Electronics World

JANUARY, 1968
60 CENTS

INSIDE THE 1968 COLOR SETS

TROUBLESHOOTING NEW COLOR CHASSIS

COLOR-TV IN THE MARKETPLACE

LIGHT-EMITTING DIODES

First Solid-State Modularized COLOR-TV

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!

You see, the air trapped inside the speaker is literally "pumped" in and out past the voice coil. The whistle is almost inevitable. Except, that is, in the E-V EIGHT.

We did two things almost nobody else bothers to do. First, we vented the woofer. Air can't be trapped inside. Then we punched six big holes in the voice coil form. Air can't be pumped back and forth. And that's how the E-V EIGHT lost its whistle (and gained almost 2 db extra efficiency in the low bass in the bargain)!

The E-V EIGHT tweeter was another story. We aimed to eliminate the "buzz" and "fuzz" so typical of modestly priced speaker systems. What was needed was a better way to control cone motion at very high frequencies. And it literally took years of testing to solve the problem.

The answer looks deceptively simple. We put a ring of short-fiber polyester felt behind the cone, and a precisely measured amount of viscous vinyl damping compound under the edge. Plus a light-weight aluminum voice coil to extend the range to the limits of your hearing. Highs are remarkably uniform and as clean as a (oops!) whistle!

Even the E-V EIGHT enclosure is unusual. Examine the walnut grain carefully, especially at the corners. It's a perfect match because we use one long piece of wood, folded to form the cabinet! And we add a clear vinyl shield on every finished surface, to protect the E-V EIGHT from the mars and scratches of day-to-day living.

There are so many good ideas inside the tiny new E-V EIGHT, you may wonder how we found room for them all. Chalk it up to top-notch engineering talent and facilities, plus a very real dedication to the ideal of better value in every product.

Listen to the E-V EIGHT with the whistle-free woofer at your nearby Electro-Voice high fidelity showroom today. Then ask the price. At no more than $44.00 it's the best story of all.

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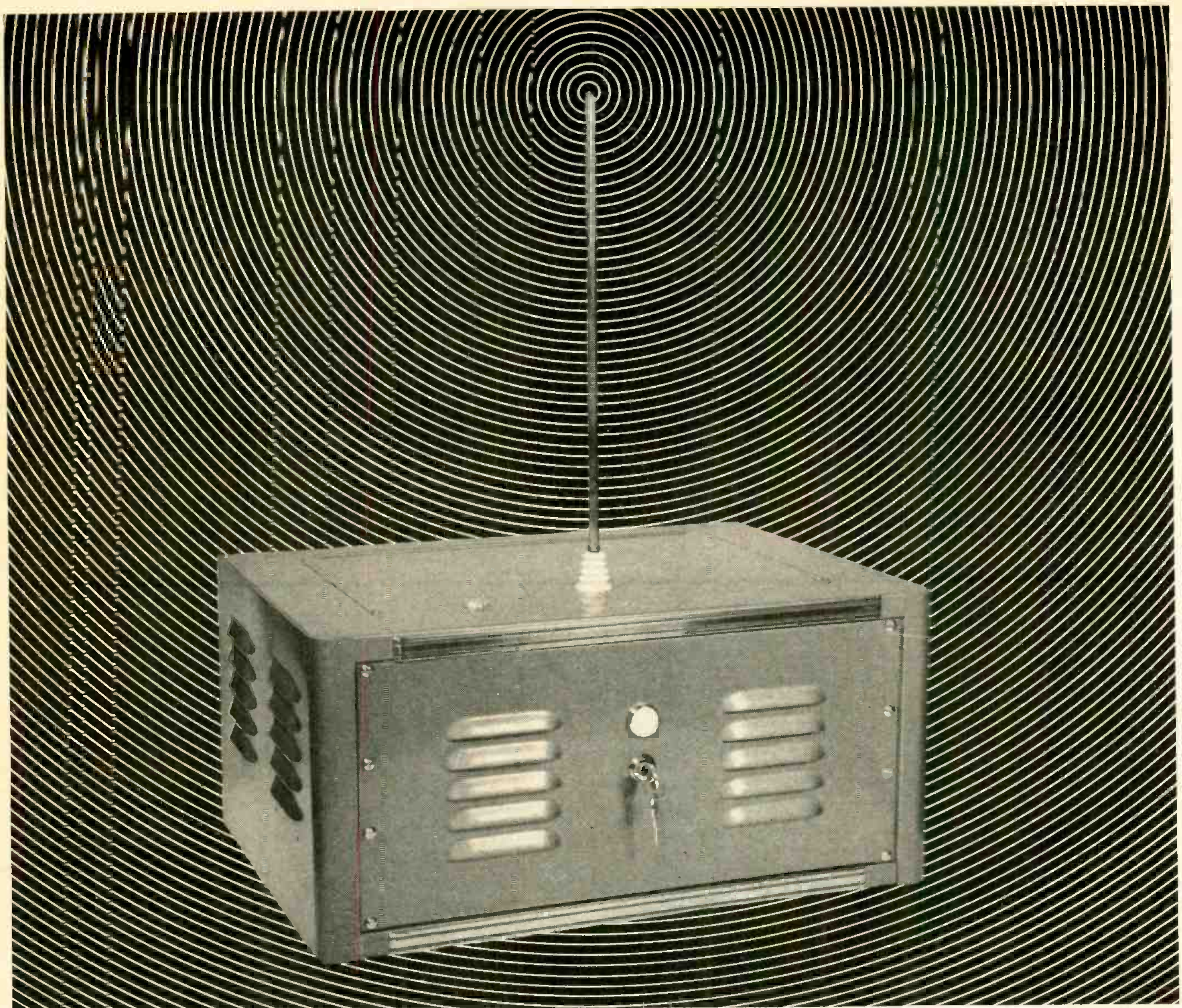

THIS MONTH'S COVER ties in with the three special feature stories and the editorial in this issue on the subject of color television. It shows the first large-screen solid-state modular-construction color set—the Motorola TS-915 chassis. The chassis uses 62 transistors, 28 diodes, one rectifier tube, and one integrated circuit. In the interest of providing simplified production and maintenance, no less than ten plug-in modules are used to make up the set. Hence, instead of time-consuming defective-component localization and replacement, the technician merely unplugs and replaces the entire module in which the fault has been localized. Photograph by Dirone-Denner.

Electronics World

JANUARY 1968 VOL. 79, No. 1

CONTENTS

MONTHLY FEATURES

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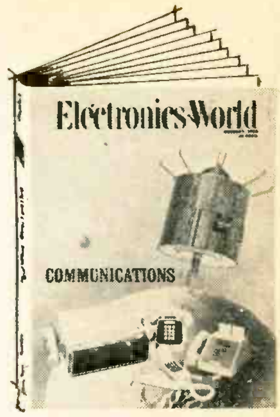
COMING NEXT MONTH



SPECIAL FEATURE ARTICLES ON: COMMUNICATIONS SYSTEMS

Have you tried to call Europe lately? If so, you may have used a touch-tone to place your number and had the message beamed over there by a communications satellite. Modern communications technology and satellites have teamed up to bowl over distance, accessibility, cost, and time; once these were almost insurmountable barriers to effective communications. In this issue, Martin Nabut of Bell Telephone Labs gives us the secret behind touch-tone operation, and W. Jack Hill of Lenkurt Electric Co. tells us how hundreds of voices can be carried simultaneously on a single wire pair.

AIRPORT SURVEILLANCE
Radar is "in" in Europe. Airfield Surface Detection equipment, once rejected as ineffective by our Federal Aviation Administration, is making new inroads. The Europeans say that the numerous advantages of the system were overlooked by the Americans.

PLASTIC POWER TRANSISTORS: ADVANTAGES AND APPLICATIONS
Plastic power transistors have burst upon the semiconductor market with all the brilliance of an exploding meteor. Half a dozen big manufacturers are now making them, and they say plastic transistors lower cost while making circuits more reliable.

INFRARED TEMPERATURE MEASUREMENTS
Like Elliot Ness, infrared electromagnetic waves are tracking down bad semiconductors and terminal boards. Author William Hamlin discusses some of the most recently developed instruments that are being used with other "untouchables" like plastic, steel, and paper.

ELECTRONIC FIRE AND SMOKE DETECTORS
When an alarm rings, it may already be too late. Fred W. Holder tells us about some recently developed devices that detect fire and smoke quickly. These are for industrial use, but modified versions may soon be developed for the home.

All these and many more interesting and informative articles will be yours in the February issue of ELECTRONICS WORLD . . . on sale January 18th.

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For the record

WM. A. STOCKLIN, EDITOR

TV Servicing—the Modular Approach

The shortage of qualified TV service technicians is becoming more and more acute. With color sets finding wider acceptance and with the increasing use of transistors and, more recently, integrated circuits, the service industry seems to be encountering rising problems.

The industry is fully aware of these problems. *RCA* has a special recruiting drive under way for technicians; the EIA recently appointed a full-time service staff and is now sponsoring special nationwide training courses; and technical training schools have stepped up their advertising to lure more men into the profession.

Motorola has a different approach. It has 40 fully qualified TV service representatives who do nothing but travel from one franchised *Motorola* service shop to another. They spend approximately 2½ days at each shop discussing the problems and reviewing the latest service techniques. But even with this sizable staff it would take *Motorola* four to five years to cover its 15,000 to 20,000 service dealers.

In our April, 1967 issue we offered some solutions to the problem:

(1) Develop an automatic tester and have TV-set test points brought out to a common terminal strip or jack.

(2) Computerize servicing. (Let the service technician call in symptoms to a centralized computer for analysis.)

Both ideas are still under consideration by at least one major TV manufacturer. At that time, we discussed modularization as a possible solution. Although this approach has proven extremely satisfactory in all-military electronic systems and fairly satisfactory in some commercial products, it was felt that the cost of modularizing consumer products would be prohibitive. Yet much to our surprise *Motorola* has taken this approach and only recently announced a complete line of transistorized and modularized color-TV sets. (See pages 38 and 42.) Some 10 individual plug-in printed-circuit boards make up the entire assembly.

Without a doubt, this approach could revolutionize TV servicing. There are many facets to this new approach. During warranty, a service technician need only remove a faulty board and exchange it at any *Motorola* distributor for a new one . . . and the customer simply pays a service-call charge.

Outside of warranty, the service shop might decide to continue on an exchange basis. *Motorola* distributors will continue to provide assembled replacement boards, or the company might prefer repairing its own circuit modules. There is also the possibility that eventually, when sufficient business is generated, independent repair shops might be set up to do nothing but repair these solid-state circuit modules. This would be no different from independent automotive carburetor and generator rebuilders and TV-tuner specialists.

To the technician . . . this means that home calls will change. *Motorola* claims that the cause of approximately 90% of all color-TV service faults can be determined by simply using a v.o.m., viewing the screen, and making front-panel control adjustments. Servicing, then, would involve removing the faulty board and replacing it with what will be known as a "rebuilt" unit. This should eliminate the need for carrying bulky test equipment. It should also eliminate the need for making parts substitutions or for pulling the set into the shop. It does mean, however, that the technician will have to carry replacement modules. The cost to the customer would range from $6 (with trade-in) for the simplest board to about $14 for the most complicated horizontal-deflection module. The average stocking cost for substitute modules would be rather high for the service shop and whether or not the shop would have to carry more than one set of modules would depend on the amount of servicing handled.

To the customer . . . it means that the cost per call will most likely be predetermined, *i.e.*, a fixed fee for each unit replaced. Obviously the cost of the service call would have to be added to this fee, and if the set required other adjustments—such as for full purity and convergence—an additional charge would have to be made for that service.

The cost per call, depending on the module involved, may seem high. Yet from past experience it has been found that transistorized designs, especially with printed circuits and modular construction, are much more reliable and require fewer service calls. In the long run, servicing should be more professional, more reliable, and cost less per year.

To the manufacturer . . . it means a construction technique which, it is hoped, will find wide acceptance. It could mean more set sales and fewer servicing problems, thus wider acceptance by the servicing fraternity. In the beginning it means higher assembly costs but it is estimated that if the same basic chassis can be used for the next three years, engineering and production costs could be amortized. This "freezing" of the design in no way precludes changes or improvement. Each circuit module should be considered a "black box." As long as the input and output requirements remain the same, the manufacturer can make any changes desired within the circuit, including the application of IC's.

The entire idea is revolutionary in the TV industry. There are several areas in which there remains some uncertainty.

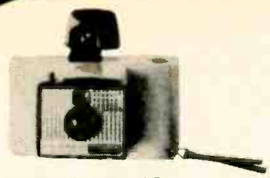
One is whether *Motorola* will stick to its present warranty program. Present plans are to terminate complete board replacements under warranty at the end of June, 1968. From that point on, only the regular one-year *parts* warranty (not complete modular assemblies) will be in effect.

This is extremely confusing and will only lead to controversy between the service technician and his customer. We feel that, in time, *Motorola* will find it advisable to change this policy.

Second, what about the parts dealer? If *Motorola* continues to supply assembled modules, one would expect parts dealers and distributors to object. On the other hand, if the independent service shop repairs its own modules, the situation won't change from present practice.

There are obviously many problems yet to be solved which will influence future trends but, without doubt, modularization is one of the most promising solutions to the shortage of good technicians. This should reduce multiple trips and at the same time eliminate transporting the set to the shop for repairs. It should standardize service charges and bring about more realistic salaries for service personnel. In the long run, it will also mean lower consumer cost over a period of time and this can only lead to greater confidence in the abilities of the service technician.

But most of all, it means the technical proficiency of the technician need not be of near-engineering caliber. It means that less technically knowledgeable personnel (and therefore greater numbers) will be available to service sets. Even though the technical proficiency requirements are lowered, this need not reflect adversely on the servicing profession. These men will be better qualified to service the simplified modular sets than most service technicians are in servicing today's complex color receivers. Therefore the service industry as a whole will be looked upon with greater respect by the consumer. ▲



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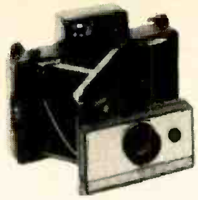

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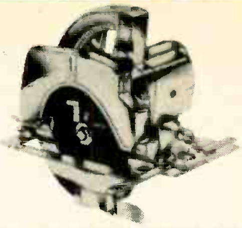

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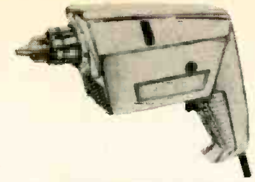

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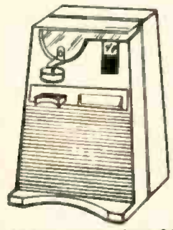

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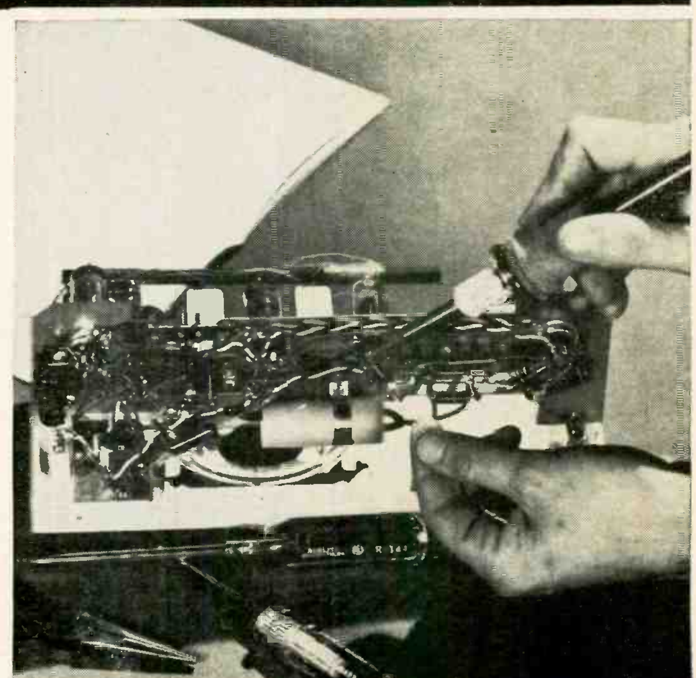

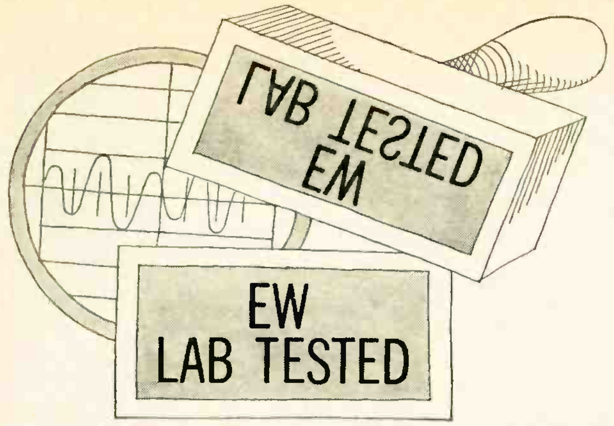

HI-FI PRODUCT REPORT

TESTED BY HIRSCH-HOUCK LABS

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Electro-Voice RE-15 Microphone

Shure M75 Stereo Phono Cartridge

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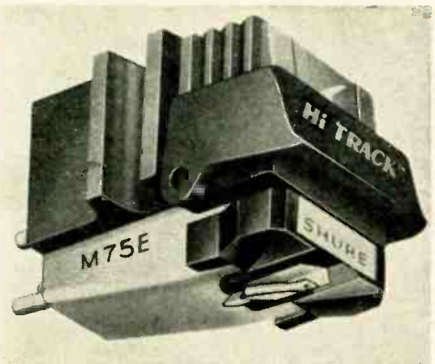


AFTER its introduction earlier this year, the *Shure* V-15 Type II stereo phono cartridge was widely recognized for its outstanding ability to track high-velocity recordings with low distortion. Since the high price of the V-15 Type II kept many music lovers from adding it to their systems, *Shure* engineers are now offering a new moderately priced series of cartridges designed around the same performance goals.

The M75 cartridges offer high tracking performance which the manufacturer claims is second only to the V-15 Type II. Like the company's other high-fidelity cartridges, the M75 series are moving magnet types and the styli are easy to replace without the use of tools. A swing-down stylus guard is an integral part of the cartridge. It flips up out of the way when the cartridge is in use and hinges down at other times to protect the jewel against careless handling.

Several diamond styli are offered for the M75. In the M75-6 there is a 0.6-mil conical stylus designed to track at from 1½ to 3 grams. The M75E, which we tested for this report, is fitted with a 0.2 x 0.7-mil elliptical diamond, tracking at from ¾ to 1½ grams. A rarely found feature among modern cartridges is the ability to play 78 r/min discs. The N75-3 stylus, of 2.5-mil radius, may be easily installed in an M75 cartridge body for playing old records at a tracking force of 1½ to 3 grams.

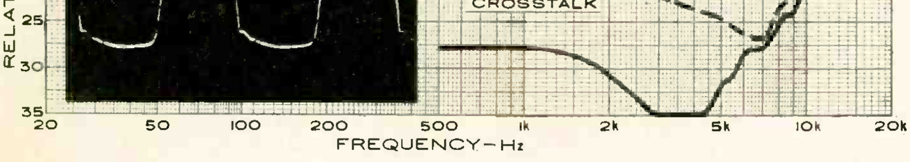
Aside from stylus characteristics, all versions of the M75 are identical. They have standard ½" mounting centers, operate into 47,000-ohm loads, and, because of the lightweight plastic body, weigh only 6 grams. This ranks them among the lightest magnetic cartridges, a desirable feature if they are to be installed in low-mass tonearms.

We measured the frequency response of the M75E using the *CBS* STR100 test record. The curve was plotted automatically, together with the stereo crosstalk. Response was smooth and uniform up to about 10,000 Hz, rising to a peak of 4 to 5 dB at 15,000 Hz and falling off at 20,000 Hz and above. The stereo separation was quite good, averaging about 20 to 30 dB up to about 9000 Hz, 20 dB at 10,000 Hz, and reducing to much less separation at still higher frequencies. (*Editor's Note: Using a slightly greater tracking force or another test record with somewhat reduced recorded velocity, such as the* RCA *12-5-71, the manufacturer has found that the frequency of the small high-frequency peak is moved up to 17,000 Hz.*)

In order to track the test bands on the *HiFi/Stereo Review* test record, a tracking force of 1.35 grams was necessary. We used 1.5 grams for our other tests on this cartridge. Intermodulation distortion was measured with the monophonic *RCA* 12-5-39 record at tracking forces of 1.0, 1.5, and 2.0 grams. At all three forces the IM was a very low 0.6% or less up to about 12 cm/sec velocity, which corresponds to a rather loud passage on most recordings. Above that velocity the distortion rose sharply when using 1.0 gram, reaching 4% at 14 cm/sec. Increasing the force to 1.5 grams, the rated maximum and the value which we found to be optimum, kept the distortion below 1% up to 22.5 cm/sec and 4% at the 27.1 cm/sec maximum level on the test record. At 2.0 grams, the distortion was only 1.4% at 27.1 cm/sec, but we do not consider it worthwhile to exceed the rated maximum tracking force for this small improvement.

The output of the M75E was 6.4 millivolts per channel at 5 cm/sec. The shielding against induced hum was very good, among the best we have found. The square-wave response, with the 1000-Hz square waves of the *CBS* STR110 record, showed negligible overshoot, one very slight ringing cycle, and a slightly rounded top characteristic of small rise in low-frequency response.

To evaluate the tracking ability of the cartridge, we used the "Audio Obstacle Course" record issue by *Shure* to demonstrate the performance of the V-15 Type II. We have developed our own rating system, assigning numerical values to the varying degrees of audible mistracking, which we have found to correlate very well with the over-all sonic performance of a cartridge. Aside from the V-15 Type II, only one of the more than a dozen



(*Continued on page 76*)

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Reflections on the news

By WALTER H. BUCHSBAUM/Contributing Editor

Horoscope By Computer

To the many scientific uses of computers, a new, pseudo-scientific application has now been added. *Time Pattern Research Institute* of Valley Stream, New York has combined the talents of an astrologer, Katina Theodossiou, with the astronomical data obtained from the U. S. Naval Observatory and the Royal Greenwich Observatory to provide detailed horoscopes on an individual basis. Working together with *Computer Centers Corporation*, they have developed a program for the *IBM* 360 which will generate a 10,000-word narrative horoscope based on the time, date, and location of a client's birth. The last item has to be converted into latitude and longitude, so that the computer can calculate the positions of the sun, moon, and planets for that particular time and place.

The positions of the sun, moon, and planets with respect to various parts of the earth for the past 80 years are stored in the memory. In preparing a horoscope, the computer first obtains the significant constellation and then, based on the astrological interpretation programmed in originally, it will select the appropriate narrative phrases to make up the 20-page personal horoscope.

The promoters of the computer-prepared horoscope estimate that 40 million Americans are interested in astrology, and in other parts of the world the "wisdom of the stars" is even more popular. While we cannot put much faith in astrology, our faith in the application of computers to every possible facet of human activity is high.

Electrochemical Timing Cell

A new, all-electronic, miniature device is now available to control timing circuits from 30 seconds to 12 days or longer. One unit, made by *Bissett-Berman*, looks like a small tantalum capacitor about ¾ of an inch long and contains two electrodes separated by a column of electrolyte. Silver is deposited at one electrode and is moved at a low current (1 to 120 microamperes) to the other electrode. To set the desired time delay, the current is reversed after the first timing cycle and the silver is carried back to its starting point. When all silver has been returned, the current stops. If the voltage remains constant, the return cycle takes exactly as long as the first timing cycle. One such cell and a flip-flop can provide an extremely compact, low-current, recycling timer adjustable from seconds to days.

A slightly different version is produced by *Curtis Instruments*. Here a column of mercury is interrupted by a gap filled with electrolyte. As current flows, the electrolyte gap moves from one end of the glass tube to the other, indicating the time or current that has passed. The glass tube is about ⅛ of an inch in diameter and less than 1 inch long. This device is primarily used as an elapsed-time meter but can be converted into a timer by having a light and photocell sense the position of the translucent gap. *Curtis Instruments* furnishes its units in a variety of mountings and scales, with 1000 hours being the standard value.

Both devices are rugged and reliable enough to meet MIL standards. The basic *Curtis Instruments* glass tube lists for $5 while the *Bissett-Berman* package lists for $25 in small quantities.

In the past, electronic timers have depended on the *RC* time constant which requires large capacitors and high resistances for long time periods. Beyond 10 minutes, electromechanical timers have been used almost exclusively. The new devices, which are based on the old electroplating principle, promise to be very accurate and reliable. Small timers should be invaluable as fuses, battery-charging controls, and operating-time indicators.

New Emergency Warning System

The emergency broadcast system now in effect requires every radio and TV station to monitor the special emergency frequency of the Office of Civil Defense. During tests or in a real emergency, these stations would then either go off the air or broadcast on one of the two assigned emergency frequencies. A new "standardized signal" has been developed to alert the general public as well as the broadcast stations. A special two-tone signal will activate emergency receivers on a specific frequency. Until additional field tests are completed, neither the signal tone coding nor the emergency frequency itself will be finalized but the FCC suggests that broadcast equipment now available may be obsolete within a short time.

When the new system goes into effect, private citizens as well as volunteer organizations will be able to buy receivers tuned to the emergency frequency. These will use little power until activated by the special tone-coded alert. Then the receiver will generate the required audible alarm or perform other, pre-scheduled functions.

Spray-Can Hazard

A new source of potential danger was recently revealed by the death of two thrill-seeking youngsters who inhaled dangerous gas from some spray cans used for cooling and cleaning. While Freon is not a noxious gas, its rapid refrigerating ability can cause freezing of the breathing apparatus for a long enough time to let the victim die of asphyxiation. Popularly used to chill drinking glasses, electronics technicians find Freon in spray cans useful for temporary cooling of circuit components when investigating intermittent defects. Other sprays, usually containing a fluorocarbon, are used as cleaning agents or lubricants for electrical contacts and potentiometers.

The reader who works with these spray-can chemicals should not inhale them or intentionally direct the spray towards the nose or mouth. A brief accidental exposure of the direct spray is relatively harmless but it is advisable to keep the spray cans away from young people, whose misguided sense of adventure can sometimes lead to tragedy.

TV for Police Helicopters

The New York City Police Department plans to add TV cameras to its helicopters to transmit pictures showing traffic conditions as well as crowd and emergency situations to headquarters. The present method of voice reporting is quite inefficient since it takes many words to describe a particular scene which then has to be plotted on a map before a command decision can be made. The TV pictures received from helicopters give police officials a detailed view of the action; such pictures can be recorded on video tape or film, and a complete understanding of traffic or crowd conditions is gained by comparing transmissions from several helicopters hovering over different critical areas of the city.

Since most of the traffic problems occur in morning and evening hours when there is little illumination, image-orthicon cameras will probably be used. A special, rapid-shutter mechanism will have to be provided to protect the sensitive camera tube from accidental burnout due to the morning sun. The mounting of the TV camera requires considerable vibration isolation as well as easy pan, tilt, and focus control by the operator. Another problem is the transmission of the TV signal from the helicopter to the ground. In New York, reflections and obstructions can be expected even at normal helicopter altitudes. Directional antennas would require a complex tracking system. For the first tests at least, omnidirectional antennas will be used at both ends. A 2000-MHz transmission link, developed by *Microwave Associates*, will be employed.

The use of TV on police helicopters may improve the ability of the police to control traffic and handle all emergencies much more effectively. We predict that some people will object on the basis that this is another instance of "Big Brother is watching."

Human Power Supply

Military requirements have spurred the development of better batteries, but the most promising power sources today are thermoelectric generators and fuel cells. Each of the three services has silent thermoelectric generators either under development or in the field, and they all have significant programs under way to improve fuel cells. One source of electrical power has, until recently, been overlooked. The human body converts food into energy and some of this energy could be used to generate electricity. A scientist at the University of Pennsylvania has assembled a fuel cell which converts the chemical energy of glucose, a form of body sugar, into electricity.

Experiments with monkeys have proven the value of this biological fuel cell and indicate that there are no detrimental effects to the body, even over several months. The amount of power available from this fuel cell is on the order of a few milliwatts, just sufficient to power present-day pacemakers. This new glucose fuel cell (implanted and connected to the circulatory system) could eliminate the batteries externally supplied or implanted in the approximately 15,000 persons whose heartbeat is electronically controlled at the present time. In theory at least, the biological fuel cell would operate without replacement or change as long as its human carrier continued to function.

One of the problems which have plagued the designers of space suits for our astronauts has been the need to conduct away the heat continuously generated by the human body. The average thermal output of an unclad man at rest at room temperature is approximately 100 watts. Even with the present relatively low efficiencies of thermoelectric generators (3% to 10%), it should be possible to provide about 500 milliwatts or so from only a portion of the human body. This would be enough to power a host of small devices for personal communications and general body telemetry. ▲

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STRENGTH OF UHF SIGNAL AT RECEIVING ANTENNA LOCATION	Strength of VHF Signal at Receiving Antenna Location: NO VHF	VHF SIGNAL STRONG	VHF SIGNAL MODERATE	VHF SIGNAL WEAK	VHF SIGNAL VERY WEAK
NO UHF		CS-V3 $10.95	CS-V5 $17.50 / CS-V7 $24.95	CS-V10 $35.95	CS-V15 $48.50 / CS-V18 $56.50
UHF SIGNAL STRONG	CS-U1 $9.95	CS-A1 $18.95	CS-B1 $29.95	CS-C1 $43.95	CS-C1 $43.95
UHF SIGNAL WEAK	CS-U2 $14.95	CS-A2 $22.95	CS-B3 $49.95	CS-C3 $59.95	CS-D3 $69.95
UHF SIGNAL VERY WEAK	CS-U3 $21.95	CS-A3 $30.95	CS-B3 $49.95	CS-C3 $59.95	CS-D3 $69.95

NOTE: In addition to the regular 300 ohm models (above), each model is available in a 75 ohm coaxial cable downlead where this type of installation is preferable. These models, designated "XCS", each come complete with a compact behind-the-set 75 ohm to 300 ohm balun-splitter to match the antenna system to the proper set terminals.

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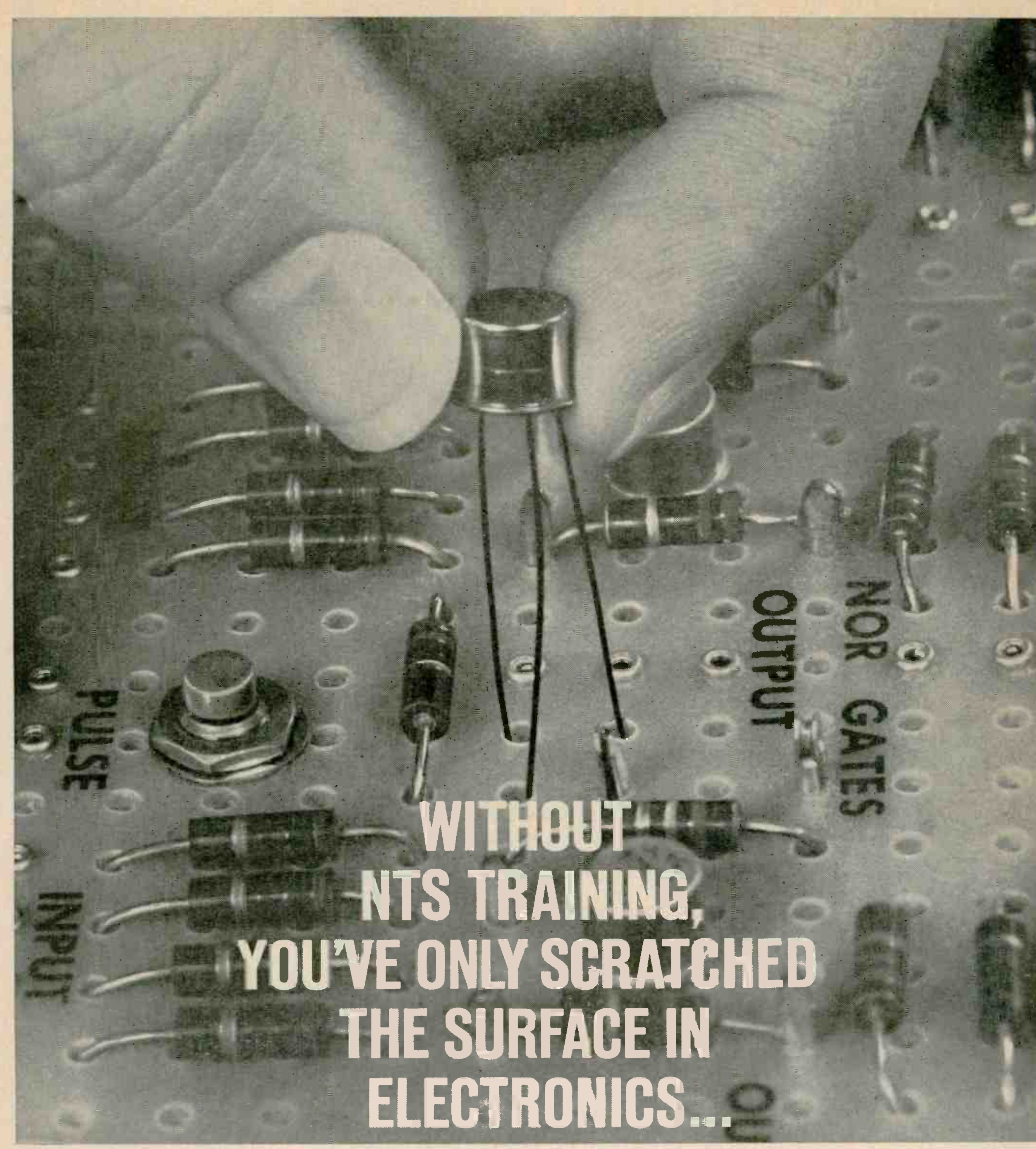
CIRCLE NO. 113 ON READER SERVICE CARD



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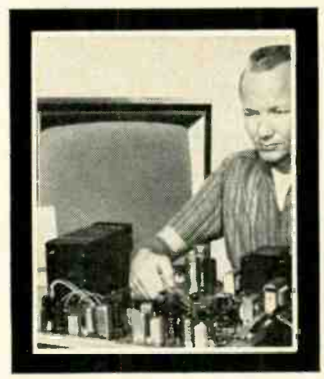

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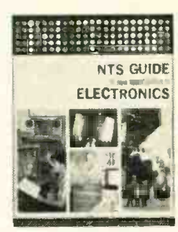

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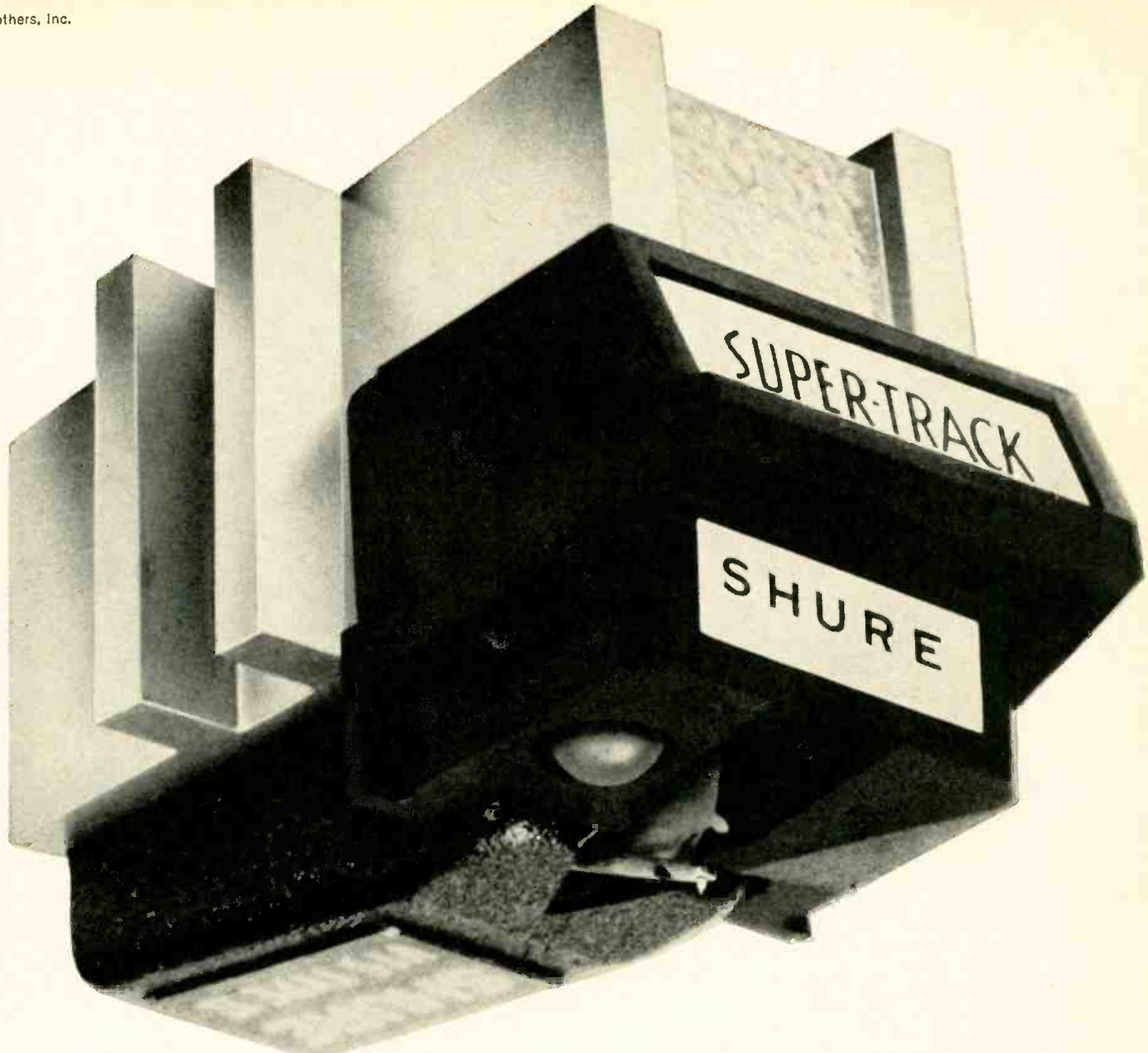

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CIRCLE NO. 93 ON READER SERVICE CARD

By FOREST H. BELT /Contributing Editor

Three-Dimensional TV Soon?

One hangup which has dampened hopes of 3-D television is bandwidth. Transmission of holographic information—so far the most promising technical method of achieving full-dimension viewing—takes up many, many megahertz of spectrum. Estimates are that one holographic TV channel would occupy as much frequency spectrum as 10.000 standard TV stations. A way has been found to reduce that bandwidth requirement. Douglas B. Brum, of the Institute of Science and Technology at the University of Michigan. and Kenneth A. Haines, of *Holotron, Inc.* in Wilmington, Delaware, have demonstrated that a piece of frosted, ground, or marbled glass can diffuse the light that carries holographic information. The end result of this discovery is a bandwidth reduction as much as 1000 times. Detail is affected, but the reproduced image is still highly viewable—and from wide angles.

Three-dimensional TV for the home? Not right away, but this new technique puts it a giant step closer. Additional work will undoubtedly turn up finer diffraction techniques with improved types of glass. Experiments with alternate modulation systems, some perhaps unheard of yet, are likely to trim bandwidth even more. Not tomorrow or next month, but next year or the year after, someone will probably put a 3-D TV signal on the air—if only experimentally. This particular item makes us wonder how full-color holography is progressing.

New Role for CATV

Speaking of spectrum crowding, one of the chief convictions of cable-television proponents is the promise of unlimited channel capability within a cable. This view is applauded by land-mobile two-way-radio interests who eye the television-band spectrum for their own frequency-hungry operations. Cable-industry seers insist that 80% to 90% of U.S. homes will be wired for cable in less than 10 years.

This combination of viewpoints focuses on a concept of cable TV which differs from that prevailing at the time of CATV's inception. Cable TV was originally "community antenna television", intended to bring off-the-air signals to areas where ordinary housetop antennas were inadequate. First there was an increase in the number of stations that could be received by any cable subscriber, next public-service-oriented programs were offered, and then there were hints of tying cable systems into a nation-wide network. Experiments now being suggested include pay-TV "cultural" or "special" offerings, an idea stoutly denied during the early days of cable operations.

The newly emerging concept—of cable systems conserving space in the television broadcast spectrum—depends on diverting cable systems further from their original intent, which was to rechannel transmitted TV-station signals into wired distribution networks. To save spectrum space, television broadcast stations would have to be deactivated as such and then converted into wire-feeding stations instead of antenna-feeding stations.

Even if this doesn't become the case, running cable into virtually all TV-owning homes opens the door to a wide variety of other services: facsimile newspapers; data of all sorts on request; electronic shopping *via* television; telephone-Picturephone tie-in; emergency communications; education; remote information storage and retrieval; library access; and others, limited only by imagination.

Direct-Broadcast Satellites

Cable TV may have some effect on these, too. At a recent conference, George W. Bartlett, Vice-President of Engineering for the National Association of Broadcasters, expressed the opinion that direct-broadcast satellites pose a greater threat to local TV stations than cable TV does. If that is true, then an interesting triangle is developing.

Direct-broadcast satellites are promised for Europe within the next few years— early 1970's, at the latest. For the U. S., they seem a little further off, but easily achievable within the next 8 or 10 years. However, if cable systems supplant off-the-air TV reception, direct-broadcast satellites will be unnecessary. Looking at it another way, however, cable systems will be unnecessary if a workable system of satellites makes possible good-quality TV reception by all homes in the country regardless of where they are situated. And, of course, as pointed out by Mr. Bartlett, local TV stations won't be necessary either, given such a satellite system. The solution of this triangle will be an exercise far more interesting—and complicated—than mere trigonometry.

Economics and Electronics

Price rises at the year end throughout the country's economy are showing up in the home-entertainment segment of the electronics industry. The biggest increases have been in post-introduction prices for color-television sets. What at introduction time was a small across-the-board reduction in prices has become just the opposite. Almost every manufacturer has announced price increases for most models. The first increases to be announced sparked some stepped-up buying in the last quarter of the year, but purchases by dealers dropped back to "normal" as the Christmas retail season approached.

In another area, the Electronic Industries Association reports that tape-recorder and tape sales are steadily rising, despite earlier holdbacks. Production is about to start keeping up with demand for both tapes and machines. The cartridge is responsible for the boom. Sales of prerecorded tape cartridges have jumped and jumped, but they still aren't cutting into disc sales, as might be expected. Consumers are buying music of all kinds, in all the forms in which it is offered. It looks like 1968 will be a banner year for all facets of hi-fi music.

Integrated Circuits—Reliable?

Many words have been pronounced and printed about the advantages and disadvantages of IC's. Now that large-scale integration (LSI) produces yields of 100 or more devices per silicon chip, prices of IC's are increasingly attractive. LSI technology hasn't yet reached the stage where complex linear and FET devices can be reproduced in these cost-cutting quantities, but that's only a matter of time.

One great concern has been reliability. Do integrated circuits, made by either normal-yield or large-scale processes, have the stamina to hold up under the indeterminate use they get in consumer electronic equipment? A panel of experts at last fall's National Electronics Conference in Chicago said "yes" and offered evidence. IC's are just as reliable as their individual transistor counterparts. Longevity tests that have been run apply to new plastic IC's as well as to hermetically sealed devices.

Improved reliability and lower cost foreordain more and more linear integrated circuits in home-entertainment devices. There's hardly a manufacturer who isn't seriously investigating how integrated circuits can be incorporated into existing designs. Just around the corner is the next step, the opposite approach: designing new equipment around existing digital and linear IC's.

No-Power-Transformer Transistor TV

There is nothing that sounds new in that revelation, and yet there is. The news is that the step-down power transformer that has been necessary in every transistor television set no longer is. Why? Two companies have almost simultaneously come out with a horizontal-output transistor that can withstand the high B+ voltages ordinarily developed by a transformerless half-wave rectifier power supply. *Matsushita* (*Panasonic*) and *Amperex* announced the new units within a week of one another. Both transistors are *n-p-n* types and use mesa-collector, planar-emitter construction. The savings will be in both weight and cost, for neither transistor will be much more expensive than the power transistors presently used in horizontal-output stages.

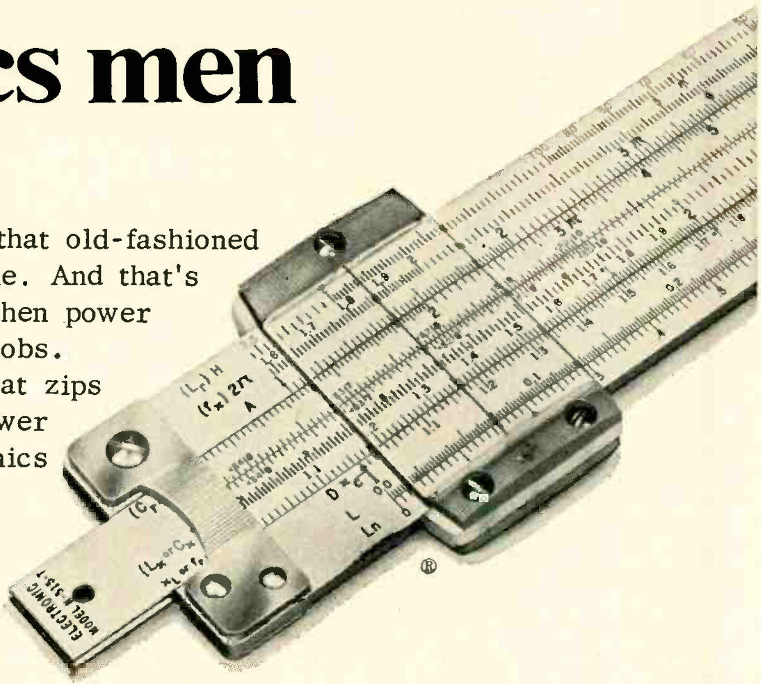
The next big hurdle in eliminating transformers from transistor TV sets is the flyback itself. When we get rid of that and the vertical-output transformer, we will have a truly transformerless transistor TV.

Where Have All the Technicians Gone?

There are nearly 40,000 independent electronics service dealers in the United States, according to National Electronic Associations, Inc. (NEA). Of these, about 50% are full-time, *one-man* businesses. Richard L. Glass, Director of Training for this coalition of state and local technicians' associations, points out that the 40,000 does not include manufacturer or distributor service departments. The 20,000 two-or-more-man shops employ more than 50,000 technicians, and they do about 75% of all the servicing work in the country. A recent survey shows that the immediate need for qualified technicians in these shops exceeds 15,000. That figure represents men who could be hired immediately.

There has been some debate over whether there really is a technician shortage. This survey seems to corroborate that there is. Some say it is because pay scales are low; few young men will take the training needed when earnings afterward aren't satisfactory. Whatever the answer, training is becoming more and more available. The Electronic Industries Association has endorsed its new Service Technician Development Program to the tune of $100,000 per year, according to Richard W. Tinnell, Director of Education and Training. International Correspondence Schools will introduce a new practical course in television servicing early in 1968. The National Alliance of Television Service Associations (NATESA) is working on apprenticeship programs; so is NEA. Virtually every domestic TV-set manufacturer has a program of some sort. It shouldn't be long now until the "technician gap" begins to close. ▲

Amazing "power tool" for electronics men



Still working electronics problems with that old-fashioned manual tool, the pencil? You're not alone. And that's kind of a shame in this wonderful age when power tools have speeded up so many manual jobs. Now here is an amazing "power tool" that zips through electronic calculations like a power saw through soft pine. The CIE Electronics Slide Rule. It has a special scale that works reactance problems in seconds. And another scale that does the same for resonance problems. Plus two more scales that tell exactly where the decimal points go.

