Radio-Electronics

60c ■ JUNE 1973

FOR MEN WITH IDEAS IN ELECTRONICS

LEONARD FELDMAN TELLS
How SQ Logic Works

TEST IC's 11 WAYS
With Your Vtvm

VIDEO TAPE RECORDERS
Where They Stand Today

PHONE SENTRY
Build It For $30

PLUS

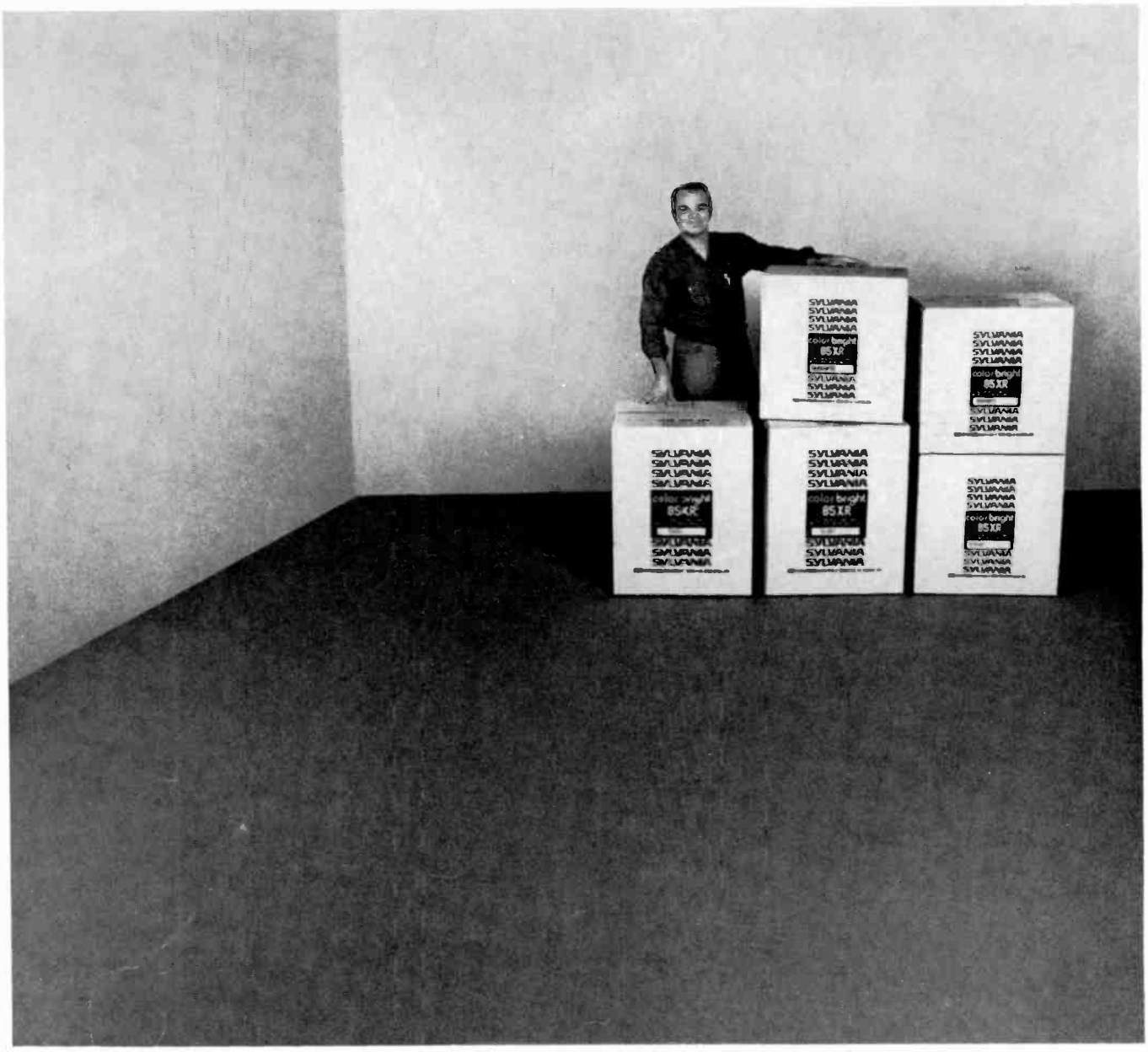
Lou Garner's State-Of-Solid-State

Troubleshooting Logically

Test for Replacement

Jukebox Service Clinic

A GERNSBACK PUBLICATION



As you can see, your Sylvania distributor has 200 picture tubes in stock.

And they're all in just five Sylvania cartons.

Because our line of five color bright 85XR® OEM-quality tubes gives maximum coverage of 19V, 21V, and 25V diagonal sets with a minimum of stock.*

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*XR23VANP22/ SRE25BGP22	Replaces 53 types
XR23VAQP22/ SRE25BHP22	Replaces 27 types
XR19VABP22	Replaces 22 types
XR18VAHP22	Replaces 82 types
XR18VADP22	Replaces 16 types

GTE SYLVANIA

If you've ever said...

"There must be a better way to earn a living..."

one of our free Career Guidance Booklets may provide the opportunity you've been looking for.

It happens to all of us, sooner or later. No matter what kind of job we have.

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"Surely," we tell ourselves, "there must be a way to earn enough extra dollars each month to balance the family budget. Surely, there must be a way to get the kind of position where you don't have to worry about job security. Surely, there must be a way to get a job that offers greater opportunity for advancement, and more job satisfaction."

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Circle 1 on reader service card

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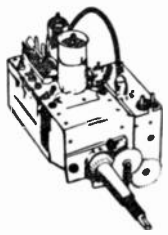
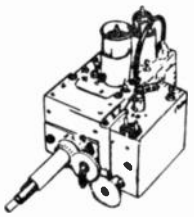


Universal Replacements from $8.95



These universal replacement tuners are all equipped with memory fine tuning and uhf position with plug input for uhf tuner. They come complete with hardware and component kit to adapt for use in thousands of popular TV receivers.

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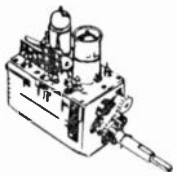
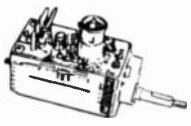
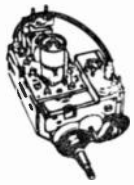
CR7S	Series 600mA	1¾"	3"	41.25	9.50
CR9S	Series 450mA	1¾"	3"	41.25	9.50
CR6XL	Parallel 6.3v	2½"	12"	41.25	10.45
CR7XL	Series 600mA	2½"	12"	41.25	11.00
CR9XL	Series 450mA	2½"	12"	41.25	11.00



Castle Replacements $15.95



Castle custom replacements made to fit in place of original tuner. Purchase outright . . . no exchange needed. Write for current list of Castle replacements, or request the part number you require (use number on ORIGINAL TUNER ONLY; do not use service literature numbers). Available for many of the popular models of following manufacturers: Admiral, Curtis Mathes, Emerson, GE, Heathkit, Magnavox, Motorola, Muntz, Philco, RCA, Sears, Sylvania, Westinghouse, Zenith and many private labels.



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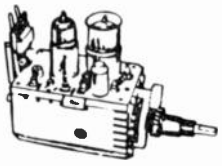
Overhaul Service $9.95

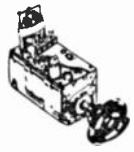
This is the service pioneered by Castle! We are now in our third decade of serving the TV Service Industry



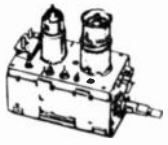
Service on all makes and models, vhf or uhf, including transistor and color tuners . . . one price $9.95 (does not include tuners older than 10 years). Overhaul includes parts, except tubes and transistors.

Simply send us the defective tuner complete; include tubes, shield cover and any damaged parts with model number and complaint. Your tuner will be expertly overhauled and returned promptly, performance restored, aligned to original standards and warranted for 90 days.

Dismantle tandem uhf and vhf tuners and send in defective unit only. Remove all accessories . . . or dismantling charge may apply.

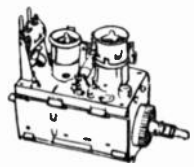


Custom Exchange Service $17.95



When our inspection reveals that original tuner is unfit for overhaul, and it is not available from our stock of outright replacements, we offer to make a custom replacement on exchange basis. Charge for this service is $15.95 for uhf tuner and $17.95 for vhf tuner.

If custom replacement cannot be made we will custom rebuild the original tuner at the exchange replacement price.



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Circle 2 on reader service card

Radio-Electronics

FOR MEN WITH IDEAS IN ELECTRONICS

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JUNE 1973

SQ DECODER is made by Sony. Do you know how it works? . . . . turn to page 44

VIDEOTAPE CARTRIDGE machine from Panasonic is one of many entries in the great home videotape race. . . . . turn to page 38

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looking ahead

Spain going PAL

MADRID—Although Spanish government sources continue to insist that it's still a wide open race between the German PAL and the French SECAM color systems, we have learned authoritatively that the decision has already been made to go along with Europe's majority in selecting PAL as the official Spanish color transmission system.

After Italy, Spain is the largest West European country still in the black-and-white age. Italy has broadcast experimentally in both PAL and SECAM systems. Spain is currently conducting test broadcasts in PAL. Spain's choice of the PAL system will leave France as the single major West European nation using SECAM. France had held out economic enticements to induce Spain to adopt its system, as it is doing in both Italy and Greece. Because Spain is a "bridge" between France and the North African countries (many of which have selected SECAM but are still broadcasting in black-and-white), Spain's choice of PAL—although not at all unexpected—will come as a bitter blow to French prestige.

Spain, with two networks (vhf and uhf) and 32 TV stations feeding some 5,000,000 TV sets, will take its time in officially inaugurating color broadcasting. It's scheduled now for early 1975. But the government-operated Television Espanola (TVE) which owns all the stations and puts on all programs, has had years of experience in color TV work—for other countries. TVE operates one of Europe's major color standard converters, used in the Olympic games and other major worldwide TV transmissions to change PAL to NTSC color. TVE produces taped programs in NTSC color for broadcast in Mexico.

50-channel cable

A new hotel and convention center in Zurich, Switzerland, gives hotel guests as well as conventioneers a choice of 50 channels of color television. Both guest rooms and meeting halls can dial a wide variety of technical, commercial, educational and other programs, as well as regular television programs. The system, developed by Rediffusion Ltd., uses 50 Philips color videotape cartridge players.

Profusion of brands

As in TV's pioneering days in America, there's a bewildering variety of television brands available in Spain. Because of a strict import quota system, almost all are made in Spain. Many of the brand names, however, are familiar because of technical and/or ownership alliances between Spanish and foreign films. An American sees such familiar makes as Zenith, Emerson and GE (called "GEE" for General Electrica Espanola), Sony and Sanyo. The ever-present Philips and Telefunken are among the best-selling brands, as are some 100% Spanish makes, such as Vanguard, Inter, Iberia and Elbe. The number of manufacturers has declined from more than 100 to perhaps 25, due to the increasing saturation of the black-and-white market.

Without color, monochrome television has reached a maximum degree of sophistication in Spain. Most large-screen sets (19 and 23 inches) have electronic varactor tuning and many are all-solid-state. There are few truly unique television products on the market here, however. One is a 23-inch battery-powered receiver by Elbe, its circuitry composed of five solid-state modules. Just the thing to take with you on a picnic when you don't want to miss the bullfight in big-screen living black-and-white.

Glass cables coming?

The promise of fiber optics—whose commercial uses up to now have been confined largely to gimmickry—may soon be realized, on the basis of development work being carried on in widely scattered laboratories around the globe. The use of a light beam to transmit messages through a glass cable theoretically could move 100 billion bits of information per second, as compared with 100 million for a coaxial cable or microwave relay system.

The problem so far has been energy loss, or leakage, which originally came to 1,600 dB per mile. New developments have reduced this leakage to as low as 6.5 dB, well below the figure required for successful long-distance transmission. There are still many problems—such as the method of modulation and the light source. One straightforward system envisions a simple and conventional light provided by one or more semiconductor diodes. Another would use a laser as a light source.

Among the advantages of fiber-optics transmission: (1) Glass is not affected by moisture or temperature. (2) Being an excellent insulator, glass would be unaffected by stray electrical fields; since modulated light is used, the system would be impervious to magnetic disturbances. (3) Glass cables could be routed through existing underground cable conduits, increasing their capacity by hundreds of times.

4-year warranty

The honors (or whatever you call them) for the longest television warranty probably go to Curtis Mathes. Applying to 19-, 23- and 25-inch modular solid-state color sets, the policy now being tested covers all components except the picture tube (which carries a two-year full warranty and six additional years of pro-rated warranty). Although there is no labor covered by the warranty, the manufacturer believes that most repairs will involve merely the exchange of one of the 14 modules in the set. Defective modules are returned by the technician to the factory for rebuilding.

Move TV upstairs?

First there was vhf, then uhf. Will it soon be time to start a new television serviceway, way upstairs in the GHz bands. One proposal by a member of the White House Office of Telecommunications Policy's Frequency Management Advisory Council suggests that perhaps it will. A. James Ebel, president of KOLN-TV, Lincoln, Neb., envisioned to his confreres a new hi-fi TV system with greater definition, truer color, stereo sound, and perhaps a 3-D picture. For this, a 20 to 25 MHz bandwidth would be required, he reasoned, and therefore stations would have to be moved far higher on the spectrum. To avoid dislocations during the transition period, he suggested that stations also continue to broadcast in lo-fi on their present frequencies.

by DAVID LACHENBRUCH
CONTRIBUTING EDITOR

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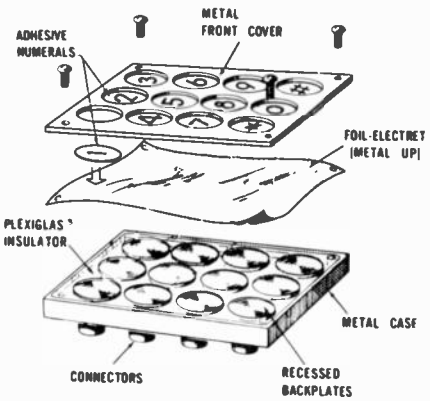
Circle 3 on reader service card

new & timely

Foil electrets miniaturize pushbutton phone "dials"

A new experimental dialing mechanism that uses less than half the space of the present one is being tested by Bell Labs scientists at Murray Hill, NJ. Instead of the electromechanical switch of the regular pushbutton mechanism, the new device uses a foil electret, a sheet of plastic about a thousandth of an inch thick, which carries a permanent electrical charge or high voltage between its opposite surfaces.

(This permanent electric field is comparable to the magnetic field of a permanent magnet, and the electret has been called the electrostatic analog of the magnet.)



ELECTRET DIALING DEVICE has a foil electret sandwiched between the metal front cover and twelve recessed conductive backplate contacts.

The foil, metal-coated on one side, is stretched over a "backplate" of 12 separate conductors. It is covered with a metal cover having twelve aperatures in the same positions as the buttons on the pushbutton mechanism. Depressing the foil through any of these apertures moves it nearer the conductor directly behind it, causing a current to flow in the circuitry.

The action is practically identical with that of a "condenser" microphone, except that the change in proximity and resultant flow of charges through the circuit is brought about by finger pressure instead of by sound pressure. (Microphones are now made with foil electrets, which carry their own polarizing charge, making a high-potential supply for the microphone unnecessary.)

The foil is protected by flexible plastic discs, on which the numbers are printed. The pushbutton switch assembly is only about one-eighth inch thick.

If the new dialing mechanism proves suitable for mass use, it can not only make telephone handsets more compact, but may be cheaper to manufacture. The principle may even be extended to replace keyboard mechanisms in typewriters, computer terminals and other keyboard-operated equipment.

Computerized metal detector makes plane trips safer

A new type of weapons detector ignores harmless objects like buckles, keys and cigarette lighters, but sounds an alarm when a person is carrying a weapon. Already installed at eight major airports, one hundred have been built under contract from the Federal Aviation Administration by Westinghouse Electric Corp.

The new gun detector is unlike conventional types, which work on the magnetometer principle, simply sensing disturbances in the earth's magnetic field. It is an active device, that generates two electromagnetic fields at different frequencies, one high and one low, in three planes within the passageway. No matter where or how the weapon is carried it is certain to be detected, according to Westinghouse spokesman R. W. Esary. "The console of the detector has data processing circuitry," he said, "that analyzes disturbances in the fields with a high degree of accuracy. This gives us the selectivity that cuts down on false alarms."

Laser and computer teamed for air pollution quick-test

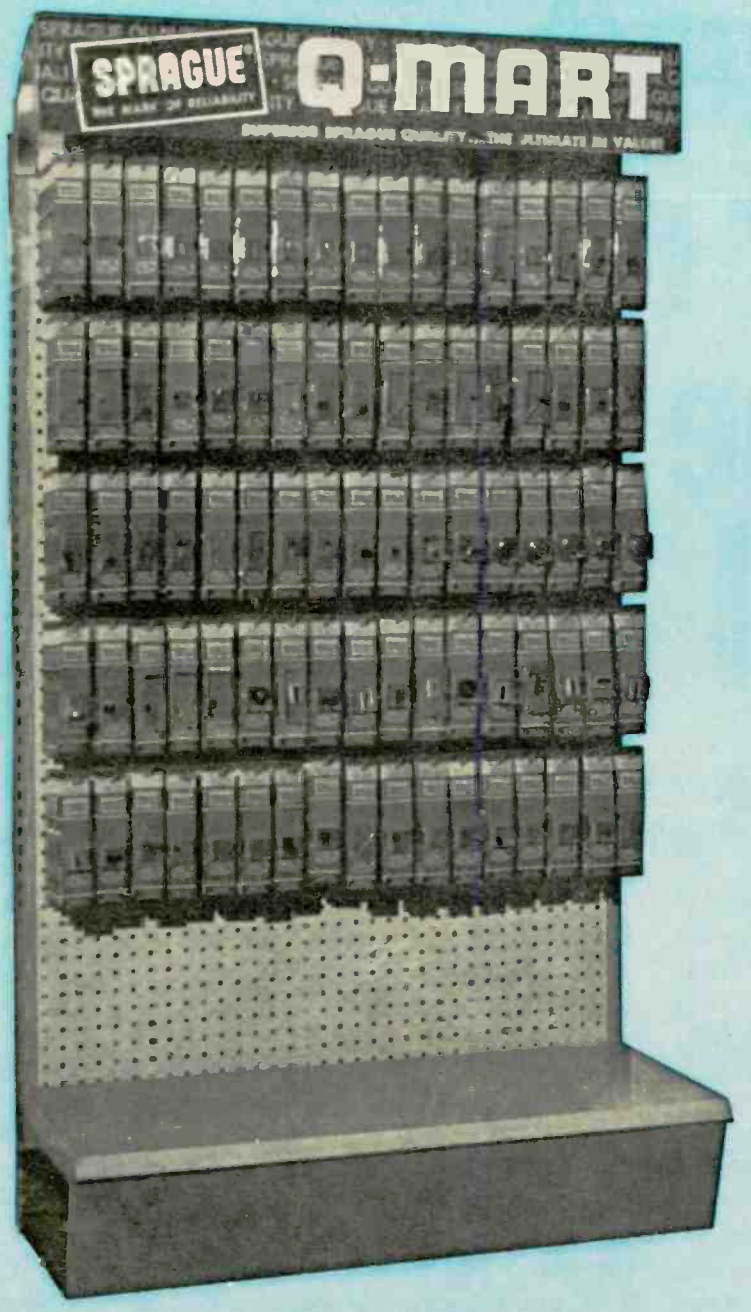
A new and quick method of detecting gas concentrations in air has been developed by Bell Labs scientist Lloyd B. Kreuzer. His method is based on modifications of ordinary gas spectroscopy, which operates on the principle that different gases absorb light at different frequencies. Thus one gas may have a strong "absorption band" near the red end of the spectrum, another in the green.

A sample of the air to be analyzed is held in a specially designed absorption cell, and a laser beam directed into the cell. If the pollutant gas is one that absorbs energy at the frequency (wavelength) of the laser light, the temperature and air pressure in the cell rise in direct proportion to the quantity of gas in the air.

Changes in pressure are registered by a microphone in the cell, and the resultant electric signal is fed into the computer, which identifies the pollutant and records its quantity. The computer also "tunes" the laser, sending various frequencies of light into the absorption cell to detect different types of pollutants. The computer can handle up to about 20 different gases simultaneously.

(continued on page 12)

AIRLINE PASSENGER clears new Westinghouse Electric gun-probe tunnel.



New

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Don't delay . . . Stop at your Sprague distributor's Q-MART today! *And while you're there, don't forget to pick up your free copy of Sprague's 48-page Semiconductor Replacement Manual K-500. Or . . . write to Sprague Products Co., 81 Marshall St., North Adams, Mass. 01247.*

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new & timely

(continued from page 6)

The new system can detect gas concentrations as low as 1 part in 10 billion, a much greater sensitivity than needed in present practical applications. It has the further advantage that it can identify

POLLUTANTS ARE MEASURED by a blend of spectroscopic, acoustic and electronic techniques in this laser-computer detection system developed by Bell Laboratories.

many kinds of pollutants without changes in instrumentation. Chemical methods of detection often require entirely different set-ups for different pollutants. The new system can also be operated by persons not specially skilled in the particular field.

NATESA Executive Council discusses convention, merger

After hearing convention chairman Nolan B. Boone report on the status of the second annual joint associations convention, the second 1972-73 quarterly meeting of the NATESA Executive Council resolved to hold the NATESA-NEA 1973 convention at the Crown Center Hotel in Kansas City, Mo, August 24-26.

Merger Committee Chairman LeRoy Ragsdale, reporting on the lack of progress by the combined merger committee, stressed a need to steer away from any tendencies toward personality conflicts and from continued dwelling on negative aspects. The Council concurred that positive action toward the goals of merger was the only sensible course. Executive Director Frank Moch reemphasized that he would not hesitate to work for the new Association if a realistic and equitable merger can be effected.

Copies of the by-laws of NEA and NATESA in side-by-side form, with a space between for suggestions and comments, have been sent to service associations by By-Laws Committee Chairman Bob Harrison. He was instructed by the Council to receive the studied suggestions and incorporate the information into a completely drafted by-laws proposal, to be submitted as a composite suggestion to the combined Merger Committee before the convention in August.

Long-playing record now 25 years old

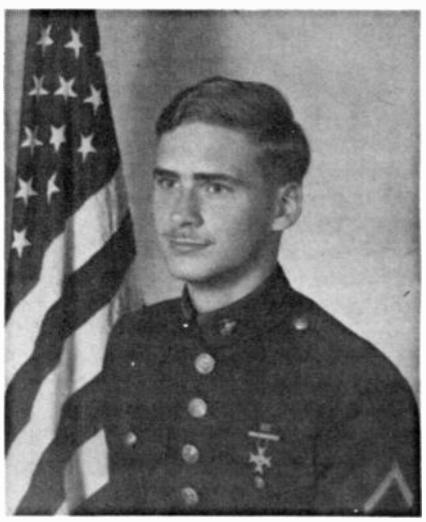
In June 1948, Dr. Peter Goldmark, engineering director of the Columbia Broadcasting System, announced a revolutionary new phonograph record, the long-playing microgroove disc, playing at 33⅓ revolutions per minute, and recorded with 224 to 300 grooves per inch, instead of the 90 grooves per inch of the (then) standard 78-rpm record. Fidelity equal to—in fact superior to—that of the high-fidelity 78-rpm record of the day was made possible, it was reported, by using a stylus only one-thousandth of an inch in diameter, one-third that of the 78-rpm styli. This stylus, it was said, played with a tracking force of only 1/5 *ounce* (in today's language, between 5 and 6 grams.).

Up to 50 minutes of playing time could be obtained with a 12-inch microgroove record, as contrasted to the 8 or 9 minutes possible up to that time.

DOCTOR PETER GOLDMARK, as he appeared at the announcement of the Columbia LP Microgroove record in 1948.

Goldmark and others made optimistic predictions for the new technique, but nobody imagined the almost complete takeover by the microgroove. The transistor celebrated its 25th birthday a few months ago, but the tube is still with us. But more than one of the youthful modern devotees of high fidelity (or rather hi-fi) has never seen a 78-rpm record, and on being shown one, calls it an "album." Possibly the greatest single factor in bringing about our age of all-pervading recorded music, it opened the way to improved recording and reproducing equipment, stereo, four-channel and all the other features of today's audio scene.

L/Cpl Tanguay wins 1973 Hugo Gernsback scholarship



Girard D. Tanguay is one winner of the 1973 Hugo Gernsback Scholarship Award, given annually to an outstanding student in each of nine home-study schools of electronics.

Now 20 years old, Girard was born and brought up in West New York, New Jersey. An Eagle Scout and member of the Order of the Arrow, he also acted as softball scorekeeper for the Town of West New York during the summers of 1969 and 1970. He enlisted for 4 years service with the United States Marine Corps in October, 1971, and is now a Lance-Corporal of the Marines. Enrolling in Career Academy, Milwaukee, Wisc. in October, 1972, he finished all the examinations and experiments by the end of January, 1973, and graduated with an "A" average.

L/Cpl Tanguay hopes that his elec-

(continued on page 14)

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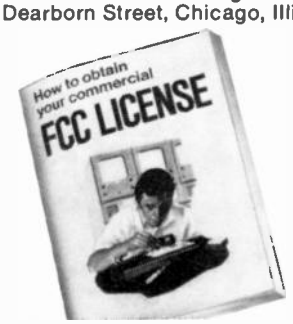

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new & timely

(continued from page 12)

tronic knowledge may help him advance in the Marines, and will go into some section of the electronics field—he has not yet determined which—upon his discharge.

Employment now opening up for engineering technicians

With the economy apparently on an upturn, it appears that there are more openings for engineering technicians than for full-fledged engineers, many of whom are still finding the going very slow. A two-year midwestern college (Scott Community College of Davenport, Iowa) reports that they have had 56 requests for engineering technicians in three months, and are having difficulty in filling the jobs. Letters or calls to graduates indicate that they, too, are practically all employed at rates that make the openings for beginners unattractive.

The positions offered vary from mechanical technician on a potato chip machine to one for work with computers, and include engineering aid, drafting, circuit design and industrial electronics. While most of the jobs appear to be one cut below engineering, some seem attractive enough to interest (at least until something better comes along) those engineers who are still having difficulty getting back into the field.

PICTURED ABOVE is equipment used in the Air Force's newest airborne radar program, the Airborne Warning and Control System (AWACS). The radar equipment was designed and built by Westinghouse, winner of a contest with a competing design (see Radio Electronics December 1972, page 14). A high-flying, long-range surveillance system to detect and track aircraft, it can also, in peacetime emergencies, manage aircraft traffic and direct rescue operations. R-E

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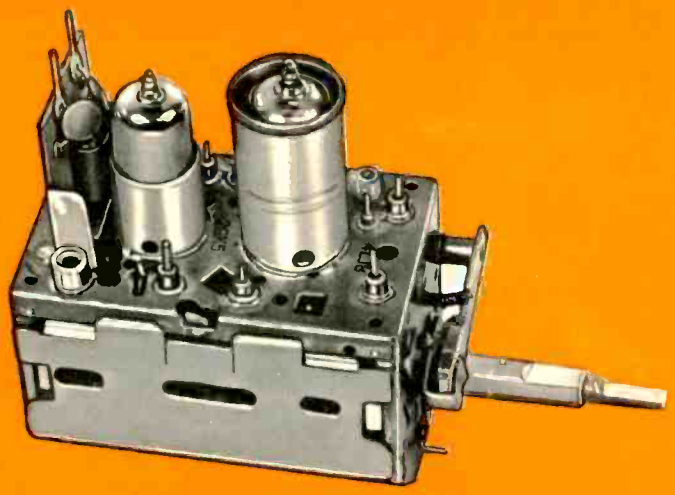

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letters

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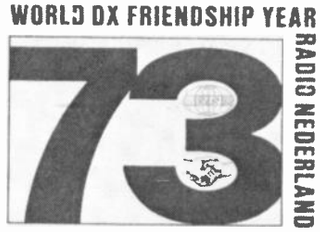


A sheet of 20 seals can be obtained free of charge from DX Juke Box, c/o Radio Nederland, P.O. Box 222, Hilversum, Holland.

HARRY VAN GELDER
DX Producer
Radio Nederland
P.O. Box 222
Hilversum, Holland

ORBITS VS ORBITS

Since reading the January 1973 issue, I have been planning to write concerning a slight technical inaccuracy that I believe reflects the lack of understanding, on the part of many people, of a major factor in modern communications. It's been some time now, but I just ran across the article again and thought it may not be too late.

On page 34, in the article on Shortwave Television, the author mentions the placing of amateur-use satellites in strategic locations over the U.S. I have heard even communication engineers propose such a thing without really thinking about what they were saying.

You see, it is not possible to place a stationary satellite (and that *must* be what was implied) over *any* part of the United States. Most proposals for simplified satellite communication systems, including those of the big-time international services, include the use of a stationary satellite to obviate the need for sophisticated tracking equipment.

What many people seem not to realize is that the only place where you can put a geostationary satellite, that is one that appears to stay in one place in the sky, is over the equator. Some kind of outer-space reflector might be placed over some point in the U.S., but it will be a powered vehicle, not a satellite.

Some who might otherwise know better have confused the synchronous orbit satellite with the stationary one. In a synchronous orbit the satellite goes around the earth in precisely one day, but may be in any orbit plane. If the plane is over the poles, for example, the satellite will follow the same path across the earth every day, but it will not "sit still". Only if the orbit is synchronous and is also over the equator, with the satellite headed east, will the satellite appear to hang motionless (except for a few minor perturbations).

RICHARD H. HOUSTON
Ricardson, Texas 75080

RINGS THE BELL

Your editorial, "Serviceability—Something For Everyone"—rings the bell.

May I suggest that you invite technicians to send in their pet gripes.

Mine is the way backs of portable TV sets are mounted. Sometimes it takes a great deal of fiddling to get them remounted. This is an unnecessary waste of time. Therefore I say—no antenna inputs—no speakers—no antenna rods should be mounted on the backs. Also, there should be a plastic panel in the bottom of the cabinet which can be removed to get at the bottom of the chassis.

Another sore point is the lack of standardization of the hardware—*in the same set.* Sometimes three different self tapping screws are used on tuners.

Plastic gears on tuners are another sore point. All uhf tuners should be separately tuned—*no gearing.*

JACK LANE
Los Angeles, Calif. 90046

WATCH OUT FOR ROCK MUSIC

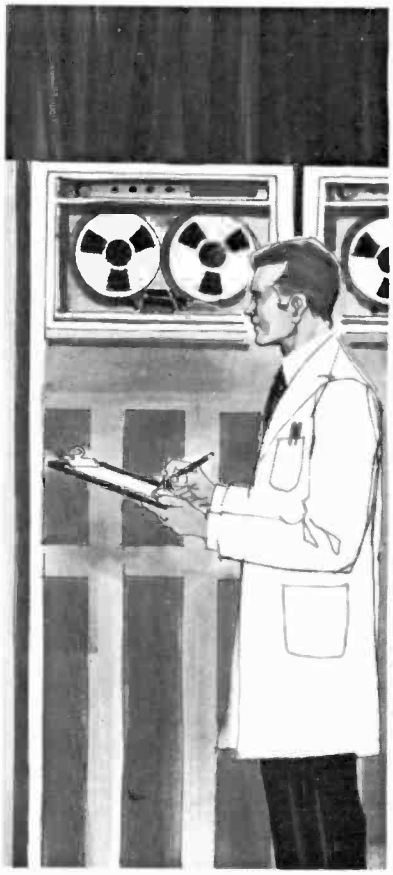
In Mr. Coronado's article's Hard Rock And Your Hearing, **Radio-Electronics,** March 1973, the point seems to be that at the expense of using forty of his unsuspecting, (or at least trusting) students as guinea pigs in a poorly-designed and useless experiment he has only succeeded in confirming what is well known about hearing loss attributable to exposure to high noise level.

In fact, had Mr. Coronado been the employer of his subjects he would be in violation of U.S. law.

One of the most amazing aspects of Mr. Coronado's cruel experiment is the foreknowledge he expresses in in-

(continued on page 22)

Great careers



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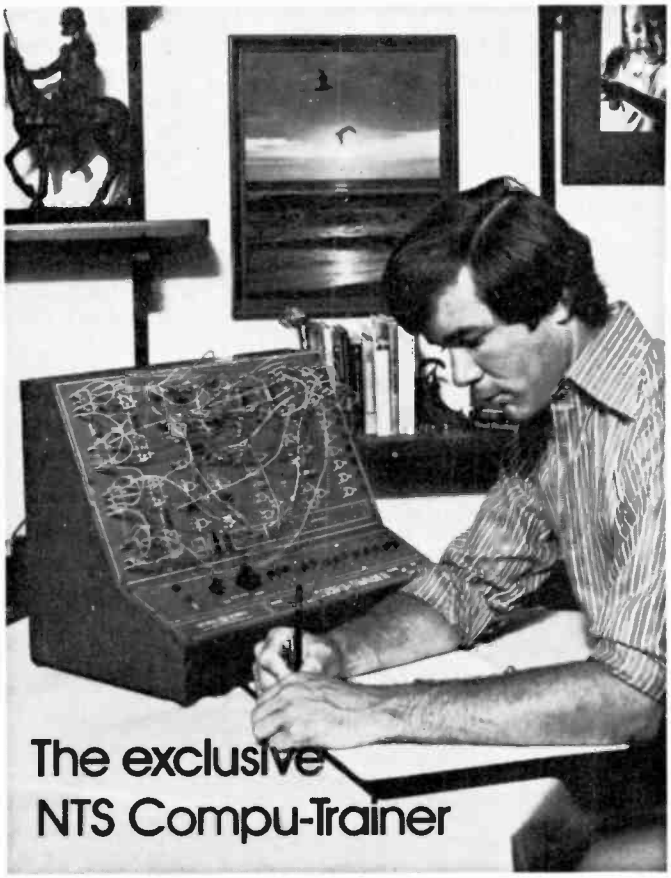

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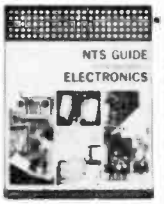

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LETTERS

(continued from page 16)

troducing the experiment to your readers . . . "It is well known that prolonged exposure to sound levels of 100 dB in some instances *may result in permanent irreversible damage to the inner ear.*"

Next he describes his experiment indicating he produced a constant level of over 100 to 120 dB, for three hours, even though his survey of discotheques indicated less severe 90 to 100 dB levels. Finally, Mr. Coronado indicates that he doesn't know whether the radically impaired hearing of his subjects ever improved because he was unable to test them the next day . . . (or presumably in the days since.)

Please inform your readers that the Walsh-Healy act sets a time limit on exposure to sound of 115 dB sound levels for no more than 15 minutes. I am not in the habit of writing letters of complaint but because of my area of work I am keenly aware of the severity of Mr. Coronado's experiment and want to minimize its possibility of repetition by some young or ignorant reader.

Other than this article, I am and have been an avid **Radio-Electronics** reader.

D. L. MILLER
Harrisburg, Pa.

REPAIR RATES

Service technicians, in general, applaud the fact that manufacturers are beginning to accept responsibility for their products. It is a wise decision to employ the independent service industry to help in this effort. We recognize that the final cost of this effort is legitimately passed on to the consumer.

Dealer views regarding warranty repair vary widely. A sales oriented dealer might expect to have to subsidize his service department. Any type of payment schedule is an improvement for this dealer who previously received nothing. Others do warranty work in the expectation of building future out-of-warranty business. Because of special considerations, others find warranty repairs profitable. Our view is that repairs must be profitable whether in warranty or out.

I don't know the method other dealers use to calculate service charges. My method is hardly scientific. It is this. We operate efficiently with competent people. We are reasonably provident. When we have difficulty meeting our financial obligations—we increase our rates.

This simple method of necessity has imposed the following schedule.

1. A basic hourly charge of $15.00, with a minimum shop charge of:
   B&W portable $15.00
   B&W console $20.00
   Color TV $25.00
2. We have no maximum shop rate, however, with the exception of combination models with multiple problems we have not charged over $45.00 shop labor.

   Our philosophy is that the minimum charge be high enough to compensate for the occasional tough dog. Insurance companies operate on this same principle.
3. On home service calls we make a trip charge of $10.00 plus $15.00 per hour. As an example, ½ hour spent in the home would be:
   Trip charge.....$10.00
   Home labor.....$ 7.50
   Total $17.50

   We charge by ¼ hour increments and the customer benefits from the odd time.
4. For the repair that cannot be completed in the home and requires shop facilities, the charges are itemized thus:

   Color TV
   Trip charge.....$10.00
   Home labor, pick up, install $20.00
   Shop time.....$25.00 to 45.00
   Total.....$55.00 to 75.00

   B&W TV
   Trip charge.....$10.00
   Home labor, pick up, install $15.00
   Shop time.....$20.00 to 35.00
   Total.....$45.00 to 60.00

We recognize that a warranty repair can be accomplished more quickly than a repair on the same TV three years later. The newer chassis and cabinet do not require cleaning. Generally, the alignment is okay. Tuner maintenance probably is not required. Additional time *is* required for warranty paper work and parts handling.

For all of the above reasons our estimate is that we can accomplish an in-warranty *shop* repair in about 70% of the time required for the older TV. I don't know the exact percentage. Nevertheless, it is an important figure for the industry to know exactly, because it is the only one we have in common.

Each servicer has arrived at his own present customary rate schedule after years of trial. The process is individualistic. It is *not* the result of collusion with other servicers. It *does* take into consideration that income is also derived from parts sales. It is *not* the result of average-time studies.

It is not the manufacturer's role to attempt to change this process. He should cooperate in it to our mutual benefit or find the "average" shop to act as his service agency. A job-rated schedule that is offered on a take it or leave it basis is a source of annoyance in a relationship that should be harmonious.

DICK HOLMES, CET
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Fallon, Nev. 89406

R-E

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Mailing weight, 125 lbs.

B. Heathkit 18V Color TV...349.95* less cabinet

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C. Heathkit 14V Color TV...299.95* includes cabinet

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Mailing weight, 69 lbs.

D. NEW Heathkit 19V B&W Portable TV...179.95* includes cabinet

The new GR-1900 is like no other B&W portable! With advanced solid-state "modular" design — most circuitry mounts on just 4 plug-in boards. Just 2 tubes; picture & high voltage. Total detent tuning on all 70 UHF channels as well as VHF. "Instant-on." Front panel controls of VHF/UHF fine tuning; brightness; contrast, master on/off; vert. hold; AGC & height. New ultrarectangular tube for a full 184 sq. in. view. Other

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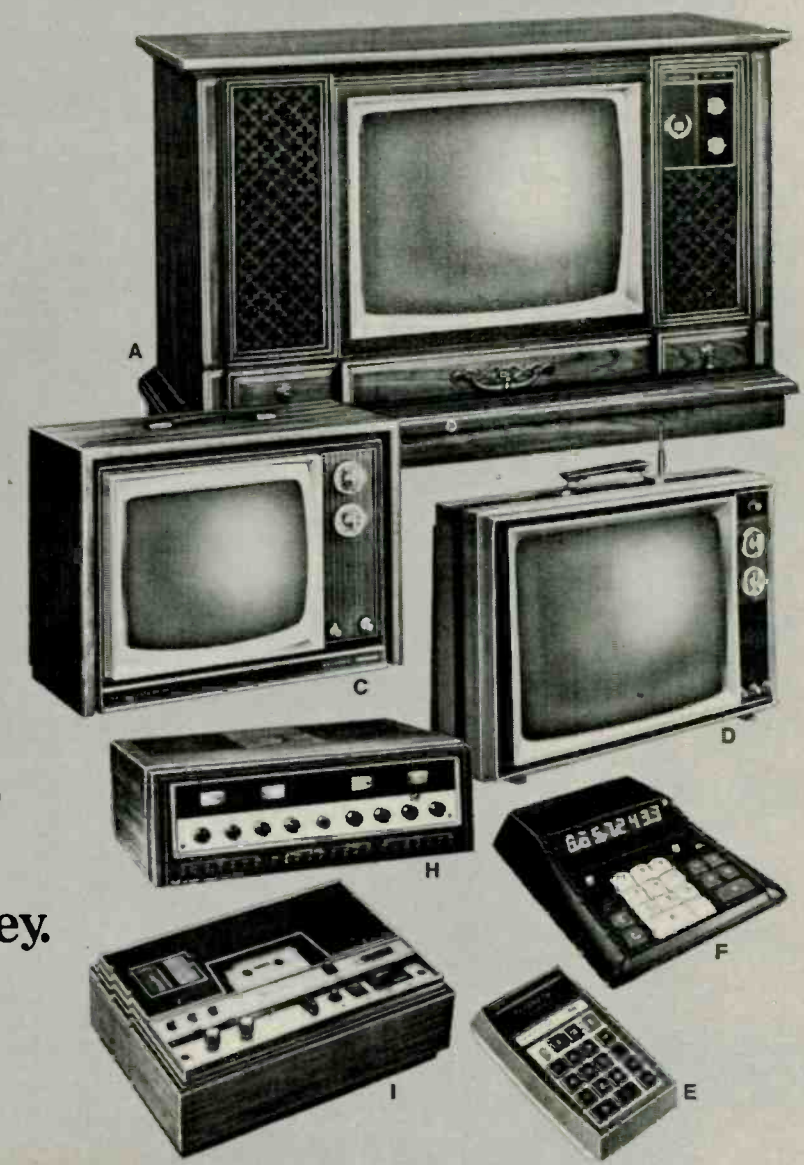


"big" set features are Automatic Vertical Linearity; dual-controlled AGC; extra-wide Video Bandwidth; 4-circuit grounded-base VHF tuner. A kit even the novice can build; both tuners come preassembled & aligned; transistors & ICs plug into sockets; and all chassis wiring is color coded. Mailing weight, 56 lbs.

E. NEW Heathkit Pocket Calculator...92.50*

The new Heathkit IC-2009 is a fully portable calculator with rechargeable nickel-cadmium battery. Or you can leave it connected to the plug-in charger for permanent desk-top use. Weighs just 12 oz. And check over these features: 8-digit capacity. Four arithmetic function. Floating decimal. Constant key. Chain calculation capability. Clear-entry key. Entry & total overflow indicators. Low battery indicator. Battery-saver circuitry. And you can build it in three evenings. Mailing weight, 3 lbs.

