plus a 15-week summer session. The length of the work and study periods depends, in part, on student participation in the program.

In some colleges and universities, the whole student body takes part in the co-op program. At Pratt it is a voluntary program in which the student receives one credit for each work period. A student is required to maintain a C or better average to be eligible for cooperative employment. Other schools treat it as an honors program where the job candidates are selected on the basis of their academic records.

To prepare the co-op engineer in his freshman year for industry and to provide him with the necessary educational background are worthy challenges for any engineering college. To meet these challenges at Pratt, the freshman takes a course in Methods of Engineering and Science (MES) which has proven successful in preparing the co-op student for industry. For lower freshmen, the MES course is designed to develop basic mathematical skills such as using the slide rule, logarithms, analyzing experimental data, applying the statistics of measurement, and plotting graphs. Concurrently, they learn Fortran II and graphics, where free-hand technical sketching is emphasized.

In class the students work out engineering-type problems, many of which have no unique solution, and are permitted to consult with each other. This course is taught by senior members of the School of Engineering and Science faculty. Every effort is made to encourage the student to think rather than rely on memorization of formulas and to learn how to apply basic methods and physical principles in arriving at a solution.

In the upper-freshman year, the students are exposed to the basic principles and problems found in the major branches of engineering. They are asked to solve problems in structures, heat transfer, fluids, pneumatics, chemical engineering, industrial engineering, in addition to problems in electrical engineering. At least five of the problems are solved on a digital computer where the student learns the use of the computer as a tool in analyzing the problems and design of simple circuits and systems. Exposure to various engineering fields helps the student gain insight into the wholeness and continuity of engineering and also enables him to choose his major with some confidence.

Freshmen are also taught to use the library for information research. Under the supervision of the science librarian, each freshman receives personal instruction on the use of the card file and engineering and science indexes and abstracts. In class the student then selects topics for written and oral reports for which he is expected to use the library for his source of bibliographical material.

Besides the MES course, the student takes freshman courses in mathematics, physics, chemistry, English, and social institutions. At the end of their freshman year, half of the co-op students enter industry; the other half remains for their sophomore year.

Critics have said that the cooperative plan caters to intellectually less able students and is therefore inferior to traditional higher education. Examination of college grades and scores on academic aptitude tests has demonstrated that this claim is without substance. Programs of Cooperative Education draw students who are as intellectually talented as students enrolled in the regular program. A recent study has shown that at Pratt 50 percent of the eligible engineering and science student body is enrolled in the co-op program; it is significant that over two-thirds of the Dean's-List students are co-ops. The median grade point is higher for the co-op students than for four-year students. The higher grades indicate that the co-operative work experience has a stimulating effect on the student's classroom performance.

Summing Up

The co-op engineering program has made an impact on the electronics industry and engineering education. It provides industry with the opportunity of hiring engineers with proven ability; the student receives a well-integrated training that combines first-hand engineering experience with classroom theory. From a dollar viewpoint, it cuts recruiting costs for industry and helps the student to defray his educational expenses. The extra year required for his baccalaureate should not be viewed as a waste of time, but as an integral part of a complete engineering education.

Finally, a Cooperative Education program promotes close contact among students, industry, and faculty. This contact is important if schools are to supply industry with qualified engineers. Industry, in turn, may have to supply technical experts, equipment, and expanded facilities to help upgrade engineering education.

Both industry and co-op students seem to be enthusiastic about the results of cooperative engineering education. It appears certain that the co-op engineer is going to play a more significant role in industry in the future, especially in the electronics field. ▲

Twin-T's

(*Continued from page 37*)

Consider, for example, that oscillator #1 is tuned to produce a note, *C*, under normal conditions. One control system is provided to shift oscillator #1 quickly up to *E*, a major third higher. Then on releasing the control element, the tone will glide down to *C*, taking perhaps one or two seconds for the glide period.

In the second system and a second control, the frequency of the first oscillator is shifted downward one semitone to *B*, and then it glides back to *C*, taking a similar second or so interval.

At the same time, the first oscillator is being controlled other oscillators undergo similar actions. For example, oscillator #2 might normally be tuned to *C*. The major third up-shift would be to *E*, with a similar down glide to *C*♯. The down-shift would be to *C*, and the up-glide back to *C*♯. Similarly other oscillators producing other tones in the musical scale would shift and glide over their equivalent increments.

In tuning the first oscillator which, for example, can be one of the *C* oscillators, *R3A* is first adjusted to *E*, when its lower end is grounded. Then *R3B* with its lower end grounded is tuned to produce the tonic *C*. Finally, *R3C*, which is normally grounded, is tuned to produce *B*, one semitone below the tonic *C*♯. Thus the oscillator can produce the three tones, *E*, *C*, and *B*, depending on which point is grounded.

The control elements are transistors *Q2* and *Q3* which serve as variable impedance elements. These elements, with the collectors connected to the resistor junctions and grounded emitters, provide the electronically controlled grounding action. The transistor bases are connected to two sets of buses through decoupling resistors *R5* and *R6*. Similar transistors are connected to similar tuning resistor elements on all other oscillators in the system. Note that the control transistors have no d.c. collector supply connection, since the collectors go to the tuning resistor networks which terminate at ground at one end and to the mid-point isolating capacitors *C1* and *C2*.

When transistors are used in this way they cannot be said to be conducting under any condition. However, when a base bias is applied in the normally conducting direction, the transistor collector-to-emitter resistance or impedance is drastically altered. When the base bias is zero, the collector-to-emitter impedance is on the order of megohms. When enough bias is applied, a condition of R_{sat} is obtained in which the collector-to-emitter impedance becomes a low value, usually 20 to 40 ohms.

At bias levels between R_{sat} and the maximum high-impedance condition (zero bias), the collector-to-emitter resistance varies with bias, just as if it were a manually turned potentiometer.

In one experimental system, up to 30 oscillators have been similarly controlled. The transistor systems have the aspect of 30 ganged potentiometers electronically manipulated by single switches.

Bus B, which operates all of the lower control transistors, terminates through *R8* on the +14-volt bus. The bias holds all of these control transistors in R_{sat}, effectively shorting all *R3C* resistors to ground. This is a normal playing position in which oscillator #1 plays *C*. Normally, the storage capacitor, *C5*, is charged to the bus voltage level but when *S2* is closed, the bias voltage on bus B is grounded out and *C5* discharges rapidly. This removes the bias from the lower control transistors, putting the *R3C* tuning resistors back in the circuit. As a result, the tone of all oscillators is lowered one semitone, a down-key shift. Now when *S2* is released, energy starts to flow back into *C5* and re-establishes the bias on the control transistors. During the time interval required to re-establish the bias, the tone glides smoothly up from *B* to *C* and, of course, all other oscillators follow through on their own semitone glide range.

Bus A controls in the opposite direction. It has a charge storage capacitor *C4*, resistor *R7*, and a normally open control switch *S1*. Normally bus A has no bias voltage and the upper control transistors are in their high-impedance state and the *R3B* tuning resistors are operative. When *S1* is closed, a charge flows rapidly into *C4*, bringing bus A quickly up to the +14-volt bias. This clamps out all *R3B* resistors, raising all oscillators a major third. When *S1* is opened, the charge on *C4* is dissipated with time, and the decreasing bias voltage causes the tones to glide smoothly down, back to their normal pitches. The shifts and glides described as a major third up and a semitone down are for illustrative purposes only. Actually, any shift interval or multiplicity of shifts can be implemented as long as they are within the 1⅓ to 1½ octave frequency range of the oscillators. ▲

Editor's Note: Two earlier articles on twin-T oscillators were written by Fred Maynard and published in Electronics World *in May 1963 and June 1964.*

In his first article, the author presented some empirical design data for simple transistorized forms of the oscillator circuit including a convenient nomogram for rapid set up of an oscillator in the audio-frequency range. In the second article, he discussed in detail applications of the twin-T oscillator electronic musical instruments.

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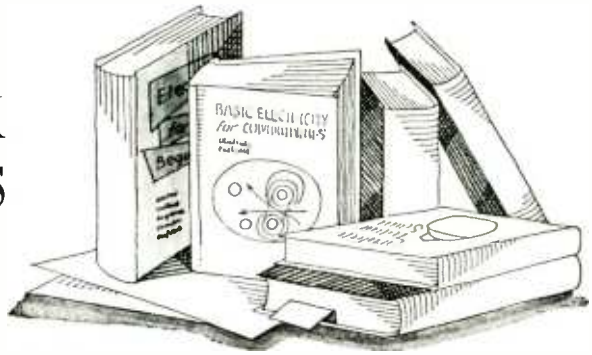


"TRANSISTOR CIRCUIT APPROXIMATIONS" by Albert Paul Malvino. Published by *McGraw-Hill Book Company*, New York. 400 pages. Price $7.95.

The author, who teaches electronics and math at Foothill College in California, has addressed this book to practicing technicians, students in technical institutes, and those in junior college level electronics courses.

Because transistor characteristics vary from device to device, the author tackles his subject by considering the variations in tolerances of transistor parameters and uses approximations in analyzing the various transistor circuits.

With a background in algebra and basic electricity, the student can learn about semiconductor physics; the *p-n* junction diode; large-signal and small-signal diode approximations; common-base, common-emitter and common-collector approximations; large-signal operation; bias arrangements; a.c. operation; cascading stages; temperature effects; frequency response; and *h* parameters. Problems appended to each chapter help the student determine his grasp of the subject matter. He can check his answers against those provided for the odd numbered problems. The text is illustrated and this plus the informal presentation of the subject matter should make it easy for the student to assimilate.

* * *

"NEW WAYS TO DIAGNOSE ELECTRONIC TROUBLES" by Jack Darr. Published by *Tab Books*, Blue Ridge Summit, Pa. 17214. 282 pages. Price $3.95. Soft cover.

