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Radio-Electronics

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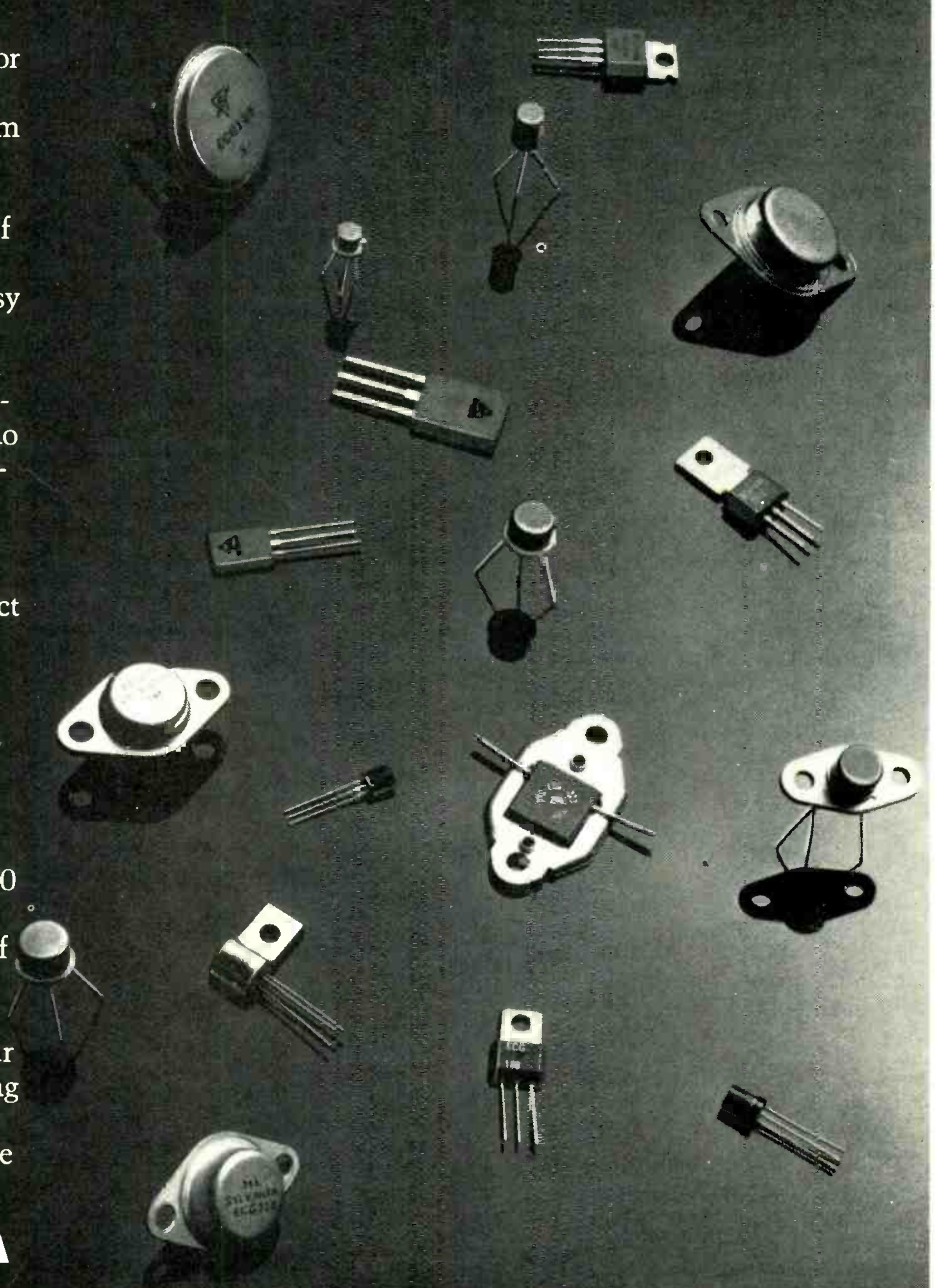

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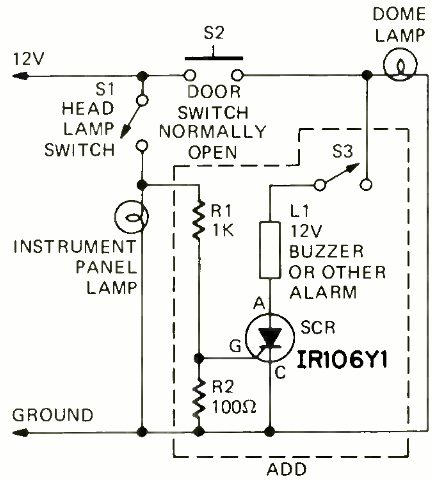
THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

More than 65 years of electronics publishing

VOLUME 45 NO. 7 JULY 1974



AN AUTOMOBILE HEADLIGHTS-ON REMINDER you can build as you study and become familiar with SCR's and their operation.
. . . see page 42

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looking ahead

Quick vs. instant

The race is on to find a substitute to instant-on, that casualty of the energy shortage which used to waste our valuable watts feeding current to tube filaments while the TV set was off. American picture tube makers are searching for a new-design cathode which heats up rapidly. Philips of Holland is already manufacturing tubes with a cathode which provides four-second warmup, and Matsushita of Japan is adopting the same principle. And Sony has put a quick-warmup cathode in its 13-inch Trinitron, for sale in Japan only for the time being. American manufacturers, meanwhile, are studying the situation, trying to make sure that quick-on doesn't mean short-life for the picture tube.

Super-8 TV

Like to show your home movies on the ol' 25-incher? Kodak's Super-8 video-player is now on the market. It's designed to accommodate cartridged tapes of the amateur variety and uses a flying-spot scanner to develop a color TV signal. The compact player is attached to the antenna terminals of a television receiver. The player sells for $1,095—and lest you think that's rather high, it's actually $100 less than the originally announced price. Although home-movies buffs presumably are welcome as purchasers, Kodak initially is aiming the videoplayer at professional users, such as schools, broadcasters and cable TV systems. •

Solid-state TV

The days of hybrid color TV seem to be numbered—thanks to the energy crisis and the FCC. RCA moved up its schedule for changeover to all-solid-state color sets by a full year and will stop producing hybrids at the end of June, accompanied by a drumbeat of publicity. It appears that other manufacturers won't be far behind. RCA hybrids are still on the market, of course, but they were made before the cut-off date. And they're not identified as 1975 models.

Several other manufacturers have quietly stopped producing tube-type color sets, too. But they've produced enough to last well into the 1975 model-year, so they're just not saying much about it and labeling their recently produced hybrids as 1975 models. That's perfectly fair, of course, since the hybrids have gone through the customary face-lifting required to indentify them as new models.

You can expect solid-state advertising for the rest of the year to feature energy-savings claims. They're perfectly true, of course—a solid-state 25-inch color set uses less power than a tube-type black-and-white. There's another convincer which decided some manufacturers to switch to solid-state. That's the FCC rule which requires "comparable" uhf tuning in all sets manufactured on or after July 1. Comparable tuning means detent or preset uhf, making uhf as simple to tune as vhf. Since most hybrid set designs contain continuous uhf tuners, some manufacturers have decided that July will be the perfect time for the changeover. Rather than retool for new hybrid models with the currently required tuners, they've decided to go with the wave of the future and build only solid-state sets.

You'll continue to see plenty of hybrids and continuous-uhf-tuning sets in the marketplace for some time. Manufacturers have been stockpiling so they won't be caught without low-priced sets to sell during the intensely competitive fall season. But finally tube-type sets seem to be in the last-gasp stage. •

Videoplayer census

There were 118,500 cartridge and cassette videoplayers and recorders in use in the United States as of Jan. 1, 1974, according to Creative Strategies, Inc., a research organization, which forecasts the number of units in use will double this year. Of the 118,500 units, 68,700 are record-and-play devices and 49,800 are designed for playback only. More than half of the machines —65,000—are the Sony U-Matic helical-scan ¾-inch VTR type. The second most popular type is the Philips half-inch helical-scan, with 27,500 in use. •

Long, long scan

The first developmental videotape recorders, beginning in 1951, were essentially speeded-up audio recorders, using fixed heads and high tape speeds. With development of quadrature (four-head) recorders for broadcast use and helical-scan machines for industrial and educational use, the simple longitudinal-scan technique was forgotten—but not quite.

Thanks to new tape transport and signal-processing developments, fixed-head, longitudinal-scan recorders now are being groomed for the home VTR sweepstakes. Their appeal is relative simplicity and low price, since they eliminate complicated and costly revolving headwheels and associated components. Longitudinal recorders are being developed by several West Coast firms, with the first demonstrations planned for this summer. A typical such unit has a tape speed of 180 ips, with 28 tracks on a quarter-inch tape. The tape whizzes past the head, changes direction and the head is automatically indexed to the next track. One of the problems of longitudinal VTR's in the past has been the picture blackout during the period the tape is reversing direction. Fast turnaround and storage techniques are now said to eliminate this blackout completely.

Whether the new sophisticated electronics and mechanics introduced to overcome the shortcomings of longitudinal scan will push prices up to the helical-scan level hasn't yet been determined. But you can expect to hear more about this new version of an old technique in the near future. •

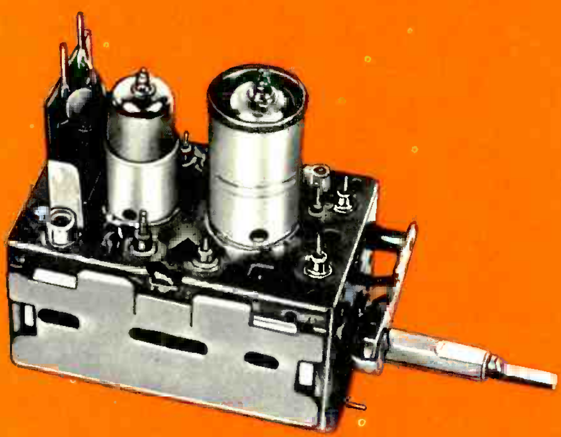
Adding up calculators

The electronic calculator became a billion-dollar market at retail last year, according to a study by Creative Strategies. The biggest share of the market was held by consumer calculators, of which 7 million were sold. Some 3.5-million of last year's unit sales were business calculators, and another 300,000 were in the "professional" category. The study indicated that the market for consumer calculators would grow about 50% this year, in terms of dollar volume, more in terms of units, due to declining prices. Component costs for calculators have dropped sharply, LC chips falling from an average of $30 in 1970 to about $5 currently. LED displays, which cost calculator manufacturers slightly less than one dollar per digit, will be closer to 50 cents before the year is over. •

RCA's home VTR

RCA, meanwhile, has embarked on a "market test" of its ¾-inch cartridge VTR to determine whether it has potential as a consumer product. In the initial phase, demonstrations are being conducted by television retailers. Observers at the demonstrations are asked to fill out a questionnaire designed to determine their interest in purchasing the device. The second phase of the test, starting this summer, will involve loans of VTR's and monochrome cameras to about 200 selected consumers, who will be asked to treat the instruments as if they owned them. RCA hopes to gather data on the suitability of the machine under actual home use, and the reaction of potential owners. R-E

by David Lachenbruch
Contributing Editor



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20th anniversary of color TV marks end of tube regime

RCA celebrated the 20th year of color TV on March 25, 1974 with an announcement that it was abandoning tubes altogether in its new 1974 line of TV receivers. With the obvious exception of the kinescope, the RCA XL-100 color TV line is completely solid-state.

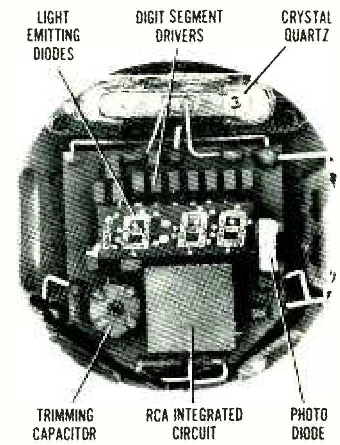
YOU'VE COME A LONG WAY, KINE! Gail Simione compares the RCA 15 V in-line color TV tube system with the round 15-inch color tube system that many technicians will remember from the first sets sold in 1954. The new tube is smaller, brighter and sharper and eliminates complex circuitry and difficult adjustments.

First reaching the market in 1954, color TV had no easy row to hoe. Only 5,000 sets were sold in that first year and it was 1960 before a half million color sets were in use. But 1960 was the turning point. Increased color programming and greater availability of color TV on the retail market combined to more than triple the number—to 1.7 million sets—in 1963. Now there are 52.6 million sets in use—9.3 million were sold in 1973 alone—and two out of every three homes in the United States has a color TV.

Integrated circuitry makes electronic watches practical

The sharp upsurge in the demand for electronic watches—due in no small part to the new digital types—can be traced to the new COS/MOS integrated circuits, which make the digital readouts practical, according to Harry Weisberg of RCA's Solid-State Division. "These circuits," he says, "are so perfect for watches that it would almost seem that their original designers had watches in mind."

The heart of the new watches—like some of the older ones—is a quartz crystal. Oscillating at 32 kHz, it is divided down to 1 Hz by a series of binary dividers, then further divided for the minutes and the hours by counters and drivers that activate light-emitting diodes (LED's) or segments of liquid crystal numerals to display the correct time—with an accuracy 10 times greater than that of mechanical or electromechanical timepieces.



THE "WORKS" OF A DIGITAL WATCH, seen with the faceplate removed. The batteries are behind the "circuit board." The photo diode increases or decreases the display's brightness according to the amount of ambient light.

The integrated circuit that does the work contains more than 1300 transistors on a match-head size silicon substrate.

Electronic revolution limiter tells motorist when to shift

A new aid to the sports car enthusiast—an electronic revolution limiter—is now available. The motorist—says Siemens, who introduced the device—is likely to overlook the fact that his motor is speeding up to the point of possible engine damage, especially when all his attention is being engaged by traffic conditions. The new device reminds him to shift up when the engine reaches its preset revolution limit.

The limiter is a measuring amplifier with a gate function. Squarewave pulses from the rev meter are rectified and filtered and the resultant dc voltage compared in an operational amplifier with a fixed voltage across a dividing network. When the voltages are equal, the transistor ignition system is turned off, then turned on again when engine speed drops below the limit and the voltage from the revolution counter drops accordingly. This causes a slight vibration that warns the driver to shift.

For a given engine, the system was set to cut the ignition out at 6600 and to cut it in again at 6500 rpm. By keeping the difference between the cut-out and cut-in points down to 100 rpm, the resulting engine vibration is small, but nevertheless discernible.

Earlier mechanical limiters have not functioned precisely enough, in certain extreme operational conditions, to prevent engine damage through late cut-out or loss of performance because of cutting out before the engine reached ideal top speed. The electronic nature of the new rev limiter makes it possible to maintain the 100-rpm separation of switch-out and switch-in precisely.

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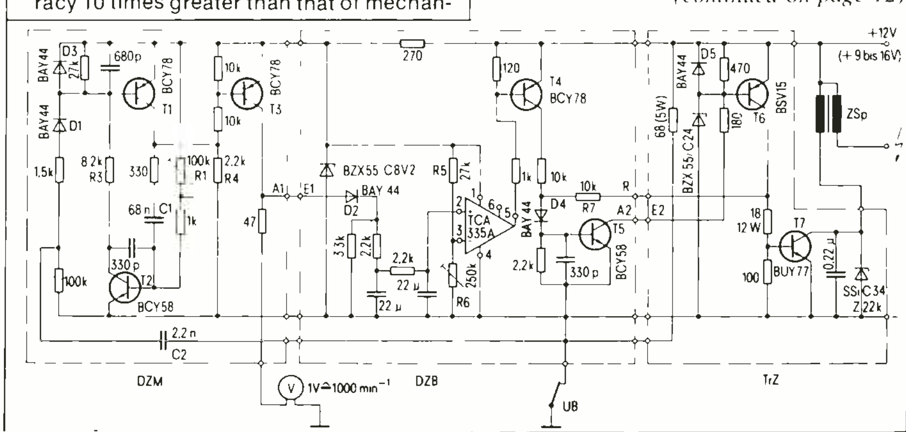

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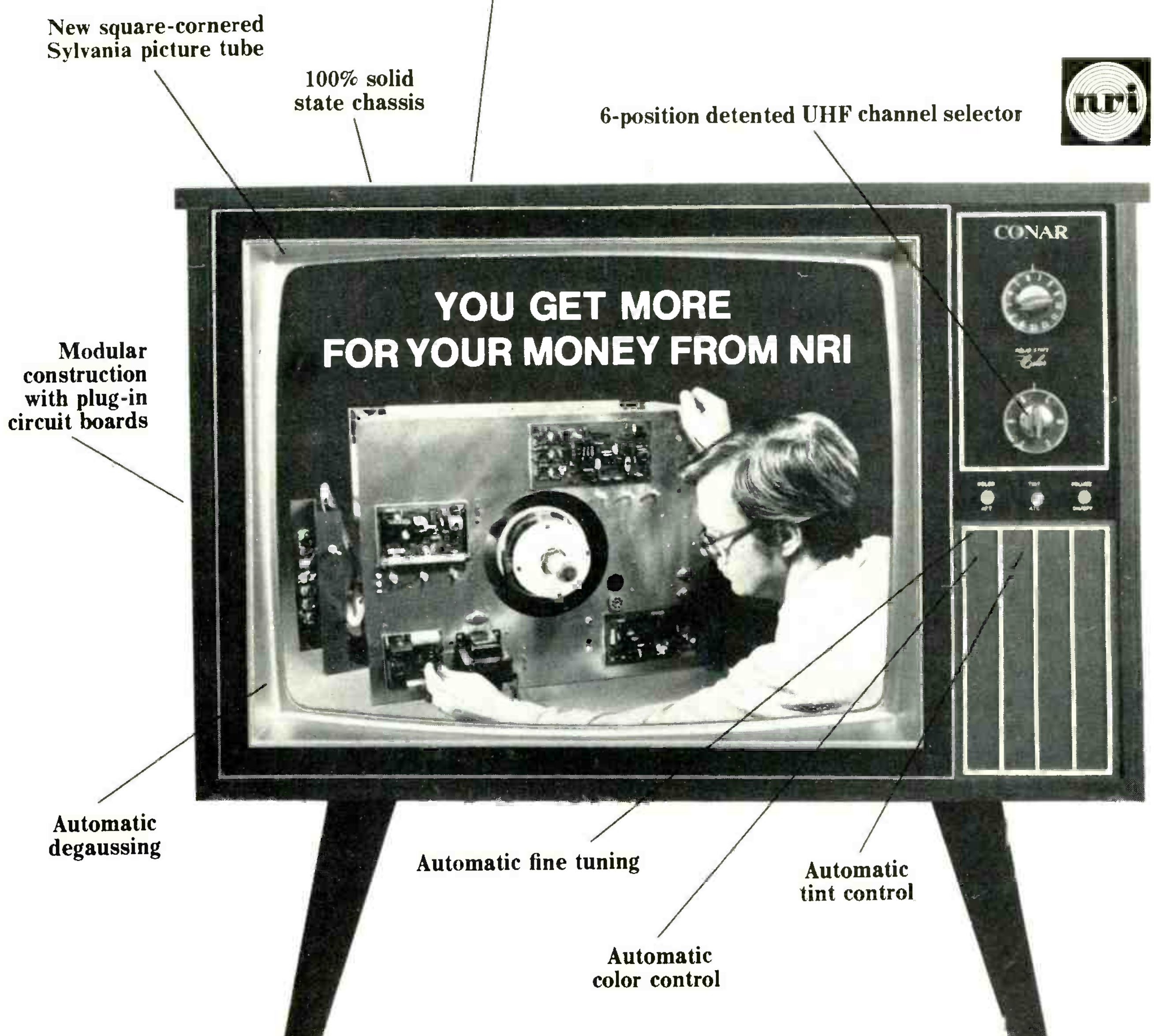

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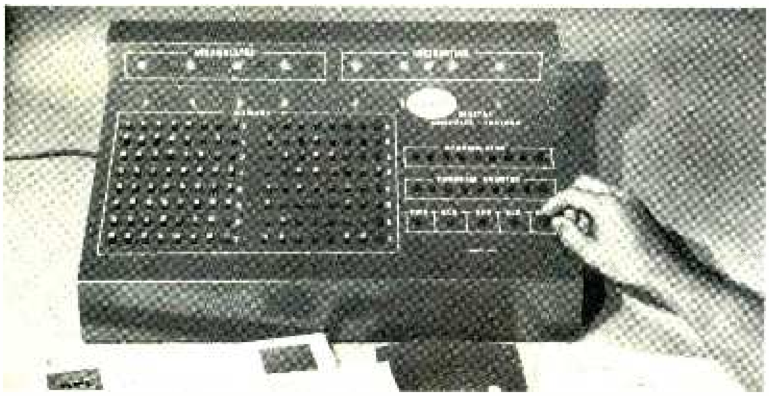

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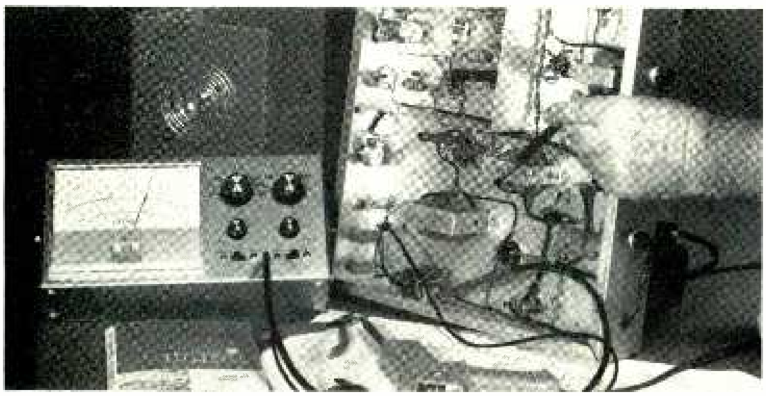

FIRST to give you true-to-life experiences as a Communications Technician. Every fascinating step you take in NRI Communications training, including circuit analysis of your own 15-watt, phone/cw transmitter, is engineered to help you prove theory and later apply it on the job. Studio equipment operation and trouble shooting become a matter of easily remembered logic.

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The NRI color TV and digital computer kits are the latest in a long line of "firsts" for NRI. For more than fifty years, NRI has been providing unique 3-dimensional home-study training that has helped hundreds of thousands of students reach their goals quickly and easily.

What NRI provides is a combination of kits and bite-size texts that give you hands-on experience while you are learning. The texts average only 40 pages each, and they are fully illustrated. You are taken step-by-step from the first stages into the more advanced theory and techniques . . . with an expert instructor ready at all times to provide valuable guidance and personal attention. (The level of personal attention provided is more than you would receive in many classrooms.) Once you've grasped the fundamentals, you move with confidence and enthusiasm into new discoveries in the fascinating world of electronics.

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 (continued from page 6)

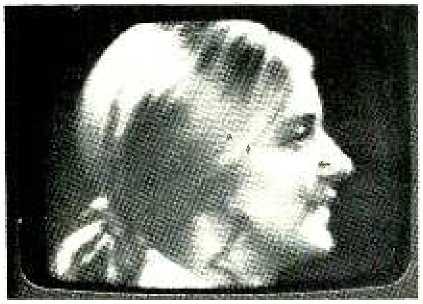
Compact solid-state TV camera can work by candle light

The world's most sensitive TV camera—capable of taking pictures by the glow of a candle—weighs less than a pound and is more compact than most photographic hand cameras.

Developed at the General Electric Research and Development Center (Schenectady, N.Y.), it is expected to reach the market soon. At present the resolution (see photo) is not as great as in commercial television cameras, but it is hoped that future models may approach and possibly equal broadcast quality.

Secret of the new camera is the charge-injection solid-state imager which takes the place of the conventional camera tube. The imager—a quarter-inch square metal-oxide semiconductor chip covered with 10,000 pairs of miniature capacitors—does the same job as the camera tube in large television cameras, converting a visual image into a video signal.

WORLD'S MOST SENSITIVE TV CAMERA (above) is compared in size with a set of keys. The resolution is shown in the picture below.



Each of the pairs of capacitors on the chip is a light-sensing device, collecting a charge proportional to the light striking it. Scanning circuits then release the charges on each pair of capacitors, "injecting" them into the base of the chip. The imager can be scanned at speeds compatible with ordinary television sets.

Unlike earlier devices, which used charge-coupled imagers, the signal is not passed from element to element down the scanning line. So if a pair of capacitors should fail, the result is only a minute dark spot on the screen instead of the darkening of possibly a whole line.

"Since this miniature camera can be fabricated with current solid-state manufacturing techniques," states Arthur M. Bueche, GE vice president for research and development, "it can potentially be made for a fraction of the cost of a conventional television camera." Immediate applications, according to Dr. Bueche, include surveillance, as on military bases and other high-security installations, banks, museums and businesses. As the camera is improved, the field of applications will become wider and it might be combined with a small video tape recorder and a home television set to produce instant replay home movies.

Mobile telephone scramblers cut down profits of crime

Much of the value of a police radio system is lost if criminals can eavesdrop on it. Burglars, narcotics dealers, car thieves and others find it worth their while to invest in the relatively simple and inexpensive equipment needed to follow the police radio. Plain-language transmissions become little more than broadcast programs; attempts at secrecy by using word and number codes are almost useless—even the police buffs understand them.

A new 7-pound mobile phone Scrambler does "foil the villains." Mounted in the trunk of a police car, with a mode selector on the dash, it makes the radio messages a hash of meaningless gabble except to a receiver set to the same code. And unauthorized unscrambling is made more difficult by the fact that there are more than 200,000 possible codes.

Boeing Electronics, manufacturer of the Scrambler, reports that they are in use by the police departments of Tallahassee and Jacksonville, in Fla.; in Abilene, Tex. and Grand Rapids, Mich. as well as over the whole island of Jamaica. One of the police departments reports that a 22% decrease in burglaries can largely be credited to the use of Scramblers.

Computer-aided stimulation brings light to blind

A wave of articles in newspapers and magazines recently told of experiments in which two blind persons were able to see spots and patterns of light. Readers of this magazine, who have been following the results of such experimental work since 1958, may have been puzzled as to what was new in the work described. It did, however, represent significant advances as well as wider study of fields previously partly explored.