F. New Heathkit Desk-top Calculator...79.95*

The Heathkit IC-2108 — a great looking full-function electronic calculator for home or office. You can assemble it in two spare evenings. Features include: Addition, subtraction, multiplication and division functions. Floating and fixed decimal. Constant key. Chain calculation capability. Clear display key. Entry and result overflow indicators. Negative answer indicator. 120 or 240 Volt operation. Mailing weight, 4 lbs.

G. New Heathkit Small-engine Tune-up Meter...39.95*

Kit CM-1045 — for all 2- and 4-cycle engines, 1 to 4 cylinders, with conventional, CD, or transistorized ignitions. Great for motorcycles, snowmobiles, outboard marine engines, etc. Clip-on leads let you check dwell, volts, ohms and continuity without tearing down the engine to get at systems buried beneath the flywheel. A built-in inductive-pickup tachometer works with any number of cylinders. Blue high-impact plastic case stores leads and three "C" batteries for ultimate portability.
Mailing weight, 5 lbs.

H. Heathkit 4-Channel Amplifier with decoder...359.95* less cabinet

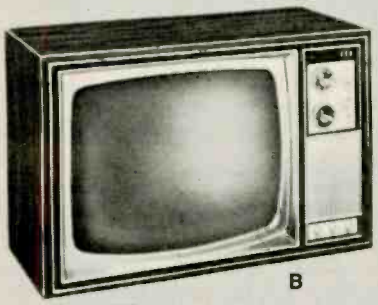
You select discrete 4-channel, or switch-in the "Universal" decoder for reproduction of all the matrixed 4-channel discs now on the market, plus "derived" 4-channel from conventional stereo. Four solid-state amplifiers produce 200 watts (4x50 IHF) into 8 ohms, with power bandwidth on all channels from less than 5 Hz to greater than 45 kHz at 0.25% distortion. Kit AA-2010, mailing weight, 37 lbs. AAA-2004-1, pecan cabinet 24.95*. Mailing weight, 7 lbs.

I. Heathkit Cassette Deck with Dolby circuitry...249.95* less cabinet

The Heathkit AD-1530 is a kit-form cassette deck utilizing the famous Dolby® noise reduction system. Accommodates the greater fidelity and dynamic range of chromium dioxide cassettes. Independent switches provide Dolby on/off and regular or CrO_2 bias control. Domestic-make tape transport comes preassembled for easy kit building.
Mailing weight, 20 lbs.

J. New Heathkit AM Radio...14.95*

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



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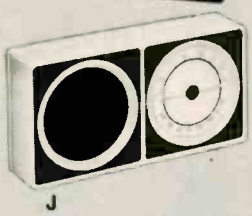

J

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Circle 100 on reader service card

equipment report

Electrix electrical kit

Circle 29 on reader service card

ELECTRIX IS AN ELECTRICAL EXPERIMENTERS kit that has been developed to help the user learn basic electrical theory. It has been popular with German youths for many years and is now available in the U.S.A. through Edmund Scientific Co. The kit includes over 135 precision engineered components and a 112 page instruction manual. Its parts includes two 2.7-volt light bulbs, two small wrenches for making the nut-and-bolt electrical connections, magnet wire, solenoids, hook-up wire, magnets, armature segments, and utility and galvanometer consoles. The consoles are plastic bases that are used when assembling most of the experimental devices. They include space for two cells and holes for components and mounting screws. Catalog No. 71647. $17.95.

Basic electricity is taught through the study of switching circuits, series and parallel connections, current flow, magnetism and by experiments involving the construction and use of such things as sockets, switches, electric bells and buzzers, electromagnets, simple motor, generators, earphone, microphone, galvanomcter and a magnetic compass. The manual leads you step-by-step through each experiment and explains what it is supposed to demonstrate. In the front of the manual it states, that all experiments have been tried and will work as described. However it was not stressed that you must do the experiments in the order that they appear; step-by-step, page-by-page, chapter-by-chapter. The manual starts with a simple experiment and then just adds more on, re-enforcing what you have already learned. Try to start with an experiment in the middle of the book and you are in deep trouble! You won't be able to complete it!!! I guess that this is what makes this kit different from others I've had. Most of the others are mainly for entertainment, this one is educational as well.

I recommend this kit to anyone from 11 years old on up who wants to learn about simple electricity and how things work. I had a little trouble with some of the experiments because some of the parts were not fully illustrated or described and I needed adult help in locating some of them.

Working with this kit will help you understand magnetism, and electricity when you study them in school.

The Electrix kit includes everything that you need except four C cells. It comes in a box 24 by 14 by 2½ in. with notches and recesses to hold the various components. It is a simple kit suitable for the beginner who wants to learn as he plays. As a 13-year-old, I recommend it to any boy—or even girl—over this age.—*Gregory Scott* **R-E**

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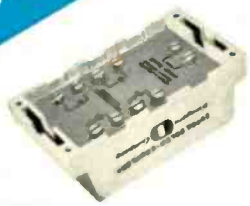

CC-482 82 CH. 4-SET COUPLER—Deluxe low loss coupler connects four TV-FM sets to a single 300 ohm downlead. Efficient coupler circuit provides a maximum amount of signal to each receiver. Specially designed for color, black and white and stereo.

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CS-387 75 OHM V-U-FM BAND SEPARATOR—Band Separator for making connection between 75 ohm coaxial downlead and separate 300 ohm antenna terminals of TV set and FM receiver. Features latest printed circuit design for low loss, high isolation and perfect match. Excellent for quality color and FM stereo reception. Connector included.

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CS-285 300 OHM V-U BAND SEPARATOR—High quality, low loss Band Separator for adapting single 300 ohm downlead to separate 300 ohm VHF and UHF antenna connections of TV set. Perfect match insures perfect color and black and white reception.

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CS-380 300 OHM V-U-FM BAND SEPARATOR—Latest Band Separator design adapts 300 ohm downlead to separate VHF and UHF antenna terminals of TV set and provides FM stereo thru handy no-strip screw terminals. Unique printed circuit design has extremely low loss, excellent match and high isolation for perfect color and FM stereo.

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CS-175 75 OHM V-U BAND SEPARATOR—Quality 75 ohm Band Separator for attaching coaxial cable to separate 300 ohm antenna terminals of TV set. Features printed circuit and latest circuitry for low insertion loss and perfect color transmission. Connector included.

uced 28%

CC-33 82 CH. 2-SET COUPLER—Inexpensive coupler for connecting two TV or FM sets to a single 300 ohm downlead. Features handy no-strip terminals for easy connection.

Low Price!

NEW

T-12BLK 82 CH. MATCHING TRANSFORMER—Compact indoor Matching Transformer for attaching coaxial cable to 300 ohm antenna terminals of TV or FM receiver. Packed 6 per poly bag, 8 bags per master carton. Connectors included.

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CC-282 82 CH. 2-SET COUPLER—Efficient 300 ohm coupler connects two TV-FM sets to a single 300 ohm downlead. Input and output connections are handy no-strip type for easy installation. Quality circuitry insures perfect color and black and white reception.

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NEW

LS-27 82 CH. LINE SPLITTER—High quality line splitter for dividing a single 75 ohm coaxial cable into two trunk lines. Indoor type with transformer network features excellent match. Connectors included.

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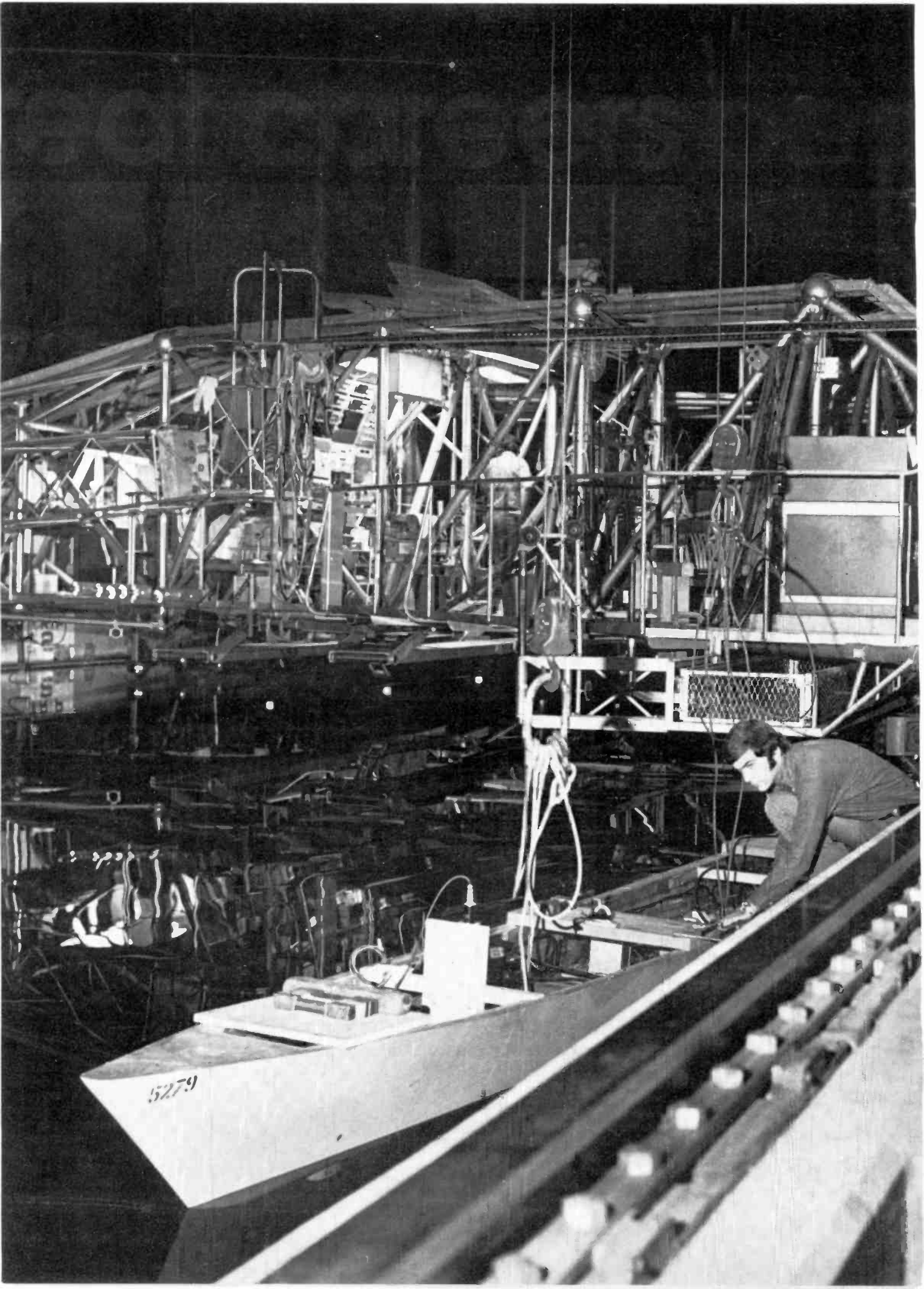
Circle 13 on reader service card



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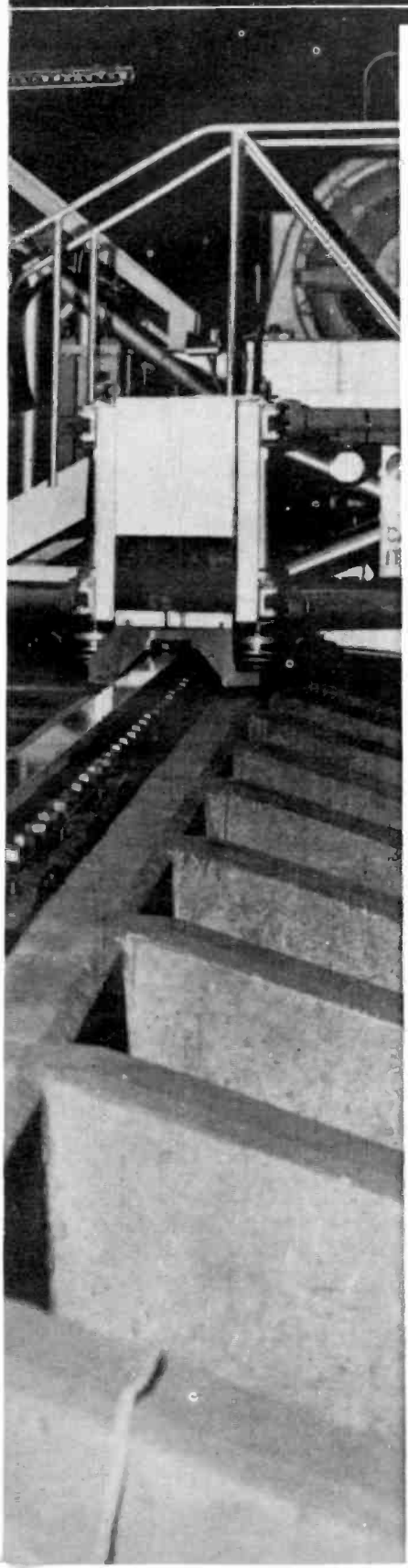

It costs millions of dollars to build modern ocean going vessels. The final design of such ships is based on extensive testing with sophisticated electronic measuring equipment using exact models as shown in the photo of the Naval Research and Development Center. The engineering technicians who check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

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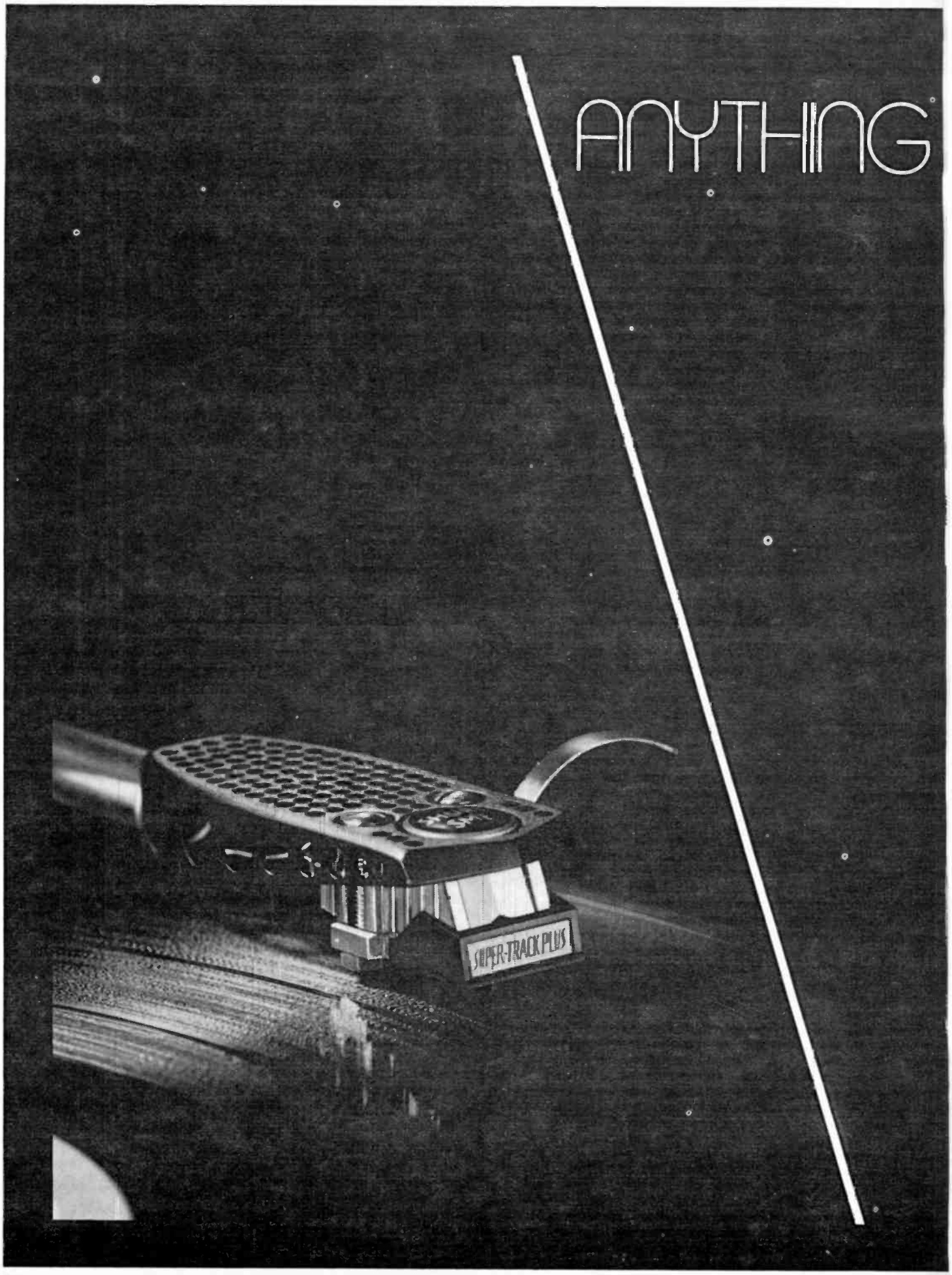
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Here's everything you'd expect from a high-priced portable multimeter.

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The B & K Solid-State Electronic Multimeter (Model 277) has 8 important features that you can get on most other quality-made units, but not at prices like ours.

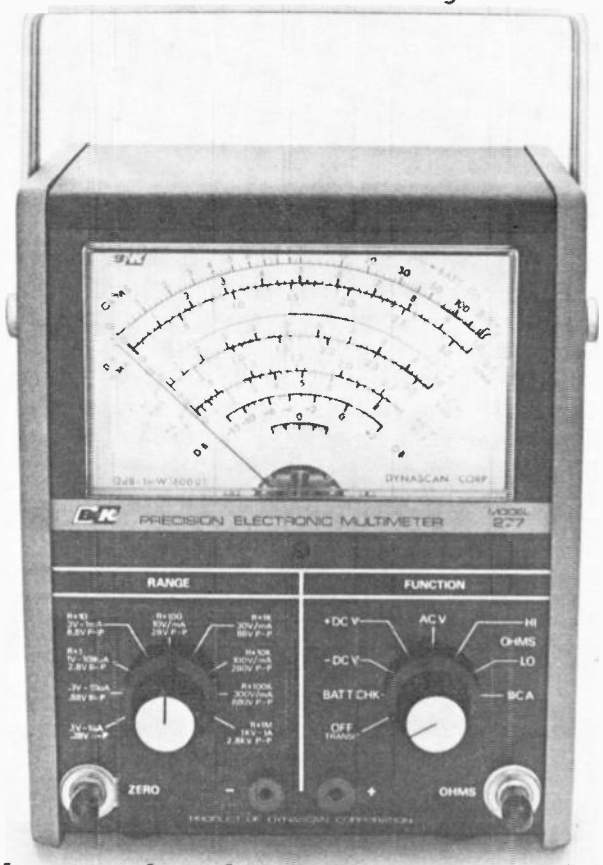
You'd expect to pay quite a lot for a multimeter featuring both high and low power ohms ranges. Both are critically necessary. The B & K 277, with its .068 V power source on low power ohms, will always read the true value of a resistor shunted by a semi-conductor without concern for the semi-conductor's presence. A conventional ohmmeter with a 1.5 volt supply could cause a shunt semi-conductor to conduct, giving a false resistance reading.

The 277's high-power resistance ranges are useful in determining whether transistors are good or bad simply by first forward biasing them to make them conduct and then reversing the leads to qualify the front-to-back ratio.

The B & K 277 has so many features you wouldn't expect at the price: like a .1 V low-voltage scale for both AC and DC; a DC current range of 1 μA full-scale for testing sensitive semi-conductor leakage; the unit is fully protected from overloads by fuse; input impedance of 15 M Ω on DC; 1% precision resistors; a 4½ inch, 50 μA mirrored scale meter; frequency response to 150 KHz and 59 individual ranges.

Our price alone doesn't make it a value, but our features at our price make it a fantastic value.

$99.95



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

Product of Dynascan Corporation/1801 W. Belle Plaine Ave., Chicago, Ill. 60613

Circle 15 on reader service card

build a phone sentry to take your calls

A simple adapter mates inexpensive cassette recorders to phone line.

by ROGER L. SMITH

NOW YOU'LL HAVE NO MORE MISSED phone calls with this home-built Phone Sentry on the job. It automatically answers the phone for you and takes the caller's message.

The Phone Sentry features an electronic control unit you can build yourself. It is used along with one or two *unmodified* cassette tape recorders. When the Phone Sentry is not being used, you may use the recorders for other purposes.

Several recent developments have made this Phone Sentry possible and practical: inexpensive cassette recorders, an endless loop cassette on which you record your "answer message", two new integrated circuits, and highly reliable yet low-cost reed relays. With the Phone Sentry, the equivalent of an expensive phone answering service is available to the smallest businesses and even for home use at a fraction of the cost of units now on the market. If you build the unit yourself, the parts will cost you $29.50, or you can buy an assembled and tested unit for $49.50 (assembled price includes a 30-second endless loop tape).

The heart of the Phone Sentry is an electronic control unit that "answers" the phone, sequences the tape recorders, and "hangs up" after the caller's message is recorded. The unit is triggered by the telephone ring. A relay is energized which turns on the answer tape player. At the end of the answer message, a pre-recorded tone signal causes the answer player to be turned off and the message recorder to be turned on. The message recorder remains on for 30 seconds to record the caller's message, then it and the entire unit is automatically turned off. The Phone Sentry is then ready to receive the next call.

Building the control box

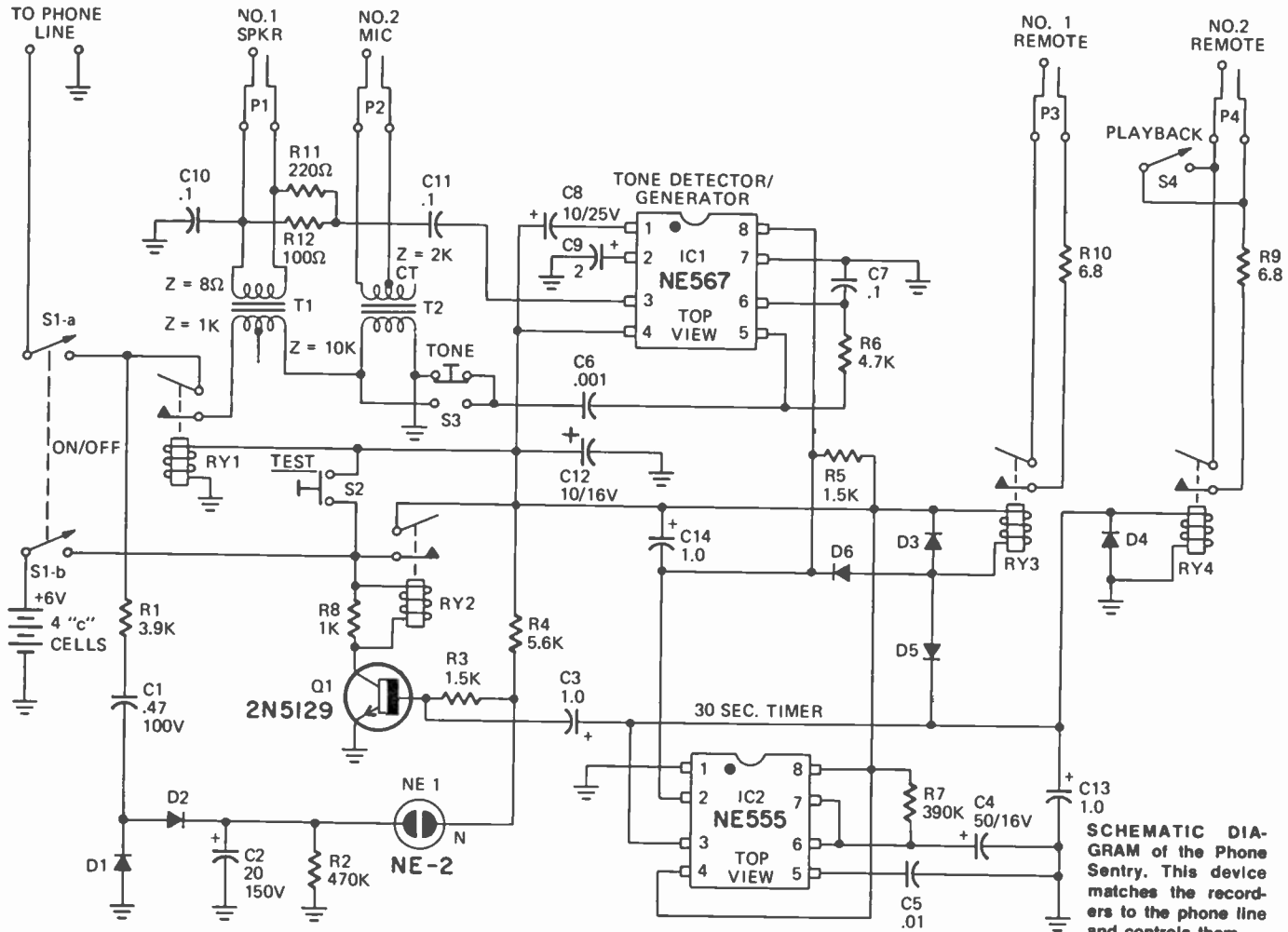
Mount the four reed relays, the two integrated circuits, transistor Q1, the neon lamp, capacitors, and resistors on the printed circuit board as shown in the pictorial diagram. Observe capacitor and diode polarities and proper orientation of IC1 and IC2. Pin 1 of IC1 and IC2 can be determined by the dot or depression in the top of the case. Mount the neon lamp on the foil side of the board and bend the leads so it lies flat against the board.

Connect 2-foot 2-wire leads to T1 and T2 (these will go to plugs P1 and P2) and to RY3 and a six-inch twin lead to RY4 (these will go to P3 and PLAYBACK switch). Using 3 6-inch leads, connect a spdt pushbutton switch (this will be the TONE button) as follows: the common terminal to C6, the normally closed terminal to ground, and the normally open terminal to the primary of T2. Connect a spst pushbutton switch using two 6-inch leads to TEST terminal (near R1) and to normally open contact of S1-6 (ON/OFF switch); this will be the TEST button.

Connect a 6-foot twisted pair cable to common terminal (near C2) and to ON/OFF switch S1-a. Connect the other side of S1-a to RY1 terminal with a 6-inch lead. Use another 6-inch lead to connect S1-6 to RY2 and connect the other side of S1-6 to positive lead from the battery holder. The negative lead from the battery holder connects to common (near C2).

Mount the printed circuit board and battery holder in the case. Connect a 2-foot twin lead to N.O. terminals of the PLAYBACK switch (goes to P4). The 2-wire lead from RY4 is already on these terminals. Bring out the five leads and solder the proper plugs (P1-P4) to their respective cables. Place a piece of white tape around the cables to P1 and P3 and mark on the tape ANSWER UNIT No. 1. Put a similar tape on the cables to P2 and P4 and label it MESSAGE RECORDER UNIT No. 2. A four-pin telephone plug, or any plug to match your phone jack, can be mounted on the LINE cable. Mount the four switches to the front cover of the case.

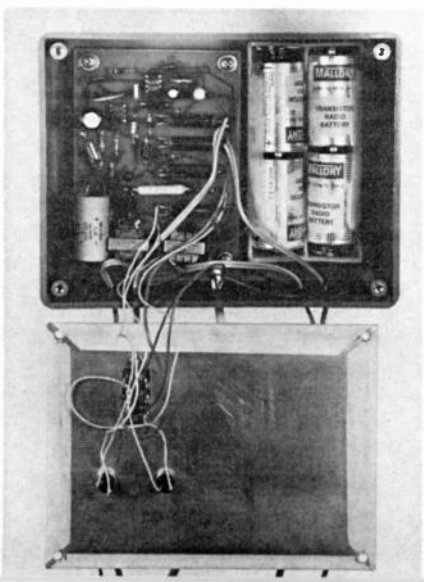
After you assemble the control unit, record your answer message on the endless loop cassette. The following message is just one example: "Hello. This is Roger Smith. Your call is being answered by an automatic Phone Sentry. This is because I am either away or unable to answer the phone at this time. However, I would like to return your call. Will you please leave your phone number or message at the sound of the tone, and I will call you back as soon as pos-



SCHEMATIC DIAGRAM of the Phone Sentry. This device matches the recorders to the phone line and controls them.

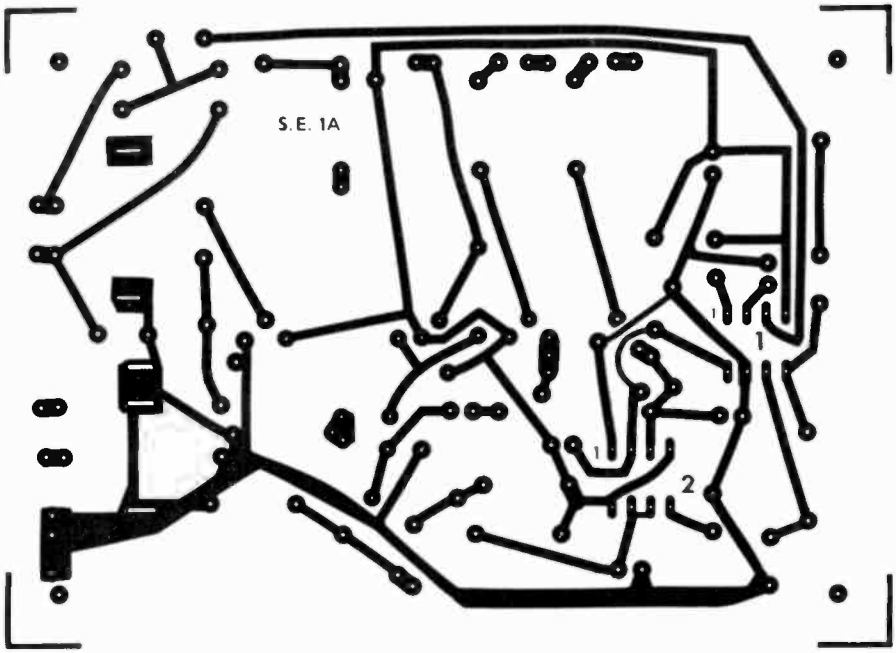
All resistors ¼ watt
R1—3900 ohms
R2—470,000 ohms
R3, R5—1500 ohms
R4—5600 ohms
R6—4700 ohms
R7—390,000 ohms
R8—1000 ohms
R9, R10—6.8 ohms
R11—220 ohms
R12—100 ohms
C1—.47 μF, 100V Mylar
C2—20 μF, 150V electrolytic
C3, C13, C14—1.0 μF, 25V electrolytic
C4—50 μF, 16V electrolytic
C5—.01 μF, 25V disc
C6—.001 μF, 25V disc
C7, C10, C11—.1 μF 25V disc
C8—10 μF, 25V electrolytic
C9—2 μF, 25V electrolytic
C12—10 μF, 16V electrolytic
NE1—NE-2 neon lamp
RY1, RY2, RY3, RY4—4 reed relays, 6-volt coil, spst (Electronic Applications)
IC1—NE 567V tone decoder IC (Signetics)
IC2—NE 555V timer IC (Signetics)
T1—Miniature audio output transformer (1,000 ohms to 8 ohms impedance)
T2—Miniature driver transformer (10,000 ohms to 2000 ohms, ct)
D1-D6—1A silicon diodes, IN4001 or equal
Q1—npn, 2N5129 or equal
P1, P2, P3, P4—phone plugs (type as req'd)
S1, S4—dpst slide switch
S2, S3—dpdt push button switches
MISC: PC board, 2-conductor speaker cable (18'), solder, endless-loop cassette tape (TDK type EC-30S or equiv.), plastic battery holder for 4 "C" cells, plastic instrument case (6 x 5 x 2)
NOTE: A kit of all of the above parts except the endless loop tape can be obtained for $29.50 (plus postage for 1½ lb.) from Southwest Technical Products Co., 219 W. Rhapsody, San Antonio, Texas 78216

sible. Remember, leave your phone message at the sound of the tone. Thank you for calling." The answer message should be about five seconds shorter than the playing time of the endless loop (30 seconds in this case). Now, insert plug P2 from the Phone Sentry into the microphone jack of the answer unit No. 1, and plug P3 into the REMOTE jack. Turn the Phone Sentry on, place the recorder in the RECORD mode and momentarily depress both the TEST and TONE push buttons, then turn off the Phone Sentry. Now turn off recorder and remove P2. You will now have a short tone signal of the proper frequency recorded at the end of your answer message on the endless loop tape. Whenever you make a new answer message and tone signal, be sure the Phone Sentry is disconnected from the phone line. You may have to check your watch closely when making the recording so you don't overlap the end of the message or the tone with the beginning of the message.



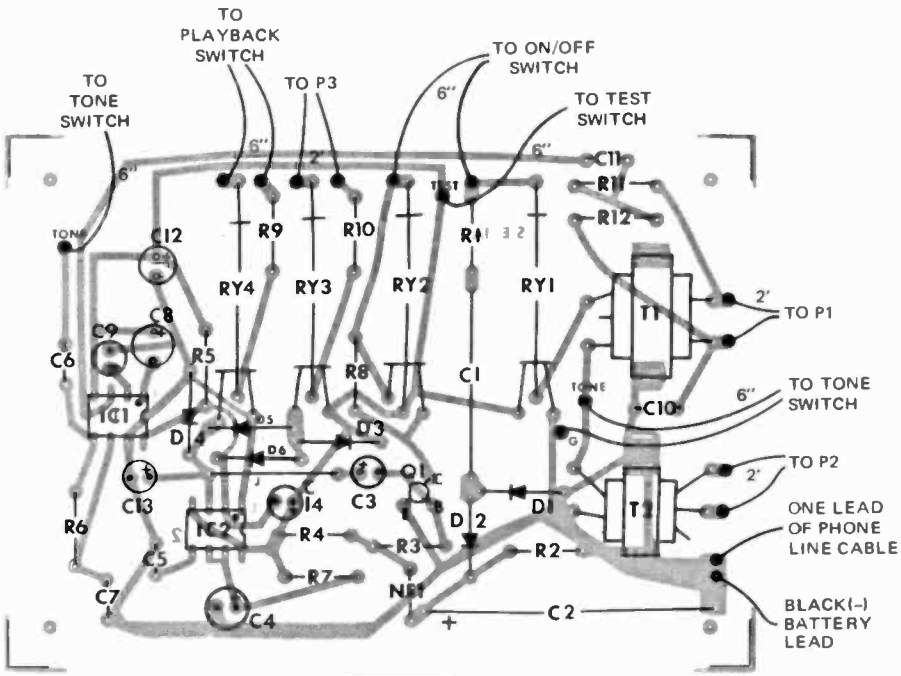
You are now ready to test your Phone Sentry. Connect the answer player unit No. 1 to plugs P1 and P3 (plug P1 to the "earphone" jack and P3 to the "remote" jack). Turn on the player to the "play" mode. Connect the message recorder unit No. 2 to

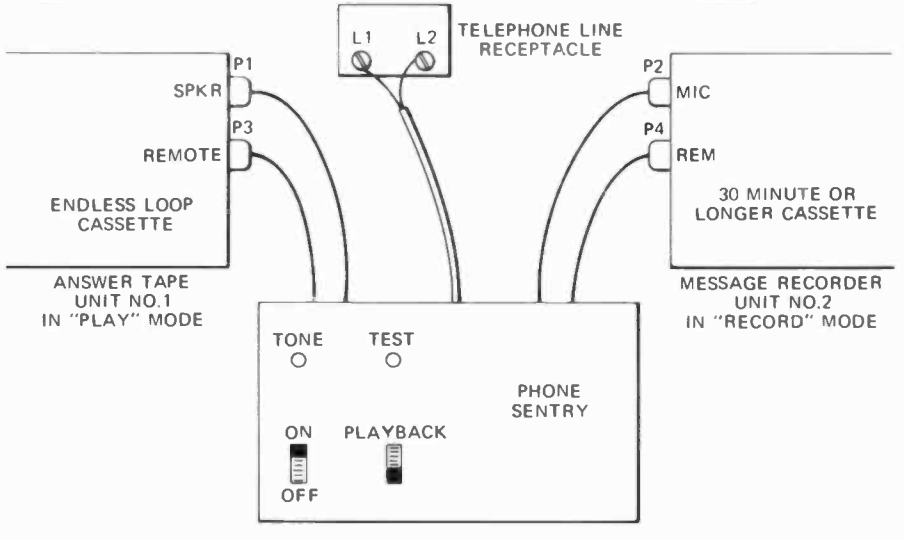
If anyone experiences trouble with the *message* recorder coming on instead of the *answer* player, add a 1-μF capacitor to the bottom of the PC board between pins 1 and 8 of IC2, the NE555. Connect the plus lead to pin 8 and mount it as close as possible to IC2. C12 provides filtering for IC1 but is not close enough to IC2 to bypass transients around it.



INTERCONNECTION WIRES TO BOARD

FOIL PATTERN (at left) for the Phono Sentry is fullsize. Parts are placed as in the middle illustration. Watch diode and capacitor polarities. The bottom diagram shows Phone Sentry connections to two unmodified cassette recorders and phone line.





SYSTEM INTERCONNECTION

plugs P2 and P4 (plug P2 to the "microphone" jack and P4 to the REMOTE jack). Turn on the recorder to the RECORD mode. With ON/OFF switch of the Phone Sentry on, depress the TEST button. The answer player should run for thirty seconds until the tone signal turns it off and turns the message recorder unit on. The message recorder should run for about 30 seconds and then both units should go off.

If all seems well, you can connect the LINE cable to the red and green (or L1 and L2 or T and R) terminals of the phone line. Your telephone junction box may have 3 or more wires, but connect only to the two mentioned. Have a friend call you to test the unit. As soon as the Phone Sentry acquires the line, the answer player should start and you can monitor the call by picking up your receiver. A little experimentation may be necessary to arrive at the proper volume control setting for your cassette recorders.

If your unit doesn't operate properly, check all connections and verify proper plug placement. Be sure all batteries are *new* since a balky recorder will cause a malfunction. Check the circuit theory section and schematic to help you track down your trouble. Also, try reversing the leads to the phone line.

Battery life using regular "C" cells should be 2 months (based on 20 calls per day). You should check your batteries or replace them periodically to insure trouble-free operation. The Phone Sentry can also be used with recorders that have ac battery eliminators.

The endless TDK loop cassette tape is highly recommended for use with the Phone Sentry because it simplifies the operation. Although it costs about $4, the investment is well worth it. Also available are endless loop cassettes of 1 minute, 3 minutes, 6 minutes and 12 minutes. These would be useful for special cases where an announcement only is desired. As you may have noticed, any type of tape recorder that has a remote on/off feature can be used as the message recorder unit No. 2.

It is possible that you do not need to record the caller's message in your particular application. This would be the case of a theatre, advertising message, or store hours announcement. In such instances, simply

(continued on page 82)

by FRED PETRAS

Astute observers are quick to tell you that in addition to colossal, spectacular achievements, the home electronics industry is noted for colossal egos and spectacular ego-complications. To name some of the latter: The battle of record speeds of the late forties, Columbia with its LP, RCA with its 45-rpm disc; The hassle between Columbia and RCA over a color TV broadcasting system in the early fifties; The struggle between GE, Zenith and others to get acceptance of their individual approaches to FM stereo broadcasting, early in the sixties; The war of "convenience" tape Formats—RCA/Lear versus Muntz, then RCA/Lear/Muntz versus Norelco—that flared in the mid sixties; and the conflict of quadriphonic sound, now raging between RCA/Panasonic/JVC ganged against Columbia and Sansui, plus Columbia versus Sansui. There's also the battle of the video record/play formats between several companies, which started in the mid sixties and still rages hot.

Each conflict represents an engagement of individual and/or corporate egos, each struggling for dominance, each wanting to be "The Champ." Each battle represents waste on a grand scale: waste of money, time, human energy, talent and resources, and other elements. But until some "super-psychiatrist" comes along and resolves the Champ syndrome, freeing the companies to realistically function *together*, the waste will continue. And the matter of standardization that the VTR segment of the electronics industry needs to make it a household word—and a mass-market product—will also remain unresolved.

STUDIO PRODUCTION VTR for recording and playback is International Video's new VCR-100, useful for both recording and playback.

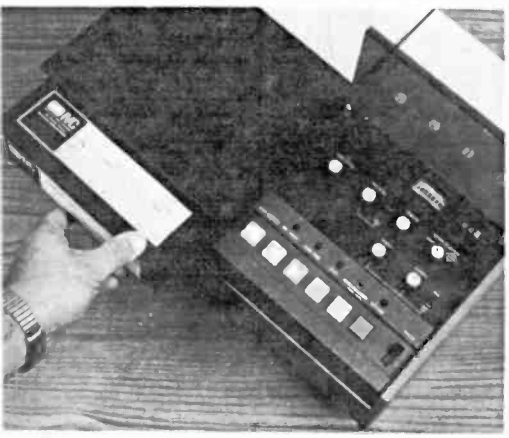
AT TOP RIGHT is RCA's SelectaVision MagTape color tape player/recorder with XL-100 TV receiver as a monitor and signal source.

Standards: Whose? Which?

In fact, the problem of VTR standardization seems even further from resolution. Consider the proliferation of systems: 1, Those now in the marketplace; 2, Those on the way in the near future, and: 3. Other systems farther off in the future.

Standardization is no longer the relatively simple matter of 1966 when it was primarily a decision as to which tape width. Today it's far more: a matter of "Which *system?*" and "Which system *within* a system?" For instance, if you opt for the convenience approach, you have to decide if it's the half-inch, three-quarter-inch, or one-inch cartridge. If you decide on the half-inch size, then it's a matter of deciding "Which cartridge—Omnivision, VCR, or Cartrivision?" The situation is further complicated by variations in terminology. Panasonic and Cartridge Television Inc. refer to their half-inch convenience formats—Omnivision and Cartrivision—as a cartridge. Norelco refers to its half-inch VCR magazine as a cassette. The three-quarter-inch Sony U-Matic is also called a cassette. RCA's upcoming MagTape is called a cartridge. International Video Corp. (IVC) calls its one-inch convenience format a cartridge. If you decide to go the video disc route, you again face up to "Which one?", with your choice encompassing three incompatible close-to-reality concepts, Teldec, Disco-Vision (MCA) or VLP (Video Long Play) (Norelco).