From his vast store of servicing experience gleaned from over twenty years at the service bench, the author shares his knowledge of tested trouble-shooting procedures with his fellow technicians.

After outlining his theory behind the "art" of electronics servicing, he covers the test sequence technique, discusses the typical schematic, and then goes on to analyze power supplies, horizontal sweep and high-voltage systems the horizontal output stage, color sweep circuit and high-voltage problems, the vertical oscillator and output stages, the picture tube and its circuits, video amplifier stages, video i.f. amplifiers, tuner, a.g.c., and sync circuits.

Those who have been following Mr. Darr's writings for years are familiar with his breezy and informal style. This book is in the same format, with extensive illustrative examples to amplify the text.

* * *

"DATA BOOK FOR ELECTRONIC TECHNICIANS AND ENGINEERS" by John D. Lenk. Published by *Prentice-Hall, Inc.*, Englewood Cliffs, N.J. 180 pages. Price $7.25.

This is a handy reference book for the libraries of both engineers and practicing technicians. Based on his long experience in the field, the author has selected the basic data he feels most electronics personnel need. By providing all of the equations and basic data of practical value in a single, easy-to-locate format, the author has performed a worthwhile service to the engineering community.

The text is divided into ten sections covering a review of mathematics for electronic applications, d.c. circuit data, a.c. circuit data, inductor and transformer circuit data, capacitor data, phase angle and impedance relationships, antenna and transmission line data, filter circuits, measurement calculations and reference values, and vacuum-tube circuit data. A 45-page appendix contains a lot of general information which spans the entire field of electronics and mathematics and hence has not been included in specific sections.

* * *

"MATHEMATICS FOR ELECTRONICS" by F. Barker & G. J. Wheeler. Published by *Addison-Wesley Publishing Company, Inc.*, Reading, Mass. 01867. 732 pages. Price $12.50.

This volume is designed for use as a text in training programs in the electronics, aerospace, and related industries and in electronics courses at the technical institute, junior college, and technical high school level.

The text material is presented in such a way that it can be used by the student working on his own. There are 23 chapters, bibliography, appendix, and answers to the odd-numbered problems. As far as possible, the authors have made each chapter a complete entity so that the student can skip around in the text and work on material of immediate interest to him. With the problems appended to each chapter he can test his comprehension of the material he has just studied.

The text is lavishly illustrated and the use of two-color diagrams to point up the section of the circuit under discussion is especially useful.

* * *

"HOW TO USE YOUR VOM, VTVM & OSCILLOSCOPE" by Martin Clifford. Published by *Tab Books*, Blue Ridge Summit, Pa. 17214. 189 pages. Price $3.95. Soft cover.

This little volume has something for everyone. For the electronics beginner, the basic information on each of the three types of test instrument is a must; for the experienced ham, experimenter, or professional technician, the application data will be useful; for the teacher of electronics courses and his students, the material supplied is a handy one-source reference manual and guide.

The text is divided into three parts covering the v.o.m., the v.t.v.m., and the scope, respectively. Each part is further subdivided to cover how the instrument works, how it should be used, and how to service with the instrument. The text is illustrated with line drawings, partial schematics, photographs, tables, and troubleshooting charts for various types of equipment. Small enough to be carried in a pocket or service kit, this little volume should earn its keep many times a day.

* * *

"SOLID-STATE ELECTRONICS" by Robert G. Hibberd. Published by *McGraw-Hill Book Company*, New York, 163 pages. Price $8.95.

Subtitled "A Basic Course for Engineers and Technicians," this is the newest volume in the *Texas Instruments* Electronics Series. It is designed to provide the non-technical reader with a general understanding of solid-state electronics and help him become familiar with the background and terminology involved.

The book is divided into "lessons" rather than chapters and each lesson includes a glossary of terms and a number of review questions, answers to some of which are included in the text. Topics covered include an introduction to semiconductors, the properties of semiconductors, preparation of semiconductor materials, the *p-n* junction, the junction transistor, characteristics and ratings, basic transistor amplifier circuits, the manufacture and testing of transistors, compound semiconductor materials, other semiconductor devices, an introduction to integrated circuits, and trends in integrated circuits.

The text is well illustrated and the presentation is clear and straightforward. ▲

ELECTRONIC CROSSWORDS

By JAMES R. KIMSEY

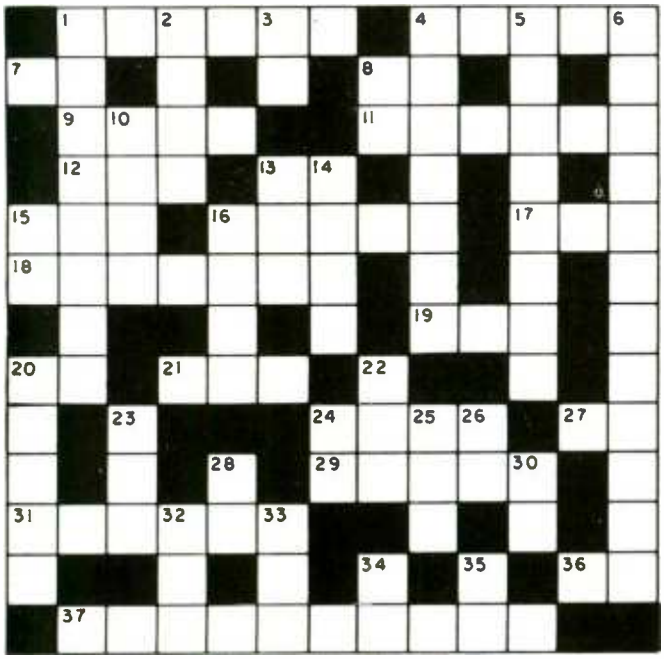
(*Answer on page 82*)

ACROSS

1. Cathode rays that emerge from a special vacuum tube through a thin glass window or metallic foil.
4. ____-beam tube. A five element tube in which the electrons flow in a beam between the cathode and plate.
7. Compass point.
8. _____ gate. This produces an output whenever any one (or more) of its inputs is energized.
9. ____-troposphere. A portion of the atmosphere about 40 or 60 miles above the surface of the earth.
11. An impurity added to a semiconductor to improve its electrical conductivity.
12. Payable, as a service bill.
13. Paid notice (colloq.).
15. An average or norm.
16. This goes well with coffee.
17. _____winding. A winding constructed from individual washer-shaped coils.
18. A basic chemical compound in the mixture used to coat recording discs.
19. 2000 lbs is one.
20. Physician.
21. A unit of energy equal to 10^9 electron volts (abbr.).
24. In a secondary radar: The undesired triggering of a transponder by its own transmitter. _____-around.
27. One one-thousandths of an ampere (abbr.).
29. _____damping. Damping obtained through displacement of a viscous material and the accompanying dissipation of heat.
31. On the screen of a cathode-ray tube, a predetermined pattern of scanning lines which provide substantially uniform coverage of an area.
36. Two of a kind (abbr.).
37. A resonant cavity consisting of lumped inductance and capacitance.

DOWN

1. ____-____ cell. A cell in an ordinary storage battery (2 words).
2. Pitch of a tone.
3. County division (abbr.).
4. An insulating washer.
5. The holding of electrons or holes by any of several mechanisms in a crystal.
6. An instrument used in servicing color-TV receivers (2 words).
8. Exterior measurement (abbr.).
10. Artificial bait.
13. Skill.
14. A ruminant mammal.
15. A system for mass communication (abbr.).
16. A type of antenna.
20. In a TV picture, a wavy or satiny effect produced when converging lines in the picture are almost parallel to the scanning lines.
22. Lubricant.
23. One of the three states of matter used in some tubes.
24. An amplifier used to increase the voltage or power at the carrier frequency.
25. Bolt accessory.
26. An enlisted man.
28. Exist.
30. A type of current (abbr.).
32. Greek letter used in electronics.
33. Southern soldier (slang).
34. A natural quartz crystal cut to vibrate below 500 kHz.
35. Government agency (abbr.).