No guesswork. No paperwork. No rough calculations. You get an accurate answer in 20 seconds or less.

It also does the things ordinary slide rules do. Like multiply, divide and extract square roots in one setting. Or find reciprocals for resistance formulas, logarithms for decibel formulas, and trigonometric functions for AC circuitry formulas. And work the formulas in seconds.

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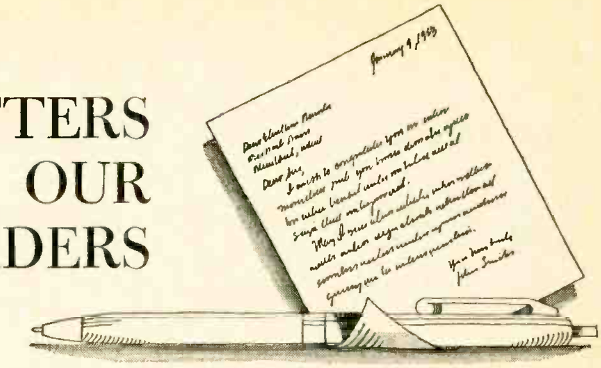
CIRCLE NO. 121 ON READER SERVICE CARD

LETTERS FROM OUR READERS



A.S.E.E.'S AND B.S.E.E.'S

To the Editors:

I am an electrical engineer currently engaged in laser research for the National Aeronautics and Space Administration. Prior to obtaining a degree in electrical engineering, I graduated from a technical institute and worked as an electronics technician for nearly twelve years. During five of those years, I served as an instructor and technical writer on guided missile electronics. Functioning both as a technician and an engineer has given me a fairly unusual view of the electronics industry.

A disturbing aspect of the industry that I have observed is the profound ignorance of many engineers with regard to the training given by the nation's technical institutes—the schools offering associate degree programs in electronics technology. Few engineers or engineering supervisors appreciate the technical depth of these programs.

As a product of both a technical institute and a university, I have been greatly disturbed by this lack of understanding. I have seen a number of instances where gross underutilization of the skills of the technical institute graduate has occurred simply because his supervisor believed that he had received only very low level training.

John H. McElroy
New Carrollton, Md.

We certainly agree with Reader McElroy. He submitted, along with his letter, a most interesting article backing up his premise. He compared the courses given at a number of universities with those given at a number of technical institutes and found that the technical institutes came off quite well. The article will appear in a forthcoming issue. We suggest our readers watch for it.—Editors

* * *

ELECTROSTATICS

To the Editors:

I have read with interest Edward A. Lacy's article on static electricity in your July, 1967 issue.

Other uses for static electricity not mentioned by the author are in office duplicating equipment (by *Xerox* and other manufacturers) and in the rubber industry. Here electrostatic charges play an important role in the mixing of rubber. By measuring the changes in electrostatic potentials during mixing, it is possible to determine the breakdown of the rubber, the time for incorporation of pigments, and the proper sequence and timing of the mixing operation.

Robert S. Havenhill
Sun City, Ariz.

Thanks to Reader Havenhill for this information and for sending us a copy of a paper written by him along with H. C. O'Brien and J. J. Rankin on the subject "Electrostatic and Tensile Properties of Rubber and GR-S at Elevated Temperatures." The paper appeared in the Journal of Applied Physics.*—Editors*

* * *

SPECIAL SECTION ON SWITCHES

To the Editors:

Your October special section on switches is, without reservation, excellent. I would be very interested in receiving a listing of available technical reprints of other special sections.

E. L. Stanley, Test Engr.
Thermoid Div.
H. K. Porter Co., Inc.
Richmond, Ky.

To the Editors:

I am writing you in reference to your October issue with its special section on switches. I found the section most interesting. It was fortunate that I received this issue when I did since I was in the market for certain types of switches that were described.

H. R. Schroeder
West Trenton, N.J.

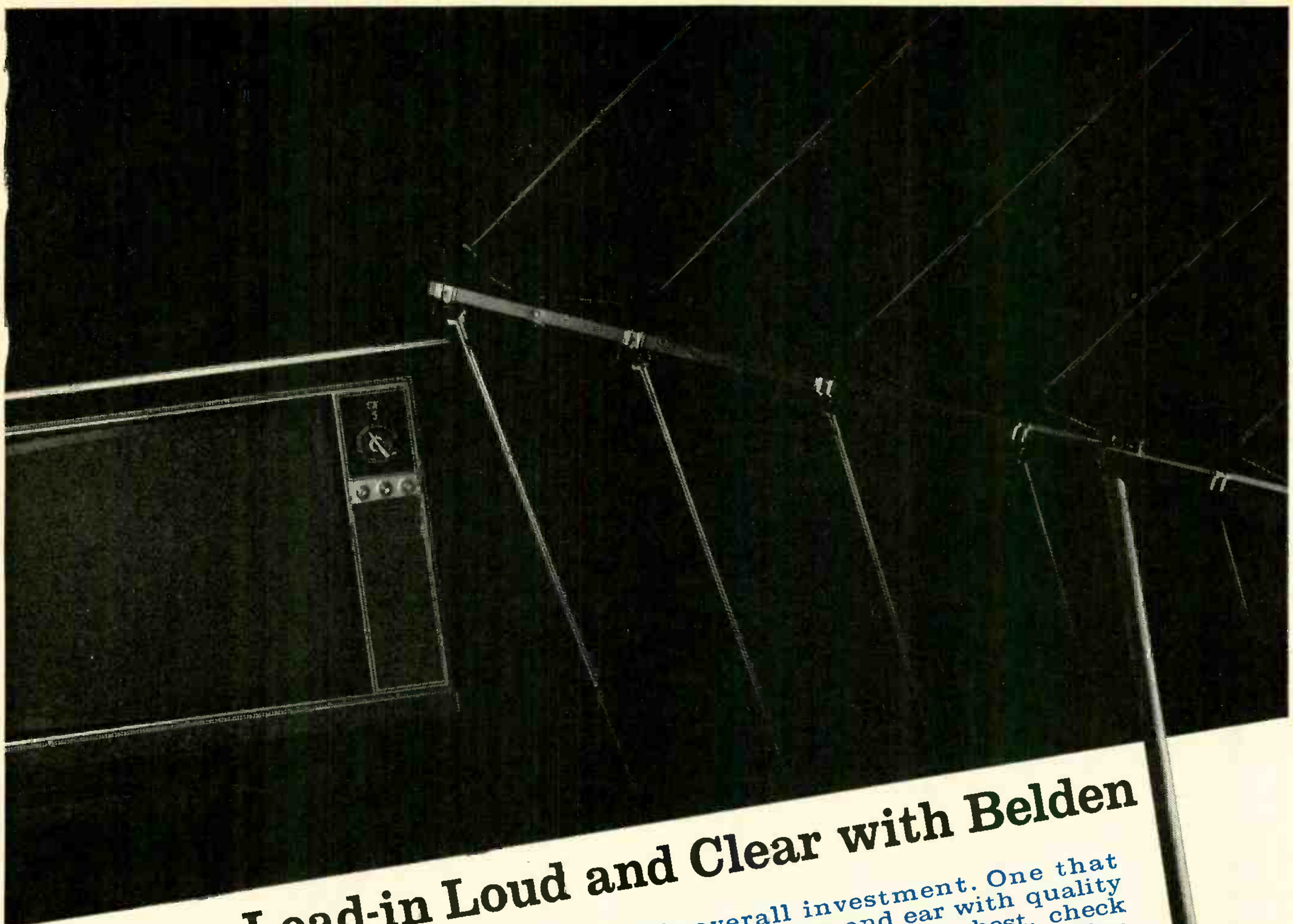
Unfortunately, we do not have too many extra reprints of the special section on switches. However, we still have reprints of the special sections on batteries, semiconductor diodes, variable resistors, relays, transistors, and chokes and coils. These are available directly from us at 25¢ each.—Editors

* * *

STANDARD COMPUTER SYMBOLS

To the Editors:

Before we create another one of those historic "confusion factors", might I suggest that we take steps immediately to



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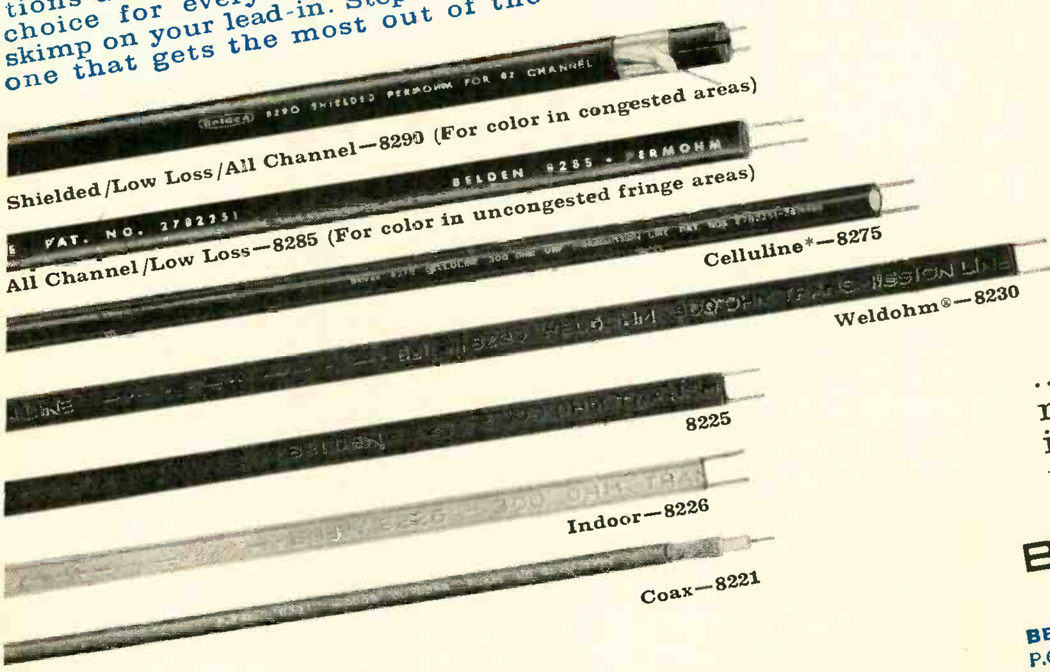
*Belden Trademark, and Belden U. S. Pat. 2,814,666

don't forget to ask them what else needs fixing?



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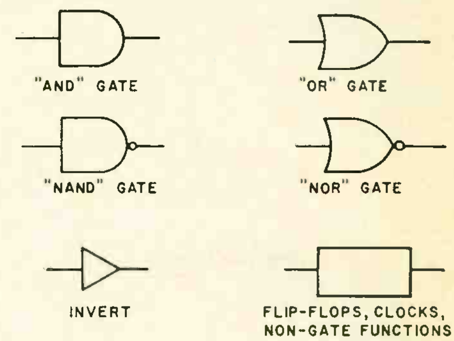
CIRCLE NO. 123 ON READER SERVICE CARD

standardize the symbols used in logic diagrams ("Digital Computer Logic: What the Symbols Mean", p. 46, August issue)?

I feel we would do well to use the symbols shown here and set forth in Military Standard MIL-STD-806B in



order to avoid any further confusion. Major manufacturers of digital logic integrated circuits have already adopted this Standard, and only good can come from the rest of the industry following suit.

William K. Heine
Training Administrator
Precision Instrument Co.
Palo Alto, Calif.

* * *

SLIDE-RULE CALCULATIONS

To the Editors:

I was very much interested in your September article "The Common Slide Rule for Reactance Calculations" (p. 93). I think the idea is great but I believe that if Mr. Houck would check, he would find that ½ π is equal to 1.57 and not 1.59 as stated in the article. If I am correct, this would make the reactance approximately 2430 and not 2390 as stated in the article.

T. E. Willis
Wahpeton, N.D.

The article in question actually showed the formula correctly although in a somewhat misleading form. The factor involved is not ½ times π, or $\pi/2$, but is the reciprocal of 2π or $1/(2\pi)$. This turns out to be 0.15915. Since the decimal point is not taken into account on the slide rule, the index mark is made at 1.5915 as stated.—Editors

* * *

AUTO DIAGNOSTIC CENTERS

To the Editors:

Just a note of appreciation for your excellent article on automobile diagnostic centers which appeared in the May issue. We thought your handling of the brake analyzer and the dynamometer was the best we had ever seen.

We appreciate your granting us permission to reprint the article for circulation to our field men and distributors —with credit to your fine magazine, of course.

William O. Merritt
Clayton Mfg. Co.
El Monte, Calif. ▲

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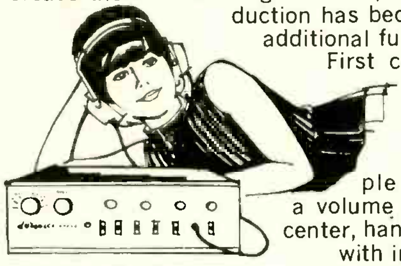
CIRCLE NO. 96 ON READER SERVICE CARD

A FLEXIBLE PREAMPLIFIER

At one time, the function of a preamplifier was simply to increase the level of a signal. Then, as the art of sound reproduction has become more sophisticated, additional functions have been added. First came tone controls, then equalization, filtering, tape monitoring, blending, and so on.



What was once a simple amplifying circuit and a volume control is now a control center, handling a variety of sources with input signals ranging from a few millivolts to several volts (a range of 1000 to 1), and which must impress special response characteristics on some of these signals. Requirements for distortion now are far more stringent than in the past. Distortion levels which were once significant laboratory achievements are now common in commercial equipment.

The resultant increase in complexity of the preamplifier has caused some confusion. The knobs and switches which the audio hobbyist considers mandatory for proper reproduction bewilder and dismay family and friends.

The Dynaco PAT-4 is a preamplifier which simplifies operation so that the basic functions are readily utilized by the uninitiated. The illuminated power switch tells you the system is on—and transistors eliminate any waiting. The two large knobs are the primary controls—one selects all sources (including the tape recorder) and the other adjusts the volume. [A third similar knob on the companion stereo Dynatuner completes the radio controls.] The smaller knobs and remaining switches contribute the complete versatility and unlimited flexibility so much appreciated by the enthusiast.

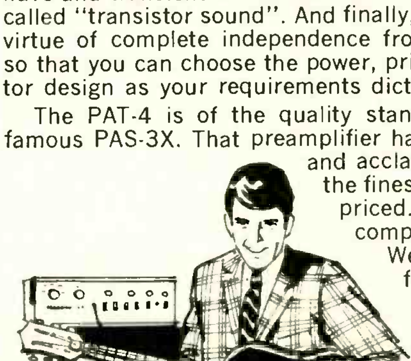
A separate front panel input lets you plug in a tape recorder, or an electronic musical instrument. Its special design even makes it possible to mix a guitar, for example, with a microphone, records, or radio. There's a 600 ohm output on the front panel, too, which enables easy connection of a recorder, and has sufficient power to drive medium impedance headphones without the need for a power amplifier.

You may save a power amplifier in another way, too. If you need a remote speaker system, or a center or third stereo channel, the PAT-4's exclusive "blended-mono" mode is all set to provide this from your regular stereo amplifier, where other preamps having center channel outputs require an additional power amplifier.

A sharp 3-position high frequency filter cuts the scratch with minimal effect on the music, and there's a low frequency filter, too. The "Special" low level input can provide for a second phonograph input, or for a special equalization position when you want to listen to older discs. Dynaco's patented "X" type tone controls provide smooth continuous tonal adjustments with the precise "center-off" assurance of step-type controls, without the complication of separate switches.

The overall quality of parts, ease of construction for the kit builder, accessibility for service, and audio performance are in the Dynaco tradition of acceptability to the perfectionist. On every performance count, the PAT-4 is exceptional. Noise and distortion are almost non-existent. Equalization is precise. Frequency response is superb, resulting in outstanding square wave and transient characteristics. There is not a trace of so-called "transistor sound". And finally, there is the undeniable virtue of complete independence from the power amplifier, so that you can choose the power, price, and tube or transistor design as your requirements dictate.

The PAT-4 is of the quality standard set by the world-famous PAS-3X. That preamplifier has been widely accepted and acclaimed for many years as the finest quality and reasonably priced. How does the PAT-4 compare with the PAS-3X? Well, the quality of both is fully comparable. It is doubtful that it would be possible to hear any difference between them on careful listening tests. The PAT-4 does have some extra features which justify its slightly higher cost for many users.



The PAT-4 is very much in demand, and it will be many months before it is in ready supply. If you are willing to forego its extreme flexibility, the PAS-3X will match its quality, with the added virtues of economy and availability. If you want the ultimate in flexibility along with quality, please wait for the PAT-4. It is worth waiting for.

PAT-4—Kit $89.95; Assembled $129.95

dynaco INC. 3060 JEFFERSON STREET, PHILADELPHIA, PA. 19121
IN EUROPE WRITE: DYNACO A/S, HUMLUM, STRUER, DENMARK

CIRCLE NO. 119 ON READER SERVICE CARD

COLOR-TV in the Marketplace

Although the growth rate of color set sales is not what the optimists predicted, sales of sets are still healthy and increasing. With only 20% of the country's 56 million TV homes with color sets, there's still a large market to be satisfied.

RUMORS are flying around the electronics industry about its glamor-child, color-TV. Certain facts support pessimistic views, but not many trend-watchers are convinced that color-TV has entered a declining phase or even a plateau. To formulate your own opinion, you need facts about the color-TV market as it stands at year's end.

First of all, what is the dilemma all about? The truth is that more color-TV sets were sold in 1967 than ever before. We didn't have year-end figures at press time, but predictions were that by the time the Christmas rush of sales is finished, 5.5-million color-television sets will have been sold in 1967. That will be nearly one million more than in 1966, so no one can truly say that sales are falling off. Sales are, in fact, continually increasing. Cause of the pessimism is the *rate of sales increase*. It is this *rate* that is declining and causing all the talk. Let's look at the record (Fig. 1).

In 1962, when color-TV sales really took off, sales nearly tripled; 1961 had recorded fewer than 150,000 color sets sold, 1962 increased to nearly 440,000. In 1963, sales were up 75%–750,000 sets. In 1964, the figure almost doubled—nearly 90% increase; sales amounted to 1.4-million receivers. By now the industry was a little spoiled. Another "almost 100%" year, 1965, saw 2.7 million more sets go into American homes.

Predictions for 1966 were understandably over-optimistic. There were more than 5-million color sets already in use, and buying seemed to be moving along at a fast clip. Color programming had by that time taken over all three networks, and the public was very color-TV conscious. Sales forecasts for 1966 ranged from a "conservative" 5 million to an optimistic 6.5 million. When the year ended with only 4.7-million sets sold, disappointment made some people in the industry unnecessarily pessimistic—even though that is a respectable 75% increase!

Everyone hoped the percentages would stay high. Some experts predicted sales above 7 million for 1967—still a 50% increase. As the year wore on, experience dampened these hopes. Sales were softer than expected through most of the year. Although they picked up some as the late-fall selling season progressed, only a real Christmas rush could push the figure to 6 million.

So it looks as though any gloom you hear about is *not* because there will be *fewer* color-set sales this year; Fig. 1 proves this. The gloom is because of the lowering trend in sales. With only 20% of the country's 56-million TV homes owning color sets, industry worries over the lag.

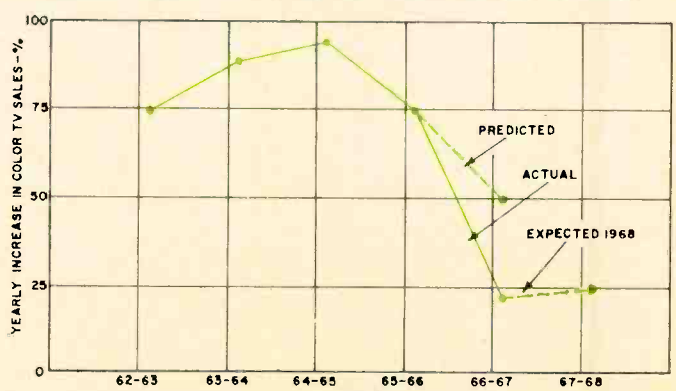
Maybe More Incentives

In the 1968 lines (described technically elsewhere in this issue) there are innovations that may capture the imagination of the color-set-buying public and stir up sales.

For example, the solid-state color set. At the beginning of 1967, industry spokesmen were saying all-transistor color was probably three years away. Such a thing seemed a little hard to figure, with nosediving transistor and integrated-circuit prices, but the spokesmen seemed to know. Then, within one week in June, two companies introduced all-transistor color receivers. The glamor of solid-state may hypo color-receiver sales slightly.

TV viewers do not like twiddling three or four knobs. Up to now they had to click the channel selector, make sure

Fig. 1. The color-TV market is still growing, but at a rate less than in 1964-65. Market growth in 1968 will be substantial.



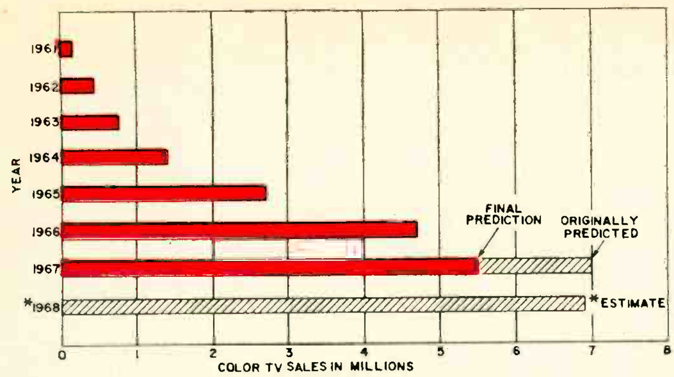


Fig. 2. The actual number of color-TV sets sold has grown each year since 1961. A continued growth seems probable.

the fine tuner was set correctly, then brightness and contrast, and finally the color and hue controls. New models sport seven- and eight-channel remote controls, automatic fine tuning (a.f.c. in the tuner), and stabilizing improvements throughout the chassis that make color viewing easier than ever before. The art has reached the state where manufacturers can concentrate on simplification.

The other factors in the new lines may prove more attractive to buyers than the mere glamor of solid-state or the convenience of simplified controls. Although *General Electric* has had its 11-inch Porta-Color available for nearly two years, the 1968 model introductions saw the first widespread lines of portable color sets—from at least eight companies. Although the portables must still be plugged into 117-volt a.c. power lines, some are light enough to be carried around. Portables may provide sales incentives for the gift-giving season that precedes Christmas.

At introduction time, several new models carried lower price tags. But later price increases have worked their way through most models of most manufacturers. There are still some low-priced portable models that may stimulate sales: *G-E's* 10-incher at $199.95, *RCA's* 15-incher at $329.95, and from *Sears* a 15-incher at $279.88.

New table model prices range from *Emerson's* 15-inch at $279.95 and *Sears'* 18-inch at $289.95, through *Sylvania's* best 18-inch model at $379.95, to *Motorola's* top 23-inch table set at $489.95. There are many prices and sizes in between those limits.

Consoles start at $399.95 (*Admiral*), with several makers selling console color sets at $449.95. The highest priced console is a 23" solid-state *Motorola* in a *Drexel* cabinet at $1200. Some combinations go higher than that.

Model for model, 1968 color receivers are as much as $50 cheaper than 1967 models. Remote control, automatic fine tuning, detented u.h.f. tuning, and other extras account for more dollars on deluxe models, keeping their prices the same or higher. In some parts of the country, discounting on certain high-end models brought price cuts of up to $100, but this was at the dealer level and not an industry-wide trend. Over-all, the American public can buy color sets cheaper than ever before. That should help sales.

An interesting point was unearthed by a researcher a little over a year ago. He found that families buying color-TV were in the above-$8000 income bracket. That figure is dropping. The lower limit in 1968 is expected to be around $7000. The drop is traceable to lower prices.

One other factor may help boost the end-of-the-year total and carry over into the early 1968 sales picture. Money is not as tight as it was during 1967, although it may tighten a little during the early part of the year. If it remains loose, credit will be easy and sales may have a healthy upswing. If credit tightens again, what with the proposed tax increase also biting into wages, the first quarter of 1968 will be bleak (the Christmas and New Year rush also dampens buying for a month or so afterwards).

Looking beyond the first quarter, long-range planners expect a loosening economy for 1968. That could help sustain the growth rate of color-TV sales. Such predictions are never sure, however, and must not be taken as gospel. From our best information, we see color-TV sales for 1968 around 25% higher, about the same *percentage* increase as in 1967. That makes our prediction for the year 1968 around 7-million color sets to be sold.

X-Radiation in Color Sets

Last June's x-radiation scare has ceased to be a scare, but manufacturers can't be sure it didn't dampen color-set sales. The noise started when 100,000 *G-E* sets got out with faulty high-voltage regulators. A bulletin issued in May informed dealers and distributors that high-voltage regulators 6EA4, 6EF4, and 6LC6 permitted "soft x-radiation in excess of desirable levels because of inadequate shielding . . . . .". Replacements were 6EH4, 6EJ4, and 6LH6, respectively.

The story developed when some news media made a rather big issue of it and some self-appointed researchers undertook to prove that color-set radiation levels could harm viewers. An industry committee showed that radiation from virtually all color receivers is far below the limit deemed allowable by the National Committee on Radiation Protection (NCRP)—0.5 milliroentgen per hour (mR/hr) at a distance of 5 cm from the set. But Congress held hearings anyway. The resultant publicity in national consumer media may have upset the buying public enough to slow down color purchases a bit, but apparently not drastically. The industry can only conjecture what the sales picture would have been without the unsavory publicity.

So far, few changes have been made in set-makers' procedures for checking radiation. The procedures in use are adequate. *Underwriters' Laboratories Inc.*—safety watchguard over home appliances—has changed its acceptable x-radiation limit to 0.5 mR/hr to agree with the limit set by the NCRP; *UL's* limit was formerly 2.5 mR/hr. The new standard is barely above the normal background radiation which exists in our surface atmosphere.

Color-TV and Integration

Integrated circuits (IC's) haven't had as much impact as was hoped for on color-set sales, possibly because only a few are in use. By late 1968, IC's will probably be used heavily in color sets. A number of possible applications have been developed around integrated circuits already on the market—some in multiple-stage uses such as *RCA's* sound-i.f.-detector IC (used in black-and-white sets for the second year, now).

Other IC uses are in the works. Some say an all-IC set is several years away, but such forecasts are often disproved. Cost is what delays an all-IC color set, along with a few technological hangups like the power requirement in sweep stages.

Texas Instruments has a design that uses a single hybrid (thick-film) IC. *Amperex, General Electric, Fairchild Semiconductor, Motorola, Philco-Ford, Texas Instruments, RCA,* and *Westinghouse* all have integrated circuits that fit into color-TV applications. Rest assured, the late-1968 models introduced in the spring will have IC's sprinkled around lavishly. 1969 models will sport even more IC's.

Integrated circuits won't trim costs much, if at all—at least not right away. Once production is heavy and the cost of multi-circuit IC's comes down to $1 or so, look for real price slashes in color sets. Right now the chief attraction of IC's is reliability (and glamor).

Selling by Size

Sizes of color sets are proliferating as wildly as in black-and-white sets. Ten different sizes were introduced for early 1968, ranging from the 7-inch Chromatron by *Sony* to the standard 25-inch (now called "23 viewable inches"). Table 1 shows screen sizes now available, along with their old designations for reference. Square-inch classifications are included since some manufacturers persist in referring to their sets in those terms.

It is too soon to judge the impact of small-screen sets on color sales. Many manufacturers (those without small-screen models) insist the market won't be ready for small screens until there is greater penetration with standard color sets. Those in favor of small-screen sets, particularly when they are accompanied by lower prices, hope to capture the second-set market as it develops.

It seems that, actually, there will be three market segments. One will be made up of those who simply aren't convinced they want color; lower prices may trigger buying. The second-set market is another segment, small in numbers but significant in purchasing power. The third segment comprises those who feel they can't afford a full-price color set but will, instead, buy the lower-cost small-screen portable; that segment could easily be the largest of all.

So far, however, the trend to small color sets stops at 11-inch models. Most color sales are still in the 18-inch-and-up models, but 14's and 15's are rapidly gaining momentum that might readily sweep them into the most-popular category later in the year.

Color-TV Worldwide

The United States isn't the only country preoccupied with color television. For example, in Mexico, where color telecasting is only a few months old, the advent of color has slowed sales of black-and-white sets. But hopes for a color boom were short-lived. The prices of color sets in Mexico are too high for that low per-capita-income country. It will be some time, and many price cuts, before Mexico attains any degree of color-receiver saturation.

That isn't the way it works everywhere, though. In West Germany last summer, the major set makers got ready to introduce their $600-and-up PAL receivers to an eager market. Color programming was to start in August. A company named *Koerting* suddenly offered a table-model color set for $460. Before the price drop, fewer than 10% of West German families felt they could afford color. Afterwards, the percentage rose to nearer 15%.

The standards feud in Europe is over for all practical purposes. However, you still hear rumblings from there, like the suggestion that PAL be used for long-distance transmission here in the United States. It wouldn't be difficult, since standards converters are practical to build. PAL-to-NTSC-and-back shouldn't be tough. *Telefunken-AEG* in Germany has developed a "transcoder" that makes it possible to receive SECAM transmissions on PAL receivers. The Netherlands started color programming in September. At press time, France was expecting to start any time, and Great Britain in December. With satellites dotting the sky, standards converters at earth stations would make a world-wide color television network a reality.

While we're on the subject of other countries, it's a good time to mention the influx of color sets from Japan, that electronics-conscious exporter. Japanese sets sold in the United States during 1967 exceeded 500,000.

Among the Broadcasters

Among the chief reasons for color-TV's finally "taking off" in 1962 were the efforts by networks and TV stations to get color programming on the air. Who would buy a color set if there were almost nothing to watch?

There are presently about 700 TV stations on the air, both u.h.f. and v.h.f. Among them, about 200 can originate programs and commercials in color. Virtually all stations can offer color programs furnished by networks.

For a long while, the rush to color put the makers of filmed commercials in a bind. There weren't sufficient production facilities to meet the demand for color-filmed commercials. About the time an answer was found—color capable video tape recorders—the color-film industry began to catch up. Many programs are produced on tape, though, so stations have been forced to include color VTR's in their equipment lineups. There are almost as many stations that can use color video tape as can show color film.

VIEWABLE DIAGONAL (inches)	CRT SIZE (inches)	SQUARE INCHES
Chromatron	7	n.a.
10	11	60
11	12	70
14	16	113
15	16	117
18	19	180
mask	21 round	mask
20	21 & 22	226
22	23	270
23	25	295

Table 1. Color-TV screen sizes are proliferating. Here are the sizes seen in the 1967 and 1968 sets, now in production.

..... And Others

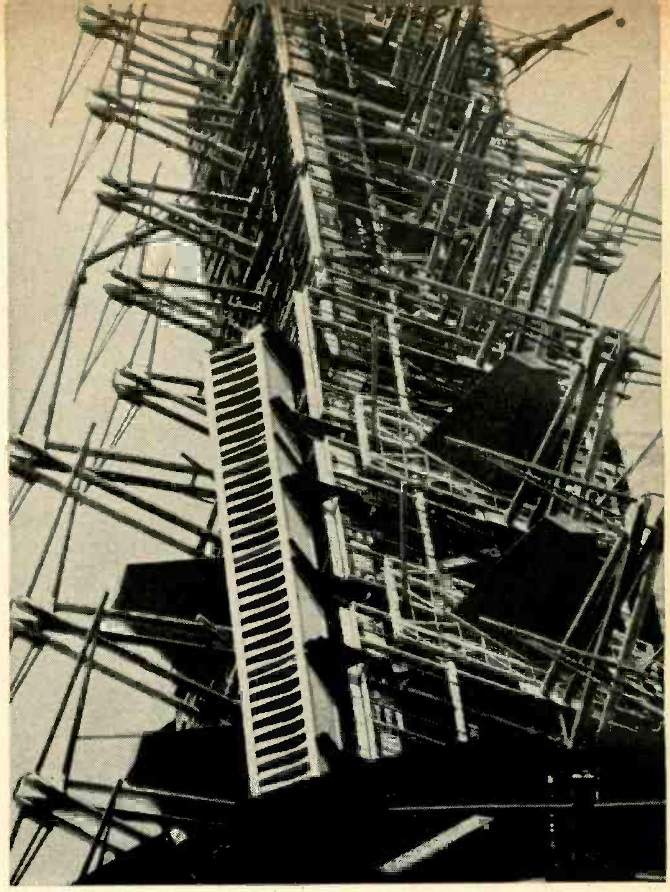
This all means dollars to the entire electronics industry. The continuing boom (we don't accept a mere slackening as a sign of the end) will keep on creating auxiliary sales in the millions of dollars. The more color-TV sets sold, the more components must be manufactured and sold for building the sets and for maintaining them in future years. Even though prices of transistors and integrated circuits are coming down rapidly, their numbers are rising at such a phenomenal rate that the dollars spent for them alone will be many millions; a good portion of these components will be used in color-TV.

Solid-state entries in the 1968 line notwithstanding, tubes are still a major factor in color television, particularly picture tubes. CRT makers in the U.S. have turned out more than 7 million color CRT's in 1967, mostly for new receivers. The rectangular shape is almost universal now. Another quarter-million or so of picture tubes will be imported, mostly as replacements for foreign-made color sets but a few for use in domestic receivers. Other receiving-tube types are doing well, and a part of their prosperity is due to strong sales of color sets.

Antenna makers are among the chief beneficiaries of the color television boom. Some low-cost antennas that were okay for black-and-white are inadequate for color. Color sets need stronger signals and the need is greater to rid the picture of ghosts.

Test equipment makers are busy designing instruments that make color servicing easier and more foolproof. No startling innovations came forth in 1967, but definite improvements have shown up in most lines. The chief bugaboo among color generators has been instability. Every manufacturer who introduced a color generator in 1967 added some feature to help overcome that problem. Sales of other test instruments—particularly wideband oscilloscopes and v.t.v.m.'s—have risen with the onslaught of color-TV service problems. Color-set troubles don't respond well to the old hunt-and-try methods.

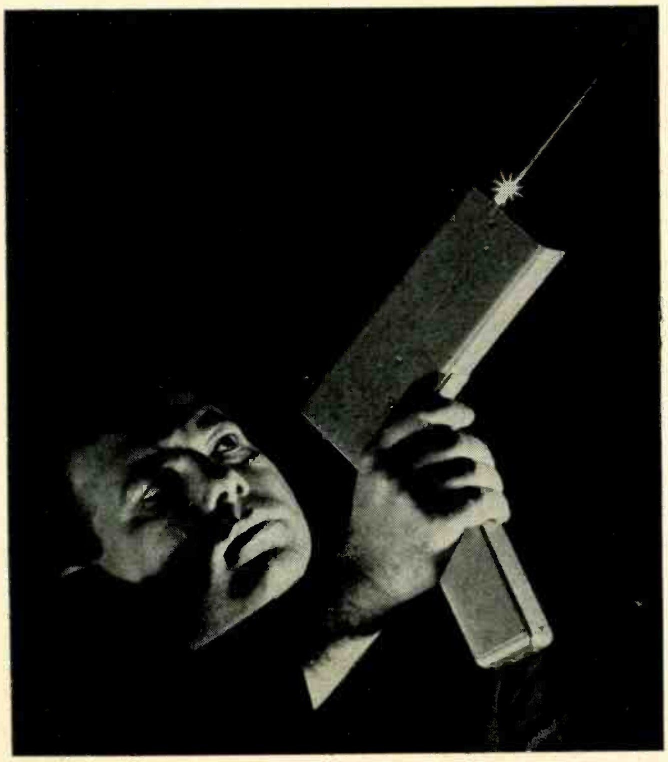
There isn't space for more than this general picture of the color television market and its effect on electronics as a whole. Although color-TV has diminished slightly in acceleration of its growth, it certainly has not diminished either in sales or in impact. In home entertainment, in education, in industry—color television is a strong economic factor—creating jobs by the tens of thousands and generating sales dollars in the tens of millions. ▲



RECENT DEVELOPMENTS IN ELECTRONICS

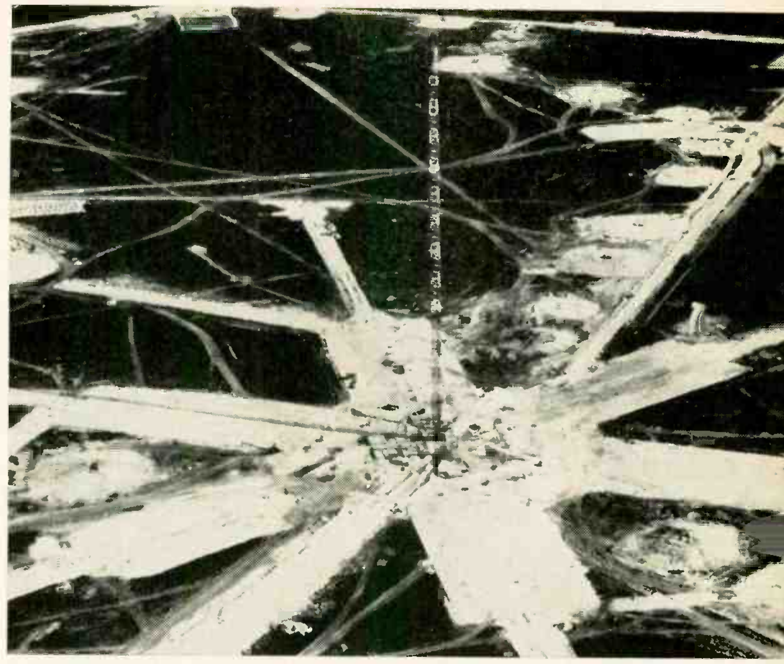
Laser Photography. (Top left) A new laser beam image reproducer, part of a revolutionary TV system that produces images of photographic quality, is being demonstrated here. The unit is recording by laser beam an image consisting of 5000 TV lines on a 9 by 9 inch photo plate. Such images are transmitted to the laser by a new "return-beam vidicon" TV camera, shown in background, that produces pictures 10 times sharper than those produced by a standard TV camera. Designed by RCA for use in a proposed earth resources observation satellite (EROS), the new system is also expected to find important uses in the manufacture of integrated circuits, in the preparation of graphic arts materials, in the transmission of news photos overseas, and in other industrial photo processes.

Circular-Polarized FM Antenna. (Top right) The four black pyramid-shaped radomes enclose the elements of a new FM broadcast antenna recently installed atop N.Y.'s Empire State Building. Four other such elements are on the other sides of the tower. The elements are crossed dipoles whose ends are bent back 60 degrees, working in conjunction with reflector screens. By feeding the elements 90 degrees out of phase, a circular polarization results. This means that listeners with FM sets in their cars and those using line-cord antennas should be able to obtain better reception of signals produced by WCBS FM, the user of the new antenna. Several other N. Y. City FM stations are also using circular polarization. Antenna is located between horizontal-dipole elements of WCBS-TV (Ch. 2) and vertical slotted waveguide antenna of WNYC-TV (Ch. 31).

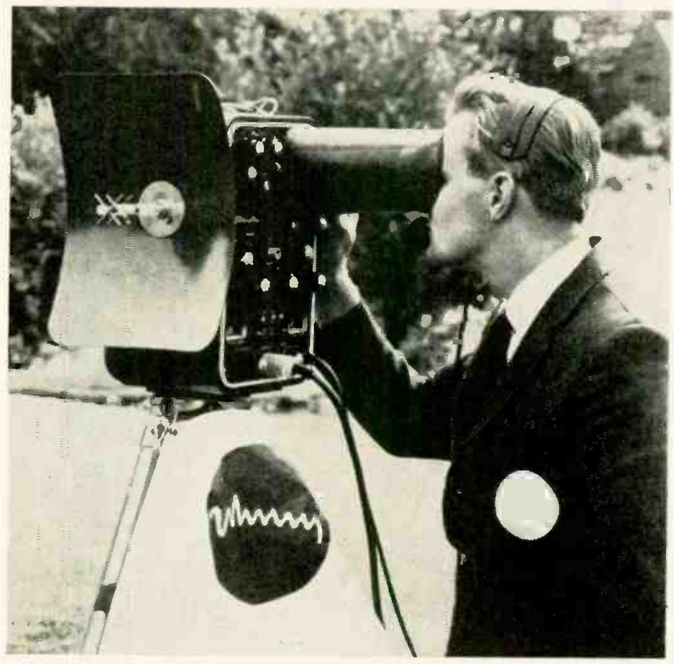


Laser Rescue Light. (Left) This battery-operated laser "gun" developed by Sperry Rand "shoots" a beam of light that is visible for up to four miles in daylight or at night. The gun could be used as a signaling device by pilots downed behind enemy lines. The beam can only be seen by someone looking directly at it (it was made visible for the photo). To a pilot of a rescue helicopter, it would appear as an intense flash of red light. The completely self-contained gas laser gun weighs less than two pounds. Its beam is only 5 to 50 feet wide at a distance of one mile and it will not harm the eyes of an observer at distances of over ten feet from the light source.

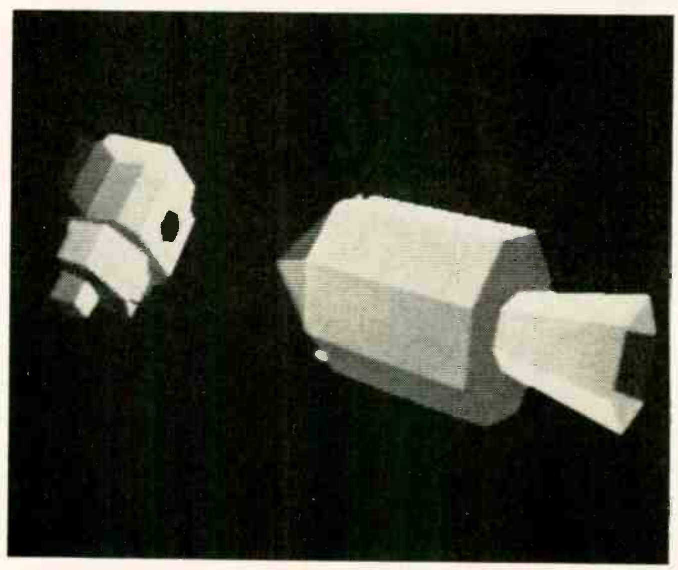
Highest V.l.f. Radio Tower. (Right) The Navy has raised the highest man-made structure in the Southern Hemisphere to improve communications to the Fleet in Far Eastern waters. Standing 21 feet taller than the Empire State Building (without its TV tower), the tower is a 1271-ft structure. The installation is at North West Cape, an extremely remote and desolate area in Australia. Feeding the giant tower is a one-million-watt radio transmitter operating on the v.l.f. band.



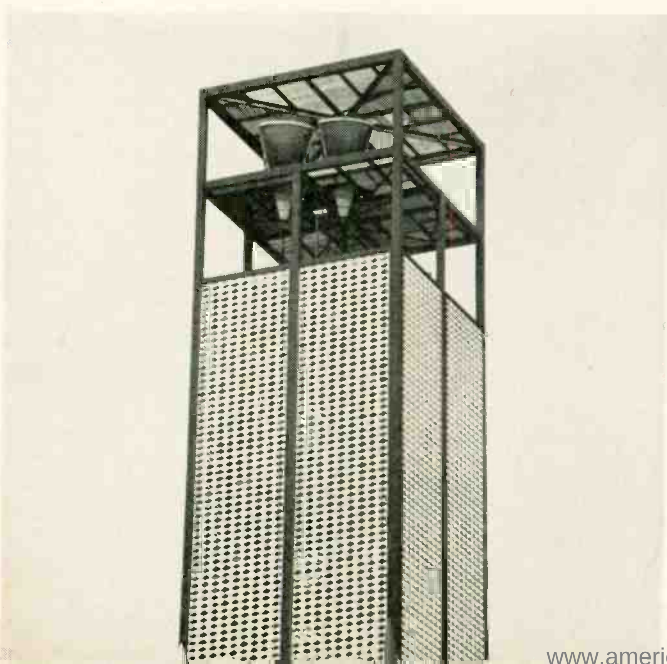
Electronics Measures Golf Drives. (Center) For the first time in any golf tournament, electronic precision measuring instruments were used recently at the Westchester (N. Y.) Classic to determine the exact length of drives of the competing players. Drive distance was measured within inches by transmission of microwave energy between master and remote stations that were set up at several of the holes on the course. The equipment used, manufactured by Tellurometer, provided immediate readout of drive distances and these measurements were relayed by means of radio to the central scoreboard.

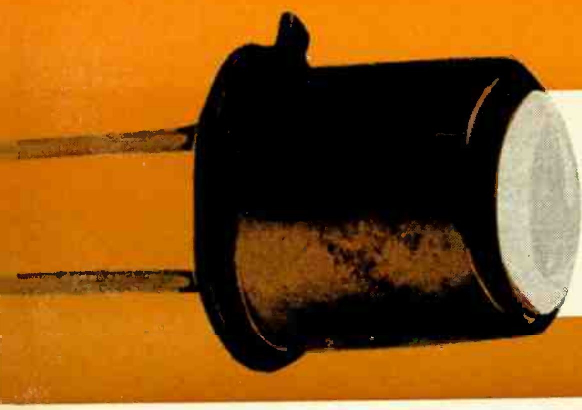


Computer-Drawn Color-TV Pictures. (Below right) These images of NASA's Lunar Modules and the Command & Service Module do not exist—except in the memory of a computer. Built for the Manned Spacecraft Center in Houston, the computer is fed numbers that describe mathematically the shape and colors of an object. It then draws the object on a color-TV screen. The viewer can "fly" around and inside the object simply by manipulating an aircraft-type control stick. The computer was designed and built by G-E, and it will be used to evaluate control systems for rendezvous and docking. The numbers that describe a particular scene are on tapes which are read into the computer's memory initially and remain there until deliberately erased or until a new tape is read in. Since the "models" are only computer tapes, it is possible to change from one simulation task to another in a matter of seconds. Currently the device that generates the images is ground-based. However, through the possible future use of large-scale integrated circuits, it would appear feasible to produce equipment for the cockpit of a plane or a spacecraft.



Modern Microwave Tower. (Below left) Neatly dressed in aluminum solar screening is this new microwave tower located in downtown Columbus, Ohio. The Alcoa screening panels conceal structural members of the local telephone company's 150-foot antenna tower which is located atop the company's nine-story office building. The structure is able to withstand sustained winds of up to about 100 miles per hour.





This G-E LED is housed in modified TO-5 case for direct mounting on a PC board. Note the hemispherical lens shape of the light-emitting surface at top of case.

LIGHT-EMITTING DIODES

By DAVID L. HEISERMAN

These new semiconductors emit light directly from their "p-n" junctions. They are beginning to be used in photoelectric circuits because of their long life, resistance to shock and vibration, and transistor compatibility.