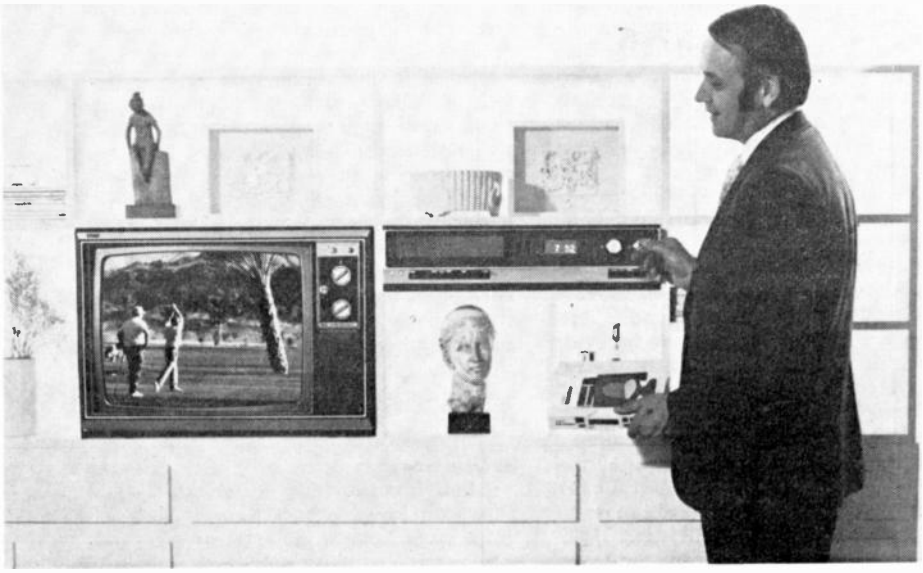
FULL HOUR PLAY OR RECORD from International Video's VCR-100. Operator inserts cartridge and pushes the PLAY button.



Anyone trying to get a "fix" on the VTR field finds that after a lot of research the feeling is that reel-to-reel VTR will eventually be confined largely to the broadcast field, and will be a highly specialized format. The encased magnetic tape formats will be bought by those wanting a choice of record/playback or just playback facilities. The disc formats will be for those wanting only playback of pre-recorded program materials.

According to Alvin Barshop, assistant general manager of Panasonic VTR/CCTV sales, "There are certain parallels to be drawn between the VTR and the film, audio tape, and other industries. In VTR, each cartridge/cassette video format is unique and has its advantages and features, and each serves a certain need in the marketplace. Each has its negatives. We at Panasonic are not here to set standards, but to serve the market what it needs." The company produces both formats, plus reel equipment. Barshop went on to say that the three-quarter-inch videocassette would serve well where 60 minutes of playing time and two sound tracks were essential, as in home entertainment programming. The half-inch cartridge format with its half-hour playing time and single sound track, and impor-

RECORD AND PLAYBACK version of a three-quarter inch video tape cassette. This is the model 2120 from Panasonic.



VTR's—many different systems

Home video recording is almost here. Compare the different systems described and see if you can pick the industry's standard of tomorrow.

tantly, EIAJ standardization for broad use on a variety of machines, would serve well for the industrial market where 90% of all programming is under 30 minutes.

Proponents of the disc system point out that the playback equipment will be cheaper than for tape playback equipment. Discs will also be cheaper, because the materials will cost less, and because mass production techniques can be used to make the end product. The predictions are that video disc costs will be in the same ballpark as high-end stereo records, overall. Further, the discs will be easier to mail. Mass distribution of video discs is likened to selling a newspaper. In fact, there is talk that someday a video disc will accompany the daily newspaper for special purposes . . . like capsule rundowns of key stories of the day, in sound, plus motion, in full color.

Opponents of the video disc note that while it may achieve a high level of popularity, that popularity will be related to program availability. To be a success, the format will require tremendous supplies of program material—possibly beyond the capacity of the software industry. If consumers sense the supply will be inadequate, they may decline to invest in the equipment.

Many crystal-ballers—taking a cue from the current home electronic product scene with its multiple-system ownership ambience—see the same happening in the VTR field. They envision homes with *two* VTR systems, one strictly for playback, the other for recording *and* playback. The first will be the video disc, the latter magnetic tape in some sort of magazine.

Other industry observers take the view that each system has its merits. They suggest that instead of being concerned about which system—or systems—will, or may, predominate, the potential purchaser of a VTR should stop waiting and direct his concern to studying the individual approaches actually available now, and settle on one that appears best for his particular needs and desires. They add that the purchaser should be aware of "future shock," and not necessarily consider his purchase to be a life-time proposition. They equate a VTR system to an automobile, asserting that the average buyer of a car does not buy it with finality in mind. Rather, the car is thought of as "the latest" in an on-going technology, and that it is but one of a series of purchases.

Recent happenings

A chart of VTR products was published in the July, 1972 issue of **Radio-Electronics**. It was devoted to some 75 models in the under-$4,000 price range, actually in the marketplace. Absent were any EIAJ-recommended-standard color versions of the half-inch cartridge concept. That concept hit the market late in 1972, and there are now several models in retail stores, with more on the way in the near future. Among key companies with half-inch EIAJ-recommended-standard color cartridge models are Panasonic (Matsushita), JVC, Shibaden, and Sanyo.

Last year's chart showed JVC, Sony and Wollensak as having U-Matic type cassette machines. That list has expanded to include models from Panasonic and Concord. Upcoming are U-Matic sets from the MGA division of Mitsubishi International Corp.

The roster of companies committed to Cartrivision has decreased by two—Emerson and DuMont. Both have left the home entertainment product field. The concept is actively being marketed by Admiral, Montgomery Ward, Teledyne Packard Bell, and Sears Roebuck.

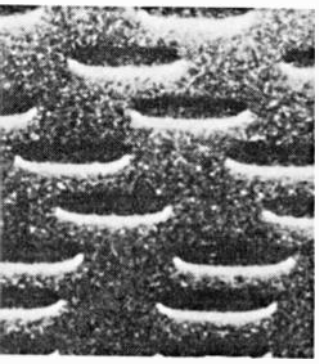
North American Philips has started retailing its "VCR" (Video Cassette

COLOR AND BLACK-AND-WHITE are recorded on Norelco video cassette machine at lower left.
CARTRIDGE VIDEO RECORDER below is the model NV-5120P from Panasonic.
HALF-INCH TAPE is in the cartridge for the compact color and black-and-white video recorder at right. The model is Panasonic's NV-5125.

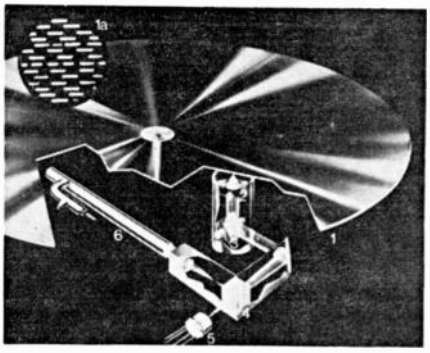
Recorder) system mentioned as "on the way" in our previous wrapup. Utilizing half-inch magnetic tape in a twin-reel cartridge, the concept uses a rotary two-headed helical-scan system and a tape speed of 6.75 ips. Playing time is a top of 50 minutes per cassette using 17-micron tape. A one-hour cassette using thinner tape was said to be possible. A blank 50-minute tape costs $32.50. The cassette measures 5¾ x 5 x 1⅜ inches.

The VCR record/playback deck sells for $1,295. (A playback-only version may be along later, at a lower price.) It offers horizontal resolution of 240 lines, audio bandwidth of 120 to 12,000 Hz within 6 dB, and signal/noise ratios of 40 dB in video and audio. The unit looks like, and operates much like an audio cassette deck. It measures approximately 18¾ x 13¼ x 6¼ inches.

N. V. Philips of the Netherlands has



PHILIPS VLP SYSTEM uses a vinyl-coated metal disc with microscopic pits carrying the necessary video and audio information. At left is surface of VLP as seen through scanning electron microscope.



10 licensees for VCR in Europe, one in Japan (Shiba Electric) and is negotiating with several potential licensees in the U.S.

Since our wrapup last July another video cartridge tape format—totally unheralded—appeared. It's from International Video Corp. (IVC), Sunnyvale, California. Claiming to be "the most compact configuration of any VCR on the market, while providing the highest performance in the VCR field," the new VCR-100 series uses self-threading *one-inch* video tape cartridges that are *tape interchangeable* with over 10,000 other IVC open-reel videorecorders now in use.

Tape in the cartridge is connected to a leader and threads itself automatically onto a permanent reel inside the recorder much the same as film in an automatic-threading film projector. The cartridge is designed for the standard 8-inch, one-hour NAB reel. Tapes made on IVC cartridge recorders can be removed from the cartridge and played on existing IVC one-inch open reel recorders. Tapes produced on master recorders can be easily placed in an IVC cartridge by the user, for playback. Running speed of the tapes is 6.91 ips. Playing time is a maximum of one hour. Standard or high-energy tape is used. It is made for IVC by 3M Co.

Three models are available: a color playback version at $1,900; a color recorder/player priced at $2,700; and a monochrome recorder/player for $2,300. The portable-cased units measure 17½ x 12½ x 7¾ inches and weigh 45 pounds.

For the moment, IVC is running alone with its format. No software program per se is under way, a company official told us. He noted that software would be developed by users of the VCR-100 series, and if duplication was required, it could be handled by specialists such as Consolidated Video Systems. He added that the format was enjoying strong acceptibility in the cable TV field, with Teleprompter, for one, standardizing on the IVC one-inch format for all its program production. IVC also has a half dozen VTR's in one-inch reel form in production in the $1,800 to $4,000 range.

Among other noteworthy recent additions to the VTR product scene is a versatile new half-inch reel model (EIAJ Type One standard) from JVC, model KV360, priced at $1,060. It records and plays at 7½ ips, but can additionally play back at slower speeds, for slow-motion studies of sports activities, etc.

Another versatile newcomer is Sanyo model VTR-1200, a half-inch reel model (EIAJ Type One standard) with four ferrite-crystal video heads. The unit has five operating modes: standard (7½ ips) speed, slow-motion, accelerated-motion, seven-hour recording, and stop-motion/frame-by-frame advance. It is priced at $2,395.

On the color camera front, Akai has brought out a six-to-one zoom model with 300-line horizontal resolution. The 5¾-pound unit has a built-in microphone and employs a ⅔-inch separate-mesh vidicon for its luminance channel. The tube is contained in the camera's vertical hand grip. The camera is compatible with any color video tape system currently sold in the U.S. industrial market. The camera, model CVC-150, comes as a system complete with power supply and adaptor, at $3,495.

EVR—electronic video recording—is apparently not near the demise predicted for it on the heels of CBS's abandonment of production and marketing of the concept in the U.S. EVR is actively being marketed in Japan, Canada, Australia, and some Arab countries by Mitsubishi Electric Corp. of Tokyo. The firm is also test marketing EVR in the U.S. through its MGA division in Chicago, but plans for actual marketing have not been concluded. Mitsubishi is part of a partnership called Nippon EVR, Ltd., formed in Japan last fall, and includes Teijin, Hitachi, and Mainichi Broadcasting "to exploit the EVR system world-wide" according to a brochure prepared by the original EVR Partnership of Imperial Chemical Industries, Ltd., of the United Kingdom, and CIBA-Geigy Ltd. of Switzerland. Toshiba is also reported to be marketing EVR in Japan.

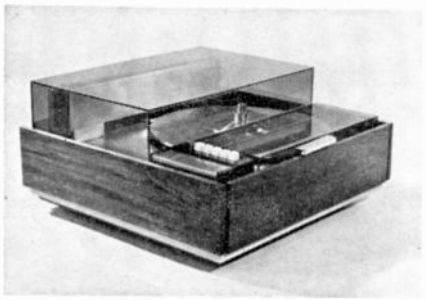
Our chart last year showed Motorola to be marketing an EVR player in the U.S. It is no longer doing so. However, the firm is continuing to produce program materials for EVR via its Teleprogram Center. The same programming is also available in the Sony U-Matic, plus Super-8 and 16-mm film formats.

Last year we talked about several video film systems, some under development, others at the talk stage. Little has happened in this medium, judging by the lack of publicity since last summer. However, vague rumors persist that a video-player attachment using Super-8 movie film will appear—when, no one seems to know. It may be based on Kodak's "feasibility" model detailed in these columns earlier, or based on a system developed by Polaroid.

As for the much-talked-about Holotape laser beam, half-inch vinyl film, play-only system announced by RCA a few years ago, it is "pretty much on the shelf" for the moment, according to an RCA spokesman. But the company is still continuing research on the idea.

In the works

Last July we stated that RCA's "MagTape" three-quarter-inch color video cartridge system was on the way, likely to see the light of day this year. That's still true. RCA says MagTape will be in commercial production by year's end. Pilot engineering runs of some key MagTape components are under way. We saw prototype MagTape



MYLAR DISCS are the medium used in MCA's Disco-Vision. Laser scanning cuts record wear.

models and they were impressive. We saw the system function in a variety of ways, and operate through five different brands of TV sets. The recorded picture quality of MagTape was virtually indistinguishable from original off-the-air broadcasts and air-shot dubbings from two-inch broadcast tapes, in terms of color quality, resolution, and brightness. There was no streaking, thanks to a built-in drop-out compensation circuit. The quality of sound was A-1, in both mono and *stereo*—the latter via optional stereo amp and speakers. As for on-the-spot recordings, they came off beautifully.

The target price for a recording deck is $795, including a one-hour blank cartridge. (A playback-only version will be available at a lower price.) The 35-pound deck measures 24 x 16¾ x 5¾ inches. The cartridge measures 9¼ x 6½ x 1½ inches. The unit records and plays at 3 ips. It runs for one hour on 918 feet of ¼-inch magnetic tape one-mil thick. Longer lengths will be available. A one-hour cartridge is expected to cost $29.95. The system uses in-cartridge scanning, with four heads. Tape contacts the headwheel in a 90° wrap (see illustration) as opposed to the 120° or 240° of the omega technique. This approach eliminates threading and reduces strain on the tape, it is claimed. Thus, headlife is longer—about 2,000 hours.

A special feature of MagTape is its ability to record a program via built-in tuner while the user is watching another TV program.

RCA will offer a black-and-white camera as optional equipment, at about $250. The firm also has a color camera under development, to be offered, hopefully, in 1974. The MagTape system will be marketed by Bell & Howell, and may also appear under the Magnavox brand name. If so, Magnavox will offer a "low-cost" color camera with its version of the concept. MagTape will appear north of the border, bearing the Westinghouse of Canada and Electrohome Limited brand names.

The Video disc

The Teldec Video Disc mentioned in our last article is still on the way. It will arrive in the U.S. early in 1974. The company actually has production prototypes and has assigned a model number—2001. Some advances have been achieved over the original concept. Now the system offers 10 minutes of playing time in color with stereo sound on an eight-inch disc, versus five minutes for the initial prototype disc. As a result of the playing time extension, the company envisions a somewhat simpler and cheaper automatic changer, at a vague price point under $400. The greater playing time per disc obviates the need for a very high speed change cycle, a spokesman explained. A single-play deck is expected to sell for around $220.

The Teldec system uses plastic discs that play at 1,500 rpm (1,800 in the U.S.) Video/sound information is contained in "hill-and-dale" modulations of the disc grooves, rather than the side-to-side, lateral modulation of audio records. A pressure pickup is used. The discs are reproduced through a color or monochrome TV set to which the Video Disc player is attached (via the set's antenna terminals).

With little preliminary fanfare, N.V. Philips of the Netherlands last September debuted its prototype "VLP" (Video Long Play) television disc technique, which will be marketed in the U.S. by North American Philips Co. (Norelco). To be available "in a few years," the concept employs metal vinyl-coated discs and a playback unit using a low-powered (one-milliwatt) helium-neon laser light source instead of a stylus, and an electro-optical pickup which plays the record without direct contact—completely eliminating disc wear. Recording information is in the form of microscopic "pits" rather than grooves as in an audio disc.

Disco-Vision

A new video disc system from MCA, Inc., Universal City, California, was shown in prototype to a select audience last December. The approach—called "Disco-Vision"—is being refined, with some improvements effected since the initial showing. When will it be on the market? The nearest to a definite statement is that the company *hopes* to introduce it late in 1974. Target prices for equipment are "under $400" for a single-play player deck that connects to a TV set (via antenna terminals), and under $500 for a changer deck that stacks up to 10 discs for a total playing time of 6⅔ hours, with only four-second change-time interruptions. Single and multiple disc albums are designed to sell for suggested list prices of $1.99 to $9.95 each, depending on content, length and subject.

Disco-Vision employs 12-inch discs made of Mylar .010 inch thick. The discs are metallized to permit handling with no more care than that required for ordinary phono records. They are recorded on one side only. Program material appears in the form of a spiral running from the outer diameter of the discs inward, with a pitch of 80 microinches per revolution. Density is 12,500 tracks per radial inch. The discs revolve at 1,800 rpm and are scanned by a 1mW helium-neon laser. Its beam is electronically steered to follow the spirals; there is no physical contact with the track itself. This technique eliminates record wear and provides unlimited playing life with proper use and handling.

Software

Software is a major hangup for the VTR industry, what with the variety of formats. Should a film company for example, put out its product in Cartrivision, U-Matic, Omnivision, or VCR form? There is just no way at present to gauge demand, or even interest. According to Stafford Hopwood, head of Videorecord Corp. of America, a national marketing firm for distribution, rental and sales of videoplayers and software, more people are after "special-interest" programming than movies. He said the industry should attempt to market software that fills the special interest needs.

Stafford feels that rentals will be a major element in the software picture since most people will not want to tie up money in programming of limited use-value. He asserted that while people will *listen to* a phono record time after time, they will *look at* a visual presentation only a few times.

What most program production firms and duplicators are doing in the interim (while marketing research goes on, as the various concepts settle in, and as the industry tries to "find itself") is standing by, ready to develop and put out their offerings in whatever form is requested. No company will commit itself exclusively to any one format—primarily as a protective measure to accommodate the vagaries of the marketplace.

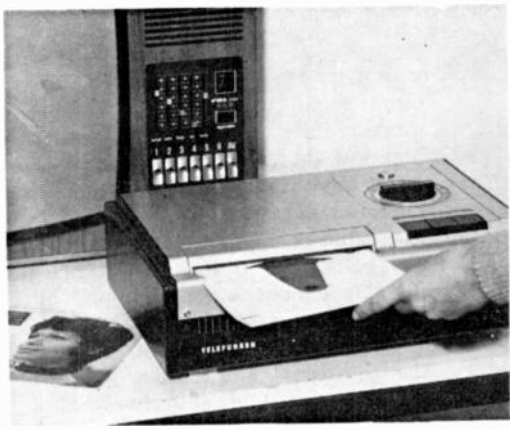
The two front-running companies actively marketing cartridge VTR equipment are doing their utmost to see that software is available to feed the equipment. Taking their cue from the audio tape field, they realize that the key to equipment sales is easy and wide availability of pre-recorded VTR cartridge tapes.

Sony, for example, with some 20,000 U-Matic units in the U.S. and Canadian markets, and expectations of selling another 100,000 world-wide this year, tells prospects as well as actual purchasers that there are over 2,000 programs available in U-Matic form. They can be bought or rented. These are from over 40 film producers and program suppliers, including Time, Inc. There are at least six U-Matic tape duplication centers around the country.

Cartrivision, currently offering some 300 pre-recorded programs, is producing additional titles at a claimed rate of 200 per month. The company has *access* to some 4,000 titles, including 2,000 major films from several film libraries. The film cartridges are for rent or purchase. Rental charges range from $3 to $7 per play, depending on program length, content, and other variables. Purchase prices range from $12.98 to $39.98 for pre-recorded cartridges running from 15 to 114 minutes. Rentals are through Cartridge Rental Network, a joint venture of Columbia Pictures and Cartridge Television Inc.

What does it cost?

What's going to happen to VTR equipment prices? That's a question being pondered in the industry. The reasoning is that as more machines come into the market, the greater will be future demand, based on the initial "seeding" process. As companies amortize some of their tremendous R & D



TELEFUNKEN TELDEC video disc and player are shown here. Disc and protective sleeve are inserted into player.

expenses, and as competition increases, the belief is that prices will come down. This has been the pattern for the entire home electronics business, ever since the twenties when radio came on the scene in a big way.

Currently there is speculation that Sony will bring out a U-Matic record/play deck priced around $800, and that Cartrivision will have one at that price also . . . to offset possible competition from RCA's upcoming MagTape machine in that price range. In effect, both Sony and CTI will be protecting their initial strong market positions—as well as their colossal investments in achieving those positions—by introducing $800 units.

The lowest priced color TV camera now available is Magnavox's "Chromavue 400" at $2,500 list. But the company is working on a derivative of that unit which it hopes to sell for "under $1,000", possibly in mid-1974. Other companies are also known to be working on low-priced color video cameras.

The price range for most one-hour blank video tapes is $33 to $40. But this range will drop as the industry expands and more machines enter the marketplace. Several audio tape firms have moved into the video field, and others plan to follow. One firm, Audio Magnetics, has as its *goal* the production of a high-quality video tape in cassette form, at a price under $10.

Irish Magnetic Tape has a line of quarter-inch video tape for Akai VTR's in 30 to 120-minute lengths, at $9.95 to $49.95. Ampex has a one-hour tape for Akai equipment at $20. **R-E**

11 ways to with your

IC's cease to be mysterious black-boxes test instruments as a FET multimeter.

VARIOUS TESTS OF INTEGRATED circuits can be made with conventional vom's or tvm's. However, the high-low (hi-lo) FET meter has a distinct advantage because resistance measurements can be made with a low value of applied test voltage. This test voltage is so low that a normal junction cannot be "turned on" by a resistance measurement.

Practically, this means that all of the transistors and diodes in an integrated circuit are effectively absent when a hi-lo FET meter is operated on its (LOW-POWER OHMS) function. In turn, resistors can be checked out accurately, and various semiconductor junctions can be checked for leakage. Although not all IC's can be completely checked out, many practical tests can be made.

Here are 11 ways to use your hi-lo FET meter to test comparatively simple IC's with a small number of built-in transistors, resistors, and diodes. (If you wish to test large-scale IC's with many built-in transistors, more elaborate test procedures must be used.

1. CHECKING RESISTORS

Equipment: Hi-Lo FET meter.
Connections: Connect ohmmeter test leads to IC terminals, as in Fig. 1.
Procedure: Set meter controls to measure low-power ohms. In the example in Fig. 2, measure resistance values between terminals 4–9, 4–10, and 5–10.
Evaluation: Because the resistance measurements were made on the LOW-POWER OHMS function, our equivalent circuit is shown in Fig. 3. The 4–9 measurement is the resistance of R1 + R3, or 6K. The 4–10 measurement is the resistance of R2 + R3, or 6K. The 5–10 measurement is the resistance of R4, or 18K. If substantially different resistances are found, reject the IC.
Note: Although other pairs of terminals could be used to measure resistance in Fig. 3, this would provide no additional information. That is, there are four resistors in the circuit, each of which is included at least once in the 4–9, 4–10 and 5–10 measurements. Or each resistor could be measured alone.

2. CHECKING THE TRANSISTORS IN AN IC FOR LEAKAGE

Equipment: Hi-Lo FET meter.
Connections: Same method as test 1.
Procedure: Set meter controls to measure low-power ohms. Referring to Fig. 2, measure the resistances between terminals 6–8, 1–2, 1–8 and 1–9. The R × 1-MEG range provides the most sensitive test.
Evaluation: The resistance measurements were made on the LO-PWR OHMS function, So our equivalent circuit is shown in Fig. 4. All junctions are normally open circuits in this test, and the meter should read infinity in the foregoing tests. If resistance readings are substantially less than infinity, reject the IC.
Note: Junctions do not normally "turn on" when the low test voltage of the LO-PWR OHMS function is applied. Therefore, the polarity of the test voltage is of no concern. If a junction is leaky or shorted, a resistance reading of less than infinity will be observed, regardless of the test-voltage polarity.

3. CHECKING A DIODE IN AN IC FOR LEAKAGE

Equipment: Hi-Lo FET meter.
Connections: Same as in test 1.
Procedure: Set meter controls to measure low-power ohms. Referring to Fig. 2, measure the resistance value between terminals 3–4. The R × 1-MEG range provides the most sensitive test.
Evaluation: Because the resistance measurement is made on the LOW POWER OHMS function, the meter should read infinity. If the resistance reading is substantially less than infinity, reject the IC.
Note: A diode junction is basically the same as a transistor junction, and is tested in the same manner. The diode junction is normally an open circuit on the LO-POWER OHMS function, regardless of the polarity of the applied voltage.

4. CHECKING THE SUBSTRATE IN AN INTEGRATED CIRCUIT FOR LEAKAGE

Equipment: Hi-Lo FET meter.
Connections: Same as in test 1.
Procedure: Set meter controls to measure low-power ohms. Referring to Fig. 2, measure the resistance value between terminal 7 and any other terminal of the IC. The R × 1-MEG range provides the most sensitive test.

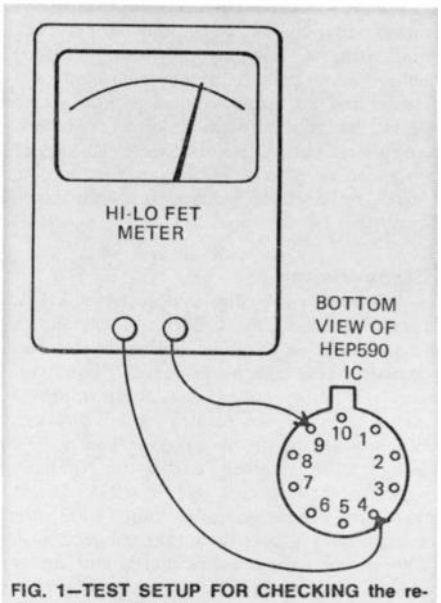


FIG. 1—TEST SETUP FOR CHECKING the resistors in a HEP 590.

test IC's FET VOM

when you can check them with such basic

Here are 11 ways you can test an IC

by ROBERT G. MIDDLETON

Evaluation: Because the resistance measurement is made on the LOW-POWER OHMS function, and the substrate effectively presents a junction to other IC terminals, the meter normally reads. If we find a resistance reading substantially less then infinity, reject the IC.

5. CHECKING THE FRONT-TO-BACK RATIO OF TRANSISTORS IN AN INTEGRATED CIRCUIT

Equipment: Hi-Lo FET meter.
Connections: Same as in test 1.
Procedure: Set meter controls to measure high-power ohms, and operate on the R × 100 range. Referring to Fig. 2, measure the resistance between terminals 2 and 1. Then, reverse the test leads and measure the resistance between terminals 2 and 1 again, Repeat the pair of measurements for terminals 6 and 8.

Evaluation: These tests are essentially the same as out-of-circuit front-to-back ratio measurements. Normally, the forward resistance will measure somewhat more than 1000 ohms, and the reverse resistance will measure infinity. A substantially incorrect front-to-back ratio indicates a defective integrated circuit.

Note: The diode in Fig. 2 can be tested similarly for front-to-back ratio between terminals 3 and 4. Test 5 yields the front-to-back ratio for the collector junction of Q2 and the emitter junction of Q3. No data has been obtained concerning the front-to-back ratio of the remaining junctions.

6. CHECKING THE FRONT-TO-BACK RATIO OF A TRANSISTOR SHUNTED BY RESISTANCE

Equipment: Hi-Lo FET meter.

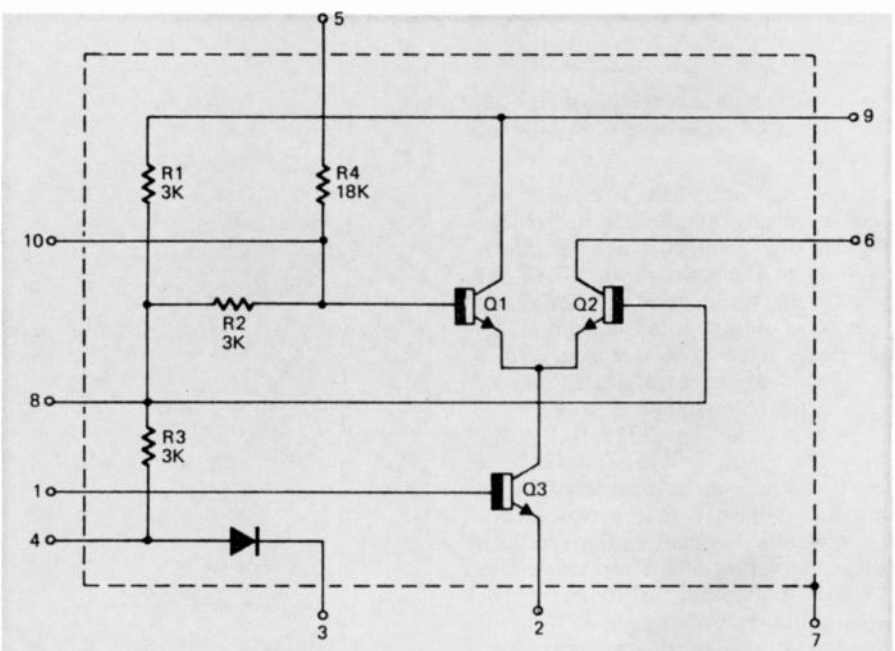


FIG. 2—COMPLETE CIRCUIT of Motorola's HEP 590 IC. Tests between various terminals indicate the condition of the resistors and the semiconductors

Connections: Same as in test 1.
Procedure: Set meter controls to measure high-power ohms, and operate on a suitable resistance range. In this example, we will employ the R × 100 range. Referring to Fig. 2, measure the resistance between terminals 9 and 10. Then, reverse the test leads and measure the resistance again.
Evaluation: The equivalent circuit in this test is for all practical purposes shown in Fig. 5. Normally, we measure somewhat more than 1000 ohms in the forward direction and 6000 ohms in the reverse direction. Since 6000 ohms is considerably larger than the normal forward resistance of the collector-base junction, the practical measurement of forward resistance compares to that in test procedure 5. However, the measurement of reverse resistance is established by the 6000-ohm shunt; therefore, this is an incomplete test.

7. CHECKING THE FRONT-TO-BACK RATIO OF A TRANSISTOR WITH SERIES RESISTANCE

Equipment: Hi-Lo FET meter.
Connections: Same as in test 1.
Procedure: Set meter controls to measure high-power ohms, and operate on a suitable resistance range. In this example, we will use the R × 100 range and check the front-to-back ratio of Q2. Referring to Fig. 2, measure the resistance between terminals 4 and 6. Then, reverse the test leads and measure the resistance between terminals 4 and 6 again.
Evaluation: The equivalent circuit in this test is shown in Fig. 6. Normally, we will measure approximately 3,500 ohms in the forward direction and infinity in the reverse direction. Since 3,000 ohms

(continued on page 78)

4-CHANNEL SQ LOGIC
a closer look at how it works

THE WAR OF THE FOUR-CHANNEL DISCS has resolved itself into two well-defined camps. Columbia Records continues to champion its matrix SQ system. Judging by the number of SQ discs now available and the relative intercompatibility between this particular matrix approach and earlier matrix proposals espoused by Electro-Voice and Sansui, CBS certainly assumes the role of "chief spokesman" for matrix discs in general.

RCA has assumed the role of the "latecomer" with its "discrete" disc and inherently more complex demodulation requirements and a notable absence of records available to the consumer. We are assured, however, that discrete discs will soon abound and that, indeed, RCA intends to catch up and surpass SQ achievements in a short time.

In the meantime, decoder circuits for SQ discs are becoming more and more sophisticated and such terms as "front-back logic" and "wave comparator circuitry" are being added to an already growing lexicon of four-channel terminology. A great deal has been written about the SQ matrix system, much of it slanted towards an understanding of the record groove itself, rather than the signal components expressed in a manner more easily understood by the electronics fraternity. To understand the SQ system and the subsequent logic-circuitry which is being added to it to enhance separation, it would be worthwhile to take another look at SQ, in terms of actual signal make-up and without resorting to the vague and nebulous references to "four kinds of groove modulations" (lateral, vertical, and two directions of "helical") which have been referred to in the past.

All matrix systems can be expressed by generalized equations for both the encoding and the decoding processes. In the case of encoding:

$L_t = AL_f + BR_f + CL_b \angle\theta + DR_b \angle\beta$ and

$R_t = AR_f + BL_f + CR_b \angle\theta + DL_b \angle\beta$

in which L_t and R_t are the composite, encoded left and right signals which are actually recorded as two conventional stereo channels in the normal manner. L_f, R_f, L_b and R_b are the left-front, right-front, left-back and right-back discrete four channel signals. A, B, C and D are coefficients having some value between "0" and "1" and angles θ and β are phase shift angles between "0" and "180" degrees and may be either "leading" or "lagging" with respect to the original, discrete signals. In the case of the CBS-SQ encoding parameters, coefficients A, B, C and D are chosen to be 1, 0, -.707 and .707 respectively while angles θ and β are chosen to be 90° and 0° respectively. Thus, to express the contents of the two composite signals in the SQ system, we may say that:

$L_t = L_f - j.7L_b + .7R_b$ and $R_t = R_f - .7L_b + j.7R_b$

(0.707 has been rounded off to 0.7 for simplicity in transcribing). The vector diagrams of Fig. 1 show the signal contents for each of the composite signals indicating amplitudes as well as angular displacement, where an arrow pointing to the right means 0° of the phase shift while arrows pointing up and down denote positive and negative phase shifts of 90° respectively.

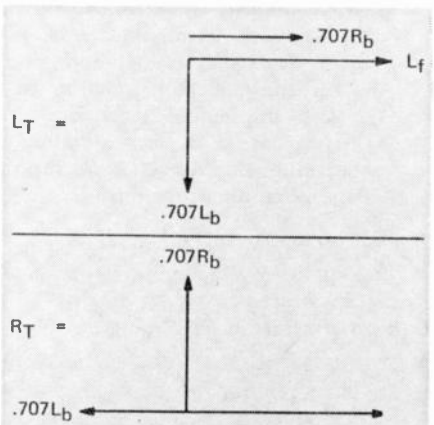


FIG. 1—AMPLITUDE AND PHASE relationships of SQ encoded L_T and R_T composites.

The decoding formulas chosen by CBS in the SQ system are:

$L_f' = L_t$: $\quad L_b' = -.707\,(-jL_t + R_t)$

$R_f' = R_t$: $\quad R_b' = .707\,(L_t - jR_t)$.

If we substitute the values for L_t and R_t established in the two encoding equations shown earlier, we can derive the values of the recovered four channels of output in terms of the *original* discrete input signals. None of the descriptions of this system which have appeared in print bothered to take the equations through this important, final step. The results obtained after going through the extra algebra are:

$L_f' = L_f - j.7L_b + .7R_b$;

$R_f' = R_f - .7L_b + j.7R_b$

$L_b' = L_b + j.707L_f - .707R_f$;

$R_b' = R_b - j.707R_f + .707L_f$

These results really explain the "design philosophy" inherent in the SQ system. Notice that for the recovered front channels, there is complete absence of R_f content in the L_f' recovered signal and complete absence of L_f in the R_f' recovered signal.

As for the back channels, the same "total separation" holds true. That is, there is no L_b content in the output of the R_b' channel and there is no R_b signal in the L_b' output. It is this effect which enables CBS to claim "full" side-to-side separation in their system. Furthermore, since stereophonic playback involves the repro-

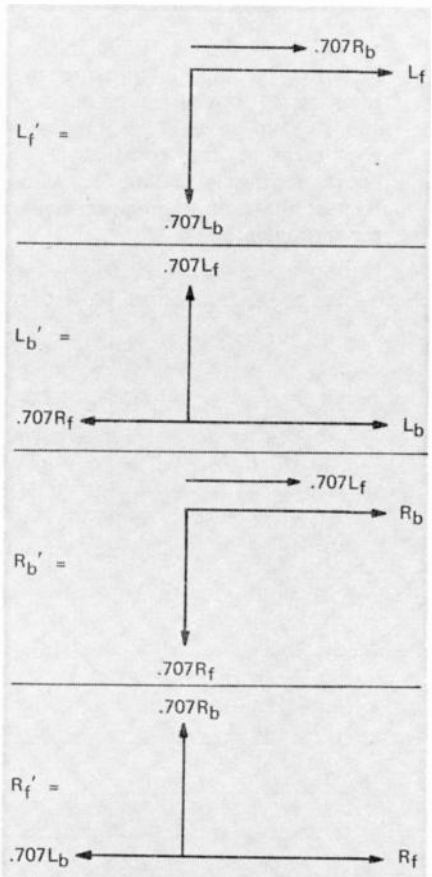


FIG. 2—PHASE AND AMPLITUDE relationships of four decoded signals in SQ system. Note that each recovered signal contains elements of three of the four discrete signals.

Columbia Record's SQ matrix system is pressing to become the quadriphonic disc standard. Here's what it's all about.

by LEONARD FELDMAN
CONTRIBUTING HIGH-FIDELITY EDITOR

duction of the L_t and R_t composite signals with *no* decoding, full left-front to right-front separation is maintained in two-channel playback as well, since the L_f and R_f signals are not "cross-blended" in the encoding process either. The vector diagrams shown in Fig. 2 again display the signal content of each of the four output channels in a simple SQ matrix decoder and illustrate amplitude as well as phase relationships of the *three* signal components which are heard from each loudspeaker.

Offsetting this excellent side-to-side separation capability are crosstalk effects from front to rear and across diagonals which are quite severe. The equations for each recovered channel clearly show that while the desired program channel dominates in level, two of the three remaining unwanted channels are present, and attenuated a mere 3 dB (0.707 in amplitude equals -3dB compared to "1" or unity). Chief criticism of the "simple matrix" decoders designed for SQ is their inability to provide good "front-back" separation, particularly when a soloist or vocalist is supposed to be up front and "center stage."

Normally, when that effect is desired, equal amplitudes of the vocalist's "signal" are fed to the front-left and front-right channels in normal two channel recordings. Upon playback, an apparent image is created between the two front speakers, since each speaker is producing the same sound at the same level. Translated to quadriphony, a recording engineer would have to apply the "C" (for "center") signal as the only contribution to the L_f and R_f signals during cthe encoding process. Let us assume that no other channels contain signals for the moment. Then $L_f = C = R_f$ and if we substitute C for L_f or R_f in the four expanded decode equations we would obtain: $L_f' = C$; $R_f' = C$; $L_b' = j.707C$ and $R_b' = .707C$. This means that the rear channels, which should have had *no* center vocalist present, are only 3 dB lower in sound than are the front channels for a condition of "center vocalist."

Front-back logic

Illustrated in Fig. 3 is Sony's model SQD-2050 SQ decoder. This unit, in addition to providing the necessary matrix decode circuitry, features additional circuitry known as "front-back" logic. The exact workings of the logic circuitry have not been disclosed to date, but essentially the "dominance" of a front signal is detected by the circuitry and variable-gain amplifiers are so biased that if a front signal predominates, the gain of the rear amplifiers is reduced. Similarly, if back signals predominate instantaneously, the gain of the front output amplifiers is reduced.

The resulting available front-back separation capability of the model illustrated is approximately 10 dB (as opposed to the inherent 3 dB of the basic matrix system), but it should be emphasized that *no* gain riding system, however complex, can compensate for *all* possible musical combinations that are likely to occur. For example, if, at a given instant, equal amplitude signals from various instruments are intended to be heard from all four loudspeakers (a different instrument from each—but all playing at approximately equal volume), no logic system yet conceived can isolate the channels completely and, under those unique circumstances, no "gain riding" takes place and separation reverts to the 3 dB which is inherent in the SQ system.

FIG. 3—SONY SQD-2050 DECODER features logic circuits to enhance the otherwise poor front-to-back separation of the SQ system.

Figure 4 is a reproduction of one of the diagrams included in Patent No. 3,708,631 issued by the U.S. Patent Office to CBS. In this early first patent, it will be noted that the four loudspeakers shown are arranged

about the author

Leonard Feldman, well-known author, lecturer and engineer consultant in the high-fidelity field, has been appointed Contributing High-Fidelity Editor of **Radio-Electronics** Magazine.

Author of numerous books and articles on audio and frequency modulation, Feldman's technical experience includes work as a project engineer on audio and FM product development and participation in the FCC field trials, which led to the approved system for stereo FM broadcasting. Active in quadriphonic sound development, he is coinventor of a matrix four-channel system. A former components manufacturer, Mr. Feldman operates his own consulting engineering firm, serving hi-fi manufacturers in the U.S. and abroad.

Feldman is also technical advisor to the Institute of High Fidelity, an organization of more than 50 leading manufacturers of hi-fi components. As chairman of the IHF's new standards committee, he is helping establish standards for rating hi-fi equipment. He is a member of the IEEE and the Audio Engineering Society.

as "front," "back," "left" and "right" systems, the so-called "diamond" pattern which was popular in the early days of quadriphonic experimentation. For this reason, an explanation of the "logic" portion of this circuit (enclosed by dotted lines) would not conform to the gain riding requirements of today's more popular "square" speaker configuration.

Nevertheless, the illustration is reproduced here merely to show the relative complexity of these "logic" circuits and the number of active amplifying stages needed if discrete components are used. The particular diagram represents only one degree of logic, in that gain of front and back speakers will be reduced when *either* a left or right signal predominates, while gain of left and right channels will be reduced when *either* a front or back channel predominates. If this system were translated (by proper adjustment of parameters and the necessary phase shifting networks) to work with square speaker configurations, it would approximate the "front-back" logic circuitry of the Sony Model 2050.

Even more complex logic circuitry is used in such models as Sony's SQD-2020 (pictured in Fig. 5), in which front-back logic is augmented by what the company calls "wave comparator" logic circuits which reduce ambiguities along the sides of the listening room. Such "two-level" logic circuits are considerably more complex than the circuit shown in Fig. 4 and the number of amplifiers and other active circuits is considerably greater.