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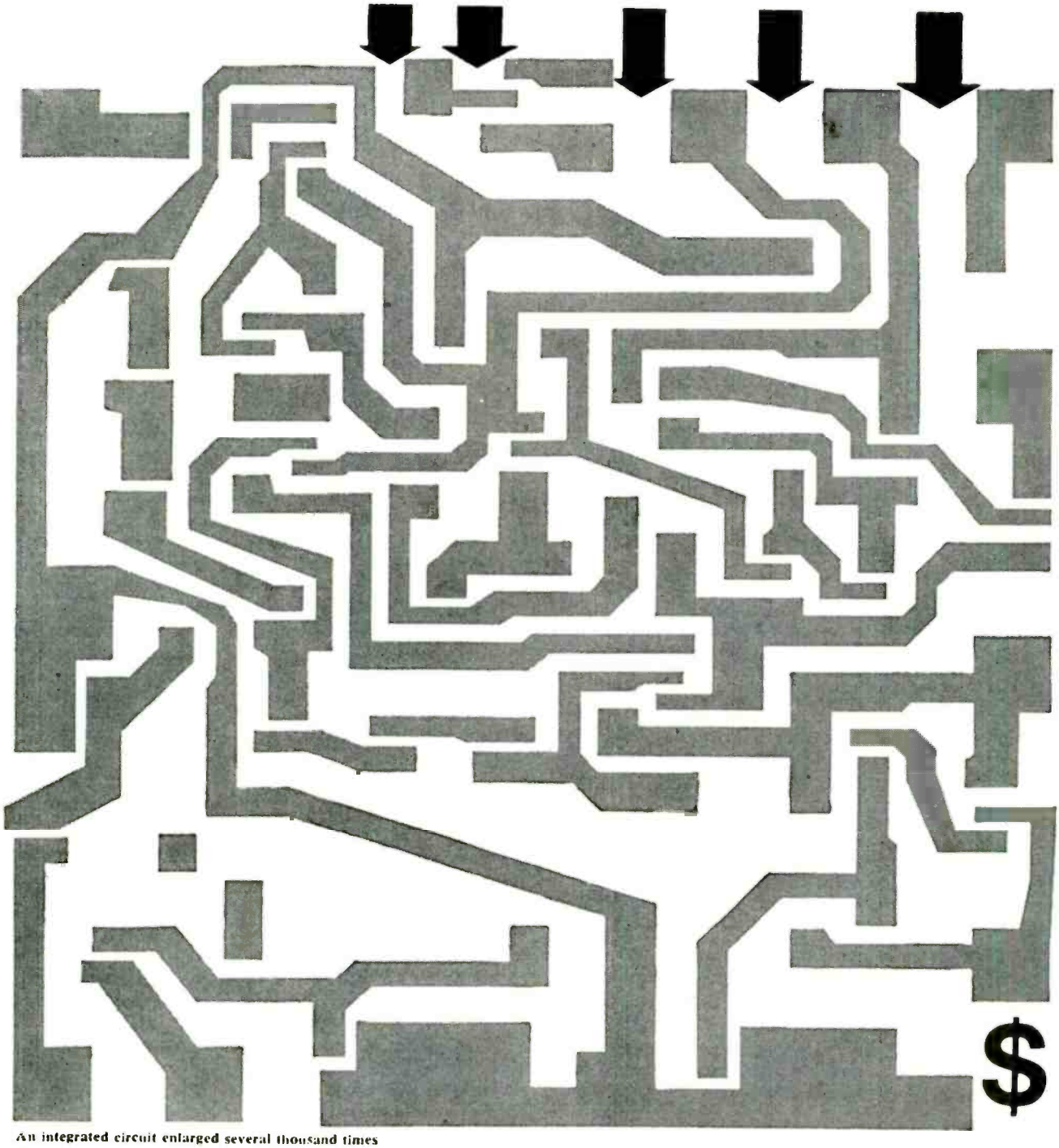

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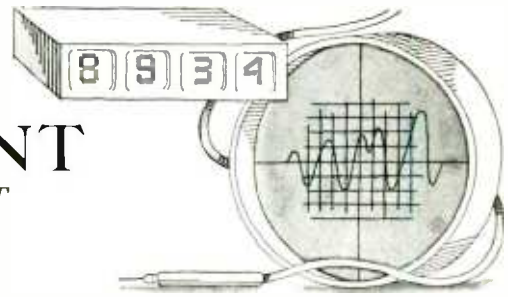
RCA

TEST EQUIPMENT

PRODUCT REPORT



Triplett Model 601 Solid-State V.O.M.

For a copy of manufacturer's brochure, circle No. 37 on Reader Service Card.

WITH more and more IC's being used in all types of electronic equipment, and with the v.o.m. being the most useful piece of general test equipment on the service or lab bench, it was only natural for a new v.o.m. to come along designed with IC's in mind. The *Triplett* Model 601 is just such an instrument.

In addition to the usual v.o.m. ranges and functions, this newest product in the *Triplett* line of meters uses field-effect transistor circuitry to provide an input impedance of 11 megohms, not only for the d.c. ranges as with the usual v.t.v.m., but also on the a.c. ranges as well.

Four push-button switches on the front panel permit the meter's polarity to be reversed, set it up for a.c. measurements, or allow it to be used for low-power resistance measurements. The very low voltage ranges, so important for testing solid-state circuits, are noteworthy. On d.c., for example, the two lowest voltage ranges are only 0.3 V and 0.1 V full-scale. On a.c., the sensitivity is even greater, with the lowest ranges being only 30 mV and 10 mV full-scale. Incidentally, both a.c. and d.c. current can be measured up to 10 mA.

In addition to the 7 conventional resistance ranges, which use a supply voltage of 1.5 V, there are 7 special low-power resistance ranges. This feature prevents electrical damage to transistors, or especially IC's. With an ordinary ohmmeter, too much voltage may be applied to the device being measured on the highest ohmmeter ranges, and too much current may flow on the lowest ohmmeter ranges. With the Model 601, supply voltage is kept so low that circuits are not damaged and there is none of the usual diode or transistor loading. In use, only 75 mV is applied across the device being tested and the maximum power applied is a mere 0.1 milliwatt.

The meter is completely portable; its circuitry operates from ten easy-to-obtain penlight cells. These should last about a year in normal use. The instrument can also check its own batteries in one position of the rotary selector switch.

Price of the Model 601 is $125, including batteries and test probes. ▲

Telequipment Type S54 Oscilloscope

For a copy of manufacturer's brochure, circle No. 38 on Reader Service Card.

WHEN one thinks of lab scopes, the company name that comes to mind immediately is *Tektronix*. This leading scope manufacturer has a well-deserved reputation for quality instruments. There are some labs, service organizations, or schools that would like to have *Tektronix* scopes but find that they are too expensive for their budgets. With a few less features and some simplification of circuit design, it would be possible to cut the price considerably.

The new *Telequipment* S54 oscilloscope represents just such an instrument. It is manufactured by an English concern, recently acquired by *Tektronix*, as a lower-priced line. This scope is a solid-state, triggered-sweep unit with a 6 by 10 cm display which sells for $350. This price makes it quite competitive with a couple of lab-scope kits that are available. The *Telequipment* line of scopes is marketed by *Tektronix* and carries the same warranty and service policy as the company's more expensive instruments.

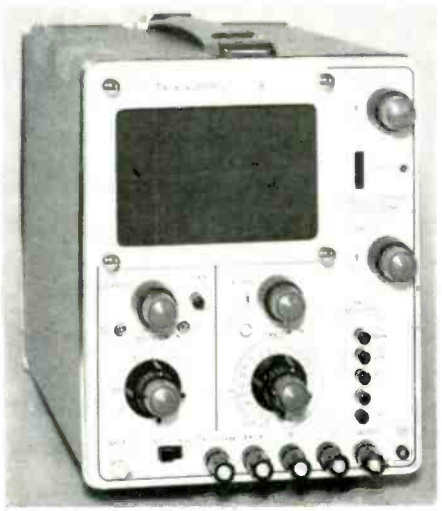
The vertical amplifier bandwidth of the S54 is d.c. to 10 MHz which adequately covers the demands of color-

TV servicing. The system risetime is 35 ns, offering good resolution for digital circuit analysis. The calibrated deflection factor is 0.1 V/cm to 50 V/cm (±5%) controlled by a convenient 1-2-5 sequence step selector. An ×10 amplifier is included to increase the deflection factor to 10 mV/cm, at reduced bandwidth (d.c. to 4 MHz).

The horizontal features, most significantly, include a triggered sweep. Here is the difference between a waveform monitor and a measurement device. It gives the user the ability to select where on the waveform the sweep will start so that he may effectively "stop" the trace and make measurements against the calibrated graticule. The 554 has both Auto and Stability/Trigger Level modes. The triggering signal is available from either the internal vertical amplifier or an external connector and, most important to the service industry, it has provision for TV Frame and Line triggering. The sweep rates are calibrated from 0.2 μs/cm to 2 sec/cm (±5%), and to approximately 40 ns uncalibrated through use of the "X Gain" control, which is a variable magnifier. The display section employs a 5-in rectangular CRT.

Power supplies are unregulated, a major concession to cost and power dissipation. The effects of voltage change and ripple are compensated for in some unique ways. For different line voltage ranges there is a convenient range selector on the rear panel which provides 5-V steps from 100-125 V and 10-V steps from 200-250 V. Relative to vertical gain, the three cascaded, long-tailed stages have local feedback to maintain constant gain as the supply changes. The CRT acceleration voltage also varies and changes the deflection sensitivity, helping to hold a constant over-all calibration factor.

Power-supply ripple is held to a minimum by *RC* filtering and its effects on the trace are further reduced by balanced amplifier stages. The internal trigger pickoff amplifier is also bal-



anced to reduce ripple effect on trigger operation, particularly at high frequencies. To prevent trace drift with supply change there is a heater stabilizer for the nuvistor input stages. All other stages use silicon transistors. Even the high-voltage power supply (4 kV) uses solid-state diodes.

The circuit was designed and laid out on one large circuit board, with all components mounted on one side to provide accessibility for servicing, and flow soldering in production. The fiberglass board has around 800 holes punched in one operation, assembled, and then mounted in the chassis, adding to the mechanical rigidity of the instrument. A cable connects all off-the-board components, such as front and rear panel controls and CRT connections. The total weight of the instrument is 17 lbs; power consumption is 30 VA; dimensions are 9″ high × 7″ wide × 16″ deep. ▲

Solitron S-100, 101, 120 SCR Testers

For a copy of manufacturer's brochure, circle No. 39 on Reader Service Card.

FOR the manufacturer who wants to test incoming shipments of silicon controlled rectifiers, or for the engineer or technician who wants to check a number of SCR's being used in a new design he is breadboarding, the Instrument Div. of *Solitron Devices, Inc.* has come up with a line of three new SCR testers. Two of these models, the S-100 and S-101, are priced at $90, while the third, the S-120, is a more flexible laboratory instrument selling for $295.

The Model S-100 is a battery-powered unit suitable for field testing, while the Model S-101 is a.c. powered. These two instruments are "go/no-go" testers valuable for quick-check in-plant inspections. They test three important characteristics of SCR's: the gate voltage needed to fire the SCR, up to 5 volts; the gate current needed to fire the SCR, up to 50 mA; and the anode-to-cathode leakage, up to 8 megohms. Each of these testers weighs 2½ lbs and measures about 5″ × 7″ × 3″. The battery-operated model is powered by 6 self-contained penlight cells.