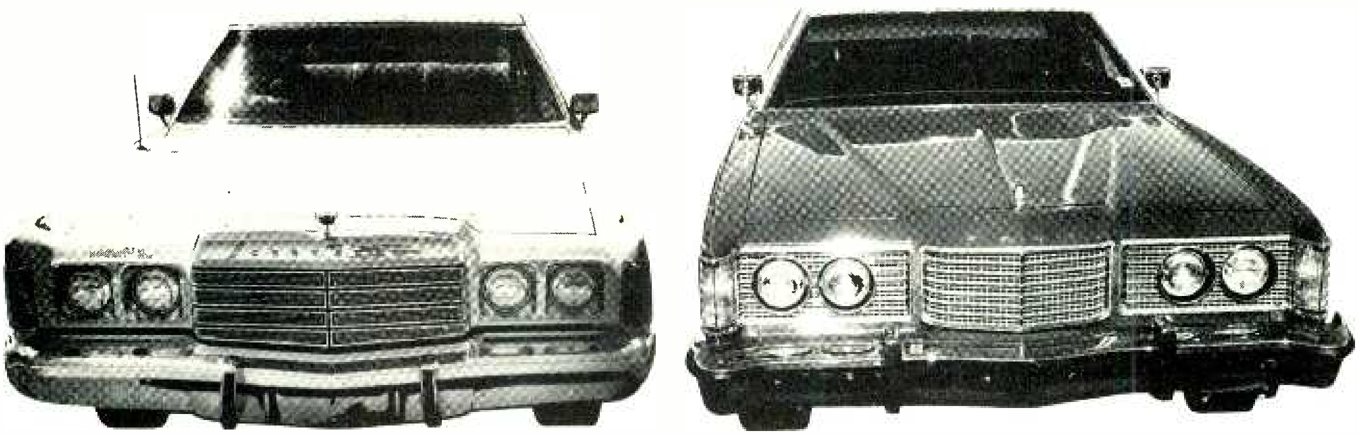
The approach of the researchers, W. H. Dobelle and M. G. Mladejovsky of the University of Utah and J. P. Girvin of the University of Western Ontario, was to place a matrix somewhat similar to the mosaic of a TV camera against the portion of the subject's brain that responds to light stimuli. This array, of 64 platinum disc electrodes 1 square millimeter each in diameter, arranged in 8 rows of 8 discs, was similar to that used by Brindley and others in England. A small window was made surgically in the skull to insert the electrodes. In was then closed in such a way that the matrix could be removed without reopening the incision.

The new technique was the use of

(continued on page 14)

BOEING SCRAMBLER II EQUIPMENT. At left is the mode selector, normally mounted on the dashboard; behind it the code processor, with the lid raised to show its 18 code-setting switches. At right is a Scrambler base station.

Fresh from the Factory. Yet These Cars Should Be Recalled.



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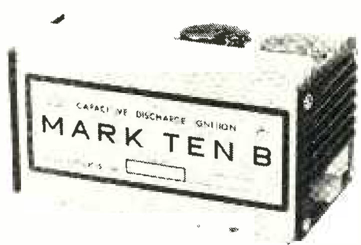

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new & timely

(continued from page 12)

electronics—a 64-channel stimulator controlled by a computer. It was in turn controlled by an electronic graphics system, so that figures drawn by a light pen on the system's screen could stimulate electrodes that would present the same pattern to the subject's brain.

Although crude figures had been presented to the brain with earlier apparatus, this refined system made it possible to transmit recognizable simple patterns and letters to the subjects.

Partly as a result of developing these new computer-aided techniques, the researchers were able to carry out further studies on previously unresolved problems of differences in response to stimuli between totally and partially blind persons, and between those who were recently deprived of sight and those who had been blind for many years.

Technician licensing for NY State?

An act to institute licensing for all television, appliance or home entertainment equipment service technicians has been introduced in the New York State Legislature, given two readings and sent to the Committee on Agriculture and Consumer Protection.

Under the terms of the bill, a temporary license would be granted to all persons who have been engaged in the given type of repair work for the last three months, or who have been engaged in this work for at least one year during the three years immediately prior to January 1, 1975. The license will be good for six months, at the end of which period the technician must pass an exam. New applicants must show evidence of successful completion of a course in an approved television, appliance, or home entertainment repair school. Licensees must be 17 years of age or older.

Proposed fees are $25 for a technician's license, $50 for a shop license, renewable annually for the same fee. In addition, there is an initial $10 fee for the application and examination.

Provision is made for an Advisory Committee of 14. Six of the members would "have had actual experience in the practice of servicing or repairing" the equipment enumerated in the bill "for not less than the past ten years" Three members could be from the management of electronic repair facilities, three from the management of appliance repair, and two "shall not, at the time of appointment, be directly or indirectly identified" with the business of electronic equipment or appliance repair (apparently representatives of the public).

The bill, if enacted into law, will take effect January 1, 1975.

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letters

TEMPORARY SUBSTITUTE TUNER CONSUMER OPERATION

It appears that there are instances of the Castle TV Tuner "Subber" (as well as home-made imitations) being left connected to the consumer's TV receiver for use as a temporary replacement when the original tuner is removed and taken away for service. This is understandable, the "Subber" is an ingenious idea for signal circuit servicing and the receiver performance is frequently better with the "Subber" than with the original tuner; this conveniently leads to the well intentioned temptation to give the customer uninterrupted service from the receiver by "loaning" the "Subber" to him.

This is a questionable practice . . . and could prove to be a very expensive mistake!

A little investigation will reveal that any major changes in the operating controls, or construction, of the TV receiver, from the design which received U.L. approval, may well modify such approval. It follows that some of the product hazard liability, which the manufacturer sought to diminish by U.L. approval, may then be transferred to the technician or service dealer responsible for the changes. Using a substitute tuner, with *any* wiring brought out of the receiver to connect the tuner, certainly constitutes a major change . . . and in many cases could be a serious hazard!

For this reason, all "Subbers" have carried a warning label discouraging such "consumer" use.

Possibly there are many service technicians who are unaware of the risks and legal responsibilities which they could face as a result of such practice and a warning against this practice is probably appropriate . . . and timely. Particularly timely in face of today's "consumerism" and the increasing public awareness of "product hazards."

CEDRIC WESTERN
Castle TV Tuner Service, Inc.
Chicago, Ill.

TV TYPEWRITER QUESTIONS

In this letter, you will find the answer to your question. Please excuse us for the need to answer you with a form letter, but it is the only practical way to handle the current volume of mail.

1. Where do I get Signetics IC's? Answer — from Signetics (long back order).

2. Please send modem plans. Answer — not yet available. Probable IC's used will be 2536 UART from Signetics, and Exar 2240 and Exar 210.

3. How do I mount the connector pins? Answer — you remove the plastic block, and suitably shorten the pins. The plastic block is used only for spacing on the male connector.

Some new keyboards are available from Dan Mayer at Southwest Technical Products. Price with encoder is $39.95.

DON LANCASTER

I'M FOR MEN!

Your (not so) subtle change in the masthead of **Radio-Electronics** has not gone unnoticed. The magazine to which I subscribed "FOR MEN WITH IDEAS IN ELECTRONICS" has apparently gone the way of all flesh. It, too, has decided to abandon all of its integrity and join the massive "Sea of Capitulation" in which the rest of our society is immersed.

Perhaps there is some significance in my observation that the very month after

Circle 8 on reader service card

your masthead change, you featured an article aptly titled *"Here Comes the FEM-To-What."* I hope that the mailing list that you got from *MS* magazine was worth the effort.

Old magazines, like old soldiers, never die—they just fade away. So let it be with my subscription.

With fond memories,
JOSEF SCHOENBRUN
Santa Monica, Calif.

Reader Shoenbrun's letter was dated April 1.

We've taken it in the spirit of that day. In case he was serious, hail and farewell ex-reader Shoenbrun! For the record let it be said that the change on the masthead from "For Men With Ideas In Electronics" to "The Magazine For New Ideas In Electronics" was made because we believe that the slogan should tell what the magazine's content is rather than what we hope it's readers are—Editor

SIMPLIFIED CLOCK CIRCUIT

In the September 1973 issue, a simple digital clock circuit was shown (p.66) by Mr. Glover. This circuit can further be simplified. Mr. Glover did not use a 7490 IC in the hours-counting section because of the particular reset function (count 1-12, reset to 1) desired.

A 7490 may be used, but instead of externally connecting it in the normal BCD fashion, the two sections (count-by-2, count-by-5) are used separately. A separate 7473 drives the "A" input of the 7447, while the onboard count-by-2 section of the 7490 drives the tens of hours display.

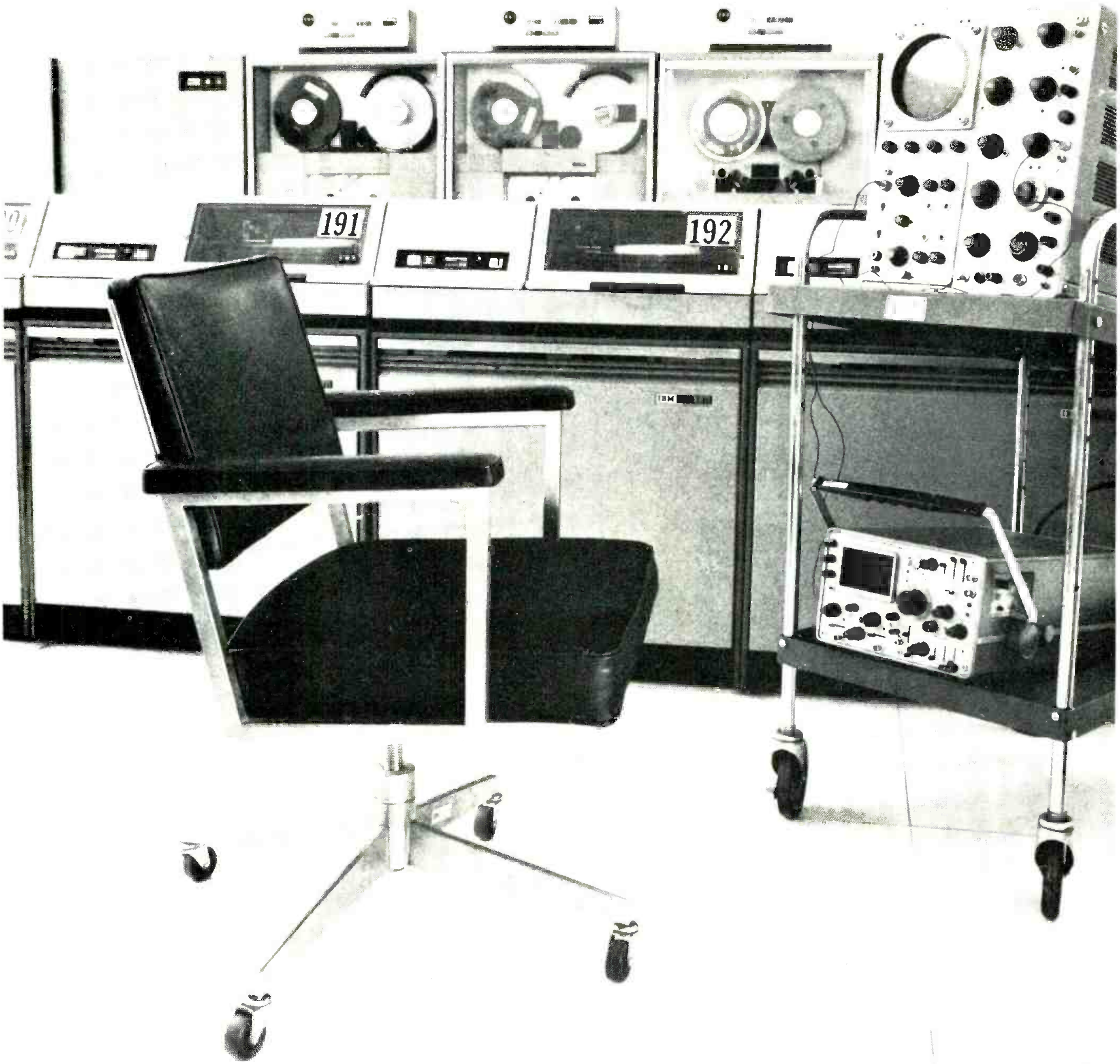
The advantage of this method is evident upon examination of the reset characteristics. A single 2-input AND gate is required to complete the reset function, and this can simply be substituted for by two diodes. The transistor is any bargain-pack, general-purpose device. The second half of the 7473 may optionally be used for an AM-PM indicator (clocked from "A"-out of the 7490).
DANIEL GOODELL
Concord, Calif.

I LIKE ELECTRONIC MUSIC

I'd like to take the time to compliment you on the recent various articles on electronic music synthesizers, especially the six consecutive articles explaining various how and whys of the PAIA synthesizer (May through October 1973). It was an ideal series for the amateur electronic musicians, as well as the technogist! I hope to see more articles on the developments of new synthesizer concepts as you are doing a fine job of keeping on top of them.

I am a year from graduating with my Bachelors degree in Electronic Engineering from DeVry Tech., and am planning to design and build an synthesizer for my seminar project! Your articles are the greatest source of references and ideas.
MICHAEL L. MURRAY
Chicago, Ill.

DON'T MISS IT!
An experimental see-in-the-dark infrared viewing system for lots of exciting experiments. You can build it for $35.



This important job (and its big income) **is reserved for a qualified electronics technician. It can be you!**

It's a fact. There are *thousands* of jobs like this one available *right now* for skilled electronics technicians. What's more, these men are going to be in even *greater* demand in the years ahead. But how about you? Where do you fit into the picture? Your opportunity will never be greater . . . so act *now* to take advantage of it. The first step? Learn electronics fundamentals . . . develop a practical understanding of transistors, trouble-shooting techniques, pulse circuitry, micro-electronics, computers and many other exciting new developments in this growth field. Prepare yourself now for a job with a bright future . . . unlimited opportunity with lasting security . . . prestige and a steadily growing paycheck.

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equipment report

Technics (By Panasonic) SL-1200 Direct Drive Turntable

Circle 86 on reader service card

IN THIS AGE OF "AUTOMATIC EVERYthing" there are still hi-fi enthusiasts who prefer a fully manual turntable, the rational being that the fewer the number of moving parts the less likely the possibility of extraneous wow and flutter. A perfect example of the high level of performance to be found as the number of rotating components is reduced is to be found in the Technics SL-1200 turntable, which has but *one* moving part—the platter.

In fact, though Panasonic touts their Technics SL-1200 as a Direct-Drive Turntable it is a complete manual record player consisting of the direct-drive platter, high performance pickup arm, acoustic resistant mounting feet and integral dust cover. But since the direct-drive platter is the most important we'll cover that item first.

The drive motor is a dc servo type with the platter attached directly to the shaft. Electronic speed control determines and holds to precision tolerances the user selected 33 rpm or 45 rpm speed. Attached to the rotor is a control rotor, actually a toothed metal wheel. Positioned around the control rotor are three pairs of coils; one coil of each pair is driven from an oscillator of approximately 50 kHz. As the rotor turns it determines the degree of coupling between each pair of coils, hence, the amount of signal induced in each secondary coil. The output from the secondary coils is rectified and used to control three power transistors which feed current through the motor windings. Three speed control coils wound on the motor windings generate a three-phase ac voltage whose amplitude is directly proportional to the motor speed. This voltage is rectified and compared to a reference voltage determined by the selected 33 rpm or 45 rpm speed. If this comparison shows a difference between speed and reference voltages the current flow through the power transistors is automatically adjusted to compensate for the speed variation. Since corrections are made with electronic swiftness speed inaccuracies are corrected before they are heard.

By the same system of voltage comparison, fluctuations in the ac line voltage or mechanical loading of the platter are corrected before they are heard.

To compensate for the variations normal to consumer equipment, and to provide "pitch" control for those so inclined to modify a recording, two "trimmer" adjustments are provided on the top deck, one for each speed. The trimmer, or *pitch*, controls provide a nominal ±5% speed adjustment range. To insure precise speed-setting by the user, the 3.86-lb. platter has strobe markings on the outer rim for both speeds for 50 and 60-Hz line frequency. A built-in lamp illuminates the strobe.

The Technics SL-1200 is spec'd for a .03% wow and flutter. Our measurements indicated .04% the difference being well within expected instrument tolerances, and certainly an outstanding value. Rumble was absolutely inaudible. Speed regulation was constant over an applied line voltage range of 90 to 150 Vac (the limits of the test equipment). Of notable interest, the platter can be held with the hand, say for cueing purposes, with no possibility of damage either present or potential. When released, the platter comes up to speed almost instantly.

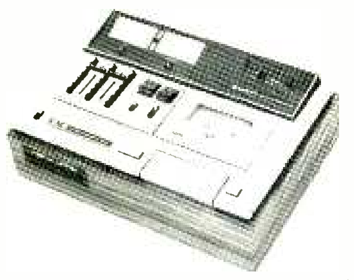
The pickup arm has an integral stylus force adjustment with a micrometer-type counterweight adjustment. Somewhat unusual, the stylus force adjustment has an automatic zero-reset when the arm is counterbalanced. It works this way: After the pickup is installed in the plug-in holder the stylus force adjustment is rotated until the pickup arm is balanced. Then the stylus force adjustment is pulled outwards, causing the indicator gauge to automatically reset to zero. Then the desired stylus force is simply dialed in. This feature is a particularly convenient for those using several pickups, say for mono, stereo and CD-4; it takes but a few seconds to balance and dial in the force for each pickup. The stylus force gauge is calibrated from 0 to 4 grams in ½ gram increments, and the stylus force can be set within ⅛ gram accuracy. A calibrated anti-skate adjustment is provided, as well as a viscous-damped cueing device (pickup arm lift). The connecting cables from the pickup are low capacitance, making the system instantly ready for CD-4 pickups.

The turntable and arm are mounted on a massive aluminum deck which sits on four acoustically resistant (sound absorbing) feet. The mounting feet have a moderate height adjustment which permit precise horizontal balance of the pickup arm.

The overall dimensions of the SL-1200 are 7 3/32" H x 16 9/32" W x 13 29/32" D. Weight, including the dust cover, is 22.1 lbs.

Admittedly, the overall size and price $279.95 of the SL-1200 is large, but the overall performance matches the size and price. When a real heavyweight in turntable performance is needed the Technics SL-1200 will certainly fill that need. **R-E**

JVC CD-1668 Cassette Deck Features New Noise Reduction System



Circle 87 on reader service card

WITH THE INTRODUCTION OF THE JVC *automatic Noise Reduction System*—termed ANRS—the audiophile now has available two anti-noise systems which do not degrade a tape recorder's overall frequency response. In many respects the ANRS is similar in basic operation to the Dolby, and as we'll show, both ANRS and Dolby tape recordings can be interchanged with a reasonable or acceptable degree of "matching."

As with the Dolby, the ANRS is a closed-loop system; all circuits between the input signal encoder and output signal decoder are included in the anti-noise processing—the tape, the playback preamplifier, and the playback line amplifiers up to the decoder. These circuits represent the inherent tape noise, the transistor noise from the amplifiers, and the bias noise (arising when electrical signals are converted to magnetic variations), all of which appear as a *background hiss*.

Also silimar to the Dolby, a single equalizer circuit functions for both encoding and decoding so that the overall record/play frequency response is optimally "flat." In the record mode, the input signal is passed through the high-frequency boost "equalizer" which is connected in parallel with a non-linear control element. The output of the equalizer is series connected to a gain compensator/control amplifier and then to the recording amplifier. When the gain compensator/control amplifier senses a high-level signal, it causes the control element to bypass the signal around the equalizer, delivering a "flat" input signal to the record amplifier. As the input signal level decreases, the control element increases the amount of signal passed through the equalizer; at 40 dB below the reference signal, level full high-frequency boost is applied to the input signal. The actual amount of boost is shown in Fig. 1. Note that at 0 dB, or reference record level, there is virtually no high-frequency boost. At -40 dB, there is 10-dB boost applied between 5 kHz and 20 kHz.

In the playback mode, the same high-frequency boost equalizer is still used, but the control element is now used in a negative, feedback amplifier so the system has a reverse characteristic to the recording system. The higher frequencies are now attenuated in the same proportion to the original signal level, as shown in Fig. 2. Since the equalizer cannot distinguish between program (signal) and noise, it attenuates both equally; as the program is restored to its original "flat" response, the noises generated within the ANRS system loop are attenuated some 10 dB between 5 kHz and 20 kHz at the lower program signal levels.

As shown in Figs. 1 and 2 the encoding and decoding are not exactly complementary as they are for the Dolby system, but the variations are so slight as to be meaningless (unheard) for program material. The big question, of course, is how interchangeable is the ANRS with Dolby? What happens when an ANRS decoder is used with a Dolby decoder and vice versa?

The first considerations are the equalization frequencies. Whereas the ANRS provides about 5 dB equalization at 1 kHz and 10 dB equalization at 10 kHz, the Dolby B (the model used in consumer equipment) has 5 dB equalization at about 800 Hz and 10 dB

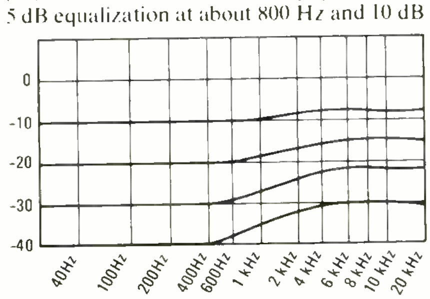


FIG. 1

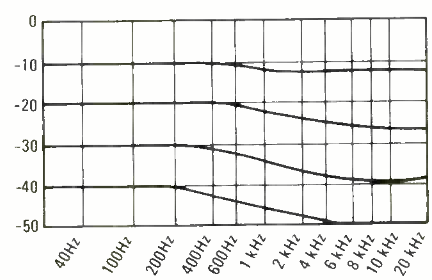


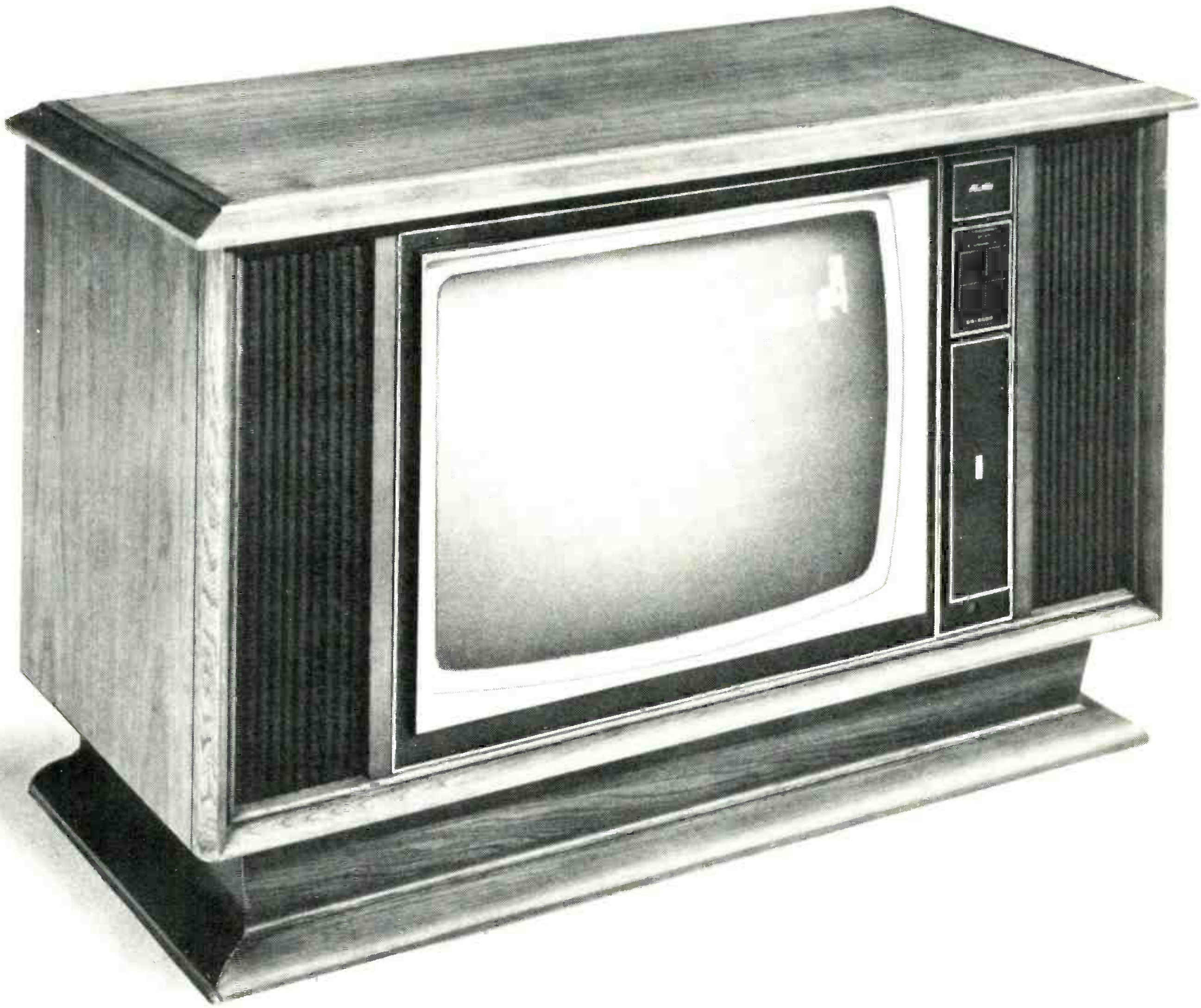
FIG. 2

equalization at about 3 kHz. Thus, Dolby provides the full 10 dB noise reduction 2 kHz below that of the ANRS. In terms of listening sound quality, though both systems deliver excellent noise reduction, the Dolby sounds slightly more quiet or "hiss free."

Because of the differences in equalization depth vs frequency, there are variations in frequency response when the systems are intermixed, such as a Dolby encoded tape with ANRS decoding. Figures 3 and 4 illustrate just what can happen. The sweep frequency is 20 to 20 kHz recorded 30 and 40 dB below the reference or 0-VU recording level, the primary "working range" of noise

(continued on page 26)

The editors' choice: Heathkit Digital Design Color TV!