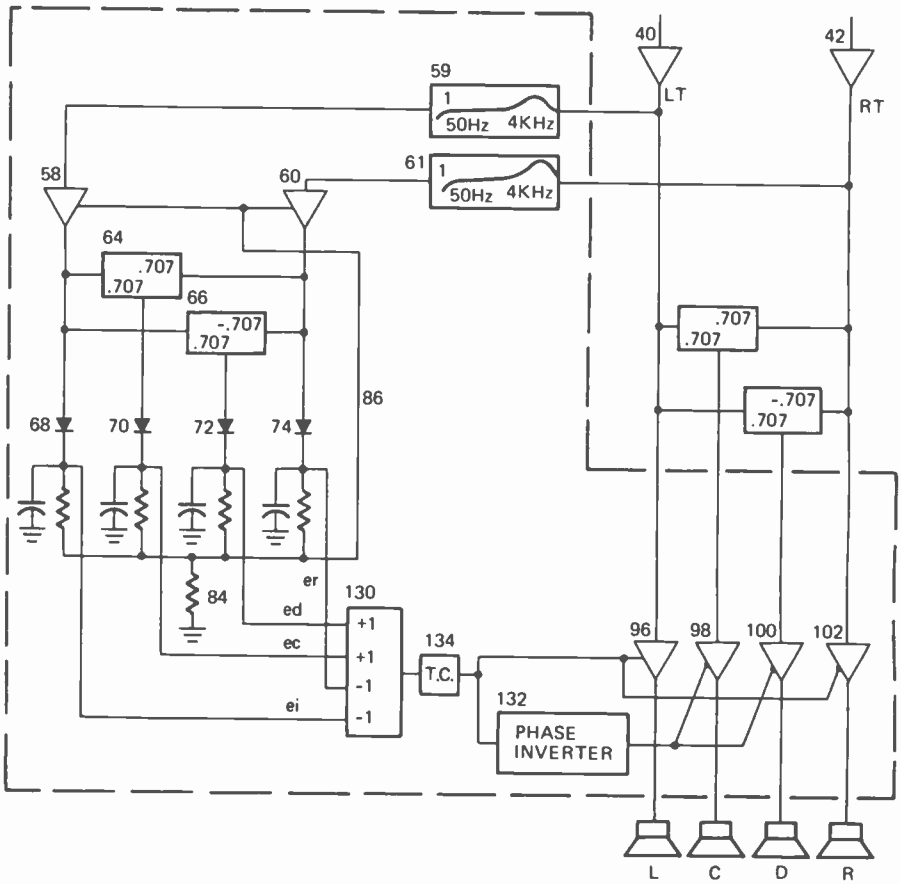


FIG. 4—SIMPLE LOGIC SYSTEM in CBS patent. Items 40, 42, 58 and 60 are amplifiers; 96, 98, 100 and 102 are gain-controlled amplifiers and 130 is a summing amplifier. Resistor 84 averages the dc voltages from rectifiers 68-74. Items 64 and 66 are separators; 59 and 61 are response weighting networks. Time-constant 134 fixes the logic attack time.

IC's for SQ

Happily, the progress made in large-scale integration for IC's prompted Motorola to develop a family of IC's which can reduce cost and simplify construction of SQ matrix decoders. The first of these decoder "chips," Motorola's XC-1312P, has been available for some time and its use in SQ matrix decoding is shown in block diagram form in Fig. 6. Actual external components used to affect the necessary 90° phase shifts are shown in the complete schematic diagram of Fig. 7 and 5% tolerance capacitors and resistors are recommended to insure accurate phase shift characteristics.

Note, that in the absence of further logic circuitry, the manufacturer shows two "blend" resistors (7.5K and 47K marked by asterisks) that may be added to the circuit to improve front-back separation. Addition of these two resistors, however, will result in less-than-perfect separation between left-front and right-front, or between left-back and right-back. As with all matrix circuits, you cannot have the best of both kinds of separation at the same time and the use of these "blend" resistors constitutes a form of trade-off when only the simple matrix decoder circuit is used.

Working closely with CBS, Motorola has developed two more IC's which, when added to the unit shown in Figs. 6 and 7, provide "full logic" decoding for the SQ system. The additional "chips" are identified as MC-1314 and MC-1315. The first of these constitutes the necessary voltage or gain-controlled amplifiers, while the second serves as the logic control circuits.

A complete suggested interconnecting diagram is shown in Fig. 8 and, because voltage-gain controlled amplifiers are used, certain side benefits accrue. A single-section potentiometer can be used to control overall gain of all four channels while other single-element potentiometers can control overall front-back balance, left-right front balance and left-right back balance.

In addition, connected to pin 13 of the MC-1315 logic-control IC is a fifth control which is identified as a "dimension" control. This last control enables the user to adjust the amount of logic action for best performance in his own listening room or to select varying amounts of logic control de-

FIG. 5—WAVE COMPARATOR used in this and other expensive decoders has front-to-back and side-to-side logic circuitry.

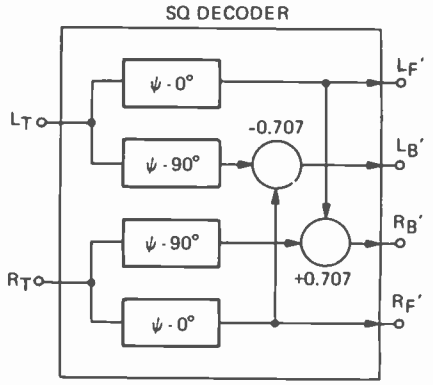


FIG. 6—BLOCK DIAGRAM of Motorola XC-1312P IC chip for use in SQ matrix decoding. The required external parts are shown in Fig. 7.

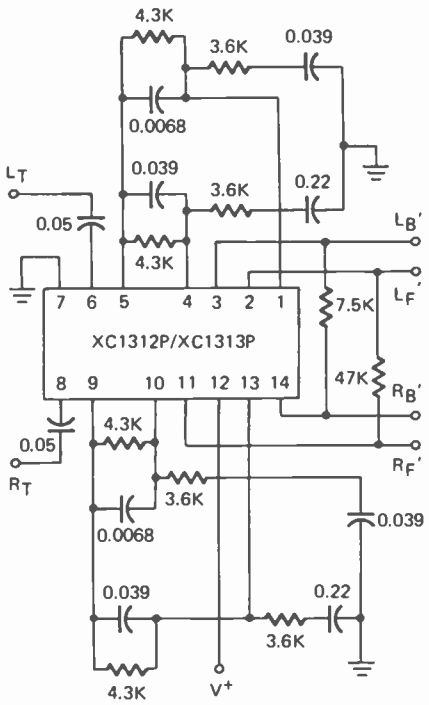


FIG. 7—SQ DECODER using Motorola IC. Blend resistors (7500 and 47,000 ohms) are connected between the L_B and L_F and L_F and R_F.

pending upon the particular SQ disc being played.

Using the entire system of 3 IC's, nominal input level is 0.5 volts at a total harmonic distortion out of the system of approximately 0.1%. Signal-to-noise ratio quoted for the system is 80 dB and voltage gain is unity. External components required for the complete system comes to 28 capacitors and 8 resistors (not including the single-section potentiometers referred to earlier).

At the present time, total-logic decoders such as the Sony SQD-2020, sell for well over $200.00 because discrete transistors are used in the logic circuitry. It is conceivable that within a few months, however, when the Motorola family of SQ IC's becomes available, prices of decoders should come down substantially. If, in fact, the price of a full-logic decoder comes down to around the $100 mark, that would be competitive with the first RCA "discrete" Quadradisc demodulators being offered.

Such a development will make the "battle" between the two record giants even more interesting. In terms of realizable instantaneous separation, Sony claims 20 dB from L_f to R_f, L_f to L_b and R_f to R_b. Center-front to center-back has been improved to 15 dB separation on the full logic product. These numbers compare very favorably with those obtained in the so-called "discrete" system, although it should be emphasized that they represent "instantaneous" or apparent separation and even the "double logic" system can be fooled ("confused" would be a better term) when certain combinations of four-channel programming occur.

Against this relatively minor disadvantage (most music does have instrumental emphasis of one sort or another most of the time), there is the rather tricky cartridge requirement of the competing "discrete" disc system which requires reasonably good response out to 45 kHz. Add a replacement cartridge to that nominal $100 for discrete four-channel disc capability and you may, perhaps, offset the total discreteness of the Quadradisc.

Actually, it's not necessary to vote for *either* system at this point. Clearly, both are going to coexist for the foreseeable future—much as the 45 rpm record coexists with the 33⅓ rpm LP. In future articles we'll delve into some of the ramifications of converting to Quadradisc four channel capability—just to be completely fair! **R-E**

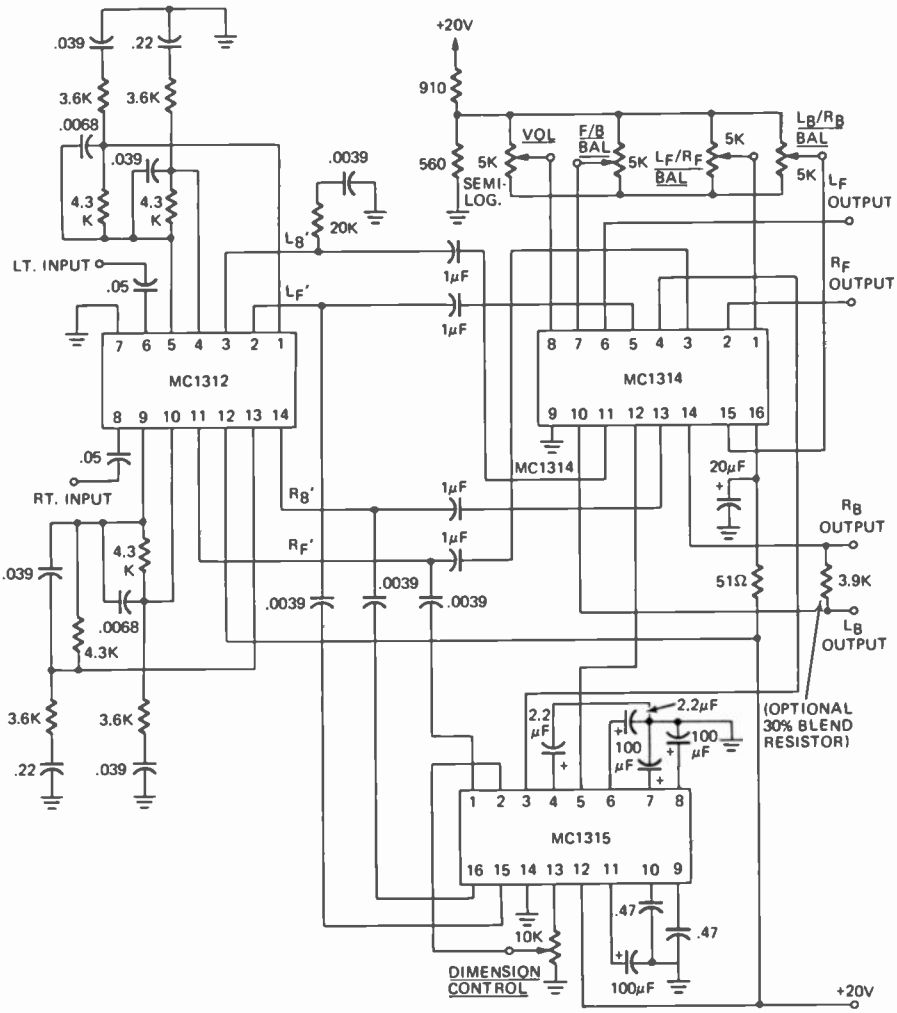


FIG. 8—FULL LOGIC DECODING is made possible by adding two new Motorola IC's to the circuitry in Figs. 6 and 7. The MC1314 has the gain-controlled amplifiers while the MC1315 serves as the logic control elements. The "dimension" control lets the listener adjust the logic circuits for his listening area and for the SQ disc being played.

SOLID STATE NEWS

National Semiconductor Corporation (2900 Semiconductor Drive, Santa Clara, Calif. 95051) has released a new series of 3-terminal negative power regulators. The new devices, designated the LM120 series, will supply up to 1.5 amperes at 20 watts dissipation. Each IC is completely self-contained, featuring preset output voltage, internal overload protection, and thermal limiting for fail safe operation. Output voltages of -5, -5.2, -12, and -15 volts are available with an accuracy of ±2%. Load regulation is typically 30 mV at 1 A, and ripple rejection is better than 60 dB. Only one external component, a compensation capacitor across the output, is required for LM120 operation. The new devices are available in both TO-3 and TO-5 packages.

Fighting inflation, Fairchild's Microwave and Optoelectronics Division (464 Ellis St., Mountain View, Calif. 94040) has announced across the board price reductions in its line of LED's, with reductions of up to 60 percent in large quantities of some units. Fairchild's FLV110, for example, has been reduced from 58¢ to 33¢ in 1,000 up quantities, and down to 17¢ each in 100,000 up lots.

SPEED TROUBLESHOOTING

Part III of a series introducing efficient troubleshooting and

by JONATHAN L. TURINO

IN THE FIRST TWO PARTS OF THIS series we developed a method of logical and efficient troubleshooting called "cut-it-in-half" troubleshooting (**Radio Electronics**, April and May 1973.) Before giving the answers to last month's quiz and the reasons for them, here's a brief review of the tenets developed in the science of logical troubleshooting.

Two things are necessary for logical troubleshooting—hardware and software. The hardware is your test equipment. You must have the right piece of test equipment for the job. The software includes your knowledge, any theory of operation and operating instructions, and most importantly, a block diagram of the equipment to be repaired. Once all of these things are at hand, troubleshooting begins by checking the simple things first, and then using all available information to proceed logically to find a defective component. With all of this in mind, let's look at the answers to last month's tape recorder troubleshooting quiz. From the symptoms given, the trouble was not in the playback section. The first answer should be point "C", the auxilliary input. This is the first logical check since it eliminates the microphone preamp and the record preamp. The second choice should have been point "D", the halfway point between the auxilliary input (known signal) and the output from the head. The third answer was "3"—the trouble is in the record amplifier, and that is where we should troubleshoot.

If you had a problem answering the tape recorder quiz correctly, it might be a good idea to review some of the things discussed earlier in this series. Being an expert troubleshooter takes a little study, but it is worth the effort even if you limit your repair work to your own home entertainment equipment.

A great deal of emphasis has been placed on the use of the block diagram for troubleshooting. The main reason for this emphasis is that with a block diagram, and some knowledge of what a piece of equipment should do, you can troubleshoot even the most complex gear, even when you are unfamiliar with how it functions internally. With the block diagram you can analyze how each section and stage in almost any piece of equipment operates. Once you have analyzed it, you will be able to troubleshoot—if you proceed in a logical fashion.

Fig. 1 shows the functioning blocks of a digital counter. Since a digital anything (voltmeter, ohmeter, thermometer) operates almost exactly the same way (the input parameter to be measured is converted to frequency by a separate "block"), once you can troubleshoot the basic counter, you are well on your way to being able to repair almost anything digital.

The counter is composed of several interconnected functions. The oscillator creates a stable frequency used as a time standard. The dividers, together with the range switch, determine how long the gate block allows the input signal (conditioned by the input signal conditioning block) to be fed to the divide-by-2 stages. The divide-by-2 stages start out reset to zero, and if eleven pulses come through when the timing dividers provide a one second

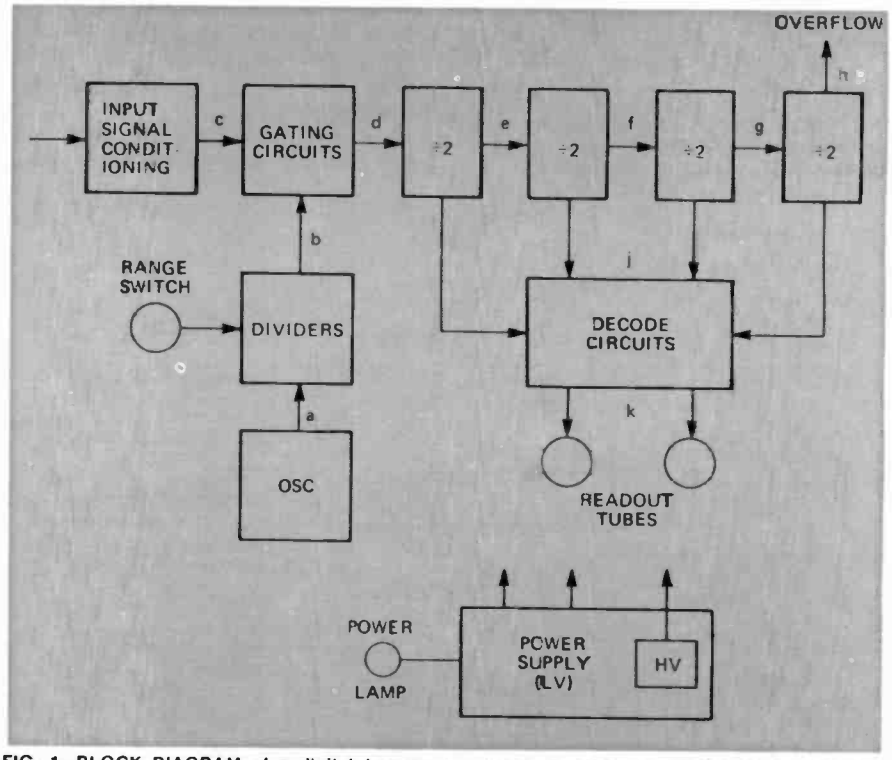


FIG. 1—BLOCK DIAGRAM of a digital frequency counter shows how easy it is to troubleshoot electronic devices when you break them down into functioning and nonfunctioning circuits.

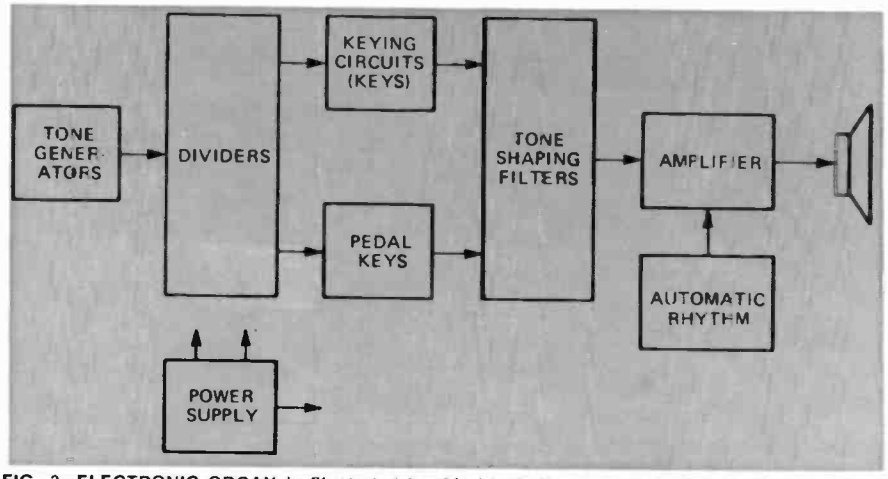
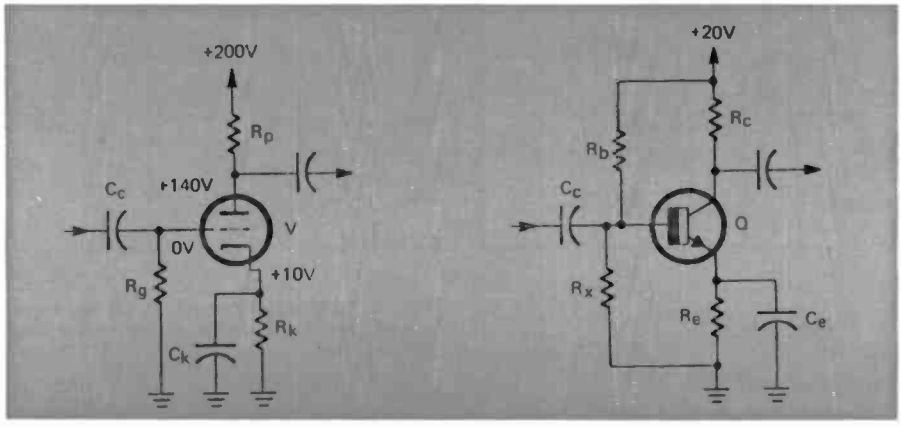


FIG. 2—ELECTRONIC ORGAN is illustrated by this block diagram. Each of the eight major sections can be broken into smaller blocks as troubleshooting brings you closer to the defect.

With A Logical Approach

a novel approach to speedy and repair of electronic gear

gate, the divide by 2 stages are set to 1011_2 by the eleven pulses. The decode block converts the binary number 1011 to a decimal number and causes the readouts (Nixie tubes, segment indicators, or any other digital readout device) to display it. If the timing dividers provide a 0.1 second gate and twelve pulses are counted by the divide by 2 stages, 120 Hz is the frequency of the input signal. You can see that even an expensive and complex device such as a digital counter can be broken down into easily understandable "function blocks."



E_p	E_g	E_k	DEFECTIVE COMPONENT
140V	0V	10V	(NORMAL)
0V	0V	0V	R_p OPEN
200V	0V	150V	R_k OPEN
100V	0V	0V	C_k SHORTED
100V	20V	20V	C_c LEAKY
200V	0V	0V	V (THE TUBE)

V_c	V_b	V_e	DEFECTIVE COMPONENT
12V	2.6V	2.0V	(NORMAL)
2V	2V	2V	Q SHORTED
20V	2.6V	0V	Q OPEN
20V	2.6V	2.6V	R_e OPEN
6V	0.7V	0V	C_e SHORTED
6V	4.6V	4V	C_c LEAKY

FIG. 3—TUBE AND TRANSISTOR AMPLIFIERS (left and right, respectively) are typical of those in functioning circuits. The chart readings pin-point the defective component.

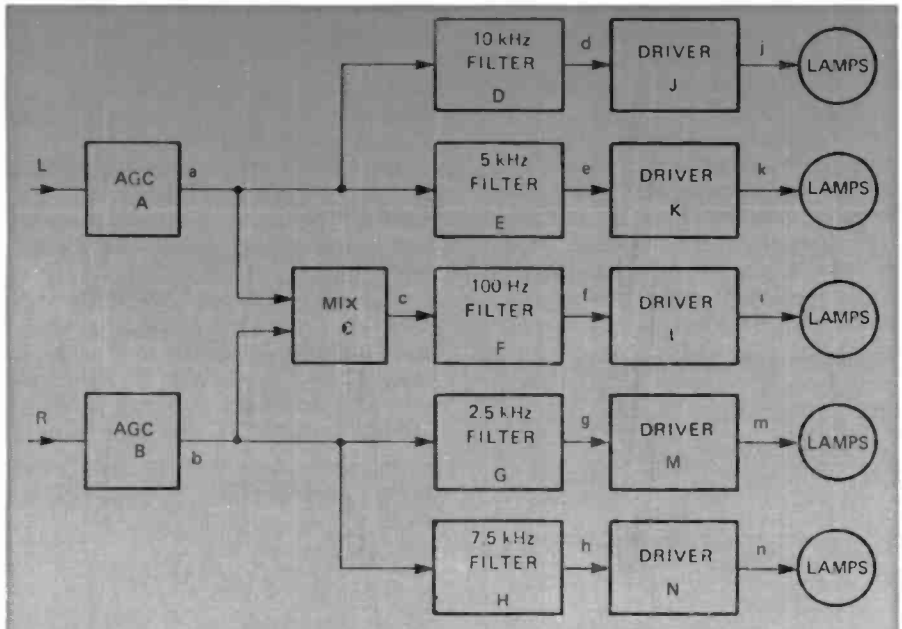


FIG. 4—TEST YOUR KNOWLEDGE of the logical troubleshooting technique covered in this series by localizing defective stage in this color organ. Answer appears next month.

How about troubleshooting this counter? Here are a few examples of how cut it in half troubleshooting can be applied. See if your diagnosis matches ours, and be sure that you can see the reasoning behind the diagnosis.

Symptom 1—The power lamp comes on, but the readout tubes will not light up (even on "00"). **Defective stage**—The readout tube section of the power supply is the most likely, although the "decode" block could be responsible. Check the power supply first.

Symptom 2—The number "00" is continuously displayed. **Defective stage**—There is no simple answer here, we have to troubleshoot. Just looking at the block diagram, point **"d"** looks like it is about the halfway mark in the counter. Suppose we find that the signal is not coming out at point **"d."** Where do we check next? The gating circuits are fed by two things—the timing dividers and the input signal conditioners. Either place is good for your next check. If the input signal is present at point **"c"**, check point **"b."** If both signals are present, it is obvious that the gating circuits stage is defective.

Troubleshooting this way is not only simple, it is fun. Treat every troubleshooting job as a challenge, a battle of wits between you and the electron, and you will excell at it.

Fig. 2 is a modern electronic organ. Most of the functions are self explanatory so there is no accompanying "theory of operation." You can't fix an organ? One further rule when troubleshooting—think positive. You can if you take the time to sit down and study the block diagram of something, or better yet, create your own block diagram from the schematic. There is nothing that you can not troubleshoot. Even though the electronic organ in Fig. 2 can cost from $500 to $5,000 and may have several thousand parts, it has only seven major functions. Isolate to the function. Each of the large blocks has several internal blocks. Sectionalize to isolate the big block, and

(continued on page 96)

STATE-OF-SOLID-STATE

A UNIQUE METHOD OF FM DETECTION using a new linear gating technique is featured in a monolithic integrated circuit now available from Signetics (811 East Arques Ave., Sunnyvale, Calif. 94086). Designated type ULN2111, the new device is intended for applications in TV audio channels, FM receivers, afc systems, and communication receivers, but also can be used in more sophisticated circuitry in telemetry receivers, automatic control systems, and servo amplifiers.

As illustrated in Fig. 1-a, the new device comprises 18 npn transistors, 6 diodes, and 18 resistors making up two functional circuits, a limiter/amplifier and a detector/amplifier. The two functional circuits are interconnected by a simple external phase-shift network, as shown in Fig. 1-b.

Assembled in a standard 14-pin DIP, Fig. 2, the ULN2111 is designed to operate from a 12-volt dc source. With a frequency range of 5 kHz to 50 MHz, the device can furnish a typical voltage gain of 60 dB, and an output of 0.6 V. with a total distortion of less than 1% at a limiting threshold voltage of only 400 μV rms. The unit's average current requirement is less than 20 mA. Input resistance is 5000 ohms shunted by 11 pF, while the detector's output resistance is 200 ohms. The internal de-emphasis resistance is 9000 ohms.

Suitable for use in both TV audio and FM broadcast applications, a practical limiter/detector circuit using the ULN2111 (IC1) is shown in Fig. 3. In operation, only a single coil, L1, is required for the phase-shift network, thus simplifying detector adjustment and alignment.

Referring to the schematic, T1 is the receiver's i.f. output transformer and C1 a dc blocking capacitor. Except for C8, all other fixed capacitors are low-voltage ceramic units, but C3 should be an NPO type. Audio coupling capacitor C8 may be a 30 to 50 μF electrolytic. The resistors (R1 and R2) are standard ¼- or ½-watt composition types.

If the circuit is to be used as a TV audio detector at 4.5 MHz, L1 should be a 7-14-μH coil (Miller type No. 9052), R1 a 20,000-ohm resistor, and C4 a 3 pF capacitor. For 10.7-MHz operation in FM receivers, L1 should be 1.5-3 μH (Miller type No. 9050), R1 3,100 ohms, and C4 rated at 4.7 pF. The output load, R_L, represents the input resistance of the following audio amplifier and, normally,

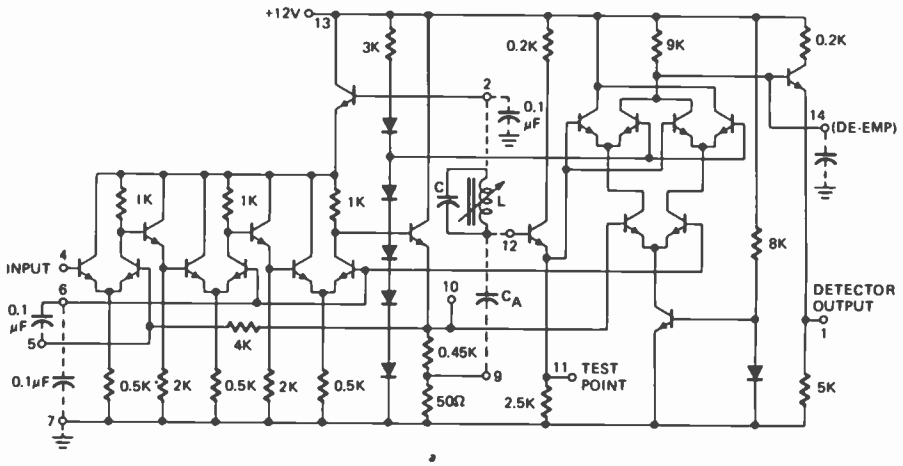


FIG. 1—INTERNAL SCHEMATIC (a) and block (b) diagram of Signetics' ULN2111 FM limiter/detector.

will be in excess of 200 ohms.

Although layout and lead dress are not overly critical, good rf wiring practice should be observed when duplicating the circuit. Signetics recommends that the decoupling capacitor leads at pins 5, 6 and 12 be kept as short as possible, with the connections to pin 4 as far removed as is practicable from the connections at pins 9, 10, and 12. The power supply connection at pin 13 should be bypassed to circuit ground with a 0.1 μF ceramic capacitor, keeping the leads short. If the power source has a large internal impedance (such as a voltage dropping resistor), then an additional high-value electrolytic capacitor should be used at pin 13 for audio decoupling at the lowest audio demodulation frequency. Because of the circuit's high gain, L1 should be mounted at right angles with respect to input transformer T1 and spaced as far away as is practicable to avoid oscillation.

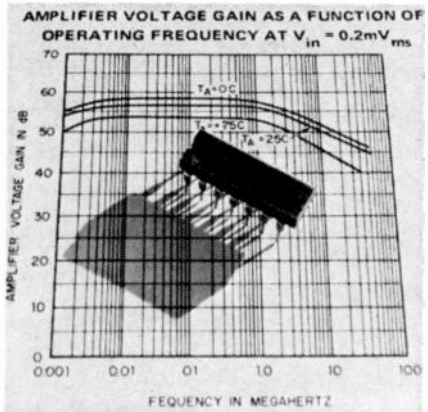


FIG. 2—THE ULN2111 is supplied in a standard 14-pin DIP.

Circuit tuning is relatively simple. Apply an FM signal of suitable carrier frequency (4.5 or 10.7 MHz) through a dc decoupling network to pin 4 at approximately 5 mV rms. Adjust L1 for maximum audio output at pin 1 or maximum rf voltage at test point (T.P.) pin 11.

Product/device news

Deep in the heart of the Lone Star State, the good guys at Texas Instruments (P.O. Box 5012, Dallas, Tex. 75222) have introduced a new series of one-ampere rectifier diodes, another of 750 mA. units, a family of high-voltage Darlington power transistors, and a new 10-digit binary-coded decimal arithmetic processor.

Designated types 1N4001 through 1N4006. TI's new 1-A diodes employ double-plug construction and hermetic sealing (see Fig. 4). With an operating ambient temperature range from -65°C to +175°C, the new diodes

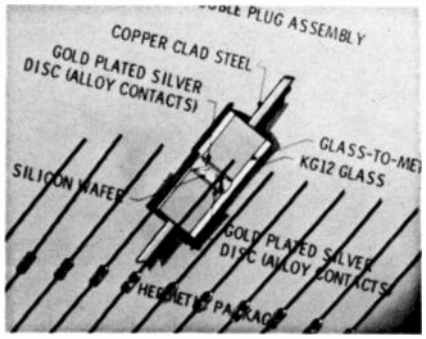


FIG. 4—TI'S NEW 1-AMP rectifier diodes.

This month we introduce more new semiconductors. The hottest of these are TV FM audio and dual zero-crossing detector IC's

by LOU GARNER
SEMICONDUCTOR EDITOR

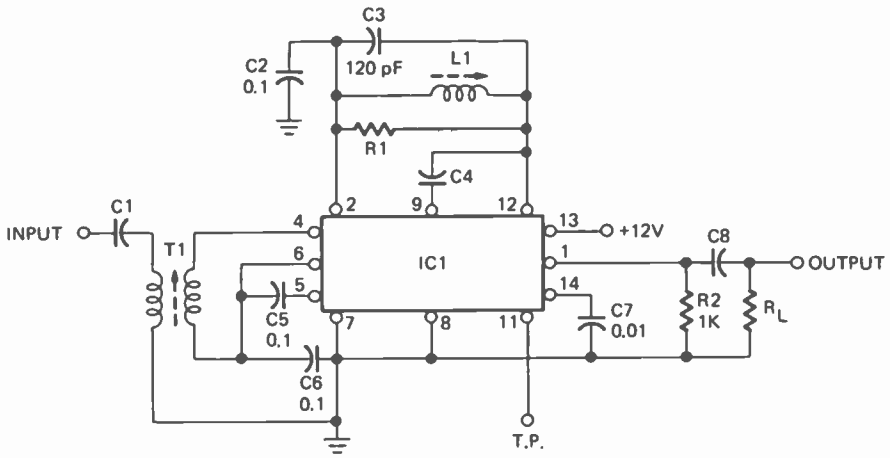


FIG. 3—PRACTICAL FM limiter—detector circuit . . . with suitable component values, the basic circuit may be used for both FM broadcast (10.7 MHz) and TV audio (4.5 MHz) applications.

carry PRV ratings from 50 V for the 1N4001 to 800 V for the 1N4006, while peak surge current capabilities are up to 30 A.

Kertron, Inc. (7516 Central Industrial Drive, Riviera Beach, Fla. 33404) has introduced a new low-cost commercial single diffused power transistor. Identified as the KD4044, the new unit is an npn device with a minimum BV_{CEO} rating of 40 volts and a minimum gain of 20. The new transistor, Fig. 5, is packaged in a hermetically sealed steel TO-3 case.

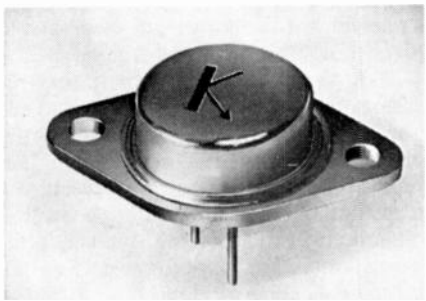


FIG. 5—KERTRON'S NEW KD4044 high power transistor.

Zero-zero

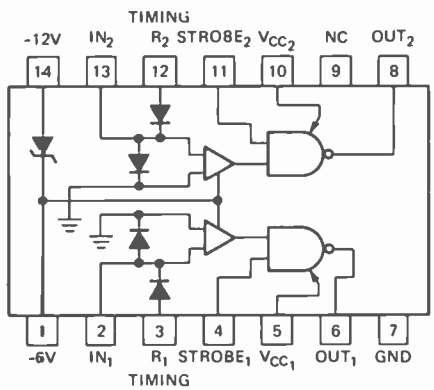
If you're a classic cinema buff, the expression *zero-zero* may evoke memories of an early aviation film with that title. The term referred to a common condition in the days before radar and ground controlled approach, when fog had closed in over an airport and created a condition of "ceiling zero, visibility zero." Our *zero-zero*, however, refers to another exciting and versatile monolithic intergrated circuit announced by Signetics—a dual zero-crossing detector.

A zero-crossing detector? Yes—a device (or circuit) that responds to an ac input signal when the voltage reaches zero during the transition from positive to negative polarity, and vice-versa. In addition to its intended primary application, the new device, identified as the model 363, also can be used as a high stability one-shot, a bi-directional one-shot, a frequency doubler, a stable low-frequency oscillator, a linear amplifier, and a frequency-to-voltage converter. Packaged in a 14-pin plastic DIP, the device nets for only $2.15 each in unit quantities.

The internal block and schematic diagrams as well as pin connections for the 363 are in Fig. 6. Each of its two sections consists of 7 npn transistors, a dual-emitter npn transistor, 2 diodes, and 5 resistors, with a single Zener diode common to both. The device features temperature compensated differential amplifier inputs referenced to zero volts and TTL compatible outputs, and will convert low-level analog waveforms of ±30 mV or more into digital signals.

In practice, two dc power sources are required for proper device operation. These may be +5 and -6 volts, referenced to ground, or +5 and -12 volts, again referenced to ground. In the -6 volts configuration, pins 1 and 14, Fig. 6-a, are tied together. When used in the -12 volts mode, however, pin 1 must be left open. Under no circumstances must the -6 and -12 volts sources be used simultaneously, for this will destroy the internal voltage-dropping Zener diode.

A basic circuit using half of a 363 as a zero-crossing detector is in Fig. 7-a. Power supply connections have been omitted for clarity, but these would be as indicated in Fig. 6. With the differential amplifier internally referenced to circuit ground, the circuit's



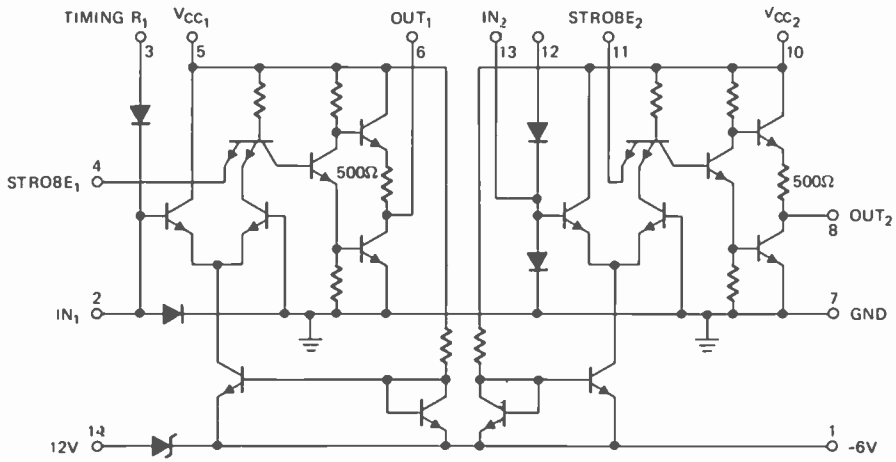
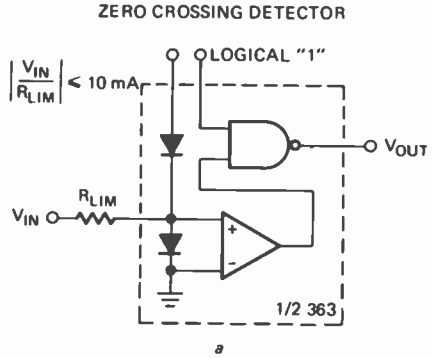


FIG. 6—BLOCK DIAGRAM (a) and internal schematic (b) diagrams for Signetics' type 363 zero-crossing detector.

COMPONENT VALUES ARE TYPICAL
PIN 3 - NO CONNECTION

NOTE: PINS 5, 6, 8, AND 10 ARE TIED TO PIN 14 THROUGH ISOLATION DIODES.



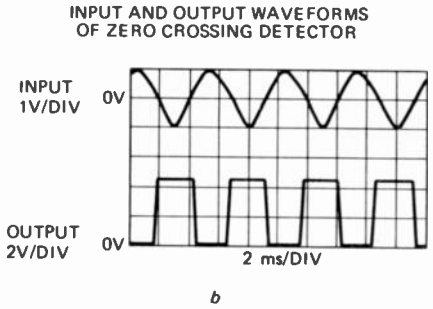


FIG. 7—CIRCUIT (a) and signal waveforms (b) of the basic zero-crossing detector.

output changes state each time the analog input signal passes through zero, converting the input signal waveform into a TTL compatible square wave, as shown in Fig. 7-b. In effect, the applied (input) signal has been sharply clipped to virtually eliminate distortion caused by amplitude fluctuations and noise, thus providing a "clean" digital signal for further processing.

A variation of the basic zero-crossing detector circuit is illustrated in Fig. 8-a. Here, both sections of the 363 are used to produce a *complete* output pulse *each time* the input signal waveform passes through zero voltage, rather than a simple change of state in the output signal. The net result is similar to the action of a frequency doubler, in that the output pulse signal is at twice the cyclic rate of the input signal, as demonstrated by the comparative signal waveforms given in Fig. 8-b.

The duration of each pulse is determined by the time required to pass through the threshold limits and depends on such factors as relative voltage levels, the choice of resistor values in the input voltage divider, and the inherent characteristics of the 363 itself. Typical values are 24,000 ohms for R1, 1,000 ohms for R2 and R3, and 30,000 ohms for R4. This circuit will not work with square-wave inputs having fast rise and fall times because there is not enough time between thresholds for the device to respond.

The 363's stable thresholds and high input impedances permit it to be used as a low-frequency oscillator. A suitable circuit using half of a 363 in conjunction with two type 380 NOR-gates is in Fig. 9-a. The operating frequency is determined by R1 and C1 and may be calculated by the approximate formula:

$$f_o \cong 1/2R1C1,$$

where R1 is in ohms, C1 is in farads, f_o is in hertz, and R1 $\leq$ 100,000 ohms. Typically, with a 100,000-ohm resistor and a 1-μF capacitor, the output frequency is approximately 5 Hz.

Another interesting circuit application for the 363 is shown in Fig. 9-b—a frequency-to-voltage converter or pulse-counting discriminator, a type of FM detector. In operation, the input signal is applied through a current-limiting resistor to half of the 363, which serves as a limiter/amplifier. The output drives the second half of

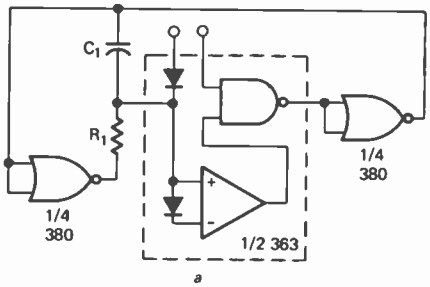
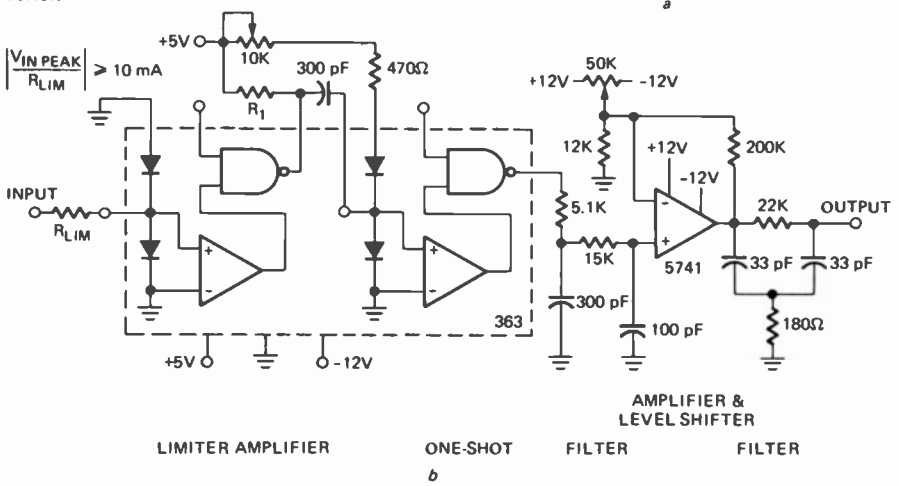
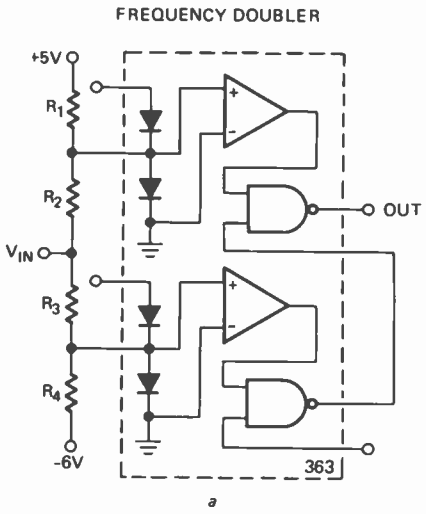


FIG. 9—ADDITIONAL APPLICATIONS for the 363 zero-crossing detector: (a) low frequency oscillator, and (b) frequency-to-voltage converter.