The more elaborate Model S-120 also checks gate voltage and current (but up to 10 V and 100 mA), and, in addition, it checks anode-to-cathode forward breakover and peak forward blocking voltages up to 1000 volts, reverse blocking voltage up to 1000 volts, leakage current in either direction up to 100 mA, and holding current up to 100 mA. This tester has jacks on the rear to supply horizontal and vertical signals to an oscilloscope to display a calibrated dynamic volt-ampere firing characteristic curve of the SCR being measured. ▲

FLOATING TEST BED

EX-AIRCRAFT carrier Bunker Hill is no longer listed in the Naval Vessel Register. She now serves the Naval Electronic Laboratory Center, San Diego as a system development facility where the newest communications and weapons systems are tested and evaluated.

Her 2600-man wartime crew has been replaced by 36 scientists and technicians from NELC; by a Naval Officer and 13 enlisted men who maintain equipment; and by a 12-man security and ship maintenance force.

To cope with the situations that modern warships encounter requires the integrated operation of many separate electronic systems. These include sensing devices such as radars, communications systems that make coordinated command and control possible, and data processing and display systems that provide information for the control and direction of offensive and defensive weapons. When all of these systems are installed within the confines of a ship, there are many undesirable interactions and interferences which must be eliminated.

In addition to testing present-day shipboard equipment, the scientists are working on advanced designs and concepts. ▲

Solid-State Kits

(*Continued from page 33*)

2N708 and others. Lead forming to TO-5 and TO-18 pin configurations is available.

FET's for Every Occasion

Seven FET kits for seven-times-seven design problems are available from *Siliconix Inc.* These kits, developed for laboratory engineers, have been put together with the designer in mind. They can be used, in a practical way, to show how he can obtain the best circuit performance for the lowest possible cost. That is, the engineer can take several kit components of a certain type and substitute each of them for other devices in his circuit; and by experimenting and evaluating the circuit performance in every case, he can select the component that does the best job.

The *Siliconix* DK 1 kit, which sells for $62.50, has nine *p*-channel FET's; the DK 2, which costs $75.00, contains six FET's developed especially for telemetry purposes plus two A20A (digital-transistor-logic) integrated circuits. One of the more popular kits, the DK 3 which retails for $19.95, is made up of eight industrial FET's—three *n*-channel and five *p*-channel devices. The $75 DK 4 has nine *n*-channel devices including one MOS (metal-oxide semiconductor).

The three other popular designer kits, the DK 5, 6, and 7, sell for $29.95 $19.50, and $84.50, respectively. The DK 5 contains nine current limiters with tolerances of 20% or better; and the versatile DK 6 contains six voltage-controlled resistor FET's which can be used in a.g.c. multipliers, filters, oscillators, and modulators. The most expensive kit of all, the DK 7, is probably the most popular; it contains four differential-amplifier FET's and two current limiters. This family of matched dual FET's provides a full range of differential gate voltage *versus* temperature characteristics (5 to 40 μV/°C) for differential-amplifier design.

Engineer/Experimenter Kits

Need a zener diode? Or an SCR? *International Rectifier Corp.* has two kits that are boons to engineers and experimenters alike. The silicon voltage-reference diode kit contains twelve components which can be used in a variety of applications such as voltage references, surge and over-voltage protective devices, square-wave generators, clippers, etc. The K545 kit sells for $6.50.

The second kit, the K505, contains five SCR's rated at 50 to 200 volts and 1.5 to 9 amps r.m.s. This kit, which sells for $7.95 has an instruction manual.

IR also has a number of kits for the hobbyist at from $0.99 to $5.95. ▲

MONITOR FOR HIDDEN INDICATORS

By E. S. KENNEDY

When panel indicators are hard to see, a little bit of noise can make servicing whole lot easier.

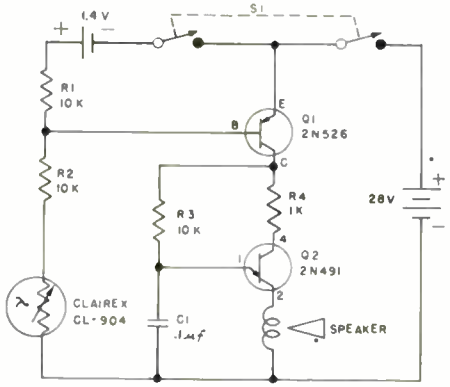
MANY times when testing or adjusting electronic equipment it is necessary to observe front-panel indicators or lights located remotely from the actual equipment. This problem is usually solved in one of three ways: by a system of mirrors set up so that the individual doing the testing can see around corners; or the adjustment is made and the individual must walk around to the other side of the equipment to observe the effect of change; or another person is delegated as observer to relay the effects of adjustments to the technician.

A fourth solution which overcomes most of the drawbacks of the other three is to use a photocell-activated (pilot-light actuated) signal device with an audio output. This permits continuous monitoring of impossible-to-observe indicator lights and the audio signal eliminates the need for glancing back and forth while making adjustments.

This device was used to troubleshoot intermittent circuits and cables connected to an automatic resistance tester. The audio signal pickups covered the indicators on the tester. The technician shook, bent, and strained the cable and when a break was found, an audio alarm would sound.

A device similar to this can be used to monitor aircraft instrument panel lamps while remote transducers or limit switches are checked in other parts of the airframe. Another application would be in monitoring indicator lamps on computer modules when stimuli are introduced at a remote console.

Fig. 1. Light picked up by the photocell causes the unijunction circuit to oscillate and emit a loud 1000-Hz audio tone.



The unit is very simple to use. After turning on the switch, a rubber photocell housing is placed over the pilot-lamp lens to be monitored. When the lamp comes on, the monitor unit automatically emits a 1000 to 1500 Hz tone from its speaker.

The circuit for the audio signal device is shown in Fig. 1. Q2 with *C*1 and *R*3 forms a unijunction oscillator circuit which operates at about 1000 Hz. Q1 acts as a switch activated by the *Clairex* photocell. When the light from the pilot lamp is picked up by the photocell, its resistance decreases and turns Q1 on permitting Q2 to oscillate. When there is no light on the photocell, Q1 is turned off and Q2 remains quiescent.

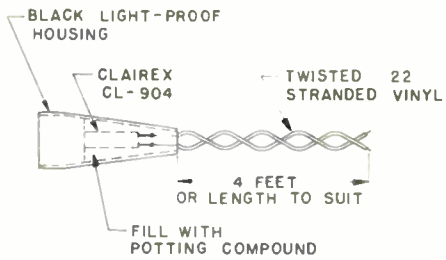


Fig. 2. Photoelectric pickup for the audio tester covers monitored pilot lamp. Lead length is not critical and may be varied to meet the needs of application.

Details of the photocell housing are shown in Fig. 2. The photocell, Type CL-904, has a resistance of 30,000 ohms at 2 footcandles and a spectral-response peak of 6900 Angstroms. This is a very sensitive cadmium-selenide type unit. Its light conduction is adequate to provide control at all pilot-lamp light levels. The unit is mounted in a hermetically sealed TO-18 case which makes it quite rugged for this application. Leads are ½" long.

The photocell is mounted in a rubber, light-proof housing. The lead entrance point at the rear of the housing is sealed with a small amount of potting compound. Potting compound is then flowed into the housing around and under the cell until it is level with the top of the photocell. It is extremely important that the potting compound not cover the cell window on top. Lead wires can be twisted #22 stranded vinyl covered. ▲

NEW PRODUCTS & LITERATURE

Additional information on the items covered in this section is available from the manufacturers. Each item is identified by a code number. To obtain further details, fill in coupon on the Reader Service Card.

COMPONENTS • TOOLS • TEST EQUIPMENT • HI-FI • AUDIO • CB • HAM • COMMUNICATIONS

COLOR-BAR GENERATOR

A new all-solid-state color-bar generator has been introduced as the WR-502A "Chro-Bar". This battery-operated instrument is designed to provide the test signals required for adjusting convergence, color-phasing, matrixing, purity, and linearity of color-TV receivers.

Patterns generated by the new instrument include color bars, dots, crosshatch, vertical lines,

horizontal lines, and blank raster. The new crystal-calibrated solid-state circuitry is especially designed to provide stable patterns with no flicker. It includes slide switches for shorting out the control grids of the color picture tube. This feature enables the red, blue, and green color guns to be "killed" as required in convergence and purity adjustments. Leads are provided for connection to the control-grid leads of the color picture tube socket.

The generator, which weighs about 4 pounds, measures 6½" x 7" x 4". RCA Electronic Components

Circle No. 1 on Reader Service Card

DIGITAL VOLTMETER

An inexpensive digital voltmeter—designed for OEM applications requiring 100 or more units annually—is now available as the Series 500. The new unit can be packaged to meet specific requirements in terms of both electronic and physical dimensions. It has an accuracy of 0.1% ±1 digit on 3-decade units and 0.03% ±1 digit on 4-decade units. Units can be furnished with automatic polarity and up to 100% overrange capability (maintaining accuracy). Visual outputs are indicated on 3 or 4 standard Nixie tubes. Units can be furnished with decimal points where needed or wired for remote operation.

Complete information on the Series 500 as well as application guidance will be supplied on request. Datascan

Circle No. 126 on Reader Service Card

HOUSEHOLD SECURITY SYSTEM

A new home protection system consisting of three units: a receiver-alarm, smoke-heat detector/transmitter, and utility transmitter is now on the market. Using a new signaling method developed by Berkeley Scientific, the unusual "load" signal generated by these units is practically unduplicable in normal devices or random noise sources, hence false alarms are extremely rare.

The system can be "customized" to the user's needs. As many units can be used as needed. Extra heat sensors can be added to the smoke-heat detector. The utility unit accepts any type of switch or sensor to guard against intrusion, fire, cooling, freezing, thawing, rising or receding water levels, and pressure changes.