EQUIPMENT REPORT
(continued from page 23)

suppressors. In following the illustrations, count the traces from the top (No. 1) at the *left side*. (The illustrations were prepared using *standard production models* of outstanding Dolby and ANRS equipments.)

In Fig. 3 the No. 1 (top) trace is −30 dB ANRS in and out. Trace No. 2 is −40 dB in and out. Note that the overall record-play frequency response is within ±3 dB from about 30 to 12kHz+. Trace No. 3 is −30 dB ANRS in and Dolby out. Trace No. 4 is −40 dB ANRS in and Dolby out. Note that at −30 dB ANRS in/Dolby out, there is a 5-dB dip slightly higher than 6 kHz which "flattens out" as the input level is reduced to −40 dB below 0-VU or reference level.

In Fig. 4, the No. 1 (top) trace is −30 dB Dolby in and out. Trace No. 2 is −40 dB Dolby in and out. Note that the overall record-play frequency response is within ±3 dB from 20 to 12 kHz+ (it's a different recorder). Trace No. 3 is −30 dB Dolby in and ANRS out. Trace No. 4 is −40 dB Dolby in and ANRS out. Note that there is now a 5-dB peak at 3.5 kHz at the −30-dB record level which flattens out as the record level is reduced to −40 dB.

While a treble boost (from the amplifier) could compensate for the intermix dip shown in Fig. 3 (similarly, treble cut for the peak in Fig. 4), the results would be, at best, barely acceptable to the hi-fi user; sort of like cutting the highs when playing a Dolbyized pre-recorded tape on a non-Dolby machine. Of course, how often are tape recordings intermixed; most users stick with tapes made on their own machines, and both noise reduction systems work well unto themselves.

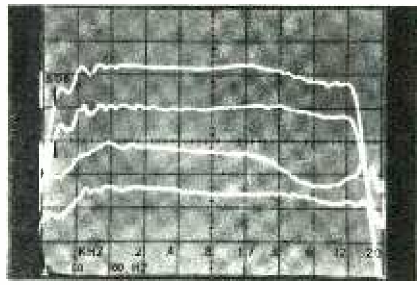


FIG. 3

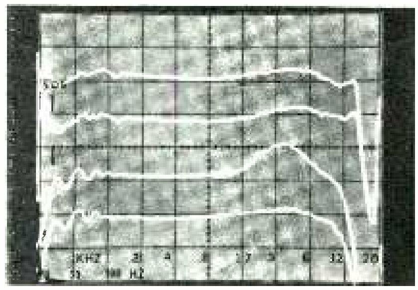


FIG. 4

The ANRS is incorporated in JVC's top-of-the-line model CD-1668, which features other unusual and to-become-important features. In addition to normal, low-noise, and chromium-dioxide bias selection, a memory reset counter that allows rewind to a user-determined location and a user removable head cover, the CD-1668 has professionally (studio) calibrated VU meters and an optical-controlled cassette eject.

With very few exceptions, cassette recorders use a 0-VU recording reference which is already at tape saturation; hence, since the meter movement cannot usually follow rapidly changing signal levels such as program peaks, the program peaks of the input signal are already well into tape saturation distortion. To avoid the peak program distortion problems, all professional recorders have their VU meters calibrated *at least* 6 dB below tape saturation—what is termed "headroom." In the CD-1668 cassette deck, JVC has not only provided 6-dB headroom, they have incorporated high-speed meter movements and a *peak signal* indicator lamp. As long as the meter shows the program is below 0-VU and the peak signal indicator is not flashing, the input signal is being recorded "undistorted." The value of this professional calibration is immediately apparent upon listening, for combined with the ANRS, the CD-1668 can turn out a tape copy of a record indistinguishable from the original.

The optical-eject is one of those ideas that takes time to appreciate. In the typical auto-eject system, a mechanical device is activated when the tape is stretched as it reaches the end of the reel. Though the tape has "run out", the applied capstan drive causes the tape to stretch, and an arm riding on the back of the tape senses the stretch; after a few seconds either the motor is stopped or the eject mechanism is activated.

The optical-eject avoids the tape stretch by using a shutter-generated signal to control an eject solenoid. The reset counter is
(continued on page 86)

Better electronic service data is aim of ISCET study

According to the International Society of Certified Electronic Technicians (ISCET) Serviceability chairman Dean R. Mock, three ingredients are necessary to the efficient repair and service of electronic products:

1. A product designed to be serviceable.
2. Availability of proper service parts.
3. Proper Service Data

NESDA, the parent association of ISCET, has been carrying on in-plant serviceability inspections, has made recommendations on and given awards for serviceability. The availability of components has been the subject of constant dialogue between organized service technicians and manufacturers. The service data phase was started early last Spring, when a group of six independent service technicians met with G.E.'s supervisor of training and publications in a day-long critique of G.E. service data.

Out of that conference and further studies have come seven criteria for evaluating service data:

1. Indexing and filing systems. A product may be identified by model number, chassis number, or even the retail sales designation. (A customer may ask for a knob for a Nadir "Netherwood" TV, a receiver may come in with only a chassis number, or data may be required for a particular model.) In all these cases, service data needs to be indexed and fileable so that the set can be quickly matched to the correct data.

2. Accuracy. The Technician is well aware of the trouble an inaccurate voltage or waveform, or a wrong component value, can cause.

3. Completeness. Essential if the job is to be done efficiently and quickly. Missing voltages and waveforms slow down the work, and may affect the quality of the finished job.

4. Readability. Lost time, errors and frustration result from microscopic print and poor printing, not to mention ambiguously or distantly placed component identifications and puzzling schematic layout.

5. Updating. This is a serious problem. One manufacturer has put out schematics for early production and another set for late production models. The hitch is that the technician may not have any way of knowing which he is working on. Or he may even be servicing a hybrid, with some early and some late features. For efficient servicing it is necessary that, whenever production changes are made, the chassis number be modified, and the service data be modified to correspond, in such a way that the technician can be sure he has the correct data for the set.

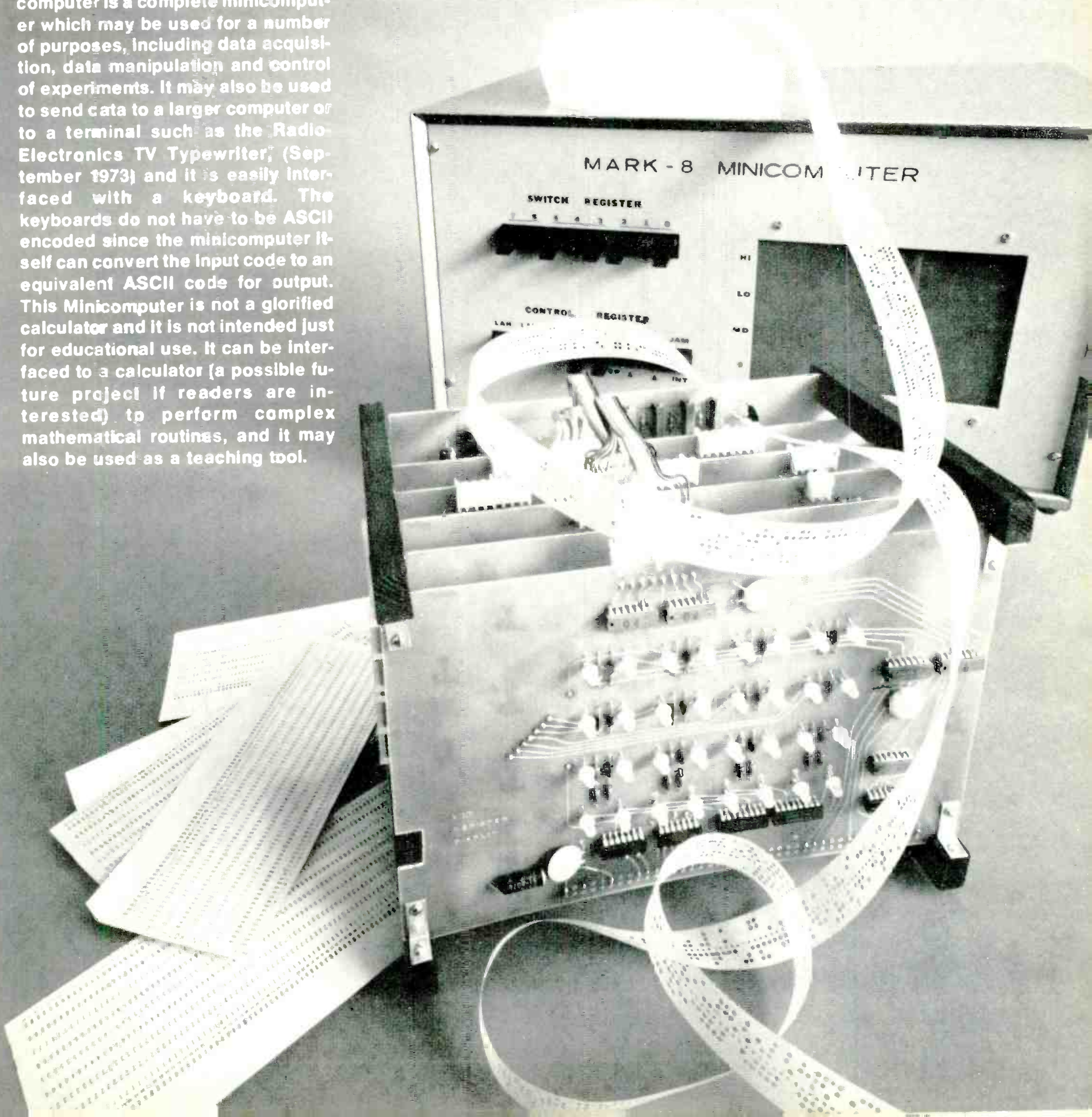
6. Availability of data. It should be published, available and mailed to subscribers prior to the date the product appears on the market.

7. Photographs, pictorials and drawings. Each component, service adjustment and control must be identified in both photos and drawings. Also included should be all mechanical tuner parts, drive assemblies, dial stringing diagrams and cabinet parts, *including knobs.* **R-E**

COMPUTER!

Build this minicomputer yourself. Add it to the TV Typewriter for a complete computer system of your own.

The Radio-Electronics Mark-8 Minicomputer is a complete minicomputer which may be used for a number of purposes, including data acquisition, data manipulation and control of experiments. It may also be used to send data to a larger computer or to a terminal such as the Radio-Electronics TV Typewriter, (September 1973) and it is easily interfaced with a keyboard. The keyboards do not have to be ASCII encoded since the minicomputer itself can convert the input code to an equivalent ASCII code for output. This Minicomputer is not a glorified calculator and it is not intended just for educational use. It can be interfaced to a calculator (a possible future project if readers are interested) to perform complex mathematical routines, and it may also be used as a teaching tool.



GET THE COMPLETE STORY

The Minicomputer is a very special story. Complete instruction information, including full-size circuit board patterns, would require a long multi-part article in Radio-Electronics.

To make it possible for interested readers to get full details of the unit and to start construction immediately, we are making available a special package of additional data. This includes complete construction details, more data on how it works, a group of eight experiments you can perform with the computer and other important information. The cost of this 52-page package is $5.00 plus postage.

Use the coupon below to order. Fill out the portion with your name and address. You must print as it will be used as your shipping label. Then check off the way you want it shipped; this determines the price. Mail your check or money order with the coupon to Radio-Electronics, Micro-Computer, P.O. Box 1307, Radio City Station, New York, N.Y. 10019. Payment must be in U.S. currency.

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Brochures will be mailed within three weeks of receipt of your order.

The heart of the Mark-8 Minicomputer is an Intel 8008 microprocessor IC that contains all of the arithmetic registers, subroutine registers and most of the control logic necessary to interface the microprocessor with semiconductor memories as well as input and output registers. Standard TTL type IC's are used throughout and commonly available 1101, 1101A and 1101A1 type memories are used for the central storage. The microprocessor with its associated logic will be refered to as the central processor unit, or CPU.

The central processor unit is an 8-bit parallel processor. A string of eight binary bits, D_7 through D_0, is used to indicate the instruction data or memory locations. Rather than repeat, "eight bits of binary data", we refer to the eight bits as a byte. As you will note, some of the instructions take up to three bytes of data and they are, therefore, called three-byte instructions. The computer takes 20 μs to execute each byte of these instructions, so the time to execute any of the basic instructions may vary from 20 to 60 μs. The time that the computer takes to execute one byte of the instruction is called the computer's cycle time. Most minicomputers have a cycle time that is about ten times faster than the Mark-8, but this will not restrict the use of this Minicomputer in most situations. *

The Intel 8008 microprocessor provides us with some sophisticated features, only found on larger, more costly computers. These include a pointer register, interrupt pointers and a stack register for multiple subroutines.

The Mark-8 is programmed in assembly or machine language, the basic language of all computers which consists of 1's and 0's grouped into bytes. While it may seem cumbersome at first, this is one of the most flexible ways to program while keeping down the cost of added storage or memory. The use of just the 1's and 0's to represent the binary numbers can become tedious after a short while. It becomes much easier to convert the binary numbers to their octal equivalent and use these direct equivalents instead.

There are 48 program instructions to use in programs on the Mark-8. Each program must consist of an orderly, logical chain of steps in successive memory locations. If data or program steps are not loaded in the correct order, the program won't work correctly and is said to have a bug in it. Those not familiar with the basic operations of a computer and the various number systems used will find *Computer Architecture*, by Caxton Foster, Van Nostrand-Reinhold, New York, New, York 1970, $12.50 an easy to read and understand introduction that should be read before attempting to build or use the Mark-8.

The basic Minicomputer consists of six modules:

1. Main CPU module.
2. Memory Address/Manual Control module.
3. Input Multiplexer module.
4. Memory module.
5. Output module.
6. Readout module.

These modules provide the experimenter with the basic minicomputer configuration. Two 8-bit input ports are provided for getting data into the computer and four 8-bit output ports are provided to output data to external devices. The memory module can accommodate up to 1024 bytes or words of storage, although only 256 words are required to start. Manual controls are provided for the user and a readout of some of the important registers is provided on the Readout module.

Six different modules

The Central Processor Unit (CPU) module contains the microprocessor IC and the extra circuitry used to interface with the rest of the computer. It is important to note that the 8008 microprocessor has been fabricated as an MOS circuit and the outputs will only drive one low-power circuit of the 74L series. Each output is buffered with a 74L04 inverter before it is used. The main, 8-line input/output bus, or I/O bus is also buffered by two 7404 circuits to give the TTL signals a high fan-out.

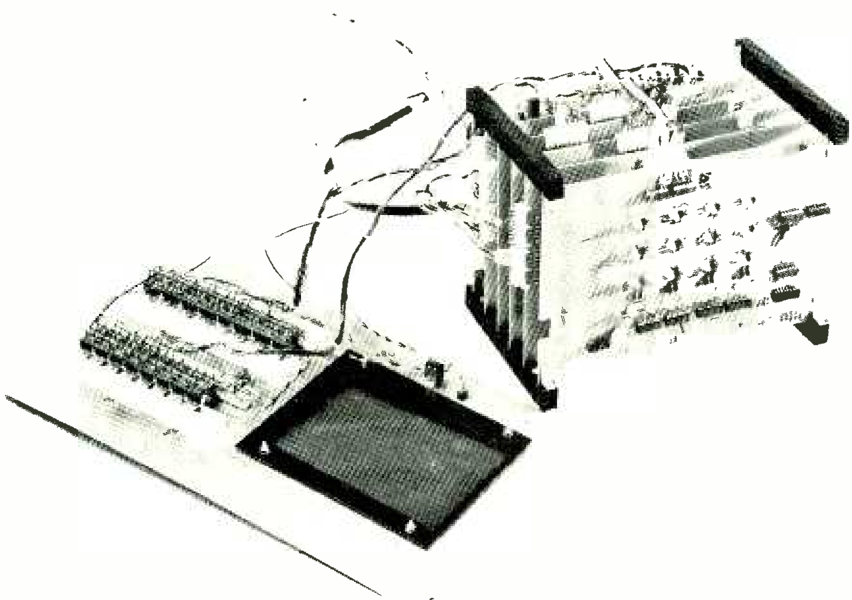
The computer is controlled by a 2-phase clock supplied by a crystal oscillator which controls the pulse widths and frequency. The clock and the synchronization signal supplied by the microprocessor are used to control some of the logical operations of the computer interface circuits. The synchronization signal synchronizes the operation of the very fast TTL circuits and the slower, clocked, MOS circuits in the microprocessor. The microprocessor also has three, state-output signals, S_0, S_1, and S_2 which are used to drive a decoder. The eight possible states are then used to control other functions in the interface logic. A complete description of the generation and use of these state outputs is included in the Intel User's Manual

Since the CPU uses a parallel 8-bit I/O bus for input and output of data there must be some control of when the bus is sending data from the CPU to an external device or when it is taking data in. Two lines are present on the CPU module, $\overline{IN}$ and $\overline{OUT}$. These lines are used by the other modules to regulate the flow of data in the correct direction at the correct time. The control of the $\overline{IN}$ and $\overline{OUT}$ lines is governed by the additional logic on the CPU module.

The Memory Address/Manual Control module is used to hold data which is to be used as the memory address. Two 8-bit latches are provided since the computer will use one set of eight bits for a memory address and the other set of eight bits for control functions. Since the microprocessor can directly address up to 16,424 words of memory, commonly noted as 16K, we will need 14 binary bits for the complete address. The complete memory address of any location is given by a 16-bit binary number: X X B_3 B_3 B_3 B_3 B_3 B_3 / B_2 B_2 B_2 B_2 B_2 B_2 B_2 B_2, where the X's represent bits that are not used. The computer specifies any address by first sending out the B_2 bits to one of the eight-bit latches, followed by the six B_3 bits and two X bits. Control of the correct latch is supplied from the CPU module.

The B_3 bits have the most significance or value in the complete digit, while the B_2 bits have the least significance. This is like comparing $1000 and $1. The further to the left the digit, in any numbering system, the more value it has. For this reason the B_3 bits are called the most significant or the HI part of the address, while the B_2 bits are called the least significant or LO part of the address. Both the HI and LO address latches are made up of SN74193 programmable coun-

COMPUTER WITH ASCII KEYBOARD makes a complete working computer system. You can use the computer without the keyboard, but it is more difficult.



THE WORKING HEART of the computer is relatively simple. The six primary circuit boards and the front-panel controls are shown here. If additional memory is needed, more circuits boards are required.

ters, since the address held in them may be incremented, by counting up by one. The usefulness of this will be seen later. The HI and LO latches are also used for temporary data storage when they are not being used to store a memory address.

The manual control portion of this module allows us to program the computer and to control its operation from an operator's console. We are able to externally address any memory location and deposit data or instructions in it. We may also return to any location and check the data stored there. Controls are also provided to allow us to single-step the computer through a program, one instruction at a time and to interrupt the computer while it is executing a program. These controls will be described in detail later.

The Data Input Multiplexer module controls the flow of all data into the computer. All data going into the computer is placed on the I/O bus during the IN cycle signalled by the $\overline{IN}$ signal. Since data may be coming in from a number of different experiments or sources, we must have some means of selecting which data is fed into the CPU. Two basic multiplexers are used for this precise gating of data. The two 8263 quad, three-line to one-line multiplexers control which of three sets of input lines are selected. Note that two sets of these input lines are input ports 0 and 1. These are the two external data input ports. The third set of data input lines comes from the memory. Data or instructions in the memory, all go through the multiplexer and into the CPU.

This multiplexer is followed by a second set of multiplexers, 8267's. These are quad, two-line to one-line multiplexers with open-collector outputs which are compatible with the computer bus structure. This multiplexer switches between the data selected at the previous multiplexer and data from the Interrupt Instruction Port. The use of the Interrupt Instruction Port will be covered in the Interrupt section. This second multiplexer may also be in an off or unselected state which is used when data is not to be sent to the CPU module. Control lines SL_0 and SL_1 are sent directly from the CPU interface logic.

Remember that when the HI address is not being used to store a memory address, it is used for control signals. During an IN or OUT cycle these control signals are decoded and used to select the proper input or output lines for the I/O bus. The Multiplexer module decodes the control bits B, C, D, and D_{Enable} and OR's them with $\overline{IN}$ to select the proper external data input port. When the computer is instructed to get some data from memory it automatically selects the memory input section of the multiplexer. The INPUT instruction is only used when you wish to input data from some external source such as a digital voltmeter or keyboard, through one of the two input ports.

The Memory module uses the widely available 1101 type of semiconductor, integrated circuit memory. The 1101 random access memory or RAM is organized as a 256 x 1-bit memory, so eight of the 1101 type memories are used to give us 256, eight-bit words. This is the minimum configuration necessary for the operation of the Mark-8. Each memory module can hold 32 of the 1101 memories for a total of 1024 or 1K words of storage. Up to four Memory modules may be used with the Mark-8, giving us a maximum 4K of storage space. More than enough for most applications.

Each of the 256 words are addressed by the eight bits from the LO address latch. Since $2^8 = 256$ we can only address 256 words using the LO address alone. Each memory also has an enable line so we may select blocks of 256 words, using this line. The HI address is, therefore, used and decoded with a standard decoder and the decoded outputs are used to enable or select the blocks. You do not have to be concerned about the particular block where data has been stored, just use the complete 14-bit address, since the memory does the complete decoding.

Each of the addressed memory locations may store one 8-bit word or byte of information. For 2 or 3-byte program steps, two or three successive memory locations are used for storage.

The 1101 type memories are volatile semiconductor memories and information stored in them will be altered or lost if the power is shut off. If you want to save a program, leave the power on.

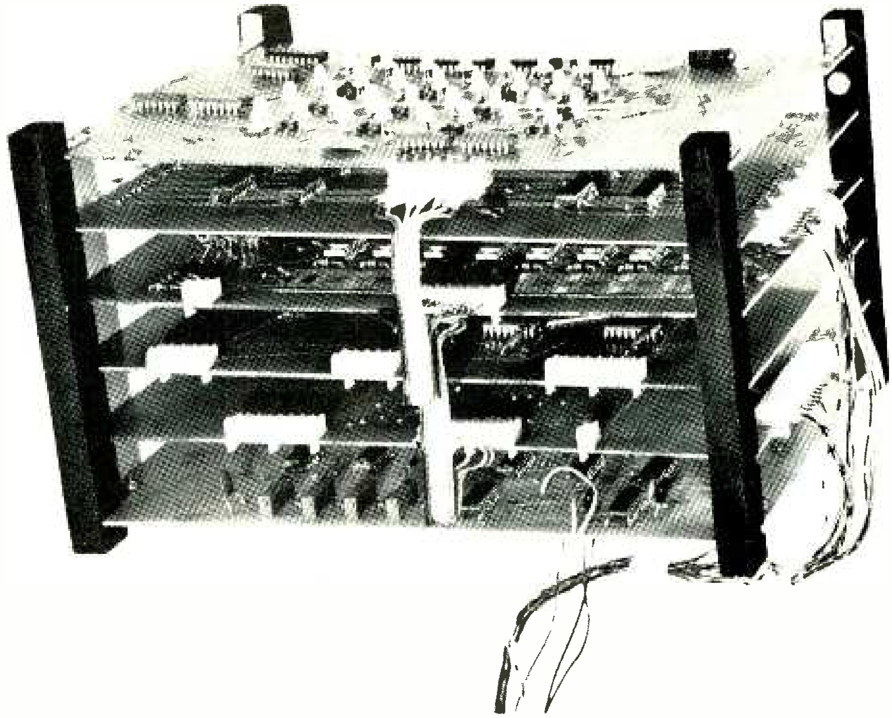
A chart in the construction section shows how the memory jumpers are wired for each of the four possible boards. Boards must be added in numerical sequence: 1, 2, 3, and 4. Blocks of memory must be added in units of 256 words in the A, B, C, and D sequence, to prevent gaps in the memory.

A read/write or R/W line is provided on the module so that data may either be read from, or written into a selected memory location. The CPU and the Manual Control module both control this line so that data may be entered under computer control or so that we may insert our program data into the memory prior to use by the computer.

The eight data-output lines from the memory are sent to the CPU I/O bus through the Input Multiplexer module. When we ask for data from the memory with an LrM type of instruction (see Intel User's Manual), the CPU senses that the memory data is needed and it sets the input multiplexer so that the data is placed on the I/O bus at the proper time.

The Output Latch module is used to send data from the computer to some external device or instrument, such as a teletype or perhaps the **Radio-Electronics** TV Typewriter (**Radio-Electronics**, September 1973). Four output latches are provided on the Output Latch module and two of these modules may be used with the Mark-8. The second module may, however, only use three of the output latches.

Note that data is sent from the LO address latch to each output port and that these connections are in parallel. The computer decides which latch is activated according to the OUTPUT instruction that we have in our program. Here, again, the HI address latch holds the control bits B, C, and D which are decoded and NORed with $\overline{OUT}$ to activate the selected eight bit output port or latch. NOTE: The OUTPUT instruction in the Intel User's Manual has two RR bits shown in it. These bits must be set to RR =



PRINTED-CIRCUIT BOARD ASSEMBLY is a stack of six 2-sided boards. Molex connectors and cables are used to interconnect the boards and to connect the boards to the front-panel controls.