DIODES capable of emitting light from their *p-n* junctions are the latest addition to the expanding field of optoelectronics. A cousin of the more exotic laser diode, the light-emitting diode (LED) changes electrical energy into light without going through the intermediate thermal stage that typifies incandescent lamps.

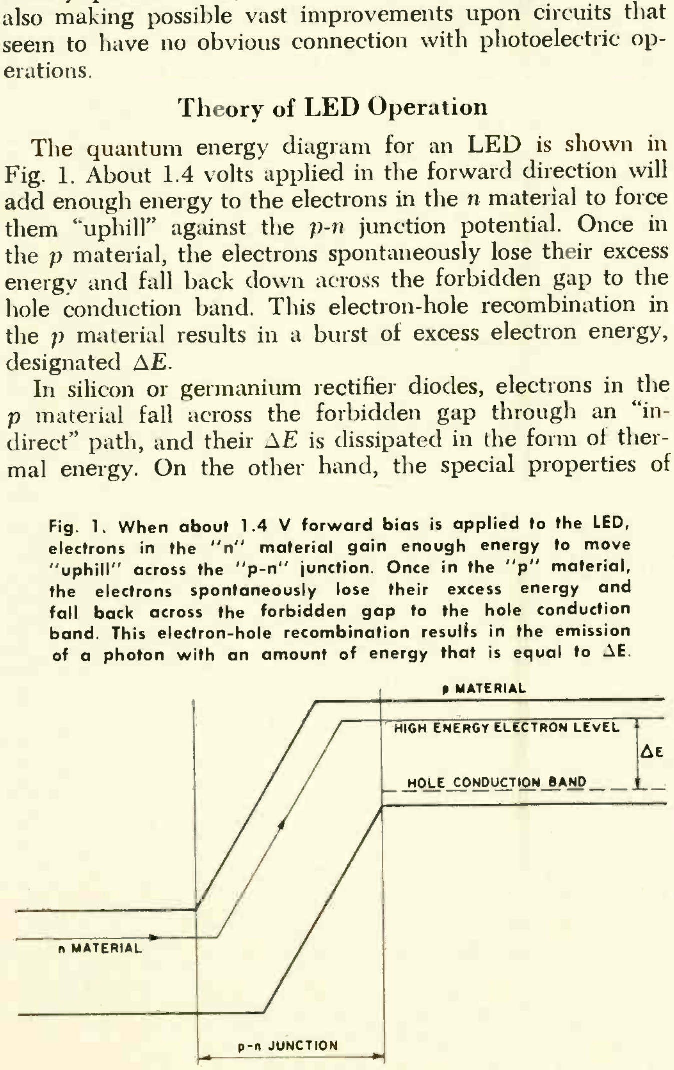
Today, the LED is not only beginning to take over tasks usually performed by small incandescent lamps, but it is also making possible vast improvements upon circuits that seem to have no obvious connection with photoelectric operations.

Theory of LED Operation

The quantum energy diagram for an LED is shown in Fig. 1. About 1.4 volts applied in the forward direction will add enough energy to the electrons in the *n* material to force them "uphill" against the *p-n* junction potential. Once in the *p* material, the electrons spontaneously lose their excess energy and fall back down across the forbidden gap to the hole conduction band. This electron-hole recombination in the *p* material results in a burst of excess electron energy, designated ΔE.

In silicon or germanium rectifier diodes, electrons in the *p* material fall across the forbidden gap through an "indirect" path, and their ΔE is dissipated in the form of thermal energy. On the other hand, the special properties of

Fig. 1. When about 1.4 V forward bias is applied to the LED, electrons in the "n" material gain enough energy to move "uphill" across the "p-n" junction. Once in the "p" material, the electrons spontaneously lose their excess energy and fall back across the forbidden gap to the hole conduction band. This electron-hole recombination results in the emission of a photon with an amount of energy that is equal to ΔE.



LED materials, such as gallium arsenide, allow about ten percent of the recombining electrons to fall through a "direct" path, and ΔE is discharged as a photon.

The wavelength of the emitted light from a direct semiconductor material can be determined by the equation: $\lambda = ch/\Delta E$, where λ is the wavelength of emitted light energy, ΔE is the energy emitted by an electron-hole recombination, h is the Planck constant, and c is the speed of light. This equation shows that the wavelength of light emitted by an LED is inversely proportional to the energy change at the instant of electron-hole recombination in the *p* material.

For example, most *GaAs* LED's have a ΔE of about 1.37 electron-volts at room temperature. At the instant of electron-hole recombination, the device will emit light at a wavelength of about 9000 Å. This wavelength is in the near infrared range of the light spectrum and falls, conveniently, within the operating range of most cadmium sulphide light-sensing devices.

General Electric, to cite another example, has developed a gallium phosphide light-emitting diode with an energy gap of 2.25 eV. With a ΔE nearly twice that of *GaAs,* its output wavelength is on the order of 5500 Å which is well within the visible green region.

Spectral Bandwidth & Output Intensity

The examples given imply that the LED has a coherent output frequency determined by a single value of ΔE. This, however, is a highly idealized case—practical light-emitting diodes, unlike their laser diode counterparts, emit a relatively broad spectrum of wavelengths. Fig. 2A shows the spectral output of a typical infrared-emitting *GaAs* LED. In this case, the diode's rated λ peaks at about 9000 Å, and the spectral bandwidth between half-power points is about 200 Å.

To date, the semiconductor industry has not developed standard means of specifying the output intensity of its light-emitting diodes. As a result, LED manufacturers list all intensity specifications in terms of percentage of maximum light output.

Fig. 2B illustrates the nearly linear relationship between the amount of forward current and relative light intensity. This direct relationship can be explained by simply noting that a change in the rate of electron flow through the *p-n* junction will cause a corresponding change in the rate of electron-hole recombinations within the *p* material.

Unfortunately, ambient temperature also influences LED output light intensity. According to Fig. 2C, LED light out-

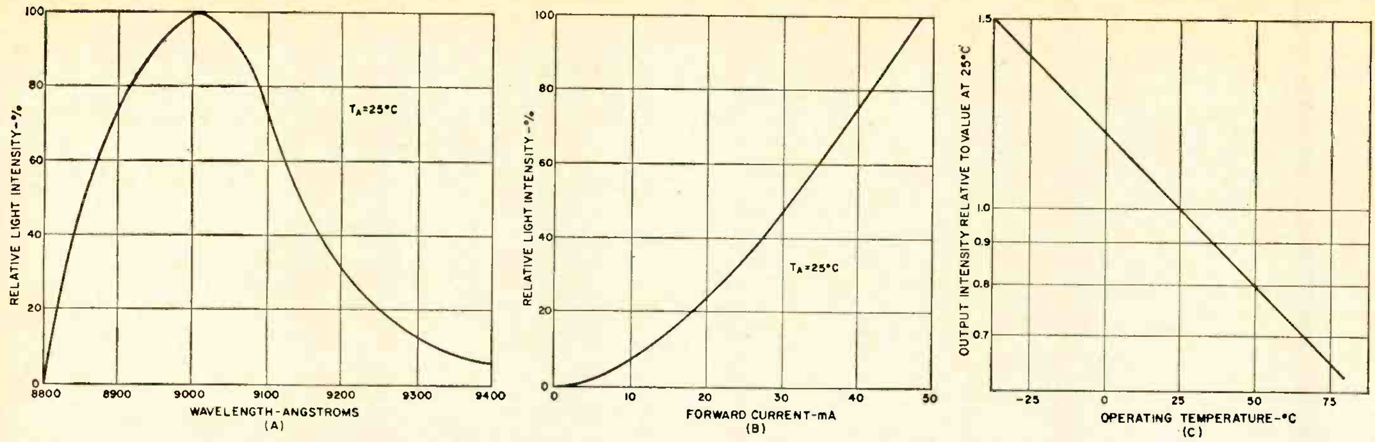


Fig. 2. (A) Spectral output of GaAs light-emitting diode. The LED's rated output wavelength is the wavelength at peak power output at 25° C. The wide non-coherent output of the LED makes it unsuitable for optical operations that characterize the laser diode. (B) There is a nearly linear relationship between the amount of light output and the forward current. (C) Relative light output as function of the operating temperature. LED is more efficient at low temperature.

put decreases with an increasing ambient temperature. This inverse effect is actually a reflection of the fact that the efficiency of an LED decreases with increasing temperature. At temperatures near absolute zero, nearly all recombining electrons follow the direct, light-emitting path. As the temperature increases, however, the system becomes more inefficient and a majority of the electrons drop across the forbidden gap *via* the indirect, heat-producing path. An LED operating at 25°C has an efficiency rating of 4 to 6%.

LED Geometry & I-V Characteristics

It is inevitable that investigations into the new technology of optoelectronics would lead to a study of optics as well as electronics. Fig. 3A shows a cut-away diagram of a light-emitting diode. If light energy emitted from the *p-n* junction strikes the semiconductor-to-air interface at an angle less than 16° (with respect to the interface), the energy reflects back into the *n*-material, contributing to the inefficiency of the device. The hemispherical shape shown in Fig. 3A minimizes the interface problem.

This lens-like configuration also allows a photosensitive device to respond to emitted light at angles up to 45° on either side of the optical axis. Fig. 3B shows the output intensity of an LED as a function of the angle from the optical axis. LED's with narrower cones of light are also available.

The forward *I-V* characteristics of an LED (Fig. 3C) show an unusually high forward voltage drop. Although not shown on the *I-V* curve, the LED is peculiar in another respect—it has a reverse breakdown potential of only 2 volts. Thus, the light-emitting diode can be used as a source of light energy, but can never be used as a rectifying element.

LED Applications

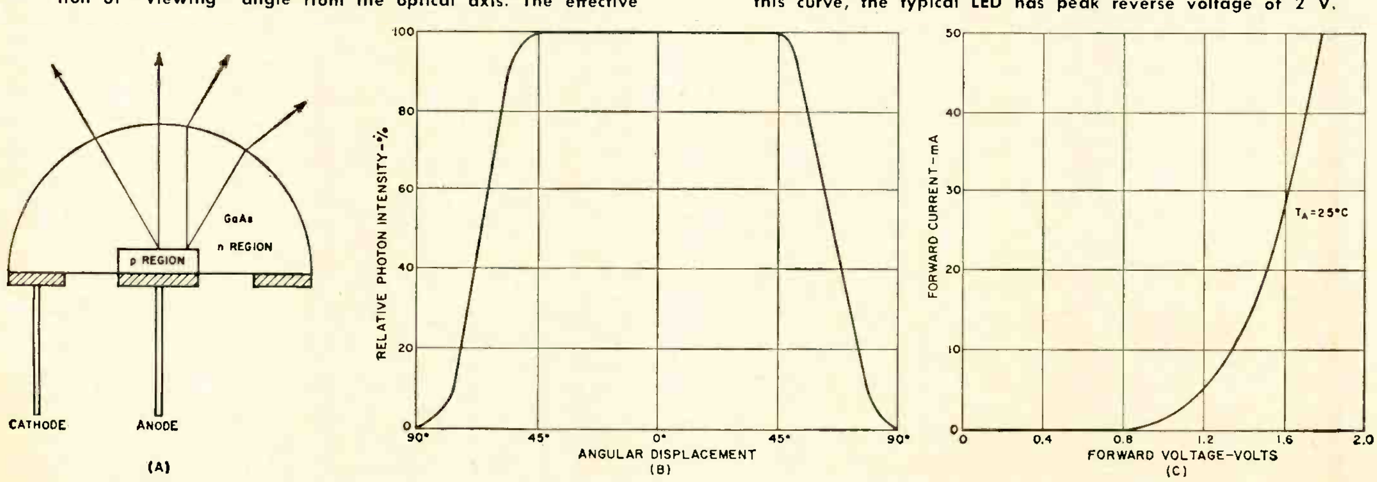
Present-day applications of the light-emitting diode fall into three general categories: (1) replacement of miniature incandescent and gas-filled lamps, (2) transmission of modulated light signals over several inches of space, and (3) coupling of electronic circuits with total electrical isolation.

As a replacement for incandescent lamps, the LED's long life, high resistance to shock and vibration, and direct compatibility with transistor circuitry make it an excellent source of light in computer and complex control systems. The infrared diodes are especially useful for non-visual operations such as card and tape reading, encoding, and character recognition.

The present position of incandescent and gas-filled lamps in visual operations, such as numerical displays, seems to be a safe one for the moment. Using arrays of red and green light-emitting diodes, however, the electronics industry can look forward to a new low-voltage light source that will eventually be less expensive and more reliable than today's visible light sources. Some of these are already available from such companies as *RCA* and *Monsanto*.

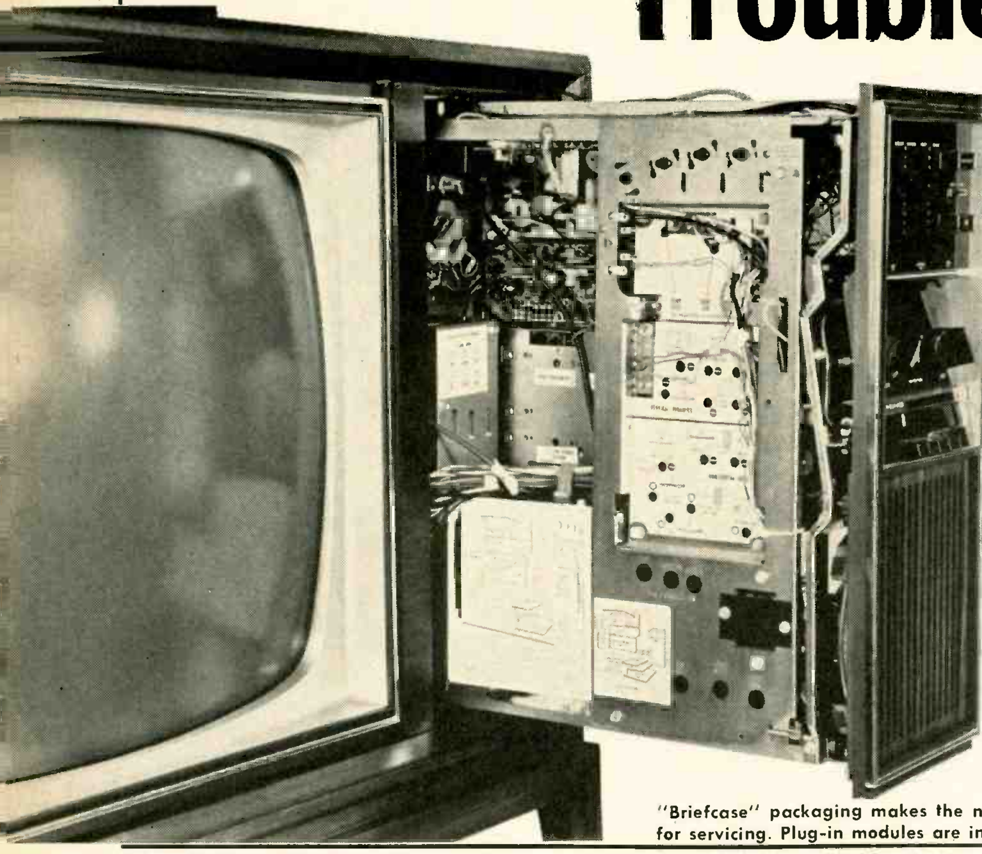
Efficient high-frequency modulation of light has been an engineer's dream for decades. The 50-MHz response of the LED makes it possible to transmit a number of multiplexed audio and video signals to a (*Continued on page* 67)

Fig. 3. (A) Physical configuration of an LED. The hemispherical shape reduces the chances of an emitted photon striking the semiconductor-air interface at less than the critical angle of 16 degrees. (B) Relative output intensity as function of "viewing" angle from the optical axis. The effective light output of this diode fills a 45-degree radius cone. Other diodes are available, however, that will fill only a 10-degree radius cone. (C) Forward I-V curve for an LED. Device has high forward voltage drop. Although not shown on this curve, the typical LED has peak reverse voltage of 2 V.



Troubleshooting NEW COLOR CHASSIS

By LARRY ALLEN



"Briefcase" packaging makes the new Motorola solid-state all-color chassis easy to reach for servicing. Plug-in modules are in warranty for year, can be exchanged when defective.

The new sets are easier to service and adjust, but added features are increasing the complexity. Hence the technician must keep up with the newest circuits.

SERVICING is a necessary part of the television business. Manufacturers have found out that, try as they will, it is economically impossible to build a television receiver that is failure-proof, or even nearly so. They and their dealers have learned that when a new set can't be used because of a breakdown that isn't repaired right away, the incident causes that customer plus his friends, neighbors, and relatives to have a poor, and often vocal, opinion of that brand. Like it or not, manufacturers have a growing interest in making sure the buyers of their television receivers have competent service available when, and if, it is needed.

Making the Job Easier

Competent color-TV technicians are long in demand and short in supply. Because of this, service charges are rising, a trend which has depressed color-set sales somewhat. In most areas of the country, the price increase is justified, because it brings service-technician wages more into line with those of other skilled trades. However, it does nothing to change the average color-TV owner's basic dislike for service calls.

There are two approaches to the color-TV servicing problem. One is to have better trained technicians. Better wages in the field will go part of the way toward this since higher caliber men will be attracted to television servicing. New training programs by manufacturers, industry associations, and forward-looking technical schools take further steps. Better-trained men do a more thorough job, in less time. This results, in the long run, in servicing costs that are lower, and increased customer satisfaction.

A second approach to reducing service costs involves the set itself. Many manufacturers are designing for reliability, hoping their color sets will need less service. At the same time, they are trying to make their sets easier to service. They try to make components more accessible and quicker to test, chassis and cabinets easier to get into, and adjustment procedures faster and more certain. By continuous effort, color-receiver manufacturers have come up with innovations that will make the servicing job easier and thus less expensive.

Some examples of this trend to serviceability have appeared before this model season. One is the hinged vertical chassis that swings out for easy access to both sides of the chassis pan. *Setchell Carlson* has long used "unitized" chassis construction, which divides an entire color receiver among six subchassis—low-voltage supply, horizontal sweep and high voltage, vertical sweep, video and sync, i.f. and sound, and color. This is the modular approach, and speeds in-home troubleshooting *provided* the technician carries a set of spare subchassis; the defective subchassis then has to be mocked up in a jig at the television service shop for repair.

Solid-State Modular Color-TV

The 1968 model season saw more innovations in the direction of easy servicing. *Motorola* modularized its solid-state color set (see "Solid-State for '68," page 42). The entire chassis slips out at the front of the cabinet for quick access and ten etched-circuit modules plug into the chassis. Replacing a module board is simple; just pull it out and plug in another. A board with a defect of any kind can be exchanged for a good one at the nearest *Motorola* distributor, which makes it unnecessary for a service technician to get involved in circuit troubleshooting at all. However, the transistor circuitry in the receiver is not especially complicated and a good TV service technician will be able to repair the circuits himself after the one-year exchange warranty has expired.

The speed of this way of servicing depends, as it does with the modular-subchassis arrangement, on the technician's carrying a stock of the plug-in modular boards with him. This could represent a sizable investment, since modules are expected to be priced from about $6 (with a trade-in board) to a high of $42 (without a trade-in) for the horizontal-deflection module. Although the technician uses little time in tracking down the faulty board and installing a replacement, he may have to run to the distributor frequently for exchange boards so he'll have good ones for the next day's calls. If he runs into two calls on the same day that have trouble in the same board, he will either have to have two boards with him or make a trip to the distributor to pick up one before he can finish repairing the set. That also means two trips to the customer's home, and those trips are costly.

The real advantage in plug-in modular construction is accessibility. The *competent* color technician may save time in the long run by tracking down the faulty part in the first place. If he does, he can unplug the module it is in and replace the part conveniently—without trying to solder in dark, unreachable corners. He may even develop the habit of "pulling the module" to the shop for service rather than lugging in a bulky chassis. A mockup chassis in the shop could speed repairs of the etched-circuit modules. With this kind of arrangement, a home-call technician need not be as highly trained. Only the benchman needs to be versed in circuit theory and the usual transistor-troubleshooting techniques.

Whichever system of servicing wins out after the modular color sets go out of warranty, the module idea is a sure bet to cut servicing costs over the long haul. There are so many ways to get the job done on them on a high-speed basis. The added reliability of transistors and integrated circuits is bound to be of help, too.

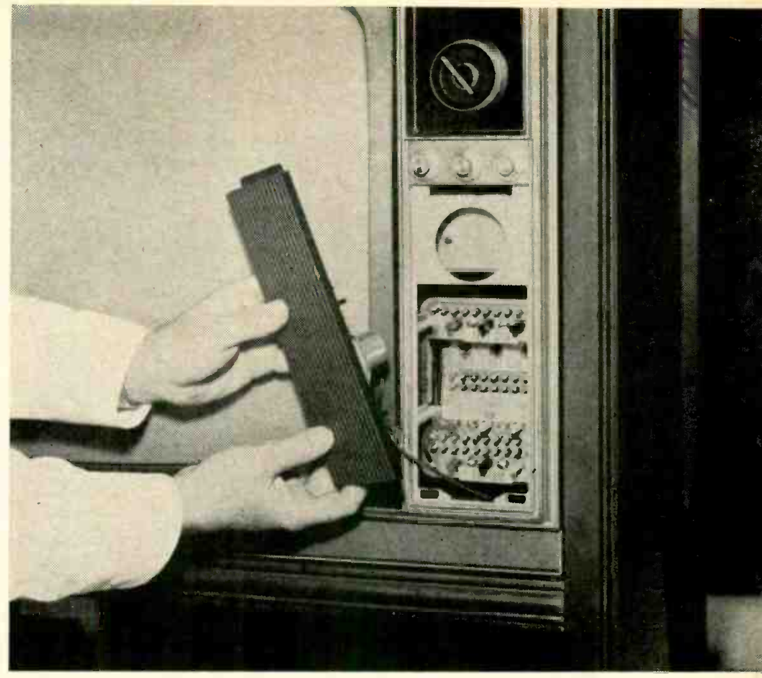
"The Servicing Position"

Manufacturers have taken more steps this season to make home and shop servicing less strenuous and inconvenient. As an example, early color sets were hard to converge—partly because the controls were so unhandy to reach. Then one color-set maker put the controls up front, inside a soap-dish-like recess. This wasn't a good location from an engineering viewpoint, although it was convenient, so the problem was finally licked by making the convergence-control panel detachable; it could be clipped into a convenient position for servicing and put away after adjustments were complete. The most recent arrangement places the convergence panel up front again, but this time on a separate subchassis instead of on the main chassis. You simply remove the speaker panel (with speaker attached, on some sets) and there's the convergence panel in a very convenient location.

In the service shop, there are "servicing positions" for many of the assemblies and subassemblies that accompany a color chassis in its cabinet. These provisions speed servicing by making it more convenient to reach controls and circuits during servicing and troubleshooting. In *RCA* color receivers, the entire tuner mount is a separate assembly that can be fastened in a servicing position, and the panel containing the auxiliary operating controls has its own servicing position. Watch for these innovations in modern color sets; they make servicing easier and safer.

Troubleshooting Charts

To speed up servicing of its solid-state color receiver, *Motorola* put together a small booklet that has charts that point the way to quicker servicing. The chart takes you step-by-step through a series of "yes/no" questions, telling you what tests to make in order to answer the questions listed.



Convergence boards are moving up front. In this Zenith set, just snap the speaker panel out to give access to controls.

The series of charts makes troubleshooting the *Motorola* color set a single operation that requires only minimal training in electronics. The charts take the troubleshooter only as far as which plug-in module holds the fault. It takes a competent transistor-TV technician to proceed any further. And there is the matter of color adjustments after the modular board is replaced; no neophyte can do the thorough job that may be necessary if the set needs a full purity-and-convergence routine.

Be that as it may, troubleshooting charts are handy in any servicing situation, particularly as a training device to teach apprentice color technicians logical troubleshooting. The charts can even be made more elaborate, to carry the technician further down into the circuits and to the exact part. Charts of this nature can be made for any television receiver, and may be a handy tool for home-service technicians. The top technician in the shop can work out the troubleshooting steps and put them into chart form for the novices and apprentices. Just a few of these charts will work for a large number of television models.

Solid-State Troubleshooting

With the advent of the *Motorola* color set, and with all the other brands that are using transistors and integrated circuits in increasing quantities, the successful technician must develop his ability to troubleshoot solid-state devices. Transistors have been around so long that most technicians have learned how to service equipment using them. Integrated circuits are something else.

ELECTRONICS WORLD recently had a two-part article (July and August 1967) that described how to troubleshoot integrated circuits. The functional approach—that is, looking at the integrated circuit as a "block box" that performs certain input-output functions—seems to be the most practical. As you can see from the diagram of Fig. 1, the integrated circuit is presented in this manner on the schematic diagram, being represented by a pair of triangular symbols. Since there is nothing you can repair inside an integrated circuit, your tests have only to reveal whether the defect is inside the IC or in one of the discrete components associated with it. The two triangles in Fig. 1 are a single integrated circuit, the combination sound i.f./discriminator/preamp

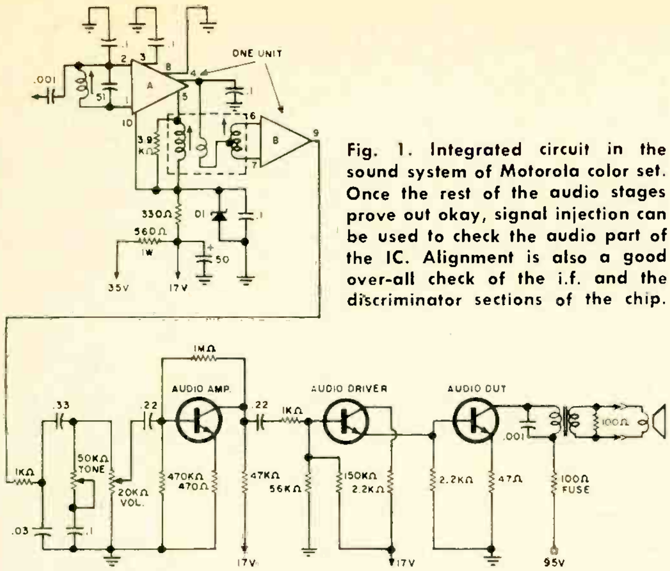


Fig. 1. Integrated circuit in the sound system of Motorola color set. Once the rest of the audio stages prove out okay, signal injection can be used to check the audio part of the IC. Alignment is also a good over-all check of the i.f. and the discriminator sections of the chip.

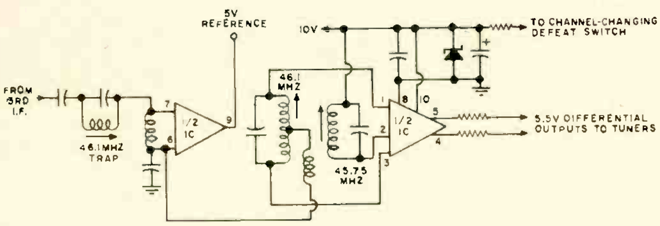


Fig. 2. Integrated circuit in RCA CTC 30 automatic fine tuning. Troubleshooting can be simplified by checking voltages in external circuit and aligning differential detector.

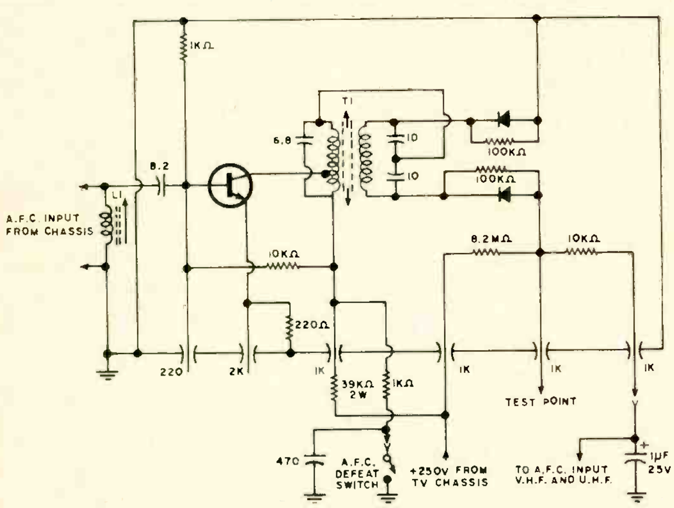


Fig. 3. Uncomplicated Zenith tuner-a.f.c. arrangement. The same troubleshooting and alignment techniques apply to this.

that is becoming popular for television sound systems. The external components consist of capacitors for bypassing (decoupling) and frequency compensation, the discriminator transformer, some power-supply divider resistors, and a zener diode. (One integrated circuit of this type has a built-in voltage regulator.)

Here is how you can test the circuit of Fig. 1. The tests will reveal a faulty IC or trouble in the external circuit. First, check the power-supply voltages at terminals 10 and 5; both should equal the zener breakdown voltage of diode *D*1. If the voltage is low at terminal 5, the primary of the transformer is obviously open. With the audio signal generator, apply a signal to terminal 9, to make sure that the transistor stages that follow are functioning; you should hear the audio note in the speaker. Apply the same signal to terminal 6; it should be louder at the speaker. This last step forces the audio through one of the IC's diodes, but does check the operation of the audio preamps inside the IC.

A modulated 4.5-MHz signal applied from your generator, first at terminal 5 and then between terminals 1 and 2, will produce an audio sound in the speaker; from 1 and 2, the signal is amplified by the IC and should be louder. But, the usual generator signal is amplitude modulated and is no check on how the discriminator is functioning. Instead, feed in an accurate 4.5-MHz *unmodulated* signal (if you don't have a 4.5-MHz crystal oscillator, use the TV station signal). Connect your v.t.v.m. to terminal 9; you should read an approximate 0.7 volt there. With an alignment tool, turn the *secondary* slug of the discriminator coil slightly in either direction. The voltage should change sharply. If the change is quick, turn the slug slightly in the other direction. The change should be quick that way too. Turn the slug back to where you started, using the voltmeter to make sure you end up with the same reading you had at the beginning.

Similar techniques work out well for other integrated circuits. The automatic fine tuning circuit (Fig. 2) in *RCA*'s new CTC 30 chassis uses an integrated circuit. Troubleshooting it is approximately the same as with the one in Fig. 1. The main difference is that the output of the a.f.t. integrated circuit consists of two d.c. voltages instead of an audio output. An easy way to check action of the differential outputs is to connect a v.o.m. between terminals 4 and 5 (past the output resistors is best). The v.o.m. should read exactly zero when a precise 45.75-MHz signal is fed into terminals 6 and 7. Turning the slug in the secondary first one way and then the other should result in sharp changes in differential voltage between the two output leads. Always leave the slug set at zero meter reading. If the circuit action is normal, then go through the regular alignment procedure in the manufacturer's service data.

From these examples you can see that the simplest method of checking out an integrated circuit is indeed the systems, or functional, approach. Just look at the entire stage as an input-output device. Check its supply of power and then apply the normal input and check for the proper output. Usually this technique will reveal trouble in any IC or in any component associated with it.

Aligning A.F.T. Circuits

Since automatic fine tuning is so common in color sets this season, familiarity with adjustment procedures for the systems can save a lot of wasted time when one of them needs realignment.

Take for example, the *Zenith* system in Fig. 3, a system that is very simple. *Zenith* calls its system "tuner a.f.c." instead of a.f.t. Here is how you can align it without any complicated sweep-alignment procedures:

1. Turn the tuner-a.f.c. switch to "off".
2. Tune in a program.
3. Turn the a.f.c. switch back on.
4. Disconnect the a.f.c. output lead (usually white).
5. Connect your v.t.v.m. to the a.f.c. output terminal.
6. Adjust the fine tuning toward the "sound" end of its rotation, until you get maximum negative d.c. voltage.
7. Adjust input coil *L*1 for maximum reading on the v.t.v.m.
8. Switch the v.t.v.m. to read positive d.c. voltage.
9. Turn the fine tuning to the opposite end of its rotation, until you get maximum positive d.c. voltage.
10. Adjust the bottom slug (primary) of discriminator transformer *T*1 for maximum positive d.c. voltage.
11. Disconnect the meter and reconnect the a.f.c. output lead.
12. Turn the a.f.c. switch "off".
13. Fine tune a program as correctly as you can.
14. Turn the a.f.c. switch on again, and notice if there is any pull-in effect. (*Continued on page* 84)

INSIDE THE 1968 COLOR SETS

By FOREST H. BELT

Here are the main innovations in the new models. Transistors and IC's, modular design, new a.f.t. circuits and remote controls, and a 3-gun Chromatron picture tube are some of the items described.

EACH new model year brings a rash of new developments that require service technicians to stay on their toes if they are to do an intelligent job of servicing when the sets develop their share of technical troubles later. In addition, engineers from each company's consumer-electronics division want to know what the competition is doing. Here, rounded up for your convenience, are the chief innovations you'll find in the early 1968 models of color-television receivers.

Although there are many new circuits, and improvements in old ones, the principal news this season lies in four areas: automatic fine tuning (a.f.t.), now available on dozens of models; remote controls, now more sophisticated and certainly more popular on all models than ever before; integrated circuits and transistors, seldom used before in color sets; and the long-talked-about Chromatron, expected in a single-gun version but appearing with three guns. All of these features have received unusual attention in the 1968 line of color sets. Many set-makers have simply improved past circuits, but there are enough new designs to justify special attention to these details.

Automatic Fine Tuning

It isn't easy to decide whether it is a.f.t. or integrated circuits that is attracting the most attention and which will be the more popular among buyers. In any case, we'll begin the discussion with automatic fine tuning systems—those devices which assure the color viewer precise fine tuning at all times.

One of the bugaboos of color has been the difficulty some viewers have in fine-tuning each channel. If the tuner isn't adjusted accurately, the color burst may be lost and the viewer thinks the color circuits in his receiver have quit

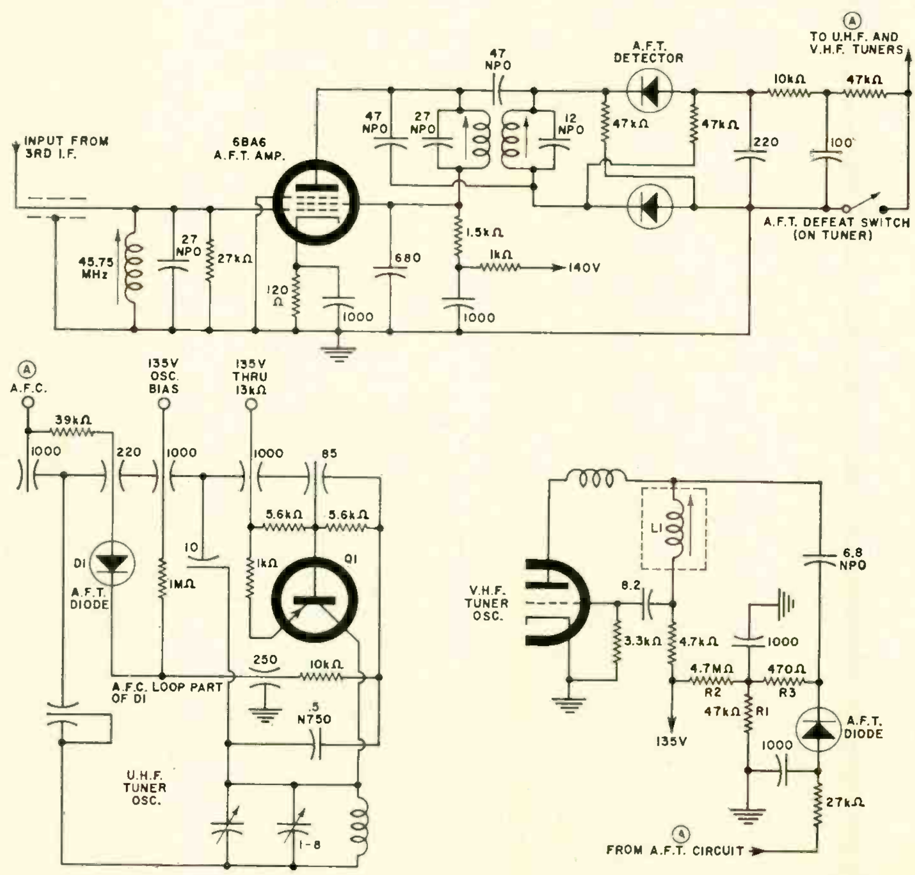


Fig. 1. Magnavox tube-type automatic-fine-tuning control circuit is the forerunner of many solid-state systems that are used in various 1968 color-TV receivers.

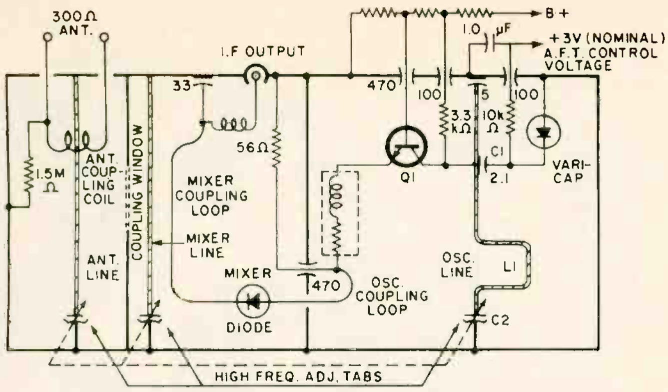


Fig. 2. Zenith transistor u.h.f. tuner with Varicap for automatic frequency control. The bias for the fine-tuning diode comes from the control circuit; it is the discriminator's "resting" voltage.

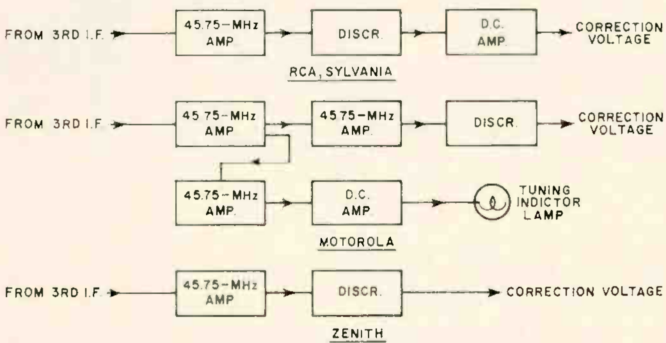


Fig. 3. Block comparison of transistorized a.f.t. control circuits.

working. Manufacturers have tried for years to get technicians to instruct color-set owners properly and have furnished instructive brochures with each set, but the problem has persisted.

A couple of years ago *Magnavox* added an automatic frequency control circuit to one of its chassis and applied the correction voltage to the tuner oscillator. A few other manufacturers soon did the same, but 1968 is the first model year in which automatic fine tuning (as tuner a.f.c. has come to be called) is included in most color-TV receivers. Automatic fine tuning is still confined to the higher priced models because of its extra cost, but most major brands have at least one chassis with a.f.t. included.

The circuit isn't really anything to get excited about, at least in terms of complexity. The system used in *Magnavox* color receivers is shown in Fig. 1, an amplifier tube and a pair of semiconductor diodes. This one is not new, but will serve to introduce you to a.f.t. methods. The input tuned circuit is peaked at 45.75 MHz (the picture i.f.) and receives a healthy signal at this frequency from the third video i.f. of the receiver. The 6BA6 tube amplifies the 45.75-MHz signal and applies it to the discriminator diodes. When the signal from the tuner is exactly at 45.75 MHz, which means the tuner oscillator is right on frequency, there is no output from the discriminator. If the tuner oscillator shifts frequency for any reason, a correction voltage is developed in the discriminator and returned from point *A* to the tuners.

The oscillator portion of both tuners is also shown in Fig. 1, along with the automatic-fine-tuning diodes and their biasing networks. Notice particularly the v.h.f. oscillator. Resistors *R*1 and *R*2 divide the 135-volt supply in a 100:1

SOLID-STATE FOR '68

EVERYONE expected it, but there were plenty of conflicting opinions about when. It shouldn't have been any big surprise, then, when *Motorola* first unveiled its new pride and joy for 1968—an all-solid-state color television receiver (see cover). It had to be a surprise to those who were predicting 1969 or 1970 for a solid-state color set. Nevertheless, here it is, and it is the big news for the 1968 color-TV season.

When the company said solid-state, they meant solid-state. The only tubes in the *Motorola* TS-915 and TS-919 chassis are a high-voltage rectifier and the picture tube. There are 62 transistors, 28 diodes, and one integrated circuit. That's solid-state!

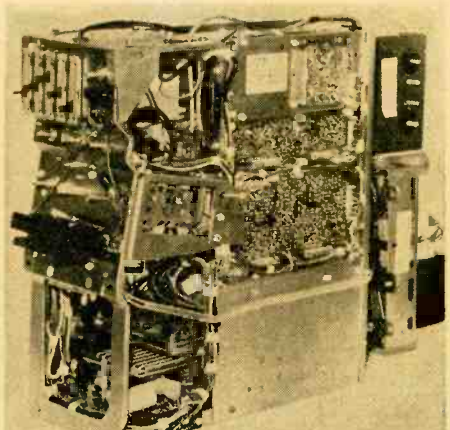
Motorola really fired its big guns with the solid-state model. The fact that it is solid-state is only part of the news. For one thing, it is the first TV chassis of any kind to use plug-in modular construction throughout. Ten etched-circuit boards plug into the main chassis. Even the power-supply section can be removed from the rest of the chassis, which serves mostly for interconnection and for mounting transformers and other heavy parts.

Something else new is the sliding potentiometers used for the volume, brightness, contrast, intensity (color), and hue controls. Similar in construction and operation to those used in modern broadcast-station control consoles, they are provided with number scales for resetting to previous adjustments.

A round control marked "Tint" may be misleading, since this label is used for the color-phase control in some color sets. In the *Motorola* it is a shading control that affects gray scale; the color-phase control is labeled "Hue". The "on-off" switch is a push-button in the upper right-hand corner.

Practically all modern color sets use transistor u.h.f. tuners, but not many use transistor v.h.f. tuners; the *Motorola* uses transistors in both. The u.h.f. tuner, in addition, is a slide-rule type that is push-button controlled, very much like in a car radio (the manner of setting the push-buttons is the same, too). With a.f.t., the push-button u.h.f. tuner is quite practical.

Motorola's new solid-state color television chassis is packed together so it could fit into a large briefcase. Ten etched circuit boards plug into the main chassis. They are easy to remove for replacement or for conventional testing and repair.



Some of *Motorola's* new circuits may be unfamiliar. For example, following the video detector is a transistor called the *video detector output amplifier*. This emitter-follower provides power gain to drive the low-impedance first video and first color amplifiers.

Three diode pairs are used in the color demodulator circuit. The delayed Y signal is fed to all of them from the second video amp, in parallel with the chroma signal from the second color i.f. amp (*Motorola's* name for the bandpass amplifier). The 3.58-MHz reference c.w. signal is fed directly to the green demodulator, is shifted −90° for the blue demodulator by a coil and +90° for the red demodulator by a capacitor. After demodulation, each color is fed through two stages of transistor amplification to the cathodes of the picture tube.

An *automatic brightness limiter* (a.b.l.) circuit controls beam current in the picture tube. Focus voltage varies with beam current in this chassis, and its changes are sensed by a control transistor and developed into an emitter bias for all three video driver transistors. The driver and output transistors are d.c.-coupled to the picture-tube cathodes so their conduction controls picture-tube conduction. The a.b.l. circuit also protects the horizontal output transistors in a roundabout way: It keeps the beam current from overloading the high-voltage and flyback circuit which would overload the transistors.

Solid-State Prototypes

Within a week of the *Motorola* solid-state debut, Sony made public its prototype of an ratio. The 1.35 volts is applied to the cathode of the a.f.t. diode by $R3$. The a.f.t. diode is a varactor—a voltage-dependent capacitor—acting in series with the 6.8-pF NPO capacitor across channel-tuning coil $L1$. The correction voltage from point A in the a.f.t. circuit is applied through the 27-k resistor to the anode of the a.f.t. diode. As you can see, the capacitance of the varactor is determined by the difference between the reference, or bias, voltage from $R3$ and the correction voltage from the a.f.t. discriminator.

Normally, the correction voltage is zero volts. The voltage across the varactor diode is 1.35 V. Suppose the tuner oscillator drifts lower. The i.f. is lowered and a slight negative correction voltage appears at point A, say −0.8 volt. This negative voltage, being on the anode of the diode, makes the difference across the diode rise to 2.15 volts. Capacitance is reduced, the frequency of the oscillator is raised, and the i.f. is raised to normal. An upward shift in oscillator frequency produces a positive correction voltage that reduces the voltage across the diode. Capacitance increases and oscillator frequency is lowered to normal. The a.f.t. correction voltage is also applied to the u.h.f. tuner, so it will control that oscillator.

The u.h.f. tuners in almost all color receivers are now transistor types. Another typical one is shown in Fig. 2, a *Zenith* u.h.f. tuner with a.f.t. The varactor diode (Varicap) in this particular tuner is biased by the "resting" voltage from the a.f.t. control circuit. Shifts in oscillator frequency change the i.f. and are detected by a discriminator, as in all a.f.t. systems. The output voltage of the discriminator raises or lowers the 3-volt nominal output, according to the oscillator shift. The Varicap is a part of a tuned circuit formed by $C1$, $L1$, and $C2$. Its capacitance varies with

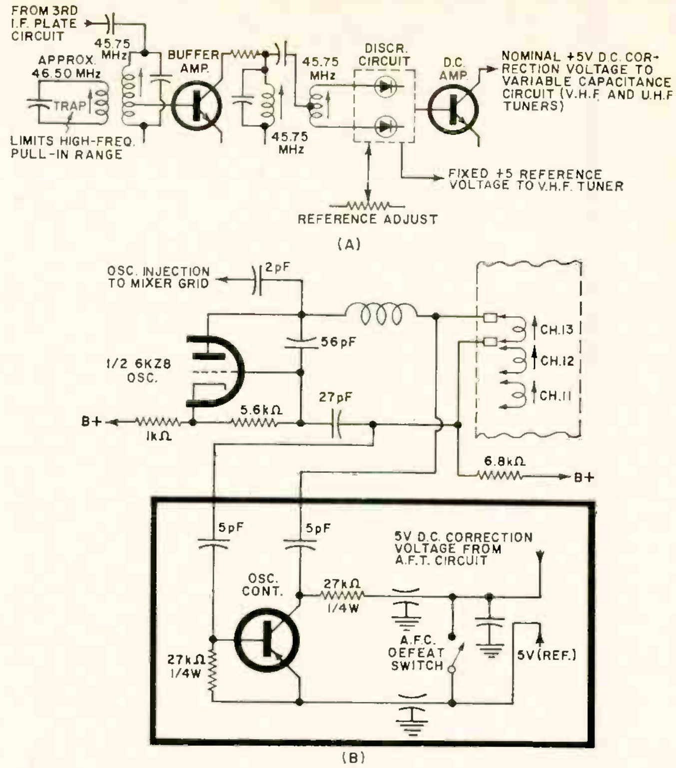


Fig. 4. Simplified layout showing how the oscillator-control transistor fine-tunes RCA sets. Correction voltage can be the type shown, or can be two voltages from differential amplifier.

all-solid-state color set using a special three-gun Chromatron picture tube. (More about this receiver on page 45.) Within a month, two other prototype solid-state color receivers have been unveiled, one by *Fairchild Semiconductor* and another by *Texas Instruments*. Both companies built their display sets as a means of demonstrating to the industry the feasibility of solid-state color receivers. Thanks to *Motorola*, feasibility was already proven.