All units are solid-state, of circuit board design. Installation, except for remote switches, is just a matter of plugging into an a.c. outlet. Complete information and specifications on the system are available on request. Heath

Circle No. 2 on Reader Service Card

SPRING-RETURN ROTARY SWITCH

A new family of spring-return rotary switches in a variety of sizes, electrical ratings, and angles of throw is now on the market. Diameters as small as 0.687" and depth behind panel of less than 1.25" (depending on the number of decks) are available. Make and break currents up to 1 ampere (117 V a.c., resistive load) can be ordered with this feature.

The standard spring-return configurations available are: one momentary position clockwise to one or more detent positions; one momentary position counterclockwise to one or more detent positions; and one momentary position each side of a detent position.

Bulletin #152 provides complete information on this new line. Grayhill

Circle No. 127 on Reader Service Card

FREQUENCY DISTRIBUTION

The DS-422 frequency distribution system accepts inputs of 5 MHz, 1 MHz, and 100 kHz and supplies sixteen highly isolated outputs, each with a level individually adjustable over the range of 0 to 2 V r.m.s. into 50 ohms.

Use of FET's in each buffer amplifier chain assures maximum interchannel isolation; if one output is shorted, the level change of all other channels is imperceptible as the system input impedance remains unchanged.

The new system serves as a convenient means of distributing high stability signals from a fre-

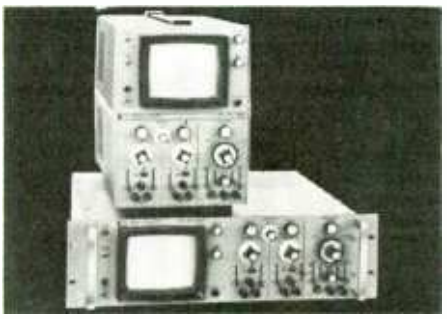
quency standard throughout a standards laboratory, engineering laboratory, production facility, test area, and receiver transmitter stations. It is especially suited for driving several frequency synthesizers or frequency counters from a single highly stable source. Vectron

Circle No. 3 on Reader Service Card

L. F. OSCILLOSCOPES

A new family of general-purpose, low-frequency scopes is now available at moderate prices. Intended for examination of waveforms where interest is confined to signal frequency components below 500 kHz, the new scopes have higher trigger sensitivity (0.2 V minimum), a.c.-d.c. trigger coupling, single sweep capability, and d.c.-coupled Z-axis input—features usually associated with lab scopes.

There are eight oscilloscopes in the new 1200 Series: four bench types, including two single-channel and two dual-channel instruments, and four rack-mount types with the same capabilities.



Complete specifications on the 1200 Series are included in a 12-page brochure which will be forwarded on request. Hewlett-Packard

Circle No. 128 on Reader Service Card

82-CHANNEL ANTENNA

The SC-1000 "Super Colortron" antenna incorporates a number of new and exclusive electronic features which the company claims makes the unit ideal for distant pickups.

A unique vertical beam phasing feature on all v.h.f. channels eliminates signal pickup from above and below the antenna, thus shutting out interference from such common sources as planes, cars, and diathermy equipment. The same feature is also said to be useful in eliminating ghosts and increasing v.h.f. capture area and power gain. A constant-focus u.h.f. screen concentrates the entire signal on the tetrapole collector element to provide the most u.h.f. signal capture area. Impedance is 300 ohms. Winegard

Circle No. 4 on Reader Service Card

DIGITAL PANEL METER

A new, low-cost miniature digital panel meter, the "DigiTec" OEM series 180, features accuracy of 0.05% of reading +1 digit, obtained through the use of high-stability circuits.

Readability is enhanced by combining the non-ambiguous presentation of digital readout with the resolute qualities of analog display. Decimal points may be placed in any desired position.

The basic 100 mV full-scale range may be extended to as high as 1000 V by choice of a single-range resistor installed internally or externally. The unit requires only 3.25" x 5.6" of panel space and less than one-tenth cubic foot behind the panel. United Systems

Circle No. 129 on Reader Service Card

ANTENNA ROTOR

The new AR33 "Autorotor" features fully automatic push-button control, precise repeatability with ±1 degree position accuracy, silent operation, solid-state circuitry, 360-degree compass dial operation, and a contemporary housing designed by Raymond Loewy/Wm. Snaith Associates.

Descriptive literature on this new TV-FM antenna rotor is available on request. Cornell-Dubilier

Circle No. 5 on Reader Service Card

TRANSFORMER FOR PC's

The new Size #8 Blue Chip transformer has been specifically designed for microcircuit applications. The unit occupies a space of only 0.015 cubic inch (0.25" x 0.25" x 0.25") and will meet MIL-T-27B, Grade B, Class S specifications.

Impedance range is 600 to 100,000 ohms, frequency range is 400 Hz to 250 kHz, and power range is 2 mW at 400 Hz to 50 mW at 1 kHz. Inductance values range all the way from 0.1 to 65 henrys.

Complete electrical and mechanical details will be supplied on request. ADC Products

Circle No. 130 on Reader Service Card

ROTARY SELECTOR SWITCH

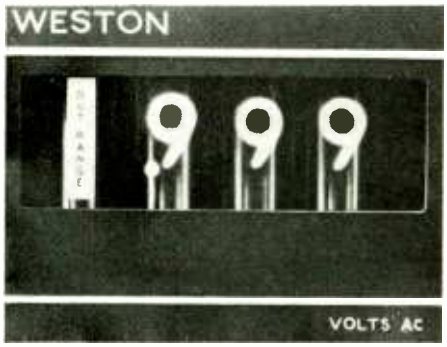
A new rotary selector switch which provides nine positions and "off" in a diameter of 0.5" yet is rated at 250 mA at 28 V d.c., resistive load, is now available. Contact resistance is 0.05 ohm maximum.

Designed for printed-circuit board mounting, with pins 0.187" long on 0.4" diameter circle, 36° indexing, terminals are gold plated for solderability and long life. A special detent design assures that the switch will not "hang up" between postions. Digilog

Circle No. 131 on Reader Service Card

A. C. DIGITAL PANEL METER

The Model 1271 digital panel meter is an a.c. unit with ±0.25% full-scale ±1 digit accuracy from line frequency to 1000 Hz in ranges from 1 volt to 500 volts. The Model 1274, which is identical to the firm's original Model 1270, but



with the added non-blinking feature; and the Model 1273, a 3½-digit unit with direct reading over-range which extends its use well beyond the 1,000 reading are also available. This latter model is offered in a choice of eight ranges: from 0-150 millivolts up to 1500 volts. The Model 1274 can be ordered in any one of ten ranges: voltage from 0-100 mV up to 1000 V, current from 0-10 μA up to 100 mA. Weston

Circle No. 6 on Reader Service Card

75-OHM COAX CABLE

Colorshield is a new 75-ohm u.h.f./v.h.f. 59U-type coaxial cable with exceptionally low attenuation loss, according to its maker. The 82-channel cable is constructed of a solid copper conductor surrounded by foam (cellular) dielectric insulator, a double-sided aluminum sheath for 100% shielding with two braided copper drain wires, enclosed in an all-weather poly jacket. Wald Electronics

Circle No. 7 on Reader Service Card

INTRUSION ALARM

The Model SS-101 u.h.f. intrusion alarm system uses transistors rather than vacuum tubes to generate the 400-MHz microwaves to detect human motion in the areas it is designed to protect.

The system consists of a remote detector, a control unit, and an alarm. As soon as an intruder enters the protected area, the lights are turned on. Then 30 seconds later, an ear-splitting police-type siren sounds. Alternatively, the system can be connected directly to police headquarters through a rented phone line or a telephone dialer. Fire sensors can also be connected into the control unit. Radar Devices

Circle No. 8 on Reader Service Card

IN-CIRCUIT TESTER

A portable, hand-held tester that checks transistors and diodes in the circuit is now available. The tester gives a quick "go/no-go" check for both conduction and cut-off characteristics. The battery-powered unit is just 9" long x 1¼" diameter and weighs only 6 ounces. It comes complete with an adapter to test diodes and a set of leads and clips to test either transistors or diodes out of the circuit if desired. Telvac

Circle No. 9 on Reader Service Card

MATV DEMONSTRATION KIT

An 82-channel master TV antenna demonstration kit has been developed to help electronic distributors, dealers, and TV system contractors show a fully operative MATV system.

Since the "Smoothline" MATV equipment is solid state, the display can be fitted into a small, light case. It comes complete with amplifiers, splitters, tap-offs, and all necessary cables. One end of the case connects to an antenna and the other end connects to a color-television receiver. JFD

Circle No. 10 on Reader Service Card

PORTABLE COUNTER

With the new Model 114, frequency measurements can be made directly to 12.5 MHz. The readout includes four digits (5th and 6th optional), an auto-positioned decimal point, a "kHz" annunciator, and display storage to assure error-free readings. Accuracy of readings is ±1 count ± power line frequency.

Without the tilt stand the unit weighs 5 pounds and measures 3¼" high x 7" wide x 8½" deep. Systron-Donner

Circle No. 132 on Reader Service Card

FRONT-ACCESS READOUT

A new miniaturized digital readout which features front lamp replacement and provides the utmost in legibility and economy, according to its maker, is now available as the Mono-bit.

The new seven-segmented bar display contains nine miniature incandescent lamps which are easily accessible from the front, reducing maintenance to a minimum. The Mono-bit displays all characters both numerically and alphabetically in the same plane, allowing wide viewing angles and visibility in a variety of viewing ranges.