PARTS LIST

All resistors are ¼ Watt, 10%

CPU BOARD

C1—33-pF disc
C2 thru C6—0.1-μF disc
IC1, IC,4, IC6, IC7, IC9, IC13, IC17, IC19— 7400
IC2, IC,3, IC14—7476 Dual JK flip-flop
IC5, IC11, IC16, IC20, IC21—7404
IC8, IC12—7474 dual D flip-flop
IC22, IC23, IC25—74L04 hex inverter, low power
IC10, IC18—7410
IC15—7420
IC24—8008 Intel microprocessor
IC26—7442 decoder
R1, R2—220 ohms
R3—560 ohms
R4—1800 ohms
R5, R6, R7, R8, R17—1000 ohms
R9 thru R16—22,000 ohms
XTAL 1—4000.000-KHz crystal type EX ($3.95 from International Crystal, 10 N. Lee Street, Oklahoma City, OK)
Misc—PC Board, No. 24 wire, solder

INPUT MULTIPLEXER BOARD

C1, C2, C4—0.1-μF disc
C2—1.0-μF 10 V electrolytic
IC1, IC2—8263 multiplexer (Signetics)
IC3—7400
IC4, IC5—8267 multiplexer (Signetics)
IC6—7402
IC7—7442 decoder
P1, P2, P3, P4—Molex type 09-52-3081 connectors
R1—1000 ohms
Misc—PC board, No. 24 wire, solder

ADDRESS LATCH BOARD

C1 thru C6—0.01-μF disc ceramic
C7—680-pF disc
IC1, IC2—74123 dual monostable
IC3, IC4, IC5, IC6, IC7—7400
IC8, IC9, IC10, IC11—74193 programmable counter
P1, P2, P3—Molex Type 09-52-3081 connectors
R1 thru R3—10,000 ohms
R4-22,000 ohms
R5 thru R16—1000 ohms
Misc—PC board, 324 wire, solder

MEMORY BOARD

C1, C2, C3—0.1-μF disc ceramic
IC1 thru IC8—1101, 1101A or 1101A1 memory circuits, 256 x 1
IC9 thru IC32—Same as above, but optional with builder
IC33—7442 decoder
IC34—7400
P1, P2—Molex type 09-52-3081 connector
R1 thru R11, R20, R21—1000 ohms
R12 thru R19—10,000 ohms
Misc—RC board, No. 24 wire, solder

OUTPUT LATCH BOARD

C1, C2, C3,—0.1-μF disc
IC1 thru IC8—7475 quad latch
IC9, IC10—7404
IC11—7402
IC12—7442
P1, P2, P3, P4—Molex type 09-52-3081 connector
Misc—PC board, No, 24 wire, solder

LED REGISTER DISPLAY BOARD

C1—100-μF electrolytic
C2, C3, C4—0.1-μF disc
D1 thru D32—MV-50, MV-5020 or equivalent Red, visible LED's
IC1 thru IC6—7404
IC7, IC8—7475 quad latch
IC9—7442 decoder
IC10—7402
P1—Molex type 09-52-3081 connector
R1 thru R32—220 ohms
Misc—PC board, No. 24 wire, solder

CONTROL PANEL

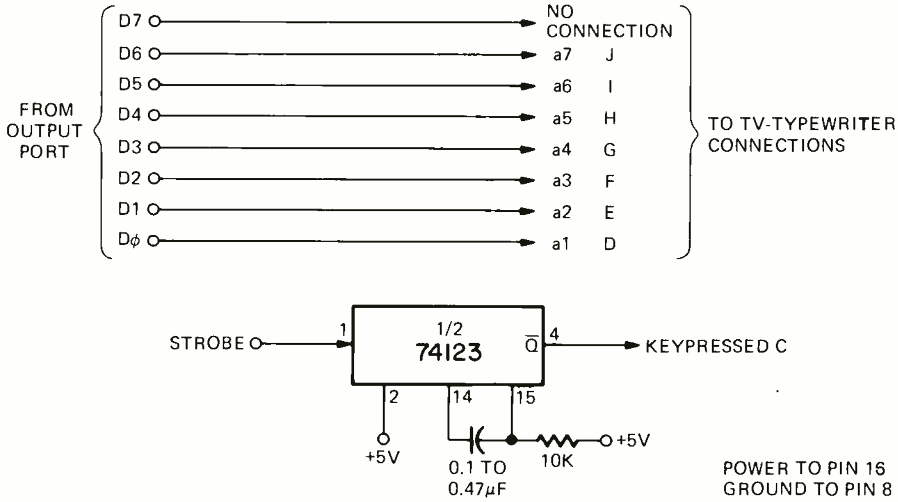
D1—MV-5020 or equivalent red, visible LED
R1—220 ohms
S1 thru S11—spdt switches, rocker or toggle
S13 thru S17—spdt momentary, spring return, rocker or toggle
PS—Power supply, logic power supply available from Precision Systems, P.O. Box 6, Murray Hill, NJ 07974. +5 volts/8.5A and −12 volts/2.0A, adjustable to −9 volts. Also other voltages available. See text.
Misc—Metal case, red plastic filter, line cord, hardware, hook-up wire, solder.

The microprocessor integrated circuit is available from Intel Corporation, 3065 Bowers Avenue, Santa Clara, CA 95051 at a cost of $120.00.

A complete set of circuit boards is available for the Mark-8 Minicomputer from Techniques Inc., 235 Jackson Stree, Englewood, N.J. 07631. Prices include shipping charges inside the United States.

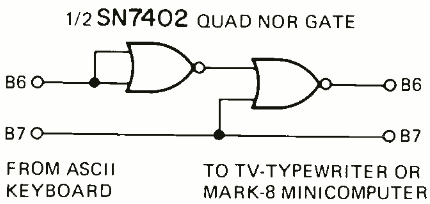
Complete set of six boards (1 of each)	**$47.50**
CPU Board	**7.50**
Address Latch Board	**10.50**
Input Multiplexer Board	**9.50**
1K Memory Board	**8.45**
LED Register Display Board	**8.45**
Output Ports Board	**8.50**

Techniques had 100 sets of boards in stock when this issue went on sale. When these boards are sold, there will be a 6 to 8-week delay before additional boards become available.



Mark-8 Minicomputer to TV-Typewriter interface

The Mark-8 Minicomputer may be used with the TV-Typewriter to display computer generated information. The interface uses either the A or B Output Port strapped to the specific output code, 1-7, that you select. The A and B output ports have strobe lines which are pulsed during the output cycle. These two lines are found above the B output lines and below the A output lines on the printed circuit board. These strobe lines provide us with the Keypressed signal required to enter data into the TV Typewriter. A monostable is attached to this strobe line to stretch the pulse width and the 10 μF capacitor used for debouncing is removed from the TV-Typewriter. This is C17 shown in Fig. 8 of the TV-Typewriter booklet.



HOOKUP THE MARK-8 COMPUTER TO YOUR TV TYPEWRITER using the circuits shown above and to the left. Wiring to the TV typewriter is just direct connections (above). The IC monostable (left) stretches the pulse width. Together, the TV Typewriter (Radio-Electronics, September 1973) and the Mark-8 make a powerful computer package.

01 for proper data output. OUT = 01 01M MM1. The MMM bits are set to the binary equivalent of the decoder state selected for that particular output port. For example 01 01<u>0</u> <u>11</u>1 would output data at output port 3, since 011 = MMM = 3.

The LED Register Display module provides you with a visual indication of the contents of the HI and LO address latches and the memory data in the selected memory location indicated by that address. Output port 0 is also located on the Readout module and it may be used in programming to give a visual output of a byte of data. Each of the output registers is represented by eight LED indicators, 1 = ON, 0 = OFF. As the data held in each register changes, so do the indicators. Data to be displayed at output port 0 must be sent with an OUT instruction 01 010 001 or 121_8.

Since the HI address latch is used for some control functions and the LO address latch may also be used for temporary storage of data going to the output ports, at various times in programs the data in these registers will change from a memory address to these control and output data and then back to an address. Checking this data visually in these registers during the debugging of a program is very helpful.

The power supply requirements of the Mark-8 are +5 Vdc at 3 amps and −9 Vdc at 1.5 amps. Since regulation at these high current levels is critical we suggest that the power supply or supplies are purchased. There are many good power supplies on the surplus market that may be used with the Mark-8. The type used with the prototype is listed in the complete parts List. A substitute, available from Wortek, 5971 Reseda Blvd., Tarzana, Calif. 91356 will work as well. Order part numbers PRS-1 and PRS-3, each $25.00 **R-E**

* For more detailed data on the Microprocessor IC write to Intel Corp., 3065 Bowers Ave., Santa Clara, Calif. 95051 - ask for a copy of "*8008, 8-Bit Parallel Central Processor Unit-Users Manual*. This manual was offered free at the time this article went to press.

This is the second time that **Radio-Electronics** has presented a construction article in the fashion. We are doing so, only because of the special nature of this story and to make it possible for interested readers to get full details on the computer in a single package. These details include full-size printed circuit patterns and parts layout overlays. We do not intend to do an article this way as a regular practice. All conventional construction articles will be published, complete, within the regular pages of **Radio-Electronics**.—*Editor*

SOFTWARE EXAMPLE

Data in the A register is output to the TV-Typewriter as a complete ASCII character. The computer then enters a short timing loop so that it can not go faster than data may be entered to the TV-Typewriter memory.

000	006		LDAI	/Load A with data
001	177		177	/Data = 177 = ASCII "?"
002	106		JSUN OUTPUT	/Jump to OUTPUT subroutine
003	040			
004	000			
005	000		HALT	/Stop, end of program
040	123	OUTPUT,	OUT1	/Data from A to output port 1
041	026		LDCI	/Load C Immediate
042	004		004	/Data
043	031	LOOP,	DECD	/Decrement D
044	110		JPFZ, LOOP	/Jump on a false zero flag to LOOP
045	043			
046	000			
047	021		DECC	/Decrement C
050	110		JPFZ, LOOP	/Jump on a false zero flag to LOOP
051	043			
052	000			
053	007		RTUN	/Unconditional return to main program

Selecting and Using

Modern hi-fi equipment is more sophisticated and complex equipment and exacting procedures to service it.

by ROBERT F. SCOTT
TECHNICAL EDITOR

WHEN MANY OF US BROKE INTO RADIO SERvicing, there was no such thing as hi-fi. Radios were relatively simple AM receivers. The audio amplifiers were the simplest circuits needed to drive a loudspeaker. Later, a phonograph pickup was added for record playing. Now, with FM and FM stereo, touch-tuning, digital readouts and audio circuits flat from below 20 Hz to well beyond 20 kHz, the listener's demands for good reproduction and performance have become more severe.

There was a time when a radio and its audio system could be serviced using a vom with output meter feature, a simple rf/af signal tracer and an rf signal generator with built-in 400-Hz (we called it 400 cycles) modulation. Now to restore a modern FM stereo receiver to its original performance specs, we may need a multiplex generator/analyzer, a lab-grade audio signal generator with sine, square-wave and sweep output, distortion analyzers, dual-channel wide-band scope with triggered sweep, wow and flutter meter, audio vtvm, audio wattmeter and a precision decade attenuator.

A piece of hi-fi gear that is inoperative or has one channel weak or completely out is generally easy to service by using an electronic multimeter for voltage and resistance measurements to localize the trouble. But, when it comes to satisfying complaints from musicians and other critical listeners, you may need "the whole bag of tricks" along with some of the most sophisticated test equipment available for hi-fi servicing.

The specialized gear you'll be likely to need should either be designed especially for hi-fi servicing or have known response and distortion characteristics that are equal or better than the equipment you'll be servicing. Now, let's take a look at what features we want in various test instruments and how we can best use them.

The audio oscillator

The basic use of the audio oscillator is as a signal source when trouble-shooting audio circuits either by signal tracing or signal substitution. For this we are mainly interested in the presence or absence of the test signal. The amount of distortion or the flatness of the generator's output over the tuning range is of little importance at the moment.

On the other hand, an audio generator used for measuring or tracking down distortion, measuring frequency response, the resonant freqency of speaker enclosures, and checking input and output impedances should deliver a signal with distortion limited to 0.5% or less over the range of 20 Hz to 20 kHz and preferably to 50 kHz. Output versus frequency should be ±1 dB or better from 20 Hz to 20 kHz or higher.

Most audio generators are R-C types using either phase-shift or Wien-bridge circuits to cover a tuning range in four or five bands with 10:1 or 100:1 tuning ratios. (Some function generator-type audio signal sources cover the range of 20 Hz to 200 kHz in only three bands.) Output impedance is generally 600 ohms, unbalanced—600 ohm is a figure designed to match long audio lines. When driving high-impedance loads, most manufacturers recommend loading their generators with a 600-ohm resistor. Most audio generators have a step attenuator, calibrated in decibels, followed by an output level control for adjusting the output from maximum down to zero. Note that most the attenuators included in these instruments do not have the fine, precision adjustments of output level that are required in some applications. There'll be times when you want to adjust signal levels in 1-dB or smaller steps. Therefore, a precision attenuator may be a required instrument in your shop. More on this later.

The square-wave output of the audio generator and a scope are useful when you want a quick look at the overall response of an amplifier. A square wave fed into an amplifier will provide a rough idea of the response from *one-tenth* its fundamental frequency up to about the *fortieth* harmonic of that frequency and will indicate phase distortion that cannot be detected in a sinewave test. Figure 1 shows some of the various patterns that result from phase shift and amplitude distortion. For example, a 20-Hz square wave presents a picture of the amplifier's response from 2 to 800 Hz. A 500-Hz square wave checks response from

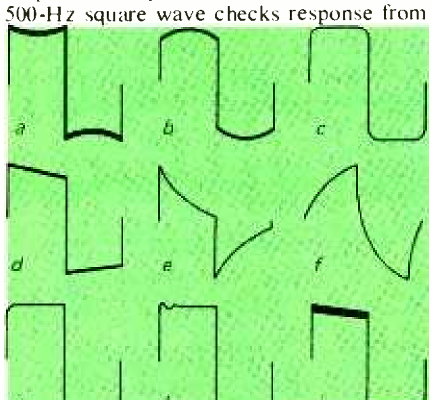
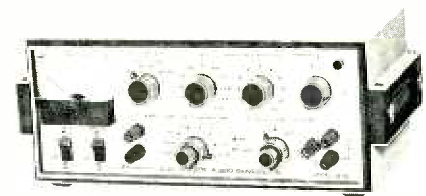


FIG. 1—SQUARE-WAVE PATTERNS produced by phase shift and amplitude distortion in an amplifier. (a) The dip between the leading and trailing edges shows amplitude loss at low frequencies. (b) The dome-effect shows low-frequency boost. (c) Rounded corners on leading and trailing edges are from high-frequency losses. (d) Low-frequency phase shift causes top to slope to trailing edge. (e) A slope and dip show low-frequency loss and phase shift. (f) High-frequency phase shift and low-frequency loss. (g) Phase shift and roll-off at high frequencies. (h) Overshoot and damped oscillations. (i) Same as (d) with hum in the trace.

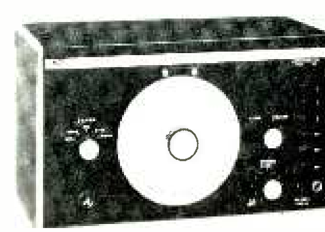
SWITCH-TYPE FREQUENCY SELECTION is used in *Heathkit IG-18* solid-state sine/square-wave generator for precise resetability. A bridged-T oscillator is used. Frequency range is 1 Hz to 100 kHz sinewave and 5 Hz to 100 kHz squarewaves. Sine and squarewaves are available simultaneously. Distortion on sinewaves less than 0.1%. Square-wave rise time less than 50 ns. Sine-wave output adjustable from 3 mV to 10 V in eight ranges;



square-wave output 0.1 to 10 Vp-p in three ranges.

A 2½-in. panel meter indicates output level in volts and in dB (0 dB = 1 mW into 600 ohms). An internal 600-ohm load resistor can be switched into the circuit on all output ranges up to 1 V. In setting up, the first two significant figures of the frequency are selected on 0—100 and 0—10 switches, the third figure on a 0—1 vernier control. Multipliers are set by X1, X10, X100 and X1000 switch.

PUSH-BUTTON ATTENUATOR and a continuously variable control adjust the output of the *B&K/Precision E-310B* sine/squarewave generator from the maximum of 8 Vrms to less than 0.25 mV. Its sinewave frequency range is 20 Hz to 2 MHz in five decade ranges. Distortion



is 0.1% typical, 0.25% maximum. Maximum amplitude variation over the frequency range is ±1 dB. Frequency calibrations accurate ±2%, 100 Hz to 2 MHz; ±2% or 1 Hz below 100 Hz.

Squarewave frequency range is 20 Hz to 200 kHz in four decades. Output is 0 to 10 V peak; rise time less than 100 ns at 20 kHz; symmetry balanced within 5% or less.

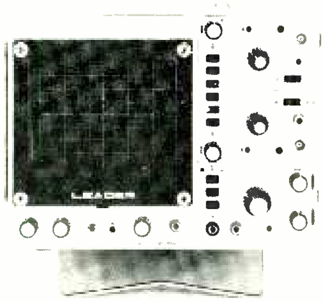
LAB-GRADE PERFORMANCE is claimed for the *Leader LBO-505* 5-inch, solid-state dual-channel scope. Triggerend and automatic sweep with speeds adjustable in seventeen steps from 1 μs/cm to 0.5 s/cm. Sweep also continuouly variable over the same range, Pre-set positions for syncing to TV vertical and horizontal scanning rates. Has X10 sweep magnification. Sweep trigger selection: alternate, chopped or channel 1 or 2. Internal or external on + or − slope.

Ac or dc coupling on each vertical channel; dc to 15 MHz bandwidth; 10 mV/cm sensitivity adjustble to 5 Vp-p/cm in nine calibrated steps. Rise time 35 ns. Input impedance 1 megohm shunted by 40 pF (10 megohms shunted by 10 pF or less with 10:1 probe).

Takes external, 15 Vp-p negative-polarity signal for intensity modulation. A panel control provides continuous scale illumination. A 0.5

HI-FI Test Instruments

than it was just a few years ago and you'll need lab-grade
Learn what instruments you'll need and how they're used.

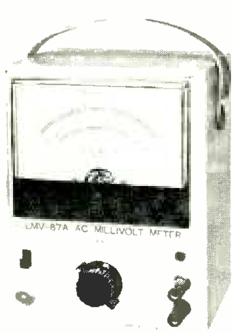


Vp-p square wave calibrating voltage is available at a jack on the front panel.

IM AND THD ANALYZER includes sensitive audio vtvm and dB meter. The *Eico 902* uses a continuously variable 20—20,000-Hz Wien-bridge rejection filter for harmonic distortion measurements. IM distortion measurements are made with 60-Hz and 7-kHz signals mixed 4:1 and 1:1 with fullscale ranges of 0.3, 1, 3, 10 and 30 percent. Accuracy ±5% of fullscale. Residual distortion 0.05%.

Harmonic distortion measurements at 20—200, 200—2000 and 2000—20,000 Hz; THD ranges 0.3, 1, 3, 30 and 100%.
Voltmeter input impedance 2 megohms; ranges 10 mV to 300 Vrms; response ±0 dB 10 Hz to 100kHz, −3 dB at 300 kHz. Decibel scale (−20 to +2) based on 1 mW across 600 ohms.

AC MILLIVOLT METER has amplifier that can be used as a wide-band scope preamplifier. The *Leader model LMV-87A* measures 1 mV to 300 V in twelve ranges. Decibel range (0 dB = 1



mW across 600 ohms) is −8 to +52 dB and bandwidth is ±1 dB 10 Hz to 1 MHz. Amplifier output is approximately 500 mVp-p at fullscale. Operates from 105—125 V, 50/60 Hz.

around 50 Hz to 20 kHz.

For an instantaneous plot of an amplifier's response while checking the equalization curves, the effect of tone controls, scratch and rumble filters, cross-over networks and for setting tape recorder bias, we may use an audio generator with linear and logarithmic sweep outputs. The generator sweeps the full range of, say 20 Hz to 20 kHz. The swept output of the generator is fed to the amplifier's input and the amplifier's output—properly terminated—is fed to the vertical input of the scope. The generator's internal sweep voltage is fed to the scope's horizontal amplifier. The sweep can be linear—each division on the scope's graticule will represent the same number of Hz—or logarithmic where each decade (20 to 200 Hz, 200 to 2000 Hz and 2000 to 20,000 Hz) occupy the same number of divisions on the scope graticule. A log sweep is preferable for viewing the overall response while a linear sweep is best when you want to read an exact frequency off the face of the scope; as when checking filters, recording and playback curves and tone-control action.

A sweep generator should have several sweep speeds (typically 2.5 ms, fast; 250 ms, medium; and 25 seconds, slow) to suit the characteristics of the scope's horizontal amplifier or of a graphic recorder. Very slow speeds—in the order of seconds—are needed when using a graphic recorder to make a perman3nt record of circuit performance.

Distortion analyzers

Any complex audio signal fed to an audio circuit can be considered as a series of pure sinewaves which we expect to find in amplified but unaltered form in the output of the circuit. But, distortion in the amplifier produces a distorted output waveform that consists of fundamentals and harmonics of these input sinewaves as well as some *sum*-and-*difference* frequencies resulting from fundamentals beating or heterodyning in non-linear circuits in the amplifier. This is called *harmonic distortion*. The most common type of harmonic distortion measurement compares the sum of the levels of the harmonics with the level of the fundamental and gives the result as the percentage of *total harmonic distortion* or THD.

The harmonic distortion meter is a relatively simple instrument as indicated by its block diagram in Fig. 2. A low-distortion audio oscillator is connected to the input of the amplifier being tested and the analyzer is connected to the preamp output or, in the case of a power amplifier, across a dummy load resistor equal to the amplifier's output impedance. The oscillator is set to a test frequency and its output level adjusted to within the range of the amplifier's input rating.

The harmonic analyzer mode switch is set to CALIBRATE and its sensitivity or level-set control is adjusted so the analyzer's meter reads 100%—the level to which the harmonic level is compared. When the meter is switched to MEASURE, a Wien bridge or

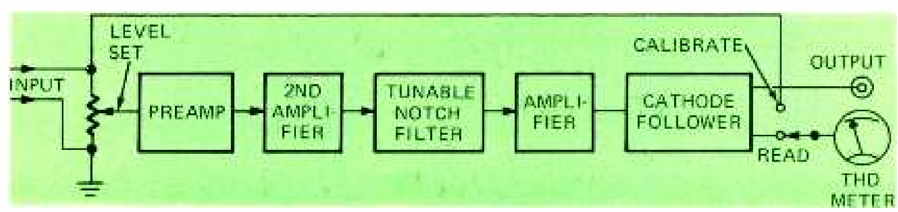


FIG. 2—BASIC HARMONIC METER. Instrument is calibrated at the test frequency and then a tunable filter is switched in and adjusted to null the test signal. Meter reads distortion.

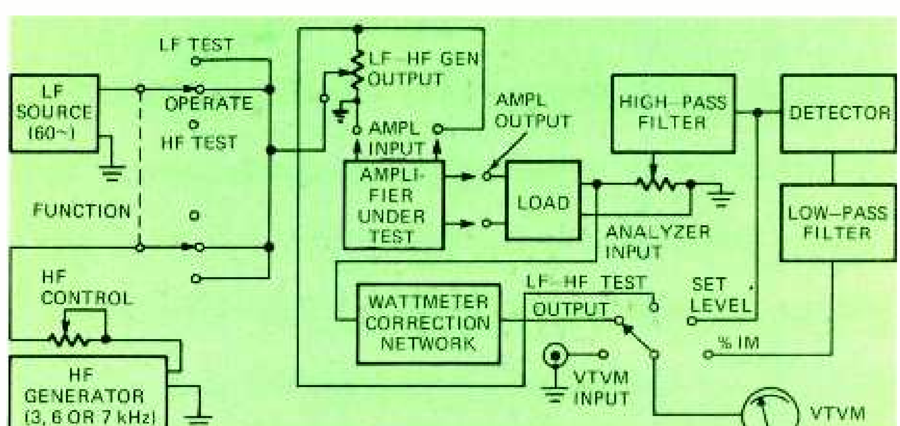


FIG. 3—BLOCK DIAGRAM of the Heathkit audio analyzer used for intermodulation measurements. The instrument also functions as an audio vtvm and as an audio wattmeter.

similar active filter is inserted in the signal path to notch out the fundamental—leaving only the harmonics which are read as a percentage of fullscale.

Since the harmonic distortion meter measures any signal that is present after the fundamental has been filtered out, you must be sure to eliminate any stray signal pick-up or hum introduced through ground loops. Be aware, also, that some amplifiers show a rising THD percentage at low output levels where the equipment's signal-to-noise ratio is low.

An intermodulation (IM) distortion analyzer tests the amplifier's ability to handle mixed high and low frequencies without mutual interaction. The test frequencies are generally 60 Hz (low) and 3000, 6000 or 7000 Hz on the high end. Let's assume that a 60-Hz and 7-kHz note are applied to the input of a non-linear circuit. The higher frequency is modulated by the lower, just as audio frequencies modulate the radio-frequency carrier in an AM transmitter. However, the situation is more complex. We not only have interaction between the fundamentals: we can have interaction between each fundamental and the harmonics of the other as well as intermodulation among the harmonics. All of these interactions can produce spurious frequencies that are equal to the sum and difference of the frequencies involved. To get an idea of these spurious frequencies generated by intermodulation, consider the typical 60-Hz and 7000-Hz test frequencies. The spurious frequencies resulting from the various combinations of fundamentals and second harmonics are:

2 × 60 = 120 Hz
2 × 7000 = 1400 Hz
120 + 7000 = 7120 Hz
7000 − 120 = 6880 Hz
14000 + 60 = 14060 Hz
14000 − 60 = 13940 Hz
14000 + 120 = 14120 Hz
14000 − 120 = 13880 Hz

A block diagram of a typical IM meter is shown in Fig. 3. The 60-Hz test signal is tapped off the power transformer; the high-frequency signal is supplied by an internal audio oscillator. Level controls are provided so the 60-Hz signal can be adjusted to four times the amplitude of the high-frequency signal for the standard 4:1 ratio or for a ratio as high as 10:1, depending on the test standard you are using.

The two signals are mixed and fed to the amplifier's input. The signal is taken off the amplifier's output and fed into the analyzer circuits in the IM meter. A high-pass filter removes the 60-Hz signal; leaving only the high-frequency signal (call it the carrier) along with any possible 60-Hz modulation. The carrier is then rectified by a linear

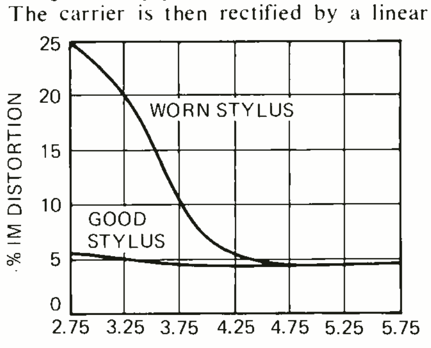
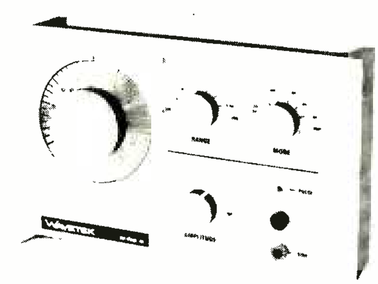


FIG. 4—IM RISE due to a worn stylus.