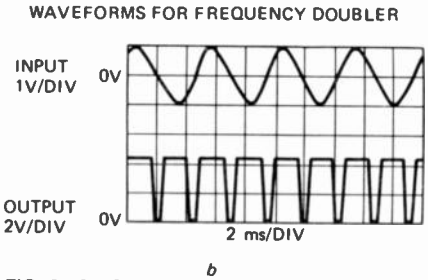


FIG. 8—CIRCUIT (a) and signal waveforms (b) illustrating the use of the 363 as a frequency doubler.

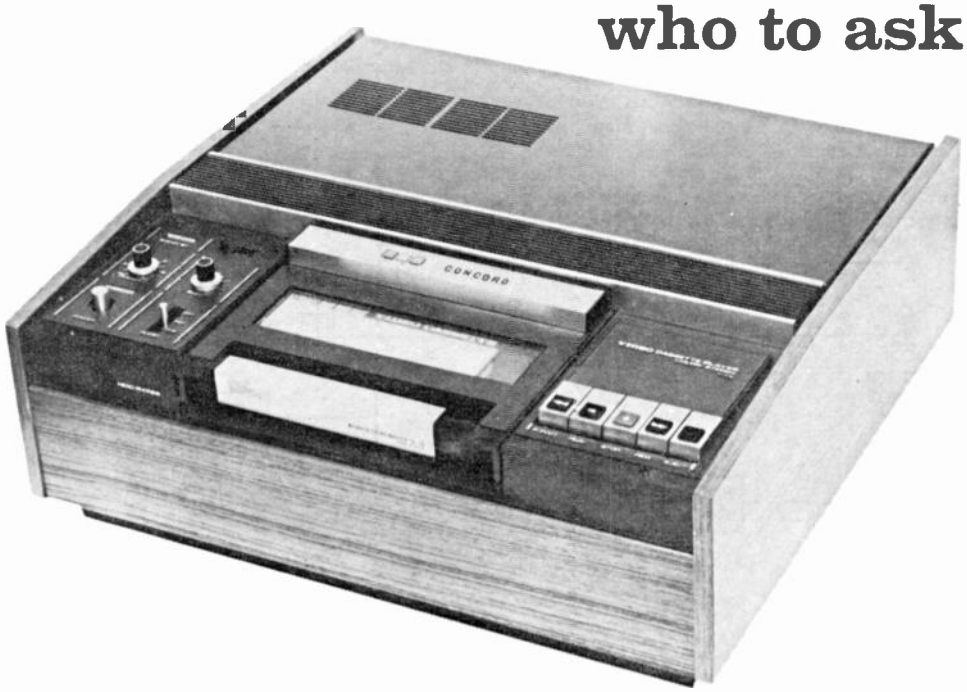
the 363, used as a one-shot to develop constant width output pulses at a rate determined by the input frequency.

A variable 10,000-ohm timing resistor permits the one-shot to be adjusted for the best linearity within the input frequency range. The original signal is now recovered by passing the constant width pulses through an RC filter network. Since the one-shot's filtered output is superimposed on an average positive dc level, the signal is applied to a type 5741 operational amplifier, which serves to shift the dc level and to amplify the signal even more. The dc level nulling is done by using a 50,000-ohm potentiometer to adjust the amplifier's negative (–) input bias. Finally, the amplifier's output, an amplified and demodulated signal restored to an average dc level of 0 volts, is filtered through a modified pi network to remove remaining carrier components.

When used as an FM discriminator with a carrier frequency of 1.5 MHz and a deviation of ±80 kHz, the circuit shown has a 3 dB bandwidth of 5 Hz to 35 kHz. The distortion at 1 kHz is less than 1%.

With additional potential applications as high stability and bi-directional one-shots as well as a linear amplifier, the 363 should be a welcome addition to the experimenter's and designer's stable of useful IC devices. **R-E**

Everything you wanted to know about video cassettes but didn't know who to ask



by ALFRED ZUCKERMAN*

IN THE LAST FIVE YEARS, AS MANY AS TWENTY videoplay systems have been promised by as many manufacturers throughout the world. In 1970 it became apparent that no industrial or government group in the U.S. would commit itself to any single system.

Several manufacturers of video tape recorders in Japan evolved a joint program of development to produce a ¾" videocassette system for the world market. The introduction, in 1972, of machines using this format interchangeably by several manufacturers resulted in acceptance by U.S. government and large industrial users for training and educational applications. As a result of this universal acceptance the system has become a defacto standard. It is estimated that 50,000 of these machines have already been sold in the world market, half of them in the U.S.

At present there are five brands of ¾" cassette being distributed in the U.S.—Sony, Concord, Panasonic, JVC and Wollensak. Interchangeability standards are such that a cassette recorded on any brand machine can be played back on any other. All of these systems use a designation involving the letter "U" (which derives from the shape of the tape path) such as "U-Vision", etc. We shall refer to the format as ¾U.

The cassette is a precision molded package 8¾" wide by 5½" deep by 1¼" thick and weighs about 1¼ pounds for a full 60-minute tape load. The tape is ¾" wide and uses a high-density coating such as chromium dioxide or cobalt-doped ferric oxide to realize the full potential of the system. By using such tape it is possible to store 25% more information than with conventional gamma oxide tape. The two reels are coplanar and are accessible to the drive hubs as on the familiar audio cassette. A small plastic plug-button may be removed after recording to prevent accidental erasure of the recorded material at a later date.

After the cassette is inserted, and the play (or record) mode is selected, a pin hooks under the tape and draws a U-shaped loop through a hinged door in the rear of the cassette (Fig. 5). By the action of the loading ring and its associated guides, this loop is drawn in a large circle over the erase head, around the rotary head drum, over the control/audio head and past the space between the capstan and pinch roller. When the appropriate position is reached by the tape the head drum starts rotating and shortly after that the pinch roller is automatically engaged and the tape motion at 3¾ ips starts. This entire process takes approximately six seconds.

At any point in the program the stop button may be depressed. When this is done, the pinch roller disengages, the motion of the loading ring described above is reversed and the tape loop is returned to the cassette. This process takes about five seconds. The tape which is essentially opaque is spliced at both ends to a translucent leader. By using a light source and photo-sensing circuit we get automatic stop and rewind at the end of play as well as automatic stop in the FF (Fast Forward) and REW (Rewind) modes.

The technique used in recording the video signal is the now-familiar helical scan or slant-track method using two heads mounted diametrically opposite on a head drum assembly which rotates at 1800 rpm. Each half rotation of the head assembly corresponds to one field of the standard EIA defined frame. One complete rotation of the head assembly generates the two interlaced fields in 1/30th second.

The information is placed on the tape in a carefully controlled pattern as shown in Fig. 1. The control track contains the information which permits the rotation speed and phase of the heads to the synchronized with the vertical synch signal. The audio tracks, which permit stereo recording are capable of providing frequency response up to 12kHz.

*Vice President, Engineering, Concord Division
Benjamin Electronic Sound Co., Farmingdale, N Y

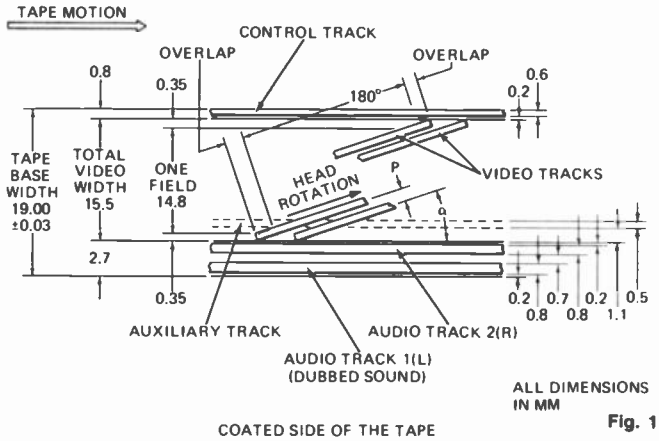


Fig. 1

FIG. 1 (left)—TRACK PATTERN for ¾-inch video cassette tape. Video track pitch (p) is 0.1373 mm; tape slant (α) is 4 -54'-49.1".

FIG. 2 (below)—SCANNING HEAD SPEED is controlled by comparing vertical sync pulse with output of head tachometer.

FIG. 3 (top right)—BLOCK DIAGRAM of the video playback processing circuit. Recovery of composite video is complex.

FIG. 4 (bottom right)—RECORDING CIRCUIT is represented by this block diagram. Color is converted to a 688-kHz subcarrier.

FIG. 5 (below)—CASSETTE LOADING MECHANISM before start of loading cycle. Pull-out arm takes tape to the head unit.

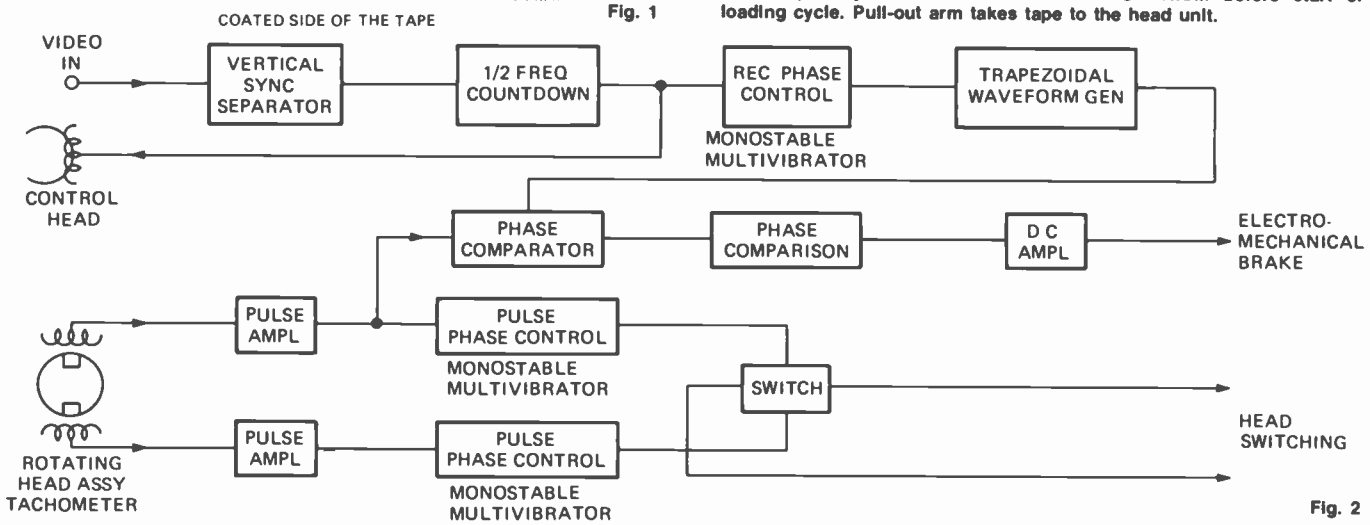


Fig. 2

Head speed control circuit

Since the rotary head system is driven by a line synchronized motor, the servo function is performed by electro-magnetic braking of the rotary head shaft. During recording the vertical sync signal is stripped out and used as the reference for the control circuit (See Fig. 2). After counting down, squaring and then differentiating the sync signal, 30-Hz pulses are recorded on the control track. The same vertical sync information is compared with the 30-Hz head assembly tachometer signal in a sophisticated servo system which controls the velocity and head position of the rotary head system.

During playback a similar circuit compares the information on the control track with the tachometer output to ensure coincidence between the rotating heads and the recorded pattern.

The video cassette control circuits are not designed to permit interlocking the playback signal with other signals as in a television studio and as a result are simpler in structure and make for simplicity in operation. The signal processing for color and black and white is shown in the block diagrams, Fig. 3 and Fig. 4. A detailed description of all of the processes exceeds the scope of this article so that only those features that are of special interest will be dealt with.

To get the best signal in the recording and playback process it has been found that the B/W (black and white) and luminance information should be recorded on the tape in the form of a frequency modulated 3.8-MHz carrier. Extreme deviation for a white peak is to approximately 5.4 MHz and in the other extreme the sync-tip level results in the frequency to about 1.0 MHz.

The chrominance signal requires special attention to maintain color values. It is, therefore, extracted from the total video signal, converted to a 688-kHz subcarrier and directly recorded on the tape in the spectrum slot below

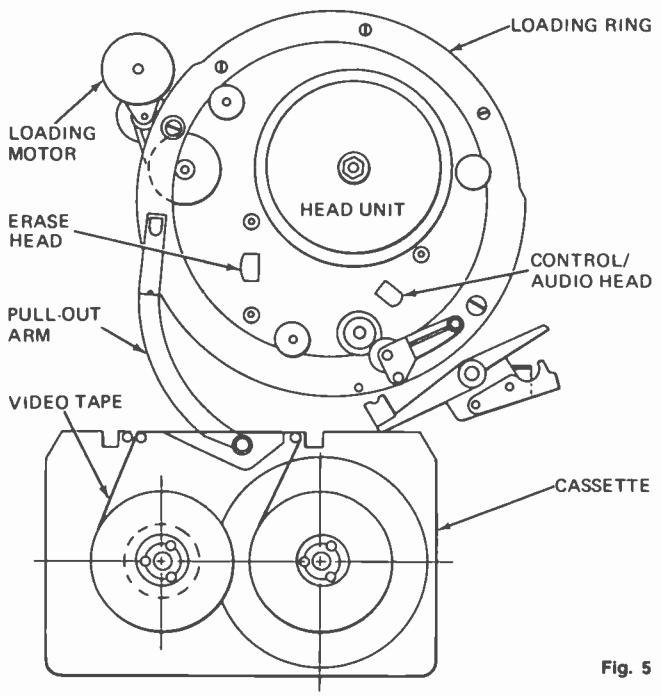


Fig. 5

the frequency modulated luminence signal. To maintain a constant chroma level an automatic color compensation circuit uses the burst portion of the signal. Since the luminence signal level is controlled by its agc circuit, the ratio of luminence to chrominance signal is kept constant.

In the playback mode the video information recovered from the tape is amplified, limited, demodulated and further processed for optimum characteristics. The chrominance signal when recovered, however, contains what are called jitter components. These are small changes in fre-

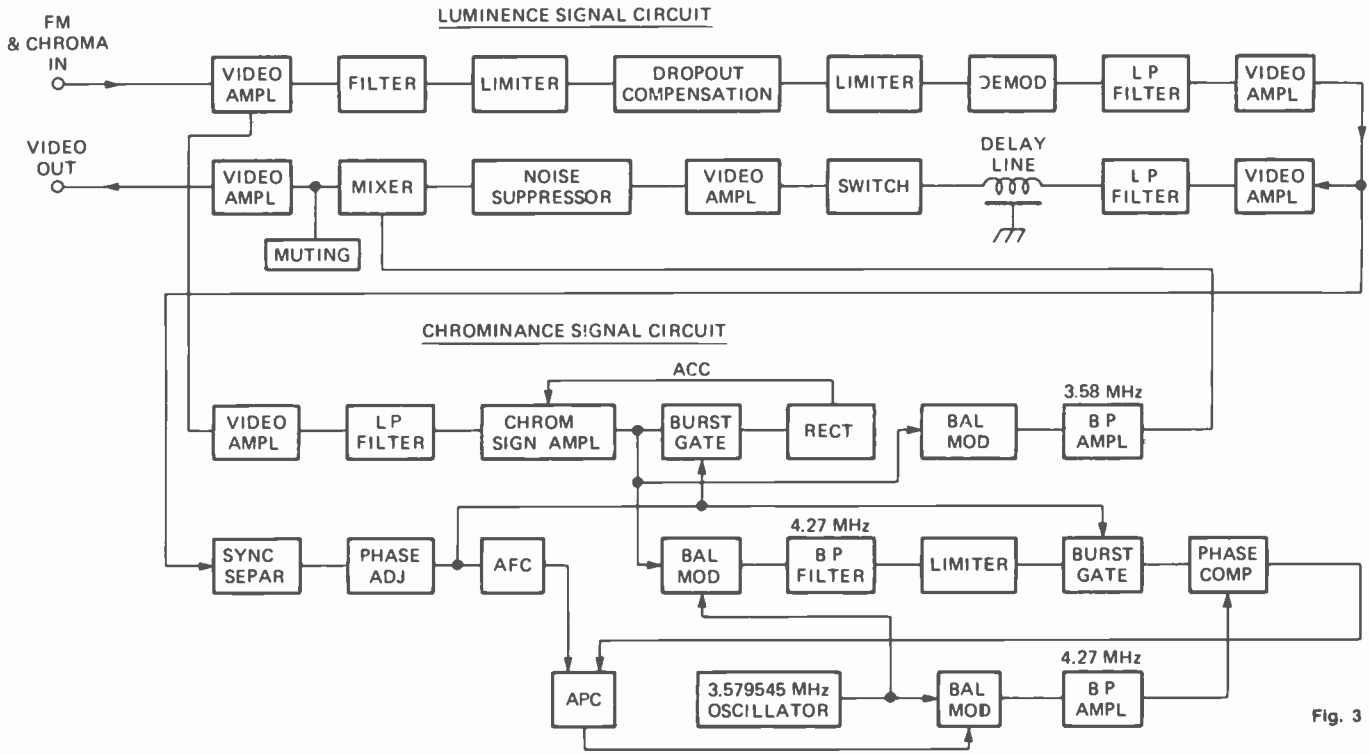


Fig. 3

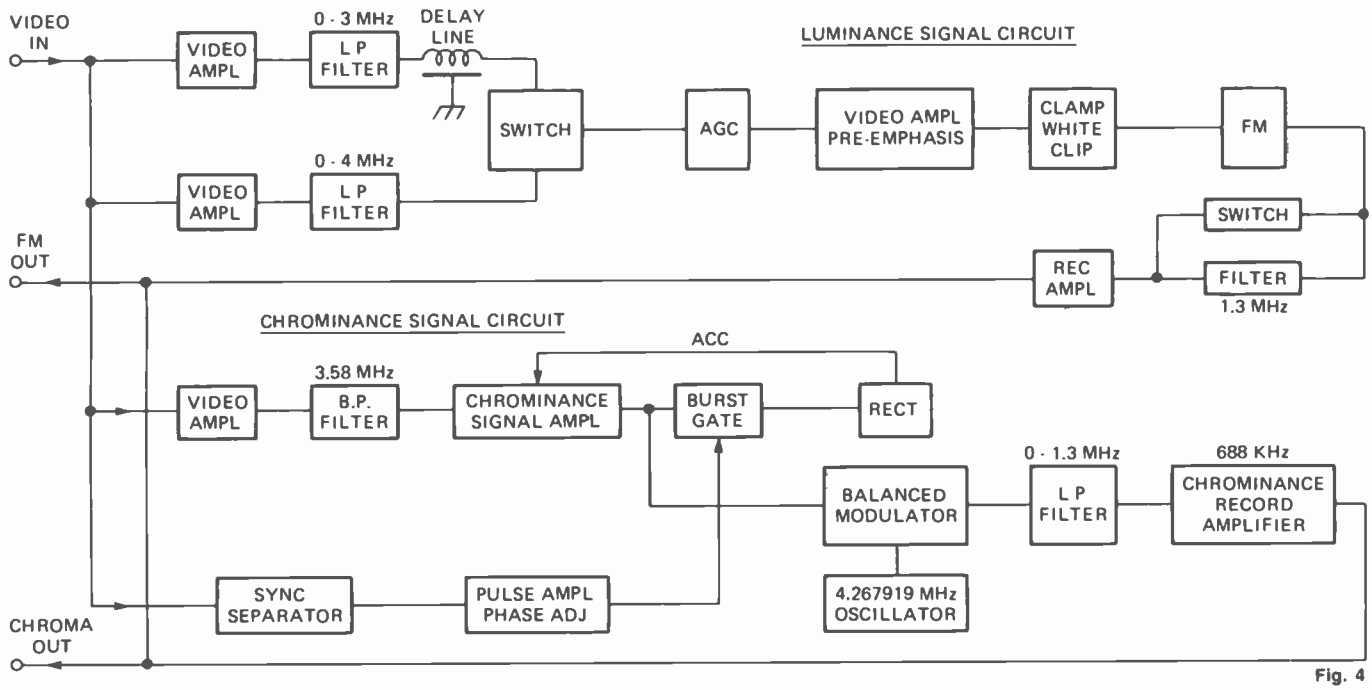


Fig. 4

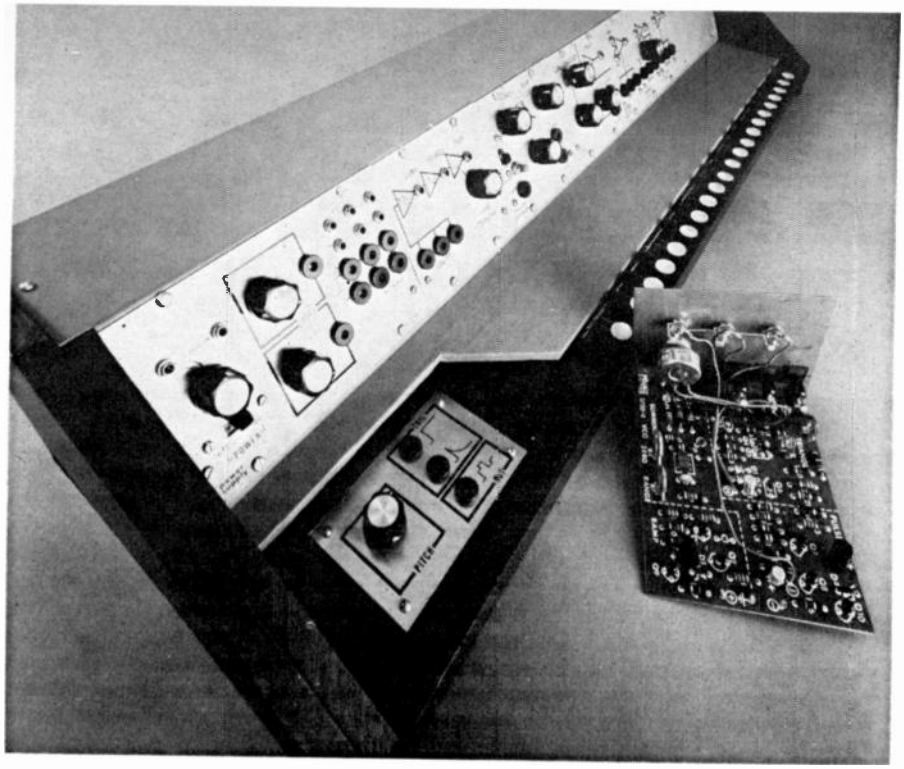
quency due to minor defects in tape motion and are analogous to flutter and wow components in audio. Because the chroma information was directly recorded on the tape and not through the use of the FM carrier, the changes in tape motion result in frequency shifts which in turn cause a change in reproduced color.

To overcome this problem, two circuits are used. The automatic phase control circuit compensates for the higher frequency components of jitter while the automatic frequency control circuit compensates for the lower frequency components.

Now that the wide use of ¾U is a fact it would be interesting to conjecture the reasons for its success and why it may continue to prevail over other systems being proposed. For the immediate industrial market which could afford the relatively high price tag the inducement was a technically sound system with simplicity of operation, both in record and playback. The bandwidth capabilities, the control of jitter and color reproduction and the ability to record for one hour were important factors. Other systems which utilized only a fraction of the fields, did not maintain color quality, did not have record capability or were not yet in production fell by the wayside.

Every manufacturer of the ¾U system offers one or more modifications or accessories which enormously expand the usefulness of the device. Still Frame, Remote Control, Automatic Rewind at the End of Video Signal, Back Space and Pause are some of these useful functions.

What is the prospect for home use? There is no question but that the basic concept of the ¾U anticipated use in the home. Every requirement for adaptation to a standard home TV set is available. An rf adapter is built in to provide Channel 5 or 6 output. Recorders are available with built-in uhf/vhf front ends. When volume production permits prices to be pegged lower, the ¾U is a natural for the home. **R-E**



BUILD

A MODULAR

Part II: The this unit.

THIS ISSUE WE WILL SHOW YOU HOW THE electronic controller circuit of the synthesizer works and how to build it. The project is relatively simple and results in an additional module for your instrument.

Controller/case

Since the primary pitch sources in synthesizers are voltage controlled, a wide variety of controllers ranging from automatic sequencers to joy sticks are possible.

The controller that we will describe is a keyboard arrangement that is designed to be built from materials commonly available in hobby shops and variety stores. If you are able to locate a standard organ keyboard it can probably be adapted to the electronics package but since keyboards vary from one manufacturer to another it is impossible to give specific details that will apply to all keyboards.

The controller circuit

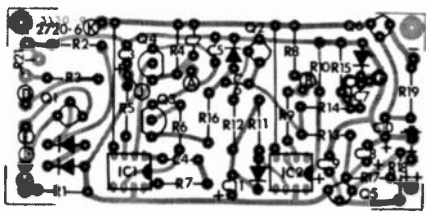
Reduced to basics the controller is nothing more than a switch controllable voltage divider but it starts to get a little more complicated as "housekeeping" functions are added. In addition to the voltage divider the circuit includes a constant-current source, trigger circuit and sample/hold circuitry.

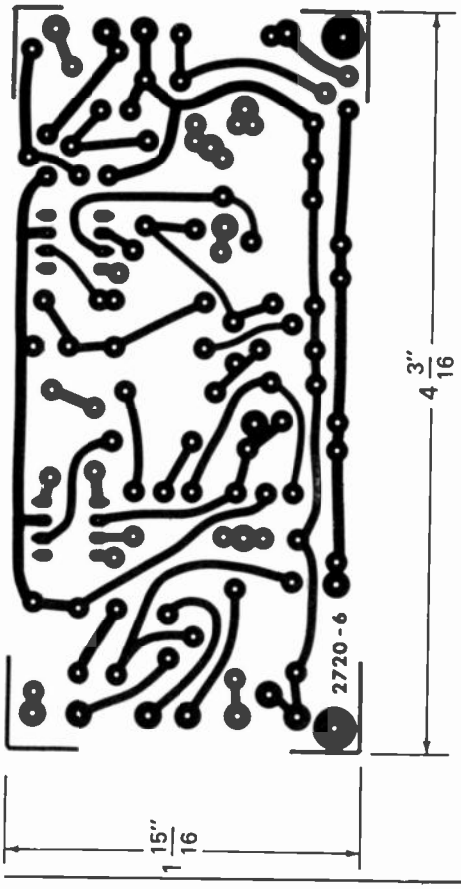
The constant-current source is a standard design built around Q1 and using the voltage drop across the series combination of D1 and D2 as a reference. The output of the current source is regulated by changing the dc feedback with emitter resistor R20. The current source feeds the voltage divider shown in Fig. 7 as R_k.

In practice the resistance is a strip of conductive vinyl having a resistivity of 377 ohms/square. One edge of the vinyl strip is cut along a curve causing the total resistance to any point on the strip—and consequently the voltage at that point—to be exponentially related to the distance from that point to the low voltage end of the strip. The need for the exponential voltage will be fully covered in another article, but for now it will suffice to say that it relates to the exponential nature of the equally tempered musical scale. Adjustable wire contacts make the connections between the resistance element and the key springs.

There are two contacts associated with the controller as indicated by the lines above and below R_k in Fig. 7. The upper line corresponds to the voltage pick-off spring that is the first to be contacted by the key spring when a key is pressed. The second line represents the key-down detector strip which contacts the key spring/pick-off spring combination when

FIG. 7—(far right) COMPLETE CIRCUIT of the controller electronics. Two IC's and six transistors are used. FIG. 8—(below) PARTS PLACEMENT on the circuit board. FIG. 9—(bottom) FOIL PATTERN of the controller circuit board.





PARTS LIST
(Controller Electronics)

C1, C7—.01-μF disc
C2—.001-μF disc
C3, C11—2.2-μF 10V electrolytic
C4—100-pF disc
C5, C6—.1-μF mylar
C8, C9, C10—33-μF 10V electrolytic
D1 thru D5—1N914
IC1, IC2—748 op-amp
Q1, Q6—2N5139
Q2, Q5—2N5129
Q3, Q4—MPF-102
All resistors—½W 10%
R1—470 ohms
R2—10,000 ohms
R3, R17, R18, R19—680 ohms
R4—15,000 ohms
R5—100,000 ohms
R6—68,000 ohms
R7—82,000 ohms
R8—1 megohm
R9, R16, R22—3.9 megohms
R10—150,000 ohms
R11—22,000 ohms
R12—4700 ohms
R13—20,000 ohms, 5%
R14, R15—33,000 ohms
R20—linear taper potentiometer, 1000 ohms
R21—pc mounting trimmer pot, 1000 ohms
MISC: Case, circuit board, hardware, control panel, wire, solder, etc.

KIT SUMMARY

The following items are available from, PAIA Electronics, Inc., P.O. Box 14359, Okla. City, OK 73114

No. 2720—Kit of all parts for duplicating the complete synthesizer. Includes all parts, panels, circuit boards and detailed instructions. $139.00 plus postage for 18 lbs and insurance

No. 2720-2—VCO kit including circuit board. $24.95 ppd.

No. 2720-2pc—VCO circuit board only. $4.00 ppd

No. 2720-6—Controller/case kit. $37.00 + 18 lbs. postage

No. 2720-6pc—Sample/Hold circuit board. $3.50 ppd.

No. 2720-7—Power Supply kit. $22.00 + 2 lbs. postage

No. 2720-7pc—Power Supply circuit board. $4.00 ppd.

A controller kit featuring a professional 3 octave organ keyboard is also available. Details available on request.

* President, PAIA Electronics

ELECTRONIC MUSIC SYNTHESIZER

controller electronics is the primary pitch source for
It is a switch controllable voltage divider

by JOHN S. SIMONTON, JR.*

the key is fully down to play a note.

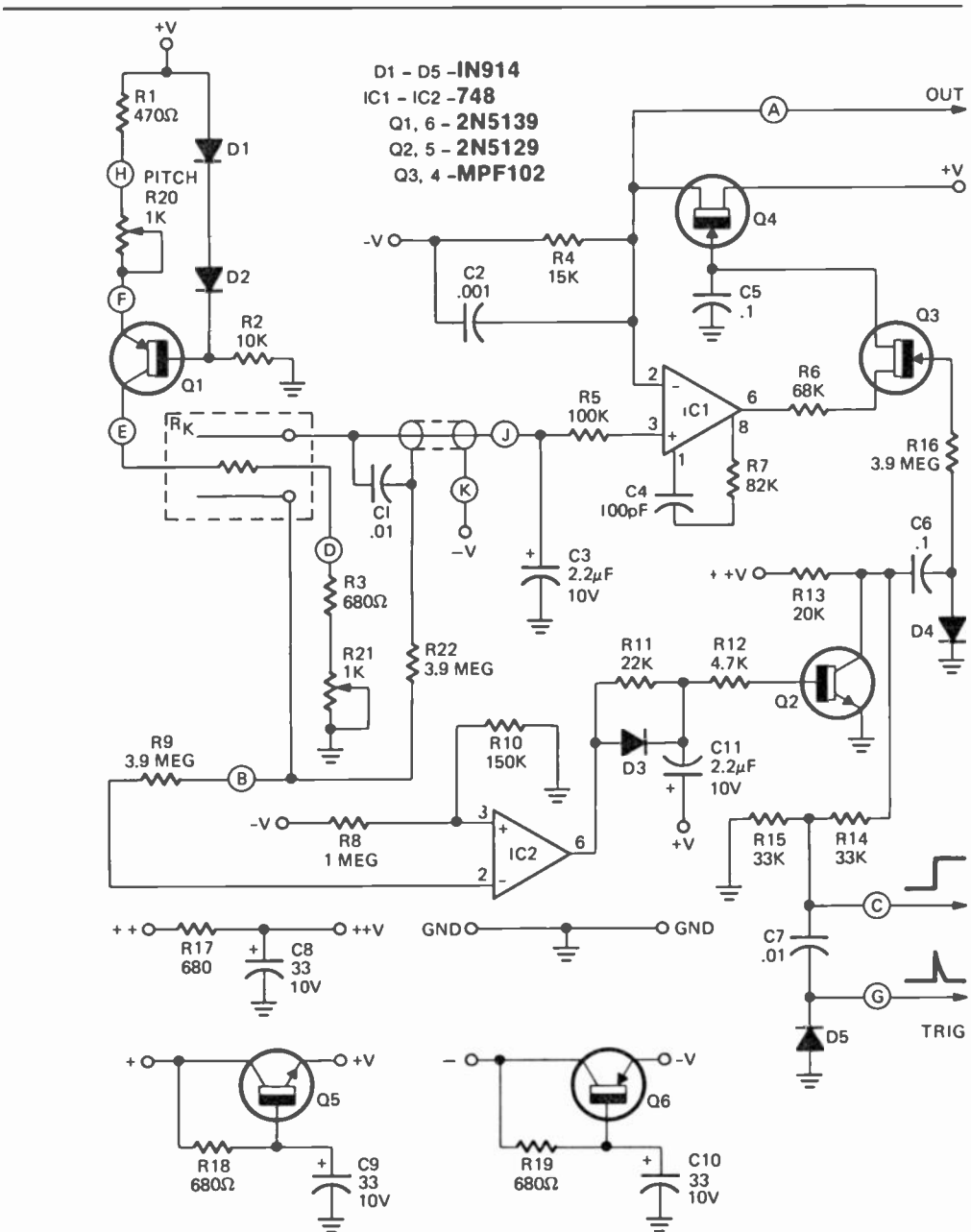
When a key is depressed, C3 begins to charge or discharge. This capacitor is simply an integrating capacitor to bypass noise from dirty or corroded contacts. Almost simultaneously, the key-down detector strip is raised from near negative supply (where it is held by R22) to whatever voltage is on the key spring being pressed. Since this new voltage is always greater than the -1-volt reference at the "+" input of op-amp comparator IC2., the output of the comparator switches from its normal high state to a voltage near negative supply. After a time determined by the discharge rate of C11 (20 ms typically) Q2 switches off causing the voltage at its collector to go from near ground up to "++" supply. This voltage charges C6 through D4 and turns on Q3.

The sample-and-hold circuit can be further broken down into comparator IC1, high input impedance FET source follower Q4, and switch Q3. The comparator is constantly comparing the input from the voltage pick-off spring to the output which appears across the load resistor of the source follower R4. The state of this comparator has no effect on holding capacitor C5 (and consequently the source follower for which this capacitor is an input) until Q3 is turned on. With Q3 on, the comparator acts to make the voltages at its "+" and "-" inputs identical and when the voltages *are* identical the circuit is balanced. Since Q4 is effectively in the feed-back loop of IC1, a FET with practically any specs can be used.

When the key is released, comparator IC2 switches and immediately turns Q2 on (C11 discharges through D3 and the low output impedance of IC2 almost instantly). When Q2 switches it "pushes" the end of C6 that is connected to the anode of D4 down to about -15 volts, the voltage C6 charged to when Q2's collector was high, causing D4 to reverse bias and thereby removing all discharge paths other than stray leakage. This large negative voltage allows for considerable variations in the parameters of Q3 so that an inexpensive device may be used here.

With Q3 off, holding capacitor C5 is isolated from any discharge paths but still serves as the source follower input so that the output voltage does not change.

The voltage step trigger output is derived from Q2 through voltage divider R14 and R15 and the pulse trigger output is formed by differentiating the step through C7. Diode D5 clamps the negative voltage spikes to ground. Q5 and Q6 serve as capacitance multipliers for the filter capacitors C9 and C10.



Put it together

The assembly of the electronic portion of the controller is pretty straightforward but because of the high gain characteristics of the two operational amplifiers you will be ahead using an etched circuit board. The etching guide is in Fig. 9.

Be just as careful with this circuit as you were during VCO assembly. Note that not all of the parts associated with the sample and hold circuit are mounted on the circuit board. Resistor R22 and ceramic disc capacitor C1 are mounted at the end of the coax that connects the sample/hold input to the voltage pick-off wire on the keyboard. Also note the two wire jumpers on the circuit board.

Next month we will show how to build the keyboard for the synthesizer and how the modules connect into the case and main-frame. You will then have a basic synthesizer and will be able to start playing it. R-E

STEP-BY-STEP TV TROUBLE-SHOOTER'S GUIDE

WHEN SERVICING A MODULAR TV, THE main consideration is, what is the fastest and least expensive path to the completed repair? Very often the actual defective part is never located because it is less expensive to simply plug in a new module than troubleshoot down to the end of the puzzle and come up with the bad part.

There are some components on the modules that should be checked before changing the entire device. For instance, in the G-E i.f. module we are going to discuss, the IC and transistors should get a quick check before changing the module.

Modular TV's still require a technician, even though he has a less challenging job. Before you just shove in a new module there are troubleshooting procedures. Let's look at a G-E MA 25 chassis and check the i.f. module.

How it works

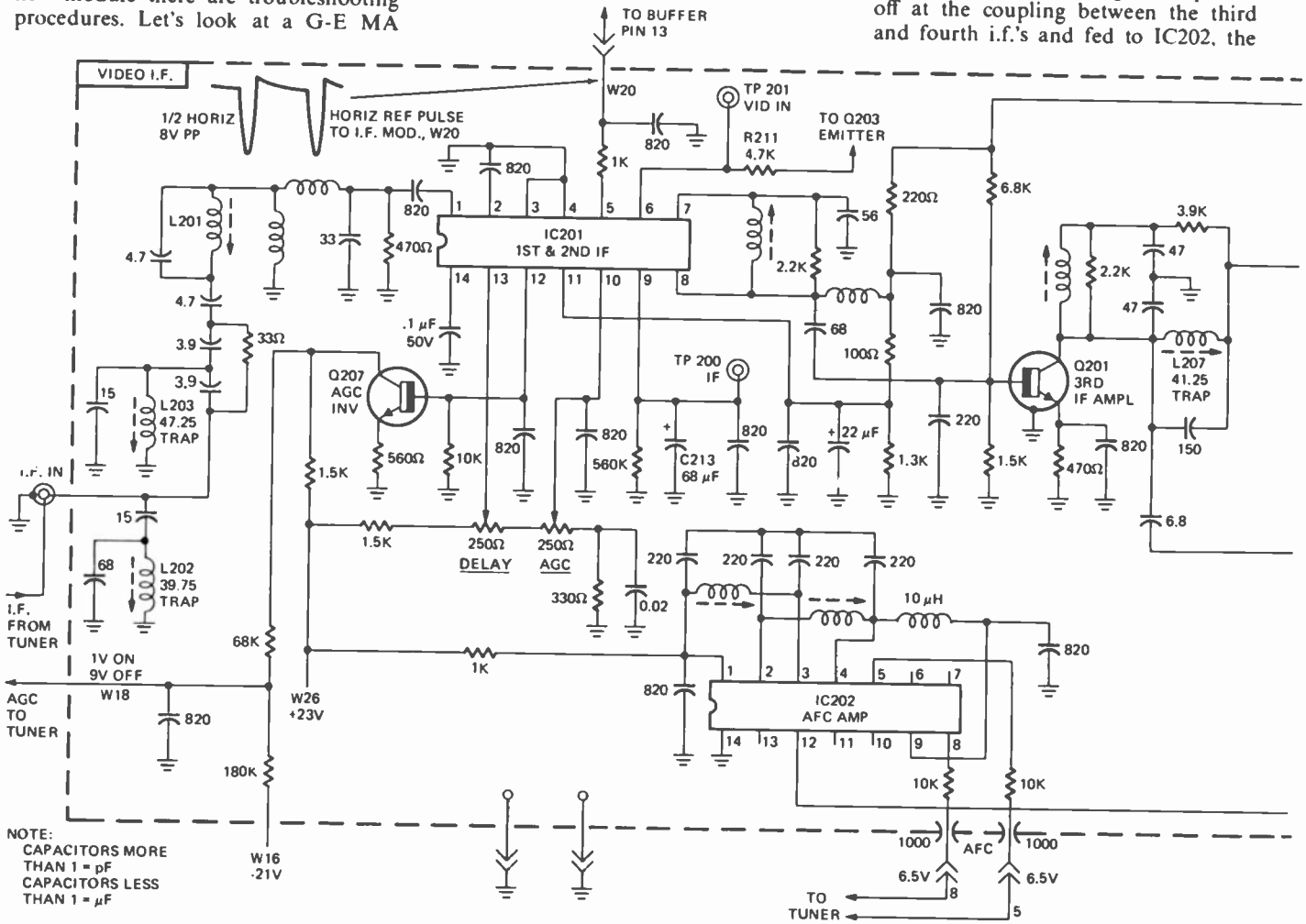
The i.f. module is enclosed in a metal shield, to preserve the i.f. alignment. Since the modules must be interchangeable, unlike ordinary i.f. strips that have to be realigned at the slightest provocation, the i.f. input circuit is unusual. Instead of having a pair of double-tuned circuits coupling the tuner output to the i.f. input, the tuner is a single broadly tuned circuit that has little or no effect on the i.f. response.

There are three coaxial cable phono-type plugs and two cable plugs. There are two screws, one at each side of the module, that secure it in place.

The link coupler is conventional and is centered around the tuning of L201. Attached to the link are the adjacent-channel traps L202 (adjacent video) and L203 (adjacent audio). The i.f. signal is injected into IC201. This integrated circuit contains the first and second stages and the agc keyer and amplifier. The third and fourth i.f.'s are ordinary npn transitors.

An audio i.f. trap (L107) tuned at 41.25 MHz is in the collector circuit of the third i.f. It not only attenuates the audio i.f. right there in the 3rd i.f. so it can't get into the video, it also provides a tap for 41.25-MHz amplifier Q208, called the auxiliary amplifier.

Some of the i.f. signal is picked off at the coupling between the third and fourth i.f.'s and fed to IC202, the



Before replacing a defective module in a TV set, try to localize the defective component. It may be something as simple as a bad IC, capacitor or resistor

by ART MARGOLIS

afc amplifier supplying the tuner.

The collector of the 4th i.f. feeds the video detector through a double-tuned circuit. The detector has a negative output that goes to the base of the 1st video amplifier. R229 is the detector load resistor.