The face of a typical unit measures 0.380" x 0.625" and is 1.000" deep. Individual units can be placed side by side, as required, to form a multiple integrated display assembly. Symbolic Displays

Circle No. 133 on Reader Service Card

ZENER VOLTAGE REGULATORS

One watt of zener power in a subminiature package is offered by the 1N4728A to 1N4764A series of voltage regulators recently put on the market. A full watt of power dissipation is available from 3.3 to 100 volts in this series. The subminiature case (similar to the DO-7 case, measures 0.20" x 0.10" diameter, with 0.030" diameter leads over 1 inch long) is molded of a specially selected plastic compound.

Bulletin C-107 includes complete technical information on the new units and will be forwarded on request. International Rectifier

Circle No. 11 on Reader Service Card

MECHANICAL FILTER

What is said to be the smallest mechanical filter ever is being marketed as the Minifilter. It is available in two packages—cylindrical brass and rectangular plastic. The brass version, F455T-150, measures approximately 0.08 cubic inch. The plastic version, F455W-150, measures 0.15 cubic inch.

Center frequency is 455 kHz, bandwidth is 15 kHz at 6 dB and less than 30 kHz at 60 dB. Passband ripple is 2 dB maximum while the source and load impedance is 70,000 ohms. Operating temperature range is —40° C to +85° C. Collins Radio

Circle No. 134 on Reader Service Card

ANTENNA-MOUNTED PREAMP

A new all-channel, antenna-mounted preamplifier that is said to more than triple the strength of all v.h.f. television signals is now available as the Model ACP-105-L. This new model takes the output from a 300-ohm antenna and feeds the signals via 75-ohm, Coloraxial cable downlead to the receiver. Frequency response of this new Powermate is flat to ±5 dB on any of the 82 TV channels. The all solid-state preamplifier has built-in shielding and circuit protection against lightning surges. Jerrold

Circle No. 12 on Reader Service Card

H. V. RECTIFIER FOR COLOR-TV

With the introduction of a solid-state high-voltage rectifier, the Quasar line of color-TV receivers becomes solid-state throughout. The

new rectifier combines state-of-the-art silicon rectifier chips of excellent uniformity with an unique encapsulant to provide a humidity and corona resistant package of good mechanical strength.

Because of the modular construction of the Quasar line, the new rectifier can be incorporated in existing receivers by means of a new high-voltage module. Motorola

Circle No. 13 on Reader Service Card

HI-FI—AUDIO PRODUCTS

DYNAMIC MICROPHONES

The new "Starmaker" line of high-performance dynamic microphones for use in professional broadcast, recording, and stage performances, as well as in home recording and communications applications, is now on the market.

The six new cardioid and omnidirectional microphones include the "96" with a frequency response of 50-15,000 Hz and a 3-position bass roll-off switch to reduce rumble and unwanted background noise; the "97" with 50-15,000 Hz response and unidirectional pickup pattern and "on/off" switch; the "98" with a 40-17,000 Hz

CIRCLE NO. 125 ON READER SERVICE CARD→

response and "on/off" switch; the "99" designed especially for the home-recording enthusiast and providing a frequency response of 80-10,000 Hz and a 500-ohm impedance; the "100", also for home recording, with a frequency response of 100 to 8000 Hz and a 50,000-ohm impedance; and the "101" with a response of 70-9000 Hz for use with CB, ham, and communications equipment. It has a press-to-talk switch in the base. RCA Electronic Components

Circle No. 14 on Reader Service Card

TAPE DECK

A compact audio tape deck featuring automatic reversing and replay, simplified threading, sound-with-sound, and tape monitoring is now available as the Model 1450. Designed to fit into

any standard size console well, dimensions are 15¾" wide x 13" deep x 6½" high. The deck weighs 29½ pounds.

The recorder has four heads and includes preamplifiers. An optional walnut cabinet with smoked glass dust cover is available extra. Ampex

Circle No. 15 on Reader Service Card

PORTABLE CASSETTE RECORDER

The Model 1100 portable cassette tape unit provides convenient on-the-go recording in the classroom, office, home, or car. It may be plugged into any standard a.c. outlet or it can be operated from five "C" batteries. The snap-on a.c. adapter looks like part of the recorder when in use.

This unit will record up to two hours monophonically on two tracks of the tape. The companion cassettes are available for 60, 90, and 120 minute recording. Features include keyboard-type push-button operation, fast forward and rewind, level battery meter, and extension speaker jack. The recorder measures 12" x 6" x 4". Allied Radio

Circle No. 16 on Reader Service Card

RECEIVER/TAPE DECK UNIT

The new TDC33 is a combination of the Nocturne 60-watt solid-state receiver and the professional TD3 three-head tape deck, packaged in a single walnut enclosure. Capable of accepting additional inputs from a turntable and a microphone and able to drive as many as four speakers regardless of size, impedance, or efficiency, the TDC33 is a complete solid-state music system.

The combination incorporates solid-state devices and technology, with IC's in the i.f. stages and MOSFET's in the FM input stages. The three-speed tape deck is constructed on a die-cast metal frame, has three balanced-coil tape heads, and

extremely narrow gap for extended frequency response for both recording and playback. A data sheet with full specifications is available on request. Harman-Kardon

Circle No. 17 on Reader Service Card

LOW-POWER MONO AMP

The AA-18 solid-state amplifier produces 4 watts music power output with a frequency response of 23 to 100,000 Hz ±3 dB. Harmonic distortion is 0.7% at 1 watt while IM distortion is less than 1.5% at 1 watt.

Using solid-state circuitry throughout, the AA-18 is designed for use with ceramic phono cartridges, mono AM or FM tuners, or any signal source having a "flat" output of sufficient amplitude. The amplifier features a complementary symmetry emitter-follower circuit that eliminates the need for transformers. A headphone jack is mounted on the front panel for added convenience. The amplifier is offered in kit form. Heath

Circle No. 18 on Reader Service Card

TAPE RECORDING MIKES

The Model 2800 microphone (or Model 2804 as a matched pair) carries a full one-year guarantee and features modern styling for console, deck, and cassette recording applications. It is a dynamic, high-impedance, omnidirectional unit with a frequency response of 70-15,000 Hz and a −63 dB output level. It comes complete with a 12-foot cable with phone plug, stand, and lavalier accessories. The matched stereo set is packaged in a convenient carrying case. Turner

Circle No. 19 on Reader Service Card

HEADPHONE & MICROPHONE

The Model MB-K84S 'M dynamic headphone is designed for stereo or mono listening. Its air cushioned earpads are of plastic and foam rubber

to assure comfort and isolation of ambient sounds. Weighing only 5 ounces, it permits hours of continuous listening.

The MB-215 dynamic microphone has a frequency response of 60-17,000 Hz with cardioid pattern. It has a built-in windscreen and is tropicalized.

Full technical specifications on these and other items in the line are available on request. Stanford International

Circle No. 20 on Reader Service Card

PORTABLE STEREO UNIT

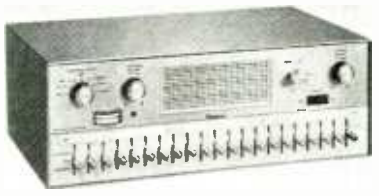
A portable stereo compact phono unit featuring matched EMI speakers, a Miracord auto/manual turntable, and Elac STS 244 magnetic cartridge has been introduced as the Model 1020.

The unit measures 15" x 26" x 7⅛" high and weighs 32 pounds. It has an output of 32 watts, a special jack for using headphones, an auxiliary input jack, and a full set of component-type controls. The electronic system is solid-state. Benjamin

Circle No. 21 on Reader Service Card

DUAL-CHANNEL CONTROL CENTER

The Model SX390 dual-channel program control center was developed especially as an economical system for small and medium-sized schools. It provides two separate program and intercom channels and makes available versatile facility expanders.



There are inputs for three low-impedance microphones, three high-impedance auxiliaries; 20 station selector keys; voice call-in facilities; selective privacy on intercom; output level meter; talk/listen switch; all-call key; plus room to connect various facility expanders.

Full descriptive details on the SX390 and the auxiliary expanders designed to be used with it are provided in a four-page data sheet which will be forwarded on request. Rauland-Borg

Circle No. 22 on Reader Service Card

CB-HAM-COMMUNICATIONS

RADIO-CONTROL SYSTEM

A 27-MHz radio-control system which features a 5-channel transmitter and a receiver using digital techniques to provide simultaneous proportional control of miniature servos, is now available.

Supplied in kit form, the transmitter Model GDA-47-1, has stick-type controls on four channels. The left stick controls rudder and throttle; the right stick controls elevator and ailerons; each has trim adjustments so that center positions result in "straight and level" flight. The fifth channel has a thumb-type control and can be used for flaps or landing gear operation.

The receiver, Model GDA-47-2, features 11 transistors, 5 silicon controlled switching devices, and 7 diodes—all mounted on two fiberglass circuit boards. Power is supplied by a rechargeable battery. The servos have three outputs.

The complete system including transmitter, receiver, two rechargeable batteries, four servos, all cables and connectors is available as the Model GD-47 or the components may be purchased separately. Heath

Circle No. 23 on Reader Service Card

SIX-CHANNEL WWV RECEIVER

A new dual-conversion WWV receiver has just been introduced as the LSR6/RPA1. The crystal-controlled receiver covers the 2.5, 5.0, 10.0, 15.0, 20.0, and 25.0 MHz WWV frequencies and exhibits a frequency stability of 1 p.p.m. In addition to its dual-conversion feature, which gives an image rejection better than 60 dB at 25 MHz, the unit uses a 6-kHz Collins mechanical filter to minimize adjacent-channel interference. It has a built-in power supply which oper-

ates from either 12 volts d.c. or 115/230 volts a.c. A self-contained speaker is included.