Nevertheless, there were some interesting innovations in the *Fairchild* and *TI* demonstration sets. The *Texas Instruments* receiver used tubes in some circuits, special new *TI* transistors in others, and one *TI* thick-film integrated circuit. The bipolar transistor v.h.f. tuner and i.f. strip achieved high gain with a very low noise figure and freedom from cross-modulation. This design seems well suited to fringe-area reception. The a.g.c. circuit used planar silicon transistors and a special sync separator used an epitaxial type. The HC 1001 hybrid (thick-film) integrated circuit served as sound i.f. amplifier, FM detector, and two-stage audio preamp; it was followed by a TIP27 audio output transistor.

The *Fairchild* color receiver used semiconductors throughout the video i.f., sound system, and chroma section. The sound system used a μA717 integrated circuit and the chroma section a μA703E IC. Both IC's are monolithic types. The use of transistors in the color demodulator arrangement was so efficient that only one additional stage of *R*,*G*, and *B* amplification was needed to drive a 19EYP22 picture tube. The entire solid-state section of the *Fairchild* color receiver seemed surprisingly uncomplicated—a feeling duplicated when you examine a full schematic of the *TI* prototype or of the *Motorola* solid-state set.

More Solid-State Parts Coming

The difficult sections in solid-state TV sets of any kind are still the deflection and high-voltage stages. All the semiconductor manufacturers are working toward more dependable high-voltage, high-current devices. One manufacturer, *Amperex*, has developed a horizontal output transistor that can work in a circuit (also of *Amperex* design) without a damper diode. The same company has a vertical output transistor, and a solid-state high-voltage rectifier that will work at up to 27 kV—plenty for color-TV. About all that remains now is for someone to develop a solid-state color picture tube.

A lot of talk has gone around about a tuner that does away with bulky ganged switches and drums presently used. *Telefunken* has a prototype u.h.f.-v.h.f. tuner that uses special varactor diodes to tune the TV bands, and a set of switching diodes to change from v.h.f. to u.h.f. The entire u.h.f. and v.h.f. bands can be tuned with less than a dozen push-buttons and a ganged potentiometer (for fine tuning).

There is heavy emphasis in 1968 on integrated circuits. Most of the leaders are concentrating on monolithic types. Companies include *Amperex*, *Fairchild Semiconductor*, *General Electric*, *Motorola*, *Philco-Ford*, *RCA*, and *Westinghouse*. *Texas Instruments* is also working heavily on hybrid types—they feel thick-film modules are a faster way to inexpensive, consumer-type integrated circuits. All will be announcing new circuits for color-TV regularly.

The next big step in color television is undoubtedly an all-IC receiver. Who will come up with *that*? And how soon?

After the manufacturers get this set in production some time in the future, we can expect to see concentrated work on a solid-state color picture tube. Quite a bit of work is now going on in the laboratories to develop solid-state monochrome display devices. Most of these have been for military use, particularly in locations where there is very limited space, as in aircraft or space vehicles. Problems so far have included insufficient brightness and inadequate resolution. Once these problems have been solved, a full-color display would be the next step. So, our color set of the future may be a large flat panel, with built-in IC's, that can be hung on the wall like a picture.

Front panel of new Motorola solid-state set. Slider-type controls are a major feature, but push-button u.h.f. tuning is something new, too. The latter wouldn't be possible without automatic frequency control in transistorized u.h.f. tuner.

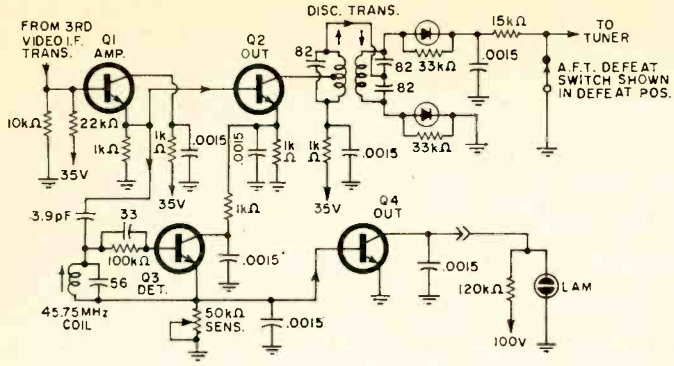


Fig. 5. Motorola automatic tuning system, named "Fine-Tuning Lock".

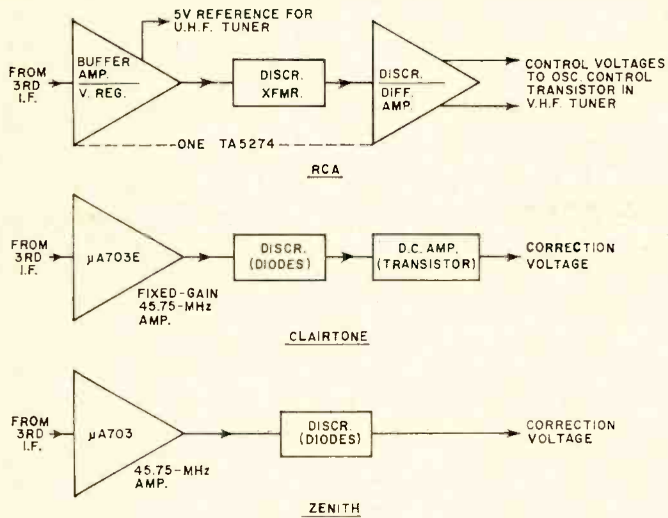


Fig. 6. Integrated circuits in color-set a.f.t. control circuits.

a.f.t. voltage and thus controls frequency in the transistor oscillator.

The *Zenith* a.f.t. control circuit is typical of several in this year's color receivers. *General Electric, Motorola, RCA,* and *Sylvania* all have transistor a.f.t. control circuits. They vary in the way they do the job, but are essentially the same in intent and purpose.

Fig. 3 shows block diagrams of the four mentioned, from which you can see the principal differences. The *Motorola* represents the main departure among transistor systems, because of its tuning indicator. The *RCA* system is interesting because it uses the junction capacitance of a transistor for frequency control in the v.h.f. tuner instead of a varactor.

The simplified diagram in Fig. 4A shows the important operating parts of the *RCA* system used in the CTC-28 chassis. The a.f.t. control circuit uses a d.c. amplifier following the discriminator. The important difference is in the KRK-131 v.h.f. tuner (Fig. 4B) which has a new way of controlling oscillator frequency (the *RCA* u.h.f. tuner this year uses a regular Varicap diode). In series across the v.h.f. oscillator tuning coil are two 5-pF capacitors and the base-collector junction of the *p-n-p* transistor. It is the capacitance of that junction which is varied by the correction voltage from the d.c. amplifier in the a.f.t. control system.

The emitter of the oscillator-control transistor in the tuner is held at 5 volts by a reference voltage from the a.f.t. discriminator circuit. The correction voltage at the collector of the d.c. amplifier is also 5 volts, when the oscillator is exactly on frequency and the i.f. is correct.

When oscillator frequency shifts, the correction voltage rises or falls. If it rises, caused by a downward oscillator shift, the collector of the oscillator-control transistor becomes more positive—the wrong condition for a *p-n-p* transistor. The control transistor is effectively backward-biased and its junction capacitance is lower. Less capacitance in the oscillator tuned circuit makes the frequency go back up to normal. The a.f.t.-defeat switch shorts the correction line to the reference line, thus holding the control transistor at a fixed zero bias. In that condition, the set's regular fine-tuning knob has control of the oscillator frequency.

The *Motorola* a.f.t. system is called "Fine-Tuning Lock" (FTL) and includes an indicator (FTI) to show the viewer when fine tuning needs manual adjustment. Many *Motorola* sets not equipped with the a.f.t. system have the indicator anyway, to aid manual tuning. The combined system is shown in Fig. 5. You already saw in Fig. 3 how the two sections interrelate, but a little more detail is in order, particularly since the *Motorola* system controls a transistor v.h.f. tuner.

The input, as usual, is from the third i.f. amplifier. The emitter follower, *Q*1, feeds the signal to both a driver transistor, *Q*2, and a tuning-indicator detector transistor, *Q*3. For a.f.t. action, *Q*2 drives the discriminator, which is adjusted for a center frequency of 45.75 MHz—the correct picture i.f. If the oscillator drifts, an incorrect i.f. is produced and the discriminator develops a correcting voltage to send to the tuner.

Meanwhile, a high-"*Q*" tuned circuit in the base-emitter circuit of *Q*3, peaked at 45.75 MHz, couples the correct i.f. signal to *Q*3 very efficiently. If the i.f. signal isn't exactly 45.75 MHz, the signal fed to *Q*3 is cut down drastically. The base-emitter junction rectifies the correct signal and feeds a strong biasing d.c. voltage to the base of *Q*4. That transistor, heavily forward-biased, acts as a short across the lamp and prevents it from glowing. If the i.f. shifts, because the oscillator is no longer held at correct frequency by the a.f.t. control circuit, less of the signal is available to be rectified by *Q*3. The bias on *Q*4 is reduced and the short is removed from the lamp. Its glow is a sign to the viewer that the set needs to be fine-tuned. Since the a.f.t. pull-in range is fairly narrow, as most are, the receiver has to be fine-tuned manually to almost the correct frequency. The indicator helps.

Newest among the a.f.t. circuits, and most advanced as far as industry technology is concerned, are the integrated-circuit systems. Basically, they are IC adaptations of designs already shown. Fig. 6 shows them in block form. The *Clairtone* uses a d.c. amplifier to gain a wider range of control voltage. The *RCA* system has one major variation: It uses a differential d.c. amplifier at the output and thus comes up with two correction voltages.

You can understand the two-output system a little easier if you refer back to Fig. 4. Notice that there are two points for feeding voltage to the oscillator-control transistor. One is labeled "Ref.". In the single-ended control system already described, a fixed voltage is applied at the reference input. The bias for the transistor is determined by which direction and how far the control voltage (the other input) varies from the 5 volts nominal. Thus, it is the *difference* between the two that really controls the oscillator frequency. The two outputs of the differential amplifier are at the same potential when the a.f.t. system senses that the oscillator is on-frequency. When the frequency drifts, the a.f.t. system develops—*via* the differential amplifier—a pair of voltages whose difference and relative polarity depend on the amount and direction of frequency shift. The result is a system that is even more sensitive to changes than the single-ended system, and which will pull the tuning back on-frequency over a wider range of error.

There are other a.f.t. systems, but those shown are representative of what you will encounter in the 1968 line of color sets. You will, however, run into a few receivers besides *Motorola* that have tuning indicators of one kind or another. These include *Andrea, General Electric, Philco,* and *Setchell Carlson.* Tuning indicators are not new with these brands, but they are one of the 1968 features that are making it easier for the viewer to obtain a good color picture.

(Editor's Note: In one color receiver, made by Westinghouse, *the picture tube is used as a tuning indicator. Two vertical bars appear on the screen when the set is mistuned. The user simply manually fine-tunes the receiver until the two bars coincide, then depresses a switch to remove the bars. For details, see p. 68 of last month's issue.)*

Remote Controls for Color

The general method of remotely controlling color-TV receivers is much the same as has been used for years with black-and-white. A series of tones are produced by a hand-held transmitter which contains a battery-operated ultrasonic oscillator. Buttons on the transmitter select the tone to be sent *via* the transmitter's transducer. In the remote-controlled TV set, a microphone picks up the tones and feeds them to a special receiver that amplifies them and applies them to a selective group of tuned circuits. The tuned circuit that is resonant to the particular tone being transmitted applies the tone signal to a transistor detector, which in turn operates a relay; this, in turn, activates the control function.

As a quick example: The viewer pushes the button marked "Color Up" on the transmitter. If the system is an *RCA*, a 44.75-kHz tone is transmitted (see Table 1 for the tones in various systems). The receiver microphone picks up the tone and sends it to an amplifier. It is then fed to all the tuned circuits, but only the 44.75-kHz tuned circuit can pass this particular tone on to its detector transistor. The transistor activates a relay, which connects power to the *clockwise* lead of the color-control motor. The color control is turned up.

Color receivers need more elaborate remote-control systems than black-and-white receivers do, because hue and color saturation are extra controls to be turned. The most elaborate system this season, and the most advanced technologically, is the *RCA* 8-function system. Since it is the most elaborate unit, an explanation of its operation will apply to most other systems.

The remote-control chassis employs an integrated-circuit preamp. The microphone picks up whatever tone is sent by the transmitter. The preamp builds it up and it is fed to the tuned selector circuits. All eight tuned circuits are in parallel, so any tone is fed to all of them. Only one tuned circuit is resonant to any one tone, however, so only one of the eight detector transistors receives the tone. The d.c. output of that detector transistor is filtered by a 10-μF electrolytic capacitor and fed to the relay, which then actuates the appropriate control motor in the TV set.

	Admiral 6-tone	Motorola 3-tone	RCA 7-tone	RCA 8-tone	Sylvania 7-tone	Zenith 4-tone
Volume "Up"	42.5	41.5	43.25	43.25	37.25	37.75
Volume "Down"	42.5	40.0*	38.75	38.75	38.75	38.75**
Color "Up"	41.0	—	44.75	44.75	43.25	—
Color "Down"	39.5	—	37.25	37.25	40.25	—
Tint Red (CCW)	36.5	38.5*	35.75	35.75	44.75	40.25**
Tint Green (CW)	38.0	41.5*	34.25	34.25	35.75	41.25**
V.H.F. Channel	35.0	38.5	40.25	40.25	41.25	41.25(up)
U.H.F. Channel	—	—	—	41.75	—	40.25(down)

*40.0 mutes sound and activates hue controls. **38.75 mutes sound and activates hue controls in place of channel change.

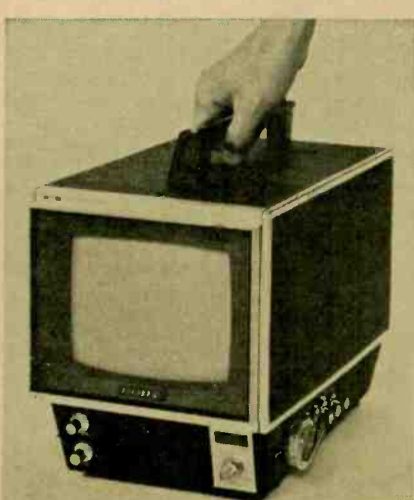
Table 1. Listing of remote-control tones (frequencies in kHz).

For a remote-control system like the *RCA*, several special motors are needed. The volume control, which also contains the "on-off" switch, is driven by a two-directional motor. So are the tint control and the color control. The v.h.f.-channel selector is operated by a unidirectional motor, as is the u.h.f.-channel selector on this particular model (which has a detented u.h.f. tuner). This model is the only one that uses a driving motor for the u.h.f. tuner.

One less function is needed by the 7-tone *RCA* and *Sylvania* systems, since no u.h.f. motor is used. You can figure this out from Table 1. Both systems use preamps with several transistors and a detector transistor for each tone.

The *Admiral* 6-tone system is (*Continued on page* 72)

"CHROMATRON-ic" SURPRISE



Only 8 x 10 x 13 inches in size, this 7-in picture tube Sony color set is solid-state and produces very bright color picture.

FOR many months in Japan there has been talk of a solid-state color receiver for the U.S. market. American engineers had kicked the idea around and decided there was a strong possibility it would use either the Colornetron picture tube that had already been introduced in a 9-inch color set in Japan, or the Chromatron, a single-gun version of the Lawrence tube, which *Fairchild Semiconductor* had already built into a transistorized prototype. Instead, when the Japanese prototype was introduced a few months ago, it turned out to be an all-transistor model built around a three-gun version of the Chromatron.

If you remember your Chromatron theory, you know that the Chromatron does away with the shadow mask and dotted phosphor, and depends instead on vertical stripes of colored phosphor. The beam that sweeps back and forth across them is sequentially switched so that only *R* color information gets to the red stripes, *G* to the green stripes, and *B* to the blue. This arrangement eliminates convergence circuitry, the shadow mask which requires frequent degaussing, and the need for three separate beams.

The Chromatron used in the new *Sony* color receiver has three color guns, but uses them to form one beam. That beam is switched at a 3.58-MHz rate which offsets it just at the moment it crosses each stripe, so that the beam strikes and activates only the colors contained in the chroma signal. There is greater light output from the Chromatron phosphors, at least double the output from typical shadow-mask phosphors. Beam efficiency is claimed to be 80% compared with 15% for the shadow-mask tube (recent new phosphors in American tubes may have slightly higher efficiencies).

We saw the *Sony* color-receiver prototype in operation. The picture was indeed bright and in colors that were very true even though the set was displayed in a room that was bright with fluorescent lighting. If the Chromatron picture has a slight bluish tinge, it could be blamed on the color temperature of the room lighting.

As far as the viewer is concerned, operation is the same as a shadow-mask set. There are only two color controls—hue and saturation. In all other respects, the little set looks and acts just as any 7-inch portable color receiver would (the smallest U.S. set is G-E's 11-inch model).

Medical Instrumentation Systems

By JOSEPH H. WUJEK, Jr.

Intensive-care monitoring unit permits continuous monitoring of patients' blood pressure, respiration, electrocardiograms, and electroencephalograms.

How electronics is helping medicine in the areas of diagnosis and patient monitoring, in therapeutic systems, and for important biomedical research.

THE birth of medical electronics may be said to have occurred before the birth of electronics itself—for in 1895 Roentgen discovered x-rays, predating by more than ten years DeForest's invention of the triode vacuum tube. In the intervening years, medical electronics has tended to lag behind developments in other areas of electronics. But the last decade has seen a closing of the gap between electronics instrumentation in general and the application of these systems to the medical art. In this article we'll take a look at some of the instrumentation systems presently finding application in medicine—systems which have long existed in industrial practice but whose use in medicine has been more recent, as well as systems developed expressly for medical research.

Table 1. Peak heart rates of astronauts during launch, reentry. Compare these with the normal adult rates of about 70 beats/min.

GEMINI MISSION	PEAKS RATES DURING LAUNCH (beats/min)	PEAKS RATES DURING REENTRY (beats/min)
3	152 120	165 130
4	148 128	140 125
5	148 155	170 178
6-A	125 150	125 140
7	152 125	180 134
8	138 120	130 90
9-A	142 120	160 126
10	120 125	110 90
11	166 154	120 117
12	136 110	142 137

Normal rates about 70 beats/min.
Data courtesy NASA Manned Space Flight Center, Houston.

We can begin by classifying these instruments in three general categories. Some areas overlap, but they furnish broad guidelines in helping us understand the principal function of the instrument system. These categories are: 1. diagnostic/patient monitoring systems; 2. therapeutic systems; and 3. biomedical research systems.

Diagnostic/Patient-Monitoring Systems

As the name implies, diagnostic systems are those systems which assist the doctor in diagnosing or determining the nature of the patient's ailment. The x-ray is a familiar example of a diagnostic tool, enabling the physician to observe bone fractures, ulcers, ingested foreign bodies, and the like.

Perhaps less well known is the electrocardiograph (ECG or EKG) for heart-signal measurements and the electroencephalograph (EEG) for signals produced by the brain. These systems are basically low-noise, high-gain amplifiers with read-out *via* strip-chart recorder and/or oscilloscope. Signals are derived from electrodes attached to the patient by a conductive paste or as is sometimes the case with the EEG, by needle-like electrodes implanted in the scalp.

The resultant signals picked up by the brain electrodes are on the order of 10 to 100 μV on the surface of the scalp and about 50 to 100 μV on the surface of the brain. Heart signals may have somewhat greater amplitude. High amplifier gain and low noise are important. Equally important is the means for rejecting *common-mode* signals, that is, signals which appear in-phase on *both* signal lines simultaneously. A *differential amplifier* is generally used for the input stage, amplifying the *algebraic difference* of signals as they appear on the input lines. Bandwidth requirements are not severe although low-frequency response should be good. Generally speaking, a passband of from d.c. or a fraction of one hertz to several kilohertz is adequate for research instruments while many clinical instruments do not cover frequencies much beyond 40 to 60 Hz.

The records obtained by ECG and EEG furnish the medical analyst with a means of comparing the patient's response to that of a known healthy specimen. These systems are capable of detecting a wide variety of heart or brain disorders which cannot be detected by other means.

We are all familiar with the bulb and arm-band method used by physicians in recording blood pressure. In some cases this method is being superseded by electronic techniques. For long-term monitoring of blood pressure, as during surgery or in an intensive-care unit, a small transducer may be implanted in the patient. The transducer output is then amplified and displayed on an oscilloscope or strip-chart recorder. Similar probes can be attached to the patient to monitor pulse and respiration rate, while a temperature probe can be used to measure body temperature. This data is then transmitted to a central console where a nurse can oversee the condition of several patients simultaneously. The central console may also incorporate a warning system so that if any of the patient's parameters go beyond preset limits an alarm is activated. While rather impersonal as compared to the bedside nurse used in intensive-care cases, the system allows closer monitoring of the patient's condition than was possible with traditional techniques. The system also permits better utilization of manpower, since one attendant may monitor the needs of several patients, depending on the seriousness of the particular patient's condition.

An important application of patient monitoring occurs each time a manned space flight mission is carried out. By means of a telemetry link, the important physiological parameters of the astronauts are monitored by an aerospace medical team. The data thus acquired is at least as important as the engineering and scientific data gathered on these missions. Clearly, there would be no future in having space systems capable of lifting a man to the moon if the occupants of the spacecraft could not survive the physical rigors of the journey. Table 1 gives the results of monitoring the heart rates of the astronauts during each of the Gemini missions, 3 to 12.

Therapeutic Systems

The x-ray machine, in addition to its use as a diagnostic tool, is also useful in therapy. In particular, the x-ray is used in the treatment of malignancies, although radioactive sources have taken the place of, or supplemented, x-ray therapy in many institutions. But x-ray therapy remains an important technique in medicine.

The diathermy machine has long been used by physicians to apply heat deep within the body. The instrument is basically an r.f. power oscillator which can be directed to focus its energy over a relatively small area. The resultant heating of the area often proves beneficial in the treatment of certain physical afflictions.

The ultrasonic machine is used to provide rapid massage of muscle strains and similar injuries. A frequency, above the audio range but well below the r.f. region, is applied to a transducer which then couples sound (sonic) energy to a liquid medium or directly to the patient. These systems are, in principle, not unlike the industrial ultrasonic cleaner. By observing differences in reflectivity of sonic energy from tissues, other types of ultrasonic machines function as diagnostic systems. The principle is similar to sonar.

Biomedical Research Systems

In this category we include electronic instruments commonly used in the field of medical and biological research as well as instruments used in clinical laboratories.

Two electrodes are attached to scalp of astronaut Frank Borman to permit NASA Medical officers to monitor his alertness during the flight.

Perhaps the most widely used instruments in this category are the *pH* meter, the titrator, and the blood-cell counter. The *pH* meter measures the relative acidity or base properties of body fluids. The solution to be tested has electrodes placed within it and then the solution under test is compared with a known (reference) solution. Different types of *pH* meters exist, but most compare current flow in the sample with that of the reference.

The electronic titrator is used to prepare a solution of given *pH*. The titrator is similar in principle to the *pH* meter, except that the information obtained is used to open and close valves to add either acid or base to the solution.

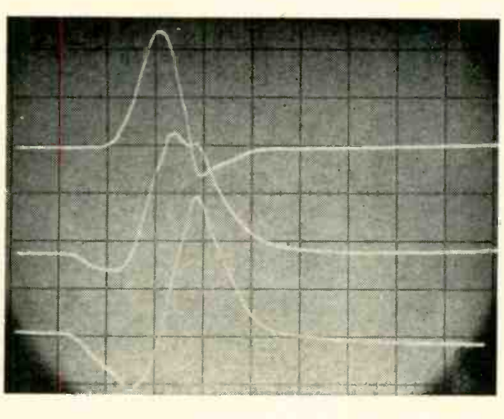
The electronic cell counter is used to determine the number of red or white cells in a blood sample. The most common type of cell counter employs a light source and a photomultiplier tube. The light is filtered, focused, and then passed through the blood sample. The amount of light which passes through the sample and reaches the photomultiplier tube is inversely proportional to the cell concentration. The instrument is calibrated by placing a sample of known cell concentration in the light path.

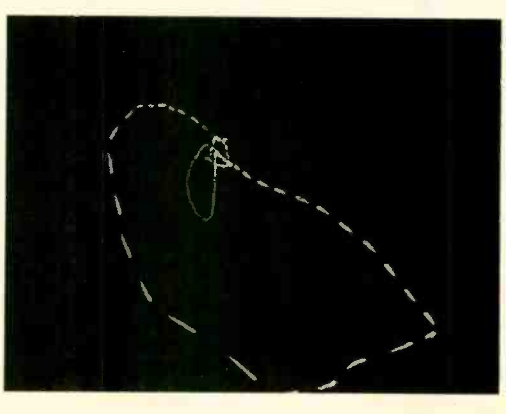
Several other systems should be mentioned although not clearly belonging to any of the general categories.

A dramatic development in recent years is the heart stimulator which consists of a low-frequency pulse oscillator that supplies stimulus to the heart muscles, causing contractions, and hence pumping, of the heart. This device has already proven itself as a lifesaver, and with future refinements will undoubtedly find ever-increasing application.

Related to the heart stimulator are the systems used to bypass various organs during surgery or to periodically serve in place of diseased or removed organs. For example, the mechanical heart is used during open-heart surgery to replace the patient's heart. The artificial kidney is called upon to perform the kidney's function, with the patient reporting to the hospital periodically for this service. While these machines are basically mechanical in nature, they have an electronic feedback control system. The control unit keeps fluid pressures, temperatures, flow rates, and other system parameters within preset limits. In this manner the electronic system functions as the "nervous system" while the mechanical parts act as the muscles and tissues.

Of great use to medical researchers are the so-called models of biological systems. These are mathematical in nature and employ both analog and digital computers. By devising a model of a particular (*Continued on page* 86)



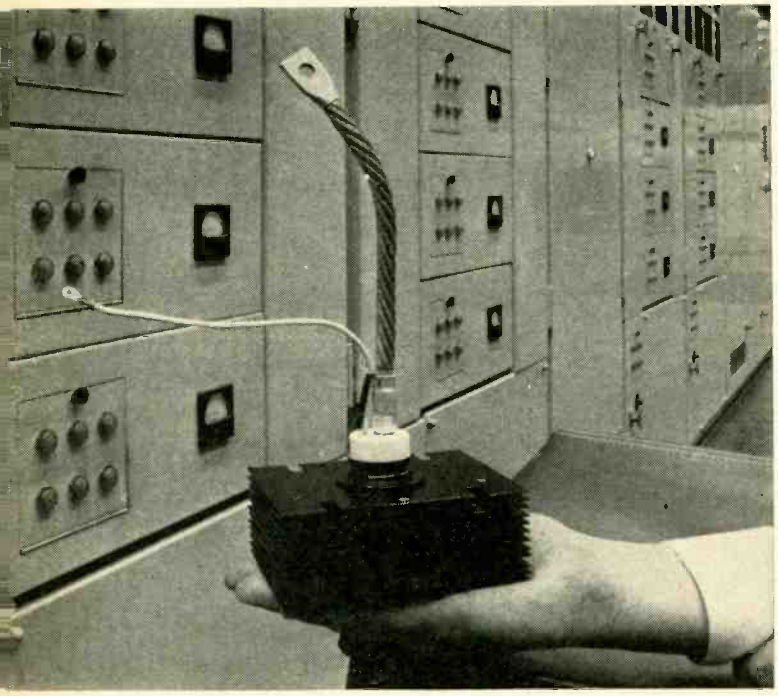


The three main components of the electrocardiogram signal are shown separately in these two displays in order to enhance the amount of information obtainable. At the left is single-plane vs time portrayal of the three components while in the display at the right the three components produce closed-loop patterns that appear to be at right angles to each other, generating a three-dimensional-like pattern.

HIGH-VOLTAGE, HIGH-POWER SEMICONDUCTORS

By JOSEPH H. WUJEK, Jr.

Description of some of the new solid-state devices having breakdown voltages above 100 volts with power ratings in tens of watts; current ratings in excess of tens of amps.



This high-powered SCR is one of many used to control speed of the rollers in a large steel rolling mill.

OVER the past decade we have experienced an enormous increase in the use of transistors for military, industrial, and consumer electronics. In addition to the popular broadcast-band transistor radio, we find transistors and, recently, integrated circuits being used in hi-fi, television receivers, and communications systems. But it is only within the past few years that high-voltage high-power semiconductors have become available for these systems. Largely due to economic considerations and partly to technological limitations, these devices were not widely used.

More recently, however, significant improvements in the area of high-voltage and/or high-power semiconductor technology have been achieved, while maintaining low cost as an objective. This article will describe some of these new devices and cite examples of applications. For our purposes, "high voltage" means devices having breakdown voltages above 100 volts, while "high power" will mean those devices capable of dissipating at least tens of watts and/or having current ratings in excess of tens of amperes. Many devices will satisfy all of these requirements.

The State of the Art

Rectifiers: By paralleling units between heat-sink plates, the current-carrying capability of silicon rectifiers can be increased substantially over single-unit operation. Some of these assemblies also use water cooling to improve heat transfer efficiency.

The *Motorola* MR 1290-1297 series are water-cooled assemblies capable of 1000-ampere continuous currents, with peak, non-repetitive surge current ratings of 18,000 amps, (½ cycle at 60 Hz). These units are available with d.c. blocking voltage ratings of up to 400 volts. With adequate cooling, these devices can be operated at up to 1500 amps continuous current. At 1000 amperes the forward voltage drop (case temperature of 150°C) is specified at 0.4 volt maximum.

Among single-chip rectifiers, the *General Electric* A296 series is typical of available high-current devices. With an average current rating of 500 amps and peak reverse voltage up to 1800 volts, these rectifiers find widespread use in industrial systems.

An example of what can be done by way of packaging is the h.v. assembly by *Microsemiconductor Corp.* A voltage multiplier is constructed by connecting capacitors and high-voltage diodes together in a ladder-like configuration and driving the input with an a.c. signal. Assemblies furnishing an output voltage of several tens of kilovolts have been fabricated by this method.

Transistors: Much of the development work in transistor technology has been directed to the production of h.v. transistors at low cost. The market potential for transistors for TV receiver high-voltage generation is providing much of the impetus for this work.

The *M.S. Transistor Corp.* recently announced a series of silicon diffused-junction devices having breakdown voltages as high as 1000 volts. Leakage currents at these voltage levels are on the order of 200 μA. *Microsemiconductor* has published tentative specifications on a similar device. Costs of these devices are presently in the tens of dollars (in quantities less than 1000) but can be expected to decrease as market volume increases.

In high-current transistors, *Silicon Transistor Corp.* has developed a diffused-junction *n-p-n* device rated at 150 amps collector current. Saturation voltage is specified at 1.5 volts for a collector current of 100 amps with a base current of 15 amps. These units are available with breakdown voltages of up to 150 volts. With heat-sinking maintaining the case at 100°C, up to 300 watts can be dissipated. A minimum *beta* of 10 at a collector current of 100 A is specified.

Westinghouse has developed a silicon transistor rated at 250 amperes and 625 watts for a 75°C case temperature. With a collector voltage rating of 120 volts and a gain-bandwidth product of 1 MHz, the device should be useful for sub-microsecond switching and power amplification.

Motorola is supplying a 150-ampere switch composed of three *p-n-p* germanium transistors, packaged on a heat-sink assembly. The unit is optionally available in an epoxy encapsulant. The three transistors are chosen for good characteristics matching and connected in parallel on the heat sink. At the rated maximum collector current of 150 amperes and a base current of 15 amps, the $V_{CE(sat)}$ is only 0.30 volt maximum. Breakdown voltage (V_{CEO}) of up to 75 volts may be had.

In addition to the transistors and firms already mentioned, *RCA*, *Delco*, *Bendix*, and others can supply transistors with collector current ratings in the tens of amperes range. In general, the higher the current rating, the slower the device switching time and the narrower the gain-bandwidth product. This result is due to the longer base-emitter region required of high-current devices and the general increase in size of the transistor chip. This increase in size yields higher capacitance in the junction and longer carrier lifetimes, hence an inherently slower device.

SCR's: The past few years have witnessed important developments in silicon controlled rectifiers. In particular, cost of these devices has dropped steadily, while current-carrying capabilities have been extended. The lower costs mean that we can expect to see more SCR's designed into consumer products as well as in industrial systems. In addition to the already familiar use of SCR's as motor-speed controls and lamp dimmers, SCR's are, or will be, used in electric ranges, dishwashers, clothes dryers, washing machines, and furnace temperature controls.

In some cases the use of SCR's will permit continuous control, rather than the discrete switched control now widely used. A case in point is the electric range, where normally only 4 or 5 heat ranges are available. Use of SCR's will permit any setting between zero and very nearly 100% of line voltage to be applied to the heating element. The oven control can also regulate to closer limits, allowing more precise temperature control. And because the mechanical switching of high currents is eliminated, appliances should have a longer useful life.

In high-current SCR's, *General Electric* is supplying the industry with an a.c. switch capable of delivering 1200 amperes (r.m.s.) continuously. The switch consists of two SCR's connected in inverse-parallel, with both gate leads brought out to terminals. The unit is water-cooled and is rated at 1800 volts continuous blocking voltage. The switch can withstand a one-cycle surge (at a frequency of 60 Hz) of 7000 amperes.

In conventionally cooled SCR's, current-carrying capabilities of up to 400 amps r.m.s. may be had in devices produced by *Westinghouse* and *General Electric*. These units are normally stud mounted, but in the lower current ranges "press-fit" types are also available. Blocking voltages of between 800 and 1800 volts are obtainable, depending on the maximum current rating of the device.

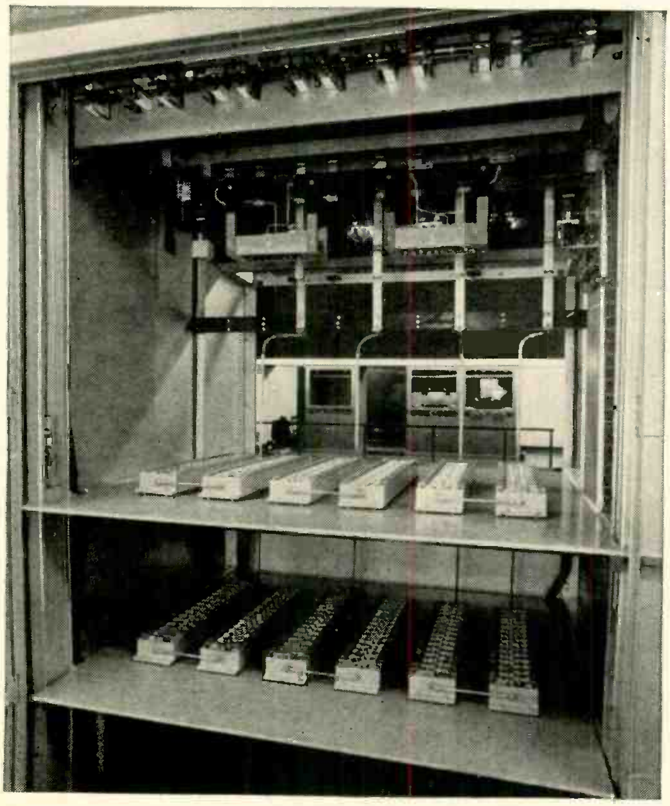
Along with the improvements in SCR technology has come a drastic price reduction in *unijunction* transistors (UJT). The UJT serves as a convenient means of triggering SCR's. A simple UJT oscillator may be constructed with only one UJT, a capacitor, and 2 or 3 resistors. The oscillator then provides trigger pulses for the SCR's. If isolation is required between the UJT oscillator and associated control circuitry, a low-cost pulse transformer may be used. Unijunction transistors suitable for SCR triggers may now be purchased in small quantities for about one dollar. Production quantities (10,000 and up) are available at a cost of 50 cents each.

Applications of the Semiconductors

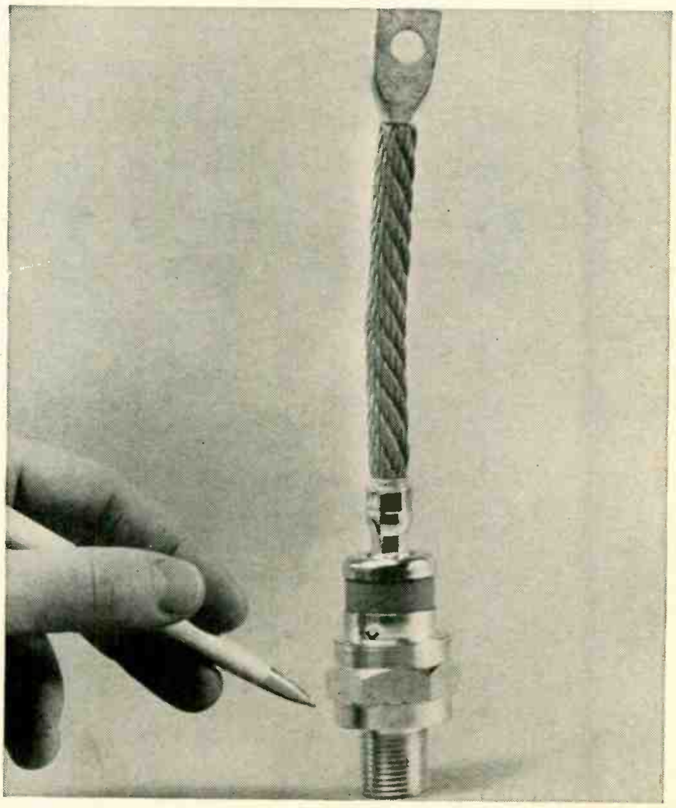
Silicon rectifiers are gradually replacing vacuum tubes and motor/generator sets in a.c.-d.c. converter systems and power supplies. An example of what can be done with present-day devices is the power supply manufactured by *Westinghouse* for the U.S. Information Agency transmitter at Greenville, North Carolina. An existing vacuum-tube diode power supply was retrofitted with silicon diodes. The supply is rated at 15 kV at 100 amperes, or 1.5 megawatts. The solid-state supply operates over long periods without replacement of diodes, unlike the earlier tube version. In addition to the increased reliability afforded by the conversion to semiconductors, there are significant cost savings in maintenance. The elimination of tube heater power supplies and special cooling equipment previously required is also a decided advantage.

The advantages of a.c. power in industry have long been recognized, particularly in the ease with which different

High-voltage high-power silicon rectifier assembly is shown here in a broadcast transmitter. Rated at 15 kV and 100 A, system replaces vacuum-tube rectifiers in much less space.



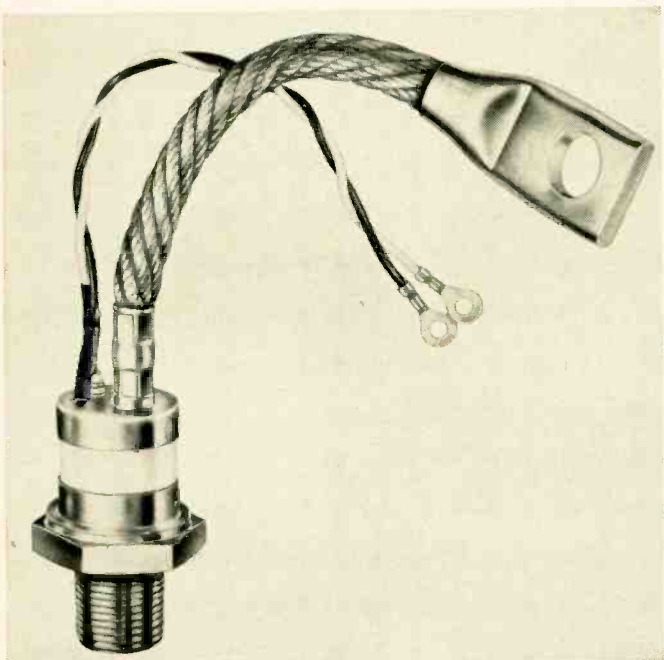
Westinghouse 240-ampere silicon rectifier which is designed for 1000- to 2400-volt applications. This rectifier is able to withstand a single-cycle current surge of 4500 amperes.



voltages may be generated by transformers. It is also true, however, that in many industrial processes a d.c. motor is more desirable as a prime mover than an a.c. motor. Hence, rectification is required.

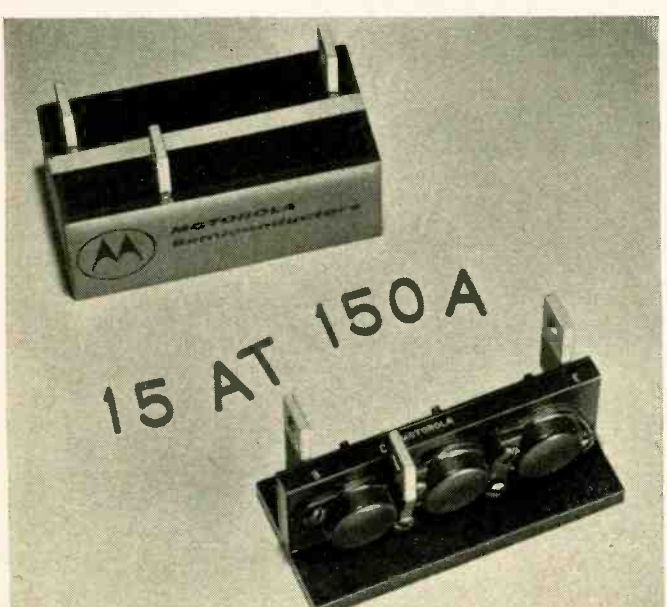
Originally, most rectification systems were motor/generator sets, where an a.c. motor is coupled to a shaft which rotates a d.c. generator. These units were cumbersome and required frequent inspection and maintenance, especially bearings and brushes. Later on, ignitrons and thyratrons replaced many of the motor/generator installations. The use of tubes was an improvement, but maintenance and replacement costs were still relatively high. Now, with high-power semiconductor rectifiers available, these tubes are being phased out in favor of the newer and more efficient solid-state devices.

In the autumn of 1965 the Electro-Motive Div. of *General Motors* announced a new diesel-electric locomotive using solid-state rectifiers. The diesel engine powers an alternator to generate a.c. power. The a.c.-to-d.c. conversion is accomplished in order to take advantage of the excellent torque characteristics of the d.c. motor, a prime consideration in traction service.



General Electric SCR handles up to 235 A at up to 400 volts.

Motorola transistor switch has a minimum beta of 15 at a maximum collector current of 150 A. The assembly is shown in unencapsulated form along with an epoxy-molded version.



Other important areas of application for power semiconductors are in static inverters and frequency changers. *Inverters* convert d.c. to a.c. and are used on most aircraft for this purpose.

Frequency changers, as the name implies, convert the frequency of a power system to a different frequency. A common use for frequency changers is in the conversion of standard 60-Hz commercial power to 400 Hz for use in standby aircraft. While on the ground, the aircraft is serviced by a standby vehicle which allows the on-board electronics to be operated at 400 Hz instead of using the aircraft's battery/inverter system. Inverters and frequency changers represent important applications of power rectifiers, transistors, and silicon controlled rectifiers.

The SCR, while replacing the ignitron and thyratron in many designs, can also replace magnetic amplifiers and relays, as well as mechanical switches, in a wide variety of systems. The SCR is finding ever increasing use, as indicated by sales figures and projections released by the EIA. In 1966, factory sales of SCR's totaled $46 million, while estimates for 1968 and 1970 are $63 and $78 million, respectively. Considering that SCR prices continue to drop as technology improves and competition grows stiffer, the increases are all the more significant.

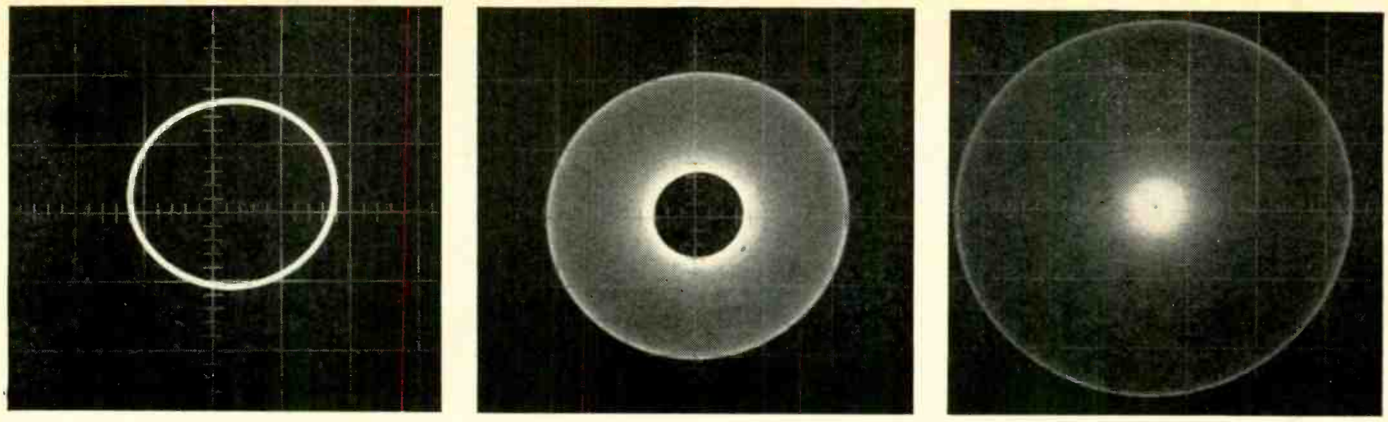
What's Ahead in Power Semiconductors

One domain which has as yet remained untouched by semiconductors is the high-power, linear-operation area of electronics. Specifically, we do not now have transistors capable of delivering thousands of watts of power as required in some communications systems. The vacuum tube continues to be the only element which can furnish sufficient power in the required frequency band to make possible long-range radio communications. Using the communications techniques now in common practice (AM, FM, PCM, etc.) semiconductors do not appear to offer a challenge to tubes in the near future. However, feasible schemes *may* some day be devised to allow pulse synthesis of an AM or FM carrier, which would alter the picture drastically. At present, and in the foreseeable future, tubes appear to have a monopoly in the r.f.-power region below microwaves.

The automotive industry can well adapt high-voltage high-power semiconductors to their products. Already, power rectifiers are used in the alternator/battery charging circuits of most automobiles. Somewhat prosaic elements, such as the horn relay and starter solenoid, are vulnerable to replacement by power transistors and/or SCR's. The more obvious use in ignition systems has already been exploited, but can be improved by elimination of the mechanical coupling between engine and ignition system. Other possible automotive applications were discussed in several articles which appeared in the May 1967 issue of this magazine.

Nearly twenty years have passed since William Shockley, John Bardeen, and Walter Brattain announced their development of the point-contact and junction transistor. By 1956, when the trio shared the Nobel Prize in physics, transistors were beginning to phase out vacuum tubes in many applications. The years since then have witnessed rapid developments in the semiconductor field.

The next decade promises even more: new MOS and junction integrated circuits, fabrication of large-scale integrated (LSI) arrays of fantastic complexity on a single chip, circuits which operate at power dissipation levels in the nanowatt regions, and faster and cheaper linear IC's. Power semiconductors, too, will receive some measure of attention. The years ahead will produce some even more startling results. ▲



Photos of the scope traces produced with no modulation (r.f. only), 50-percent modulation, and 100-percent modulation.