The second video amplifier Q204 is an emitter follower. The 4.5-MHz trap is L215 and its associated components. The SOUND REJECT pot is factory preset. The emitter follower matches the video output into the next module called "video low level".

In addition to routine i.f. duty the module also performs work in the agc, afc and audio i.f. However, since we are only discussing the **RASTER ONLY** symptom this month and afc and audio are not involved we'll only cover the agc, along with the i.f.

Agc—Integrated circuit IC201 contains all of the agc circuitry except the final agc delay which is centered around Q207, the agc inverter.

Terminals 5, 6, 9 and 10 lead into the agc keyer stage. The flyback pulse from the horizontal buffer module goes into terminal 5. The video signal enters 6 and the i.f. agc control is attached to 10. The agc storage capacitor C213 hooks into 9.

Conduction in the agc inverter is controlled by the dc voltage fed to its base from terminal 12. Q207 amplifies and inverts the voltage changes. A small positive voltage change at the base causes a large negative voltage change at the collector. This varies the agc input to the tuner rf stage.

A series voltage divider between -21 and +23 volts sets up the collector voltage for this stage.

In between pins 5, 6, 9 and 10 and pin 12 on the IC201 lies the agc keyer, agc amplifier and initial agc delay stages, all in microminiature form completely inaccessible to a test probe. The technician, from a practical standpoint, can forget about these stages as separate entities and think of them in a block diagram manner. When agc trouble strikes, the IC replacement is first automatic step.

When the symptom **raster only** occurs, the prime suspects are the tuner, i.f. strip and agc circuits.

The modular approach, even though quite easy still requires a voltmeter and scope. Perhaps you could get by with a P-P voltmeter scale but the scope is the most accurate.

Isolate the trouble before disconnecting and unscrewing everything. This brings up a precautionary measure. Do not pull or re-attach any plugs unless the TV is **OFF.** Otherwise a static or filter charge could blow a transistor or IC, compounding the problem.

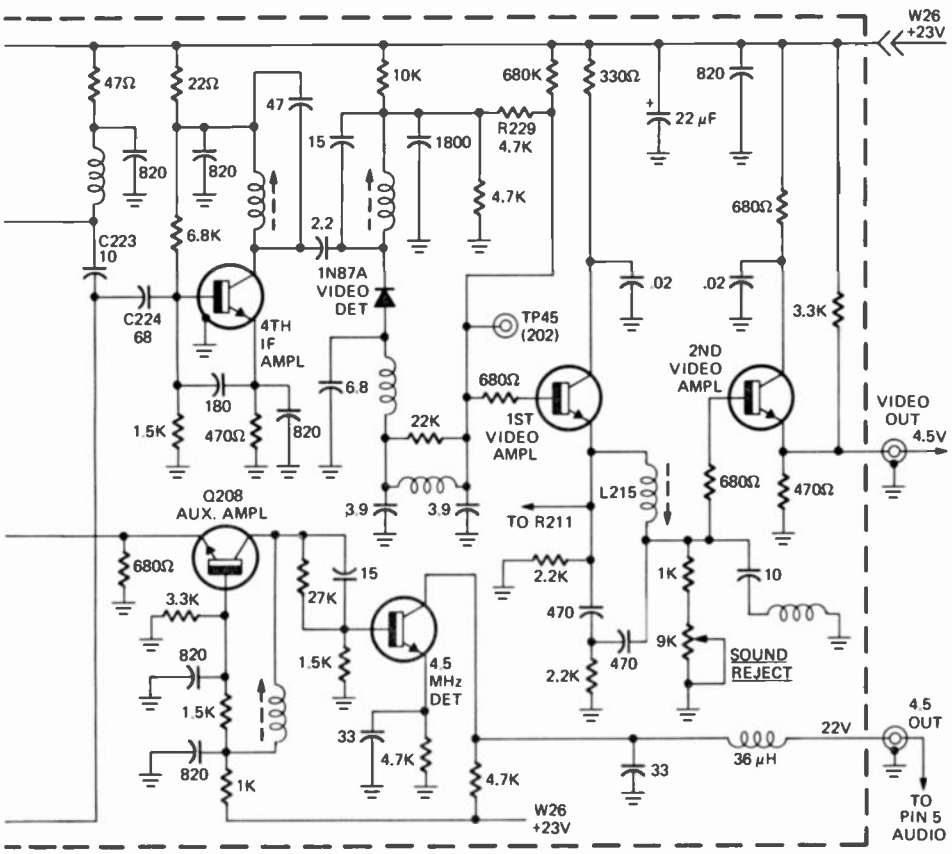
The approach is to disconnect the coax cable that goes from the tuner to the i.f. module. Then turn on the TV and analyse the raster and audio. Is there any snow or static?

If there is, the tuner area has the trouble. Test the coax cable. It could be shorted or open. If it is OK then test the tuner inputs. When there is no B+ then the power supply becomes suspect. If there is no rf agc, the i.f. module rf agc area is indicated. When both B+ and rf agc check out correctly, then the tuner needs service.

When the symptoms remain the same, and with the cable disconnected and there is no snow or static, the i.f. module area is the seat of the trouble.

First step there is to quick check. Try a new horizontal buffer module. It could be the agc keyer pulse is not arriving and the buffer module could be at fault. If that doesn't cure, then try a new IC201. If that doesn't fix the trouble, reach for the voltmeter again.

When they do not have the test replacement parts, like the buffer module and IC201 on hand, a lot of technicians will skip those steps and



SCHEMATIC DIAGRAM of the i.f. module in the G-E type MA color television chassis. Two integrated circuits greatly reduce the number of components that can fail and cause trouble. Terms such as auxiliary amplifier and 4.5-MHz detector are new but their functions are not.

dig into the circuits. This is foolish because for the large percentage of times, the trouble is not in the circuits, but is in these modules or IC's. It's better to wait a day or two till the part is obtained than dig into good circuits.

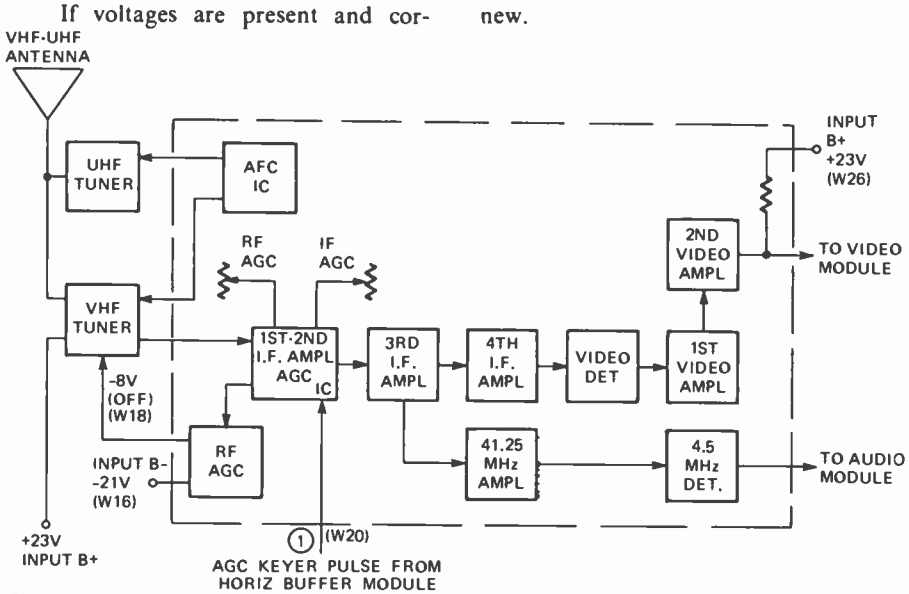
Once the modules, IC's and other easily checked parts have been eliminated as trouble sources, read the B+ input at W26 and B- at W16. If either is missing then the power supply is indicated.

If voltages are present and correct, it's now scope time. Look at the agc keyer pulse at W20. It should be about 8 volts P-P.

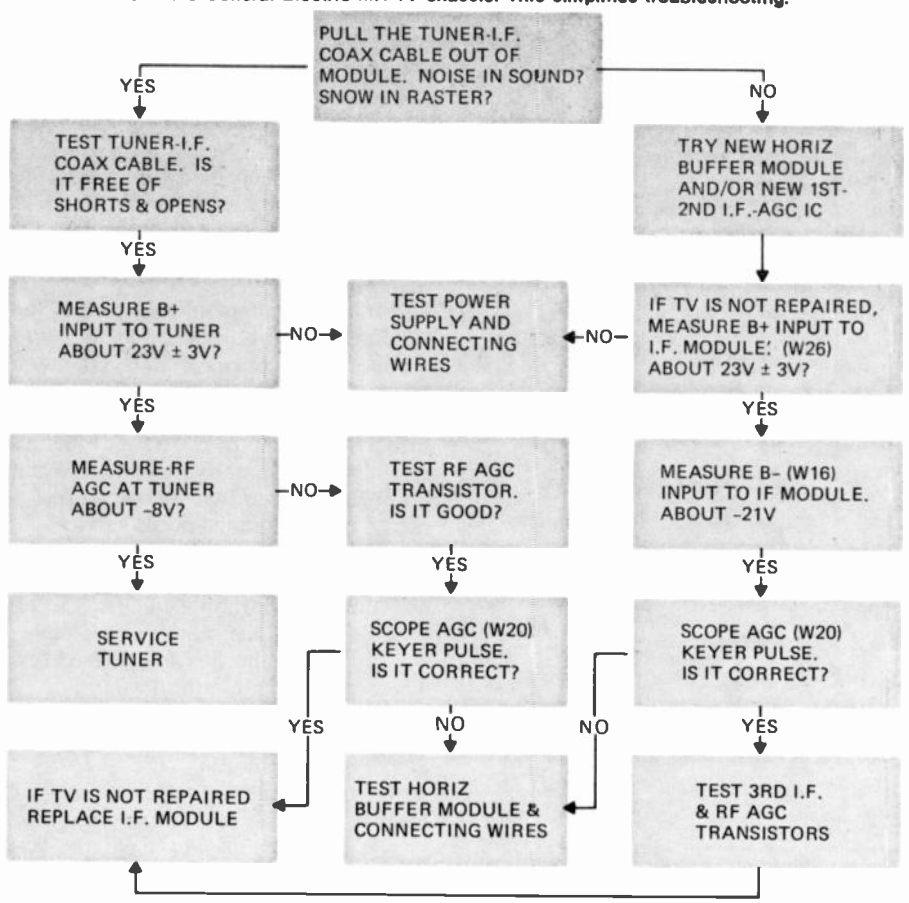
If the pulse is missing the buffer module and connecting wires are suspect. Should the pulse be present and correct then test the 3rd i.f. transistor Q201 and the agc inverter transistor.

When the transistors are good, the time has come. It is now economically sound to replace the i.f. module.

Turn off the TV, unplug and unscrew the old unit and reinstall the new.



BLOCK DIAGRAM shows the circuit breakdown and function of the various elements making up the i.f. module in the General Electric MA TV chassis. This simplifies troubleshooting.



QUICK-CHECK TROUBLESHOOTING CHART leads you step-by-step through detailed servicing procedures. You perform the various tests almost as fast as you can locate the test points.

Module repair

Since there are so many discrete components and the i.f. module is worth money, if you have a little time, you could repair the module with conventional printed board techniques.

If it's a "raster-only" symptom then the 4th i.f., video detector, 1st and 2nd video amplifers and both audio circuits are eliminated. If the video circuits are defective you'll still have sound since the audio is picked off in the 3rd i.f. The afc IC of course is hardly involved.

That leaves the i.f. link circuit, IC201, Q201 and Q207 circuits. It might be worthwhile to trace the circuit from W16 to W26 through the series divider network. Also trace electron flow from the collector of Q201 to W26. Lastly, check the emitter resistors of Q207 and Q201. It's just possible you'll lock-in on a bad component.

If not, from an economic standpoint, the old i.f. module is junk and should be discarded (or if in warranty, credited). The only time it has to be repaired is when the TV is in a remote area and the replacement module is absolutely not available. **R-E**

R-E's substitution guide for replacement transistors Part IV

compiled by ROBERT & ELIZABETH SCOTT

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

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

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

ICC—International Components, Div. of IESC, 10 Daniel Street, Farmingdale, N.Y. 11735

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

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

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

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

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

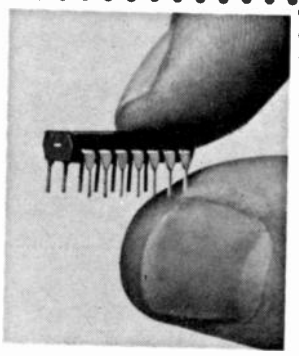
SYL—Sylvania Electric Corp., 100 1st Ave., Waltham, Mass. 02154

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

	ARCH	GE	ICC	IR	MAL	MOT	RCA	SPR	SYL
2N684*	NA	GEMR-3	ICC-R1473	IR-685	NA	HEP-1473	NA	NA	NA
2N685*	NA	GEMR-3	ICC-R1473	IR-685	NA	HEP-R1473	NA	NA	NA
2N686*	NA	GEMR-3	ICC-R1475	IR-687	NA	HEP-R1475	NA	NA	NA
2N687*	NA	GEMR-3	ICC-R1475	IR-687	NA	HEP-R1475	NA	NA	NA
2N688*	NA	GEMR-3	ICC-R1475	IR-688	NA	HEP-1475	NA	NA	NA
2N689*	NA	NA	NA	IR-689	NA	NA	NA	NA	NA
2N690*	NA	NA	NA	IR-690	NA	NA	NA	NA	NA
2N692*	NA	NA	NA	IR-692	NA	NA	NA	NA	NA
2N694	RS276-2003	GE-1	ICC-3	IRTR-81	PTC 109	HEP-3	SK 3008	NA	ECG 126
2N695	RS276-2003	GE-9	ICC-3	IRTR-89	PTC 107	HEP-3	SK 3006	NA	ECG 126
2N696	RS276-2009	GE-18	ICC-53	TR-21	PTC 125	HEP-53	SK 3124	RT-100	ECG 123
2N697	RS276-2009	GE-18	ICC-53	TR-21	PTC 125	HEP-53	SK 3024	RT-100	ECG 123
2N698	NA	GE-18	NA	IRTR-87	PTC 125	NA	NA	NA	NA
2N699	NA	GE-18	ICC-713	IRTR-78	PTC 125	HEP-713	SK 3045	RT-110	ECG 154
2N700	RS276-2003	GE-9	ICC-3	IRTR-89	PTC 107	HEP-3	NA	NA	ECG 160
2N701	RS276-2009	GE-9	ICC-53	TR-21	PTC 123	HEP-53	SK 3124	RT-100	ECG 123
2N702	RS276-2009	GE-61	ICC-50	IRTR-95	PTC 121	HEP-50	SK 3039	RT-113	ECG 108
2N703	RS276-2009	GE-61	ICC-50	IRTR-95	PTC 121	HEP-50	SK 3039	RT-113	ECG 108
2N705	RS276-2003	GE-9	ICC-3	IRTR-89	PTC 107	HEP-3	NA	NA	ECG 160
2N706	RS276-2009	GE-20	ICC-50	IRTR-95	PTC 123	HEP-50	SK 3039	RT-113	ECG 108
2N707	RS276-2009	GE-61	ICC-50	IRTR-95	PTC 121	HEP-50	SK 3039	RT-113	ECG 108
2N708	RS276-2009	GE-17	ICC-50	TR-21	PTC 121	HEP-50	SK 3122	RT-102	ECG 123A
2N709	RS276-2009	GE-17	ICC-50	IRTR-95	PTC 121	HEP-50	SK 3939	RT-113	ECG 108
2N710	RS276-2003	GE-9	ICC-3	IRTR-89	PTC 107	HEP-3	NA	NA	ECG 160
2N711	RS276-2003	GE-9	ICC-3	IRTR-89	PTC 107	HEP-3	NA	NA	ECG 160
2N715	RS276-2009	GE-20	ICC-50	TR-21	PTC 121	HEP-50	SK 3124	RT-100	ECG 123
2N716	NA	GE-20	NA	NA	PTC 121	HEP-S0004	SK 3122	NA	NA
2N717	RS276-2009	GE-20	ICC-50	IRTR-95	PTC 121	HEP-50	SK 3039	RT-113	ECG 108
2N718	RS276-2009	GE-20	ICC-736	TR-21	PTC 121	HEP-736	SK 3122	RT-113	ECG 108
2N719	NA	GE-18	NA	IRTR-87	PTC 125	HEP-S0001	SK 3024	NA	NA
2N720	NA	GE-18	NA	IRTR-87	NA	HEP-S0001	SK 3024	NA	NA
2N721	RS276-2023	GE-21	ICC-52	TR-20	PTC 103	HEP-52	SK 3114	RT-115	ECG 159
2N722	RS276-2023	GE-21	ICC-52	TR-20	PTC 103	HEP-52	SK 3114	RT-115	ECG 159
2N723	NA	GE-21	NA	IRTR-88	PTC 131	NA	NA	RT-126	ECG 106
2N725	RS276-2003	GE-9	ICC-3	IRTR-89	PTC 107	HEP-3	SK 3008	NA	ECG 160
2N726	RS276-2023	GE-22	ICC-52	TR-19	PTC 103	HEP-52	SK 3114	RT-126	ECG 106
2N727	RS276-2003	GE-22	ICC-52	TR-19	PTC 103	HEP-52	SK 3114	RT-126	ECG 106
2N728	RS276-2009	GE-63	ICC-50	TR-21	PTC 121	HEP-50	SK 3124	RT-100	ECG 123
2N729	RS276-2009	GE-63	ICC-50	TR-21	PTC 121	HEP-50	SK 3124	RT-100	ECG 123
2N730	NA	GE-20	NA	NA	PTC 121	HEP-S3020	SK 3122	NA	NA
2N731	NA	GE-20	NA	TR-21	PTC 121	HEP-S3020	SK 3122	NA	NA
2N734	NA	GE-18	NA	TR-21	PTC 123	HEP-713	SK 3122	NA	NA
2N735	NA	GE-18	NA	TR-21	PTC 123	HEP-713	SK 3122	NA	NA
2N736	NA	GE-18	NA	TR-21	PTC 123	HEP-S0007	SK 3122	NA	NA
2N738	NA	GE-18	NA	IRTR-78	PTC 125	HEP-712	SK 3045	RT-110	ECG 154
2N739	NA	GE-18	NA	IRTR-78	NA	HEP-712	SK 3045	RT-110	ECG 154
2N740	NA	GE-18	NA	IRTR-78	NA	HEP-S0005	SK 3045	RT-110	ECG 154
2N741	RS276-2003	GE-9	ICC-3	IRTR-89	NA	HEP-3	SK 3006	NA	ECG 160
2N742	RS276-2009	NA	ICC-50	TR-21	PTC 121	HEP-50	SK 3124	RT-100	ECG 123
2N743	RS276-2009	GE-20	ICC-50	IRTR-95	PTC 121	HEP-50	SK 3039	RT-113	ECG 108
2N744	RS276-2009	GE-20	ICC-50	IRTR-95	PTC 121	HEP-50	SK 3039	RT-113	ECG 108
2N745	RS276-2009	GE-20	ICC-50	TR-21	NA	HEP-50	SK 3122	RT-102	ECG 123A
2N746	RS276-2009	GE-20	ICC-50	TR-21	NA	HEP-50	SK 3122	RT-102	ECG 123A
2N747	RS276-2009	GE-20	ICC-50	TR-21	NA	HEP-50	SK 3122	RT-102	ECG 123A
2N748	RS276-2009	GE-20	ICC-50	TR-21	NA	HEP-50	SK 3122	RT-102	ECG 123A

	ARCH	GE	ICC	IR	MAL	MOT	RCA	SPR	SYL
2N749	RS276-2009	GE-18	ICC-50	TR-21	NA	HEP-50	SK 3122	RT-102	ECG 123A
2N750	RS276-2009	GE-20	ICC-50	TR-21	NA	HEP-50	SK 3122	RT-102	ECG 123A
2N751	RS276-2009	GE-18	ICC-50	TR-21	NA	HEP-50	SK 3122	RT-102	ECG 123A
2N752	NA	GE-17	NA	IRTR-95	PTC 121	HEP-713	SK 3039	RT-113	ECG 108
2N753	RS276-2009	GE-61	ICC-50	TR-21	PTC 121	HEP-50	SK 3122	RT-102	ECG 123A
2N754	RS276-2009	GE-18	ICC-50	TR-21	PTC 125	HEP-50	SK 3122	RT-102	ECG 123A
2N755	NA	GE-18	NA	IRTR-95	PTC 125	HEP-713	SK 3122	NA	ECG 108
2N756	RS276-2009	GE-18	ICC-50	IRTR-95	PTC 121	HEP-50	SK 3039	RT-113	ECG 108
2N757	RS276-2009	GE-18	ICC-50	IRTR-95	PTC 121	HEP-50	SK 3039	RT-113	ECG 108
2N758	RS276-2009	GE-18	ICC-50	IRTR-95	PTC 121	HEP-50	SK 3039	RT-113	ECG 108
2N759	RS276-2009	GE-18	ICC-50	IRTR-95	PTC 121	HEP-50	SK 3039	RT-113	ECG 108
2N760	RS276-2009	GE-18	ICC-50	IRTR-95	PTC 121	HEP-50	SK 3039	RT-113	ECG 108
2N761	RS276-2009	GE-17	ICC-50	IRTR-95	PTC 121	HEP-50	SK 3039	RT-113	ECG 108
2N762	RS276-2009	GE-17	ICC-50	IRTR-95	NA	HEP-50	SK 3039	RT-113	ECG 108
2N768	RS276-2003	GE-9	ICC-635	IRTR-89	PTC 107	HEP-635	SK 3008	NA	ECG 160
2N769	RS276-2003	GE-9	ICC-635	IRTR-89	PTC 107	HEP-635	NA	NA	ECG 160
2N770	RS276-2009	GE-20	ICC-50	TR-21	PTC 123	HEP-50	SK 3124	RT-100	ECG 123
2N771	RS276-2009	GE-20	ICC-50	TR-21	PTC 123	HEP-50	SK 3124	RT-100	ECG 123
2N772	RS276-2009	GE-20	ICC-50	TR-21	PTC 123	HEP-50	SK 3124	RT-100	ECG 123
2N773	RS276-2009	GE-20	ICC-50	TR-21	PTC 123	HEP-50	SK 3124	RT-100	ECG 123
2N774	RS276-2009	GE-20	ICC-50	TR-21	PTC 123	HEP-50	SK 3124	RT-100	ECG 123
2N775	RS276-2009	GE-20	ICC-50	TR-21	PTC 123	HEP-50	SK 3124	RT-100	ECG 123
2N776	RS276-2009	GE-20	ICC-50	TR-21	PTC 123	HEP-50	SK 3124	RT-100	ECG 123
2N777	RS276-2009	GE-20	ICC-50	TR-21	PTC 123	HEP-50	SK 3124	RT-100	ECG 123
2N778	RS276-2009	GE-20	ICC-50	TR-21	PTC 123	HEP-50	SK 3124	RT-100	ECG 123
2N779	RS276-2003	GE-9	ICC-3	IRTR-89	PTC 107	HEP-3	NA	NA	ECG 160
2N780	RS276-2009	GE-61	ICC-50	IRTR-95	PTC 121	HEP-50	SK 3039	RT-108	ECG 107
2N781	RS276-2003	GE-1	ICC-3	IRTR-89	PTC 109	HEP-3	SK 3004	NA	ECG 160
2N782	RS276-2003	GE-2	ICC-3	IRTR-89	PTC 107	HEP-3	SK 3123	NA	ECG 160
2N783	RS276-2009	GE-20	ICC-50	TR-21	PTC 123	HEP-50	SK 3122	RT-102	ECG 123A
2N784	RS276-2009	GE-20	ICC-50	TR-21	PTC 123	HEP-50	SK 3122	RT-102	ECG 123A
2N789	RS276-2009	GE-20	ICC-50	TR-21	PTC 123	HEP-50	SK 3124	RT-100	ECG 123
2N790	RS276-2009	GE-20	ICC-50	TR-21	PTC 123	HEP-50	SK 3124	RT-100	ECG 123
2N791	RS276-2009	GE-20	ICC-50	TR-21	PTC 123	HEP-50	SK 3124	RT-100	ECG 123
2N792	RS276-2009	GE-20	ICC-50	TR-21	PTC 123	HEP-50	SK 3124	RT-100	ECG 123
2N793	RS276-2009	GE-20	ICC-50	TR-21	PTC 107	HEP-50	SK 3124	RT-100	ECG 123
2N794	RS276-2003	GE-9	ICC-3	IRTR-89	PTC 107	HEP-3	NA	NA	ECG 160
2N795	RS276-2003	GE-9	ICC-3	IRTR-89	PTC 107	HEP-3	NA	NA	ECG 160
2N796	RS276-2003	GE-9	ICC-3	IRTR-89	PTC 107	HEP-3	NA	NA	ECG 160
2N797	RS276-2001	GE-7	ICC-641	TR-08	PTC 108	HEP-641	SK 3010	RT-122	ECG 103
2N799	RS276-2005	GE-1	ICC-254	TR-05	PTC 109	HEP-254	SK 3004	RT-120	ECG 102
2N800	NA	GE-1	NA	TR-05	PTC 109	HEP-632	SK 3123	RT-121	ECG 102A
2N801	RS276-2005	GE-1	ICC-254	IRTR-85	PTC 102	HEP-254	SK 3005	RT-118	ECG 100
2N802	NA	GE-1	NA	IRTR-85	PTC 102	HEP-629	SK 3005	RT-118	ECG 100
2N803	RS276-2005	GE-1	ICC-254	NA	PTC 135	HEP-254	SK 3005	RT-118	ECG 158
2N804	NA	GE-1	NA	IRTR-84	PTC 107	HEP-629	SK 3005	RT-118	ECG 158
2N805	RS276-2005	GE-1	ICC-254	IRTR-84	PTC 135	HEP-254	SK 3005	RT-118	ECG 158
2N806	NA	GE-1	NA	IRTR-84	PTC 107	HEP-630	SK 3005	RT-118	ECG 156
2N807	RS276-2005	GE-1	ICC-254	IRTR-85	PTC 135	HEP-254	SK 3005	RT-121	ECG 102A
2N808	NA	GE-1	NA	IRTR-85	PTC 135	HEP-631	SK 3005	RT-121	ECG 102A
2N809	RS276-2005	GE-1	ICC-254	IRTR-85	PTC 102	HEP-254	SK 3005	RT-118	ECG 100
2N810	NA	GE-1	NA	IRTR-85	PTC 102	HEP-631	SK 3005	RT-118	ECG 100
2N811	RS276-2005	GE-1	ICC-254	IRTR-85	PTC 102	HEP-254	SK 3005	RT-118	ECG 100
2N812	NA	GE-1	NA	IRTR-85	PTC 102	HEP-632	SK 3005	RT-118	ECG 100
2N813	RS276-2005	GE-1	ICC-254	IRTR-85	PTC 135	HEP-254	SK 3005	RT-121	ECG 102A

(continued on page 66)



4,000 functions in a single LSI circuit. *The functions of four thousand separate transistors, represented by the dots above, can now be performed by the LSI circuit shown in the photo.*

LSI...will it make or break your job future?

The development of LSI (large scale integration) technology in the 1970's is the dawn of the newest revolution in Electronics. It means that many of today's job skills soon will be obsolete. But at the same time, it opens the door to thousands of exciting new job opportunities for technicians solidly grounded in electronics fundamentals. Read here what you need to know to cash in on the Science of the Seventies and how you can learn it right at home.

LSI circuits, some no bigger than a bumblebee, are bringing about a fantastic new Industrial Revolution. Already these miracles of micro-circuit technology are a part of exotic equipment that saves lives, works complicated mathematical formulas in an instant, or tells time within a tolerance of two seconds per year.

LSI's may also put you into a whole new and more rewarding career . . . or put you out of a job!

In the fall of 1972, BUSINESS WEEK reported, "Because of its fast pace of innovation, the U. S. semiconductor industry leads the world. In the LSI market, U. S. domination is even more pronounced."

A single LSI circuit now can perform the function of more than 4,000 components and scientists predict that the use of electron beams to trace the circuit patterns will soon make it possible to put 10,000 transistors and similar devices on a silicon chip a few millimeters square.

Miniature Miracles of Today and Tomorrow

Already, as a result, a two-way radio can now be fitted inside a signet ring. A complete hearing aid can be worn entirely inside the ear. There is a new computer/calculator that weighs only nine ounces, fits easily into a shirt pocket, yet in a split second performs logorithmic, trigonometric and mathematical functions with a single keystroke and 10-digit accuracy. And new, extremely accurate watches consisting only of a quartz crystal, LSI circuits and a solid-state time display take only minutes to assemble.

And this is only the beginning.

Soon kitchen computers may keep the housewife's

refrigerator stocked, her menus planned, and her calories counted. Her vacuum cleaner may creep out at night and vacuum the floor all by itself.

Money may become obsolete. Instead you will simply carry an electronic charge account card. Your employer will credit your account after each week's work and merchants will charge each of your purchases against it.

When your telephone rings and nobody's home, your call will automatically be switched to the phone where you can be reached.

Doctors will be able to examine you internally by watching a TV screen while a pill-size camera passes through your digestive tract.

New Opportunities for Trained Men

What does all this mean to someone working in Electronics who never went beyond high school? It could mean the opportunity of a lifetime — if you take advantage of it.

It's true that the "LSI" may make a lot of manual skills no longer necessary.

But at the same time the booming sale of articles and equipment using integrated circuitry has created a tremendous demand for trained electronics personnel to help design, manufacture, test, operate and service all these marvels.

There simply won't be enough college-trained engineers to go around. So men with high school educations who have mastered the fundamentals of electronics theory may soon fill really interesting, high-pay jobs as engineering aides, technicians and service specialists.

How To Get the Training You Need

You can get the up-to-date training in electronics fundamentals you need and do it at home in your spare time without giving up your present job or income. Cleveland Institute of Electronics courses are specially designed for home study and feature AUTO-PROGRAMMED® Lessons. Even if you have no experience in Electronics or had trouble studying before, CIE courses help you advance faster and easier than you would have believed possible. You learn at your own pace.

Unlike a classroom situation where you have just one instructor throughout the course, at CIE you get help from a number of instructors. Each is selected on the basis of his specialized knowledge of a particular area of Electronics. In this way, you benefit from the combined knowledge of our entire staff.

Money-Back FCC License Warranty

A Government FCC License is certification of your knowledge of Electronics. Some jobs, especially in broadcasting, require a license, but nearly every employer recognizes its value. So why doesn't everyone who wants a good job in Electronics get an FCC License?

The answer: it's not that simple. You must pass a Government licensing exam. A good way to prepare for your FCC exam is to take a licensing course from Cleveland Institute of Electronics. Our training is so effective that in a recent survey of 787 CIE graduates, better than 9 out of 10 CIE grads passed the Government FCC License exam.

That's why we can offer this famous Money-Back Warranty: when you complete any CIE licensing course, you'll be able to pass your FCC exam or be entitled to a full refund of all tuition paid. This warranty is valid during the completion time allowed for your course. You get your FCC License — or your money back!

Praised by Successful Graduates

CIE training has been a big boost towards success for many men. Says Joseph Zauhar, Duluth, Minnesota, "I had three good job offers after I finished my CIE training and accepted a position as Technical Editor for Electronic/Technician Dealer Magazine. I've since been promoted to Managing Editor." From Cambridge, Massachusetts, Joe Perry reports, "I'm now an Engineering Specialist with National Radio Company, Inc., testing prototype equipment. CIE training gave me the electronics technology I needed to pass the exam for First Class FCC License. I'm already earning more than I could have without my CIE training."

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RE-19

	ARCH	GE	ICC	IR	MAL	MOT	RCA	SPR	SYL
2N814	NA	GE-1	NA	IRTR-85	PTC 107	HEP-633	SK 3005	RT-121	ECG 102A
2N815	RS276-2005	GE-8	ICC-254	IRTR-85	PTC 108	HEP-254	SK 3011	RT-121	ECG 100
2N816	NA	GE-8	NA	IRTR-85	PTC 108	HEP-632	SK 3011	RT-121	ECG 102A
2N817	RS276-2004	GE-6	ICC-253	TR-08	PTC 108	HEP-253	SK 3011	RT-119	ECG 158
2N818	NA	GE-6	NA	TR-08	PTC 108	HEP-629	SK 3011	RT-119	ECG 158
2N819	RS276-2004	GE-6	ICC-253	IRTR-85	PTC 108	HEP-253	SK 3011	RT-121	ECG 102A
2N820	NA	GE-6	NA	IRTR-85	PTC 108	HEP-629	SK 3011	RT-121	ECG 102A
2N821	RS276-2002	GE-6	ICC-641	TR-08	PTC 108	HEP-641	SK 3011	RT-119	ECG 101
2N822	RS276-2002	GE-6	ICC-641	TR-08	PTC 108	HEP-641	SK 3011	RT-119	ECG 101
2N823	RS276-2002	GE-5	ICC-641	TR-08	PTC 108	HEP-641	SK 3011	RT-119	ECG 101
2N824	RS276-2002	GE-5	ICC-641	TR-08	PTC 108	HEP-641	SK 3011	RT-119	ECG 101
2N825	RS276-2005	GE-1	ICC-254	IRTR-85	PTC 109	HEP-254	SK 3011	RT-120	ECG 102
2N826	NA	GE-1	NA	IRTR-85	PTC 109	HEP-632	SK 3004	RR-120	ECG 102
2N827	RS276-2003	GE-53	ICC-3	IRTR-89	PTC 107	HEP-3	NA	RT-121	ECG 160
2N828	RS276-2003	GE-9	ICC-3	IRTR-89	PTC 107	HEP-3	NA	NA	ECG 160
2N829	RS276-2003	GE-51	ICC-3	IRTR-89	PTC 107	HEP-3	NA	RT-101	ECG 160
2N834	RS276-2009	GE-20	ICC-50	IRTR-95	PTC 136	HEP-50	SK 3122	RT-113	ECG 108
2N835	RS276-2009	GE-20	ICC-50	IRTR-53	PTC 136	HEP-50	SK 3122	RT-102	ECG 123A
2N837	RS276-2003	GE-52	ICC-3	IRTR-89	PTC 109	HEP-3	NA	RT-120	ECG 160
2N838	RS276-2003	GE-53	ICC-3	IRTR-89	PTC 107	HEP-3	NA	RT-121	ECG 160
2N839	RS276-2009	GE-61	ICC-50	TR-21	PTC 121	HEP-50	SK 3122	RT-102	ECG 123A
2N840	RS276-2009	GE-61	ICC-50	TR-21	PTC 121	HEP-50	SK 3122	RT-102	ECG 123A
2N841	RS276-2009	GE-61	ICC-50	IRTR-95	PTC 121	HEP-50	SK 3039	RT-113	ECG 108
2N842	RS276-2009	GE-61	ICC-50	TR-21	PTC 121	HEP-50	SK 3122	RT-102	ECG 123A
2N843	RS276-2009	GE-61	ICC-50	IRTR-95	PTC 121	HEP-50	SK 3039	RT-113	ECG 108
2N844	RS276-2009	GE-61	ICC-50	TR-21	PTC 121	HEP-50	SK 3122	RT-102	ECG 123A
2N845	NA	GE-18	NA	IRTR-87	PTC 125	HEP-713	NA	RT-108	NA
2N846	RS276-2003	GE-61	ICC-3	IRTR-89	PTC 109	HEP-3	SK 3123	NA	ECG 160
2N849	RS276-2011	GE-61	ICC-56	IRTR-95	PTC 121	HEP-56	SK 3039	RT-113	ECG 108
2N850	NA	GE-61	NA	IRTR-95	PTC 121	HEP-718	SK 3039	RT-113	ECG 108
2N851	RS276-2011	GE-20	ICC-56	IRTR-95	PTC 136	HEP-56	SK 3039	RT-113	ECG 108
2N852	NA	GE-20	NA	IRTR-95	PTC 136	HEP-56	SK 3039	RT-113	ECG 108
2N858	RS276-2023	GE-21	ICC-52	TR-20	PTC 131	HEP-52	SK 3114	RT-115	ECG 159
2N859	RS276-2023	GE-21	ICC-52	TR-20	PTC 103	HEP-52	SK 3114	RT-115	ECG 159
2N860	RS276-2023	GE-22	ICC-52	TR-20	PTC 131	HEP-52	SK 3114	RT-115	ECG 159
2N861	RS276-2023	GE-22	ICC-52	TR-20	PTC 131	HEP-52	SK 3114	RT-115	ECG 159
2N862	RS276-2023	GE-22	ICC-52	TR-20	PTC 131	HEP-52	SK 3114	RT-115	ECG 159
2N863	RS276-2023	GE-22	ICC-52	TR-20	PTC 103	HEP-52	SK 3114	RT-115	ECG 159
2N864	RS276-2023	GE-22	ICC-52	TR-20	PTC 103	HEP-52	SK 3114	RT-115	ECG 159
2N865	RS276-2023	GE-22	ICC-52	TR-20	PTC 103	HEP-52	SK 3118	RT-126	ECG 106
2N866	RS276-2009	GE-20	ICC-50	TR-21	PTC 123	HEP-50	SK 3124	RT-100	ECG 123
2N867	RS276-2009	GE-20	ICC-50	TR-21	PTC 123	HEP-50	SK 3124	RT-100	ECG 123
2N868	NA	NA	NA	TR-21	NA	NA	NA	NA	NA
2N869	RS276-2023	GE-22	ICC-52	TR-20	PTC 103	HEP-52	NA	RT-126	ECG 106
2N870	NA	GE-18	NA	IRTR-87	PTC 123	HEP-713	NA	RT-108	NA
2N871	NA	GE-18	NA	IRTR-87	PTC 123	HEP-713	NA	RT-108	NA
2N876*	NA	NA	NA	NA	NA	HEP-R1001	NA	NA	NA
2N877*	NA	NA	NA	NA	NA	HEP-R1001	NA	NA	NA
2N878*	NA	NA	NA	NA	NA	HEP-R1002	NA	NA	NA
2N879*	NA	NA	NA	NA	NA	HEP-R1003	NA	NA	NA
2N880*	NA	NA	NA	NA	NA	HEP-R1004	NA	NA	NA
2N881*	NA	NA	NA	NA	NA	HEP-R1005	NA	NA	NA
2N884*	NA	NA	NA	NA	NA	HEP-R1001	NA	NA	NA
2N885*	NA	NA	NA	NA	NA	HEP-R1001	NA	NA	NA
2N886*	NA	NA	NA	NA	NA	HEP-R1002	NA	NA	NA
2N887*	NA	NA	NA	NA	NA	HEP-R1003	NA	NA	NA
2N888*	NA	NA	NA	NA	NA	HEP-R1004	NA	NA	NA
2N889*	NA	NA	NA	NA	NA	HEP-R1005	NA	NA	NA
2N902	NA	NA	NA	NA	NA	HEP-734	NA	NA	NA
2N903	NA	NA	NA	NA	NA	HEP-734	NA	NA	NA
2N904	NA	NA	NA	NA	NA	HEP-734	NA	NA	NA
2N905	NA	NA	NA	NA	NA	HEP-734	NA	NA	NA
2N906	NA	NA	NA	NA	NA	HEP-738	NA	NA	NA
2N907	NA	GE-63	NA	IRTR-87	PTC 144	NA	NA	RT-108	NA
2N908	NA	GE-18	NA	IRTR-87	NA	NA	NA	RT-108	NA
2N909	RS276-2009	GE-20	ICC-50	TR-21	PTC 121	HEP-50	NA	RT-100	ECG 123
2N910	NA	GE-18	NA	IRTR-87	PTC 123	HEP-S0001	NA	RT-108	NA
2N911	NA	GE-18	NA	IRTR-87	PTC 123	HEP-713	NA	RT-108	NA
2N912	NA	GE-18	NA	IRTR-87	PTC 123	HEP-713	NA	RT-108	NA
2N913	RS276-2009	GE-17	ICC-50	IRTR-95	PTC 121	HEP-50	SK 3039	RT-113	ECG 108
2N914	RS276-2009	GE-17	ICC-50	IRTR-95	PTC 121	HEP-50	SK 3039	RT-113	ECG 108
2N915	NA	GE-20	NA	TR-21	PTC 121	HEP-S004	NA	RT-100	NA
2N916	RS276-2009	GE-17	ICC-50	IRTR-95	PTC 121	HEP-50	SK 3039	RT-113	ECG 108
2N917	RS276-2011	GE-60	ICC-56	IRTR-95	PTC 121	HEP-56	SK 3019	RT-113	ECG 161
2N918	RS276-2011	GE-61	ICC-709	IRTR-95	PTC 133	HEP-709	SK 3018	RT-113	ECG 108
2N919	RS276-2009	GE-63	ICC-50	TR-21	PTC 136	HEP-50	SK 3122	RT-102	ECG 123A
2N920	RS276-2009	GE-63	ICC-50	TR-21	PTC 136	HEP-50	SK 3122	RT-102	ECG 123A
2N921	RS276-2009	GE-63	ICC-50	TR-21	PTC 136	HEP-50	SK 3122	RT-102	ECG 123A
2N922	RS276-2009	GE-17	ICC-50	TR-21	PTC 136	HEP-50	SK 3122	RT-102	ECG 123A
2N923	RS276-2023	GE-21	ICC-52	TR-20	PTC 131	HEP-52	SK 3114	RT-115	ECG 159
2N924	RS276-2023	GE-21	ICC-52	TR-20	PTC 131	HEP-52	SK 3114	RT-115	ECG 159
2N925	RS276-2023	GE-21	ICC-52	TR-20	PTC 131	HEP-52	SK 3114	RT-115	ECG 159
2N926	RS276-2023	GE-21	ICC-52	TR-20	PTC 131	HEP-52	SK 3114	RT-115	ECG 159
2N927	RS276-2023	GE-67	ICC-52	TR-20	PTC 131	HEP-52	SK 3114	RT-115	ECG 159
2N928	RS276-2023	GE-67	ICC-52	TR-20	PTC 131	HEP-52	SK 3114	RT-115	ECG 159
2N929	RS276-2009	GE-61	ICC-50	TR-21	PTC 121	HEP-50	SK 3122	RT-102	ECG 123A
2N930	RS276-2013	GE-62	ICC-728	TR-21	PTC 121	HEP-728	SK 3122	RT-102	ECG 123A
2N933	RS276-2003	GE-50	ICC-3	IRTR-89	PTC 107	HEP-3	NA	NA	ECG 126
2N934	RS276-2003	GE-2	ICC-3	IRTR-89	PTC 102	HEP-3	NA	RT-120	ECG 160
2N935	RS276-2023	GE-21	ICC-52	TR-19	PTC 103	HEP-52	SK 3114	RT-115	ECG 159
2N936	RS276-2023	GE-21	ICC-52	TR-19	PTC 103	HEP-52	SK 3114	RT-115	ECG 159
2N937	RS276-2023	GE-21	ICC-52	TR-19	PTC 103	HEP-52	SK 3114	RT-115	ECG 159
2N938	RS276-2023	GE-21	ICC-52	TR-19	PTC 131	HEP-52	SK 3114	RT-115	ECG 159
2N939	RS276-2023	GE-21	ICC-52	TR-19	PTC 131	HEP-52	SK 3114	RT-115	ECG 159
2N940	RS276-2023	GE-22	ICC-52	TR-19	PTC 103	HEP-52	SK 3114	RT-115	ECG 159
2N941	RS276-2023	GE-22	ICC-52	TR-19	PTC 131	HEP-52	SK 3114	RT-115	ECG 159
2N942	RS276-2023	GE-22	ICC-52	TR-19	PTC 131	HEP-52	SK 3114	RT-115	ECG 159
2N943	RS276-2023	GE-22	ICC-52	TR-19	PTC 131	HEP-52	SK 3114	RT-115	ECG 159
2N944	RS276-2023	GE-22	ICC-52	TR-19	PTC 131	HEP-52	SK 3114	RT-115	ECG 159
2N945	RS276-2023	GE-67	ICC-52	TR-19	PTC 131	HEP-52	SK 3114	RT-115	ECG 159
2N946	RS276-2023	GE-67	ICC-52	TR-19	PTC 103	HEP-52	SK 3114	RT-115	ECG 159
2N947	RS276-2009	GE-20	ICC-50	TR-21	PTC 121	HEP-50	SK 3122	RT-102	ECG 123A
2N948*	NA	NA	NA	NA	NA	HEP-R1001	NA	NA	NA
2N949*	NA	NA	NA	NA	NA	HEP-R1002	NA	NA	NA
2N950*	NA	NA	NA	NA	NA	HEP-R1003	NA	NA	NA
2N951	NA	GE-20	NA	NA	NA	HEP-R1005	NA	RT-100	NA
2N955	RS276-2002	GE-11	ICC-641	TR-08	PTC 108	HEP-641	SK 3011	TR-119	ECG 101
2N956	RS276-2009	GE-18	ICC-736	IRTR-87	PTC 121	HEP-736	NA	RT-108	NA
2N957	RS276-2009	GE-61	ICC-55	TR-21	PTC 121	HEP-55	SK 3122	RT-102	ECG 123A
2N958	NA	NA	NA	NA	NA	HEP-727	NA	NA	NA

*These devices are silicon controlled rectifiers.