FUNCTION GENERATOR—the *model 30* by *Wavetek*—covers 2 Hz to 200 kHz in three overlapping 1000:1 ranges (2 Hz to 2 kHz, 20 Hz to 20 kHz, 200 Hz to 200 kHz) delivering sine, square and triangular waveforms. Can be used as a vcg (voltage-controlled generator) with the frequency controlled by a voltage applied to a jack on the rear and by the setting of the range switch. Fullscale frequency change requires about 1 volt input for either liner or log tuning. Using the internal sweep source, the generator sweeps the full frequency range in either a



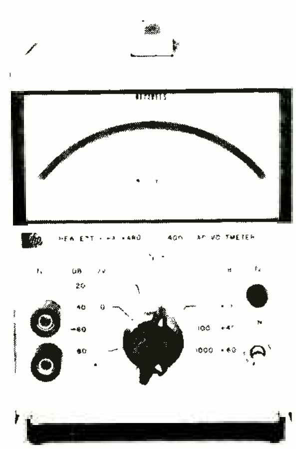
linear or logarithmic manner. Sweep speeds are 2.5 ms, 25 ms and 25 seconds.

Output: High-level sinewave variable up to 1 Vrms. Low-level sinewave is approximately 1% of the high-level output setting. Squarewave with 50% duty-cycle at nominal TTL levels (0 to +0.5 V low and +3 to +4.5 V high). Triangle (output on rear panel) 1 Vp-p, less than 2 mA peak current.

Operates from 9-volt battery. NiCad battery and charger available as accessories.

AC VOLTMETER—the *Hewlett-Packard 400GL*—features a 20-dB dynamic range on a 4½ in. linear scale and a single logarithmic voltage scale for measuring 100 µV to 1000 Vrms fullscale in eight 20-dB steps. Input impedance is 10 megohms on all ranges. The ac amplifier has a gain of 80 dB and delivers up to 1 volt rms open-circuit for fullscale deflection.

Frequency response is 20 Hz to 4 MHz on 1-mV to 1000-V ranges; 30 Hz to 100 kHz on

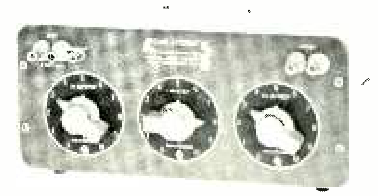


100-µV range. A switchable 100-kHz low-pass filter is provided to increase accuracy when measuring low-level low-frequency signals. The filter is switched in automatically on the 100-µV range. A 10:1 voltage-divider probe is available as an accessory to provide a low imput capacitaance at the point of measurement. Its response is 0 to 10 MHz.

The 400GL operates from 115- or 230-volt, 48 to 440-Hz lines. Terminals on the rear panel are for optional operation from batteries delivering positive and negative voltages between 35 and 55 volts.

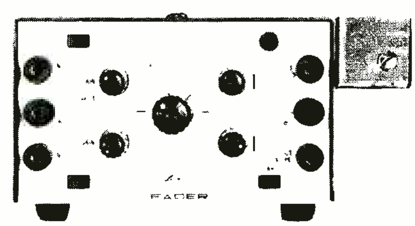
DECADE ATTENUATOR, *model 1450-TB*, by *General Radio*, has an attenuation range of 111 dB in steps of 0.1 dB and handles up to 1 watt. Each ofthe three decades has eleven positions—0 to 10 inclusive—so the ranges overlap. Frequency discrimination less than 0.1 dB ±1% of indicated value for frequencies below 200 kHz. For increments in attenuation, the 1% tolerance holds out to 1 MHz.

Impedance is 600 ohms in either direction. An etched calibration chart indicates mismatch losses for circuit impedances other than



600 ohms. Each decade is individually shielded with the shields connected to the panel and a ground terminal. The decade attenuator is also available as the *model 1450-TBR* for rack mounting.

WIDE-BAND AMPLIFIERS are featured in the *Heathkit ID-101* electronic switch. Each channel has 1-mehohm/50-pF input impedance. Response dc to 5 MHz +1.5 dB, −3 dB; gain is greater than 10. Minimum input signal 50 mV;

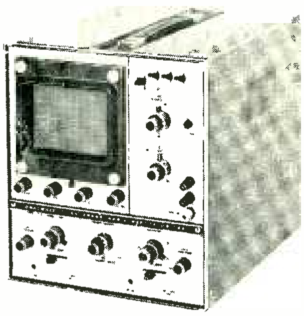


maximum 600 Vp-p or dc. Maximum output 8 Vp-p. Chopping rates approximately 100, 500 1000 and 5000 Hz. Hum and noise (single channel only) less then 40 mV p-p.

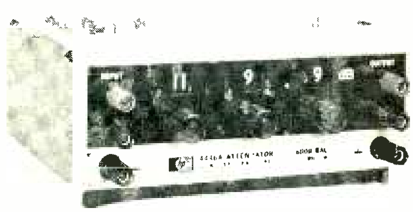
WOW AND FLUTTER measurements can be made with any carrier in the range of 2 kHz to 8 kHz with the *Manke model M-1* at input levels ranging from −20 dBm to +30 dBm. Input impedance 400K; ranges are 30, 10, 3, 1, 0.3 and 0.1 percent fullscale for rumble, wow and flutter measurements. Accuracy is 0.01%. The 3-kHz test oscillator delivers 1.5 volt into 120K, 35 mV

into 600 ohms and 10 mV into 250 ohms. The instrument can be used as an audio voltmeter with 400K input impedance and fullscale ranges of 1 mV to 100 Vrms in eleven 10-dB steps. Frequency response (−6-dB points) is 0.3 Hz to 100 kHz. The −10 to +2-dB scale is referenced to 1 mW into 600 ohms. Powered by eight "C" cells.

ALL SIGNALS REQUIRED FOR FM STEREO and monophonic alignment and troubleshooting are supplied by the *Heathkit IG-37* FM stereo generator. Generates mono FM or composite multiplex stereo FM signals, a phase-test signal composed of left and right channels in phase; a crystal-controlled 19-kHz pilot adjustable from 0 to 10% for checking receiver lock-in range, and a selection of 400 Hz, 1000 Hz, 5000 Hz, 19 kHz, 38 kHz and 65 or 67 kHz for complete alignment of decoder circuitry. In addition, the IG-37 delivers a 100-MHz sweep signal (adjustable ±2 MHz) for overall rf and i.f. alignment and provides crystal-controlled 10.7-, 90.95-, 96.30-, 101.65- and 107-MHz markers for i.f. and dial-tracking checks. Sweep width adjustable to ±75 kHz. Rf output level variable in three 20-dB steps. Operates from 105—125/210—230 V, 50/60-Hz lines.

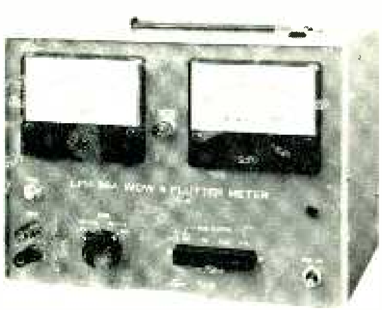


IN-LINE READING DIALS show attenuation at a glance on the *Hewlett-Packard 4436A* (shown) and *4437A* decade attanuators. Both have a maximum attenuation of 119.9 dB in 0.1-dB steps. Frequency range is dc to 1.5 MHz (0 to



110 dB) and dc to 1.0 MHz (0 to 119.9 dB). Input and output impedances 600 ohms (balanced in the *model 4436A* and unbalanced in the *4437A*). Maximum input power is 1 watt (24.5 V maximum).

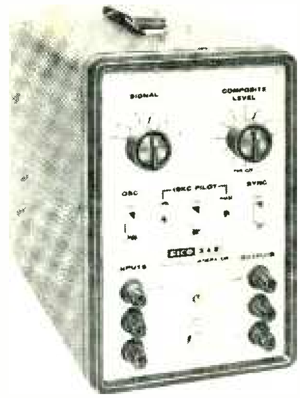
WOW AND FLUTTER METER features a separate panel meter for measuring drift in tape speed. Drift test range is −5% (2850 Hz) to +5% (3150 Hz) in one range. The Leader LFM-36A measures wow and flutter in 0.1%, 0.3%, 1%



and 3% push-button selected ranges. Can be used with scope to observe wow and flutter content.

Input signal level is 15 mV to 10 Vrms. Input impedance is over 100K, unbalanced. A 3-kHz test source is included in this instrument. Operates from 115/235 V, 50/60 Hz.

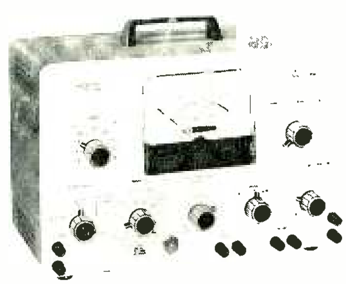
COMPOSITE AUDIO OUTPUT for direct injection into multiplex decoder as well as for modulating the 100-MHz carrier with deviation up to 75 kHz is generated by precision circuits in the *Eico 342* FM multiplex signal generator. Channel separation is 40 dB from 200 Hz to 10 kHz, 30 dB from 50 Hz to 15 kHz. Composite signal output is continuously variable from 0 to 8 Vp-p at 1500 ohms. Internal modulation 1 kHz with less than 0.3% THD. External modulation 1 V rms into 10,000 ohms for 100% modulation. Stereo source modulation input: 1 Vrms each channel across 1 megohm for maximum output; pre-emphasis built-in. The 19-kHz crystal-controlled pilot is adjustable ±45° in phase, 0 to 15% in amplitude. Power: 117 V, 50/60 Hz.



TAPE-SPEED CHECKER uses frequency meter-type circuitry to check tape recorders for speed and drift. Made by *Leader*, the *LFM-30* can test recorder speed at 1, 2, 3, 4, 5, 6, 7, 8, 9 and 10 kHz. You can test a 2-speed recorder

using a 3-kHz tape calibrated for 3-¾ ips and then using the same tape as a 6-kHz test source for 7½ ips. Test range −3% to +3%. Input level 100 mV to 10 Vrms. Input impedance 150K.

RECTANGULAR CRT is used in this solid-state dual-trace wide-band oscilloscope that is available as the *IO-105* kit from *Heath*. You can display two separate waveforms on channels 1 and 2; channels 1 and 2 alternately; 1 and 2 chopped at a 50-kHz rate, or 1 and 2 displayed in the X-Y mode. The vertical amplifiers have input impedances of 1 megohm shunted by 35 pF and frequency response 0 to 15 MHz. They are balanced for 5° or less phase shift to 50 kHz. Rise time 23 ns; overshoot less than 10%. Attenuators have nine positions varying sensitiv-



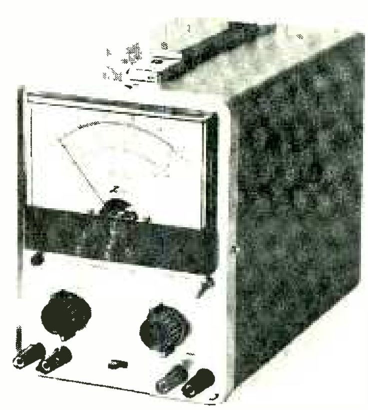
ity from 0.05 V/cm to 20 V/cm. Input sensitivity 0.05 V/cm.

The triggered horizontal time base has 18 calibrated sweep rates ranging from 0.2 μs/cm to 100 ms/cm. Sweep also continuously variable (uncalibrated) over the same range. Sweep sync delayed 600 ns; in auto mode zero crossing ±½ cm; and within viewing area in normal mode. Sync source: channel 1, channel 2 or both; polarity selectable + or − slope.

The CRT is an 8×10 cm flat-face type. The graticule is edge-lighted.

IDEAL FOR STEREO is *Leader's LMV-89* 2-channel solid-state millivolt meter. The instrument features a single meter with two independent scales and separate pointers. Especially useful where there is a great difference in the voltage levels at the two points being metered. Individual switches and amplifiers are used for the two channels. The channels can be used together or separately.

Fullscale voltages are 100 μV to 300 V in twelve steps. Decibel ranges are −80 to +52 when 0 dB = 0.775 V and −80 to +50 when 0 dB = 1.0 V. Input impedance 10 megohms shunted by 40 pF at 1 to 300 mV and by 20 pF at 1 to 300 V. Amplifier output is approximately 2.5 Vrms fullscale at 200 ohms. Power supply 115/230 V, 50/60 Hz.



detector—usually an infinite-impedance detector—that leaves the carrier whose amplitude is varying at a 60-Hz rate. A low-pass filter removes the carrier, leaving only the modulation product. The amplitude of the detected 60-Hz signal is read on the meter in terms of percentage of the high-frequency signal passed through the high-pass filter.

Intermodulation measurements are usually made at different power levels up to the amplifier's maximum power rating. Most IM meters—often called analyzers—include load resistors for the amplifier under test. The instrument's panel meter can be used as a vtvm to measure signal levels used in the test, as a wattmeter to measure amplifier power output and to measure IM distortion.

The meter used is calibrated to measure the rms value of sinewaves so the non-sinusoidal waveform resulting from the two-tone IM test will have a value higher than the single-frequency rms value. Thus, when measuring IM power levels, you must apply a correction factor to the wattmeter reading. Use a factor of 1.25 for a two-tone test with a ratio of 4:1; determine the correction factor by comparing the peak value of the signal, as observed on a scope, with the meter reading.

IM distortion measurements are valid only when the amplifier under test is flat over the range of the two test frequencies so be sure that tone controls are in the FLAT position and that scratch and rumble filters have been switched out of the circuit.

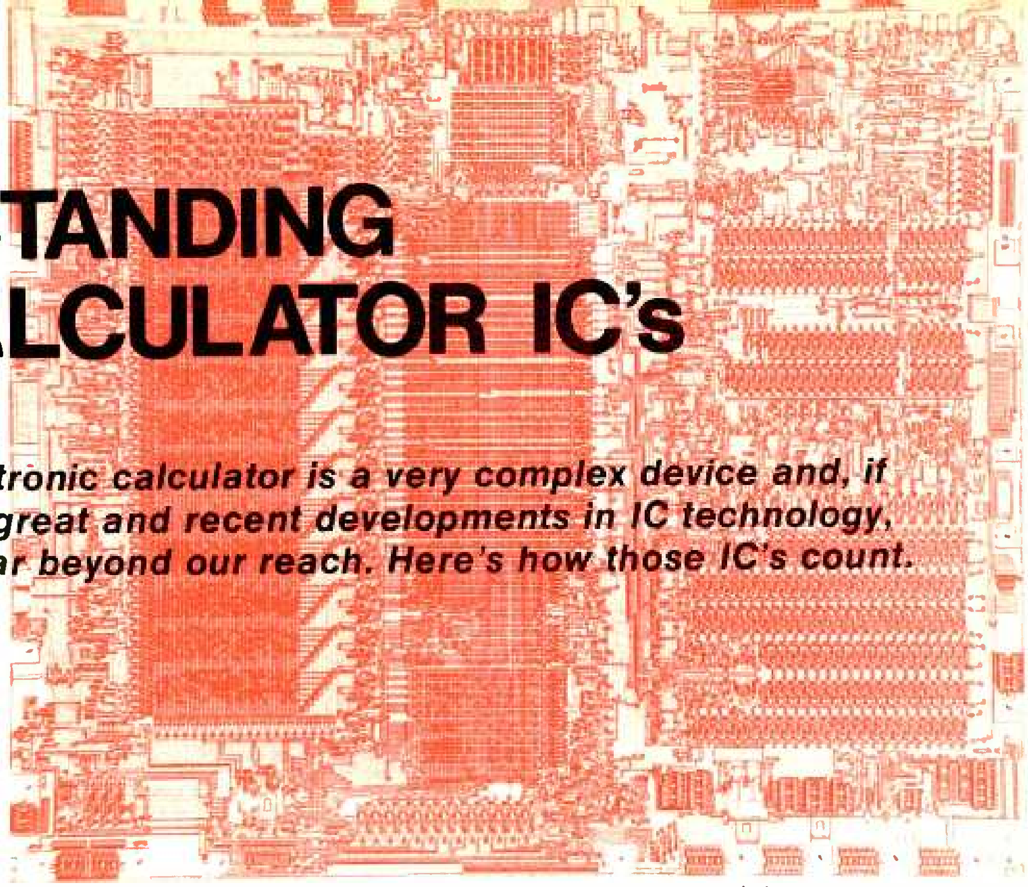
You can check phonograph cartridges for IM distortion by using one of the special test records made for this purpose as a signal source. Poor tracking due to a worn stylus or incorrect stylus alignment can cause a sharp rise in IM distortion as the stylus moves across the record. Figure 4 compares the IM distortion from a good stylus and a worn one at different points on the test record.

The ac vtvm

A main advantage of an audio voltmeter or ac vtvm over the average high-impedance multimeter is its added sensitivity, response flat within ±1 dB or better over the audio range and a wide-range dB scale.

(continued on page 74)

UNDERSTANDING CALCULATOR IC's



Basically, the electronic calculator is a very complex device and, if it were not for the great and recent developments in IC technology, it would be priced far beyond our reach. Here's how those IC's count.

by DON LANCASTER

MOST LOWER PRICED CALCULATOR SYSTEMS CONSIST OF very few parts—a display and driver assembly, a keyboard, a battery and case, a clocking system and decimal point and constant selectors, and, finally, a single integrated circuit that does all the work. A block diagram of a typical calculator is in Fig. 1. Numbers and program commands entered by the keyboard are carried out and used by the integrated circuit, and answers are then routed to the display.

Since the integrated circuit does everything, our overall system complexity changes very little if we add squares, square roots, percentages, metric conversion, etc. . . . All that happens is that the inner workings of the integrated circuit get slightly more complex, and perhaps a key or two is added. The way to understand these circuits is to understand what the IC does and how it works. Let's take a closer look.

Some basic operating principles

If we had no worries about total calculation time, supply power, circuit complexity, or the number of pins and interconnections on the package, there'd be a lot of different possible ways to do the job. But, when we take all these restrictions into account and at the same time aim at circuitry that *eventually* will sell for $19.95 or even $9.95, there's only one really good route to do the job. While best current pricing is still $29.95 and up, the inner workings and mechanical complexity of a 4-function calculator is far less than a $4 transistor radio.

What is the best route to do the job? It's based on several circuit principles:

- Serial by digit arithmetic
- Repetitive use of a simple, unsophisticated arithmetic unit to do complex functions
- Use of a multiplexed display
- Use of a scanning keyboard
- Use of a dynamic shift register *stack* to store inputs, calculation products, and answers.

Let's look at these one at a time, starting with the simpler concepts, and then going on to put the whole thing together as a working system.

Multiplexed displays

Our display typically consists of a group of light emitting diodes (LED's) or an arrangement of neon display characters, although some calculators also use miniature fluorescent display tubes or liquid crystal readouts. Regardless of the method we use, we have to select a means of driving the display that has a minimum need for power, interconnections, and storage restrictions.

If we were to display all the digits all the time, we'd need at least 80 leads for a 7-segment, 10-place display. This is clearly inefficient.

Instead, *we only display one digit at a time,* but we *sequentially* change *which* digit we display fast enough that the eye averages everything out into a continuous process. Each digit is lit to many times "normal" brightness for a fraction of the total time. The final result is a digit that is *apparently* continuously lit to normal brightness. This circuit trick is called *display multiplexing*.

Multiplexing is shown in Fig. 2. Most calculator systems internally use a 4-bit BCD (Binary Coded Decimal) code. To drive the popular 7-segment displays, the chip internally converts the 4 BCD bits into the proper 7-segment patterns.

The output of the 7-segment converter goes to *all* the digits being displayed in parallel. Now, the trick is that we use a one-of-N decoder to provide supply power or *digit line power* to only *one* entire numeral at a time. Thus, while *all* the digits know what the numeral is to be, only *one* of them receives supply power at any single instant, and only one of them lights at a time. We bring the digits information out one digit at a time, and at the same instant, we step and decide which digit line gets power. The result is a sequence of digits being lit. The sequence repeats so fast that you see everything as a continuous display.

One very handy circuit-saving trick the calculator people use is that they sequence the digits at the same rate they do the calculations and in the same order—thus our digit sequencing is essentially "free," as the numbers have to go around anyhow when a calculation is being made. When a calculation is *NOT* being made, the numbers still go around, but the internal arithmetic unit (more on this in a bit) goes into a *do-nothing* mode and does not change the contents of the *display or answer register* that is storing the number being output.

Multiplexing needs a display system that has internal diodes, thresholds, or nonlinearities. If the system was perfectly linear, you would get *sneak paths* through series combinations of supposedly off segments, causing ghosting and other problems. Light emitting diode displays are inherently diodes, and eliminate the problem, as do the nonlinearities associated with fluorescent displays. Panaplex and Sperry neon displays have a well-defined threshold that also eliminates the problem. Liquid-crystal readouts do not inherently multiplex very well, and for this reason, very few calculators use the otherwise ideal liquid crystal display systems.

Driving a display

Ideally, we'd like to come directly out of our calculator IC, and go directly to the display without needing any interface circuitry at all.

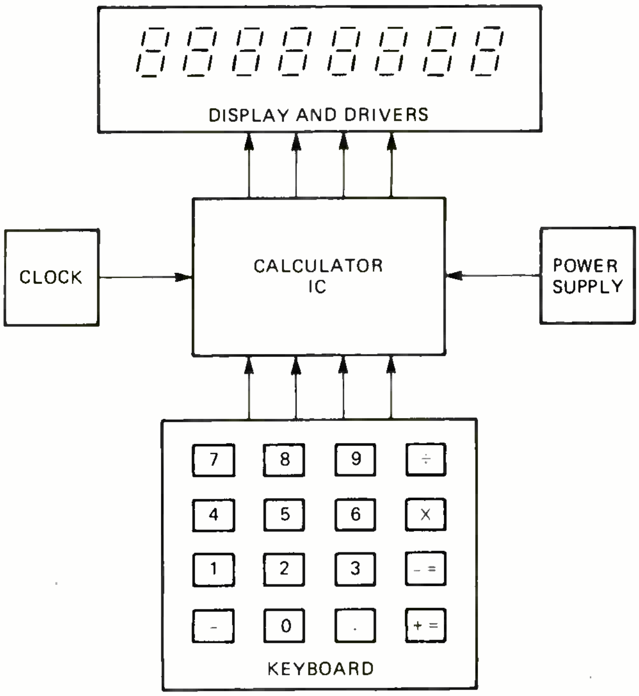


FIG. 1—CALCULATOR BLOCK DIAGRAM. Keyboard generates 4-bit BCD numerals. The clock — a multivibrator — controls operational sequence.

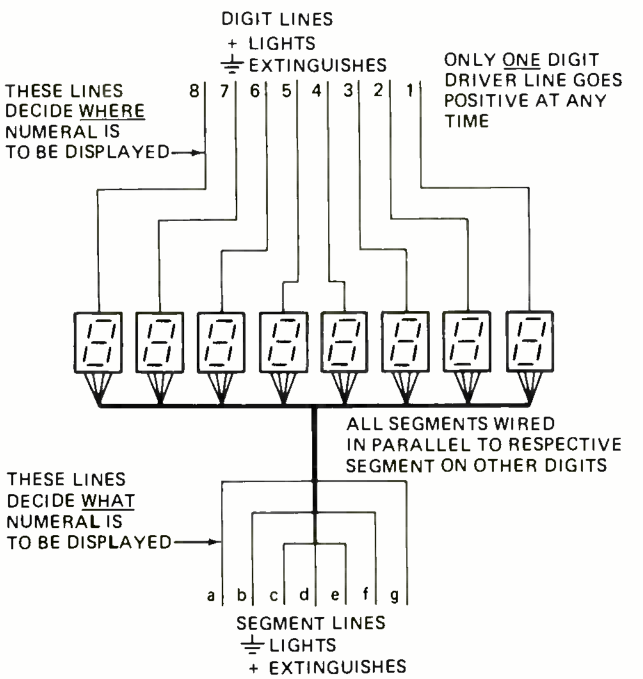


FIG. 2—THE SEVEN-SEGMENT READOUTS ARE MULTIPLEXED to reduce circuit interconnections and instantaneous power drain.

Unfortunately, every display system in use today has some interface restrictions, owing to needing more current or more voltage than a calculator IC can provide. Some typical interface circuits are shown in Fig. 3. In the case of neon-type displays (Fig. 3-a), drive voltage is usually the problem. Most neon systems need considerably more drive voltage than the calculator IC's can provide. For LED's, current is the problem, for each individual segment needs a few mils, while the digit driver lines may need several *hundred* milliamperes of drive, since a digit driver may have to drive up to 7 segments at once, and since multiplexing magnifies the peak-to-average current ratio additionally by a bunch.

Figure 3-b shows how two driver integrated circuits (the Texas Instruments 75491 and 75492 being typical) are used to drive a LED-type display. Special high-voltage integrated circuits are available for neon-type displays, or discrete circuitry consisting of Darlington connected transistors and resistors may be used.

Obviously, the $9.95 calculator won't be able to afford any inter-

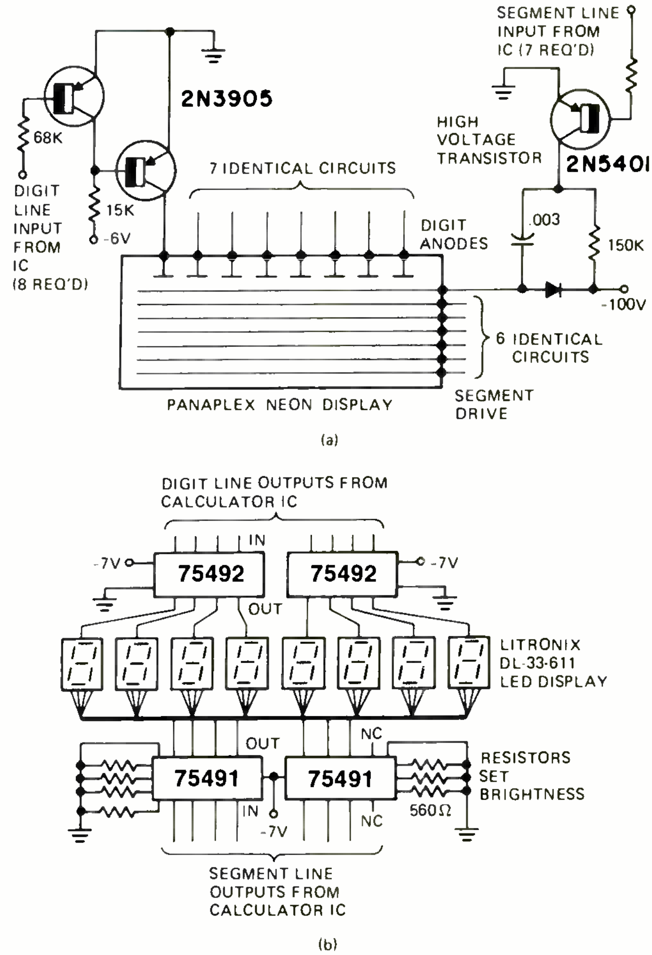


FIG. 3—DISPLAY DRIVERS ARE NEEDED when the calculator IC cannot handle the current or the voltage required by the readout.