Although designed for standard 19-inch rack mounting, a tilt-up cabinet is available to house the receiver. Linear Systems

Circle No. 135 on Reader Service Card

TWO-CHANNEL SSB UNITS

A new series of low-cost, crystal-controlled SSB transceivers designed for use by CAP, MARS, and 160-meter operators is now on the market. Each unit has an input of 20 watts p.e.p. on single sideband and 25 watt input with carrier for compatibility with AM stations. The CAP version employs upper sideband, MARS upper and lower sideband, and the 160-meter model lower sideband.

Other features of the transmitter section include: crystal filter sideband generation; two channels, switch selected; fixed tuned for simple PTT operation; carrier and sideband suppression of 45 dB; and crystal-controlled frequency within ±0.005%.

Any of the units can be powered by the HP-13 d.c. supply for mobile use or the HP-23 a.c. supply for fixed-station operation. Both kit and assembled versions are available. Heath

Circle No. 24 on Reader Service Card

23-CHANNEL CB UNIT

The "Invader 23" is a 5-watt, 23-channel, solid-state CB transceiver which features an illuminated "S" meter/r.f. power output meter, p.a. amplifier, mike jack, squelch control, "on/off" switch, volume control, channel selector switch, and p.a./CB switch—all on a panel measuring 2½" high x 8¾" wide. The unit is 9½" deep.

Twenty-nine solid-state devices are used in the circuit. The transceiver will operate on 12 volts d.c. or 117 volts a.c., with an optional power supply. Mark Products.

Circle No. 25 on Reader Service Card

MOBILE CONVERTER

The Model 191 r.f. converter permits a car radio to be used to receive police and fire calls or aircraft, business radio, utilities, and taxicab transmissions. Of all solid-state design, the converter is crystal controlled. It has a 1-MHz band-

spread by tuning the broadcast receiver. The converter operates direct from the 12-volt car battery. Frequency range is 25 to 175 MHz.

The compact, easy-to-mount case measures 5" x 2¼" x 2¼". Mobil Electronics

Circle No. 26 on Reader Service Card

MANUFACTURERS' LITERATURE

LOGIC HANDBOOK

A 512-page book which includes a digital logic primer covering numbering systems, Boolean algebra, binary-coded decimal codes; 27 pages of module application notes; a 68-page study of analog-to-digital conversion; and a 23-page computer catalogue is now available.

This edition provides complete technical information on two new products lines: M Series integrated circuit modules and K Series industrial modules. The new book also includes five appendices on MIL-Std.-806B and DEC symbols; a powers of two table; a list of standard electronic abbreviations; definitions; a bibliography; and a price list. Digital Equipment

Circle No. 136 on Reader Service Card

DIAMOND NEEDLE GUIDE

A condensed diamond needle cross-reference guide showing individual needle illustrations, cartridge name and number, tip sizes, and the numbers of all competitive diamond needles is now available for distribution.

This quick, easy-to-use guide has been specifically designed for dealer counter personnel. Transcriber

Circle No. 27 on Reader Service Card

ANECHOIC CHAMBERS

A one-page supplement to "New Designs 7" describes the recently completed shielded anechoic chamber at the Technical University of Denmark. The chamber has a quiet zone 8 feet in diameter and 33 feet long and is lined with 80-inch long pyramids of Eccosorb HPY-80. Average reflectivity is 40 dB down or more from 100 MHz to 10 GHz. Photographs in the data sheet show some of the interesting features of this chamber. Emerson & Cuming

Circle No. 28 on Reader Service Card

AUDIO CONTROLS

A 12-page publication, entitled "Professional Audio Controls", has just been announced as No. AL-1365.

Written by Arthur C. Davis and Donald B. Davis, sound engineers, the booklet explains the merits of fixed gain amplifiers, passive control devices, and low-impedance transmission circuits. Altec Lansing

Circle No. 29 on Reader Service Card

TECHNICAL REPORT

A 10-page technical report on the "Thermal Characteristics of Film Resistor Modules" has been published as TR 22.571. Written by two engineers, the text material is lavishly illustrated with line drawings, performance graphs, bar charts, and photographs. The authors have also provided a list of references and a bibliography. IBM Components Div.

Circle No. 137 on Reader Service Card

PLUG-IN POWER SUPPLIES

A two-color data sheet which describes 21 new a.c.-to-d.c. plug-in power supplies is now available. The literature describes features of the power supplies including built-in short-circuit protection, instant start-up, and operation without additional heatsinking. Acopian

Circle No. 138 on Reader Service Card

SOLDERING BULLETIN

How to solder materials considered difficult or impossible to solder is described in Bulletin SL88A. The technique described permits soldering magnesium, aluminum, beryllium, stainless steels; refractory metals such as titanium, tantalum and tungsten; even carbon, glass, and plastic.

Methods and equipment for performing this work are detailed along with information on how to apply a solderable coating to the various metals. Actual applications are described and illustrated. Selectrons

Circle No. 139 on Reader Service Card

READOUT DEVICE

A new digital input/electromechanical readout device that enables engineers to solve many problems in electronic systems design is described in a new illustrated bulletin. The publication details the modular design, size, power and performance specifications of the Vernidex which can be mounted in electronic equipment where a direct readout of numbers and/or letters is required. Vernitron

Circle No. 140 on Reader Service Card

SPEAKER ENCLOSURE HANDBOOK

Details on constructing enclosures for the firm's "F" series speakers are contained in a 14-page publication, CF706-1. Each speaker in the series is described and illustrated and its recommended application discussed. There are 5½ pages of diagrams covering the construction of suitable enclosures. Hints on good construction practice are also included. JBL

Circle No. 30 on Reader Service Card

HEADPHONE/MIKE CATALOGUE

A new catalogue covering headphones and capacitor, ribbon, and dynamic microphones for radio and recording professionals is now available for distribution. Complete technical specifications are provided on the various models along with information on applications. Stanford International

Circle No. 31 on Reader Service Card

PRECISION RESISTORS

An 18-page catalogue describing the company's capabilities and precision resistor line is now available. Engineering information, power derating curves, load-temperature curves, as well as data on voltage coefficients, stability, and tolerances are covered for the basic line of carbon film and wirewound resistors and resistor networks in the line.

Terminal styles, body dimensions, etc. are detailed for high-voltage and high-frequency/high-megohm types in the standard carbon film line together with similar applicable specifications for standard resistors in the MIL-R-93, MIL-R-29, epoxy sealed, commercial, and meter multiplier wirewound products. Resistance Products

Circle No. 141 on Reader Service Card

PHOTO DEVICE POCKET GUIDE

A six-panel folder entitled "Photo Device Pocket Guide" has just been issued. It provides a brief listing of parameters and applications for the company's light emitters, light sensors, and tape reader arrays. Photodiodes, phototransistors, and complex optical arrays are included in the listing. The folder, which opens out to 8½ x 11 inches, contains two panels of diagrams showing dimensions and details of the photo device packages. Fairchild Semiconductor

Circle No. 142 on Reader Service Card

CONDENSED SEMICONDUCTOR DATA

The newly published 1968 condensed catalogue describing the major electrical specifications for more than 3500 individual semiconductor types is now available. The catalogue also includes ordering information on some 12,000 of the firm's devices.

A new feature of the 1968 edition is an alpha-numerical listing of all 1N, 2N, 3N, and non-registered type numbers contained therein. Located at the beginning of this reference guide, the listing aids the user in the quick identification of device types and helps him locate more complete component information about a particular device.

A 5-page section at the end of the catalogue contains complete device outline dimensions for the more than 93 different cases in which the firm's semiconductors are packaged. Motorola Semiconductor

Circle No. 143 on Reader Service Card

PANEL METER CATALOGUE

A 16-page, two-color catalogue listing a full selection of stock panel meters is now available

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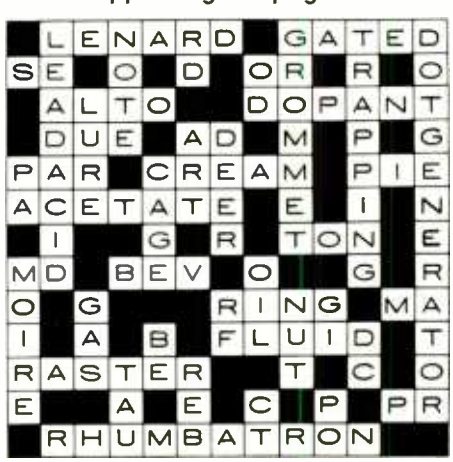
Answer to Crossword Puzzle appearing on page 67



as No. 35F. The new publication presents ranges, prices, resistances, photographs, diagrams, and mounting specifications for d.c. and a.c. meters within the 1½", 2½", 3¼", and 5" sizes in both taut-band and pivot and jewel construction. The catalogue also lists models, sizes, voltages, and prices for the firm's line of elapsed-time indicators, vu meters, and null indicators. Honeywell Precision Meter

Circle No. 32 on Reader Service Card

NEON GLOW LAMPS

A revised, 8-page illustrated brochure describing neon glow lamps for indicator application, voltage regulators, and circuit components has just been published. The brochure contains catalogue information dealing with the various lamps in the company's line, a V series voltage regulator, and a reference tube chart. Signalite

Circle No. 144 on Reader Service Card

IC ACCESSORIES CATALOGUE

A six-page catalogue covering a complete line of IC accessories, including dual in-line sockets, flat-pack holders, pluggable circuit cards, patchcord kits, connectors, IC breadboards, and wrappable wiring panels is now available.

Fully illustrated and detailed with specifications, performance, and ordering data, Catalogue 91 provides easy-to-use reference literature on the entire line. Cambridge Thermionic

Circle No. 145 on Reader Service Card

STOCK PANEL METERS

A new panel meter catalogue which gives complete details on over 1400 stock sizes and types of panel meters has been issued as Bulletin No. 2679. New products featured in the catalogue include rugged seal contactless meter relays, contact-type meter relays and pyrometers, and the new low-height Designer Series meters.