(continued next month)

R-E's Service Clinic

replacement parts

An exact replacement may be a must

JACK DARR
SERVICE EDITOR

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

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

YOU HEAR THE FACTORY MEN SAY "Always use exact duplicate replacement parts, our part number————". In a few cases, you can find suitable substitute replacements. In others, brothers, you'd *better* use the factory replacement part. If you don't, you can "build-in" a real stinker of a problem. I ran into a couple of very good examples not too awfully long ago, to illustrate this point.

The subject was a Magnavox T933, which showed only blue, and a little green. It had been worked on just before I got it; complaint "wrong colors". So, I ran a gray-scale on it, and after forgetting that in these sets you must set the screens with the brightness control turned *off*, got a fairly decent monochrome picture. No color at all.

Up bar-dot generator and at 'em. Now I've got color all over the place. Take bar-dot off, hook up antenna, fine color picture. What happened? Oh, oh. Intermittent. Turn off, cool, turn on—no color now. Up scope. Touch plate of 3.58-MHz oscillator tube with probe. Pow! Color again, and oscillator signal. Repeat test, with same results. Turn off, cool, no color, apparently due to loss of oscillator signal. Touch *anything* in the circuit, and the oscillator starts.

Now sit there and think of a really clever way of checking this without touching it. OK; place the scope-probe near, but not touching, the plate. Recheck. No oscillator. Wait. No signal, after several minutes. The oscillator will *not* start by itself. Touching the plate, even with the tip of a pencil, starts it, and it's right on the money.

Try running the regular oscillator setup tests. These produce very odd results, and the oscillator still won't start. Maybe this is the crystal. Oscillators refuse to start because of insufficient feedback, and in this one, the crystal is the main element in the feedback loop.

Having a couple of crystals on the bench, I try one. Same problem. Try another crystal; Same, only worse this time. Find brand-new crystal, for Motorola replacement. Try this. Hmm. Won't work either. OK, try the acid test; go down the street to the Magnavox dealer, and get the right crystal.

Put this in, turn it on and presto, It works. Run the setup adjustments, and everything is copasetic. For a recheck, I tried the Motorola crystal once more, and one of the others. Same thing; they won't work. So I make a resolution. When I see what I suspect will be crystal trouble, from now on I will always use the *right* one! There are enough differences in circuitry, constants, and so, so that the wrong crystal will refuse to work, or won't work as it should!

That got the color problem. However, while working on that, I'd noticed some odd beats, etc, on the screen. I ignored these, since they didn't seem to be associated with the color problem, and weren't. Now I went after them. The tuner was apparently oscillating; low-band stations were OK, but on the high bands the thing was as hot as a pistol. Touch the lead-in at any point, on high-band stations, and the picture went all to pieces.

This is ordinarily due to improper neutralization, in the "Neutrode" tuners. I'd seen it in certain RCA tuners, and cleared it up by readjusting the neutralization. However, this one didn't *have* a neutralization adjustment. Let's try a new rf tube. Pull the tube, which is a brand-new one. Hmm. Tube layout calls for 6HQ5, and this one is a 6HA5.

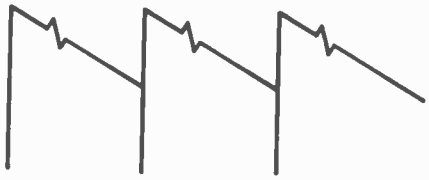
On a hunch, I got a 6HQ5 and tried it. Perfect. No oscillation, no squiggles, nothing. Put the 6HA5 back, here we go again. Apparently, this "substitute" tube had just a little bit *too much* gain, making the tuner unstable. Installing the correct tube type fixed the whole problem.

So: the moral of this is that if you must substitute for any part, check the set's *performance* after the replacement is in. *This* is the final cri-

terion. I *have* substituted one tube type for another, with good results. I have substituted a lot of transistors for the original types, also with good results. I have also tried substitute transistors and tubes, and found out that they wouldn't work satisfactorily.

For one final weirdo, A Zenith 14N22 had a severe case of vertical jitter. Full, linear raster, all control reactions normal, plenty of sync, etc., but it jittered. (Did not suspect the tube, because of full raster, etc.) The scope showed an odd pattern on the output waveform of the vertical integrator (see diagram). There was a tiny glitch on the scan portion of the waveform. This was intermittent.

After checking all of the parts I could think of, and replacing the sync-separator and integrator, I went to the



Zenith dealer and got a 6FM7 tube (as usual, I didn't have the one I wanted). Try this. No jitter! No glitch on the waveform. Put the original tube back. Jitter again. Get still another 6FM7 tube; no jitter.

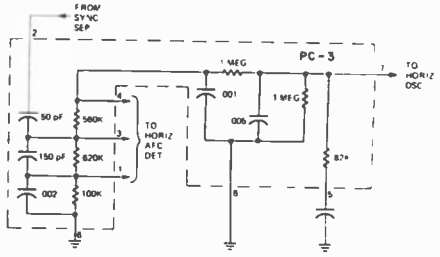
This one, I am *not* going to try to explain, for I have no idea of the cause. However, that one particular 6FM7 tube *would* cause the jitter, and the others wouldn't. There are "fixes" given for this, including adding a diode in the oscillator cathode, but these had no effect. The jittering tube checked perfect, of course.

So when you run into mysterious symptoms like these, try a new tube, or better still, a couple of new tubes, and see if this won't help. Even though the original seems to check out perfectly, and works almost normally, try some more tubes. Sometimes, it pays! **R-E**

reader questions

DOUBLE PIX

This Olympic NPD chassis makes nice pictures—two of them side by side! Just as stable as can be. Horizontal hold, horizontal oscillator coil won't bring it to a single picture, although both show normal "effects". Shorting the afc, you can adjust for a single picture, remarkably stable for no sync!—I.D., Mattoon, Ill.



Afc trouble, as you thought. Look for an *open* bypass capacitor in that Res-Cap unit, PC-3 in the Sams diagram. Most likely suspect, the .002-μF at the bottom of the dual-diode network, between terminals 1 and 6. Bridge one across it, externally. If this makes the set hold, you won't have to replace the whole thing.

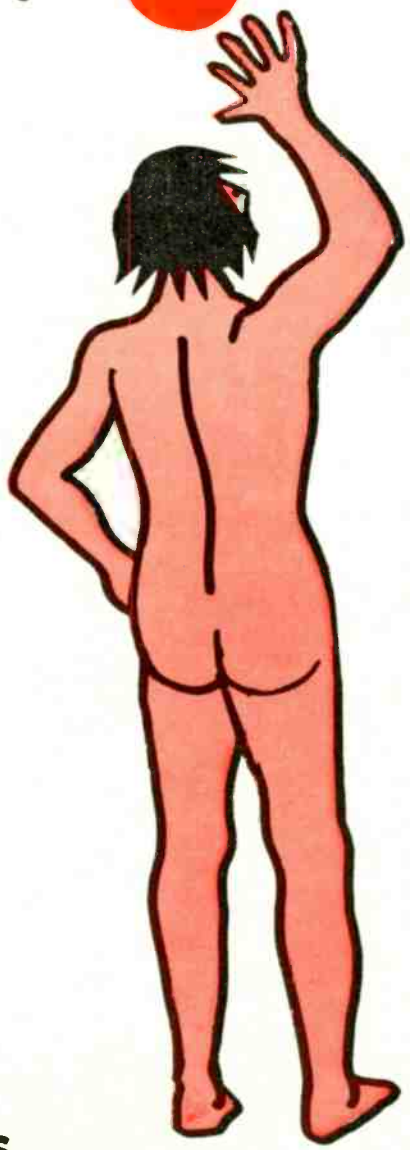
SMALL RASTER

I've got an odd condition on this Sylvania D-12. The raster is pulled in on all sides. My B+ is OK at about +320 volts. However, I get +220 volts on the screen grid of the 6LR6, and almost -90 volts on the control grid. Should be -45 volts on the control grid and +120 on the screen. The High Voltage Adjust control has no effect, but I've got 20 kV.—D.M.S., Tucson, Ariz.

Try a new 6BK4 regulator tube. In the older circuits, this wouldn't have the same effect. However, this

(continued on page 70)

Don't give in to temptation!



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Circle 17 on reader service card

chassis has a "High-Voltage Hold-down" circuit, as required by HEW. Failure in the high-voltage regulator will reduce or cut off the high voltage to prevent radiation. In "marginal" cases, it will just make the raster shrink.

RESISTOR BURNOUT

The 1500-ohm resistor in the first i.f. cathode circuit, in a Zenith 15L33 chassis, burns up. I've changed the tubes, and checked all resistors; no luck.—B.T., Delta, Ia.

This sounds a little "basic", but the resistor is carrying too much current! (Sorry about that, but it's true.) Since the only thing that causes current-flow in this resistor is the *tube*, something must be wrong there.

Not the tube itself, since it's been replaced. So, this leaves us only one thing—the grid bias. If this is "too far positive", the tube *will* draw excessive plate current. These little frame-grid tubes can handle surprisingly high currents, with incorrect bias.

The bias for this tube comes from the agc. Check the cathode voltage, and the control grid voltage. Note the high "offset" cathode voltage (see diagram). The cathode is +42 volts, from ground, but the grid is +35 volts. These are no-signal voltages. So, the net bias on this tube is -7 volts.

If something is wrong in the agc which lets the grid go *more positive*, it will cause the tube to draw a heavy

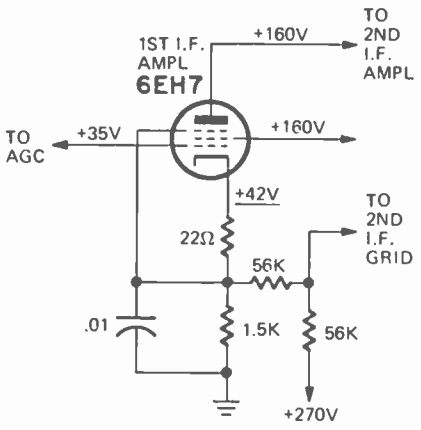


plate current and burn up the cathode resistor. (In case anyone is wondering about why the 22-ohm resistor doesn't burn up, too, it's easy. It's so little that it doesn't develop the I^2R drop (power) across it that the 1500-ohm one does!)

NO CONTRAST, SYNC BAD

I've got several problems in a GE I.Y chassis. The picture is so weak I can hardly see outlines, the sound buzzes, and the agc isn't working.—G.R. Greensboro, N.C.

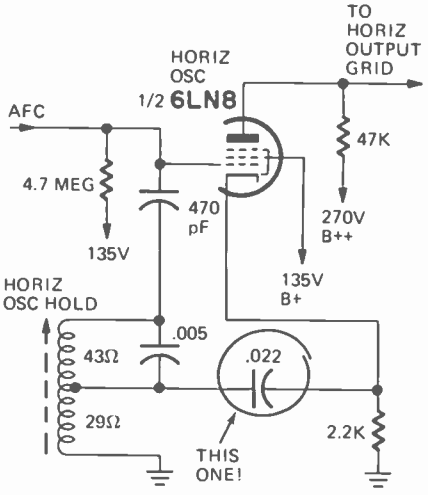
Whenever you find a mess of "multiple symptoms" such as this, look for a *common cause*. In this instance, I'd say the video detector was bad. Note that it not only supplies video to the output stage, but also to the sync separator and agc stages. Without the proper *video* signal, none of these will work.

Check the signal level at the video detector output with a scope. Should be about 1.5 volts p-p at this point, and show good clean sync. To check the video output stage look at the signal on the pix tube cathode; it should have about 50 volts p-p here. Also, check video on sync and agc stages.

THE MISPLACED POINT

The picture won't stay in horizontal sync on this Motorola TS-597. The hold control is supersensitive; pix falls out just the second you move it. I tried new capacitors across the horizontal oscillator coil/hold control. If I use the 0.22 μF on the lower half, as shown in the schematic I have, it won't oscillate at all!—C.C., Johns Island, S.C.

Two things here. The "0.22 μF" capacitor across the coil should be a



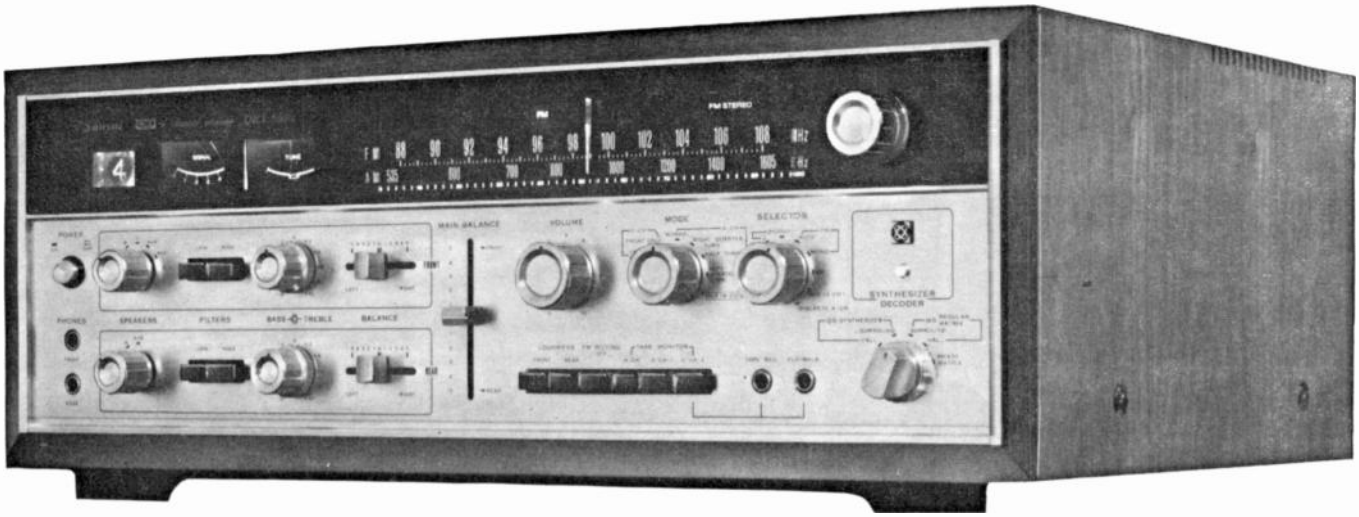
0.022 μF. Someone has moved a decimal point. Incidentally, when replacing these capacitors, be very sure that you get the right one across each section of this coil. You can get some strange and wonderful effects by reversing them.

Two: your *oscillator* is working. This is an afc problem, if it won't hold. Check the dual diode unit, and the 150-pF sync coupling capacitor.

TUNER PROBLEM

The tuner on this Zenith 16Z7C50Z has one of the funniest problems I've ever seen. I get Channel 7 on the 6 setting, and so on all up the line.

(continued on page 76



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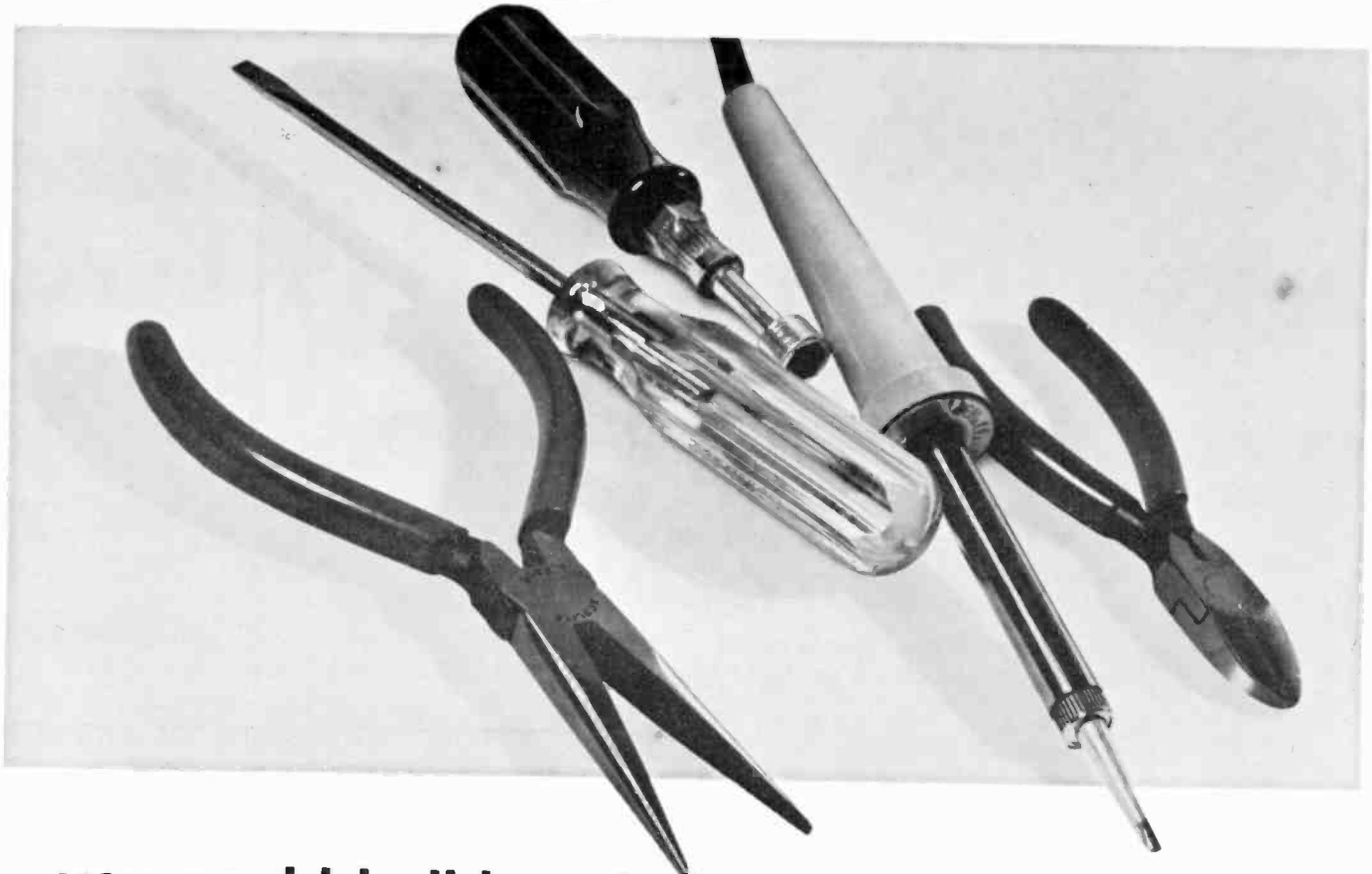

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Fine tuning seems to be OK. You can't get Channel 7 on 6, or can you?—T.S., Wickes, Ark.

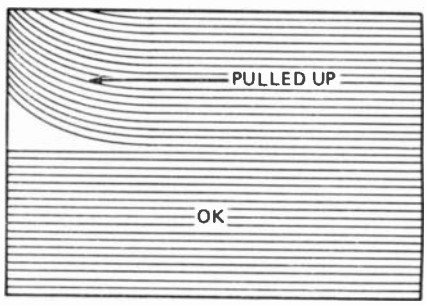
Nope. The cure for this is simple. Look at the back of the tuner. The *indicator* is driven by a small plastic pinion gear, spring-loaded, and a large plastic gear on the tuner shaft. This little gear can *slip*, skip a few teeth, and then your dial says channel 6 when the tuner is really on 7! Just lift the little gear against the spring, move the indicator to the right number, and let go.

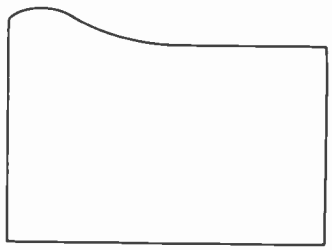
It *is* possible to fine-tune another channel, especially on the high bands; 9 on 10, etc. Most fine tuners have this much range. However, if the dial is one number off all the way around, look for mechanical trouble.

TRAPEZOID RASTER

I've never seen a case like this! The raster on this Olympic CT-910 is distorted, as in the drawing. The scan lines pull off and up to the left in the top left corner of the screen. If I adjust controls to make the raster smaller, it shows the same shape. Varies with brightness.—J.H., Pittsburgh, Pa.

This is a rare one. I've seen it happen only twice (Once on *my own* set!) This problem is almost certainly due to an *open connection* inside the picture tube—to the ultor button. The inside coating of dag has broken loose. The high voltage arcs across the gap, and apparently creates a mag-





RASTER

netic field which causes the pulling up of the raster lines.

Check: wipe the glass clean around the ultor connection. Now darken the room, and turn the set on. If this is the trouble, you'll see tiny arcs, very obviously *inside* the glass, usually all the way around the ultor button. A new tube is the only cure.

FLYBACK RESISTANCE DIFFERENT

I've just replaced the flyback in an RCA CTC-17X. Works very well, but my cathode current on the 6JE6 is running 230 mA, and I can't get it below that. Horizontal efficiency coil dipped, high-voltage regulator current about 1.4 mA, boost OK, and so on.

I used a well-known replacement flyback. I noted that the resistance of the high-voltage winding is given as 660 ohms, and this one is only 500 ohms. Would you suspect a short, or something like that?—H.B., Hayward, Calif.

Under these circumstances, no. I can't see a short in the high-voltage winding with only 230 mA of cathode current in the 6JE6. This is too close to being in the ball-park. I'd say that the lower resistance of this winding could be due to the use of slightly *larger* wire; if your high-voltage is up to normal, etc. then the *inductance* almost has to be correct.

For the excessive current, check the "High-Low" ac line switch. It might be in the wrong position. **R-E**

11 WAYS TO TEST IC'S

(continued from page 43)

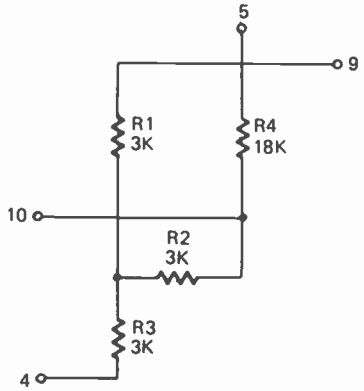


FIG. 3—EQUIVALENT CIRCUIT of the HEP 590 when low-power resistance measurements are made. The test voltage is too low to turn on the transistors.

is considerably greater than the normal junction resistance of Q2, it adds substantially to the junction-resistance value. However, 3,000 ohms has no practical effect on the reverse-resistance measurement.

Note: A junction resistance is different from a fixed resistance, in that the effective value of a junction resistance depends upon the value of applied voltage. Therefore, junction resistances cannot be added and subtracted like fixed resistances. In the foregoing test, the effective value of the junction resistance is about 500 ohms, but with some other value of series resistance in a circuit, the effective value of the junction would change more or less. Test 7 actually provides no new data—it is included at this point merely for instruction.

8. CHECKING A CONTROL-ACTION TEST OF A TRANSISTOR IN AN INTEGRATED CIRCUIT

Equipment: Hi-Lo FET meter.

Connections: Same as in test 1.

Procedure: Set meter controls to operate on its high-power ohms function and the R × 1-MEG range. Referring to Fig. 2, apply the positive test lead to terminal 10, and apply the negative test lead to terminal 2. Note scale indication. Then, touch your finger to terminal 1 and note any change in the scale indication.

Evaluation: This is basically a control-action test for transistor Q3. That is, the test voltage is polarized so that the base-emitter junctions of Q1 and Q2 conduct. However, since Q3 is cut off when its base connection is open, the ohmmeter normally reads infinity. But when you touch your finger to terminal 1, Q3 is driven by stray hum voltage. Accordingly, Q3 conducts on the positive peaks

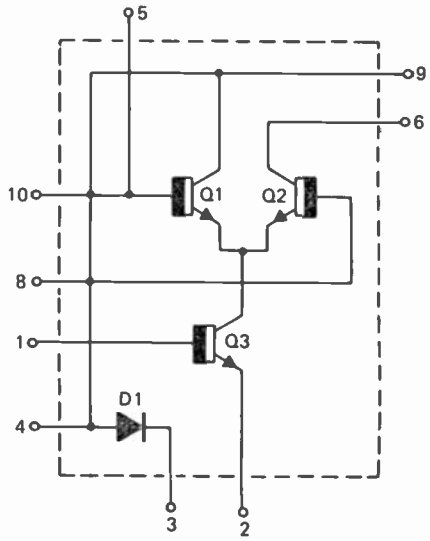


FIG. 4—EQUIVALENT CIRCUIT for transistor test with all junctions as open circuits. Resistance measurements less than infinity show IC is bad.

of the drive voltage, and the ohmmeter reading normally decreases. If this general type of response does not occur, the IC is defective.

Note: The exact amount of decrease in resistance reading will vary in the foregoing test, depending upon how much hum voltage your body is picking up. If you are close to ac wiring, the hum level will be comparatively high. Note that stray hum voltage may impose a limitation on the tests that can be made on high-gain IC's. That is, if the test situation is favorable to amplification of the hum voltage picked up by the IC terminals, the test results can be erroneous.

9. CHECKING AN INTEGRATED CIRCUIT FOR INTERMITTENTS

Equipment: Hi-Lo FET meter.

Connections: Same as in test 1.

Procedure: Same as in any foregoing test, except that the IC is tapped while the measurement is being made.

Evaluation: If the pointer "jumps" on the scale, it indicates that the IC is intermittent and should be rejected. (Be sure that your test connections are tight.)

10. TESTING AN INTEGRATED CIRCUIT FOR CURRENT DRAIN

Equipment: Hi-Lo FET meter.

Connections: This test is made with the IC wired into its normal circuit, such as an i.f. amplifier shown in Fig. 2. Disconnect the lead from terminal 9 of the IC; this is the supply-voltage lead. Connect the meter leads between

(continued on page 80)

11 WAYS TO TEST IC's

(continued from page 78)

terminal 9 and the supply-voltage lead.

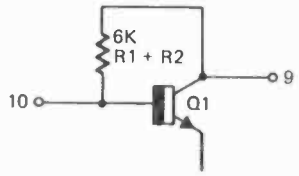


FIG. 5—FRONT-TO-BACK TEST of transistor Q1's collector-base junction finds this equivalent circuit in the HEP 590.

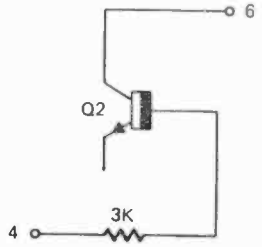


FIG. 6—SERIES RESISTANCE is part of equivalent circuit of Q2's collector-base junction in Motorola HEP 590 IC.

Procedure: Operate the meter on its DC CURRENT function, and measure the current flow into the IC.

Evaluation: Compare the measured current value with the rated current value for the given supply voltage, as specified in the IC manual. If there is a substantial discrepancy, a defect is indicated in the IC or in its associated external circuitry.

11. TESTING OPERATING VOLTAGES AT IC PINS

Equipment: Hi-Lo FET meter.

Connections: This test is made with the IC in its normal circuit, such as an i.f. amplifier as in Fig. 2. The meter test leads are applied between each of the IC terminals in turn and the common bus.

Procedure: Operate the meter on its DC VOLTS function, and measure the voltage value at each terminal.

Evaluation: Compare the measured voltage values with those specified in the receiver or equipment service data. If the corresponding values are in substantial discrepancy, there is a defect in the IC or in its associated external circuitry. Note that when service data are not available, it may be possible to make a comparison test on a similar IC in another stage, such as in first and second i.f. amplifiers. **R-E**

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by Robert G. Middleton

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Circle 25 on reader service card

PHONE SENTRY

(continued from page 37)

record the announcement with the tone signal at the end and do not connect up the message recorder No. 2.

You are now ready to put your Phone Sentry to use. Whenever you leave your business or home, switch the control unit on and place the answer player in the PLAY mode and the message recorder in the RECORD mode. When you return, turn the control unit off, turn on the PLAYBACK switch and rewind the message recorder tape. You then can play the messages and return the calls.

The incoming ring signal is rectified by diodes D1 and D2 charging capacitor C2. The present value of C2 (20 μf) allows the phone to ring for 2 to 3 seconds. For longer ring periods, increase the value of C2. When this charge reaches 65 volts, after two or three seconds of ringing, the neon bulb conducts, turning Q1 on. RY2 pulls in and is latched on by R4. Positive +6 volts is now supplied to the rest of the circuit, causing RY1 and RY3 to pull in. This connects transformers T1 and T2 to the line and starts the answer player unit No. 1. The output of the answer player is coupled to the telephone lines through T1 and to the input of tone detector IC1 through capacitor C11.

IC1 contains a phase-locked loop designed for frequency sensing. It has a controlled oscillator, a phase detector, quadrature phase detector and a power output stage. When a signal is applied to input pin 3 of the same phase as the oscillator, the output pin 8 will go low.

When the output of IC1 goes low, the 30-second monostable IC2 is triggered and its output (pin 3) goes high. This turns on relay 4, starting the message recorder unit. After the tone, IC1 goes high, RY3 turns off stopping the answer player. R7 and C4 were chosen to give a 30-second on time for unit No. 2. This time can be changed by changing R7 and/or C4. The caller's message is coupled to message recorder unit No. 2 through T2. At the end of 30 seconds, output pin 3 of IC 2 goes low and this negative-going signal is coupled through C3 to Q1, causing Q1 to turn off and release RY2, de-energizing the circuit.

The Phone Sentry control unit has been designed to provide proper coupling to the phone line with no dc voltage on the line and the recorders isolated. The tone signal frequency is below 2400 Hz as required by the phone company. Four "C" cells power the unit. **R-E**

Introducing the end to the battered mic.

These two new one-piece swedged-steel-case mics were designed to be abused by the roughest, rockingest performance conditions. Without breaking apart, without losing a dB of sensitivity or a Hz of response. There isn't a mic on the market that can beat them in so many ways.

Look what you get . . .

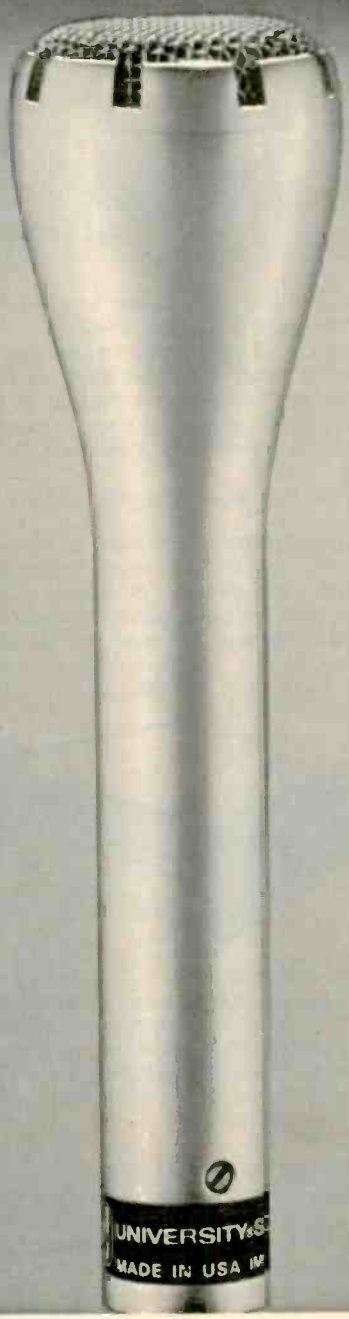
The swedged all-steel cases have unsurpassed ruggedness. No plastic parts to break. Nothing will dent! The non-reflective satin nickel finish prevents on-camera glare, while the smooth-flow styling snugs into the hand naturally, eliminates distractions. Fully shock-mounted, magnetically shielded unitized cartridge elements that are field replaceable. Built-in wind-pop filters. Every mic comes with a snap-on swivel adapter for cradle mounting, and a cable set.

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

University gives you more . . .
mics that can't be battered.

UNIVERSITY® SOUND
ALTEC DIVISION OF ALTEC CORPORATION
1515 S. Manchester Ave., Anaheim, California 92803

Write us about our full line of mics and mic stands.



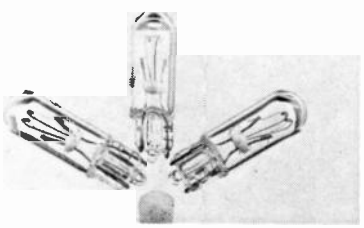
Circle 28 on reader service card

new products

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

SUB-MINIATURE LAMPS, *T-1 ¾* have all-glass wedge bases for use where space is at a premium.

These 12-V lamps are available in three models: *GE-73* has average life of 15,000 hours and light output of approximately 0.3 candlepower; *GE-37,* 1,500

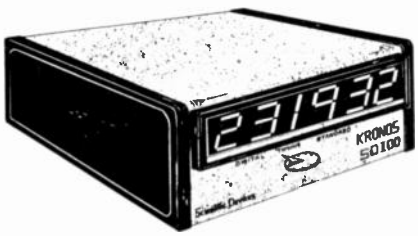


hours and 0.5 candlepower and *GE-74,* 500 hours and 0.7 candlepower.

Lamp and socket take up less space than other bulbs; push-pull insertion and removal from socket. Less than ¼" in diameter, 8/10" long, 44¢ each.—**General Electric Co.,** Nela Park, Cleveland, Ohio 44112

Circle 31 on reader service card

CHRONOMETER KIT, *Kronos KR100 series* uses LSI National clock chip and 32-page step-by-step illustrated brochure. Includes three setting controls, 1-hour per second, 1-minute per second and hold button. Easy-to-change from 12 to 24 hours, 4 to 6 digits, 50 or 60-Hz



operation. 2" x 6" x 5¼".

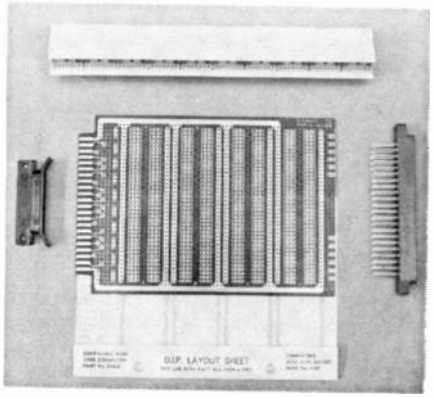
7-segment MAN-3 type LED's, 6-digit kit, $47.00; 7-segment MAN-1 type LED's, 6-digit kit, $69.95; 7-segment Nixie type tube kit, $47.00.—**Poly Paks Inc.,** P.O. Box 942, South Lynnfield, Mass. 01940

Circle 32 on reader service card

IC CIRCUIT BOARD *D.I.P. 24 Kit* eliminates the need for etching, drilling and making terminals. Boards mount and interconnect dual-in-line packages. Supply lines are positioned adjacent to all DIP locations and connect to outer edge contacts.

Layout pattern permits mounting packages having any number of terminations provided they are 0.1" centers. When boards are in horizontally mounted card frames, the DIP's are positioned in parallel vertical rows.

Consists of a *11824* board that is



4.5" wide and 6.5" long with 22 contacts on two sides, 0.156 center; 44-pin edge connector; card extraction handle, design sheet and ten 14-pin DIP sockets; $16.22.—**Vero Electronics Inc.,** 171 Bridge Road, Hauppauge, N.Y. 11787

Circle 33 on reader service card

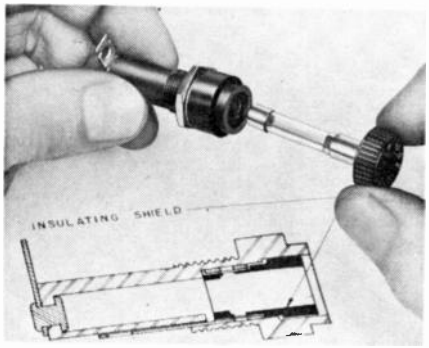
VEHICLE BURGLAR ALARM SYSTEM, *model SE-812* features the latest sound used by police, fire and emergency vehicles. Has full vehicle protection: sounds

alarm when trunk, door, hood, ignition, lights or brake are activated. Installs in less than 15 minutes; 100% solid state. Protects cars, boats, campers, trailer trucks and buses.

Includes hood and trunk switches and brackets (for cars without hood and trunk lights), electrical switch lock with built-in dust cover and two keys, wire, mounting hardware, instructions, two warning decals and guarantee.—**On-Guard Corporation of America,** 350 Gotham Parkway, Carlstadt, N.J. 07072

Circle 34 on reader service card

SHOCK-SAFE FUSEHOLDER, *345001* accommodates standard 3AG fuse. Has insulating shield that completely encloses the contacting ring section of the fuseholder side terminal. Electrical continuity is completed by a bayonet-style



fuse extractor knob. Rated at 20 A for any voltage to 300 volts.—**Littelfuse Inc.,** 800 East Northwest Highway, Des Plaines, Ill. 60016

Circle 35 on reader service card

FIELD STRENGTH METER, *model FSM-4* is portable and solid-state. Includes separate vhf and uhf tuners. Delivers accurate signal-strength readings in dBMV and microvolts from 10μV to 100,000 μV on a large-scale taut-band suspension meter.

Features include audio output jack (earphone provided), gold-plated, accu-

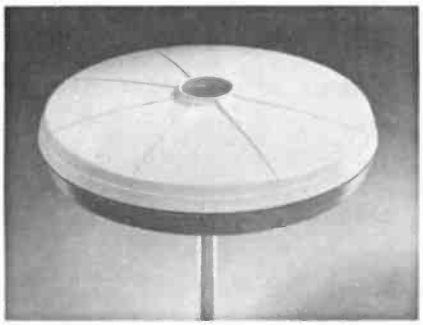
rately calibrated attenuator switches and 75-ohm, type F connector for signal input. Meter is calibrated to read average signal strength. Unit operates on four 9-

volt batteries.

Accuracy in the vhf band is ±3 dB while uhf readings are accurate to within ±4 dB. 4 lbs., 6 oz.; 9" x 6½" x 4".—**Blonder-Tongue Laboratories, Inc.,** One Jake Brown Road, Old Bridge, N.J.

Circle 36 on reader service card

MINI TV ANTENNA SYSTEM, *model 5MS440,* a new type of TV antenna system intended for metropolitan and suburban reception areas. System consists of a miniature unidirectional antenna, special solid-state amplifier and an electrical rotating mechanism; all enclosed inside



a weatherproof plastic case. Also includes power supply, uhf/vhf band separator, rotator control unit and hardware. Small 18-inch diameter of unit permits installation in many locations not accessible to conventional antennas.—**RCA Parts and Accessories,** Deptford, N. J.

Circle 37 on reader service card

VHF TV DISTRIBUTION AMPLIFIERS, *series 1000* includes five models that provide compatibility between CATV and MATV requirements. Feature constant match and constant signal-to-noise ratio with changes in gain control ranges having minimal effects on these characteristics. Superior input and output match

assures improved color response and clearer picture quality.

Guaranteed to deliver full rated output for both 7- and 12-channel operation. MATV system performance can be upgraded to CATV specifications.—**Kay-Townes Antenna Company,** P.O. Box 593, Rome, Ga. 30161.

Circle 38 on reader service card

HEADSET AND DECODER provides a complete system for 4-channel headset listening. Owner uses present 2-channel stereo equipment and plays 4-channel encoded records or FM. Those who own discrete or matrixed equipment with appropriate phone jacks, can purchase headset separately.

Moving-coil drivers have low-distortion, high-level output at 30 Hz and uniform frequency response up to 16

kHz. Clark/4 *CH-A* headset is $80.00 and headset with *DC-2A* decoder is $95.00.—**David Clark Co. Inc.,** 360 Franklin Street, Worcester, Mass. 01604

Circle 39 on reader service card

SOLID-STATE AMPLIFIER, *Stereo 400* delivers 200 watts rms per channel into an 8-ohm load, 300 watts rms per channel into 4 ohms or 100 watts rms per channel into 16 ohms. It may also be

switched to provide a mono 600-watt output into 8 ohms that can directly drive a 70.7-volt distribution system.