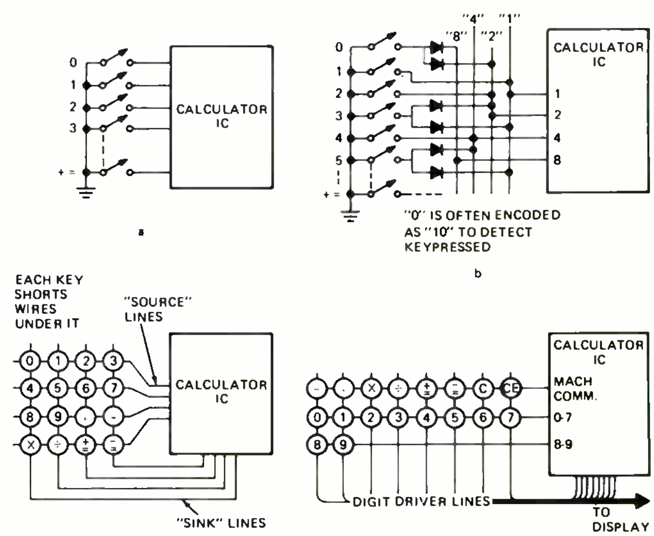


FIG. 4—KEYBOARDS MUST BE SIMPLE to minimize the number of lines and external parts. Matrix (c) and scanning types (d) are best.

face circuitry. Newer calculator IC's such as the *General Instruments* CZL-550 can directly drive some LED display segments, and a companion IC is available for digit line driving. At the same time, LED systems are becoming more efficient, and reducing their current needs to levels that are compatible with calculator IC technology. Liquid-crystal displays, with their essentially zero current consumption and low-voltage operation, should eventually dominate the calculator display market, *if and when* practical multiplexing schemes are worked out and a few other production and life problems are worked out.

With today's chips and circuitry, you still must use some sort of interface circuitry, either in the form of additional IC's, or Darlington connected transistors and resistors. The interface circuitry obviously must meet both the needs of the IC and the display, taking into account the data sheet values of each device.

Scanning keyboards

Our keyboard data entry system must use the simplest possible key switches, minimum external encoding components, and a minimum number of package pins. How can we do all this at once? Several keyboard systems we could use are in Fig. 4.

Figure 4-a shows about the worst we could do. Here, we have one common lead and one output lead for each individual key. If we had 16 keys, this would take 17 leads. We can cut down on the number of leads with a diode encoding network as in Fig. 4-b by encoding 1-of-16 to 1-2-4-8 4-line binary. This takes a bunch of diodes, but saves us on package pins. In a system of this type, we might make a "0" the equivalent of a binary "10," or 1010. This way, our "0000" state can be a do-nothing state, and any other combination indicates a key-pressed command. Thus, binary 1 through 10 would be the numbers, and binary 11 through 15 would be the add, subtract, multiply, divide, and equals commands.

We can go to the keyboard matrix of Fig. 4-c to eliminate the diodes. Here we arrange our keys in a 4 x 4 array. There are four lines *from* the calculator that *source* current; there are four lines *to* the calculator that *sink* current. Press any one key, and one of the source lines gets shorted to one of the sink lines. There are 16 possible combinations of source-to-sink shorts that may be uniquely internally recognized as a numeral or a machine command.

This eliminates the diodes, but we still need 8 input leads. Can we do any better? Remember that we already have 8, 10, or 12-digit driver lines going to our multiplexed display. If we use these in our matrix as in Fig. 4-d, we end up with a *scanning keyboard* that only needs *two* new leads for a 16-key system, and only *three* new leads for up to 24 keys if there are eight digit drivers. Pressing any one key connects one of the digit driver lines to one of the keyboard input lines. The internal circuitry recognizes the time slot of digit driver pulse, and enters the appropriate numeral or machine command. While quite a bit of internal circuitry is needed, the same circuitry also provides debouncing, minimizes the package pins needed, and eliminates any need for diodes or other encoding components.

Any given calculator chip can only work with one of the 4 systems of keyboard entry shown—the newer the chip, the more likely it will use the scanning configuration of Fig. 4-d since it is the best in terms of pins and simplified external circuitry.

Inside the chip

So, what goes on *inside* the calculator chip? There are several important circuit areas, as the block diagram on Fig. 5 shows us. These essential parts include the *memory stack*, where numbers are stored; the *arithmetic unit*, where *simple* arithmetic operations are carried out; the *microprogram*, where the simple arithmetic unit is told what to do over and over again and in what sequence; the *keyboard interpreter*, where numbers are debounced and entered and machine commands (add, subtract, multiply, equals, etc. . . .) are sorted out and used to sequence the microprogram; finally some *housekeeping* functions, such as decimal point circuitry, output BCD to 7-segment conversion, etc. . . .

There are two basically different types of memory in a calculator IC. The memory stack contains the numbers and changes from time to time, as we enter new numbers or as changes are made as a calculation is being carried out. This changeable memory is called a read-write or Random Access Memory (RAM). On the other hand, the microprogram sequencing information need never be changed, for once we teach the calculator how to sequentially perform a calculation, we henceforth and evermore want it to do the same thing. So, the microprogram is in a *fixed* data storage mode, and is called a *read-only* memory. Let's look at the memory stack first.

Remember that our multiplexed display needs something that goes round and round, sequentially putting out digits in the proper order so they can be displayed. A memory that does this is called a *shift register*, and the shift register is arranged to normally *re-circulate* its numbers by connecting output to input via a logic circuit. Calculator shift registers usually are dynamic ones; they have to be kept moving at all times or the data will be lost. Arithmetic is usually done in the 4-bit BCD code. This takes four bits per numeral, so we really have four separate but identically clocked shift registers to march the numerals around, one at a time. Such a system is called a *parallel by numeral, serial by digit* arrangement. A typical memory from a memory stack is in Fig. 6. The length of the shift register used is determined by the number of digits to be displayed, plus a sign digit, plus some possible locations for overflow and underflow digits. Regardless of its length, at any instant, all four bits of a digit appear at the output of a stack memory.

The memory is shifted or advanced one stage at a time, usually by an internally derived clock one-fourth the frequency of the system clock you provide to run the IC. It takes nine or more internal clockings to exactly once turn over the memory, depending on the number of stages in the shift register. The turn-over time is called the *machine cycle time*, and a calculator with a 25-kHz-or-so system clock would end up with a machine cycle time around 2 milliseconds or so.

If we connect a stack memory to a BCD, to-7-segment decoder, and then connect this decoder to our display, the number stored in that portion of the memory stack will be displayed.

One stack memory can only store one number. It takes more memory than that to do the job. We need an *answer* memory and a *keyboard* memory at the very least for simple addition and subtraction. If we are also to multiply and divide, we also need an *arithmetic* or *operand* memory, and, as an option, if we are to store a constant, we would need a fourth *constant* memory. So, there are three or four separate shift register memories in our memory stack, one for keyboard, one for answer, one for arithmetic, and an optional one

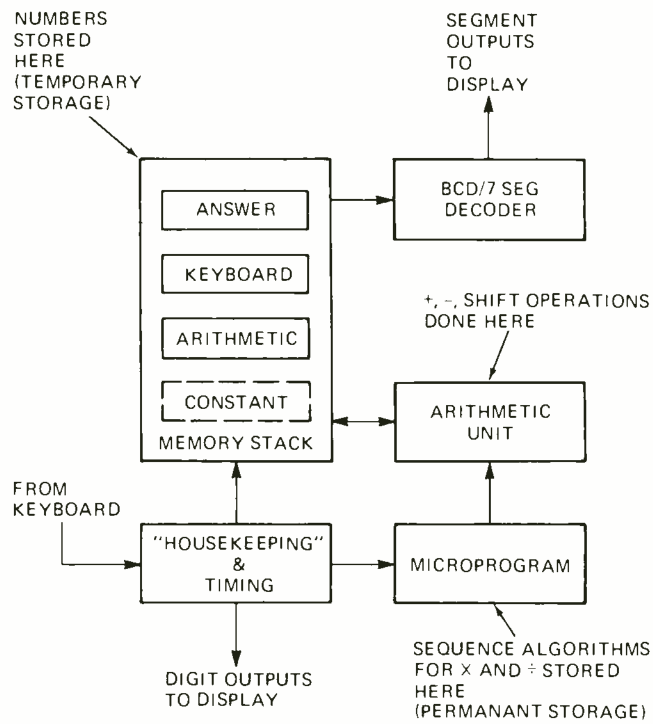


FIG. 5—INSIDE THE CALCULATOR IC. The "keyboard" section reads and sorts out input signals from the keyboard.

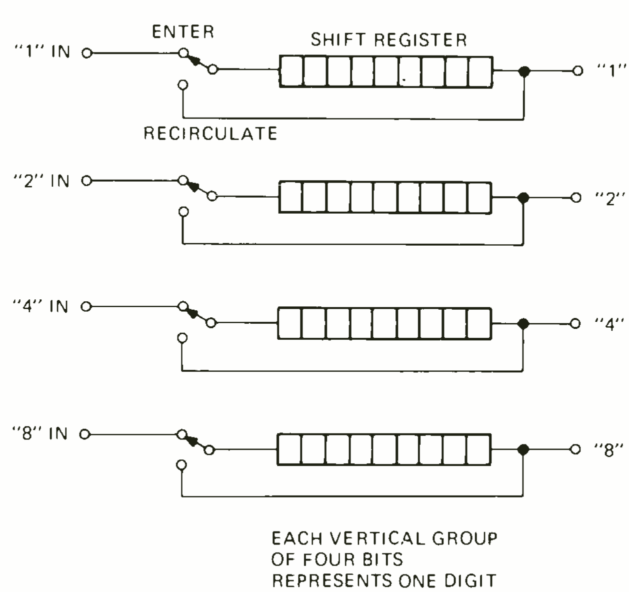


FIG. 6—TYPICAL MEMORY in memory stack. Length of shift register depends on number of numerals and sign digits to be shown.

BETTER FM TUNING

A stereo multiplex receiver must be tuned very precisely if you want the optimum channel separation and the best signal-to-noise ratio. Two unique circuits simplify tuning in new Harman-Kardon receiver.

by LEN FELDMAN

THE PERFORMANCE OF MODERN, HIGH-quality FM tuners and receivers has reached a point of near-perfection that generally exceeds the performance of a majority of FM stations' broadcast practices. There are tuners and receivers available now that can recover audio programming from the incoming signal at signal-to-noise ratios of 75 dB and better. Few station studio consoles provide that kind of signal-to-noise and hum performance.

Many tuners and receivers can decode the stereo multiplex composite signal with channel separation exceeding 40 dB, even though the FCC requires only that stations transmit separation of at least 30 dB from 50 Hz to 15,000 Hz. Harmonic distortion in modern tuners is down to a fraction of one percent, but with most music broadcast over FM coming from records and tapes, one seldom is able to take advantage of this low-distortion capability since even the best phono cartridges and tape playback machines used at broadcast stations fall short of reproducing the recorded material at such a low level of distortion.

Small wonder, then, that recent efforts in the design of new FM high-fidelity components have concentrated more on "convenience" features. These do not directly affect audible performance, but do make it easier for the user to take advantage of the superb performance capability built into these products. Harman-Kardon's new model 900+, shown in Fig. 1, has two interesting circuits which are worth noting—both of which are directed towards more accurate and better tuning of FM stations.

The two circuits analyzed here *replace* the conventional signal-strength meter and center-of-channel meter so common in better quality FM receivers and tuners. Although a tuning meter is clearly visible in the front-panel photo of the 900+ quadriphonic receiver, its function and mode of operation is quite different from that of meters normally called signal-strength tuning meters.

Typically, conventional signal-strength meters obtain the voltage necessary for their pointer's deflection from either an i.f.-agc voltage (which, of course, increases with increased signal strength) or from a rectified portion of the 10.7-MHz i.f. signal obtained at the output of the first or second limiter in the FM i.f. system as shown in Fig. 2. The disadvantage of this kind of signal-strength indicator is that it is difficult to determine the exact center-of-channel point because the

FIG. 1—FRONT PANEL VIEW of Harman-Kardon model 900+ quadriphonic receiver.

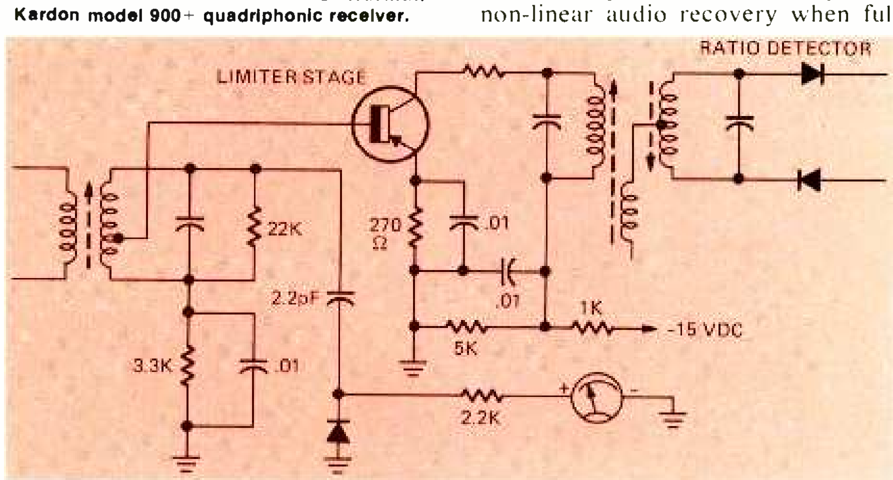


FIG. 2—CONNECTION POINT FOR TYPICAL "signal-strength" FM tuning meter.

"maximum" indication follows the typical limiter voltage curve which, in a wideband limiter, has a poorly defined and broad maximum value. Furthermore, maximum indication on this type of meter does not necessarily correspond to best received audible signal, if by best received signal we mean the signal tuned to greatest degree of quieting.

Ratio detector circuits used in modern FM tuners lend themselves to a fairly simple metering system which works better for center-of-channel tuning. Since the ratio detector circuit shown in Fig. 3 has a dc output as well as a demodulated audio output and since the dc value at the center-tapped tertiary winding of the secondary of the transformer will be zero when the tuner is correctly tuned to exactly 10.7 MHz, a suitable dropping resistor and a center-pointer meter can be connected as shown.

Now, when the set is detuned either above or below 10.7 MHz, the meter pointer deflects either to the left or to the right of its center point. Generally, this meter action is easier to use when seeking center-of-channel tuning. However, it too has its limitations. The peak-to-peak value of the ratio detector "S"-curve shown in Fig. 4 may well be 2 volts or more and the meter's total excursion is so small that visual centering of the pointer may well occur over a range of a significant fraction of a volt—enough of an error to permit non-linear audio recovery when full ±75-kHz modulation occurs in the transmitted signal.

A quieting meter

The meter used in the H-K 900+ is totally different from ordinary signal-strength *or* center-of-channel tuning meters. Harman-Kardon calls it a quieting meter because it actually responds to the degree of noise quieting offered by the tuner in amplifying and receiving an FM signal. The entire circuit board schematic involved in both the quieting meter operation and the new "in-tune" indicator of this receiver is shown in Fig. 5.

The output of the conventional ratio detector is first fed to a dc differential amplifier consisting of Q102, Q103 and

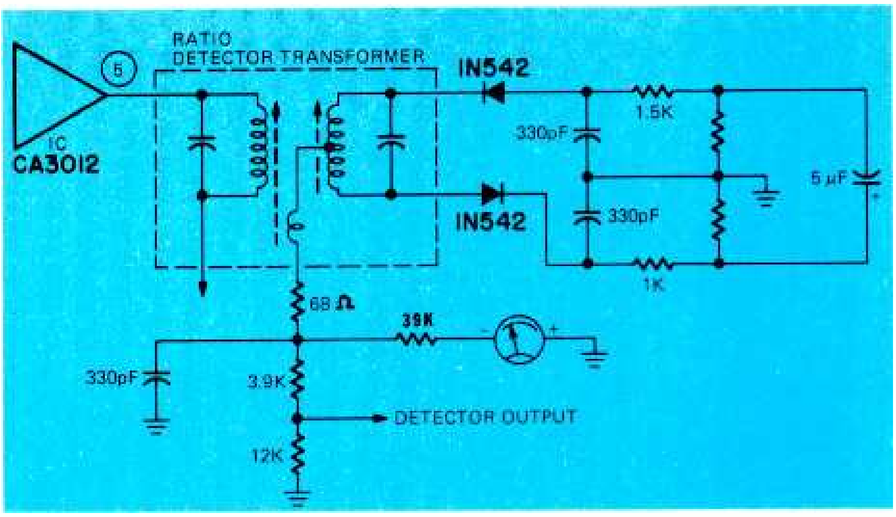


FIG. 3—CONNECTION POINT FOR CONVENTIONAL "center-of-channel" FM tuning meter.

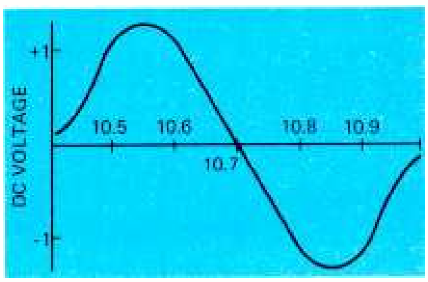


FIG. 4—TYPICAL RATIO-DETECTOR "S" curve swings over wide positive and negative dc voltage range. For proper tuning, 0 dc point must be exactly 10.7 MHz as shown.

Q104. In addition to affording accurate dc offset control (by means of VR101), stable temperature tracking and isolation from the circuits which follow, this arrangement also provides the opportunity for frequency compensation so that the effective output of the FM demodulator has flat response all the way from dc to 100 kHz, important for the multiplex decoding circuitry to follow later.

This composite signal is fed via C201 to gain control VR201 and on to a T-section filter consisting of C204, L201, C203 and C205. This high-pass filter has a voltage gain of several dB at noise frequencies of about 110 kHz while effectively rejecting all lower frequencies of the composite stereo audio signal. The random-noise frequencies are passed on to a high-gain feedback pair of transistors, Q201 and Q202. With no rf signal received (condition of maximum random noise), the peak-to-peak voltage at the output of Q202 is quite high, approaching 30 volts. R208 and Q203 form a voltage-variable attenuator in what amounts to an agc loop while Q204 and Q205 are another high-gain pair of transistors with a feedback network around them. The collector load of Q205 is tuned to 110 kHz.

The amplified noise is applied to C210, D201, D202 and C212, the combination of which acts as a peak-detector-voltage doubler. Q206 serves as a dc buffer amplifier and the output of its emitter completes the agc loop back to Q203. The dc voltage output from Q206 applied through R215 and D203 converts this agc voltage to a diode-drop log characteristic, a characteristic which is important to the ultimate operation of the quieting meter. The resultant dc voltage is then applied to dc buffer-amplifier Q207, the emitter circuit of which drives the quieting meter. VR202 is used to calibrate the meter which reads *downscale* as quieting improves with signal reception. With no signal received, the meter pointer reads "O" at the right of the scale.

As signal is received (and "quieting" improves), the pointer moves downscale along a calibration of numbers reading from zero to ten at the extreme left of the scale. The circuitry described is so arranged that the readings correspond almost linearly (in dB) to the actual quieting obtained.

An "In-Tune" light indicator

The schematic of Fig. 5 also shows how another novel circuit of the H-K 900+ receiver works. Transistor stages Q213 through Q219 are used to trigger on an IN TUNE lamp located on the receiver's front panel. The dc voltage output from the ratio-detector (via differential amplifier Q102, Q103 and Q104 described earlier) is direct-coupled via voltage-divider resistors R201, VR205 and R230 to the base of Q213 across base resistor R231 (3.3 K). VR206 is used to set perfect dc zero voltage or a balanced condition between the differential amplifier pair Q213 and Q214.

When the dc voltage at the ratio detector output is close enough to "zero" (actually within about ±10 mV) so that the set is considered to be "in tune," the voltage across both R232 and R233 is less than the V_{be} of either Q215 or Q216. Under these circumstances neither Q215 or Q216 conducts significantly and the voltage across R237 is near zero. If the receiver is detuned so that *either* a positive or negative voltage exceeding 10 mV appears at the ratio-detector output point, the voltage across R232 *or* R233 exceeds the V_{be} of Q215 and Q216 and one or the other of these transistors conducts heavily (into saturation), causing a potential to develop across R237.

Note that Q217 is hooked up not as a transistor, but rather as a diode. In fact, it exhibits the characteristics of a Zener diode, but has a non-critical breakdown voltage of anywhere from 4 to 9 volts dc. When breakdown voltage is reached, that voltage is applied to the base of Q218, which then conducts heavily, reducing the voltage at the collector of Q218, which then conducts heavily, reducing the voltage at the collector of Q218 and at the base of Q219. Q219 is therefore cut off and collector current is shut down so that the in-tune lamp is not illuminated.

The reverse action takes place when the receiver is in tune. With little or no voltage developed across R237, Q217 (the "Zener Diode") remains below breakdown voltage, Q218 conducts only slightly so that the voltage at its collector is high enough to cause Q219 to conduct and turn on the IN TUNE lamp on the front panel. The action is that of a true gating circuit and the width of the "in-tune window" can be calibrated at the factory so that the user does not find it too critical a task to tune to a station and yet be assured of low-distortion reception when the in-tune light is on.

Though VR205 shown in the schematic on Fig. 5 is not depicted as a variable potentiometer, in the actual receiver it is adjustable (hence the designation VR – instead of just plain R –) and its adjusted value determines the percentage of total dc swing of the radio detector that should be applied to this novel circuit. Differential amplifier pairs Q213/Q214 and Q215/Q216 operate so that regardless of whether the tuning error results in a positive or negative dc voltage at the output of the ratio detector, the end result is always a positive voltage developed across resistor R237. Figure 6 further clarifies the gating action.

The additional transistor stages not used or described in connection with either the quieting meter or IN-TUNE light circuits are involved in the muting and stereo-threshold switching circuits of the 900+. Q208 and Q209 comprise a Schmitt trigger circuit which, in combination with Q210, determines at what signal strength the stereo demodulation circuitry should be "turned on." VR203 is used to adjust this sensitivity and is accessible to the user from beneath the chassis. Q211 and Q212 constitute a second Schmitt trigger with the voltage at the output of the "Zener

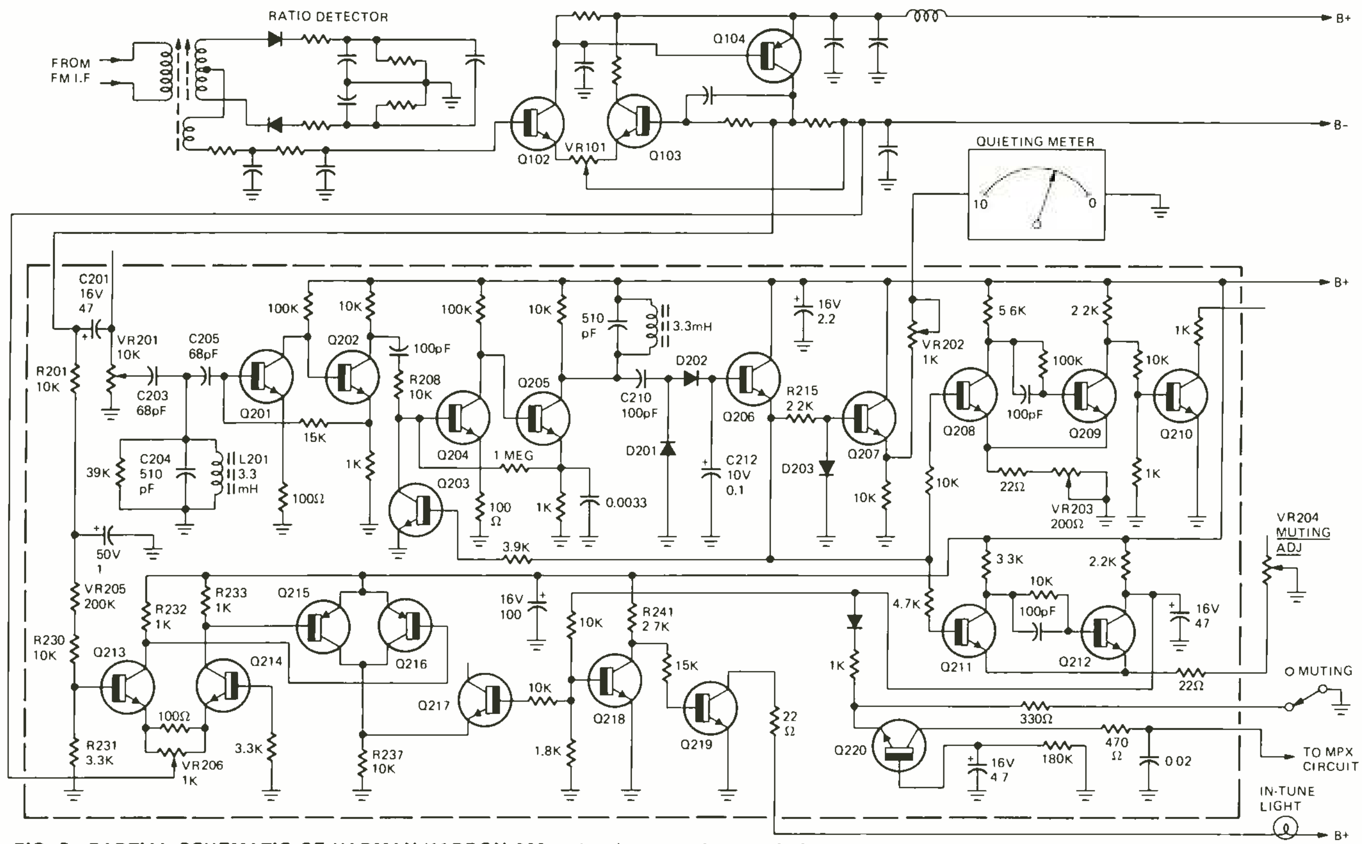


FIG. 5—PARTIAL SCHEMATIC OF HARMAN-KARDON 900+ showing complete "quieting meter" and "in-tune light" circuits.

diode" Q217 acting to trigger the circuit. Sensitivity of this circuit, however, is adjusted independently with a rear panel potentiometer, VR204. Thus, the user may *hear* an audio signal with the muting switch in the on position well before the IN TUNE light becomes illuminated. If the program is one he desires to listen to, he then proceeds to tune more carefully until the IN TUNE light goes on—otherwise, he can quickly pass it by and proceed to the next station which defeats the muting circuit. Any other arrangement would have resulted in an extremely tedious and long process when using the muting feature.