AMPLITUDE MODULATION TESTER

By D. STEPHANI*/Brookhaven National Laboratory

Design of novel instrument that operates directly off the transmitter and produces an unusual CRT display of the percentage of modulation.

IF you are involved in commercial, and especially marine, communications, how often have you had problems in measuring percentage of amplitude modulation of the transmitter, especially when there was no a.c. power available? The author has developed an instrument that operates on 6 or 12 volts d.c., is small in size, independent of voltage variation, reliable, and accurate. Also, it is able to measure amplitude modulation without opening the transmitter.

The device consists of two resonant-tuned circuits connected to a CRT as shown in Fig. 1A. A one-inch tube, such as the 1CP1, is satisfactory for this application. One resonant circuit is tuned to lead at the frequency of interest by 45 degrees and the second to lag by 45 degrees. The coils of the tuned circuits are wound on a single form and are loosely coupled to the transmitter antenna. The author used a 3-foot adjustable whip for coupling to the transmitter antenna. Resistors across the coils lower their "Q" to prevent them from "locking" in phase.

Unmodulated r.f. will appear as a circle on the CRT due to the 90-degree phase shift (Fig. 1B). Modulated r.f. will produce an annulus bounded by two circles of radii, $R1$ and $R2$ (Fig. 1C) with the percentage of modulation equal to $[(R2 - R1)/R2 + R1)] \times 100$. At 100% modulation there will appear a shaded circle and a dot in the center (Fig. 1D). Excessive brightness at the dot will represent over 100% modulation. Non-uniform variation in the shading of an annulus is an indication of distortion.

The test was performed on various bands from 1 to 160 MHz. One can make plug-in coils for the different bands of interest. The inductance values which are required for two frequencies of interest are shown on the complete schematic diagram of Fig. 2.

The instrument has superior display compared to an oscilloscope, and you don't have a sync problem to worry about when using voice as a signal source for the modulation check. ▲

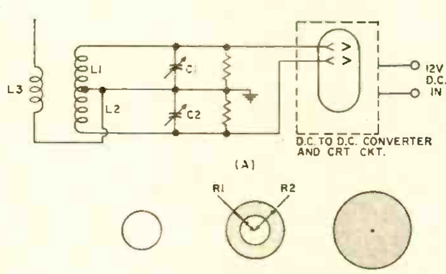
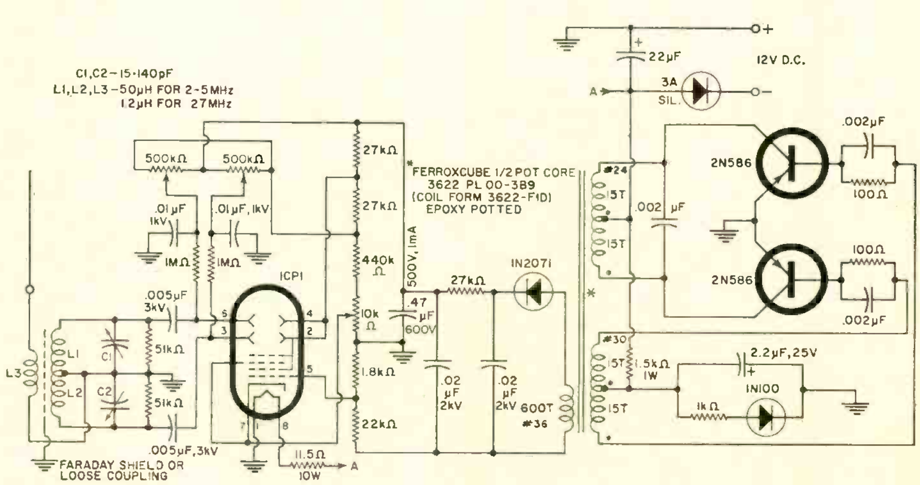


Fig. 1. Basic circuit and patterns produced.

Fig. 2. Complete schematic of the tester.→ For 6-volt operation, remove 11.5-ohm resistor.



*Work performed under auspices of U.S. Atomic Energy Commission.

A New Electronic Organ Kit

A whole new group of exciting electronic organs is now available—from the very small combo for teenage ensembles to the large "theater" type for family enjoyment.

The Heathkit-Thomas "Paramount" theater organ.

WHILE the musical-instrument industry is enjoying a tremendous growth, it is at the same time faced with its greatest change. The many teenage musical ensembles that have sprung up across the country are looking for individuality—their hair, dress, and even their musical instruments are all part of this trend. Each wants to be different, and the more unusual the musical instruments are and sound, the more desirable they become.

Electronic guitar amplifiers with their vibratos and tremolos were the start and now, to continue this trend, new and yet-to-be-designed electronic instruments will be the vogue. The guitar-organ developed by the *Thomas Organ Company* and the electronic saxophone by *Selmer-Paris* and *Electro-Voice* are just two examples. Combo organs of all sizes, prices, and complexities comprise another area of interest.

Electronic musical instruments are not restricted to teenagers. The electronic organ, for example, is finding its way into many homes as a family instrument. In fact, there are more electronic organs than pianos sold today and there is a good reason for this. There is not another musical instrument that provides as much personal enjoyment. To be able to combine the voices of a complete orchestra gives a sense of satisfaction that cannot be described. On any of the reasonably sized organs, with both solo and accompaniment manuals as well as foot pedals (pedal claviers), one can make combinations of literally a dozen different instruments—yet it is simpler to play than a piano.

A key of an organ is strictly an on/off switch; its tonal response is not influenced by lightness or heaviness of touch, whereas that of a piano is. The piano is also a percussive instrument; its tones drop off rapidly. An organ, on the other hand, will maintain its tones as long as the keys are depressed. Therefore, it can be played much more slowly while learning, without the annoying staccato-type response one would get from a piano.

Early attempts at electronic organ design involved photoelectric techniques and a spinning disc. Other designs used electrostatic and magnetic means of developing tonal characteristics. *Electro-Voice* today makes an electrostatic model (costing over $10,000) based on a French patent. *Hammond Organ Company's* early popularity derived from the firm's unique magnetic design. Magnets on a rotating drum developed their particular tonal response. Of course, *Hammond's* famous chord organs, which are easier to play than conventional organs, also helped promote the popularity of this manufacturer's line. (It has just come to our attention that the Defense Supply Agency has awarded a contract to *Hammond* for 28 organs totaling $44,490. Some 35 companies were invited to bid.)

It wasn't really until the advent of transistors and other solid-state devices that we were able to produce instruments as compact and inexpensive as those popular today. Today's organs are all quite similar in their basic operating principles. Oscillators are used to develop the various frequencies. In some organs, 12 oscillators (one octave) are used and dividers are employed to develop all other tones. In other organs, separate oscillators are used for each key and pedal. In order to develop the various voices, mixing circuits and filters are employed.

Although most new organs utilize the same principle of design, no two organs produced by different companies sound alike. Each engineer has his own unique idea of how the tonal characteristics should be obtained and what each tone and voice should sound like. *Wurlitzer* has just announced a new addition to its line of electronic organs—a single-manual, 49-key combo aimed at the teenage market. Of particular interest is the fact that this new organ uses 36 integrated circuits as double flip-flops for frequency division. Most combo organs have limited voicing facilities and are designed for use with conventional guitar amplifiers.

There are two manufacturers, *Heath* and *Schober*, who market electronic organ kits. There are four designs in the *Schober* line, all of which use 12 individual tone generators. *Heath* has three organs in its line. All are actually standard *Thomas* organs which have been packaged by *Heath* as kits.

The largest of the three, and the one with which we are most familiar, is the Heathkit-*Thomas* "Paramount" theater organ. It has solo and accompaniment manuals with 44 keys each and a 13-pedal clavier, providing 15 manual voices and four pedal voices. The solo manual consists of 16′, 8′, 5⅓′ and 4′ pipes, providing ten different voices: diapason, bass clarinet, trumpet, English horn, oboe, violin, and four woodwind tibia (flute) voices. The accompaniment manual covers 8′ pipes and has five separate voices: diapason, saxophone, French horn, oboe, and cello. The pedal clavier has diapason 16′, major flute 8′, bass clarinet 8′, and string bass 8′ voices.

The organ also has three tremolant tabs (vibrato, tremolo, and slow) that affect all the voices, and percussion tabs that provide a means of selecting different percussion effects (short, medium, and repeat). In addition, it has various tabs that permit combinations of solo and accompaniment manuals and pedals to be switched back and forth between two separate power-amplifier systems. One amplifier drives two 12″ speakers and the other drives a 2-speed Leslie rotating-baffle speaker system.

Voices of the Organ

All musical instruments have their individual timbres, not solely as the result of a harmonic series or overtones, but also because of what we refer to as formant. Each instrument has its own dominant frequency range with its specific harmonics and overtones in definite relationship. Another fact affecting formant is the growth and decay patterns of the tones. The violin voice of an organ should sound like a violin. Similarly, flutes, clarinets, etc. should sound like their respective counterparts.

Instruments vary—string instruments, for example, produce a smooth response (mostly harmonic) up to as high as 10× the fundamental at middle C and up to 30× on low notes. Circular stretched membranes of skin or parchment (as in drums, banjos and the like) produce a response with only an odd number of anti-nodes. The fundamental frequency depends on size, mass, and tension of the membrane.

One of the oldest tone-producing devices known is the tuning fork. When fixed at one end, it produces overtones at frequencies of 6.27×, 17.55×, and 34.40× the fundamental. When placed on a resonating box, only the fundamental is heard and at a greatly amplified level. Since the fundamental is a sine wave, it is void of harmonics and its tone is relatively lifeless and flat. This response is typical of the harmonica, saxophone, clarinet, piano-accordion, and others.

This same tuning fork, in the form of an unclamped bar, produces overtones of 2.75×, 5.40×, and 8.93× the fundamental. Its performance is typical of such instruments as the glockenspiel, xylophone, and marimba.

Large, 4-manual pipe organs may have as many as 100 voices which could evolve from the mixing of tones of some 7,000 separate pipes—each pipe having its own specific characteristic. It has been found that open pipes have anti-nodes at each end and produce all odd and even harmonics. Pipes closed at one end have anti-nodes at the open end and nodes at the closed end—and

BUILDING THE TO-67 ORGAN KIT

THERE is always a feeling of personal accomplishment in building kits, no matter how simple or how complex. This feeling, in many cases, surpasses that of simply trying to save money. Our first reaction to the Heathkit/*Thomas* TO-67 organ kit was frustration because of the great number of parts—but the feeling quickly changed to one of "If this works, we should be able to build an *IBM* 360 computer."

One can visualize the various parts that go into an organ—each of the keys, some 88 of them; 13 foot pedals, all broken down so that one must add the springs, contacts and cushions; the various circuit boards (there are 12 oscillator circuits alone)—yet there is much sameness to the kit. The oscillators are basically all the same, and the keys for both manuals are identical. So in the final analysis, construction is not difficult, only time-consuming.

Heath suggests that from 80 to 100 hours be allotted for the over-all construction, which is a more realistic figure than the 68 hours it took us. We did spend another 15 hours tuning the tone circuits.

In constructing the kit, our time was equally divided between mechanical and electronic assemblies. The organ is an all-solid-state design with conventional printed-circuit boards throughout. We were, however, extremely impressed by the various mechanical assemblies, and especially with the keyboards and voicing tabs. The keys themselves, when assembled, operated very smoothly and were light to the touch without any feeling of an "on-off" switch operation. This degree of perfection must have evolved through years of gradual improvements. One of the greatest advantages of this organ is the wedding of many years of design experience by *Thomas Organ Co.* to the kit "know-how" of the *Heath Co.*

Our greatest enjoyment came from tuning the oscillator circuits. We tried several different methods simply to see what accuracy we could attain. The kit is shipped with the "C" tone generator built and pretuned, the suggested method being to beat successive tones in a predetermined procedure. This is a relatively accurate method which does not require test equipment. We followed the procedure and then checked the performance against a *Hewlett-Packard* audio oscillator. This was simpler but did not increase the accuracy. Just out of curiosity we also checked the tone generators against the *General Radio* Model 1150-B digital frequency counter and this proved interesting. Obviously, the accuracy we could attain with this instrument (less than 1 Hz out of 1400 Hz) was much better than required, and our previous settings were found to be within 0.006%.

The subject of tuning organs—and pianos—is a most interesting one. In all organs using 12 tone generators (one octave), recommended tuning follows the tempered scale. This scale divides the octave interval into 12 parts, each having a frequency ratio of the twelfth root of two. The same procedure is used in tuning pianos but applies only to the center range of the keyboard. At the extreme low and high frequencies, the correct procedure, according to the pros, does not follow a fixed frequency progression.

In practice, piano tuning is done by ear and the low-frequency tones are slightly lower than normal while the highs are slightly higher. The degree of variation changes from instrument to instrument and depends on various overtones. One of the advantages of organs that employ separate oscillators for each key is that this type of tuning is possible. In reality, only professionally trained musicians or critical listeners can tell the difference resulting from the different tuning procedures.

Building the kit was, as we had expected, an enjoyable project. Upon completion it worked, also as we had expected. Learning to play the organ was another challenge. The writer had played the violin for some 11 years and, on various occasions, tried his hand at the Hawaiian guitar, Spanish guitar, and piano.

The writer's first thought was that the organ would be almost impossible to play because it requires great coordination of hands and feet. Yet, by following the simplified lessons and phonograph records available, it wasn't too difficult to learn to play reasonably well. Actually, the organ proved to be easier to play than any of the other instruments the author had tried. By its very nature, the organ can be played slowly and, when using multiple voices, the over-all tonal response is enjoyable. Like any other instrument, though, to become proficient requires many hours of practice. Learning to play can be a "do-it-yourself" project with very rewarding results!

Just as we were going to press we were able to add the Heath *"Band Box" to the organ. This is one of the advantages of a kit of this type in that you can add at your convenience and as funds permit. The Band Box is a complete assembly in that it provides its own power supply, voicing circuits, etc. Its only connections are to the accompaniment and pedal keyboards. It provides 10 additional voices (crash and brush cymbals, bass and snare drums, drum roll, bongos 1 and 2, block, clave, and castanet). Adding this unit to the organ presented no problems but it did take about 8 hours. In playing the Band Box, one can simply push individual buttons for the various voices or they can be connected, individually or in groups, to accompaniment or pedal keyboards.*

Playing the Band Box with its various cymbals, drums, and such turned out to be a lot of fun even for a novice, but adding these voices properly is an art in itself. Obviously, the more proficient one is at playing the organ, the more enjoyment one can get from the Band Box.

Apparently there is no end to musical ideas . . . we just heard that Heath has developed a "Playmate". This new kit will provide 15 dance rhythms and will simplify the playing of the Band Box. We hope to add this as soon as possible.

The Schober recital organ, available in kit form, and the Wurlitzer Compact Combo. The Combo organ uses 36 integrated circuits as double flip-flops for frequency division.

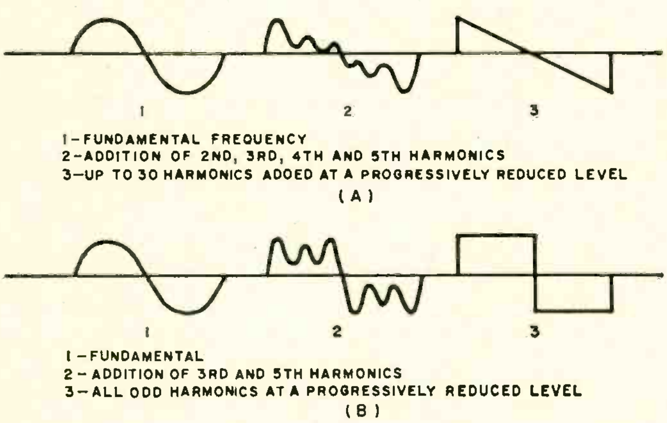


Fig. 1. (A) shows how the addition of even harmonics to a sine wave results in a saw-tooth output. (B) shows how the addition of only odd harmonics results in a square wave.

produce only odd harmonics. Size, shape, and other characteristics influence the sound of an organ pipe. A straight, open pipe produces the diapason voice so familiar as the conventional organ sound; a stopped metal pipe will produce a flute-type voice; and reed pipes result in a trumpet or oboe response. These are only a few of the thousands of different pipes that are used in large cathedral-type pipe organs.

Although engineers attempt to duplicate electronically the tone of a pipe organ, the end result is only a close approximation if for no other reason than that, with an array of pipes, the sound is produced over a broad front—usually in a large hall—and not from small individual speakers. Also, the wind of a pipe organ is lacking in an electronic organ.

Tone Structure

From the foregoing, it is obvious that the tones of musical instruments are made up of sine waves—sometimes with all harmonics and sometimes with only odd or even harmonics.

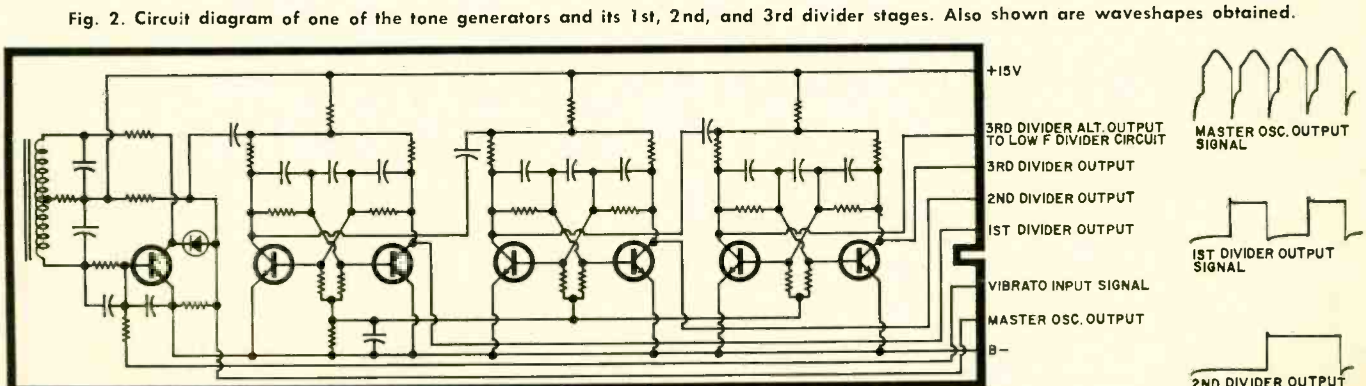
Fig. 1A shows how a fundamental sine-wave frequency is converted to a saw-tooth waveform by the addition of the second, third, fourth, and fifth harmonics, and so on up to 30 harmonics added at progressively reduced levels. The sine wave by itself, since it is devoid of harmonics, is a pure tone that usually becomes tiring and irritating in time. Therefore, in almost all cases, there is a dire need for harmonic reinforcement. The saw-tooth wave is a most desirable one since it contains both even and odd harmonics. The saw-tooth or staircase waveform can also be developed by adding harmonically related square waves at progressively reduced levels.

If we add only the odd harmonics to a sine wave, the evolution of a square wave results, as shown in Fig. 1B. All odd harmonics have been added at progressively reduced levels. This type of wave is of great value for simulating such sounds as the stopped diapason, clarinet, and bassoon.

The heart of the Heathkit-*Thomas* TO-67 organ consists of 12 individual tone generators covering an octave range from F♯4 (739.989 Hz) to F5 (1396.913 Hz). These master oscillators are basically modified Hartley circuits that deliver an output signal as shown in Fig. 2. The output from these oscillators is rich in both the even and odd harmonics that are so essential to good organ tone. The leading edge of this signal provides the trigger signal for the first frequency-divider network.

To cover the complete frequency range of the organ, the 12 notes above the master oscillator up to F6 (2793.826 Hz) are produced synthetically by band-pass filters tuned to the second harmonic of the master oscillators. All other frequencies below the master oscillators are obtained from Eccles-Jordan bistable flip-flop frequency-divider circuits. The first, second, and third divider circuits, along with their waveshapes, are shown in Fig. 2. The output of any one of the divider circuits is exactly one-half the frequency of its input. Each tone-generator circuit board has four output signals: one master oscillator output and three divider outputs. An alternate output signal is also available from the third divider circuit, which is only used in connection with the F-tone (*Continued on page* 92)

Fig. 2. Circuit diagram of one of the tone generators and its 1st, 2nd, and 3rd divider stages. Also shown are waveshapes obtained.



TRANSISTOR CURVE TRACER

By MELVIN CHAN/Ampex Corporation

Design of an instrument which produces on a scope a definitive family of characteristic curves that can be measured as well as interpreted to derive principal parameters for most transistors.

TRANSISTOR-checking instruments assume many forms. These include: the v.o.m. which will identify polarity and indicate shorts, but will not evaluate transistors; the forward-transfer-ratio indicator, which is more useful but will not reveal significant characteristics; the simple curve tracer, which requires a scope and provides a single curve that is indicative of condition but does not provide more than a relative measurement of *beta*; and increasingly elaborate instruments that measure and check every imaginable characteristic.

The practical needs of the engineer or technician are satisfied by the unit to be described, which displays a definitive family of characteristic curves from which the parameters of principal interest may be interpreted. This instrument does this at a parts cost of less than $50. In addition, this curve tracer facilitates exploring a wide range of interesting transistor phenomena, such as effect of temperature on electron mobility, effects of nuclear radiation, or effect of light energy. If your interest lies in this direction, you will find many fascinating areas to explore.

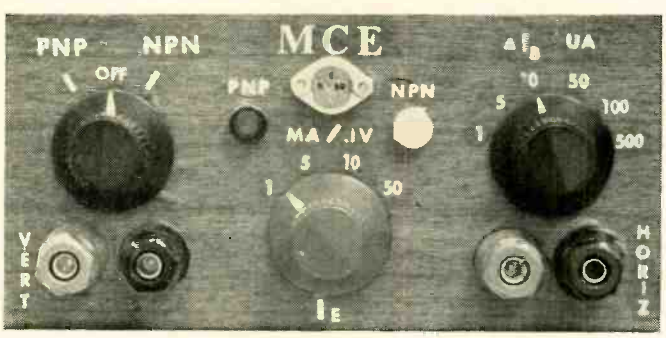
Families of characteristic curves simplify the solution of transistor design problems that are otherwise tedious, difficult, or impossible. For instance, they are useful for selecting matched pairs of transistors, for selecting complementary pairs, for determining *beta* (h_{FE}) under a chosen condition or at a particular point on a characteristic curve, and for determining linearity of I_E or I_C *versus* I_B.

The design criteria for this instrument included the following:

1. Have the ability to test *p-n-p* or *n-p-n* types of transistors.

2. Establish peak collector sweep voltage (V_{CE}) in the range from 12 to 15 volts.

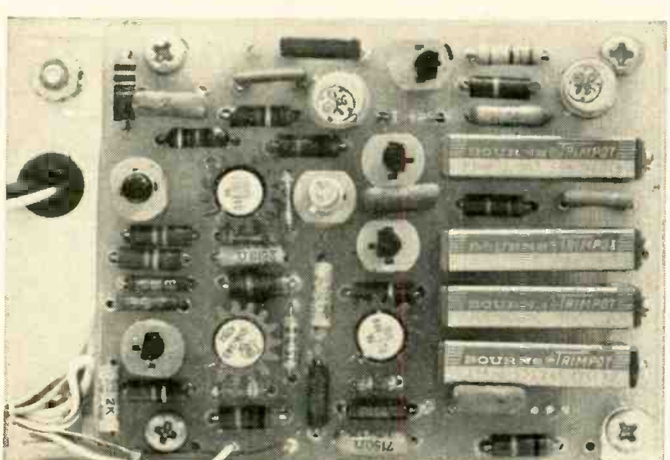
3. Provide a selectable current increment between traces (*i.e.*, I_B, or the incremental base-current range) in predetermined steps from 1 to 500 μA.

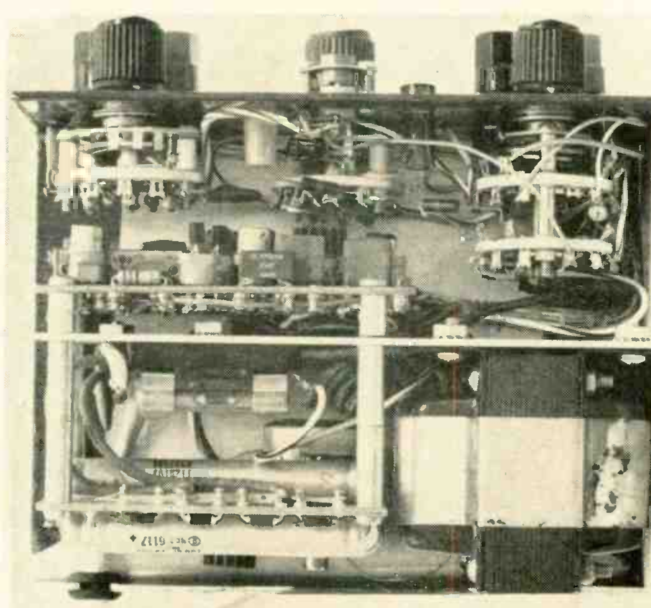


(Left) Clean layout of front panel typifies the construction of this special transistor tester that can trace gain curves.

(Below) Top view of curve tracer shows power-supply and the switching systems. Leads are kept as short as possible.

(Below left) Smoothest layout and compact construction with PC board. Note clip-on heat sinks used on three transistors.





4. Provide a readout of emitter current (I_E) in steps of 1, 5, 10, and 50 mA per 0.1-volt deflection on the oscilloscope display.

5. Use only readily available components.

The final design includes all of the design criteria and is a compact 3″ × 6½″ × 5″. The layout of the control panel provides a symmetrical and functional grouping of the controls. The control labels may appear to be quite abbreviated but the constructor will find them entirely adequate by the time he has completed the alignment.

Many of the components will be found among your collection of salvaged electronic parts; the others may be purchased from your electronics parts supplier.

Construction

The placement of components is not especially critical. However, the layout adopted should group them to allow short leads and to avoid unwanted interstage coupling.

The complete circuit of the curve tracer section (excluding the panel controls and the power-supply section) may be built on a printed-circuit board or it may be hand wired. The printed-circuit board permits the greatest compactness, if this is a factor; the hand-wired technique is usually the simplest, least fragile, and the easiest to troubleshoot. The circuit board is mounted vertically, in a plane that parallels that of the control panel.

The transistors in the tracer section may be grouped by their circuit functions, as indicated in Fig. 1. Power transistors *Q*3, *Q*7, *Q*8, and *Q*9 must be mounted on a heat sink; clip-on heat sinks may be used on the other transistors. Unijunction transistors *Q*1 and *Q*4 should be the 2N2646 (*G-E, Motorola*) because of its low cost and adequacy for the job; more expensive types offering similar characteristics may, of course, be substituted.

Use shielded wire between the base connection of the test socket and switch *S*3, and between the base of *Q*5 and *R*29 (see Fig. 2). The other lead of *R*29 will be common-connected with *R*19, *C*6, the emitter of *Q*4, and the emitter of *Q*11 at T.P.2. Connect one end of each shield, and the indicated lead of *C*11, to *chassis* ground (special symbol in Figs. 1 and 2).

The group of resistors (*R*31*A* through *F*) that set base current in the prototype are 5% units. You may use 1% resistors for greater precision in setting the base-current increments of the transistor under test. The resistance of *R*31*F* is not in direct ratio to the others; instead, it is a compromise value that is needed to test transistors whose *beta* is less than 10.

Rotary switches *S*2 and *S*3 must be of the make-before-break (shorting) type so the bias applied to each element of the transistor under test is not interrupted when either switch is reset.

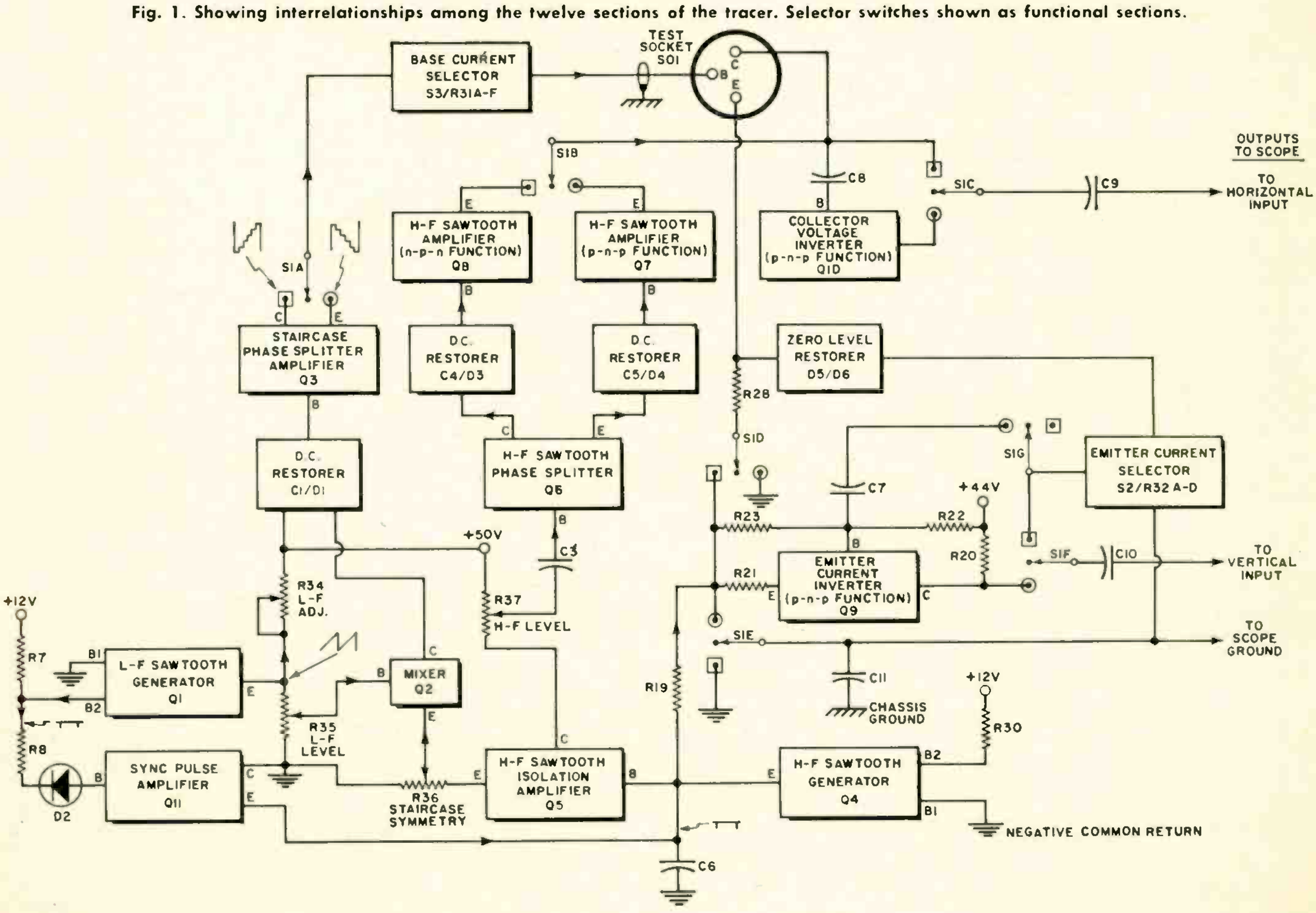
Potentiometer *R*36 should be a multi-turn miniature, because a small change in the setting greatly affects the symmetry of the staircase waveform.

Zener diodes *D*5, *D*6, and *D*9 should be rated at 1 watt. *D*5 and *D*6 should be 3.9-volt zeners identical within 10%. *D*9 should be a 12 volt with 10% tolerance.

The power-supply section of the tracer unit is a conventional voltage doubler which uses a readily available power transformer (Fig. 3). It should be built at the rear of the chassis. Zener diode *D*9 provides the 12 volts reference; transistors *Q*12 and *Q*13 provide the series-shunt regulation which minimizes ripple.

Note that the negative common (marked with the conventional ground symbol) is not grounded to the chassis. Chassis ground is switchable for testing *p-n-p* and *n-p-n* transistors, respectively. An examination of Figs. 2 and 3 will reveal that *S*1 selects the *p-n-p* or *n-p-n* test functions and, at its center position, turns off the power supply. Note also that the *n-p-n* terminal of each section of switch *S*1 is identified by a square and that the *p-n-p* terminal is identi-

Fig. 1. Showing interrelationships among the twelve sections of the tracer. Selector switches shown as functional sections.



fied by a circle. S1 is turned fully clockwise for the *n-p-n* function and fully counterclockwise for the *p-n-p* function. Neon indicators *PL*1 and *PL*2 show which test function is selected; when neither is lighted the power supply is "off".

Do not connect the d.c. outputs of the power-supply section to the curve-tracer section until you are directed to do so during the alignment procedure.

Theory of Operation

The time relationships of the waveforms that are generated in the instrument to produce a family of characteristic curves in the oscilloscope display, are shown in Fig. 4. In essence, low-frequency (approximately 400 Hz) and high-frequency (approximately 4000 Hz) sawtooth waveforms are mixed to produce a staircase waveform that drives the base of the transistor under test. The high-frequency sawtooth is also applied to the collector and is used to drive the horizontal amplifier of the scope. The vertical sweep signal for the scope is taken from the emitter of the transistor under test.

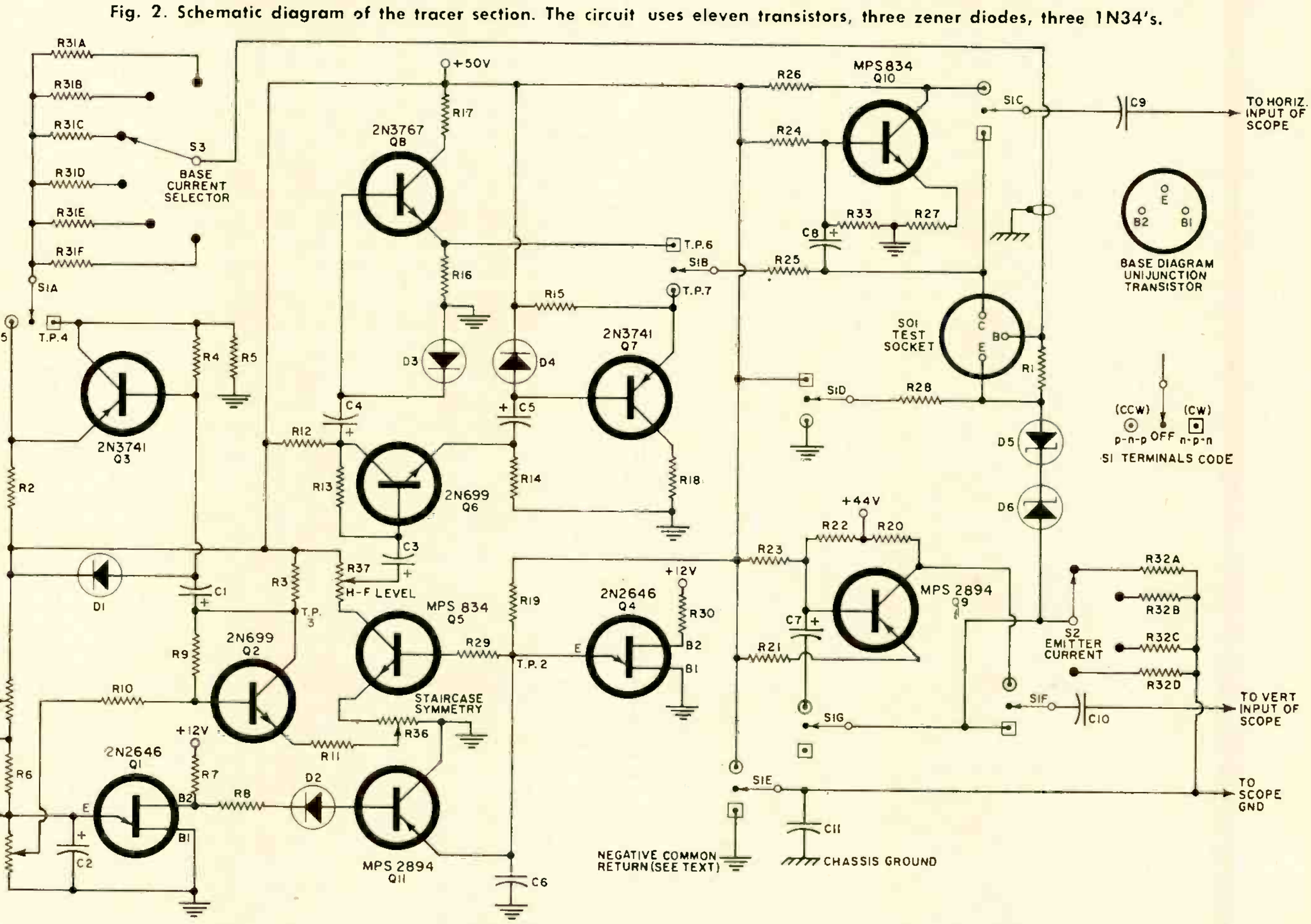
Each step of the staircase signal sets the duration of one horizontal sweep; each step is of constant amplitude for each trace. Each trace in the family of curves displayed therefore represents emitter current *versus* collector voltage under one condition of constant base current.

The control panel includes the selector switches for test function, base-current increment between traces, and emitter current for the transistor under test. It also includes the test socket and the vertical and horizontal drive outputs for the scope, and the neon indicators that show the test function selected.

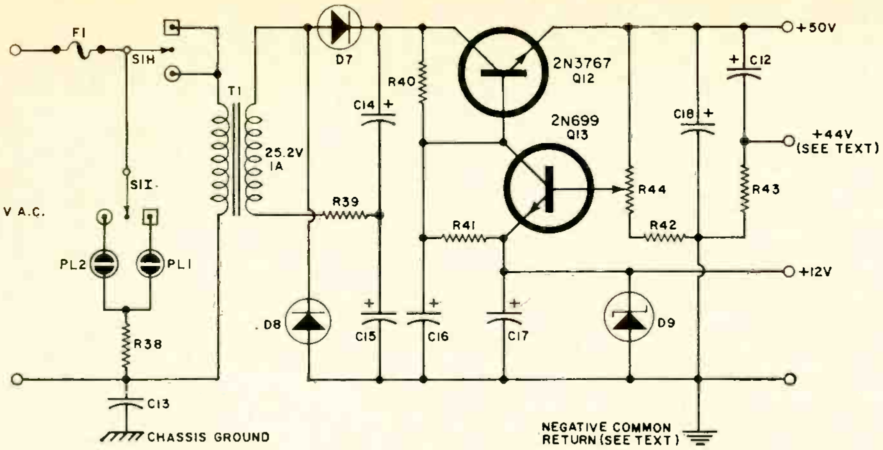
Switch S1 and the neon indicators were described earlier. Switch S3 (near the upper right corner of the control panel) picks out the base-current steps (ΔI_B) between traces; switch S2 (at the center of the control panel below the test socket) selects the emitter current. The signal across the dropping resistor chosen by S2 is the vertical-amplifier drive signal for the scope.

You can follow the circuit description in Figs. 1 and 2. Unijunction transistor *Q*1 is a relaxation oscillator which generates the low-frequency sawtooth waveform and develops sync pulses at the same repetition rate. The setting of potentiometer *R*34 establishes the frequency of the sawtooth signal. During the alignment procedure, *R*34 is set for approximately 400 Hz. The sawtooth waveform from the emitter of *Q*1 is applied through level potentiometer *R*35 to

Fig. 2. Schematic diagram of the tracer section. The circuit uses eleven transistors, three zener diodes, three 1N34's.



R1, R13—470,000 ohm, ½ W res.
R2, R5, R7—470 ohm, 2 W res.
R3—6800 ohm, ½ W res.
R4—1 megohm, ½ W res.
R6, R20, R21, R23—10,000 ohm, ½ W res.
R8, R10, R12, R14—2200 ohm, ½ W res.
R9—330,000 ohm, ½ W res.
R11, R15, R16, R30—1000 ohm, ½ W res.
R17, R18—360 ohm, 2 W res.
R19—15,000 ohm, ½ W res.
R22—27,000 ohm, ½ W res.
R24—120,000 ohm, ½ W res.
R25—33 ohm, ½ W res.
R26, R27—22,000 ohm, ½ W res.
R28—47,000 ohm, ½ W res.
R29—100,000 ohm, ½ W res.
R31A—1 megohm, ½ W res. ±5%
R31B—200,000 ohm, ½ W res. ±5%
R31C—100,000 ohm, ½ W res. ±5%
R31D—20,000 ohm, ½ W res. ±5%
R31E—10,000 ohm, ½ W res. ±5%
R31F—1800 ohm, ½ W res. ±5%
R32A—100 ohm, ½ W res. ±1%
R32B—20 ohm, ½ W res. ±1%
R32C—10 ohm, ½ W res. ±1%
R32D—2 ohm, ½ W res. ±1%
R33—33,000 ohm, ½ W res.
R34—10,000 ohm linear-taper pot
R35—50,000 ohm linear-taper pot
R36—200 ohm, multi-turn linear taper pot (Bourns 236P or equiv.)
R37—5000 ohm linear-taper pot
C1—10 µF, 50 V elec. capacitor
C2, C4, C5—1 µF, 6 V elec. capacitor
C3, C8—1 µF, 50 V elec. capacitor
C6, C9, C10—0.1 µF, 200 V non-polarized capacitor
C7—10 µF, 6 V elec. capacitor
C11—1 µF, 50 V non-polarized capacitor
S1—10-pole, 3-pos. non-shorting sw. (Centralab PA-2031 or equiv.)
S2, S3—S.p., 12-pos. shorting sw. (Centralab PA-2000 or equiv.)
The unused positions of S2 and S3 serve as tie points.
SO1—Transistor test socket (Cinch-Jones 2TS-4 or equiv.)
D1, D2, D3, D4—1N34A or equiv.
D5, D6—3.9 V, 1 W zener diode (Z1100, Motorola 1N4730, or equiv.)
Q1, Q4—2N2646 unijunction transistor
Q2, Q6—2N699 transistor
Q3, Q7—2N3741 transistor
Q5, Q10—MPS834 transistor (Motorola)
Q8—2N3767 transistor
Q9, Q11—MPS2894 transistor (Motorola)



R38—100,000 ohm, 1/2 W res.
R39—22 ohm, 1/2 W res.
R40—680 ohm, 1 W res.
R41, R42—1000 ohm, 1/2 W res.
R43—120,000 ohm, 1/2 W res.
R44—10,000 ohm linear-taper pot
C12—300 µF, 6 V elec. capacitor
C13—0.1 µF, 200 V non-polarized capacitor
C14, C15—500 µF, 50 V elec. capacitor
C16, C18—50 µF, 50 V elec. capacitor (Mallory TC or equiv.)
C17—250 µF, 12 V elec. capacitor
F1—1/2 A "slow-blow" fuse
PL1, PL2—NE-2 or NE-51 neon lamp
T1—Power trans. 117/25.2 V, 1A (Stancor P-6469 or equiv.)
D7, D8—1N4003 silicon rectifier
D9—12 V, 1 W zener diode (Z1112, Motorola 1N4742, or equiv.)
Q12—2N3767 transistor
Q13—2N699 transistor

Fig. 3. Regulated power supply for curve tracer. Two sections of switch S1 are in the power supply.

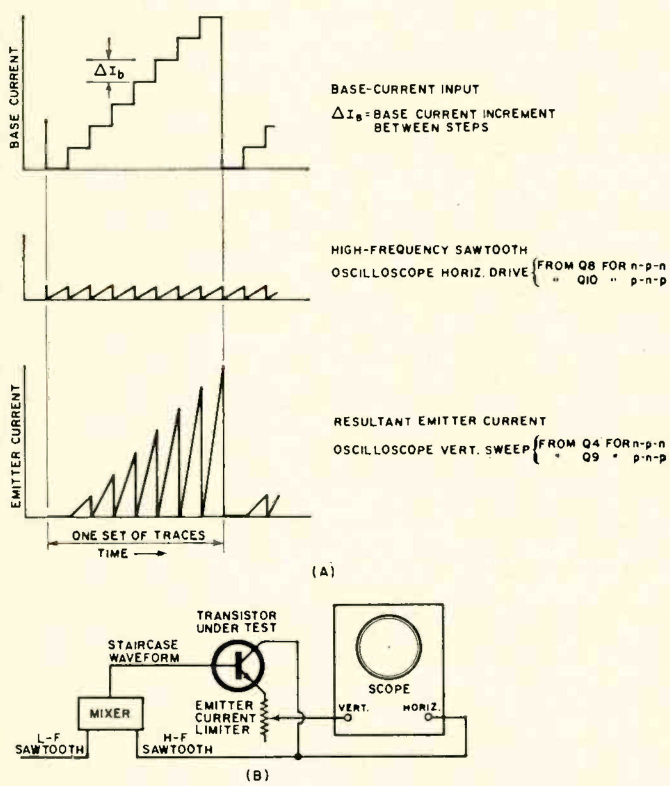


Fig. 4. A staircase voltage applied to the transistor base, and a sawtooth applied to the collector, combine to display the transistor's I_E/V_C curve for a given set of constant base-current settings. Sawtooth that is applied to collector of transistor is also used to sweep the scope horizontally.

the base of mixer Q2. Negative-going sync pulses are taken from base 2 of Q1, through diode D2 to the base of common-collector sync amplifier Q11. The resulting negative-going sync pulses at the emitter of Q11 are applied to the top of high-frequency timing capacitor C6, which is common with the emitter of unijunction Q4.

The sync pulses synchronize the (approximately) 4-kHz sawtooth waveform generated by Q4. They cause the ramp of the 4-kHz sawtooth to begin at the proper time with respect to the negative-going excursion of the 400-Hz sawtooth from Q1.

The 4-kHz sawtooth at the emitter of Q4 drives voltage amplifier Q5, which provides two outputs. The *collector* output of Q5 is applied through the slider of potentiometer R37 and capacitor C3 to the base of phase splitter Q6. In effect, the setting of R37 (during alignment procedure) establishes the amount of voltage ultimately applied to the collector of the transistor under test. Meanwhile, the *emitter* output of Q5 is applied to the emitter of mixer Q2 through potentiometer R36. The setting of R36 controls the symmetry of the staircase waveform which is developed at the collector of Q2. The final setting of R36 is also determined during the alignment procedure.

The staircase waveform is applied through d.c.-restoring network C1-D1 to the base of phase splitter Q3. (Note that the collector output of Q2 may be monitored at T.P. 3.) The collector output of Q3 is connected to the *n-p-n* terminal of switch S1A; the emitter output of Q3 is connected to the *p-n-p* terminal.

The emitter output of phase splitter Q6 is connected through d.c.-restoring network C5-D4 to the base of sawtooth amplifier Q7, whose emitter output is connected to the *p-n-p* terminal of S1B. The collector output of Q6 is connected through d.c.-restoring network C4-D3 to the base of amplifier Q8, whose emitter output is connected to the *n-p-n* terminal of S1B.

The collector terminal of the test socket is connected through R25 to the slide of S1B and directly to the *n-p-n* terminal of S1C. The emitter terminal of the test socket is connected through R28 to the slide of S1D, then through zero-level restorer D5-D6 and switch S2 (the I_E selector) and one of the R32 resistors to the swinger of S1E; the base terminal of the test socket is connected to the swinger of S3 and through one of the R31 resistors to the swinger of S1A.