Features *Dynaguard*, an adjustable power limiter that permits full-power capability for short-term transient wave forms but clamps the sustained output above the power level selected on a front panel control. Thermal cutout indicator, heavy-duty power switch and individual load protection.—**Dynaco Inc.**, 3060 Jefferson Street, Philadelphia, Pa. 19121

Circle 40 on reader service card

MONITOR RECEIVER, *Duo-Vox* 2-channel vhf FM unit has externally adjustable squelch control. Fully transistorized; uses mercury or rechargeable Ni-Cad battery; low battery drain; 146 to 160 MHz frequency range; built-in antenna plus fractional microvolt sensitivity for extended range. 2-11/15 W x 5-1/2" D; 9-1/2 oz.—**Unimetrics Inc.**, 23 West Mall, Plainview, N.Y. 11803

Circle 41 on reader service card

RECORD CLEANER, *Groovemaster* as delicately balanced as a precision pickup arm is designed for professional as well as amateur use.

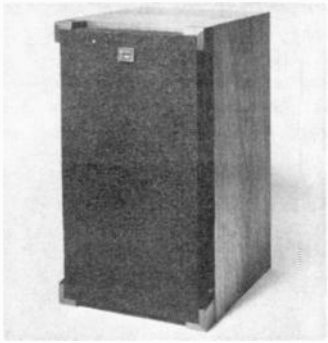
As the record spins, a velvet cylinder rides gently over the surface, removing dust and dirt from recording grooves. A nylon brush for applying anti-static cleaning fluid to the velvet is also used to clean the cylinder. $11.75.—**Robins Industries Corp.**, 75 Austin Blvd., Commack, N.Y. 11725.

Circle 42 on reader service card

SPEAKER SYSTEM, *SS-7100* incorporates a new means of distortion reduction called Ultra Linear Magnetic Circuit. It uses hollow pole-pieces that remain

magnetically saturated at all points of the wave form plus a shorting ring of non-magnetic copper whose effect is to neutralize the remaining pole-piece effects.

As a result, third-order harmonic distortion is reduced to as low as 1/5 that

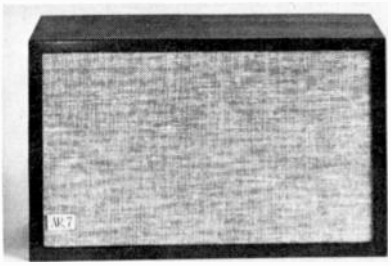


of conventional speakers while higher harmonics (and the second harmonic at high frequencies) are reduced still further. 8" woofer and 1" dome tweeter; $79.95.—**Sony Corporation of America,** 47-47 Van Dam Street, Long Island City, N.Y. 11101

Circle 43 on reader service card

SPEAKER SYSTEM, *AR-7* offers low distortion, extended and smooth frequency response and wide dispersion. New woofer whose magnetic circuit, voice coil and precisely controlled moving system mass yield optimal use of the acoustic suspension principle was designed specially for this size cabinet.

Both drivers have high temperature voice coils for additional power handling



capability. This system is suited for 4-channel installation.

Impedance is 8 ohms; crossover frequency is 2000 Hz. 8" acoustic suspension woofer, 1½" wide dispersion tweeter. 9¾" x 15¾" x 6¼". $60.00.—**Acoustic Research Inc.,** 24 Thorndike Street, Cambridge, Mass. 02141.

Circle 44 on reader service card

DIGITAL MULTIMETER, *model 245* a 4½-digit portable unit. Has 21 ranges to

measure dc volts, ac volts, dc current, ac current and resistance with 0.005% resolution.

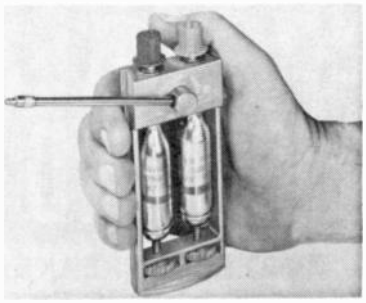
Special circuit reduces zero offset, drift and time constant errors. Single LSI/MOS chip.

5½" wide x 1¾" high x 3½" deep; 1.3 lbs., $295.00.—**Data Precision Corp.,** Audubon Road, Wakefield, Mass. 01880.

Circle 45 on reader service card

GAS WELDING TORCH is completely self-contained and produces a flame temperature of 5000° F. For welding, brazing or soldering small items made of copper, steel, stainless steel, brass, bronze, aluminum and zinc base alloy as well as rare metals.

Produces high-temperature flame using miniature cylinders of LP gas and Micronox. Needle valves control the flow



of the gases. Size and heat of flame can be adjusted.

Comes complete with torch, flame tips, torch tube, gaskets, gas supply and instructions; $24.95. Deluxe set includes

torch flame tips, bench brackets, flux brazing rods, spark lighter, spare gas cylinders, welding book and instructions; $34.95.—**Microflame, Inc.,** 3724 Oregon Avenue South, Minneapolis, Minn. 55426.

Circle 46 on reader service card

TACKY TRAY has pressure sensitive surface that prevents any small parts from tipping, sliding, rolling or intermingling. Parts stay where put until released with

normal finger-tip grip. Particularly useful for assembly and repair operations, handling minute parts and components.

Consists of six 5½" x 10" peel-off sheets stacked on sturdy plastic mat. When surface becomes soiled or loses its tack, a handy corner tab facilitates easy removal. Three adhesive tabs on bottom for anchoring to various surfaces.—**Bio-Serv Inc.,** Frenchtown, N.J.

Circle 47 on reader service card

QUICK PICKS, *No. 9216* offer a quick and easy method of removing transistors or PC type vertical capacitors. Set of seven versatile tools in a convenient plastic carrying case fit more than 25 different outlines of transistors or can

capacitors. Nonmagnetic tools leave hands free to desolder leads and are color coded for size selection. Also make excellent heat sinks. $9.95.—**GC Electronics,** 400 South Wyman Street, Rockford, Ill. 61101. **R-E**

Circle 48 on reader service card

new lit

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

4-CHANNEL SOUND BOOKLET with 20 questions and 20 answers covers basic definitions and deals with converting stereo systems to 4-channel, matrix vs. discrete sound, rear-channel speaker and power requirements, quadriphonic tape formats, matrix compatibility and enhancement of stereo sound sources.—**BSR-Metrotec,** Blauvelt, N.Y. 10913.
Circle 49 on reader service card

ANTENNA CATALOG, #*AC-73.* 8-page catalog includes a cross-referenced center fold-out that lists replacement rods for portable AM/FM radios and TV's, walkie-talkie's, indoor FM, uhf, automobiles and scanners. Illustrations of rods and assemblies plus an application chart included.—**Russell Industries, Inc.,** 96 Station Plaza, Lynbrook, N.Y. 11563.
Circle 50 on reader service card

SUPER INSTANT-WELD ADHESIVES. 6-page booklet presents detailed information on four different types of the powerful, quick-setting, permanent bond alpha cyanoacrylate adhesives. 2-page chart of specifications includes setting time, appearance, viscosity, refractive index, and flash point, as well as application data as to best type for use on various materials and combination of materials.—**Oneida Electronic Mfg. Co. Inc.,** P.O. Box 558, Meadville, Pa. 16335.
Circle 51 on reader service card

TOOL KIT BROCHURE. 16-page catalog describes six professional tool kits, each engineer-designed to do a particular job. Included are field engineer kit, electronic technician kit, compact detective kit, electronic lab kit, instrument repair kit, electronic technician roll-pouch kit. Tool kits from $44.50 to $555.00. A variety of cases sold separately are also described.—**Jensen Tools and Alloys,** 4117 North 44th Street, Phoenix, Ariz. 85018.
Circle 52 on reader service card

DRAFTING TEMPLATES. 8-page catalog presents line of templates for printed circuit design and drafting. Fourteen templates described and illustrated.—**Tangent Template Inc.,** P.O. Box 20704, San Diego, Calif. 92120.
Circle 53 on reader service card

GRANTHAM SCHOOL OF ENGINEERING BULLETIN describes a degree of Associate in Science in Engineering Technology and a degree of Bachelor of Science in Electronics Engineering. Bulletin includes general information about the program, educational services provided by the school, home-study student services, courses per semester, admission requirements, school policies and G.I. Bill benefits.—**Grantham School of Engineering,** 1505 North Western Ave., Hollywood, Calif. 90027. R-E
Circle 54 on reader service card

ELECTRIC HEATERS AND SAFETY DEVICES

by JACK DARR
SERVICE EDITOR

EVEN IN HOMES WITH CENTRAL HEATing, there are a lot of small portable electric heaters around. These are used for special purposes. For example, daughter likes the bathroom very warm, but the rest of the family doesn't want to swelter. These are very common in England; they call them "Electric Fires." Incidentally, these are the only electrical appliances which are almost 100% efficient. There is practically no loss at all. What we want is heat. So we connect a resistance element across the line, and it gets hot. Nothing is wasted.

Heating elements come in a large assortment of sizes and shapes—coiled wire, ribbon, sealed types, and so on. They're all exactly the same, except for the wattage. Just resistance wire, usually an alloy called Nichrome and variations; nickel and chromium. The wattage of a heating element depends on its resistance. The lower the resistance, the higher the current and the more heat.

As far as diagnosis of electrical faults is concerned, they're really pretty elementary. They're either good or open. (Or since they're electrical, they can be intermittent!) There are only a few things to go bad; line cord, switch or heating element. Easy to check out with an ohmmeter or a simple neon trouble lamp.

Most of the troubles will be in the things like broken line cords, open heating elements or dirty switches. Due to the high currents, a dirty switch contact or loose connection will cause trouble. They will arc, and this can cause heavy interference in nearby TV and radio sets. If they are allowed to arc for too long a time, the contact will burn open.

Loose connections to the ends of the heating elements cause a lot of problems. These are usually made with a long bolt. It goes through a hole in the metal frame, with ceramic insulators. On the top side, the end of the heating element is fastened between two flat washers, held by a nut. Below the insulators, the line cord is fastened in the same way, between

appliance clinic

two flat washers, held by two nuts. If either of these works loose, or wasn't properly tightened to start with, the connection will arc. This can actually weld the nuts to the threads, so that you can't move them, either to take them off or tighten them.

I ran into one of these not too long ago. I could get the line-cord connector off, but the other end had been arcing too long. The nut was firmly welded to the threads and the element was very loose. (The idea is to get the end of the element loose without breaking it.) In the end, I managed to unwind a couple of turns of the flat ribbon element, and get enough of it out of the cabinet to clamp the bolt in a vise. Then, I sawed the head of the bolt off. The space was so small that I had to use a special razorblade saw, with a very thin blade, (which is a part of an X-Acto-Knife set; in radio-TV and hobby stores).

The better grade of heaters have safety devices. Many have thermostats which can be adjusted for any amount of heat desired. Others have special switches, for HIGH, MEDIUM or LOW heats; these switch the heating elements into various combinations. For example, one that I know of has two 1-kW elements. For low heat, one element is turned on. For medium heat, both are connected in series across the 120-volt line. For high heat, both are connected in parallel.

Safety devices are also used. If one of these heaters was sitting on a carpeted or plastic covered floor, and tipped over face down, it could set the floor on fire. So, a device called a "tip-switch" is used. Most of these are pretty simple. On one make, it's just a little rod sticking through the bottom of the case. The top of the rod holds a spring switch closed, as long as the case is upright. If it falls over the spring loaded rod moves down and the switch opens.

This can cause problems while you're working on one if you don't know they use a tip-switch. You may replace an element, and then try to get it to heat up while lying on its back on the bench. If it won't work, check to see if it has a tip-switch.

Replacement heating elements can be purchased at any electrical supply store or hardware store. Be sure to check the wattage rating of the original, and get one exactly like it. This rating should be on the rating plate on the back of the case, near the point where the line-cord goes in. If necessary, you can use a fifferent type of element; a flat ribbon in place of a coiled wire, or vice versa. Just be *sure* that you mount the element tightly on the ceramic insulators.

When replacing line cords, check the wattage rating. You must use a cord which has wire big enough to carry the current without getting hot itself. For the smaller types, No. 14 wire is good, but for the bigger ones you'd better use either No. 12 or No. 10 stranded wire. Older ones used to use the heater-cord type, which was asbestos insulated, with a heavy braided jacket. Newer models use a plastic insulated cord, like the zipcord on TV line-cords, but much bigger. The important thing is wire size. **R-E**

next month

JULY 1973

- **Build A Modulated IC Function Generator**
  This unit delivers six different waveforms—sine, triangle, square, sawtooth, ramp and pulse with both AM and FM modulation over a frequency range of 1 Hz to 1.5 MHz. It's built around two Exar IC's.

- **How To Test Hi-Fi Amplifiers**
  Equipment setups and procedures for measuring power output, distortion, power bandwidth, sensitivity, damping factor, signal-to-noise-ratio and frequency response of any hi-fi amplifier.

- **Inside A Modern Calculator Kit**
  See what it's like to build the MITS 1440 desk calculator. You'll also get a look at the electronics that make it work.

- **Amplifier Strapping**
  Leonard Feldman, R-E's new Contributing High-Fidelity Editor, shows what happens when a 4-channel amplifier is switched to 2-channel playback. It sounds simple, but is actually quite complex.

PLUS
Step-By-Step Troubleshooting
Lou Garner's State-Of-Solid-State
Boolean Algebra Made Easy
Jack Darr's Service Clinic
R-E's Transistor Substitution Guide

books

MONOCHROME GENERAL ELECTRIC TV SERVICE MANUAL (TAB Book No. 558), MONOCHROME MOTOROLA TV SERVICE MANUAL (TAB Book No. 594), by Harvey F. Swearer. GENERAL ELECTRIC COLOR TV SERVICE MANUAL, Volume 2 (TAB Book No. 609), by Stan Prentiss. TAB Books, Blue Ridge Summit, PA 17214. 8½ x 11 in. 160 pps, 196 pps and 212 pps, respectively. $7.95 (each title) in vinyl leatherette cover, $4.95 paperbound.

These are three of the latest additions to a series of TV service manuals that need no introduction to Radio-Electronics readers. Each manual is a comprehensive compilation of pertinent service information on the latest TV receiver models of a particular make. Included are detailed analysis of circuit functions and operation, along with all necessary schematics, photographs, waveforms, alignment tables and troubleshooting information to enable the technician to troubleshoot and service the subject receivers. The theoretical presentation, alone, is well worth the cost of the manual.—*RFS*

THE SEMICONDUCTOR DATA LIBRARY, 1st Edition. By Technical Information Center, Motorola, Inc., P.O. Box 20924, Phoenix, Ariz. 85306. 3-volume set, 7 x 9¾ in., more than 3200 pp. Leatherette covers. $6.50 for basic set, $10.00 for set and updating service covering 18 months and consisting of two supplements to Volume II and three quarterly brochures and two completely revised editions of The Reference Volume.

The Semiconductor Library presents Motorola discrete semiconductors in three volumes, organized as follows:

Volume I—Complete data sheets for Motorola devices bearing EIA numbers to 1N4999 and 2N4999. *Volume II*—Complete data on EIA numbers 1N5000 and 2N5000 and higher as well as 3N . . . types and those bearing special Motorola type numbers. *Volume II* will be updated by two supplements during its life.

Reference Volume—A compendium of semiconductor devices and IC information prepared to enable the reader to locate and select devices for almost any application or circuit. Separate indexes cover EIA-registered devices, non-registered Motorola types, microcircuit components, groupings of devices by categories and applications and Military specifications. Dimensional outlines and packaging and hardware information are supplied. This volume will be completely updated twice a year; with supplementary publications quarterly.

NORTH AMERICAN RADIO-TV STATION GUIDE, 8th Edition, by Vane A. Jones. Howard W. Sams Co., 4300 W. 62nd St., Indianapolis, Ind. 46268. 5½ x 8½ in., 160 pp. Soft cover $3.95 ($4.95 in Canada).

White's Radio Log it isn't, but it is the nearest thing to it. This new and up-to-date guide contains listings for all radio and TV stations in the U.S., Canada, Mexico and The West Indies.

The over 5500 AM stations, over 3000 FM stations and nearly 1200 TV stations in operation, scheduled to start soon or temporarily off the air are listed three ways—by call letters, frequency or channel and geographical location. Other pertinent information includes network affiliation; power (day and night), height of antennas, and whether or not an FM station broadcasts in stereo. A must for the broadcast and TV DX'er and tourist in the countries covered.—*RFS*

MECL SYSTEM DESIGN HANDBOOK. Compiled by Wm. R. Blood, Jr., et al, Computer Applications Engineering Dept., Motorola, Inc., P.O. Box 20924, Phoenix, Ariz. 85036. 7 x 9¾ in. 214 pp. Soft cover, $2.00.

The Handbook presents complete up-to-date information on MECL devices. (MECL is a Motorola trademark used to identify its emitter-coupled logic devices.) It gives the designer the information needed to establish design rules for his own high-performance systems. Included are rules and guidelines for working with the MECL II, MECL III and new low-power MECL 10,000 series logic devices and for interfacing the various other logic systems with MECL.

UNDERSTANDING OSCILLATORS by Irving M. Gottlieb. Howard W. Sams & Co., Indianapolis, Ind. 46268. 8 5/16 x 5 3/16 in. 160 pp. Softcover, $4.50.

Here is the book on fundamentals of oscillators you have been looking for—how they work, their personalities, their strong and weak points, and how they are used in practical applications. A number of circuits, with their various active devices, will be seen to derive their operations in a more or less similar manner. Emphasis in the text has been directed toward the application of semiconductors to oscillators, even though the tube circuit retains its place as the basic oscillator throughout the exposition.—*MCL* R-E

hearing through the teeth

Not so long ago, Dr. Earl Collard of the University of California was playing with a tuning fork. Accidentally placing it against one of his teeth just after it had ceased sounding, he was surprised to hear a clear, easily audible tone. The tuning fork was still vibrating, and the sound—not loud enough to be heard by ear—came through "loud and clear" by tooth conduction.

Professor Collard decided that the new principle—hearing through the teeth—might become "the basis of an entirely new method of communication," and named it *Audionetics.*

The idea is not quite as new as Dr. Collard thinks. Hugo Gernsback patented, in December 1924, a device for hearing through the teeth. It consisted of a vibrating electromagnet with two rubber bit pieces to be held between the teeth of the user. It was intended to be connected to the output of a radio, or to be used with a microphone and amplifier, as an aid to the partially deaf. Gernsback called it the *Osophone* (*os*-bone, *phono*-voice).

Incidentally, this was the first bone-conduction hearing aid. Later, in 1934, Gernsback worked out a similar device, to be applied to the forehead.

But the original Gernsback devices both got their signals from an audio amplifier and both depended on large and rather clumsy devices to get the sound to the listener's bone channels. Dr. Collard has added a new idea. His transducer is a tiny radio receiver, placed *inside* the listener's mouth. It may be mounted in bridgework, in a gap left by a missing tooth,

or even inserted as a filling in a tooth itself. A tiny transceiver (or more correctly, translator) carried in a pocket or suspended in clothing would pick up radio signals from a given source (a wireless microphone for example) and retransmit them to the tooth receiver. It in turn would send them through the bones of the jaw and into the inner ear. **R-E**

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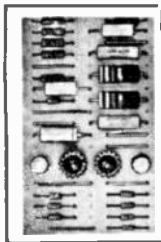

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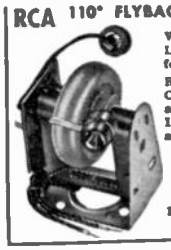

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Circle 80 on reader service card

SPEED TROUBLESHOOTING

(continued from page 49)

then localize to isolate the little block. It will not take long to find the one defective component, even among thousands.

The component isolation, once a defective stage has been found, is not usually quite as difficult as finding the defective stage was in a complex piece of equipment. Even though a circuit may have one of a great many functions, it will have a certain number of characteristics that are common to all circuit functions.

Any stage (there will always be exceptions to prove the rule) will have at least one active component (a tube or transistor) and several passive components (resistors, capacitors, diodes, inductors, etc.) It has a steady state condition and an operating, or dynamic, condition.

Most defective components can be found while a circuit is operating in the steady-state mode. Voltmeter checks on the elements of the active device will usually provide enough information to pinpoint the problem. More often than not the active device is defective in a nonoperating stage. Capacitors, either shorted, leaky, or open, are next on the list of likely failures. Leaky or shorted capacitors will usually upset the circuit's steady-state (dc) operation, but open capacitors will usually have to be found with signals applied.

When measurements are made in either tube or transistor circuitry, the proper test equipment is a must. The loading effect of a piece of test dquipment not only introduces measurement error, but may upset circuit bias values enough to cause a stage to cease to operate. That does not help when you are trying to troubleshoot. Inputs to stages are usually much more susceptible to this type of effect than outputs, but know what your test equipment does to a circuit before deciding that the circuit is defective.

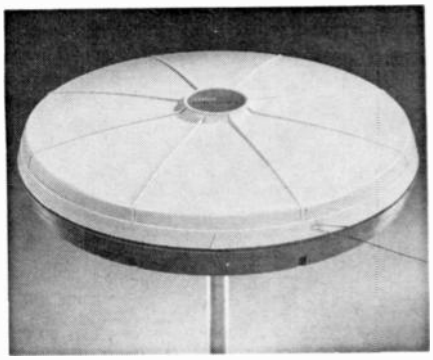
Fig. 3 shows the simple tube and transistor circuits which form the basis for a great many functioning blocks in any equipment. The charts beside each circuit show the component most likely to be defective for a given set of readings. Remember that the chart is not ironclad and that there are always variables in a circuit that may not be readily apparent.

Now that you are an expert at logical troubleshooting, and can isolate the defective stage in almost anything, we have a quiz (Fig. 4) for you.

The concluding article next month will have the answers to this month's quiz and a three-part test to enable you to sharpen your troubleshooting skill—down to the component. **R-E**

equipment report

RCA 5MS440 Mini-State TV Antenna System



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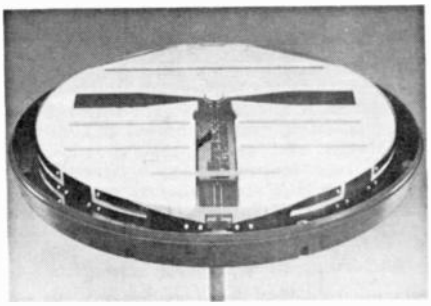
AT FIRST GLANCE YOU MAY THINK that you're seeing a flying saucer hovering over the roof tops, but it's really a new amplified miniature outdoor TV antenna. The 21-inch diameter weatherproof plastic case encloses a vhf travelling-wave antenna and its low-noise electronic solid-state amplifier, a multi-element uhf antenna and a compact, yet efficient rotator.

Having other small antennas before (see **Radio-Electronics,** January 1971, page 26) we set this one up at a test site some 20 miles from the TV transmitters in a densely-populated suburb of New York City. We put the antenna on the roof of a two-story house, connected it to a convenient color set and checked the reception. All local channels—2, 4, 5, 7, 9, 11, 13, 31, and 47—appeared on the screen sharp and clear. There was no discernible snow and ghosts could be eliminated by using the rotator.

As a result of our tests we conclude that this antenna works. While it is a more expensive replacement than a conventional roof antenna, it is the best alternative in locations where you are unable to use or mount a conventional antenna.

Let's look inside the case. As you can see from the photograph the vhf antenna is formed around a foamed plastic form. The ends of the antenna are terminated with a 360-ohm resistor This antenna delivers a broad forward lobe and a sharply curtailed reception pattern from the rear. As a result it is possible to effectively eliminate ghost sources that a dipole cannot tune out.

Connected to the vhf antenna is a



transistor preamplifier with built-in interference filters. The preamp is used only for the vhf antenna. It is powered through the antenna leadin.

Atop the same plastic form you can see the multistage uhf antenna.

The entire vhf/uhf antenna array is mounted on a circular platform that can be rotated through a full 360°. The entire assembly, antenna and rotator, is housed inside a weatherproof plastic case that is a only 21 inches in diameter, 7 inches high and weighs less than 6 pounds.

Possible antenna mounting locations for the Mini-State .antenna are numberless. They include alongside a chimney, on the side of a house, outside an apartment window, under the eaves, in the attic, or in a closet.

The antenna system comes with a separate power supply and uhf/vhf transformer band separator connected behind the set.

A hand-held remote control with 8 feet of connecting cable plugs into the power supply provides remote control of the rotator. An 18-foot optional extension is available.

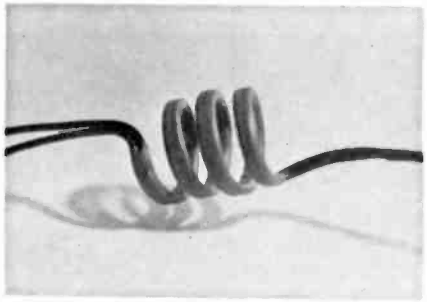
The antenna comes with a set of snap-on legs for closet or attic mounting and a special clamp is included for installation on a standard mast.

To sum up, the Mini-State is an outdoor antenna that can also be effectively used indoors. It is designed for use where a conventional rooftop antenna cannot be used and a top-of-the-set antenna does not deliver satisfactory performance. **R-E**

try this

MAKE YOUR OWN COILED CABLE

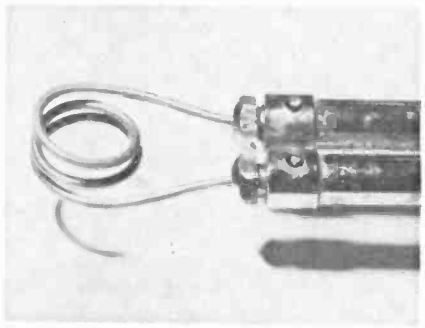
You can make your own coiled wire. Simply run the wires through some shrinkable tubing, along with .010-.015 inch spring-steel wire. Wrap it on a wooden dowel of the diameter



desired and place it over a source of heat such as a heat gun, bathroom heater, gas burner, etc. Tighten the wrap as the tubing shrinks. Allow the tubing to cool thoroughly before removing from the dowel.—*A. E. Plavcan*

SOLDERING GUN DEMAGNETIZER

You've probably noticed the annoying habit your soldering gun has of picking up ferrous objects that you're attempting to solder. By increasing the ½ turn coil to 2½ turns you can accentuate this effect and use it to demagnetize small tools. The gun should be slowly withdrawn while switched on, of course, as with a bulk



tape eraser.

Pick the heaviest solid copper wire you have to approximate the resistance of a regular tip.

On the other hand, if you want to magnetize, say a screwdriver, you'll have to play roulette with the power line. Switch the gun on and off with the screwdriver in the coil until you get acceptable polarity and strength.—*R. G. Cooper* **R-E**

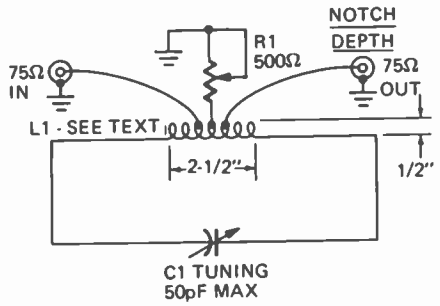
circuits

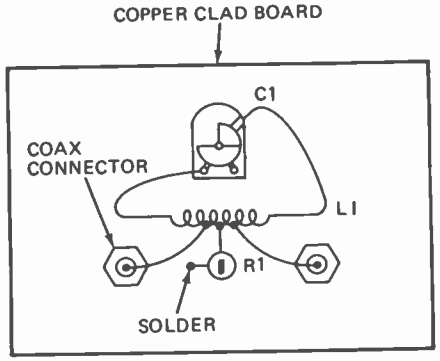
BRIDGED-T TRAP

How many times has reception of a weak TV station been ruined by spill-over from a strong adjacent-channel station? Here in New York City, many people try to get channel 3 in Connecticut for blacked-out games. After installing one (or more) channel-3 Yagis, they discover that channel 3 is useless because of the poor adjacent-channel rejection of their TV set.

The textbook solution to this is a $\lambda/4$ stub cut to trap out the offending carrier (adjacent sound and video do the most damage). But in practice this offers less than 20 dB rejection—not enough for really strong interference. Good traps are available, but are expensive since they are designed for CATV head-ends.

An alternative is the bridged-T L-C filter. Easily homemade, it will provide 50+ dB rejection and a very narrow notch bandwidth. This version is designed for 75-





ohm coax, and will tune from 50 to 110 MHZ. This includes the 6-meter ham band, channels 2–6 TV and the FM band. The trap should be built on a small piece of copper-clad board. Notice *both* capacitor terminals are *above* ground. An insulated rotor type should be used. The Hammarlund MAPC-50 or equal is ideal. The coil is 9 turns of No. 18 copper wire wound with an inside diameter of ½ inch. Turns are spaced to occupy 2½ inch. It is tapped in the exact center, one turn before, and one after. This is to match the coax into the trap properly. Chassis mounting F-type connectors are used for convenient connection into your antenna lead. To tune up, vary C1 to reduce the QRM. Peak the effect with the NOTCH DEPTH control, a 500-ohm miniature trimmer. Repeat these steps. For less than $5.00 and an hour of work you can now enjoy clear reception. Good dx'ing!—*Jerry Pulice, WB2CPA* **R-E**

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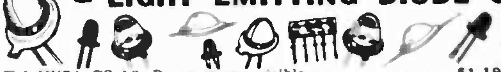

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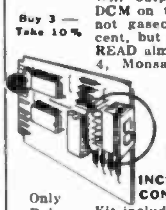

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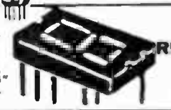

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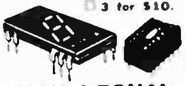

MAN-4 EQUAL

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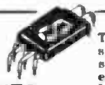

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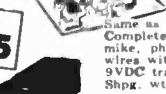

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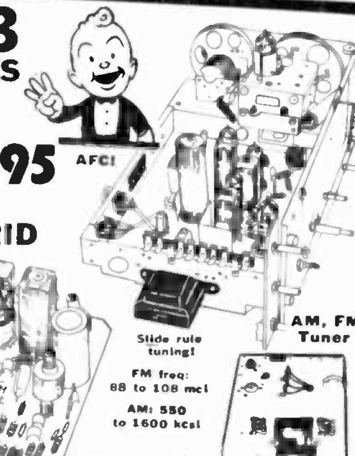

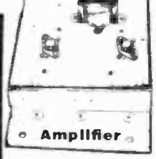

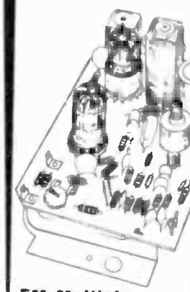

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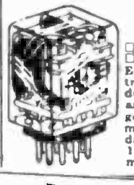

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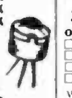
☐ 750	☐ 75.K
☐ 1.0K	☐ 100K
☐ 2.5K	☐ 250K
☐ 5.0K	☐ 2 Meg
	☐ 5 Meg



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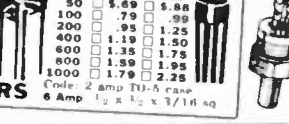

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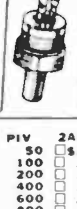

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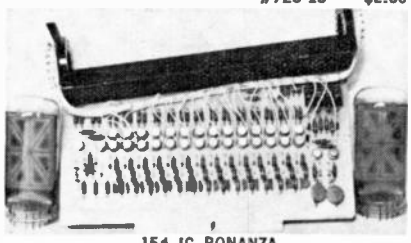

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(A) TO-5 or DIP dual in line pak

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☐ LM-308	Super gain op amp	1.50
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*TO-3 case, — others TO-5

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Delivers 3 watts continuous, 10 watts peak. With heat sinks; micro-mini size: ¾x¾x½". 9 to 30V supply. High sensitivity, 4 to 16 ohms. For mono and stereo phonos, tape, FM, AM, TV, servo.

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(continued on page 105)

ADVERTISING INDEX

RADIO-ELECTRONICS does not assume responsibility for any errors which may appear in the index below.

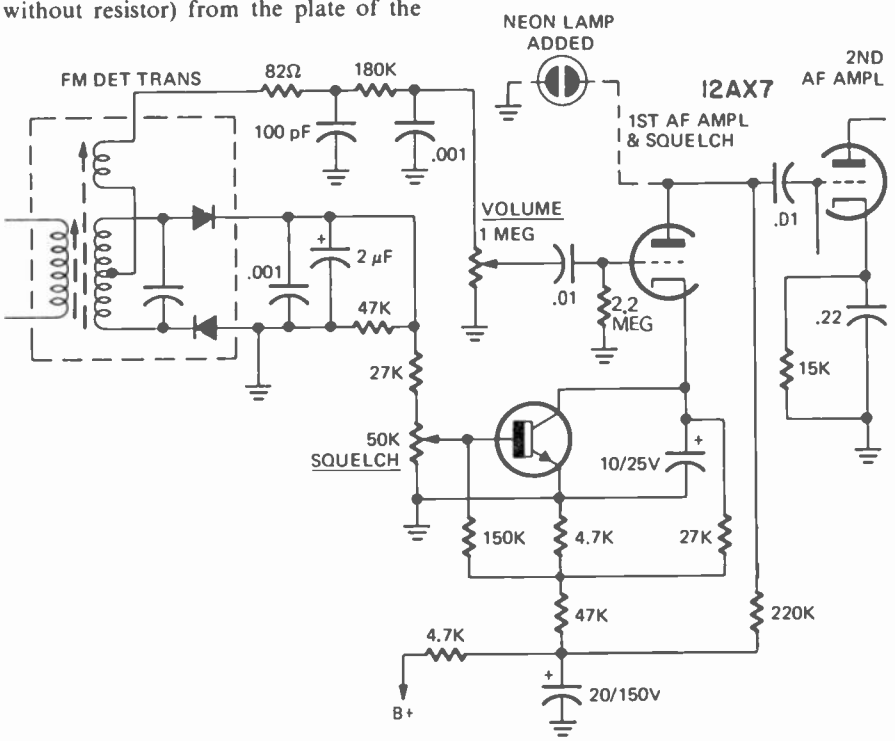
technotes

SQUELCH ON MONITOR RECEIVER

Squelch in the Knight-Kit 220 and 221-A vhf FM monitor receivers is obtained by increasing the bias to cutoff on the first audio input stage. This lets the interstage coupling capacitor (between the first and second af amplifiers) float at the B-plus level and may make hum in the squelched audio worse than the unsquelched background noise.

I solved this problem by connecting a small neon lamp (1/25 watt, without resistor) from the plate of the first af amplifier to ground. When the tube is biased to cutoff, the rising plate voltage fires the neon lamp, which then acts as a voltage regulator to prevent the voltage across the capacitor from soaring.

I had to replace the 12AX7 with a 12AT7—at a cost of a slight loss in gain—to bring the plate voltage down low enough on conduction to extinguish the lamp. Changes in plate load resistance and B-plus supply voltages in an effort to still use the 12AX7 gave inferior results.—*H. P. Neylon*



BLUE DROOP

Blue droop is the inability to converge horizontal blue lines at the edges. In Magnavox color chassis this condition can be corrected by optimumizing the value of R816 which is connected in series with the HORIZONTAL BLUE TILT control. In most chassis R816 will be a 10-ohm, 1-watt resistor. In some cases, however, the circuit tolerances are such that the optimum value of R816 for proper correction may be 22 or 33 ohms. If blue droop is noticed on any chassis, you may find that the best value of resistor R816 may be anywhere between 10 ohms and 33 ohms.—*Magnavox Service News Letter* **R-E**

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Solve problems, play games, predict weather, even play miniature chess, with this actual working model of giant electronic brains. Amazing new fun way to learn all about computer programming . . . logic, decimal, binary systems, Laws of Sets. Even do your own programming after completing the simplified, 116-page instruction booklet. Circuits are easily changed, readout is from an illuminated control panel. Requires 2 "D" batteries (not incl.)

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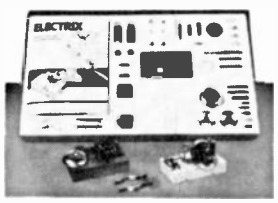

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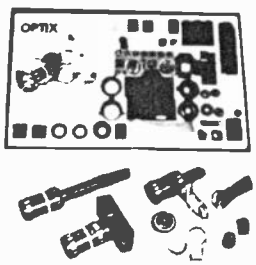

and photography! Optix® Experiments Kit is a complete optical & photography lab for 130 exciting experiments. Lets you recreate the periscope, telescope, microscope, kaleidoscope! . . . Build a 35mm reflex camera with interchangeable lens system! Make, develop photographic film! Enjoy the fun and fascination of having your own optics lab. Fully illustrated 112-pg. manual, 8½"x11", clearly explains usage of this stimulating kit's 114 precision engineered components.

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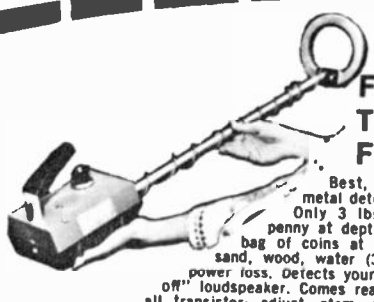

Best, easiest to use solid state metal detector at its price. U. S. made! Only 3 lbs. 6" search head detects penny at depth of 5", silver dollar at 8", bag of coins at 18". Easily works thru dirt, sand, wood, water (30" deep) and rock with no power loss. Detects your "find" sharply with "sound-off" loudspeaker. Comes ready to go. One tuner control; all transistor; adjust. stem; perfect balance. Includes 9v battery, FREE TREASURE GUIDE To 101 Treasure Sites.

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SOUTHWEST TECHNICAL PRODUCTS CORPORATION

219 W. RHAPSODY
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PHONE: 512 DI 4-3140

May 1973

Dear Radio-Electronics Reader,

As promised last month, I am going to let you in on some of our secrets, and explain some of the neat features that you will find in our kits. This month I am going to talk about color organs. In case you don't know it Southwest Technical makes two of the most sophisticated color organs available anywhere. Color organs have gotten a bad name with many people due to the "Mickey Mouse" things that have been sold for color organs. I have seen so called color organs that consisted of a lamp, an SCR and a capacitor.

Southwest Technical Products has two color organs. Both have four channels and both will handle up to 800 Watt loads on each channel. The most unique of the Two is our Psychedelia II, the world's only digital color organ. This circuit actually measures the frequency of the music input to the color organ and then displays the result as a particular color of light. The rate at which measurements are taken is adjustable, so you can have slow changes from one color to another, or you can set it fast enough to get a strobe effect from the lamps. Since the color organ will never sync with the music exactly at the same point from one time to the next the display will be different each time even with the same music. This type color organ does not follow the music in quite the obvious way that the more common filter types do. The display seems more random due to the sampling process used. Input level may be anything from 50 Mw to 50 Watts with no effect on the circuit's operation. The input is transformer isolated so that the Psychedelia II may be safely driven from any speaker terminals. Watching this one go is a real trip. If you are a rock fan, you will probably really dig this kit.

For those who are more at home with Lawrence Welk than the Grand Funk, we have our Psychedelia III. This is a classical filter type color organ circuit that splits the incoming music into four frequency bands and then varies the intensity of the lamps in each channel in proportion to the level of the sound in that channel. Filtering is done with operational amplifier active filter systems. The input system has a compressor amplifier that allows a 40 dB variation in music input level before the color organ display is affected. No jumping up and down to adjust the color organ every time the record changes with this circuit. The lamps are controlled by our exclusive ramp integrator system. This power control system is able to change the power level up to sixty times a second. Thus you never get a lag in color organ response with Psychedelia III. The display lamps themselves are the only things that limit the reaction time of this system. Transformer isolated input for safety.

Both kits are built on 8¼ x 5½ fibreglass circuit boards. As in all of our kits the components are first class new material. You can have either in kit form for $44.95, or assembled and tested for $60.00. Your Bankamericard or Master Charge is welcome—just send number and expiration date. If you did not understand half of what you read about our color organs, please buy the assembled unit. Our kits are not designed for beginners. Your gray headed old mother could not put one together. If you don't understand schematics, read color codes and know how to solder please save us both lots of hassle and don't buy a kit from us.

If you would like a copy of our FREE new 1973 catalog listing these and many other unique and interesting kit projects, call, write, or circle our number on the bingo card in the back of the magazine. I will get one to you immediately. See you next month.

Daniel Meyer

SOUTHWEST TECHNICAL PRODUCTS CORPORATION
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Announcing the RCA MINI-STATE Antenna System

The profitable new achievement in antenna technology.

The Mini-State is brand new from RCA. It's the first true miniaturized rotating antenna system on the market. *It works . . . and works well!*

This system is specifically made for your metropolitan and suburban customers who want the quality reception of an outdoor-type antenna, in a beautifully compact unit suitable for homes and apartments.

Measuring just 21" across and 7" high, the Mini-State is completely enclosed in an attractive sturdy plastic case that's weatherproof and resistant to dust and dirt. It weighs just 6 pounds and can be mounted almost anywhere: rooftop, chimney, window, attic and closet.

The RCA Mini-State's uni-directional pattern, VHF slotted ring and multi-element UHF design, combined with its completely integrated solid state circuitry, provides excellent reception on all channels, and helps avoid interference and ghosts.

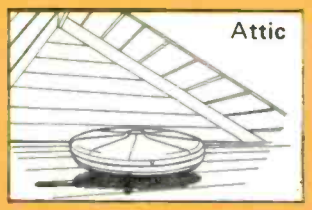
Mini-State model 5MS440, with built-in rotator, allows your customers to zero-in for best reception on any channel. Exclusive direction indicator light on the hand held control unit tells them where the antenna is aimed.

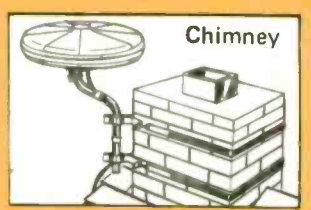
The RCA Mini-State rotating antenna system includes: The antenna with built-in amplifier. Built-in rotator and hand held remote control unit. A 120 volt AC power supply. A VHF-UHF antenna matching transformer. An outdoor mast clamp. Legs which can be snapped into place for indoor use.

Although regular coaxial and rotator cable may be used, a unique combined coaxial and rotator cable is available in prefabricated lengths for quick, easy installation. (A fixed non-rotating model 5MS330 is also available.)

Yes, this new RCA Mini-State antenna system can mean maxi-profits for you. See your RCA Parts and Accessories distributor today, or contact RCA Parts and Accessories, P.O. Box 100, Deptford, N.J. 08096. Make sure you're in on the ground floor of this profitable new era in TV antenna systems.

RCA





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