The combination of quieting meter and IN TUNE light indicator on this receiver is *not*, as might first appear, a redundant situation. Ideally, if the user is equipped with a rotator for his atenna (or can send a friend up to the roof to do it the hard way), the quieting meter's most important function is in helping to orient the antenna for best (and that means *quietest*) reception. Since quieting is often directly affected by multipath reflections (out-of-phase arrival of reflected signals can often cause cancellation of signal and noisy reception), the smooth action of this meter arrangement beats trying to use a conventional "signal-strength" meter which, in most receivers, hits top reading point at 40 or 50 mV—often well before maximum quieting is reached.

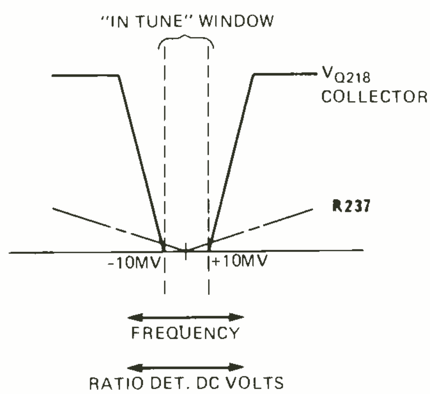


FIG. 6—VOLTAGE RELATIONSHIPS at individual points in "in-tune" circuit.

Once the best signal is delivered to the antenna terminals, the IN TUNE light then insures that the user is properly tuned to it for lowest distortion and best separation if it happens to be a stereo signal. **R-E**

International friendship theme of ARRL National Convention

"International Friendship through Amateur Radio" is the major theme of the National Convention of the American Radio Relay League, to be held at the Waldorf-Astoria Hotel, New York City, July 19 through July 21. A secondary theme is "Building for the Amateur Radio Operator of Tomorrow."

As in the many former conventions of the League, which has represented the radio amateur since before World War I, the meeting will feature authoritative papers and discussions on ham subjects, and also the usual social activities of a ham gathering.

ISCET starts technical library of electronic information

"An international Technical Electronic Clearing House (TECH)" is the way librarian Henry V. Golden, CET, describes the newest move of the International Society of Certified Electronic Technicians (USCET). The library just started will be, he says, "a depository of otherwide unavailable technicial information, a place where you can deposit that valuable—maybe only one of a kind—piece of technical information, that will still be available to you, yet be a means of getting a fellow craftsman out of trouble."

ELECTRONIC TECHNICIANS DISCUSS the electronic clearing house and look over the literature that has arrived at the new library.

Mr. Golden reports to the NESDA and ISCET constituency that he is ready to receive help in the program, in the form of any and all new electronics textbooks, service manuals, all old issues of trade and technical magazines, as well as service manuals and diagrams of old test equipment. The address is ISCET/TECH, 8017 Paseo, Kansas City, MO 64131.

More information on how you can give and receive aid will be available by the time this appears, he says. Write for it to the same address.

Grid-clamps; diodes and VDR's

A very simple form of high-voltage regulation is used in some sets (mostly the smaller screen types, with lower high voltage). This uses a diode rectifier, in the grid return circuit of the horizontal output tube. Figure 3 shows a typical circuit. The diode (D1) is biased by a resistor network back to B-plus. The pulse from the flyback will cause the diode to conduct whenever the voltage goes above the bias level. The diode conducts and charges the capacitor. This is a negative voltage. It's fed to the bottom of the horizontal output tube grid resistor.

If the high voltage tries to rise, the pulse voltage also rises. This makes the diode develop a higher negative voltage. This is fed to the grid as a higher negative voltage. This cuts down conduction of the tube and the output drops back.

The VDR clamp

You'll find VDR's (Voltage Dependent Resistors) used in some of these circuits. These are rather special resistors. When the voltage across them rises, their resistance goes down. So, they will actually act as "rectifiers" if a high-amplitude pulse is fed across them. The resulting dc voltage will have the same polarity as the applied pulse. If this is a negative-going pulse, a negative dc voltage will appear, etc. Figure 4 shows a schematic of this type.

You will find this circuit used in addition to the pulse regulators in quite a few sets. Here, its main purpose is as a high-voltage hold-down circuit, to meet the HEW regulations on high-voltage supplies.

If the regulator is working normally, and the output tries to rise beyond the range of the regulator, the extra pulse amplitude will

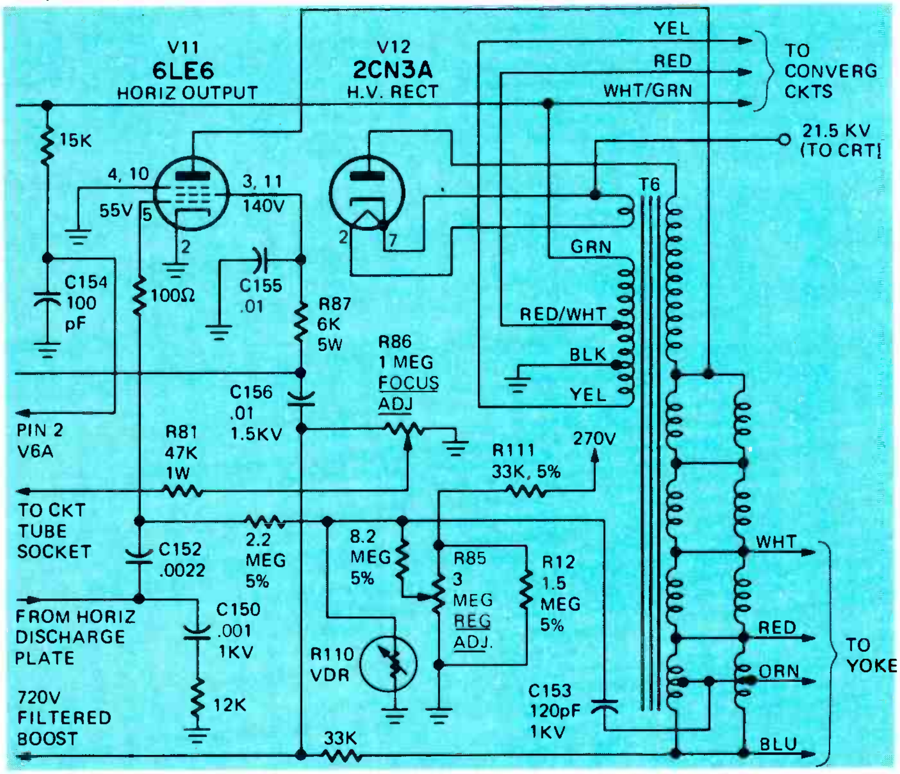


FIG. 4—VOLTAGE DEPENDENT RESISTOR R110 acts as a rectifier of flyback pulses to develop partial bias for the horizontal output grid. This is a hold-down circuit.

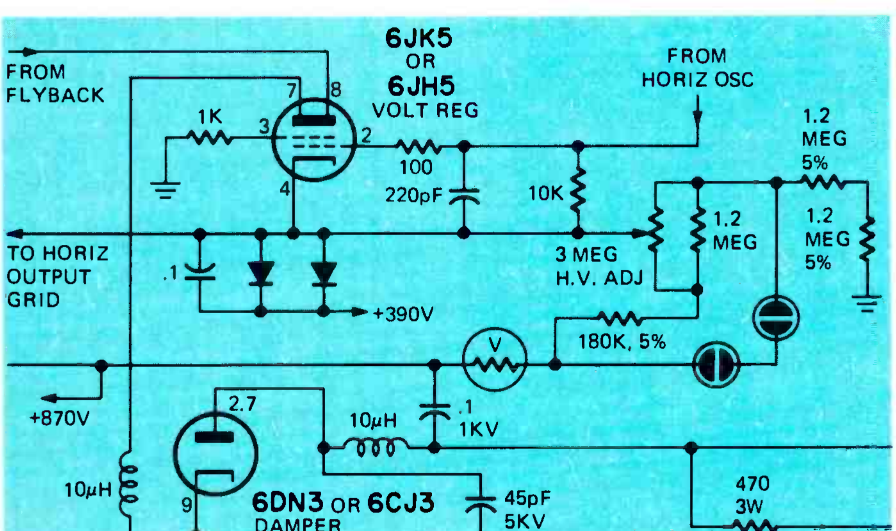


FIG. 5—HIGH-VOLTAGE HOLD-DOWN CIRCUIT used in some pulse-type high-voltage regulators. Neon lamps limit the high voltage if the adjustable control shorts.

be converted into added negative bias on the horizontal output tube. This will definitely keep the high voltage from exceeding safe limits. You'll find VDR's used in the grid bias networks of pulse regulator circuits for the same reason. Here, they signal an increase in voltage by changing the regulator grid bias.

You'll find some interesting circuits in these hold-downs. For one example, in the Zenith 20CC50 and 25CC50 series, a pair of neon lamps is connected in series across the HV ADJUST control. If the control shorts at the low side, the high voltage could increase. With the neons in the circuit, the increased voltage drop fires them. This loads the circuit and prevents the high voltage from rising. This is shown in Fig. 5. Note another interesting thing: the 6JK5 and 6JH5 pulse regulator tubes used here have dual plate pins. The current through the damper is connected in series with the high-voltage regulator plate! If the regulator tube is pulled from the socket, no current can flow through the damper, and the sweep/high-voltage system is disabled. In still others, the heaters of the high-voltage regulator and damper are connected in series. If either one burns out, the system is again disabled completely.

Checking high-voltage regulators

These circuits are actually quite easy to test. All you need is vom or vtvm with a high-voltage probe. Read the high voltage; then turn the brightness up and down. If the high voltage stays within the limits given (24 to 25 kV), it's working. Variation should not exceed more than ±1 kV.

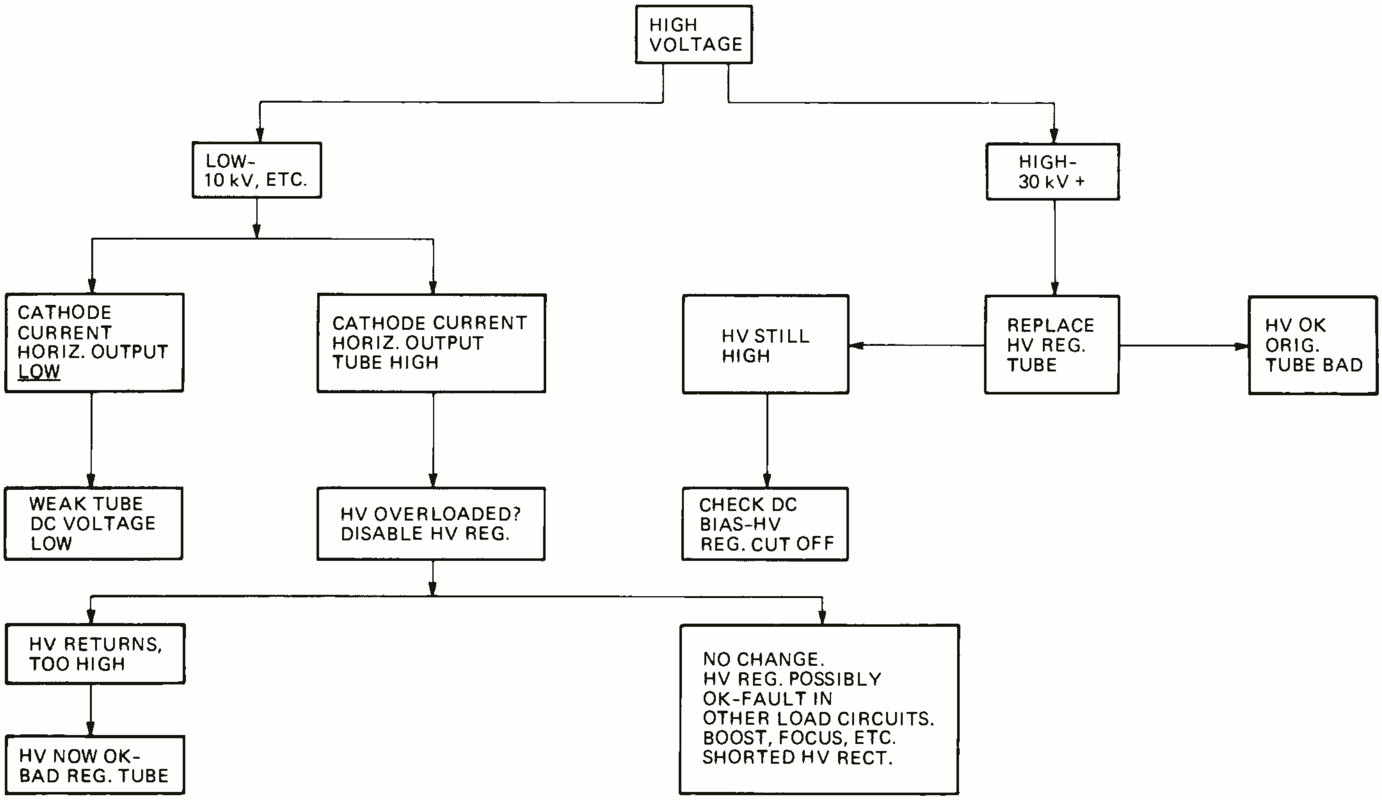
If the high voltage reads low, and you also have excessive cathode current in the horizontal output tube, the high-voltage regulator may have incorrect bias on it. This will cause an overload. It can happen in all types of high-voltage regulators if the dc voltages are off.

The old shunt regulators are the easiest to check. Just pull the plate cap off the regulator tube (place it where it can't arc to ground if the high voltage does come back). Recheck. If your high voltage rises to about 30 kV, the regulator is overloading it. Screen brightness and focus should be close to normal. Try a new regulator tube. If this still doesn't clear it up, go to the dc voltages on the regulator.

In practically all circuits using this circuit, you'll find a 1 k resistor in series with the cathode of the regulator tube. This is for ease in reading the regulator cathode current. Just connect a vom *across* the 1 k resistor, and set it on a low dc voltage scale. For each 1.0 mA of current flowing, you'll see a 1.0-volt deflection of the meter.

For practically all of these sets, using 6BK4's and similar tubes, normal regulator current should *never* be more than about 1.0 mA, with the pucture tube screen dark (maximum current flowing in regulator). This should drop to about 0.1 or 0.2 mA with the brightness full up. If you see more than 1.5 to 2.0 mA with a bright screen, the regulator is taking too much current. This will overload the high-voltage supply, and you'll probably see an overload of cathode current in the horizontal output tube, too.

Most of this trouble will be caused by drift in the matched pair of resistors in the regulator grid. Leakage in the small capacitor connected from grid to cathode of the regulator will also do it. If this capacitor shorts, you'll have zero grid bias, and the regulator



TROUBLESHOOTING CHART helps you find and eliminate defects in high-voltage regulator circuits fast and efficiently.

will conduct very heavily. The 6BK4 plate will probably get red hot. This has been known to blow horizontal output tubes, and even burn up flybacks.

The pulse regulator tubes can be checked in much the same way. In cases where the high voltage is far too high, and the HV ADJUST control won't bring it down, even if it *does* make it vary, check the dc voltages on grid and cathode. In one typical set, the grid voltage was found to be +200 volts. Since the cathode had +390 volts, the regulator grid had a −190-volt bias! This is enough to make the tube cut off completely. Normal grid voltage is +345 volts, giving a −45-volt bias. The regulator was doing nothing, so the high voltage went up to around 30 kV. This was due to a faulty resistor.

Diode clamp and hold-down circuits can be tested in the same way. Check to find out exactly *what* the thing is doing. Does it have normal high voltage, very low high voltage, or what? Read the grid voltage of the horizontal output tube. In most sets, this will be about −55 to −60 volts. If you read −100 volts or even more, you have some kind of trouble in the grid bias circuitry. See if you read a higher negative voltage across the control diode than you get at the grid. You can ground the bottom end of the horizontal output tube's grid resistor. If this brings the grid voltage back to almost normal, check the bias control circuits.

Check diodes for leakage or opens; also, since the control voltage is developed across the little capacitor, as a negative charge, check this for an open. Scope the diode to see that the flyback pulse is there. Average amplitude runs around 200 volts p-p.

The key tests for trouble in this circuit will be *both* the high voltage itself and the cathode current of the horizontal output tube. If you see low high voltage, and the cathode current is also well below normal, say about 100 mA (200 mA is normal, average), this would point to a weak horizontal output tube, low dc voltages, or something in that area. Low grid drive on the horizontal output tube will show low grid voltage, and increased cathode current. Check the horizontal oscillator.

Do *NOT* try to read the pulse on the plate of a pulse regulator tube. This is definitely a *DO NOT MEASURE* point; you'll have the same pulse there as on the yoke; around 5 kV. To check this, just hold the scope probe near it. You'll have plenty of stray pickup to tell whether your pulse is normal. Check a few sets that work, to see about what kind of waveform you would see at this point.

Limit switches or lockouts

In quite a few of the newer solid-state color TV sets, you'll find "latching" or "lock-out" high-voltage circuits used. These will be triggered by a rise in high voltage. When they're fired, they disable some circuit. In most of them, it will stay off until the set is repaired. One version kills the horizontal oscillator, by killing its dc voltage supply. A small SCR is used; it's connected as a "crowbar short" across the +24 V. This is fed by dc; when it is gated on, it stays on.

The set must be turned off, and left for about half a minute. The charge leaks off the circuit, and the SCR turns off. So if you find a set where turning the BRIGHTNESS control up and down makes the raster go out, this is probably what's doing it. Check out the regulator, which will be in the *low-voltage* supply in these chassis. In some cases the SCR trips a little too fast. Try a new one, and see if there are any factory modifications to eliminate false tripping.

Resistors, of course, can be checked with an ohmmeter. VDR's must be substituted; they can be checked but it is a long process! Besides, no one ever gives you any spec's on VDR; just the part number! R-E

R-E's Substitution guide for replacement transistors

PART XVII

compiled by

ROBERT & ELIZABETH SCOTT

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

DM—D. M. Semiconductor Co P.O Box 131, Melrose, Mass. 02176

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

ICC—International Components, 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

WOR—Workman Electronic Products, Inc., Box 3828, Sarasota, Fla. 33578

ZEN—Zenith Sales Co., 5600 W. Jarvis Ave., Chicago, Ill. 60648

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	DM	G-E	ICC	IR	MAL	MOT	RCA	SPR	SYL	WOR	ZEN
2N3554	NA	TS-3001	NA	ICC-S0001	IRTR-65	PTC 144	HEP-S3001	NA	NA	NA	WEP 712	NA
2N3563	RS276-2015	NA	GE-61	ICC-720	IRTR-70	PTC 115	HEP-720	SK 3018	RT-108	ECG 107	WEP 720	ZEN 109
2N3564	RS276-2015	T-720	GE-20	ICC-720	TR-21	PTC 121	HEP-720	SK 3018	RT-108	ECG 107	WEP 720	ZEN 109
2N3565	RS276-2009	T-55	GE-62	ICC-55	TR-21	PTC 139	HEP-55	SK 3124	RT-102	ECG 123A	WEP 55	ZEN 103
2N3566	RS276-2009	T-55	GE-62	ICC-55	IRTR-51	PTC 153	HEP-55	SK 3124	RT-102	ECG 123A	WEP 55	ZEN 103
2N3567	RS276-2009	T-736	GE-20	ICC-736	TR-25	PTC 123	HEP-736	SK 3024	RT-114	ECG 128	WEP 736	ZEN 120
2N3568	RS276-2009	T-736	GE-18	ICC-736	IRTR-87	PTC 123	HEP-736	SK 3124	RT-114	ECG 128	WEP 736	ZEN 120
2N3569	RS276-2009	T-736	GE-20	ICC-736	IRTR-87	PTC 123	HEP-736	SK 3024	RT-114	ECG 128	WEP 736	ZEN 120
2N3570	NA	T-56	NA	NA	IRTR-83	PTC 127	NA	SK 3018	RT-113	ECG 108	WEP 56	NA
2N3571	NA	T-709	NA	ICC-709	IRTR-83	PTC 127	HEP-709	SK 3018	RT-113	ECG 108	WEP 709	ZEN 105
2N3572	NA	T-709	NA	ICC-709	IRTR-83	PTC 127	HEP-709	SK 3018	RT-113	ECG 108	WEP 709	ZEN 105
2N3573	NA	T-803	NA	ICC-803	NA	NA	HEP-803	NA	NA	NA	NA	NA
2N3574	NA	T-803	NA	ICC-803	NA	NA	HEP-803	NA	NA	NA	NA	NA
2N3575	NA	T-803	NA	ICC-803	NA	NA	HEP-803	NA	NA	NA	NA	NA
2N3576	RS276-2023	T-52	GE-20	ICC-52	TR-20	NA	HEP 52	NA	RT-126	ECG 106	WEP 52	NA
2N3579	RS276-2023	T-52	GE-21	ICC-52	TR-31	PTC 103	HEP-52	SK 3114	RT-115	ECG 159	WEP 52	NA
2N3580	RS276-2023	T-52	GE-21	ICC-52	TR-31	PTC 103	HEP-52	SK 3114	RT-115	ECG 159	WEP 52	NA
2N3581	RS276-2023	T-52	GE-21	ICC-52	TR-31	PTC 103	HEP-52	SK 3114	RT-115	ECG 159	WEP 52	NA
2N3582	RS276-2023	T-52	GE-67	ICC-52	TR-31	PTC 127	HEP-52	SK 3114	RT-115	ECG 159	WEP S3052	NA
2N3583	NA	TS-3021	GE-12	ICC-S3021	NA	PTC 144	HEP-S3021	SK 3021	RT-128	ECG 124	WEP S3021	ZEN 208
2N3584	NA	T-240	GE-66	NA	NA	PTC 144	NA	SK 3021	NA	ECG 124	WEP 701	NA
2N3585	NA	T-240	GE-66	NA	NA	PTC 144	NA	SK 3021	NA	ECG 124	WEP 701	NA
2N3587*	NA	T-736	NA	ICC-736	TR-21	PTC 123	HEP-736	NA	NA	NA	WEP 736	ZEN 120
2N3588	RS276-2003	T-3	GE-50	ICC-3	TR-17	PTC 107	HEP-3	SK 3006	NA	ECG 160	WEP 3	ZEN 301
2N3589	NA	TS-3021	GE-32	ICC-S3021	NA	NA	HEP-S3021	NA	NA	NA	WEP S3021	ZEN 208
2N3590	NA	TS-3021	GE-32	ICC-S3021	NA	NA	HEP-S3021	NA	NA	NA	WEP S3021	ZEN 208
2N3591	NA	TS-3021	GE-32	ICC-S3021	NA	NA	HEP-S3021	NA	NA	NA	WEP S3021	ZEN 208
2N3592	NA	TS-3021	GE-32	ICC-S3021	NA	NA	HEP-S3021	NA	NA	NA	WEP S3021	ZEN 208
2N3593	NA	TS-3021	GE-32	ICC-S3021	NA	NA	HEP-S3021	NA	NA	NA	WEP S3021	ZEN 208
2N3594	NA	TS-3021	GE-32	ICC-S3021	NA	NA	HEP-S3021	NA	NA	NA	WEP S3021	ZEN 208
2N3595	NA	TS-3021	NA	ICC-S3021	NA	NA	HEP-S3021	NA	NA	NA	WEP S3021	ZEN 208
2N3596	NA	TS-3021	NA	ICC-S3021	NA	NA	HEP-S3021	NA	NA	NA	WEP S321	ZEN 208
2N3600	RS276-2011	T-56	GE-17	ICC-56	IRTR-95	PTC 133	HEP-56	SK 3018	RT-113	ECG 108	WEP 56	ZEN 104
2N3605	RS276-2009	T-55	GE-20	ICC-55	TR-24	PTC 136	HEP-55	SK 3019	RT-102	ECG 123A	WEP 55	ZEN 103
2N3606	RS276-2009	T-709	GE-20	ICC-55	TR-24	PTC 136	HEP-55	SK 3019	RT-102	ECG 123A	WEP 55	ZEN 103
2N3607	RS276-2009	T-50	GE-20	ICC-50	NA	PTC 136	HEP-50	SK 3019	RT-102	ECG 123A	WEP 50	ZEN 100
2N3608	NA	T-803	GE-FET-1	ICC-803	NA	PTC 152	HEP-803	NA	NA	NA	NA	NA
2N3611	RS276-2006	T-230/232	NA	ICC-230/232	TR-01	PTC 105	HEP-230/232	SK 3009	RT-127	ECG 121	WEP 232	ZEN 325/326
2N3612	RS276-2006	T-232	NA	ICC-232	TR-01	PTC 105	HEP-232	SK 3009	RT-127	ECG 121	WEP 232	ZEN 326
2N3613	RS276-2006	T-230/232	NA	ICC-230/232	TR-01	PTC 105	HEP-230/232	SK 3009	RT-127	ECG 121	WEP 232	ZEN 325/326
2N3614	RS276-2006	T-232	NA	ICC-232	TR-01	PTC-105	HEP-232	SK 3009	RT-127	ECG 121	WEP 232	ZEN 326
2N3615	RS276-2006	T-232	NA	ICC-232	TR-01	PTC 105	HEP-232	SK 3009	RT-127	ECG 121	WEP 232	ZEN 326
2N3616	RS276-2006	T-625	GE-16	ICC-625	TR-01	PTC 105	HEP-625	SK 3009	RT-127	ECG 121	WEP 232	NA
2N3617	RS276-2006	T-232	NA	ICC-232	TR-01	PTC 105	HEP-232	SK 3009	RT-127	ECG 121	WEP 232	ZEN 326
2N3618	RS276-2006	T-625	GE-16	ICC-625	TR-01	PTC 105	HEP-625	SK 3009	RT-127	ECG 121	WEP 232	NA
2N3619	NA	TS-3002	GE-28	ICC-S3002	NA	NA	HEP-S3002	NA	NA	NA	WEP S3002	NA
2N3620	NA	TS-3020	GE-28	NA	NA	NA	NA	NA	NA	NA	WEP S3023	NA
2N3621	NA	TS-3020	GE-66	NA	NA	NA	NA	NA	NA	NA	WEP 701	NA
2N3622	NA	TS-3020	GE-66	NA	NA	NA	NA	NA	NA	NA	WEP 701	NA
2N3623	NA	TS-3020	GE-28	ICC-S3002	NA	NA	HEP-S3002	NA	NA	NA	WEP S3002	NA
2N3624	NA	TS-3020	GE-28	NA	NA	NA	NA	NA	NA	NA	WEP S3002	NA
2N3625	NA	TS-3020	GE-66	NA	NA	NA	NA	NA	NA	NA	WEP 701	NA
2N3626	NA	TS-3020	GE-66	NA	NA	NA	NA	NA	NA	NA	WEP 701	NA
2N3627	NA	TS-3020	GE-66	ICC-S3002	NA	NA	HEP-S3002	NA	NA	NA	WEP S3002	NA
2N3628	NA	TS-3020	GE-28	NA	NA	NA	NA	NA	NA	NA	WEP S3023	NA
2N3629	NA	TS-3020	GE-66	NA	NA	NA	NA	NA	NA	NA	WEP 701	NA
2N3630	NA	TS-3020	GE-66	NA	NA	NA	NA	NA	NA	NA	WEP 701	NA
2N3632	NA	T3-3007	GE-66	ICC-S3007	IRTR-66	NA	HEP-S3007	NA	NA	NA	NA	NA
2N3633	RS276-2011	T-56	GE-66	ICC-56	IRTR-80	PTC 136	HEP-56	SK 3039	RT-113	ECG 108	WEP 56	ZEN 104
2N3638	RS276-2021	T-716	GE-22	ICC-716	TR-20	PTC 103	HEP-716	SK 3025	RT-115	ECG 159	WEP 716	ZEN 107
2N3639	RS276-2024	T-57	GE-21	ICC-57	TR-20	PTC 127	HEP-57	SK 3118	RT-115	ECG 159	WEP 57	NA
2N3640	RS276-2024	T-57	GE-21	ICC-57	TR-20	PTC 103	HEP-57	SK 3114	RT-115	ECG 159	WEP 57	NA
2N3641	RS276-2009	T-736	GE-17	ICC-736	TR-21	PTC 123	HEP-736	SK 3018	RT-102	ECG 123A	WEP 736	ZEN 120
2N3642	RS276-2009	T-736	GE-17	ICC-736	TR-21	PTC 123	HEP-736	SK 3122	RT-102	ECG 123A	WEP 736	ZEN 120
2N3643	RS276-2009	T-736	GE-18	ICC-736	TR-21	PTC 136	HEP-736	SK 3124	RT-102	ECG 123A	WEP 736	ZEN 120
2N3644	RS276-2021	T-716	GE-67	ICC-716	TR-20	PTC 127	HEP-716	SK 3114	RT-115	ECG 159	WEP 714	ZEN 107
2N3645	RS276-2021	T-708	GE-67	ICC-708	TR-20	PTC 127	HEP-708	NA	RT-115	ECG 129	WEP 52	NA
2N3646	RS276-2009	T-50	GE-20	ICC-50	TR-21	PTC 136	HEP-50	SK 3019	RT-102	ECG 123A	WEP 50	ZEN 100
2N3647	NA	T-736	GE-20	ICC-736	TR-21	PTC 136	HEP-736	NA	RT-100	ECG 123	WEP 736	ZEN 120
2N3648	RS276-2011	T-56	GE-20	ICC-56	NA	PTC 133	HEP-56	SK 3039	RT-113	ECG 108	WEP 56	ZEN 104
2N3649	NA	SR-1301	NA	ICC-R1301	NA	NA	HEP-R1301	NA	NA	ECG 5501	NA	NA
2N3650	NA	SR-1302	NA	ICC-R1302	NA	NA	HEP-R1302	NA	NA	NA	NA	NA
2N3651	NA	SR-1304	NA	ICC-R1304	NA	NA	HEP-R1304	NA	NA	NA	NA	NA
2N3652	NA	SR-1306	NA	ICC-R1306	NA	NA	HEP-R1306	NA	NA	NA	NA	NA
2N3653	NA	SR-1307	NA	ICC-R1307	NA	NA	HEP-R1307	NA	NA	NA	NA	NA