Zener diodes D5-D6 slightly offset the voltage applied to the emitter of the transistor under test so that emitter bias will exceed the starting levels of test signals V_C and I_B.

Phase inverters Q9 and Q10 are used only when switch S1 is set for testing *p-n-p* transistors.

The horizontal amplifier of the oscilloscope is driven by the signal selected by the setting of S1C; the vertical amplifier is driven by the signal that has been selected by the setting of switch S1F.

Alignment Procedures

The alignment procedure requires a d.c. oscilloscope and a reasonably accurate d.c. voltmeter with a sensitivity of 1000-ohms-per-volt or higher. All voltages and waveforms are measured with reference to the negative common—not to chassis.

Preliminary Checks

1. Refer to Fig. 3 and carefully check the wiring of the power-supply section; refer to Fig. 2 and carefully check the wiring of the curve-tracer section. Inspect the quality of each soldered connection. If there is evidence of underheating, reheat the connection; if there is evidence of overheating, remove the old solder and resolder. Check the polarity of all diodes and polarized capacitors.

Power Supply

2. Temporarily connect a 27,000-ohm resistor in shunt

with capacitor $C12$. Connect the power cord to 117 volts a.c. Turn switch S1 in either direction. Connect the negative lead of your voltmeter to negative common return.

3. Touch the positive lead of your voltmeter to the 50-volt terminal and adjust potentiometer $R44$ for 50 volts. Move it to the 44-volt terminal, and make sure this voltage is within ± 1 volt. Move the lead to the 12-volt terminal; this voltage should be within the tolerance of the 12-volt zener diode.

4. Use a fingertip to test the components in the power supply for excessive heating. If any are too hot to touch, return S1 to center position and recheck connections or polarity or test parts for an internal short.

5. Turn off line power. Remove the 27,000-ohm resistor installed in Step 2.

6. Connect the 50 volts, 44 volts, 12 volts, and the negative common to corresponding terminals of the curve-tracer section.

Sawtooth Waveform Generators

7. Set switch S1 at the *n-p-n* position; the *n-p-n* neon indicator should glow. Recheck the positive d.c. supply voltages at the power-input terminals of the curve-tracer section. If the 50-volt level has changed, re-adjust potentiometer $R44$ in the power-supply section. Measure the difference between the 50- and the 44-volt terminals, which should be approximately 6 volts.

8. Set the oscilloscope for an a.c. display. Connect the scope ground to the negative common. Touch the probe to T.P. 1 and make sure the frequency of the sawtooth waveform is approximately 400 Hz and that its amplitude is 4 to 5 volts peak-to-peak.

9. Move the probe to T.P. 2 and determine that the frequency of that sawtooth waveform is 10 to 15 times that of the waveform at T.P. 1 (*i.e.*, in the region of 4 to 6 kHz) and that its amplitude is 4 to 5 volts peak-to-peak.

10. Move the probe to T.P. 3. Adjust potentiometer $R34$ for the number of steps shown in staircase waveform A. The number of steps should be two more than the number of characteristic-curve traces desired. If there are to be seven such curves, there should be nine steps. Note that the setting of $R34$ also affects the sync and the angle of rise of the steps in the staircase waveform.

11. Adjust $R35$ for a sync level that stabilizes the staircase display. Adjust $R36$ until the tops of the steps are horizontal. Trim the adjustments of $R34$, $R35$, and $R36$ to make the staircase display as symmetrical and as well defined as possible.

12. Move the probe successively to T.P. 6 and T.P. 7 and adjust $R37$ until the amplitude of the staircase signal is 15 to 20 volts peak-to-peak at both test points (waveforms B and A).

13. Set the scope for d.c. display. Place the probe successively at T.P. 4, 5, 6, and 7 and check all waveforms for proper relationship to the negative common return. The two opposite-phase h.f. sawtooth signals at T.P. 6 and 7 may exhibit some distortion by being flat at the top and bottom; this distortion will not impair operation of the unit.

14. Connect the vertical and horizontal outputs (on the control panel) to the corresponding inputs of the scope. Reset the oscilloscope for an a.c. display. Turn switch $S3$ to the 1-μA position. Turn switch 2 to the 1-mA-per-0.1-volt position. S1 remains at the *n-p-n* position. Adjust the horizontal gain of the scope until the full width of the trace can be seen.

15. Turn switch S1 to center (*i.e.*, power "off" position). The display should recede vertically and horizontally to a dot and neither neon indicator should be lit.

"N-p-n" Test Function

16. Select an *n-p-n* transistor whose V_{CE} is known to be at least 12 to 15 volts. Determine that both neon indicators are unlighted (*i.e.*, power "off"), then insert the C, B, and E leads in the respective receptacles of the test socket.

17. Set the scope vertical amplifier for 0.1-volt-per-inch (or cm) on the scope graticule. At this scope setting, each unit of the screen represents the emitter current (I_E) corresponding to the setting of S2. Turn switch S1 to the *n-p-n* position.

18. Manipulate switches S2 and S3 until the display resembles waveform C or D. Then turn S1 to its center position (to turn power "off") and remove the transistor from the test socket.

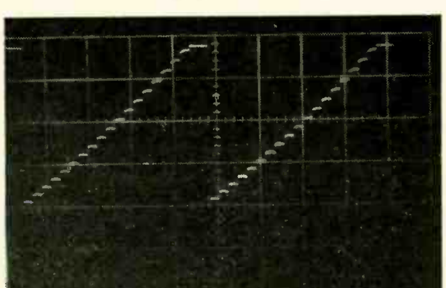
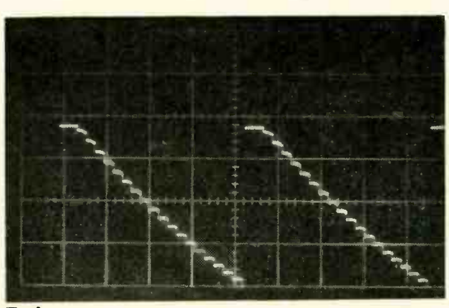
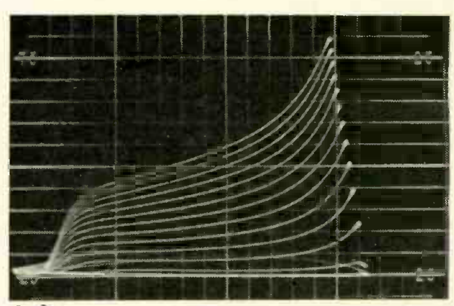
"P-n-p" Test Function

19. Testing *p-n-p* transistors is identical to testing *n-p-n* except that switch S1 must be set at the *p-n-p* position which, through phase inverters $Q9$ and $Q10$, reverses signal polarities applied to the transistor under test.

Final Adjustments

The family of characteristic curves that are produced by this particular curve (*Continued on page 66*)

Scope waveforms of curve tracer. (A) Staircase signal at test points 3,5, and 7. (B) Staircase at test points 4,6. (C and D) Germanium-transistor curves that are traced at low and high currents. (E) Curves of high-beta "n-p-n" silicon unit. (F) Curves showing breakdown; these caused by high V_{CE}. This unit tested "good" on a l.v. tester.

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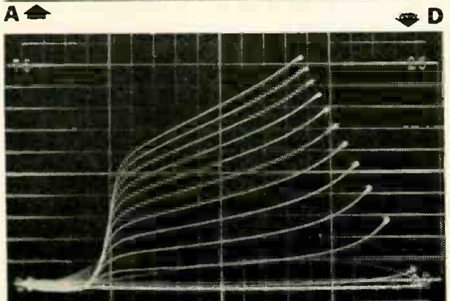
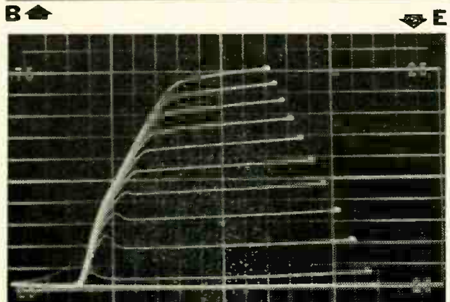
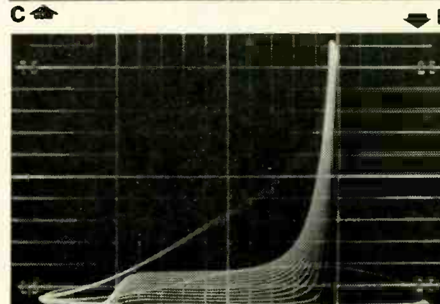

JOHN FRYE

The sophisticated wide-band triggered-sweep scope does much more than just display waveforms. You can make accurate amplitude plus time and frequency measurements with its calibrated controls.

THE LABORATORY OSCILLOSCOPE

WITH Christmas and New Year's over, Barney, second banana at Mac's Service Shop, thought things were pretty well settling back to normal until that January morning when his employer came through the door of the service department lugging a shiny new—and obviously heavy—oscilloscope and heaved it up on the service bench.

"That's the heaviest forty pounds I ever carried," the older man said, breathing hard. "Having to hold it away from your body to keep from bumping it with your knee makes it seem twice as heavy."

"So what's wrong with our old scope?" Barney asked.

"Not a thing, but for some time I've had a growing yen for a new d.c., triggered, delay-line scope; so I splurged and bought myself a Heathkit IO-14 for Christmas and have spent the last several nights putting it together, calibrating it, and trying to figure out all the unfamiliar circuitry. This morning I decided I might as well bring it down here so we both could learn to use it."

"Judging by the odd-ball names above these knobs, switches, and indicator lights, that's going to take a little doing," Barney observed and went on to read aloud from the face of the instrument: 'A.c.-D.c.' 'Balance,' 'Uncal,' 'Volts/Cm,' 'Stability,' 'Trigger Level,' 'Auto-Norm,' 'Time/Cm,' 'Mag On,' 'Trigger Source'—hey! where's the old familiar X1, X10, X100 step attenuator? the sweep-frequency selector switch? the sync-selector switch?"

"They are like the cost of the traveling salesman's new coat and his expense account," Mac replied with a grin. "Remember? 'It's there, but you just can't see it!' Every one of those basic scope functions is present behind that panel, but it's called a different name and does the job a little differently.

"For example, that 'Volts/Cm' switch is actually a frequency-compensated step attenuator calibrated in p-p volts. It's the input terminal voltage that yields a centimeter of vertical deflection on the screen. This, of course, is with the vertical amplifier operating at a preset fixed gain level; but since you have a choice of .05, .1, .2, .5, 1, 2, 5, 10, or 20 volts/cm, you rarely need to cut in the continuously variable gain control just above the 'Volts/Cm' switch to display a signal properly on the 6-cm-high graticule. When in use, the variable control roughly fills in the gap between any two settings of the 'Volts/Cm' switch, but naturally the calibration feature is lost. That's why a warning 'Uncal' light comes on when the variable control is turned away from its extreme clockwise 'Cal' position."

"I get it!" Barney interrupted. "This type of scope is actually a peak-to-peak v.t.v.m. as well as a scope. All I need do is notice how many centimeters high the trace is on the graticule and multiply this by the value indicated by the 'Volts/Cm' switch and I have the peak-to-peak amplitude of the signal without having to take another reading with a v.t.v.m. or use a voltage calibrator with the scope. That should be a servicing time-saver."

"Right. The other main difference between a lab-type and a good wide-band service-type scope lies in the horizontal sweep circuits. As you know, our old scope employs a recurring saw-tooth sweep oscillator to spread out the trace across the screen. A step-type frequency-selector switch backed up by a vernier control permits setting the free-running oscillator frequency near that required to display the desired number of cycles of the signal. Then a sync signal taken from the vertical amplifier is used to lock the sweep generator to the proper submultiple of the signal frequency so that any rhythmic recurring signal is made to stand still on the screen. The sync signal can be made either positive- or negative-going so that the trace can be initiated on the upward or downward excursion of the display.

"The difficulty is that we have only a rough idea of the sweep frequency. The oscillator is either free-running or is tied to some submultiple of the signal frequency. There is no simple way to determine the signal frequency by examining the trace on the screen.

"A triggered-sweep scope solves this problem. The sweep generator is basically a one-shot oscillator. When triggered by a signal, it sweeps the spot across the screen once and then snaps it back to the left side of the screen where it rests until another triggering signal initiates a second sweep. The length of the horizontal trace is fixed at a little more than the 10-cm width of the graticule, and then the sweep generator is calibrated so that the spot moves at selectable and predictable uniform speeds across the face of the tube. In this instrument, for example, by proper setting of the 'Time/Cm' switch and a '1, 2, 5 Multiplier,' the spot can be made to sweep a centimeter of horizontal distance in exactly 1, 2, 5, 10, 20, 50, 100, 200, or 500 microseconds, or 1, 2, 5, 10, 20, 50, 100, 200, or 500 milliseconds."

"Yeah," Barney again interrupted, "and if you know how fast the spot is sweeping horizontally and can see how many centimeters one cycle occupies, you can easily figure the frequency of the signal being observed."

"Right again. All you do is multiply the length of one cycle in centimeters by the product of the settings of the 'Time/Cm' switch and the 'Multiplier' switch and you get the period of one cycle. The frequency is simply the reciprocal of the period. For example, if one cycle of the signal occupies 5 cm when the 'Time/Cm' switch is on 1 ms and the 'Multiplier' is on 2, the period is $5 \times .001 \times 2$, or .01 second. The frequency is 1/.01, or 100 hertz. I might also mention that you can, at a flip of a switch, spread out that horizontal sweep to five times its normal length. That means that what formerly occupied 2 cm on the graticule now fills the entire 10-cm width. It also means, of course, that the sweeping speed of the spot is accelerated five times so that the top sweeping speed is increased from 1 μs/cm to .2 μs/cm.

"However, when the magnifier is on the accuracy of the 'Time/Cm,' calibration is degraded from 3% to 5%; the 'Mag On' light comes on to remind you of this."

"That scope is not only a p-p v.t.v.m., it's a frequency meter, too," Barney marveled.

"A triggered sweep does much more than let you read out frequency," Mac said. "For one thing, it's much easier to get a linear slow-moving sweep with this arrangement. With the 'Time/Cm' switch at .1 second and the 'Multiplier' switch at 5, the spot requires five whole seconds to traverse the 10-cm width of the graticule. This, in conjunction with the d.c.-coupled vertical amplifier, permits the observation of very slow changes in input level—changes that are not rhythmic and that may occur only once."

"You say that the vertical amplifier is direct-coupled for reading d.c., and I know that removes all limits to the low-frequency response; but according to this switch on the front you can switch to a.c. coupling."

"That's right. All that switch does is put a capacitor in series with the input so that the d.c. component does not deflect the trace. By switching from a.c. to d.c. and noting how far and in which direction the display moves, you can determine immediately the polarity and amplitude of the d.c. voltage present at the point where the signal is being observed. Another time-saver!"

"How about the upper frequency limit of the amplifier?"

"With this particular instrument, that is in excess of 8 MHz. Many general-purpose lab scopes, costing from $1000 upwards, go much beyond this. But actually, the frequency response of a lab scope is usually given in nanoseconds of rise time, which brings up another important feature of a triggered scope. When a near-perfect square wave is put through the amplifier and the time is noted that is required for the leading edge of the wave to increase from 10% to 90% of its full value, you have a measure of the upper frequency limit of the amplifier, the point where the response is down 3 dB. It is given by the formula .33/rise time equals frequency response. The rise time of the scope amplifier is given as 40 nanoseconds, so $.33/(40 \times 10^{-9})$ yields a frequency response of about 8.25 MHz.

"The only joker is that you have to be able to *see* the leading edge of the square wave when the writing speed is high enough to give appreciable inclination to even a fast-rising trace. But ordinarily such a trace has already 'risen' before the sweep gets moving. The answer lies in incorporating calibrated delay lines between the vertical amplifier and the deflection plates so that the display signal is delayed a quarter of a microsecond after the sweep is started. That renders the leading edge easily visible."

"Just one thing bugs me," Barney said. "I see how the triggered sweep works fine on a single sweep, but how about when I want to look at a rhythmically repeating signal, such as an ordinary sine wave? Won't the sweep be triggered haphazardly by succeeding sine waves and produce traces that do not coincide?"

"Not at all. You see, the 'Trigger Level' control permits you to adjust the d.c. level, in either a positive or negative direction, at which the sweep is triggered. This means the sweep will always be triggered at precisely the same point on succeeding sine waves so that the resulting traces are perfectly superimposed. In fact, you haven't seen a rock-steady trace until you see it on a triggered scope. What's more, that sweep-starting triggering point can be moved to any desired spot on the wave."

"Aren't there any drawbacks at all to using triggered scopes?"

"You bet there are, and the first is price. Most laboratory scopes cost hundreds or even thousands of dollars. And I do not mean to imply that this one will do everything quite as well as one costing a thousand dollars or so. But *Heath's* Model IO-14 and *Allied Radio's* Model KG-2100 lab scope kit provide instruments in kit form that will outperform the technician's wide-band service scope at a price he can afford.

"But you can't realize the full capabilities of either of these or of any other good lab scope without having a high-quality, fast-rise-time pulse- or square-wave generator to go with it. In fact, you *must* have such a generator—since *Heath* candidly admitted their own square-wave generator wasn't satisfactory for the job, I borrowed a *Hewlett-Packard* generator just to calibrate the IO-14 and properly match the delay line impedances and compensate the attenuator. Such a generator is quite expensive at present, but I'm hoping that the growing demand for such generators plus the possibility of adapting logic-circuit IC's to their construction will bring the price down to where the technician can afford one to use in testing and in recalibrating his instrument when he has to change a tube—and don't forget the IO-14 uses 26 tubes!

"However, the d.c., triggered scope is the kind the technician will encounter if he goes to work in any research and development or industrial laboratory, and before long it will be the standard service scope; so the sooner he becomes familiar with its operation the better. Finally, a good scope is the best 'teaching machine' for an electronics technician that has ever been invented. ▲

(Editor's Note: For further information on the Heath *IO-14 and* Allied Radio's *"Knight-Kit" KG-2100, refer to the test-equipment reports that appeared in our October, 1966 and June, 1967 issues, respectively.)*

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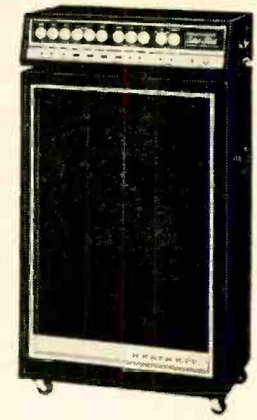

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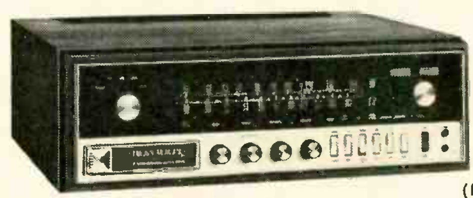

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CIRCLE NO. 110 ON READER SERVICE CARD

Transistor Curve Tracer

(*Continued from page 60*)

tracer represents base current (I_B) *versus* emitter current (I_E). Thus there is no direct measure of collector current, which is necessary for the formula I_C/I_B by which *beta* (or h_{FE}) is properly calculated. However, the collector current can be calculated from the curve-tracer data by subtracting the base current from the emitter current ($I_E - I_B = I_C$).

The exact number of traces displayed is the choice of the constructor; it is determined by the setting of *R*34. However, the base-current interval between traces has great significance, and requires calibration of the unit by the following procedure:

20. Determine that line power is "off" (*i.e.*, S1 set at center position). Insert the leads of an *n-p-n* or *p-n-p* transistor in the socket and set S1 for the type inserted. Temporarily disconnect the vertical and horizontal leads from the scope, but leave the ground leads connected.

21. Decide the number of traces you want to display, a practical number is 7 to 10.

22. Place the scope probe at T.P. 4 or 5. While observing the staircase display, adjust potentiometer *R*34 until two more steps than the number of traces desired appear in the staircase waveform. If the range of *R*34 does not permit the number of steps desired, change the capacitance of *C*2 or *C*6 as necessary.

23. Adjust potentiometer *R*35 until the voltage difference between successive steps is exactly 1 volt. For example, if the staircase waveform includes 9 steps, its maximum amplitude should be set at 9 volts.

24. Adjust potentiometer *R*36 for the most symmetrical staircase waveform obtainable. If non-linearity is observed, favor the symmetry of the highest steps.

25. Turn S1 to its center position (power "off") and remove transistor from test socket. Reconnect vertical and horizontal drive outputs of the curve tracer to scope.

Operating Notes

a. Remember to turn power "off" before a transistor is connected to or removed from the test socket.

b. The staircase waveform needs no adjustment when you switch between the *n-p-n* and *p-n-p* test functions. However, the number of traces may be fewer for one than for the other because of their different offset values.

c. An error in selecting the test function will be indicated by a failure of the display to show a vertical sweep or by an exhibit showing breakdown by reverse junction voltage. The current-limiting feature of this instrument will generally protect the transistor under test.

d. The maximum power available for a transistor test is 250 mW. However it is possible to set the base current above the tolerable limit of a low-*beta* transistor.

e. Because the retrace is quite rapid and does not interfere with the characteristic curves, no retrace blanking is necessary or provided.

f. The choice of the 0.1-volt-per-unit vertical sensitivity on the scope facilitates calculations; the use of 1 volt or more per unit would introduce errors.

g. Waveforms C and D illustrate curves for typical germanium transistors. Waveform E illustrates the typically flat or linear curves of silicon transistors. Waveform F illustrates an instance where a low-voltage test indicated that the transistor was OK, but higher voltages exhibited a breakdown.

Although this particular transistor curve tracer is a fairly elaborate piece of test equipment, its versatility and the highly useful display of a complete family of characteristic curves should more than repay the constructor for his time and effort. Even for those who do not contemplate building the unit, a study of the circuity will be fruitful. ▲

Light-Emitting Diodes
(*Continued from page* 37)

photosensitive device. Although the distance is limited, computer R&D laboratories are seriously considering replacing short runs of interconnecting wires with multiplexed LED signals.

Taking advantage of the LED's flat audio frequency response, the *Norton Company* has developed what may be the first economical home movie sound system. With all circuitry inside the camera, the incoming audio signal intensity modulates an LED focused upon one edge of the film. When the film is processed, the amateur movie maker has a true sound track that is perfectly synchronized to the picture.

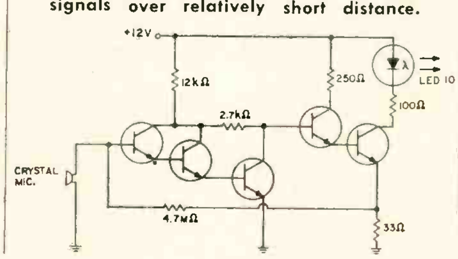
A similar AM light system developed by *General Electric* is shown in Fig. 4. The high impedance of a crystal microphone is matched to the LED by means of a modified Darlington amplifier. Such a circuit may be used for either optical recording or transmission of AM light signals through air or fiber optics.

The first commercially available device to take advantage of the virtually infinite impedance between an LED and a phototransistor is *Texas Instruments*' "optically coupled isolator". With the output of one circuit connected to the LED, and the input of the following stage connected to the phototransistor, the rated interstage impedance is better than 10^{13} ohms. The voltage isolation between stages is up to 15 kV.

Such optoelectronic isolators are finding their place as replacements for electromechanical relays in the high-G environments of missiles, rockets, and aircraft electrical systems.

Modulating a single phototransistor with a number of pulsed LED's forms the basic idea behind the new concept of optical mixing. Since this optical scheme eliminates old problems such as crosstalk between input stages, NASA is experimenting with optical mixing as part of its advanced satellite telecommunications systems program. Other interesting uses are in the works. ▲

Fig. 4. AM modulation of LED with an audio signal. Two Darlington amplifier stages match the high impedance of the crystal microphone to the LED's low impedance. This circuit can be used in an optical recording system or as means of transmitting amplitude-modulated light signals over relatively short distance.



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	Average No. Copies Each Issue During Preceding 12 months	Single Issue Nearest to Filing Date
A. Total no. copies printed (net press run)	233,290	225,860
B. Paid circulation		
1. Sales through dealers and carriers, street vendors and counter sales	42,650	40,000
2. Mail subscriptions	136,220	130,550
C. Total paid circulation	178,870	170,550
D. Free distribution (including samples) by mail, carrier or other means	1,660	1,660
E. Total distribution (Sum of C and D)	180,530	172,210
F. Office use, left-over, unaccounted, spoiled after printing	52,760	53,650
G. Total (Sum of E & F—should equal net press run shown in A)	233,290	225,860

I certify that the statements made by me above are correct and complete.

PHILIP SINE, Treasurer

The 1968 Color Sets

(Continued from page 45)

similar, except that the relay driven by the 42.5-kHz detector activates a pilot relay that drives a stepper relay which connects resistors in the volume-control circuit to control the sound output level. If the 42.5-kHz button on the *Admiral* transmitter is depressed once, it turns the receiver "on", with low volume; again, and the volume is increased to medium; again, and the volume is at whatever maximum has been preset by the regular volume control; again, and the set is turned "off".

The *Zenith* 4-tone and the *Motorola* 3-tone systems use a function-switching relay to make single tones do two jobs. Take the *Zenith*, for example, in Fig. 7. (Incidentally, *Zenith* is the only manufacturer that still uses mechanical-rods-and-hammer to generate the ultrasonic tones in the transmitter.) The 37.75-kHz coil and detector transistor drive a pilot relay which turns the "on-off-volume" stepping relay. The 38.75-kHz coil and transistor drive a pilot relay that activates a muting and function relay. When it has been actuated, this relay alters the functions of the 40.25 and 41.25 tones. Under ordinary circumstances, with the function relay *not* actuated, the 41.25-kHz coil-transistor-relay combination turns the v.h.f.-channel selector toward higher channels; the 40.25-kHz stage turns it toward lower channels. When the 38.75-kHz function relay is activated, it transfers the contacts of the 41.25 and 40.25 relays so that they operate the hue control motor clockwise or counterclockwise, respectively.

The *Motorola* 3-tone system operates in much the same way. A 40-kHz tone switches the function relay. The 41.5-kHz tone, instead of operating the volume control, then turns the hue control clockwise. The 38.5-kHz tone turns the channel-selector motor; if preceded by a 40-kHz tone, a 38.5-kHz tone turns the hue control counterclockwise.

IC's and Solid State

The 1968 model year isn't quite the year of the IC in color. The IC hasn't taken over by any means, but it has shown up in several brands and models. The most common use is in the sound i.f. and detector section, the use pioneered by *RCA* in its 1967 black-and-white sets. The *RCA* line of color sets this year uses an IC followed by one or two transistors as audio amplifier and output.

There are plenty of ways IC's are put to work in color, though. As already pointed out, *RCA* uses one in the remote-control receiver preamp; *Clairtone*, *RCA*, and *Zenith* use them in their a.f.t. systems; *Motorola*, *RCA*, and *Sylvania* use them in sound i.f.'s and detectors. IC's are no longer strangers to color-TV.

Transistors are catching on in a big way. Only one manufacturer made a full commitment to transistors in a color chassis (see page 42 for data on the *Motorola* solid-state set) but many others have transistors scattered throughout their sets. Practically all manufacturers use u.h.f. tuners with transistors, and have for a couple of years, so that isn't anything new or different. However, here are some uses that transistors are being put to in 1968 color chassis:

By *Admiral*, in one chassis—the PCT-198: the entire sound system, the entire chroma section, and for low-voltage regulation.

By *General Electric*, in the KD chassis: as first video amplifier and a pair

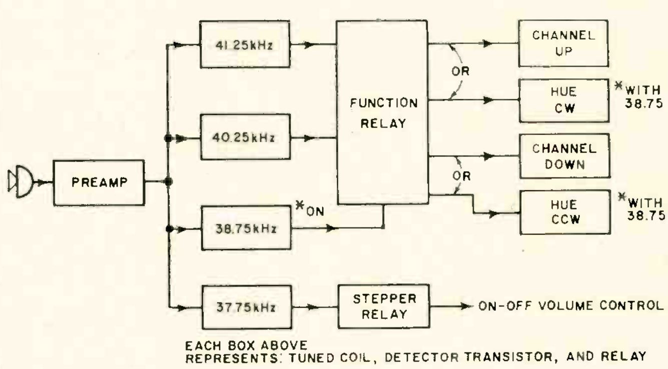


Fig. 7. Functional diagram of Zenith "Space Command 600" remote control receiver. Four tones perform five functions (six, if you count "on-off"). Motorola uses similar setup to get extra functions without need for extra channels in remote receiver.

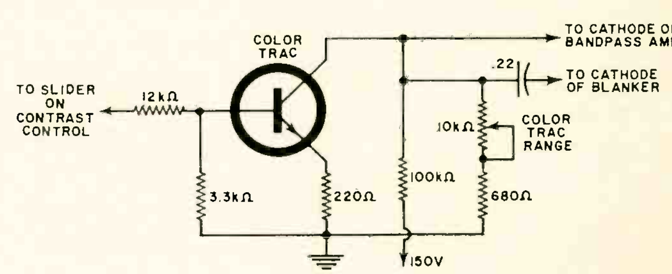


Fig. 8. Hoffman's circuit that helps out gray-scale tracking.

to operate the tuning meter that is used.

By *Hoffman*: a pair to operate a color-reception indicator light; in another chassis, a single transistor in a Color-Trac circuit (Fig. 8) which helps chroma gain follow the settings of the contrast control.

By *Motorola*: in the entire solid-state chassis; in all remote-control receivers; and in pincushion correctors of TS-918 tube color chassis.

By *Philco*, who has used a hybrid chassis for several seasons: entire i.f. system, a.g.c. system, and as video output amplifier.

By *RCA*: in some a.f.t. chassis, in remote-control transmitters and receivers, as chroma a.c.c. (automatic color control), and as color killer.

By *Sylvania*: in D10 chassis, for entire picture i.f., a.g.c. circuit, first and second video amps, audio and audio output amps, sync system, noise gate, a.f.t., and remote-control transmitters and receivers. In the D06 chassis, transistors are used sparingly—as second video amplifier, as color killer, and as noise amplifier and gate.

By *Toshiba*, in TAC-2210 chassis: in picture i.f. strip, in a.g.c. system, and as sound i.f. amplifiers. Also, the v.h.f. tuner is all-transistor.

By *Zenith*: as first video amplifier, in remote-control receivers, and in the a.f.t. circuit.

From this, you can see that solid-state circuits are definitely finding their way into color-TV, in the form of IC's and transistors as well as the old faithful semiconductor diodes. Some semiconductor manufacturers—notably *Amperex*, *Fairchild*, and *Texas Instruments* —have built prototype color receivers to show off more of their solid-state products. Solid-state color receivers seem destined to become commonplace within a short time.

Other 1968 Circuit Changes

There have been so many small changes in color sets this model year that there isn't room to show all of them schematically or to explain all of them in detail. The following list calls attention to some of the more interesting ones. If you are asked to service one of the models, the following list and last year's schematic may be all you need to understand the circuits. This list may omit a few changes, but it is as inclusive as we can make it from information we have been able to get from manufacturers. Where it seems important, a schematic is included. Carryover chassis are not mentioned, unless there are major improvements.

Admiral. Chassis H10. Horizontal output tube 6KG6, used in late production runs (not interchangeable with 6KD6 and 6KN6 used in earlier runs). Late runs also use 6JD6 i.f. amplifiers.

Conar (National Radio Institute). This is a new chassis, Model 600, which will be part of an *NRI* course in servicing color television. Comes in kit form and is built a section at a time.

General Electric. The KD chassis is mostly a repeat of the KC chassis of 1967, with some changes in the high-voltage section. The h.v. rectifier is changed to a 6CN3 from the old 3A3. In the schematics we've seen, the high-voltage regulator is listed as 6LJ6. (This is *not* one of the obsolete types that *G-E* has been rounding up because of x-radiation. Those bad ones were 6EA4, 6EF4, and 6LC6—all replaced by okay types, respectively: 6EH4, 6EJ4, and 6LH6. *None* of the bad ones got into 1968 models.)

Heath. Newest addition to the color-TV kit line is Model GR-227. Chassis will be similar to holdover Models GR-180 and GR-295.

Magnavox. There are a number of changes in the chroma section. The 6GU7 color-difference amplifiers have been replaced by 6MD8's, the 6EW8 burst amplifier makes way for a return to the 6GH8A, the 6JU8 diodes have been eliminated in favor of semiconductor diodes in the killer and phase detectors, and the 6GU7 blanker has been replaced by the triode section of a 6GH8A. In the focus circuit, the 2AV2 rectifier is used in a few early 1968 models, but has been exchanged in most for the old standby 1V2; a 3.3-ohm filament resistor is needed with the 1V2. The audio output, formerly a 6GC5, is back to a 6AQ5, except in chassis that are part of a combination.

Packard Bell. In the 98C17 chassis, similar in many ways to the 98C15 last year, there are a few changes. Tube differences include the horizontal oscillator, formerly a 6B10 that included the a.f.c. diodes, replaced now by a 6FQ7 and a semiconductor dual diode, and the damper tube, formerly 6DW4 and now 6CL3. In the picture-tube drive circuit, a 10-megohm resistor and a 3900-ohm resistor have been added (Fig. 9) to improve gray-scale tracking during brightness shifts. The 10-megohm resistor senses wide brightness shifts by their effect on the h.v. regulator grid and changes the d.c. potential at the top of the drive controls slightly. The 3900-ohm tracking-range resistor can be connected or not for best gray-scale adjustment.

RCA Victor. As usual, there is a whole raft of new color chassis from *RCA*. Biggest change is a series of new picture tubes: 19GWP22, 22JP22, and 25XP22. The red phosphor in all these is highly efficient, so the new chassis include a "Red Drive" control—formerly omitted. A 6CL3 damper tube is used in place of the old 6DW4. The "Service" switch is changed to a push-pull type, in place of the conventional slide switch; it still has three positions: "Normal/Service/Raster".

The CTC-30 is the top of the 1968 color line. It has the integrated-circuit a.f.t. and 8-function remote control already described, and an improved a.c.c. circuit. The unusual innovation in this chassis, however, is detented u.h.f. tuning. The tuning range of the u.h.f. tuner is divided into 24 segments of 3 channels each. A 25-stop detent wheel makes it possible to snap the u.h.f. tuner from channel to channel the same as you do the v.h.f. tuner, and also makes possible motorized u.h.f. tuning—hence the extra channel on the remote-control system.

At any position of the tuner, the u.h.f. fine-tuning knob can be turned by the viewer to tune any one of the three channels indicated in the u.h.f. dial window. For example, if a nearby u.h.f. station happens to be channel 31, the viewer switches the u.h.f. tuner to *31-32-33*, which are all at one detented position of the u.h.f. tuning dial. With the fine-tuning knob, the viewer fine-tunes the station just as he would operate the preset-type fine tuning of a v.h.f. tuner. This tunes that position of the u.h.f. tuner solidly to channel 31, which will then appear every time the u.h.f. selector is rotated to that stop. This is done for each local u.h.f. channel. Then the u.h.f. tuning motor operates just like the v.h.f. one, and the extra function on the remote control can be used to actuate it.

Sylvania. The D06 chassis is a parallel-filament version similar to last season's D05, but with several additions and changes. First, new tubes: the 6LN8 burst gate clipper is changed to a 6BL8; 10JT8 video output and color killer tube replaced by 12HL7 video output tube and 2N3694 transistor color killer; 6CL8 horizontal oscillator and high-voltage regulator exchanged for 6BL8 oscillator and control tube and standard 6BK4 shunt regulator for high voltage. The change in horizontal oscillator necessitated a few wiring changes in the a.f.c. diode circuit. Better operation of the horizontal output tube is achieved by changing its screen supply from the 150-volt line to a 340-volt source. Also in the video amplifier, the SE1002 transistor is replaced by a 2N3694, and the circuit arrangement changed considerably. There is a new tone-control circuit. Finally, a couple of diodes are omitted from the convergence board.

The *Sylvania* D10 chassis is the top of the 1968 line. It was described earlier, in the section about solid-state, since a whole series of transistors are being used, and an IC in the sound i.f. and detector. This chassis includes transistor a.f.t. and a 7-function remote control.

Zenith. Not too many changes this time. Some in the hue circuit: the hue control is now across one half of one winding of the burst-phase transformer (Fig. 10). There is also a slight circuit improvement in the color killer. The 6JS6 horizontal output tube has been replaced by a longer-life 6LB6 or 6LF6 (depending on the run); the new tube has been found to withstand up to 15 minutes of *no-drive* operation without damage. The convergence board is up front (remove the speaker panel), a feature in some other brands this season. Convergence should be easier, because of the labeling system on the newly laid out board; it shows which

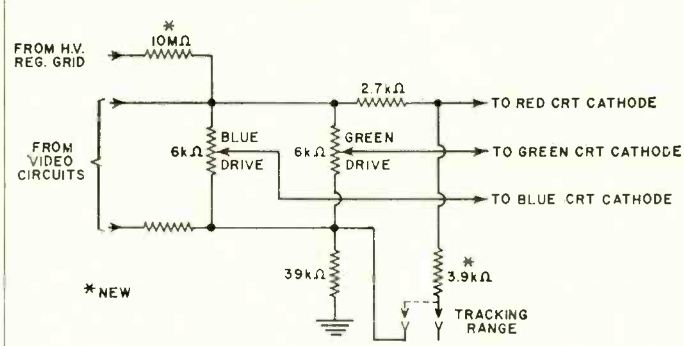


Fig. 9. Packard Bell helps tracking by adding two resistors.

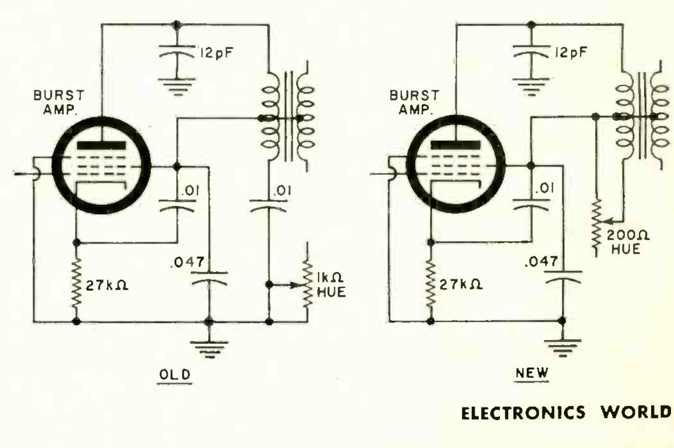


Fig. 10. Zenith hue control has new position in the circuit.

particular raster area each control affects.

What's Coming Next?

Few color-set manufacturers will commit themselves before model-introduction time. Any information they offer is therefore off-the-cuff and tentative. However, we can surmise what's in the wind for the Spring (the late-1968 models) from a little nosing around and listening. Here are a few features you can expect, either this Spring or later in the year when the 1969 color receivers make their debut.

More transistors worked into top models of all major brands, particularly in chroma sections. More transistor v.h.f. tuners, at least by 1969 models. A better color-phase control system by one manufacturer, to help overcome the "green face" syndrome. Integrated circuits in the sound sections of more models, and integrated circuits in at least one chroma section. Another all-solid-state color chassis. Another approach to modularization, possibly but not necessarily similar to *Motorola's.* Hybrid (thick-film) integrated circuits in at least one brand, perhaps two; IC's used so far are monolithic types. A push-button v.h.f. tuner, using Varicap diodes as tuning capacitances. A signal-seeking automatic continuous-type u.h.f. tuner.

Whatever innovations are forthcoming, this year and next are bound to witness great strides in color television receiver manufacture. ▲

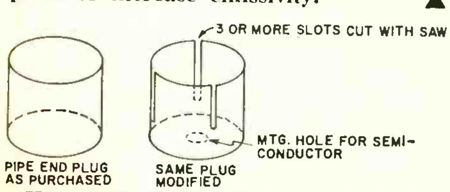
PIPE-PLUG HEAT SINKS

By C.C. MORRIS & J.E. PAPE

OFTEN the need arises for special size heat sinks for use with semiconductor devices. Most suppliers stock the more conventional sizes but quite often space or packaging limitations prohibit their use. In many instances, available heat-sink devices are physically larger than necessary.

One solution to this problem is to design and make your own heat sink for your particular application. An easy way to do this is to use copper pipe and plugs which are readily available in assorted sizes at most hardware dealers. These plugs are the sweat-solder cup-shape type designed to fit inside open ends of copper tubing or pipes.

These plugs are easy to drill and can be finned by cutting slots in their side walls with a hacksaw. If desired, various types of mounting tabs can be soldered to these plugs. Upon completion, the plugs may be painted with black spray paint to increase emissivity. ▲



NOTE: PLUGS ARE AVAILABLE IN MANY DIFFERENT SIZES

EW Lab Tested

(*Continued from page* 12)

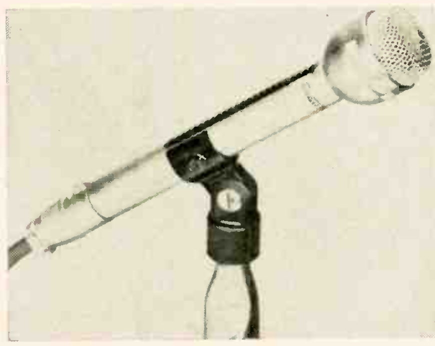
cartridges tested surpassed the M75E in its ability to reproduce high-level transients, particularly in mid- and high-frequency ranges, without shattering distortion. The difference between one of these cartridges and the M75E was small enough to be well within the limits of our judgment in assigning numerical scores to the cartridge performance on the various test bands.

We therefore agree with the manufacturer's contention that the M75E is an exceptionally fine cartridge in all respects. The 15,000-Hz peak adds a trace of sparkle to its sound, but no stridency or significant coloration. It is thoroughly smooth and clean sounding at all times, as a good cartridge must be.

The *Shure* M75E sells for $39.50. The M75-6 with a conical stylus and essentially the same performance is only $24.50, which makes it an outstanding value. ▲

Electro-Voice RE-15 Microphone

For copy of manufacturer's brochure, circle No. 34 on Reader Service Card.



THE *Electro-Voice* Model RE-15 microphone is termed by its manufacturer a "Super Cardioid." It is one of the firm's "Professional Series" microphones designed for critical public address, recording, or broadcast applications.

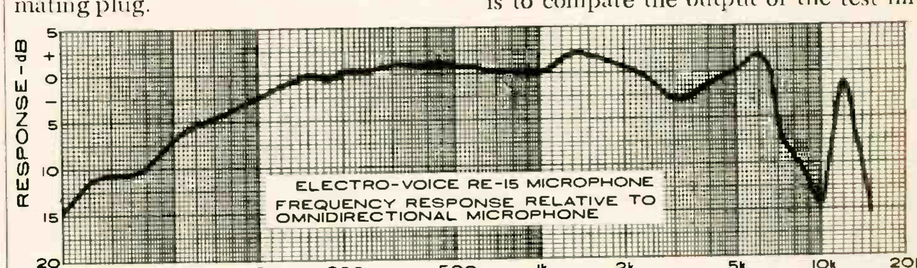
Like most other microphones intended for this type of service, the RE-15 is a dynamic unit. It is a low-impedance microphone rated at a nominal 150 ohms. The diaphragm is non-magnetic and the case is steel, for magnetic shielding as well as physical ruggedness. As cardioid magnetic microphones go, the RE-15 is exceptionally compact and unobtrusive. Its over-all length is 6⁷⁄₁₆″, and for most of that length the diameter is only ¹¹⁄₁₆″. The microphone structure proper is housed in a 1⅜″ diameter bulbous end of the unit, about 1½″ long.

On the slim body of the microphone is a recessed switch which rolls off the bass response below a few hundred hertz. For certain room conditions or for close talking, this helps to maintain a pleasing sonic balance. The roll-off amounts to about 5 dB in the 50 to 80 Hz region. A *Cannon* connector is built into the end of the handle and the 18-foot shielded cable supplied with the RE-15 is fitted with a mating plug.

The cardioid pattern produced by this microphone is obtained by opening ports at the rear of the diaphragm which allows sound waves entering from the side or rear to cancel the signals entering from the front. Although the cancellation cannot be complete, a front-to-back ratio of 15 to 20 dB is obtainable. In its simplest form, this type of microphone may exhibit good directional properties at middle and high frequencies, but often has little or no directionality at low frequencies. One of the principal reasons for using a cardioid microphone is to reduce pickup from speakers or sound sources in front of the user and, obviously, if some frequencies are not rejected, there remains a possibility of feedback occurring or of an unnatural sound balance from an off-axis source.

The "Continuously Variable-D" construction of *Electro-Voice* sub-professional or general-purpose microphones, which have a row of openings extending rearward along the body of the microphone, allows a good directional pattern to be maintained over a wider frequency range. In the professional RE-15, this technique has been further refined to the extent that the frequency response is practically the same at any angle over the full rated 80-15,000-Hz frequency range of the microphone. Also, the maximum rejection is at an angle of 150 degrees to the axis of the microphone instead of the normal 180-degree angle. This allows the RE-15 to be operated at a more usual 30-degree angle to the horizontal while retaining maximum rear rejection in the horizontal plane. (This characteristic is referred to by the manufacturer as "Super Cardioid".)

Our usual microphone test procedure is to compare the output of the test mi-



crophone with that from our calibrated capacitor microphone, with both in identical positions relative to a wide-range loudspeaker. The difference between the two automatically run response curves, corrected if necessary for the slight departures from flatness of the reference microphone, can be considered as the frequency response of the test microphone. Although the measurements are made indoors in a fairly "live" room, we operate within 12" of the speaker to minimize room reflections.

This method, although far from rigorous, yields fairly good results when testing an omnidirectional microphone since our reference microphone has that characteristic. When the test microphone is directional, however, sizable errors occur, particularly at high frequencies. This is true since the test microphone does not respond to signals arriving at an angle in the same manner as the reference microphone.

In spite of this difficulty, we found the RE-15 to have an unusually smooth frequency response, quite superior to any of the better sub-professional dynamic microphones we have tested. The response was within ±2.5 dB from 100 to 7000 Hz. At higher frequencies, the interference effects mentioned previously prevented measurement of its true response. At lower frequencies it followed closely the manufacturer's published curve, falling off gradually and smoothly to −5 dB at 60 Hz.

As a final, definitive check we make tape recordings in which the test microphone is compared with other microphones of known performance. The RE-15 showed its true mettle in this test, producing the most natural male voice sounds we have heard from any microphone short of our much more expensive laboratory microphone. It is unusually free from blasting or bassiness in close talking, sounding practically the same at one inch as at one foot from the speaker. Speaking at an angle to the microphone axis resulted in much weaker output, but with relatively little of the "off-mike" hollowness which most cardioid microphones exhibit in this situation.

The microphone comes in a metal case with a fitted styrofoam insert to protect it. It is finished in non-reflecting matte satin nickel, which adds to its unobtrusive appearance. It should make an excellent addition to a high-quality tape recording system, being one of the few microphones at a reasonable price that can do justice to the quality built into modern tape recorders. Its output is too low for use with most recorders having high-impedance inputs, but a matching transformer (502B) is available from *E-V* which steps up the microphone output for use with high-impedance amps.