A table of stock meter characteristics and accuracy tolerances is included at the back of this 28-page publication, along with a glossary of terms commonly used in the electrical indicating instrument industry. Simpson

Circle No. 33 on Reader Service Card

LAB POWER SUPPLY

A new type of laboratory instrument, which can serve as either a high-precision power supply or a power differential voltmeter is described in a new 12-page brochure.

Bulletin LS describes the basic LS Series high-precision power source and the two plug-in accessories designed for use with the basic power source. The illustrated brochure gives complete specifications, capabilities, and prices and will be forwarded on request. Lambda

Circle No. 146 on Reader Service Card

TEST EQUIPMENT CATALOGUE

Two new hand-size v.o.m.'s and a new solid-state v.o.m. with a 7" scale and v.t.v.m. features are highlighted in a new 16-page test equipment catalogue now available.

Complete operating specifications and prices are given on the line of equipment designed for industrial electronic and electrical testing. A copy of Bulletin 2078 will be forwarded on request. Simpson

Circle No. 34 on Reader Service Card

INFRARED TEMP CONTROLLERS

A four-page data sheet on infrared industrial temperature controllers is now available for distribution. Bulletin 68-6 contains complete details on four models of the Opti-trol instruments and information on applications in specific industries. Barnes Engineering

Circle No. 147 on Reader Service Card

ANGLE MEASUREMENTS

Fifteen models of high-precision angle measuring instruments used in the production testing of gyros, servos, or any device using synchros or resolvers are described in technical bulletin AMI-1 which is now available.

A chart shows how the fifteen models are derived from five basic types by the selection of accuracies, resolutions, readout indicators, and feedback elements that adapt the instrument to specific applications. Micro Metrics

Circle No. 148 on Reader Service Card

POLYCARBONATE CAPACITORS

An engineering bulletin, #1701, covering polycarbonate "Wrap and Fill" capacitors is now available.

Types E10, E10R, specially constructed to offer excellent resistance to humidity and for use where space is critical, are covered, including complete technical specifications, performance characteristics, and related curve material. Film Capacitors

Circle No. 149 on Reader Service Card

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GENERAL INFORMATION: First word in all ads set in bold caps at no extra charge. Additional words may be set in bold caps at 10¢ extra per word. All copy subject to publisher's approval. **Closing Date:** 1st of the 2nd preceding month (for example, March issue closes January 1st). Send order and remittance to: Hal Cymes, **ELECTRONICS WORLD**, One Park Avenue, New York, New York 10016

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JUST starting in TV service? Write for free 32 page catalog of service order books, invoices, job tickets, phone message books, statements and file systems. Oelrich Publications, 6556 W. Higgins Rd., Chicago, Ill. 60656.

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METERS—Surplus, new, used, panel and portable. Send for list. Hanchett, Box 5577, Riverside, Calif. 92507.

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FREE ELECTRONICS (new and surplus) parts catalog. We repair multimeters. Bigelow Electronics, Bluffton, Ohio 45817.

SURVEILLANCE EQUIPMENT—NEW HIGH PERFORMANCE SUBMINIATURE MODELS. ELECTRONIC COUNTERMEASURE DEVICES TO PROTECT PRIVACY. FREE DATA: SECURITY ELECTRONICS-EW, 15 EAST 43RD STREET, NEW YORK, N.Y. 10017.

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SURVEILLANCE COUNTERMEASURES BROCHURE $1.00. ENGINEERING LABORATORIES, BOX 1036, ANDERSON, INDIANA 46015.

TRANSISTOR-Tube-Radio-Television-Phono, **SIGNAL GENERATOR,** $4.00. Takoma Servicing School, 11808 Pittson Road, Wheaton, Maryland 20906.

ELECTRONIC Ignition, various types. Free literature. Anderson Engineering, Epsom, N.H. 03239.

PROXIMITY switch detects nearness of human body! Free information. Claremont Products, 860 Reed, Claremont North, Calif. 91711.

SURVEILLANCE EQUIPMENT, latest devices, also construction plans, free catalog. **FISHER ELECTRONICS,** Box 350, N. Miami Beach, Florida 33160.

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DISPOSAL—$80,000.00 hi-fidelity retail store inventory. New/used equipment: Ampex, Marantz, Fisher, others. Hewlett-Packard test equipment. Free-list—Marco Electronics, Box 336-D, Winter Park, Fla. 32789.

NEW Sensitive Treasure Metal Detectors. New low prices. Professional models from $29.95 to $129.50. Write for free catalog today. Jetco Electronics, Box 132-E, Huntsville, Texas 77340.

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REGULATED Power Supply Range 3.6V to 18V 5A short circuit protection with schematic $9.95. 115VAC 1000W photocell units $4.95. Alphatronics, 14251 East Colfax, Aurora, Colorado 80010.

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TRIACS

TO-66
5 AMP

PRV	
100	.90
200	1.40
300	1.75
400	2.25
500	2.60

Silicon Control Rectifiers

PRV	3A	7A	20A	70A
50	.35	.45	.70	
100	.50	.65	1.00	4.00
200	.70	.95	1.30	8.00
300	.90	1.25	1.70	
400	1.20	1.60	2.10	12.00
500	1.50	2.00	2.50	
600	1.80	2.40	3.00	16.00
700	2.20	2.80		
1000			5.00	24.00

Silicon Power Rectifiers

PRV	3A	12A	20A	40A
100	.09	.30	.40	.75
200	.16	.50	.60	1.25
400	.20	.70	.80	1.50
600	.30	1.00	1.20	1.80
800	.40	1.25	1.50	
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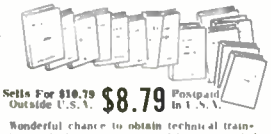

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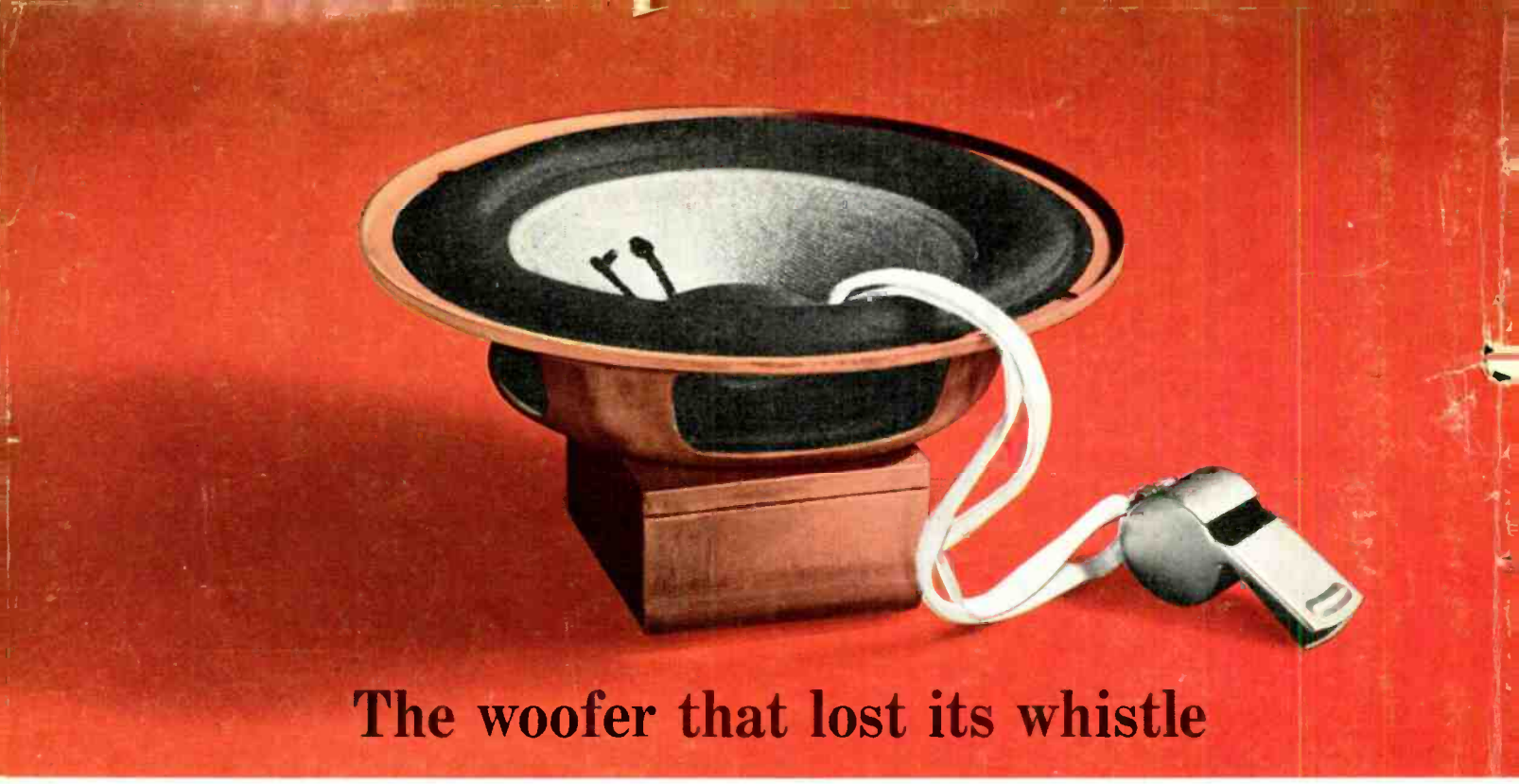

The woofer that lost its whistle

...and other stories.

The woofer cone in a very small enclosure must move a long way to provide all the bass you want to hear. In the new E-V EIGHT, for instance, the 6-inch cone moves back and forth over one-half inch. But in most woofers something strange happens as it moves. It whistles!

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