The *E-V* RE-15 sells for $153 (net). The 502B matching transformer is about $10.00. ▲

"CIE training helped pay for my new house,"

says Eugene Frost
of Columbus, Ohio

Gene Frost was "stuck" in low-pay TV repair work. Then two co-workers suggested he take a CIE home study course in electronics. Today he's living in a new house, owns two good cars and a color TV set, and holds an important technical job at North American Aviation. If you'd like to get ahead the way he did, read his inspiring story here.

If you like electronics—and are trapped in a dull, low-paying job—the story of Eugene Frost's success can open your eyes to a good way to get ahead.

Back in 1957, Gene Frost was stalled in a low-pay TV repair job. Before that, he'd driven a cab, repaired washers, rebuilt electric motors, and been a furnace salesman. He'd turned to TV service work in hopes of a better future—but soon found he was stymied there too.

"I'd had lots of TV training," Frost recalls today, "including numerous factory schools and a semester of advanced TV at a college in Dayton. But even so, I was stuck at $1.50 an hour."

Gene Frost's wife recalls those days all too well. "We were living in a rented double," she says, "at $25 a month. And there were no modern conveniences."

"We were driving a six-year-old car," adds Mr. Frost, "but we had no choice. No matter what I did, there seemed to be no way to get ahead."

Learns of CIE

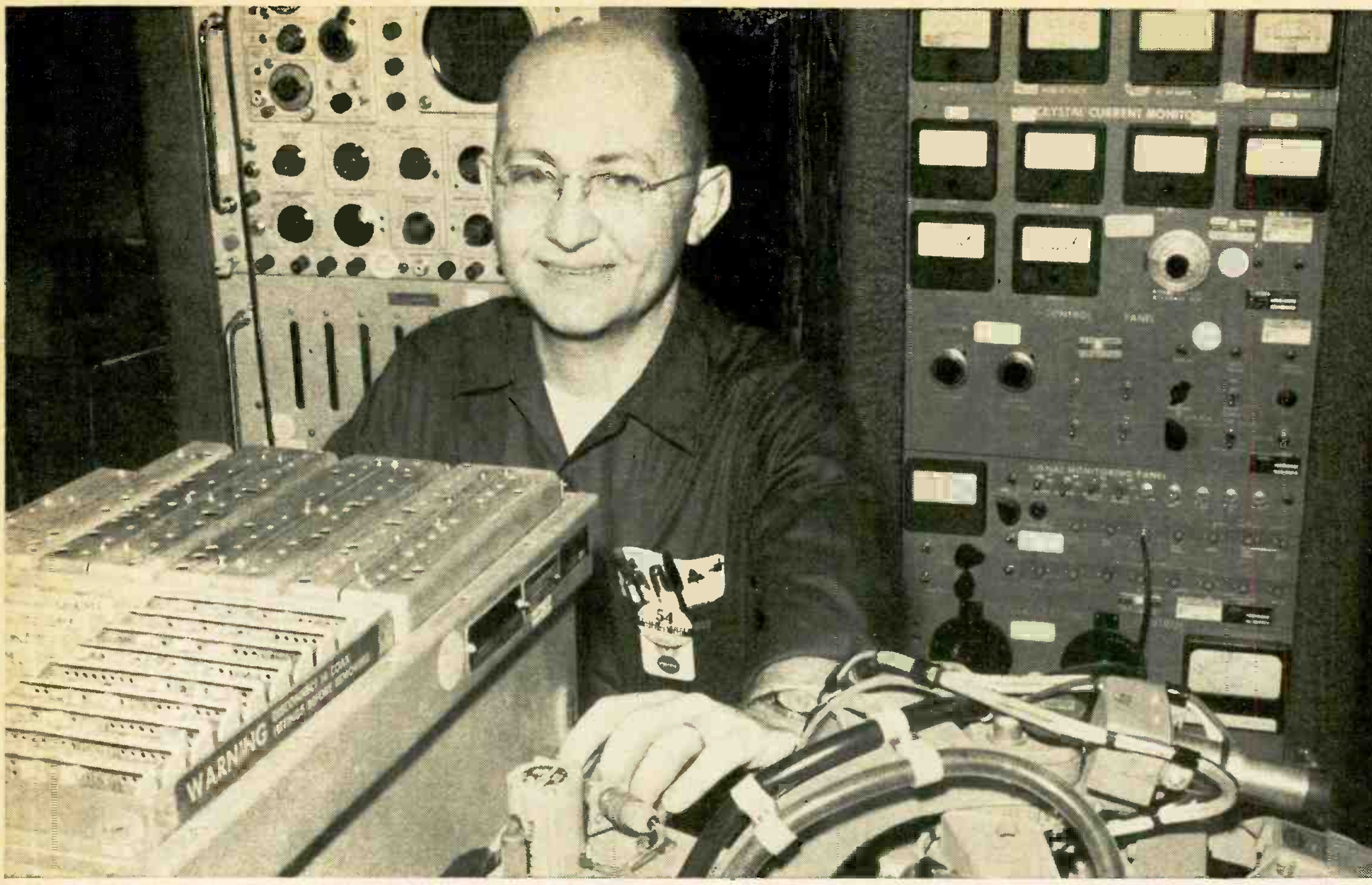
Then one day at the shop, Frost got to talking with two fellow workers who were taking CIE courses... preparing for better jobs by studying electronics at home in their spare time. "They were so well satisfied," Mr. Frost relates, "that I decided to try the course myself."

He was not disappointed. "The lessons," he declares, "were wonderful—well presented and easy to understand. And I liked the relationship with my instructor. He made notes on the work I sent in, giving me a clear explanation of the areas where I had problems. It was even better than taking a course in person because I had plenty of time to read over his comments."

Studies at Night

"While taking the course from CIE," Mr. Frost continues, "I kept right on with my regular job and studied at night. After graduating, I went on with my TV repair work while looking for an opening where I could put my new training to use."

His opportunity wasn't long in coming. With his CIE training, he qualified for his 2nd Class FCC License, and soon afterward passed the entrance examination at North American Aviation. "You can imagine how I felt," says Mr. Frost. "My new job paid $228 a month more!"



Currently, Mr. Frost reports, he's an inspector of major electronic systems, checking the work of as many as 18 men. "I don't lift anything heavier than a pencil," he says. "It's pleasant work and work that I feel is important."

Changes Standard of Living

Gene Frost's wife shares his enthusiasm. "CIE training has changed our standard of living completely," she says.

"Our new house is just one example," chimes in Mr. Frost. "We also have a color TV and two good cars instead of one old one. Now we can get out and enjoy life. Last summer we took a 5,000 mile trip through the West in our new air-conditioned Pontiac."

"No doubt about it," Gene Frost concludes. "My CIE electronics course has really paid off. Every minute and every dollar I spent on it was worth it."

Why Training is Important

Gene Frost has discovered what many others never learn until it is too late: that to get ahead in electronics today, you need to know more than soldering connections, testing circuits, and replacing components. You need to really know the fundamentals.

Without such knowledge, you're limited to "thinking with your hands" ...learning by taking things apart and putting them back together. You can never hope to be anything more than a serviceman. And in this kind of work, your pay will stay low because you're competing with every home handyman and part-time basement tinkerer.

But for men with training in the fundamentals of electronics, there are no such limitations. They think with their heads, not their hands. They're qualified for assignments that are far beyond the capacity of the "screwdriver and pliers" repairman.

The future for trained technicians is bright indeed. Thousands of men are desperately needed in virtually every field of electronics, from 2-way mobile radio to computer testing and troubleshooting. And with demands like this, salaries have skyrocketed. Many technicians earn $8,000, $10,000, $12,000 or more a year.

How can you get the training you need to cash in on this booming demand? Gene Frost found the answer in CIE. And so can you.

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Thousands who are advancing their electronics careers started by reading our famous book, "How To Succeed In Electronics." It tells of the many electronics careers open to men with the proper training. And it tells which courses of study best prepare you for the work you want.

If you'd like to get ahead the way Gene Frost did, let us send you this 40-page book free. With it we'll include our other helpful book, "How To Get A Commercial FCC License." Just fill out and mail the attached card. Or, if the card is missing, write to CIE at the address below.

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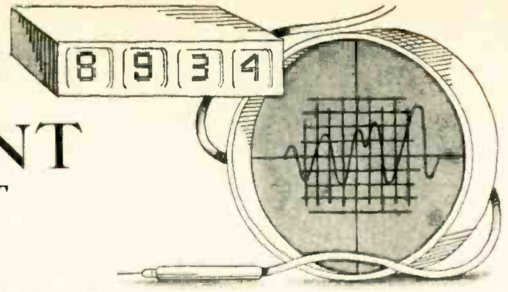
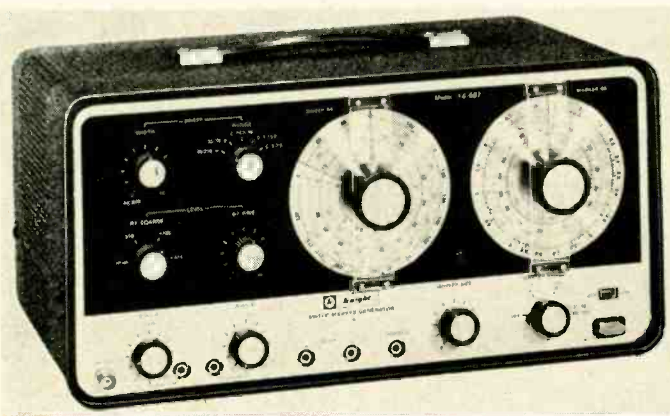


"Knight-Kit" Model KG-687 Sweep/Marker Generator

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



SWEEP alignment of the tuned circuits in a TV receiver or an FM set is not a job that the technician has to do every day. However, when components are replaced or when heat and aging detune the critical circuits, a good sweep/marker generator is absolutely essential to permit the technician to readjust such circuits for optimum performance. We have even found some brand-new inexpensive FM receivers that must have gone through the factory alignment line quite rapidly. When such receivers were sweep-aligned, improvements in sensitivity, distortion, and tuning characteristics were readily made. Of course, sweep alignment should only be attempted if the technician has complete information from the receiver manufacturer on the frequencies to be used, the bias voltages required, and the proper procedure.

A new piece of test equipment that will help do this job is the "Knight-Kit" Model KG-687 sweep/marker generator. This is one instrument in the manufacturer's new line of distinctively styled, all-solid-state test equipment. The generator uses 9 silicon transistors (see block diagram) and 7 diodes. The heart of the unit is a 5-band saturable reactor in the tuned circuit of the sweep oscillator that is used to generate fundamental frequencies from 3 to 220 MHz in five bands. A control winding on this reactor has 60-Hz a.c. applied to it, which changes the inductance of the windings in the tuned circuits and swings the center frequency of the oscillator over a range that has a maximum value of up to 18 MHz on the highest band of frequencies produced.

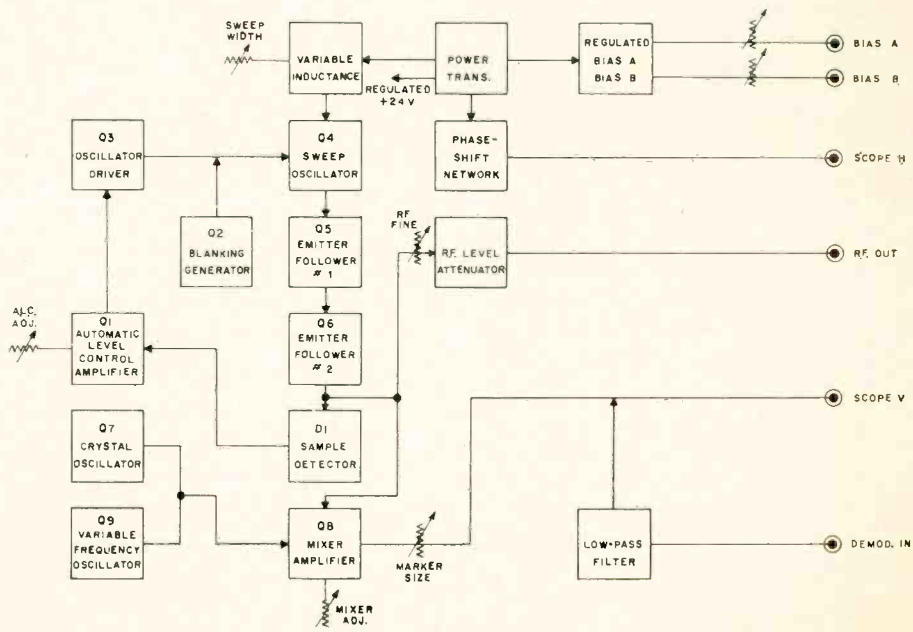
In order for this type of generator to produce an accurate response curve, it is necessary that the output level be kept quite constant as the frequency swings back and forth. This is accomplished in the KG-687 by an automatic level control (a.l.c.) circuit. The circuit samples the sweep output and then readjusts the output amplitude of the sweep oscillator to keep it flat. This circuit performs beautifully, as evidenced by the straight-line traces we saw on our scope over the entire operating range of the instrument.

Along with the sweep generator, the unit has a built-in separate marker generator covering from 2 to 75 MHz on fundamentals and up to 225 MHz on calibrated harmonics. A crystal oscillator is also incorporated so that very accurate markers can be produced. A 4.5-MHz crystal is supplied for marking the TV sound i.f. frequency exactly. Other crystals, such as for 10.7 MHz and 5 MHz, are available separately for plug-in. Both crystal and v.f.o. markers can be used together in order to put several "birdies" on the response curve. We found the frequency calibrations on the marker-generator dial quite accurate and the tracking good over all the bands.

Incidentally, this instrument, like several of the better sweep generators, uses a post-injection marker system. In other words, the circuit is arranged so that the markers do not pass through the tuned circuits being aligned but are added after detection. As a result, the markers are not distorted or reduced in amplitude if they happen to fall outside the bandpass of the circuit being adjusted.

Still another useful feature of the new generator is a pair of isolated 0 to −20 volt regulated and calibrated voltage supplies. These are used during alignment to supply the required bias voltage to the stages being adjusted. In some cases, different voltages are required for, let us say, the r.f. and i.f. stages. With two voltage sources, this requirement can be met conveniently without having to jury-rig an extra bias-box.

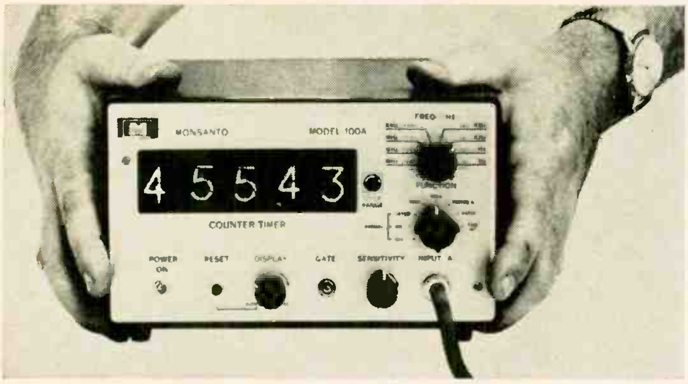
The instrument wiring, which is all point-to-point rather than printed, is really spread out so that there is plenty of room to work or to do any servicing that might be required. As a matter of fact, the absence of tubes makes the top of the chassis look quite empty. Construction of the instrument kit is simple and straightforward. The Model



KG-687 measures 14¾" by 7⅞" by 10¼" deep. It is priced at $120 in kit form only and is available from *Allied Radio Corporation.* ▲

Monsanto Model 100A Counter/Timer

For copy of manufacturer's brochure, circle No. 150 on Reader Service Card.



A NEW compact 5-digit counter/timer, the Model 100A, in which virtually all active elements are integrated circuits, has been announced by *Monsanto's* Electronics Technical Center. The instrument is "half-rack" size, measuring only 4½" high by 7½" wide by 9" deep. It is suitable for a wide range of production applications or for laboratory use. The manufacturer calls the timer a "true fourth-generation" instrument, not only because of the full use of the latest integrated circuits, but also because it has been simplified in design and operation so that only the most important basic functions have been incorporated. As a result, cost has been kept down to $575, a truly respectable figure for a 5-digit instrument.

The timer provides capabilities which include measurement of average frequency from 5 Hz to 12.5 MHz, frequency ratio from 1 to 10^6, time interval from 10 microseconds to 10^6 seconds, and single periods from 10 microseconds to 10^6 seconds, in addition to totalizing from 0 to 10^6.

The Model 100A employs a crystal-controlled clock having an aging rate of better than 5 parts in 10^7 per day after a 72-hour warm-up. The instrument has a basic sensitivity of 50 mV, r.m.s.

The final decade carry-pulse is available at a rear-panel connection, permitting cascading of slave units to extend range and/or resolution in multiples of 5 digits. Additional features of the timer include front-panel overrange and gate indicators as well as a built-in check system. ▲

B&K Model 161 Transistor Tester

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

TRANSISTOR testers are coming from the test-equipment manufacturers almost as rapidly as new transistors are being introduced. The latest one to come to our attention is the new *B&K* Model 161 "Dynamic Transistor Analyst."

This new tester performs checks for a.c. *beta* without removing transistors from their circuits. In addition, out-of-circuit tests are performed for a.c. *beta* and for collector-to-base leakage current (I_{CBO}). Values of *beta* are read directly in two ranges on the 7-inch mirrored-scale meter: from 2 to 100 and from 10 to 500. Leakage current is also read directly on a single expanded scale with a maximum range up to 5000 μA. Transistors are readily identified as to whether they are *p-n-p* or *n-p-n* types simply by flicking a switch on the front panel. Front-to-back resistance of diodes can also be measured with this new instrument.

As an added feature, the tester may be personalized by inlaying the own-

er's name on the carrying handle. The Model 161 comes with a transistor specifications handbook and a basic transistor "brush-up" manual.

The instrument measures about 7 inches square and 3⅝ inches deep. It is a.c.-powered and costs $89.95. ▲

Troubleshooting Color Chassis

(*Continued from page* 40)

15. Adjust the top slug (secondary) of discriminator transformer *T*1 for minimum pull-in effect while you switch the a.f.c. back and forth between "off" and "on".

16. Check another channel. If there is pull-in on some channels and none on others, even though manual fine tuning is normal for all, the r.f. and i.f. stages of the receiver probably need complete alignment.

Note: You can leave the v.t.v.m. connected during steps 12 through 16, and adjust the slug so there is no fluctuation of the meter pointer as you flip the a.f.c. switch back and forth between "off" and "on".

Motorola's a.f.t. system (which they call FTL for Fine Tuning Lock) is adjusted differently, but a v.t.v.m. is still the only equipment you need. The procedure is this:

1. Tune in a program.
2. Defeat the FTL by pulling out on the fine-tuning control.
3. Adjust the fine tuning to a point *just before* the 920-kHz sound beat appears in the picture.
4. Connect a v.t.v.m. across the FTL defeat switch. Set it to measure d.c. volts and zero-center the meter pointer.
5. Push the fine-tuning control back in, to activate the FTL circuit.
6. Back out the top slug of the discriminator transformer until it is near the top of the transformer.
7. Back out the bottom slug until it is near the bottom. Notice which side of zero the meter pointer moves to during this step.
8. Adjust the bottom slug for maximum meter indication in that direction.
9. Adjust the top slug to move the meter pointer back to zero center.

Note: The r.f. and i.f. alignment should be correct before any attempt is made to adjust the FTL circuit.

Color Servicing Caution

Many manufacturers have issued bulletins explaining how technicians can prevent color-television receivers from producing x-rays. While the x-rays produced by a normally operating receiver cannot harm humans or animals in any way, an abnormally operating set can generate enough to exceed the limitations considered best for health. Even then, considerable exposure is necessary to do any biological damage, but it is very easy to prevent even that slight possibility.

X-rays can be produced in two areas in a color television receiver: in the picture tube, and in the high-voltage section—specifically, by the high-voltage regulator and in lesser amounts by the high-voltage rectifier. In every case, the technician and his customer will be protected from any harmful amount of x-radiation if the following general precautions are observed.

Watch only from a distance of 6 feet or more.

Always adjust the horizontal efficiency coil (if the set has one), the high-voltage regulator current, and the high voltage exactly as recommended by the manufacturer. If it will not adjust correctly, find out why and cure the trouble. Never let an incorrectly adjusted color set go back to a viewer.

When you have a color set on the bench, avoid turning the bottom of the chassis toward yourself or anyone else in the shop.

Make sure all parts of the high-voltage cage are in place, and that all screws are securely tightened.

These precautions will make color-TV servicing on the 1968 chassis (and all others) safer for the technician and will eliminate viewer worry about x-rays from his color-TV set. ▲

BOOK REVIEWS

"THIN-FILM AND SEMICONDUCTOR INTEGRATED CIRCUITRY" by John Doyle. Published by *McGraw-Hill Book Company*, New York. 308 pages. Price $6.95.

This book is for those working in the field and covers the general problems associated with integrated circuitry and the techniques used to solve such problems. The author discusses the many disciplines involved in the fabrication of thin-film and integrated circuits, including photolithography, vacuum technology, chemistry, packaging, and reliability. Emphasis is also placed on actual production-line techniques and plant requirements.

The text is divided into twelve chapters covering an introduction, photolithographic masks, thin-film technology, semiconductor technology, application notes, packaging techniques, reliability, electron-beam processing, magnetic films, cryogenic thin films, optoelectronics and functional electronic blocks, and vacuum systems.

The author has assumed that his readers have a working familiarity with conventional discrete-component circuitry and have the requisite engineering background. The text is well illustrated by diagrams, graphs, line drawings, and photographs. Each chapter carries a group of "exercises" and a list of references for further reading.

* * *

"SINGLE SIDEBAND: THEORY AND PRACTICE" by Harry D. Hooton, W6TYH. Published by *Editors and Engineers, Ltd.*, P.O. Box 68003, New Augusta, Ind. 46268. 340 pages plus foldout section. Price $6.95.

This is a "middle-level" book covering the origin of SSB, the derivations of single-sideband signals, carrier suppression techniques, sideband selection, carrier generators, speech amplifiers and filters, SSB transmitters, linear r.f. power amplifiers, SSB communications receivers, transceivers, tests, and measurements.

This volume is addressed to persons who use SSB as well as personnel involved in the design, construction, installation, and maintenance of SSB equipment. Emphasis is on basic principles and circuitry, rather than mathematics. Where possible, representative commercial equipment is shown.

The sections on the design, construction, and adjustment of linear amplifiers contain enough information to permit any qualified person to build his own equipment. Detailed schematics are included in the special foldout section at the back of the book.

* * *

"RCA TRANSISTOR MANUAL" compiled and published by Commercial Engineering, *RCA Electronic Components and Devices*, Harrison, N.J. 07029. 544 pages. Price $2.00. Soft cover.

This revised and expanded edition (Technical Series SC-13) includes up-to-date information on the firm's complete line of semiconductor devices: bipolar transistors, MOSFET's, thyristors (SCR's and triacs), silicon rectifiers, tunnel diodes, and other semiconductor diodes.

The manual is divided into 21 sections including 116 pages of text, then technical data on specific products, outlines, circuits, and an index. Anyone working with transistors is almost certain to need the information contained in this handy manual. Because of its compact size, it could easily be carried in a coat pocket or in a technician's service-call caddy.

* * *

"ZENER DIODE HANDBOOK" complied and published by the Applications Engineering Department, *Motorola Semiconductor Products Inc.*, Box 13408, Phoenix, Ariz. 85002. Price $2.00. Soft cover, spiral bound.

This completely new handbook includes application information on zener diodes and zener-like devices. It covers applications for temperature-compensated zeners, reference standards, current-regulator diodes, and zener transient suppressors, as well as the latest types of zener diodes.

The handbook has been organized with the circuit designer in mind. It offers all necessary data for the efficient use of zener components with major emphasis on circuit design. Proven, basic circuits are also provided as take-off points for the designer's own requirements.

The material is divided into ten chapters dealing with zener diode theory, production techniques, reliability considerations for the circuit designer, characteristics, temperature-compensated zeners and special devices, basic voltage regulation using zener diodes, protective circuits and techniques, voltage sensing circuits and applications, miscellaneous applications of zener-type devices, and a selection guide for *Motorola's* regulator devices.

* * *

"ANALYSIS AND DESIGN OF INTEGRATED CIRCUITS" prepared by the Engineering Staff, *Motorola Inc.*, Semiconductor Products Div. Published by *McGraw-Hill Book Company*, New York. 539 pages. Price $16.50.

This is another volume in *Motorola's* excellent solid-state electronics series designed to keep engineers abreast of the latest developments in IC technology. It includes a detailed quantitative analysis and design techniques for both digital and linear integrated circuits. It uses a transistor model which is applicable to both types of integrated circuits and provides a theoretical foundation which will still apply even as the technology changes.

The text is divided into three main parts, each part containing five or more chapters. Part 1 covers the fundamentals of integrated circuit design, Part 2 is devoted to integrated logic circuits, while Part 3 discusses linear integrated circuits.

Six appendices have been included to provide the required reference material without recourse to other sources. The text is illustrated and the treatment is, of necessity, mathematical. Engineers and graduate students working in the IC field will welcome this in-depth treatment of the subject.

* * *

"ELECTRONIC DESIGNER'S HANDBOOK" by T.K. Hemingway. Published by *Business Publications, Ltd.* Available in the U.S. from *TAB Books*, Thurmont, Maryland 21788. 293 pages. Price $8.95.

The author, circuit consultant to *Marconi Instruments Limited*, has been involved with the design of transistor circuits since junction transistors first became available in the United Kingdom in 1954.

In this volume he is sharing his expertise with his fellow engineers. The book is divided into three parts: basic circuits, special circuits, and useful techniques. In sixteen chapters the author covers semiconductor diode properties, d.c. characteristics, the transistor as a switch, transistor T-equivalent circuit, linear sweep circuit, constant-current circuits, practical design of simple amplifiers, negative feedback, d.c. amplifiers, complementary circuits, a wide-range voltage-controlled oscillator, ultra-high gain in one stage, the transistor pump, the transistor cascode, bootstrapping, and prototype testing.

As is the case with most British engineering texts that reach these shores, this volume requires an engineering background and a familiarity with mathematical procedures. ▲

Medical Instrumentation

(*Continued from page 47*)

bio-system the researcher can save years of valuable research time in studying the responses of these systems to various stimuli. The computer also assists the medical researcher in performing statistical analysis of the results of experiments.

The transducer is of prime importance in medical systems. These devices convert pressure, temperature, or other physiological parameters into electrical signals. The transducer must, in some cases, be capable of withstanding the temperatures of sterilization. If the unit is to be implanted within the body or beneath the outer tissue, it must be chemically inert and not react with body fluids.

The Future of Medical Electronics

The laser has already found use in surgery, particularly in the field of eye surgery and the treatment of certain types of malignancies. Although much of this work is still experimental, the laser promises to be an important medical tool of the future.

The miniaturization of electronic circuits for aerospace applications may well provide medicine with a new generation of instruments. The notion of a TV camera that may be swallowed by the patient is not outside the realm of possibility. With such a device available, the need for exploratory surgery will be greatly reduced. Related to these miniature probes would be implantable transmitters for monitoring body functions, and artificial organs. Clearly, there is much important work to be done in these areas.

Besides the medical applications of the computer already mentioned, the ordinary bookkeeping chores of the hospital are readily performed by the computer. These tasks include keeping tabs on medications, special diets, patient progress, and the like. The computer thus serves to free hospital-staff personnel for more important tasks requiring their expertise.

The computer could someday serve as a diagnostic catalogue for the physician. Since many patients seen by general practitioners as well as specialists have their complaints diagnosed by comparison with other cases the doctor has observed, the computer could act as a memory device. By supplying the machine with input consisting of the patient's symptoms, the computer would classify the ailment by comparing the symptoms with other case histories. The computer would then diagnose the ailment and perhaps prescribe treatment. A bold suggestion to be sure, but recognition of the nature of the art reveals its feasibility. ▲

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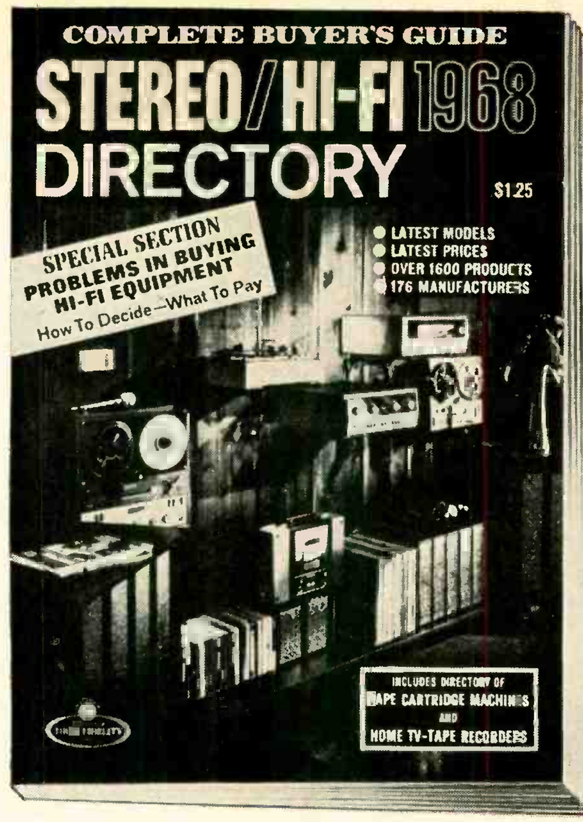
No salesman **knows** everything.



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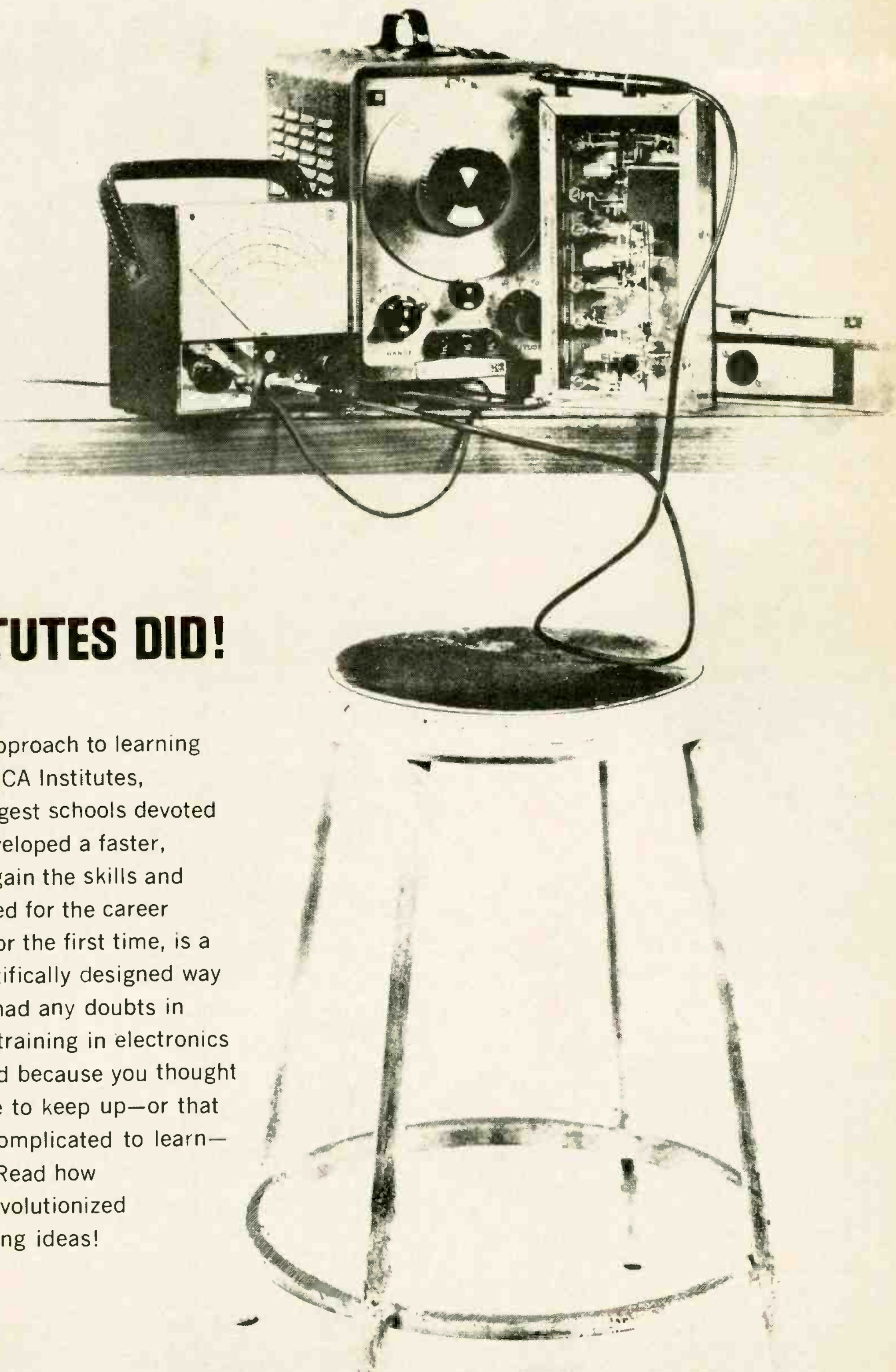

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Electronic Organ Kit
(*Continued from page* 54)

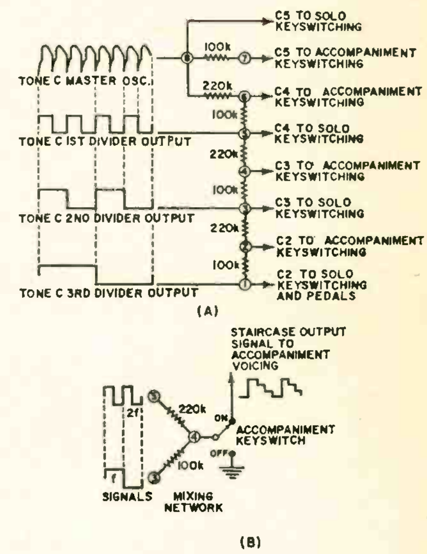
generator. This signal is eventually frequency-divided and is used as the low F key tone on the solo and accompaniment keyboards.

The output signals from each of the master oscillators, including the fundamental and the three subharmonics, are passed on to individual mixing circuits as shown in Fig. 3A. These signals are then directed to either the solo or the accompaniment keyboards as indicated. Since the square waves simply contain odd harmonics, as pointed out previously, it is necessary to provide harmonic mixing to develop the staircase output shown in Fig. 3B—which is now rich in both odd and even harmonics. The mixing of all notes pertaining to the accompaniment keyboard is done directly on the so-called distribution board. Those signals directed to the solo manual are mixed directly at the solo voicing circuits.

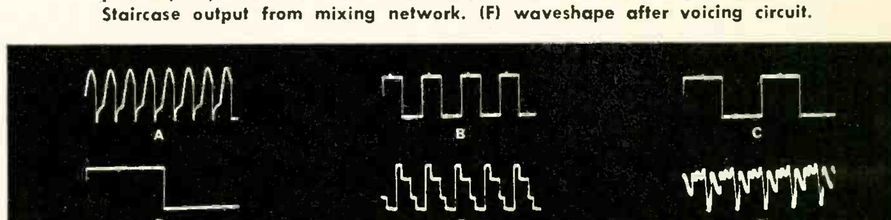
The output signals from the tone generators, in passing through the keying circuits just described, are extremely rich in harmonic frequencies. In order to develop the various complex voices, these same signals are passed through high-pass, low-pass and band-pass filters (or combinations of these). These passive filters shape the output signals so that they will have a harmonic content like that of the musical instrument being imitated. The bass clarinet voice, for example, uses only the 16′ tone signals, while the 8′ English horn, the 8′ violin, and the 8′ oboe mix 8′ and 4′ tone signals to develop their particular responses.

The voicing circuits of any organ are the most critical design problems. Variations among different makes are usually the result of different design philosophies. Once the voicing circuits have been determined, the balance of the circuitry is straightforward. Preamplifiers are used to drive a power-amplifier system. In the TO-67 organ, two separate power amplifiers are used. As mentioned previously, one drives two 12″ cone speakers and the other drives the 2-speed Leslie rotating-baffle speaker system. ▲

Fig. 3. (A) How tone signals from master oscillator and divider stages are combined prior to being connected to the solo and accompaniment manuals. Note that points 2, 4, and 6 are mixed outputs. (B) One of the mixing circuits used to obtain staircase output. Example shown combines tones C3 and C4. The various voices are obtained by combining harmonic related tones in specific relationships and then passing them through specially designed filters.



Waveshapes taken from Heath-Thomas TO-67 organ showing progression of waveshaping taking place from original oscillator to the final amplifier. Waveforms taken were those using the clarinet voicing tab. (A) Basic oscillator output. (B), (C), and (D) show second, third, and fourth divider stage outputs. (E) Staircase output from mixing network. (F) waveshape after voicing circuit.



MINIATURE RELAY DOES GIANT JOB

ALTHOUGH less than half as big around as a dime, a new signal switching relay developed by Hi-Spec Electronics Corp. claims to outperform other relays in crystal or TO-5 cans. "It's more reliable, consistent, and predictable", they say.

According to Hi-Spec engineers, the Type RD relay has only one moving part, an armature. There is no intermediate actuator or moving contact spring. A gold button is bonded directly to the armature and, as the armature responds to the magnetic force of an energized coil, the contact moves with it. Lack of moving parts helps make the relay more reliable.

The RD relay's moving contact travels one-third the distance of conventional relay contacts in the same time. Consequently, the RD's contacts move at a lower average speed and less kinetic energy is dissipated in the mating process. This reduces relay bounce. ▲

NEW MEDICAL TOOL

DEVELOPMENT of an old idea and a new tool is under way at *Applied Radiation Corp.* in Walnut Creek, Calif. It is an electron linear accelerator. It will be the newest and largest device ever developed for cancer treatment; even more importantly, it will provide doctors with three forms of high-energy radiation—neutrons, x-rays and electrons—to more effectively treat different types of cancer.

The new accelerator, called the Mevatron 50, will have a maximum energy output of about 50 million electron volts. Earlier medical linear accelerators have operated in the 1- to 15-MeV maximum energy range. The first Mevatron 50 is being built for Roswell Park Memorial Institute in Buffalo, New York at a cost of $600 thousand. It's due for completion next year.

In addition to its therapeutic capabilities, the accelerator has a second function. It can produce short-lived radioactive isotopes for diagnostic studies and medical research. The isotopes are produced by bombarding materials such as iodine and chromium with neutrons in the accelerator's neutron head.

The Mevatron 50 will be the first practically useful machine capable of generating neutrons for precise cancer treatment. Research in neutron therapy has been carried on at the University of California and at the Brookhaven Laboratory of the Atomic Energy Commission using reactors. Hammersmith Hospital of London has treated patients with neutrons generated by a cyclotron.

The usefulness of neutrons stems from the chemical differences found in the different parts of the tumors and from the physics of interaction among x-rays, electrons, and neutrons and the particular atoms they bombard. Electrons and x-rays are absorbed by collision and interact mainly with other electrons; that is, they interact with atomic particles that have many electrons in their outer shell. Neutrons interact best with the larger particles found in the nucleus of the atom (neutrons and protons).

In treating malignancy, the outer portions of many tumors can be made to have a high oxygen content which may render those portions responsive to treatment by x-ray or electron therapy. The inner portions of these tumors, however, are often oxygen deficient but since they contain much hydrogen they are susceptible to destruction by neutrons. When hydrogen nuclei capture neutrons, they release protons which can have a highly destructive effect on malignant cells. Hence, neutrons should prove useful in treating the inner tumor tissues. ▲

TELEPHONES OUTDATE SIRENS

Telephone alarms reach fire stations quickly and quietly.

VOLUNTEER firemen in hundreds of towns across the country no longer listen to coded signals from a centrally located horn or siren. Special telephone conference circuits have been installed which enable fire department dispatchers to contact all firemen in a particular area simultaneously and tell them the fire's location and give other instructions.

According to James J. Clerkin Jr., Executive Vice-President, Telephone Operations of the *General Telephone & Electronics Corp.*, development of the telephone alarm system has helped fire departments expedite emergency calls. "It unquestionably has been a major factor in minimizing losses caused by fire," he said. *GT&E* operating companies have installed more than 500 emergency alerting systems for volunteer fire companies.

In most systems when fire calls are received, the dispatcher lifts a telephone receiver connected to the fire-alerting conference circuit which links the homes of all volunteer firemen. If a fireman's telephone is busy, a special tone is sounded on his line as a signal for both parties to hang up. Firemen responding to the tone are connected to the conference circuit when they depress and release the switchbutton on their telephones. The dispatcher then gives location of the fire and other information simultaneously.

There are several variations of the system. In one, the fireman on duty repeats the fire location and other instructions into a recording machine and then dials a three-digit number on a special telephone which causes the telephones of all the volunteer firemen to ring. As each fireman answers, he hears the recorded message and then leaves immediately for the fire.

In another variation, telephone-alarm boxes in residential and business districts are tied to call-recording equipment and an operator's console in the main fire station.

The moment a person reporting a fire lifts one of these phones, the fire station operator is alerted by a buzzer and a flashing light keyed to the telephone. Simultaneously, the call activates two supplemental devices—an electric typewriter which automatically makes a printed tape of the calling telephone's number plus the time and date the call was made; and a tape unit which records the entire conversation between the caller and the fire station operator. ▲

ELECTRONIC CROSSWORDS

By JAMES R. KIMSEY

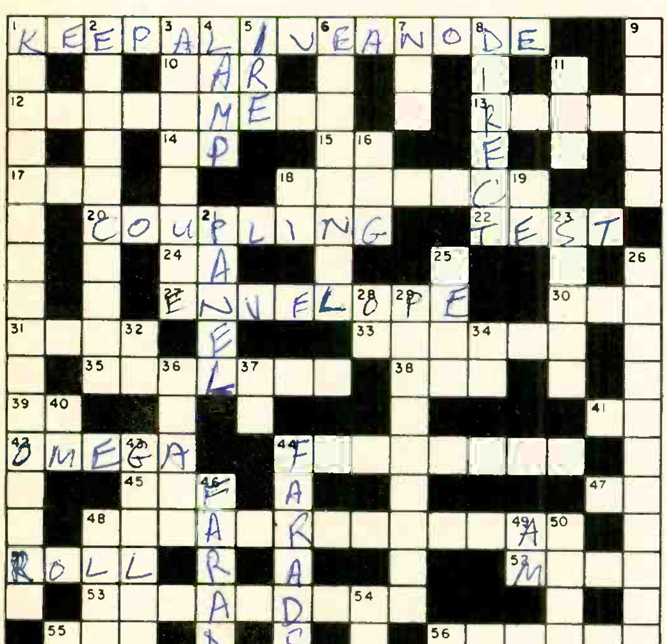
(*Answer on page* 102)

ACROSS

1. An auxiliary electrode that maintains a d.c. discharge in a mercury-pool tube (3 words).
10. Airfield radar system aimed along the approach path of an aircraft and used for its guidance during approach (abbr.).
12. A small change in the value of a variable.
13. General term for a receiver.
14. Tube manual abbreviation.
15. Urban transportation system (abbr.).
17. To place a binary cell in the "1" state.
18. A modulator whose output is substantially equal to the carrier × the modulating wave.
20. The association of two or more circuits or systems in such a way that power may be transferred from one to another.
22. A procedure for determining how certain equipment is operating.
24. Egyptian sun god.
27. Housing for a vacuum tube.
30. ______wave antenna: a receiving antenna suitable for use over a wide range of frequencies.
31. An inert element from Group O of the Periodic Table.
33. To line with sound-absorbing material.
35. Central part of an atom.
38. Agency of the FCC set up to detect unlicensed radio stations (abbr.).
39. FCC designated frequency band between 30 and 300 kHz (abbr.).
41. ______switch: an electronic antenna switch.
42. Greek letter used to designate "ohms".
44. Common computer circuit (2 words).
45. Complete system of components.
47. Part of "to be".
48. Array of dipole antennas aligned in a vertical plane, known as the radiating curtain, with a second parallel array forming the reflecting curtain (3 words).
51. Upward or downward movement of a TV picture due to lack of vertical sync.
52. A method.
53. ______reception: a form of superhet reception in which i.f. signal is obtained from auxiliary oscillations superimposed on the plate circuit of the first tube.
55. Becomes stable and constant through storage, as electronic components, sometimes under power.
56. Mechanism used on indexed rotary switches to hold the switch firmly in each position.

DOWN

1. A folded horn, back-loading speaker assembly (tradename, 2 words).
2. Ornamental plate around an opening.
3. In a TV camera tube, the cross-sectional area of the scanning beam.
4. General term for an artificial source of light.
5. Former name of the industry's engineering group (abbr.).
6. ______circuit: all wires and other conductors which are outside the source.
7. A terminal (abbr.).
8. An electric current that flows in only one direction.
9. To amplify.
11. Automatic compass (abbr.)
16. Communications record.
18. 3.1416.
19. Chemical symbol.
21. Electrical instrument board.
23. Part of a phonograph needle which is clamped into the pickup or cutting head.
25. Prefix meaning "half".
26. Having the property of emitting light during electronic bombardment.
28. Cable dimension (abbr.).
29. ______amplifier: a type of amplifier which converts a single-ended input circuit into a push-pull output circuit.
32. Greek letter used to designate reluctivity, frequency.
34. Voltage drop (abbr.).
36. ______reaction: a self-sustaining reaction.
37. For example.
40. Broadcast band.
43. Wood or metal bars across the front of a speaker in a receiver for protective purposes.
44. Units of capacitance.
46. Toothed wheels for transmitting energy.
48. Connecting device on the end of a cord.
49. Common system of radio broadcasting.
50. Set of coils placed over neck of magnetically deflected CRT to deflect the electron beam when currents are passed through them.
54. Canadian Province (abbr.).



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

DISC CAPACITOR LINE

An improved line of "Ultra-Kap" disc capacitors that provide more capacitance although the units are smaller in size has just been announced.

Rated at 16 and 25 volts, these new disc capacitors outperform the company's 3, 10, and 20 volt "Ultra-Kaps" which feature 100 times the capacitance of conventional ceramic dielectrics. Units are available with capacitance values of 0.01, 0.022, 0.033, 0.05, 0.068, and 0.1 μF.

Leakage resistance of the 16 and 25 volt units is 10 megohms while the maximum dissipation factor is 5% at 1 kHz. Disc diameters vary from 0.290" to 0.760" and all units have a maximum thickness of 0.156". Centralab

Circle No. 126 on Reader Service Card

SNAP-ON VOLT-OHM-AMMETER

The "Snap 6" is a portable, pocket-size snap-around volt-ohm-ammeter featuring a rotary dustproof meter compartment that snaps into 5 positions. The scale always faces the user and permits easy reading in crowded switch boxes. Its insulated snap-around jaws allow instant and accurate current measurements without service interruption or shutdown.

Readings are on a graduated scale. A rotary dial selector snaps the scale selected into position. The instrument is available in three models, each with six ranges: two current, three voltage, and one ohmmeter.

A data sheet providing full specifications on the unit will be forwarded on request. A.W. Sperry

Circle No. 1 on Reader Service Card

OUTLET PLATES FOR TV/FM

A series of outlet plates that install flush on the wall and provide plug-in outlets for TV and FM sets and speakers is now available as "Colortap".

These outlets offer a number of new features. In addition to providing convenience, they are specially designed to withstand the heavy abuse to which such outlets are subjected. "Colortap" consists of a flush-mounting wall plate to which the antenna lead-in cable is attached via screws. It is not necessary to strip the lead-in. There is also a plug to which the twin-lead is attached with just a turn of one screw. To assure a long-lasting connection, an exclusive automatic detent locking plug holds the twin-lead secure and assures positive connection. Beryllium-copper contact springs are used for long life. Blonder-Tongue

Circle No. 2 on Reader Service Card

VARIABLE-SPEED JIG SAW

A new sabre/jig saw with a thumb-pressure-operated speed control provides proper torque and continuously variable cutting speeds from 0 to 2800 one-inch strokes per minute.

The Model 521 incorporates the special "Mind Reader" switch which reacts to the downward pressure of the operator's hand on the handle. The pressure speed control is built into the forward or guiding position of the saw's handle.

The tool is powered by a heavy-duty ½-horsepower, 4-amp a.c. motor. The power is transmitted to the blade by heavy-duty hardened gears and the saw runs smoothly through the use of heavy-duty roller and oilite bearings.

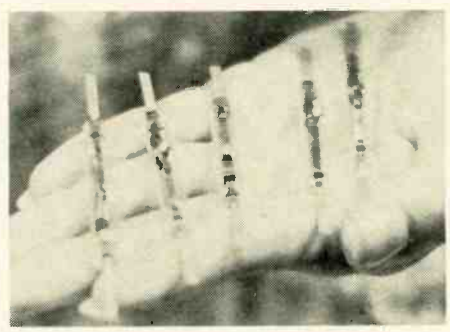
Completely portable, the Model 521 weighs 4½ pounds and is equipped with a 6', 16 gauge, 3-wire electrical cord and grounding plug adapter. It measures 8½" long x 4½" wide x 8" high. It operates on 110-120 Hz a.c. and is UL approved. Wen

Circle No. 3 on Reader Service Card

INDUSTRIAL REED SWITCH

A reed switch capable of handling higher industrial loads without the need for arc suppression circuitry or intermediate amplification has been introduced as the "Powereed".

The new unit will take an inductive inrush of 15 amperes or 1875 volt-amperes and break current loads of 3 amps or 375 volt-amperes when operated at 125 volts a.c. At 250 volts a.c., the switch will stand an inductive surge of 10 A or 2500 volt-amperes and break current loads of 2 A or 500 volt-amperes.



The switch has hermetically sealed contacts, high reliability, and long life, according to the manufacturer. The performance of the switch is obtained by means of separate members for current carrying and magnetic path. There is a fixed air gap between the terminal and the armature, assuring clean dropout by reducing the effects of residual magnetism.

A data sheet listing comparative characteristics between conventional reed switches and the "Powereed" is available on request. Cutler-Hammer

Circle No. 127 on Reader Service Card

PHOTOCONTROLLED RESISTORS

A new photocontrolled resistor (Type 5082-4510) uses a cadmium-sulfoselenide photocell to obtain stability in a changing temperature environment. The photocell resistance, when illuminated, changes typically by a factor of only 1.5 with a change in temperature from 25 to 65 degrees C.

The photocontrolled resistor contains a 12-volt incandescent lamp that illuminates the photocell. The illumination level controls the cell resistance over more than a 5-decade range, from greater than 100 megohms with the lamp dark to less than 1000 ohms with maximum permitted input power (12 V, 45 mA).

These are useful wherever high isolation is required between controlled and controlling circuits, such as in current monitoring in high-voltage supplies or silent switching of channels in a communications system. Electrical isolation between lamp and photocell is greater than 10^{12} ohms and coupling capacitance is less than 0.01 pF. Hewlett-Packard

Circle No. 128 on Reader Service Card

HEAT-SHRINKABLE TUBING

The newly developed Type VII heat-shrinkable neoprene tubing shrinks down promptly to 25% of its supplied i.d. (with some longitudinal foreshortening) upon exposure to heat of 160° F, without cracks. Shrinkage can be restrained at any point.

The tubing is especially suited for encapsulating soldered joints, parts, components, plastic fittings, metal or wood, terminals, harness jackets, etc. One supplied size may be used for a variety of intermediate recovered requirements. Standard availability, black only, is ½", 1", 1½" 2" i.d. Product bulletin #71SN contains full details. Penntube

Circle No. 129 on Reader Service Card

FOUR-LAMP SYSTEMS

Four-lamp types have recently been added to the firm's line of CR103 Type D illuminated push-buttons and indicating lights. Designed for use on power-station control and instrument panels, laboratory instruments, computer consoles, and other types of equipment where positive indication of status is a requirement, a maximum of two lamps are on at any one time, the other two lamps in the four-lamp system lighting only should a primary lamp fail. The additional lamps also eliminate the necessity for frequent bulb replacement in many applications.

Three contact actions and four contact arrangements are available. The complete line comes in a variety of housing colors and color field divisions. Full details will be forwarded on request. General Electric

Circle No. 130 on Reader Service Card

COLOR-TV RECEIVER KIT

A color-TV receiver kit, engineered for training purposes, is now being marketed as the Model 600. A table-top model with 180 square inches of viewing area, the new receiver comes with a wood-tone vinyl-clad steel cabinet.

Printed-circuit boards are used throughout to speed assembly. The design incorporates 21 tubes, a solid-state u.h.f. tuner, solid-state noise

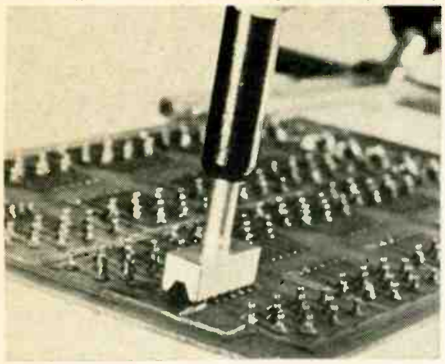
cancellation circuit, and 16 solid-state diodes. The low-voltage power supply contains three silicon rectifiers.

Separate gun killer switches and a crosshatch generator are built in for ease and convenience of maintenance. The Sylvania rare-earth picture tube has a bonded, non-glare face for maximum brilliance. According to the company, the kit builder will need no special tools or expensive

test equipment to assemble this receiver. Conar
Circle No. 4 on Reader Service Card

IC DESOLDERING TIP

IC removal now takes only seconds with the new IC desoldering tip just put on the market as the #859. Chromed and pre-tinned, the tip



is designed for use with the company's 46½-watt heat unit #4045 and #776 or #777 clean room handle.

The IC desolderer melts all sixteen solder pads at the terminals simultaneously, freeing the IC in less than 30 seconds. This is in marked contrast to the usual way of desoldering one terminal at a time. Ungar
Circle No. 5 on Reader Service Card

VIDEO TAPE RECORDER

A self-contained, high-resolution, moderately priced video tape recorder has just been put on

the market as the Model SV-8000U. The new unit has guaranteed tape interchangeability from one SV-8000U to another or any other model in the company's ½-inch SV series. The new unit features a built-in 9-inch receiver/monitor and an audio-video modulator.

The new recorder has been designed especially for business, industrial, and educational use. It employs two rotary heads of specially developed metal and operates on the helical-scan recording principle. Response is more than 3.5 MHz, providing more than 300 lines of horizontal resolution and 42+ dB signal-to-noise ratio.

The ½-inch video tape used in the machine permits up to 60 minutes of continuous recording on a 7-inch reel at 7½ in/s. It records "live" action in sight and sound using a CCTV camera, or directly off-the-air through its built-in receiver/monitor.

The recorder measures 30" w. x 11" h. x 17½" d. and weighs 75 pounds. Shibaden
Circle No. 6 on Reader Service Card

MOLDED PUSH-BUTTON SWITCH

A new molded push-button switch providing extended, snap-in modular applications with unlimited stacking, short stroke, and light operating pressure has just been put on the market.

The new switch is intended primarily for electronic data processing peripheral equipment, but is also suitable for test equipment, communications gear, and other applications where its special features are required.

The switch clip is available in silver-plated brass; silver alloy; silver alloy, hard-gold plated; and silver alloy with hard-gold alloy rolled on the surface.

An almost unlimited number of switch combinations can be built using the modular molded unit. Up to 12 switches can be snapped into a mounting channel and any number of channels can be stacked. The units have either inboard or outboard mounting capability. The push-buttons are ¾" on center. Maximum push rod length is 2¾". Oak Electro/Netics
Circle No. 131 on Reader Service Card

GARAGE-DOOR OPERATOR

The new "Electro-Lift" garage-door control is activated by a cigarette-package-size remote control unit which uses a patented "Pulse Tone" triple code to eliminate accidental operation of the door by other garage-door openers in the neighborhood, by aircraft, or by pranksters.

The door-control motor housing has been streamlined and has no exposed wires or gears. The wall-mounted radio receiver is accessible for ready maintenance and the auxiliary control button on the receiver adds flexibility to the system.

The system's instant-stop feature makes accidents impossible. The instant an obstacle is encountered the door stops. When started again, it automatically reverses direction, eliminating the danger of a person or object being trapped. "Electro-Lift" is all solid-state. Perma-Power
Circle No. 7 on Reader Service Card

REGULATED D.C. SUPPLY

A regulated miniature power supply, designed to apply conditioning voltages to integrated circuits, has just been introduced.

Measuring 1.475" h. x 3¼" w. x 4" l., it provides a 50-W power output at 10 amperes. Input is 117 volts, 47-500 Hz with both single- and three-phase 400 Hz available. The regulated d.c. output has transformer isolation. Overcurrent protection is a standard feature, as is RFI shielding. The supply can also be furnished in 20-,100-, and 250-watt versions. General Power
Circle No. 132 on Reader Service Card

ALL-CHANNEL ANTENNAS

Two new antenna kits for use on travel trailers and mobile homes have just been introduced as the Models TTR-1 and TTW-1.

The TTR-1 consists of an all-channel u.h.f.-v.h.f.-FM antenna mounted on a telescoping mast and rotator mechanism which allows the antenna to be rotated from inside the vehicle through a full 360°. When on the move, the antenna is folded down, closed up, and locked in a safe travel position below the vehicle rooftop.

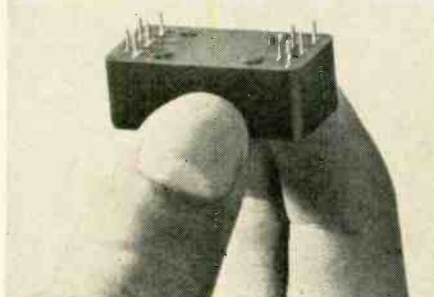
The TTW-1 is an all-channel u.h.f.-v.h.f.-FM antenna which mounts to the vehicle on a wall mount. The antenna and top mast section are removed for travel. The fully preassembled antenna elements simply snap closed for convenient storage. Finney
Circle No. 8 on Reader Service Card

REED RELAYS FOR PC BOARDS

Miniature dry-reed relay packages for printed-circuit boards combine the advantages of open construction with the ruggedness of molded and encapsulated units, according to their maker.

Designated Series MRRK, the package has a two-piece, molded thermoplastic case. Terminals and cover are welded ultrasonically to form a sealed, moisture-proof enclosure. The design minimizes distortion of the glass-encapsulated reed switch that can occur in molded and encapsulated units.

The relay base holds up to 10 terminals with



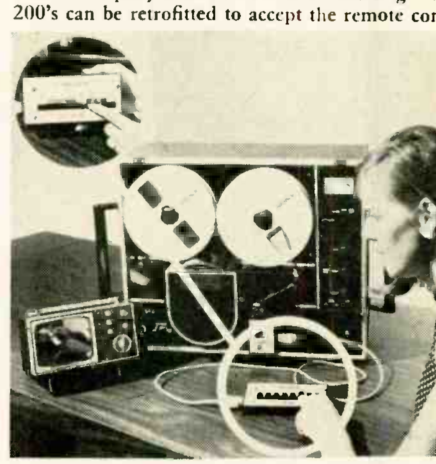
0.1" grid spacing. The case measures 0.66" w. x 1.1" l. x 0.48" h., excluding terminals. One standard terminal layout and case size can accommodate most coil and contact combinations found in PC boards. The package can enclose both single- and double-coil relays.

Full details on the line and available configurations are included in Data Bulletin B/3110 which will be forwarded on request. Struthers-Dunn
Circle No. 133 on Reader Service Card

REMOTE CONTROL FOR VTR

A self-contained remote control model of the EV-200 "Videocorder" is now available. Known as the EV-200R, the new unit includes eight push-buttons on a detachable control panel which can be used up to 300 feet away from the recorder. Controls are "Audio Dub", "Record", "E-E" (electronics to electronics), "Slow", "Fast Forward", "Forward", "Stop", and "Rewind".

The company announced that all existing EV-200's can be retrofitted to accept the remote con-



trol unit. Complete specifications on both the remote control and the new EV-200R will be supplied on request. Sony
Circle No. 9 on Reader Service Card

POWER SUPPLIES FOR IC'S

The "D" and "H" series modular and rack power supplies are available with voltage and current levels for all types of integrated circuitry. The response to overvoltage of less than 10 μs and a maximum voltage overshoot of 0.5 volt above the overvoltage set point guarantees protection of the integrated circuitry.

The supplies have fixed overvoltage protection, output resolution as low as 1 mV, and the absence of "on-off" overshoot. Four models are currently available: a 5-volt modular unit with 0-1 A rating, a 5-volt bench or rack unit in three ratings of 0-6.4 A, 0-25 A, and 0-50 A. Voltage regulation (line and load) is ±0.05 or ±1 mV for modular and bench rack models, with regulation available to 0.005%. Dynage
Circle No. 134 on Reader Service Card

HI-FI—AUDIO PRODUCTS

ECONOMY P. A. AMP LINE

An economy line of public-address amplifiers is now available in four models as the "Challenger" CHS series.

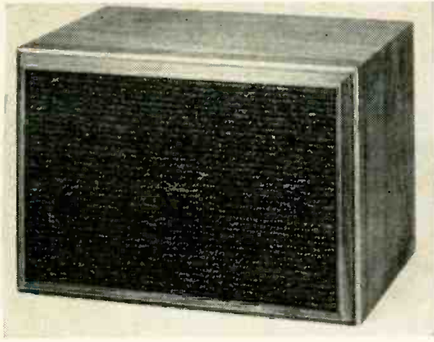
Ranging in power from 20 watts to 100 watts, the amplifiers will operate continuously at full output from −20°C to +65°C. All major components are mounted on printed-circuit boards which insure uniformity of manufacture and result in significant savings to the user, according to the company.

In the higher powered models, CHS100 and CHS50, all-silicon semiconductors are used. Rated at 100 and 50 watts, respectively, these amplifiers provide two microphone inputs. The 35-watt model, CHS35, also offers two microphone inputs and may be operated from a 12-volt battery as well as a.c. The Model CHS20 is similar to the CHS35 except that it is rated at 20 watts and has one microphone input. All

models have two auxiliary inputs on fader control. Bogen
Circle No. 10 on Reader Service Card

COMPACT SPEAKER SYSTEMS

A complete line of compact and bookshelf speaker systems has just been introduced under



the company's "Maximus" label to meet the demand for quality yet budget-priced systems.

The line ranges from the "Maximus 22", a two-way system of compact size, to the "Maximus 55", a full three-way system which may be used horizontally on bookshelves or, in a vertical position, free-standing.

All units in the series feature acoustic-suspension woofers, with unique magnetic design which permits their use with amplifiers of relatively low power. All have removable grilles to allow substitution of custom grille fabrics to blend with any special decor and hand-rubbed oiled walnut cabinets. UTC
Circle No. 11 on Reader Service Card

ELECTRONIC TELEPHONE ANSWERING

An electronic telephone answering unit for home or office has been introduced as the Crown "Telephone Valet". The unit automatically an-

swers the phone, relates a prerecorded message, and then feeds the caller's message into a tape recorder. When the caller finishes with the message, the telephone valet automatically hangs up the phone.

The unit will work with any transistorized tape recorder. The number of calls answered and recorded is limited only by the tape reel size of the recorder used. When used with a 3¼" recorder, up to 120 messages can be recorded and twice that number with 5"-reel units. The Model CTA4000 measures 8¼" x 2" x 10½" and weighs 4.4 pounds. Industrial Suppliers
Circle No. 12 on Reader Service Card

8-TRACK HOME TAPE PLAYER

The MJC-26 "Mark 8" tape player is an ultra-compact unit which plugs into the tape jack

provided on many stereo consoles, stereo receivers, or component systems. While small in size, the unit plays the "Stereo-8" tape cartridges, offering 80 minutes of uninterrupted music. Featuring a highly styled wood cabinet, the MJC-26 measures only 3⅝" high x 6¾" wide x 9¾" deep. There is an illuminated indicator which highlights the particular pair of tracks being played. RCA
Circle No. 13 on Reader Service Card

CARDIOID MICROPHONE

A new cardioid microphone, designed for various p.a. and recording applications, is now being offered in two models.

The Model 700 offers a choice of high or low impedance while the Model 701 is high impedance only, with a frequency response of 100-13,000 Hz and a —56 dB output level. It has a removable cable.

Both microphones feature modern styling, satin chrome finish, "on-off" switch, and an internal foam pop and blast filter. Turner
Circle No. 14 on Reader Service Card

HOME MUSIC SYSTEM

A complete home entertainment system which provides for AM-FM-FM stereo listening, tape recording, and tape playing has just been introduced as the Model HES-1.

The system includes a stereo receiver, compact stereo cassette tape deck, and two acoustically matched hi-fi speakers designed to fit on a bookshelf, inside a small cabinet, or other limited-space areas.

The receiver features an exclusive stereo indicator system for tuning accuracy; a.f.c.; stereo balance, bass, and treble controls; back-lighted tuning dial; and a five-position mode switch. Frequency response of the solid-state receiver is 40-18,000 Hz with stereo separation of 25 dB at 1000 Hz. Power output is 10 watts. The receiver measures 14⅞" wide x 4¾" high x 10⅜" deep.

The speaker systems each measure 7⅜" wide x 9½" high x 4⅝" deep. The stereo cassette, whose response is 40-18,000 Hz, measures 9½" wide x 2½" high x 8" deep. The entire system is housed in dark-grained teak cabinets. Concord
Circle No. 15 on Reader Service Card

FM-STEREO RECEIVER

The new Model 711B FM-stereo receiver features integrated circuitry, an FET tuner section, silicon transistors throughout, and an IHF rated output of 100 watts dynamic power (50 watts per channel).

The tuner section uses a four-gang tuning capacitor to provide a maximum ratio of selectivity. The 711B has complete facilities for operation of a record player and tape recorder, headphones, and remote speakers—which may be operated simultaneously with the main speaker

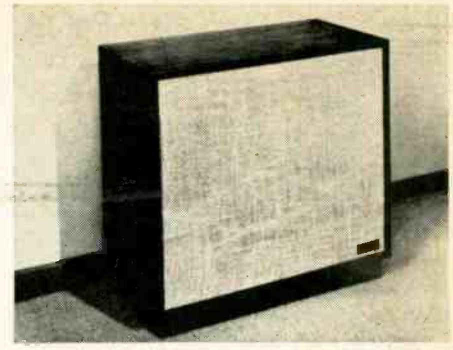
system. The transistorized circuitry is protected by automatically resetting circuit breakers.

Amplifier frequency response is 15-30,000 Hz ±1 dB. Tuner sensitivity is 1.9 μV and capture ratio is 2.5 dB. The complete unit measures only 5⅜" high x 16⅜" wide x 12" deep. It is housed in a simulated walnut metal case with satin black and gold anodized panel. A hand-rubbed walnut cabinet is available at extra cost. Altec Lansing
Circle No. 16 on Reader Service Card

CONSOLE SPEAKER SYSTEM

The Z-960 is a full-range, console loudspeaker system which incorporates three electrostatic radiators for the treble and a specially designed dynamic cone woofer for the bass.

Low frequencies in this newest JanZen speaker are handled by the Model 350D cone woofer



which has a heavily weighted, high-compliance cone capable of ⅝" excursions without breakup or doubling. The woofer is sealed in a fiberglass-filled enclosure with the three electrostatics to provide a highly linear response from 30 to beyond 30,000 Hz.

The oiled walnut enclosure measures 26¾" high x 27½" wide x 14½" deep. The speaker is designed to be used with any high-quality amplifier of 20 watts or more. Neshaminy
Circle No. 17 on Reader Service Card

3-CHANNEL HOME MUSIC SYSTEM

A three-channel stereo system which incorporates separate amplifiers for each of the three separate speaker systems has been introduced as the "Triphonic 75".

This complete home music center has provisions for a turntable or record changer, tape

recorder, and stereo headphones. The system consists of an FM-stereo receiver and three individually amplified speaker systems in a compact unit. The right- and left-channel speakers measure 14" x 7½" x 3¼" while the third speaker measures 14" x 10" x 5" and is designed to be placed anywhere in the room for effective dispersion of the bass frequencies from 25 to 100 Hz. The receiver measures 14" x 10¼" x 5¼" and is housed in a walnut case which matches the speaker enclosures. Grille cloths are available in sand beige, Oriental cane, royal maroon, Danish green, and Spanish olive.

The receiver delivers 75 watts of dynamic power. Construction is modular. It features a stereo indicator light, center-scale tuning meter, speaker "on-off" switch, and a stereo headphone output jack. Compass
Circle No. 18 on Reader Service Card

122-WATT SOLID-STATE RECEIVER

The new Model 399 is a 122-watt, AM-FM-stereo receiver which uses 82 semiconductors in its solid-state circuitry. The receiver, with full-feature stereo preamp, tunes FM-stereo, FM mono, and wideband AM.

The FM circuit has four dual-tuned i.f. stages, interstation muting, two limiters, Schmidt all-electronic automatic stereo/mono FM switching, nuvistor front-end, and a multi-ganged tuning capacitor with independent oscillator.

The amplifier section provides power output of 244 watts peak, 122 watts total IHF, 43 watts per channel continuous sine-wave at 4 ohms. Frequency response is 18-60,000 Hz ±1 dB. Inputs are provided for magnetic and ceramic phono

(Continued on page 101)

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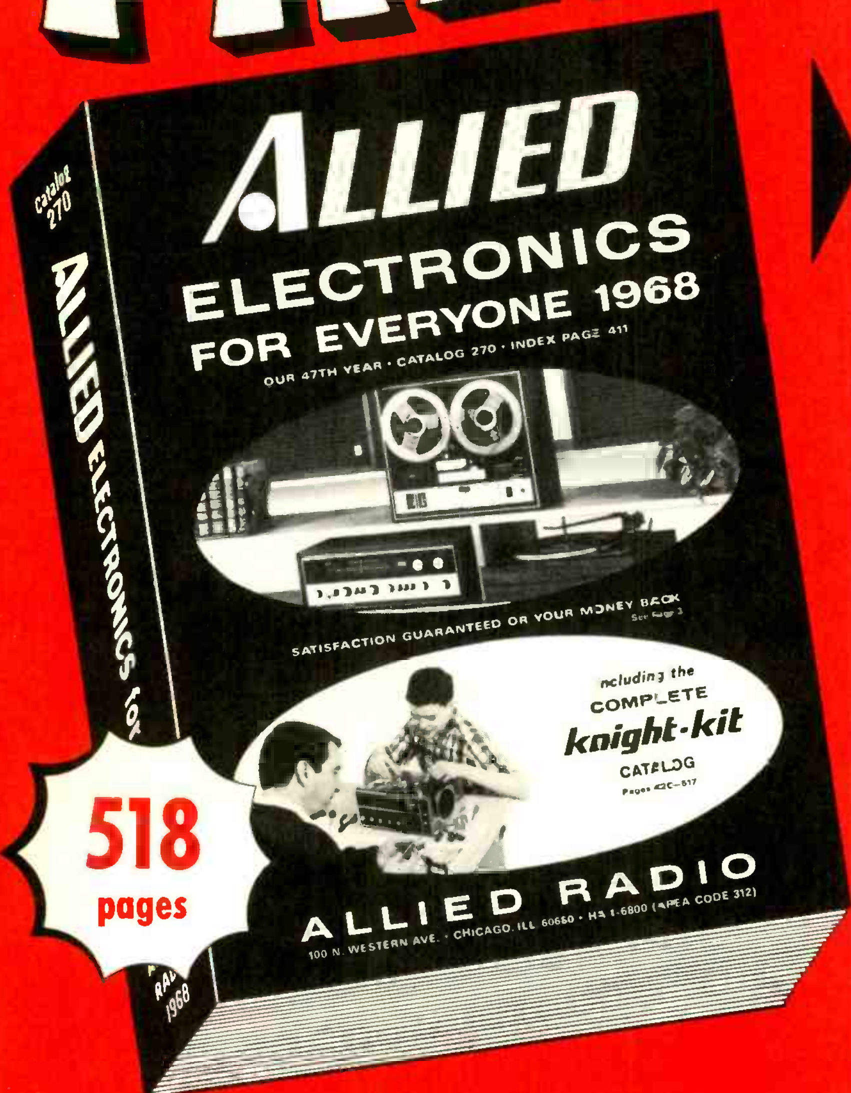

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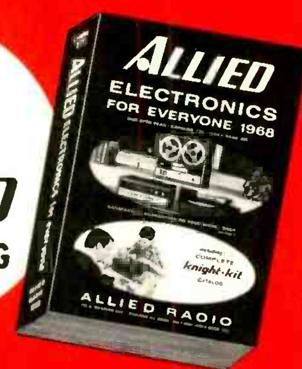

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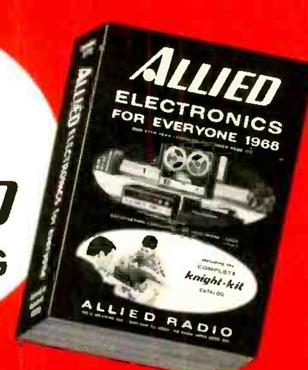

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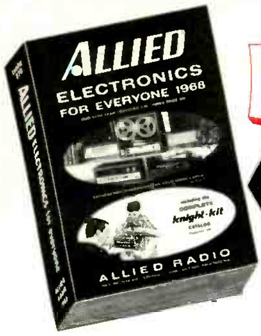

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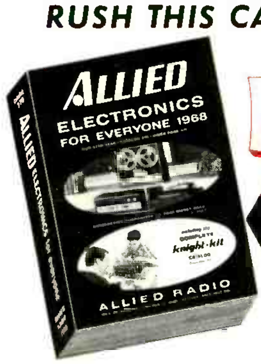

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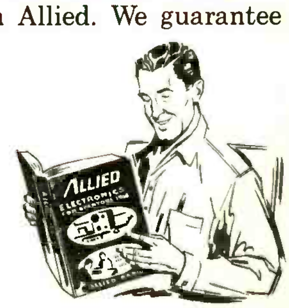


cartridges, tape head, tape monitor, and auxiliary. Outputs are provided for 4-16 ohm speakers, recorder, and headphones.

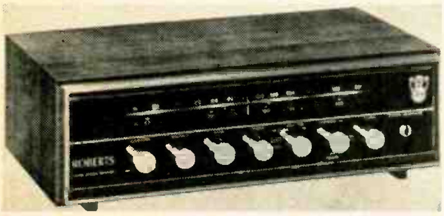
The Model 399, which measures 16" wide x 12" deep x 5" high, comes in a metal case. An optional walnut wood case is available at extra cost. Allied Radio

Circle No. 19 on Reader Service Card

AM-FM-STEREO RECEIVER

The Model 30 is a 30-watt peak AM-FM-stereo receiver, housed in a furniture walnut cabinet, which provides plug-in connections for tape recorder and record changer.

Special features of the new unit are controlled-injection a.f.c., a broad-scale logging dial, all-



solid-state circuitry, and sufficient output to drive the new acoustic-suspension speaker systems.

Full specifications on the Model 30 will be forwarded on request. Rheem Roberts

Circle No. 20 on Reader Service Card

90-MINUTE TAPE CASSETTE

A 90-minute tape cassette, containing Scotch brand "Dynarange" oxide-coated tape, is now available as No. 292 C-90.

According to the company, the Dynarange construction provides better recording and playback characteristics at the slow operating speed of 1⅞ in/s. The tape also incorporates the company's special silicone lubrication which permits the tape to glide smoothly over the recorder heads with a minimum of friction and wear.

The cassette has a large window to permit easy checking of tape consumption. The heat-resistant cassette comes in a mailable plastic box. The 60-minute version of this cassette is catalogued as the No. 271 C-60. 3M

Circle No. 21 on Reader Service Card

INTEGRATED SPEAKER SYSTEM

The IS-80 is a three-speaker system which is driven by two 45-watt solid-state amplifiers and an electronic crossover network that has been matched electronically to the speakers' characteristics. It can be used as one channel of a stereo system or as a complete mono system.

The integrated speakers provide wide linear response with very low distortion, according to the manufacturer. The system produces a maximum of 1% harmonic distortion throughout the entire frequency range of 30 to 20,000 Hz.

Amplifier controls on the front of the speaker enclosure can be adjusted to achieve acoustic balance in any room environment. Pioneer

Circle No. 22 on Reader Service Card

30-WATT SOLID-STATE RECEIVER

An all-transistor AM-FM-stereo tuner/amplifier, the LR-99, delivers 30 watts of dynamic power at 8 ohms, 15 watts per channel. The tuner section features a stereo search function that produces a tone to audibly indicate when an FM-stereo station has been tuned in. The illuminated d'Arsonval tuning meter pinpoints both AM and FM stations.

The receiver has flywheel tuning, each channel has ganged bass and treble controls, rocker

switches for a.c. power, loudness, mode (stereo/mono), stereo (receive/search), hi-filter, and speakers (main/remote).

Frequency response at 1 watt is 20-20,000 Hz ±2 dB, power bandwidth is 40-17,000 Hz. The tuner section has an IHF sensitivity of 3 μV and image rejection of 55 dB. Stereo separation is 32 dB at 400 Hz.

The receiver measures 13¼" wide x 4½" high x 10" deep. It is housed in a simulated walnut-grain metal case with a gold finish extruded aluminum panel. Lafayette

Circle No. 23 on Reader Service Card

LOW-NOISE MASTERING TAPE

A new low-noise mastering tape for use with professional and consumer recorders is now available as the 404 Series. Featuring a new uniform oxide binder formula which the company claims results in true low-noise characteristics in addition to providing higher frequency response and greater undistorted dynamic range, the tape is being offered in various reel sizes and in ¼", ½", and 1" widths on both polyester and acetate base materials. Ampex

Circle No. 24 on Reader Service Card

COMPACT MUSIC SYSTEM

Two new AM-FM-stereo compact systems, the Models 1050 and 1030, include record-playing facilities, speakers, and solid-state receivers to provide home entertainment in space-saving form.

The Model 1050 incorporates an Elac/Miracord 50 automatic turntable with four-pole induction motor, two EMI Model 93 speakers, and an 85-watt IHF dynamic power receiver. It has a special microphone and instrument input with gain controls to permit playing guitar or other instruments through the system and doing "voice over" records.

The Model 1030 is a lower powered unit which incorporates many of the features of the Model 1050. It uses a Miracord Model 620 turntable and EMI Model 62 speakers and provides 50 watts IHF dynamic power. Both record players come with a compatible mono/stereo magnetic cartridge with diamond stylus.

A Philips-type cassette tape recorder is available as optional equipment. Benjamin

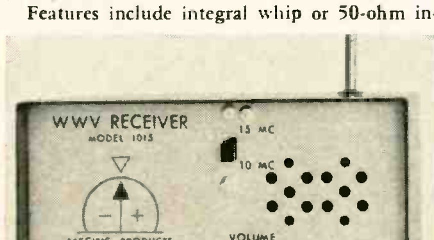
Circle No. 25 on Reader Service Card

CB-HAM-COMMUNICATIONS

PORTABLE WWV RECEIVER

The Model 1015 is a 3¼" x 6¼" x 4", lightweight WWV receiver which is completely portable. It is a crystal-controlled, sensitive receiver for the 10 and 15 MHz time and frequency transmissions from the NBS radio stations WWV at Fort Collins, Colorado and from WWVH at Maui, Hawaii.

Features include integral whip or 50-ohm in-



puts, speaker and headphone jack, sensitivity of 1 μV, and 9-volt internal battery operation. Specific Products

Circle No. 26 on Reader Service Card

NOISE-SUPPRESSION PRODUCTS

A new line of noise-suppression accessories has just been introduced under the tradename "Electro-Shield". Designed to reduce engine interference in all two-way communications equipment and other electronic gear, the new line includes kits for ignition suppression, alternator filtering with shielding, d.c. power line filters with cable, and a universal suppression package.

The new line is designed for police and fire vehicles, mobile ham installations, CB mobile applications, truck fleets and other two-way radio users. Estes Engineering

Circle No. 27 on Reader Service Card

FM MONITOR RECEIVERS

Two new solid-state FM monitor receivers for use by police, fire, and other municipal, civilian defense, or federal departments have been introduced as the Models FR-104 (25-50 MHz) and FR-105 (150-175 MHz). Each comes complete with a.c. and d.c. power cables and mounting bracket. Crystals are not included.

The receivers measure only 6⅞" w. x 2⅝" h. x 8½" d. so that they will fit into the smallest vehicles. The units incorporate a quadruple-tuned r.f. stage for greater image rejection, dual

limiter and Foster-Seeley discriminator, a temperature-compensated noise-free squelch, provisions for continuous tone (squelch decoder) using a contactless tone reed, and plug-in crystal channels for instant frequency change.

A heavy-duty 2" x 6" speaker with moisture resistant cone and 1½-watt audio output provides adequate level. Provision is also made for connecting an external speaker. Sonar

Circle No. 28 on Reader Service Card

POWER SUPPLY FOR CB UNITS

The Model 103 is a 117-volt a.c. power supply for 12-14 volt CB transceivers. It will convert

117-volt a.c. to 12 volts d.c. for operation of any solid-state CB transceiver which does not draw more than 1.7 amps on receive or transmit. The unit is fused for short-circuit protection, although momentary shorts will not adversely affect fuse or set operation.

The compact 6½" x 4½" x 5" unit is housed in an all-aluminum cabinet finished in light blue baked-on enamel. Regency

Circle No. 29 on Reader Service Card

PACKAGED POWER UNIT

A new packaged power unit for the communications industry, featuring rectifiers, a ringing frequency generator, tone generator, and interrupter has just been introduced.

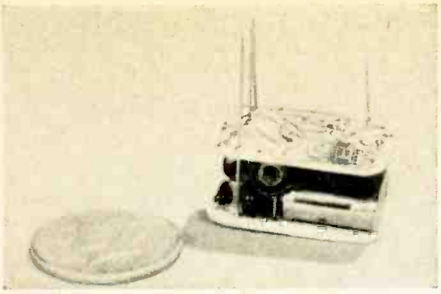
The unit is designed to operate on 117 volts or 208 and 230 volts nominal with input voltage swings of ±10%. In addition to line-voltage-regulation capability, the unit is said to have good load regulation.

The company will supply complete specifications on this unit on request. Sola

Circle No. 135 on Reader Service Card

CRYSTAL OSCILLATORS

A new line of miniature precision crystal oscillators that are both temperature-compensated and voltage-controlled has been developed and is being marketed as TC/VCXO's.



These all-solid-state units are designed for communications and aerospace applications where small size, high accuracy, and low power drain are primary considerations. They are available for generating any frequency to 50 MHz. Units generating two or more frequencies can also be provided.

Sine, pulse, and sawtooth waveforms are offered. Frequency adjustment range is 6 ppm minimum. Aging rate is less than 1 ppm/year. Warm-up time is zero. Models can be designed to accept any input voltage from ±10 to ±50 V d.c. Units can be furnished to meet MIL or NASA specifications. Arvin Frequency Div.

Circle No. 136 on Reader Service Card

MANUFACTURERS' LITERATURE

NICKEL-CADMIUM CELLS

A new 12-page illustrated booklet (No. BA-112, revised edition) that discusses rechargeable, sealed nickel-cadmium battery cells has been issued. Areas covered include construction, electrical parameters, charging and discharging, temperature characteristics, cycle life, environmental conditions, and applications.

The booklet also contains a table giving physical and electrical characteristics of the company's complete line of nickel-cadmium sealed cells. Sonotone

Circle No. 30 on Reader Service Card

NEW C/R BRIDGE

Described and illustrated in a new 2-page data sheet is the Model B201 100 kHz-1 MHz capacitance-conductance bridge. Designed for highly precise simultaneous in-circuit measurement of capacitance and conductance over an extremely wide range, the new instrument can be used to check capacitors and components of printed circuits and/or encapsulated assemblies.

Complete mechanical and electrical specifications are provided. Wayne Kerr

Circle No. 137 on Reader Service Card

GAS LASERS

Described and illustrated in a new 6-page full-color catalogue is a line of gas lasers and accessories. The Model 140 argon-ion laser, the company's newest and most advanced instrument, is completely detailed with specifications for both laser and exciter.

Specifications are also listed for a number of Stabilite lasers along with numerous representative applications. Available accessories include a power meter, polarization rotator, beam-expanding telescope, and a cavity extension. Spectra-Physics

Circle No. 138 on Reader Service Card

INDICATOR LIGHTS

A new 6-page foldout brochure (No. 6702) on a line of panel-mounted indicator lights has been released. Complete electrical and mechanical specifications, ordering instructions, and dimensional drawings are provided for nearly 100 different two-pin cartridge lamps and midget flanged indicator lights. Drake

Circle No. 139 on Reader Service Card

TWO-WAY RADIO SYSTEMS

A new 16-page illustrated booklet which enables a business/industrial two-way radio user to select the right system for his particular requirements is now available.

The brochure defines Business/Industrial radio as compared with Citizens Band, explains licensing requirements, discusses range expandability and frequency selection, and describes typical short-, medium-, and long-range systems and how to create them from specific units. E. F. Johnson

Circle No. 31 on Reader Service Card

INTEGRATED CIRCUITS

A new 48-page brochure (Bulletin SC-10212) describing a line of 180 TTL monolithic integrated-circuit types, with 39 distinct circuit functions, is now available.

Half the illustrated booklet is devoted to product descriptions and application information on speed and performance stability, noise immunity, worst-case testing, and cost-saving logic flexibility. The remainder of the publication covers logic diagrams and pin configurations, design loading rules for combining TTL with DTL circuits in common systems, and a quick-reference chart showing what is available. Texas Instruments

Circle No. 140 on Reader Service Card

THYRATRON TUBES

A new 19-page application report on thyratron tubes (No. P-111) has been published. Intended for the design and applications engineer, the manual features a lengthy introduction on the fundamentals of thyratron operation, characteristics, and circuit considerations. The remaining sections of the booklet cover thyratron installation and definitions of ratings.

Concluding the brochure is a 3-page listing of the company's thyratron tubes with their operating characteristics and descriptive functional data. Amperex

Circle No. 141 on Reader Service Card

PRECISION TOOLS

Described and illustrated in a new 4-page catalogue is a wide range of precision tools for electronic and electrical production, repair, and laboratory use. Included are low-voltage miniature production soldering irons, replacement tips, soldering tweezers, a thermal wire stripper for Teflon, a pocket microscope, and various tools for instrument assembly and repair. Telvac

Circle No. 32 on Reader Service Card

WIRING SYSTEMS

A new 12-page bulletin (No. E-7) describing and illustrating the versatility of Signaflo wiring systems has been made available.

Presented in the booklet are the basic elements and techniques of these wiring systems, as well as applications for signal transmission, control wiring, flexing wires, and interconnection and structural systems for memory devices. aci.

Circle No. 142 on Reader Service Card

CERAMIC CAPACITORS

A new 57-page catalogue covering 20 standard VY porcelain and VK ceramic capacitor series has been issued. The publication consists of 21 two- and four-page data sheets which can be easily removed for filing and updating. Each data sheet contains detailed specifications, typical curves, diagrams, photos, and ordering instructions. Vitramon

Circle No. 143 on Reader Service Card

POTENTIOMETERS

A comprehensive 120-page catalogue covering trimming and precision potentiometers, counting dials, and instrument motors has recently been published. Each product listed in the catalogue (No. C-67) is shown in a cutaway view along with a complete description of mechanical, electrical, and environmental specifications. Amphenol Controls.

Circle No. 144 on Reader Service Card

RECORDING SYSTEMS

"Recording High Off-Ground Signals Without Electrical Noise", a new 20-page illustrated technical booklet, has been published. The brochure presents solutions to the special problems encountered in recording test or troubleshooting data from automatic systems in which d.c. voltages of 500 to 1000 volts are used.

Topics covered include elimination of hazards to personnel and equipment, isolation of signals from high off-ground voltages, elimination of ground loops, selection of signal conditioners and signal cables, and special precautions in cable routing and connections. Brush Instruments

Circle No. 145 on Reader Service Card

THUMBWHEEL SWITCHES

A new 4-page bulletin (No. CS901) describing a line of panel-mounted thumbwheel switches for use in single-pole, double-pole, and four-pole switch applications has been released.

Complete mechanical and electrical specifications are supplied, along with truth tables, schematic diagrams, and mounting dimensions. A. W. Haydon

Circle No. 146 on Reader Service Card

WAVEGUIDES

A new 14-page illustrated brochure (No. S-12) covering a complete line of waveguides and accessories is now being offered. Included are waveguide-to-waveguide and waveguide-to-coaxial transitions, waveguide terminations, flanges, straight sections, twists, bends, and special configurations. Specialty Waveguide

Circle No. 147 on Reader Service Card

INTEGRATED POWER SUPPLIES

A new 12-page four-color brochure describing a line of integrated power supplies using the Hi-Pac process has been issued. The publication outlines the features and advantages of these power supplies, provides technical data, and illustrates product applications. Solitron

Circle No. 148 on Reader Service Card

POWER MODULES

More than 4000 standard all-silicon solid-state power supplies and power modules are described and illustrated in a new 62-page catalogue (No. 671). Complete specifications are given, along with prices, installation data, and thermal requirements.

New products introduced in the catalogue include modules designed especially for IC applications, high-efficiency d.c.-d.c. converters, and miniature d.c.-d.c. local regulators. Technipower

Circle No. 149 on Reader Service Card

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Answer to Crossword Puzzle appearing on page 95

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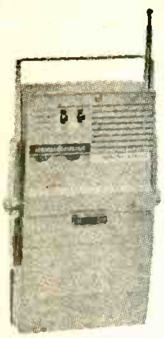

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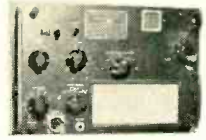

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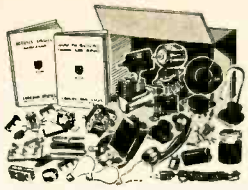

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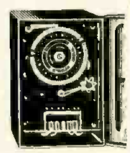

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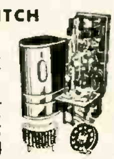

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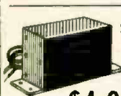

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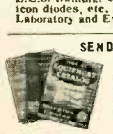

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PRV	3A	12A	20A	40A
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200	.16	.50	.60	1.25
400	.20	.70	.80	1.50
600	.30	1.00	1.20	1.80
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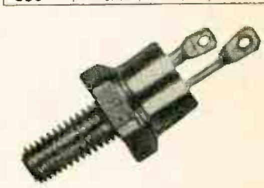
400	.12	1400	.65
600	.18	1600	.80
800	.22	1800	.90



Silicon Control Rectifiers

PRV	3A	7A	20A
50	.35	.45	.70
100	.50	.65	1.00
200	.70	.95	1.30
300	.90	1.25	1.70
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700	2.20	2.80	
1000		4.00	

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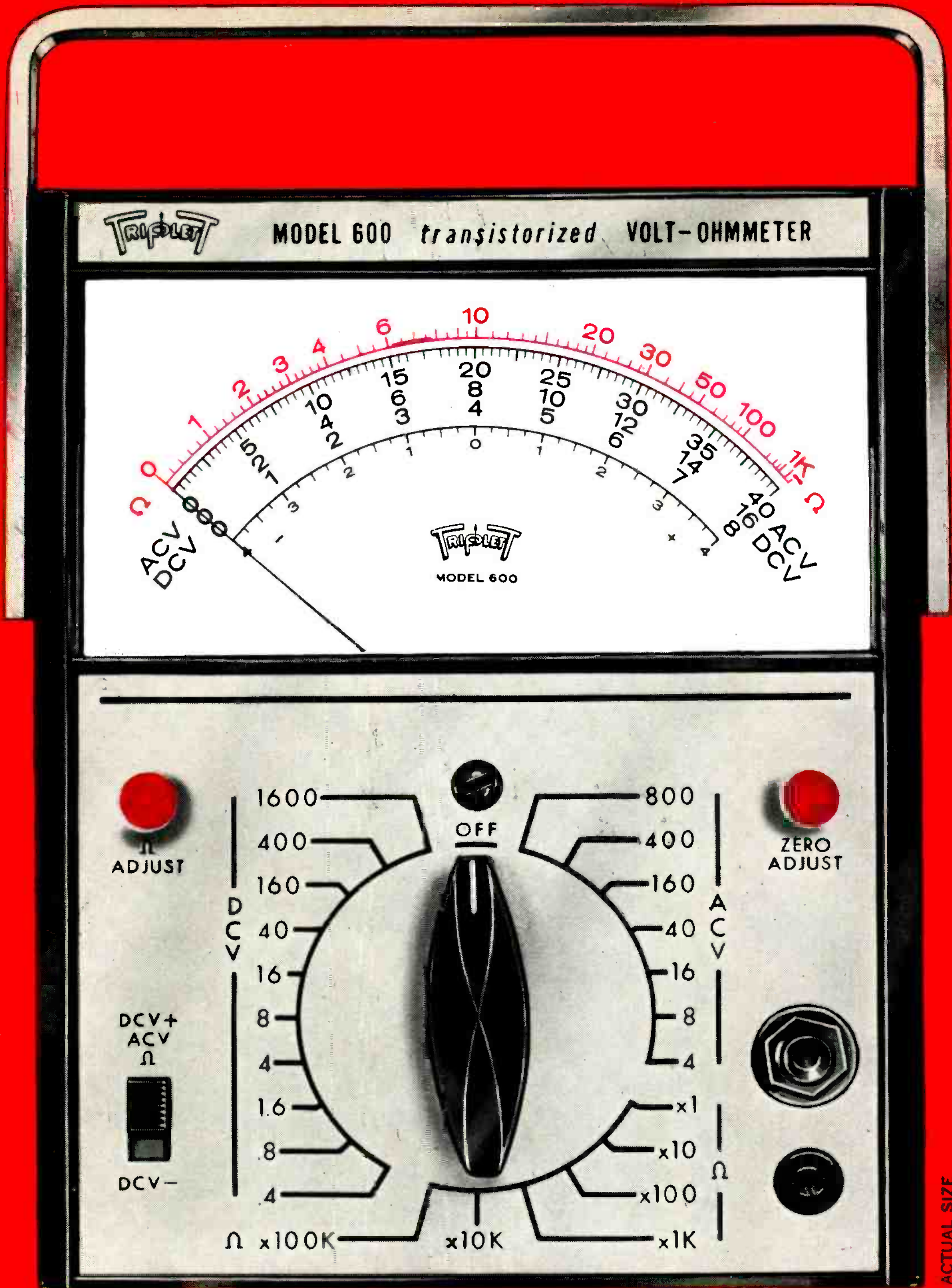

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