NA=NOT AVAILABLE

(continued on page 68)

	ARCH	DM	G-E	ICC	IR	MAL	MOT	RCA	SPR	SYL	WOR	ZEN
2N3654	NA	SR-1301	NA	ICC-R1301	NA	NA	HEP-R1301	NA	NA	ECG 5501	NA	NA
2N3655	NA	SR-1302	NA	ICC-R1302	NA	NA	HEP-R1302	NA	NA	NA	NA	NA
2N3656	NA	SR-1304	NA	ICC-R1304	NA	NA	HEP-R1304	NA	NA	NA	NA	NA
2N3657	NA	SR-1306	NA	ICC-R1306	NA	NA	HEP-R1306	NA	NA	NA	NA	NA
2N3658	NA	SR-1307	NA	ICC-R1307	NA	NA	HEP-R1307	NA	NA	NA	NA	NA
2N3659	NA	TS-3021	GE-32	ICC-S2021	NA	NA	HEP-S3021	NA	NA	NA	NA	ZEN 208
2N3660	NA	T-242	GE-29	ICC-242	NA	PTC 111	HEP-242	NA	NA	NA	WEP 242	NA
2N3661	NA	T-242	NA	ICC-242	NA	PTC 111	HEP-242	NA	NA	NA	WEP 242	NA
2N3662	RS276-2011	T-56	GE-11	ICC-56	IRTR-70	PTC 126	HEP-56	SK 3039	RT-108	ECG 107	WEP 56	ZEN 104
2N3663	RS276-2011	T-56	GE-11	ICC-56	IRTR-70	PTC 126	HEP-56	SK 3018	RT-108	ECG 107	WEP 56	ZEN 104
2N3665	NA	T-714	NA	ICC-714	NA	PTC 144	HEP-714	NA	NA	NA	WEP S3021	NA
2N3666	NA	T-714	NA	ICC-714	NA	PTC 110	HEP-714	NA	NA	NA	WEP S3021	NA
2N3667	NA	T-704	NA	ICC-704	NA	PTC 140	HEP-704	SK 3036	RT-131	ECG 130	WEP 704	NA
2N3668	NA	NA	NA	NA	IR-1844A	NA	NA	NA	NA	NA	NA	NA
2N3669	NA	NA	NA	NA	IR-1846A	NA	NA	NA	NA	NA	NA	NA
2N3670	NA	NA	NA	NA	IR-1849A	NA	NA	NA	NA	NA	NA	NA
2N3671	RS276-2021	T-51	GE-21	ICC-51	TR-20	PTC 103	HEP-51	SK 3025	RT-115	ECG 129	WEP 51	ZEN 101
2N3672	RS276-2024	T-57	GE-21	ICC-57	TR-20	PTC 103	HEP-57	SK 3114	RT-115	ECG 159	WEP 57	NA
2N3673	RS276-2024	T-57	GE-21	ICC-57	TR-20	PTC 103	HEP-57	SK 3114	RT-115	ECG 159	WEP 57	NA
2N3675	NA	TS-3002	GE-66	ICC-S3002	NA	PTC 110	HEP-S3002	NA	NA	NA	WEP S3002	NA
2N3676	NA	TS-3002	NA	ICC-S3002	NA	PTC 110	HEP-S3002	NA	NA	NA	WEP S3002	NA
2N3677	RS276-2023	T-52	GE-21	ICC-52	TR-30	PTC 103	HEP-52	SK 3025	RT-115	ECG 129	WEP 52	NA
2N3678	NA	TS-3001	NA	ICC-S3001	NA	NA	HEP-S3001	NA	NA	NA	NA	NA
2N3680*	NA	T-728	NA	ICC-728	IRTR-51	PTC 121	HEP-728	NA	NA	NA	WEP 728	ZEN 114
2N3681	NA	T-709	GE-11	ICC-709	IRTR-80	PTC 126	HEP-709	NA	NA	NA	WEP 709	ZEN 105
2N3682	RS276-2001	T-56	GE-20	ICC-56	NA	PTC 136	HEP-56	SK 3039	RT-113	FCG 108	WEP 56	ZEN 104
2N3683	NA	T-709	NA	ICC-709	NA	PTC 126	HEP-709	NA	NA	NA	WEP 709	ZEN 105
2N3684	NA	T-801	GE-FET-1	NA	NA	PTC 152	NA	SK 3112	NA	ECG 133	WEP 801	NA
2N3685	NA	T-801	GE-FET-1	NA	NA	PTC 152	NA	SK 3112	NA	ECG 133	WEP 801	NA
2N3686	NA	T-801	GE-FET-1	NA	NA	PTC 152	NA	SK 3112	NA	ECG 133	WEP 801	NA
2N3687	NA	T-801	GE-FET-1	NA	NA	PTC 152	NA	SK 3112	NA	ECG 133	WEP 801	NA
2N3688	RS276-2013	T-728	GE-60	ICC-728	TR-24	PTC 121	HEP-728	SK 3039	RT-113	ECG 108	WEP 728	ZEN 114
2N3689	RS276-2013	T-729	GE-60	ICC-729	TR-24	PTC 121	HEP-729	SK 3039	RT-113	ECG 108	WEP 729	ZEN 115
2N3690	RS276-2013	T-729	GE-60	ICC-729	TR-24	PTC-121	HEP-729	SK 3018	RT-113	ECG 108	WEP 729	ZEN 115
2N3691	NA	T-734	GE-60	ICC-734	TR-24	PTC 121	HEP-734	SK 3018	RT-113	ECG 108	WEP 723	ZEN 118
2N3692	RS276-2013	T-729	GE-20	ICC-729	TR-21	PTC 121	HEP-729	SK 3124	RT-113	ECG 108	WEP 729	ZEN 115
2N3693	RS276-2013	T-729	GE-61	ICC-729	TR-24	PTC 121	HEP-729	SK 3122	RT-113	ECG 108	WEP 729	ZEN 115
2N3694	RS276-2013	T-729	GE-63	ICC-729	TR-24	PTC 121	HEP-729	SK 3122	RT-102	ECG 123A	WEP 729	ZEN 115
2N3695	NA	T-803	NA	ICC-803	NA	NA	HEP-803	NA	NA	NA	NA	NA
2N3696	NA	T-803	NA	ICC-803	NA	NA	HEP-803	NA	NA	NA	NA	NA
2N3697	NA	T-803	NA	ICC-803	NA	NA	HEP-803	NA	NA	NA	NA	NA
2N3698	NA	T-803	NA	ICC-803	NA	NA	HEP-803	NA	NA	NA	NA	NA
2N3700	NA	T-714	NA	ICC-714	NA	NA	HEP-714	SK 3045	RT-110	ECG 154	WEP S3021	NA
2N3701	NA	T-714	NA	ICC-714	NA	PTC 144	HEP-714	NA	NA	NA	WEP S3021	NA
2N3702	RS276-2021	T-716	GE-67	ICC-716	TR-30	PTC 127	HEP-716	SK 3114	RT-115	ECG 159	WEP 716	ZEN 107
2N3703	RS276-2024	T-57	GE-21	ICC-57	IRTR-54	PTC 103	HEP-57	SK 3114	RT-115	ECG 159	WEP 57	NA
2N3704	RS276-2009	T-735	GE-20	ICC-735	TR-21	PTC-136	HEP-735	SK 3024	RT-1 .2	ECG 123A	WEP 735	ZEN 119
2N3705	RS276-2009	T-55	GE-20	ICC-55	TR-21	PTC 136	HEP-55	SK 3124	RT-102	ECG 123A	WEP 55	ZEN 103
2N3706	RS276-2009	T-55	GE-63	ICC-55	TR-21	PTC 136	HEP-55	SK 3025	RT-102	ECG 123A	WEP 55	ZEN 103
2N3707	RS276-2009	T-723	GE-62	ICC-723	TR-21	PTC 139	HEP-723	SK 3124	RT-102	ECG 123A	WEP 723	ZEN 111
2N3708	RS276-2009	T-732	GE-17	ICC-732	IRTR-54	PTC-139	HEP-732	SK 3124	RT-102	ECG 123A	WEP 732	NA
2N3709	RS276-2009	T-55	GE-61	ICC-55	IRTR-54	PTC 139	HEP-55	SK 3124	RT-102	ECG 123A	WEP 55	ZEN 103
2N3710	RS276-2009	T-55	GE-61	ICC-55	IRTR-54	PTC 139	HEP-55	SK 3124	RT-102	ECG 123A	WEP 55	ZEN 103
2N3711	RS276-2009	T-55	GE-62	ICC-55	TR-21	PTC 139	HEP-55	SK 3124	RT-102	ECG 123A	WEP-55	ZEN 103
2N3712	NA	T-714	GE-20	ICC-714	IRTR-87	NA	HEP-714	SK 3045	RT-110	ECG 154	WEP S3021	NA
2N3713	NA	T-247	GE-14	ICC-247	NA	NA	HEP-247	SK 3036	RT-131	ECG 130	WEP 247	NA
2N3714	NA	T-704	GE-14	ICC-704	NA	NA	HEP-704	SK 3036	RT-131	ECG 130	WEP 704	NA
2N3715	NA	T-247	GE-14	ICC-247	NA	NA	HEP-247	SK 3036	RT-131	ECG 130	WEP 247	NA
2N3716	NA	T-704	GE-14	ICC-704	NA	NA	HEP-704	SK 3036	RT-131	ECG 130	WEP 704	NA
2N3719	RS276-2025	T-242	GE-29	ICC-242	IRTR-88	PTC 142	HEP-242	SK 3025	RT-115	ECG 129	WEP 242	NA
2N3720	RS276-2025	T-242	NA	ICC-242	IRTR-88	PTC 142	HEP-242	SK 3025	RT-115	ECG 129	WEP 242	NA
2N3721	RS276-2016	T-54	GE-62	ICC-54	TR-33	PTC 153	HEP-54	SK 3124	RT-108	ECG 107	WEP 54	NA
2N3722	NA	T-714	NA	ICC-714	NA	PTC 110	HEP-714	NA	NA	NA	WEP S3021	NA
2N3723	NA	T-714	GE-27	ICC-714	NA	PTC 110	HEP-714	SK 3104	NA	NA	WEP S3021	NA
2N3724	NA	T-714	GE-28	ICC-714	NA	PTC 110	HEP-714	NA	NA	NA	WEP S3021	NA
2N3725	NA	T-714	GE-18	ICC-714	NA	PTC 110	HEP-714	NA	NA	NA	WEP S3021	NA
2N3726*	NA	T-716	NA	ICC-716	NA	PTC 127	HEP-716	NA	NA	NA	WEP 716	ZEN 107
2N3727*	NA	T-716	NA	ICC-716	NA	PTC 127	HEP-716	NA	NA	NA	WEP 716	ZEN 107
2N3728*	NA	T-729	NA	ICC-729	NA	PTC 121	HEP-729	NA	NA	NA	WEP 729	ZEN 115
2N3729*	NA	T-729	NA	ICC-729	NA	PTC 121	HEP-729	NA	NA	NA	WEP-729	ZEN 115
2N3730	NA	T-234	GE-25	ICC-234	TR-27	PTC 122	HEP-234	SK 3034	NA	ECG 127	WEP 235	NA
2N3731	NA	T-235	GE-25	ICC-235	TR-27	PTC 122	HEP-235	SK 3035	NA	ECG 127	WEP 235	ZEN 328
2N3732	NA	TS-5005	GE-25	ICC-S5005	TR-27	PTC 122	HEP-S5005	SK 3034	NA	ECG 127	WEP S5005	NA

*Indicates a dual transistor for high-speed switching, diff amplifier etc. Likely to be a matched pair. Use two of the type specified, matching when necessary, on a curve tracer or lab-type transistor checker.

NA=NOT AVAILABLE

(continued next month)

R-E's Service Clinic

Blanking circuits—why and how they work

Symptoms are often weird but easy to blank out. Here's how.

by JACK DARR
SERVICE EDITOR

WHAT IS BLANKING? THE CLINIC MAILBAG gets pretty heavy sometimes with assorted problems which all have something to do with blanking circuits. This circuit is getting pretty complex, in application, although it's pretty basic in theory. In the older sets, if we lost the blanking, all we got was a few vertical retrace lines on the screen. In the newer sets, and most especially in color TV sets, blanking troubles can cause some really weird symptoms. Most of these *do not* appear to be due to blanking, but they are. Let's look at the basic circuitry first, and then take a look at some of the oddballs.

Blanking means just what it says. We feed two pulses, one horizontal frequency, the other vertical frequency, into the circuit. Both of these occur in their respective sync interval. They are fed into some point in the circuit that will make the picture tube cut off, so we don't see the syncs in the picture. In black-and-white (B/W) sets, they were fed directly into the picture tube; a negative-going pulse to the grid or a positive-going pulse to the cathode.

In color sets, where we split up the signal into B/W (video or Y) and color, you may find blanking fed to the video amplifier stages, the color amplifier stages or both. By feeding the blanking in at an early stage, we can use a low-level pulse. By definition, a blanking pulse must be of such a polarity that it will make the amplifier *cut off*. Negative going on a tube grid, positive on the cathode; reverse bias to a transistor base; positive for pnp, negative for npn. If the pulse is fed to the emitter, in a common-emitter stage, its polarity is reversed to that of a base pulse. This is often found in hybrid or solid-state sets.

Problems

Now how about some of the odd problems that we can get from blanker troubles? The worst ones are the type that cause a *bias upset* in the amplifier stage. This causes effects not readily associated with blankers. For the first one, the older color sets using three color-difference amplifiers, with common cathodes for matrixing, often had the blanking fed into the cathode circuit, as in Fig. 1

The blanking pulse here is high, negative going, so that it causes cutoff of the picture tube. It does this by making the color-difference amplifier tubes conduct more heavily. This causes their plate voltage to drop (go more negative) which in turn biases-off the picture tube grids. (This kind of polarity reversal will be quite common and confusing, so watch out for it.)

What happens if the blanking pulse is lost? In this circuit, we lose the *raster*. The presence of the large blanking pulse on the cathodes of the color difference amplifiers develops a bias of about 7 volts. Without the pulse, this drops to a very low voltage, less than 1.0 volt. The triodes conduct very heavily, and the picture tube cuts off. This happens if the blanker coupling capacitor opens, or the blanker tube goes dead. Key clues: low plate voltage on color-difference amplifier tubes, along with low cathode voltage, and absence of blanking pulse on cathode, with scope.

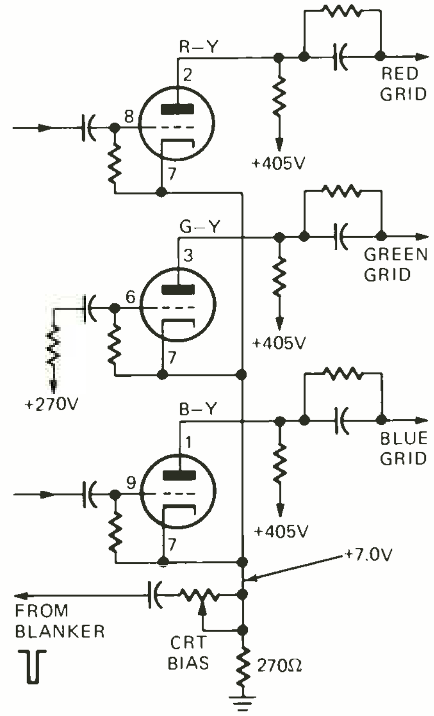


FIG. 1

In another set, of about the same vintage (RCA CTC-38, etc), the blanker tube is actually in series with the picture-tube bias control, which varies the dc supply to the picture tube grids. It does this because the control is in the dc supply line to the *color amplifier plates*. Figure 2 shows this version. Note that there is a dc path for current from the bias control, *through* the plate-cathode circuit of the blanker tube, and then on to ground (actually completed through the cathode resistor of the 2d color bandpass amplifier).

If the blanker tube goes dead, this will upset the dc voltages. They will go higher, more positive, and the picture tube grids will

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. If return postage is not included, we cannot process your question. Write: Service Editor, Radio-Electronics, 200 Park Ave. South, New York 10003.

follow. This will overdrive the picture tube, and the raster will flare up. In some sets the raster will flare up, then go dark. This is due to the overload on the high-voltage supply.

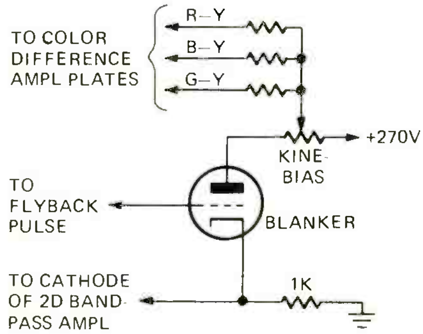


FIG. 2

Key clue: variation of dc voltages on picture tube grids, and loss of dc voltage on blanker cathode. This can also be due to an open cathode ribbon in the blanker tube.

Blanking diodes

Diodes have become very popular for blanking in the later sets. Some will use transistors, and some a combination of both. The advantage of a diode is that it can be *biased*, so that only the desired part of the blanking pulse passes through. For example, in many Zeniths, you'll find both horizontal and vertical blanking diodes.

For the horizontal blanking, a pulse from the flyback is fed through a biased diode (Fig. 3 shows the circuit). The bias keeps the diode cut off until the pulse voltage has risen above the bias level. So we get an input pulse as shown, with quite a bit of normal ringing along the baseline (which is during the *scan* period). The output pulse is clean, with the ringing clipped off. This is

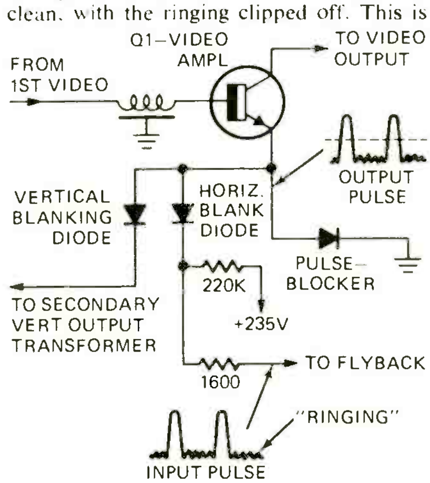


FIG. 3

fed into the emitter of a transistor video amplifier stage.

If this diode shorts, it does not put the raster out. You'll see an odd symptom; the picture will have about six thick, black vertical bars at intervals, with the picture showing between them. These are called *jail-bars*, for obvious reasons. The bars are caused by blanking of the raster, due to the peaks of the ringing waveform, which are now getting through the diode unclipped.

The vertical blanking is applied in the same amplifier circuit, with another diode. It is goes bad, we see another odd effect. When the brightness control is turned down, the raster will go out from top to bottom, exactly like a window shade being pulled down. If the diode is just leaky, you may not see a full window-shade effect, but the raster will be shaded from top to bottom; the top is usually the darkest.

Neon lamps

You'll also find neon lamps used in blanking circuits. Neons will fire at about the same voltage, usually somewhere around 65 volts. When they fire, they conduct a small current. So this too can be used to pass a pulse voltage. The neon lamps do sometimes become defective. Strange as this sounds, they can become gassy, and fire all the time. This upsets the blanking. They can also crack, admit air, and refuse to fire at all which also upsets things. If you have doubts, try a new neon lamp of the same type. In some circuits, you'll find *polarized* neon lamps. These must be replaced by an exact duplicate, and with the right polarity.

Blanker transistors

Blanker transistors are found in most hybrid and solid-state sets. Like all of the rest, they can cause some unusual symptoms. In Sylvania's D-12 color chassis, a bad blanker transistor can cause a series of *faint* vertical lines to show up in the raster. Scoping the blanker transistor will show you the same signal on both base and emitter, quite low in amplitude. This happens when the transistor is leaky. If this transistor should open, the roaster will still be there, but it will turn *purple*. (Don't ask! I know not why, but it does!)

Another jail-bar symptom, but this time affecting only the *color*, shows up in circuits such as Zenith hybrid 14Z8C50 chassis. The B/W picture will be good, but when you turn up the color control, you get a jail-bar effect in the color. Here again, the cause is a shorted horizontal blanking diode. This time, it is in the emitter circuit of the second color bandpass amplifier transistor. The reaction is just the same as before; the shorted diode allows the ringing on the baseline to get hhrough, and blank out only the color signals (Fig. 4 shows this one).

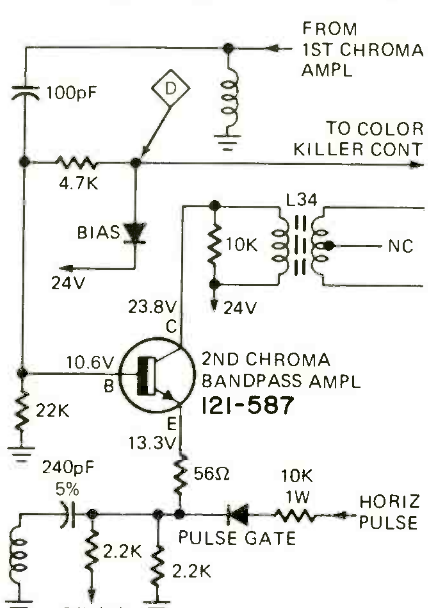


FIG. 4

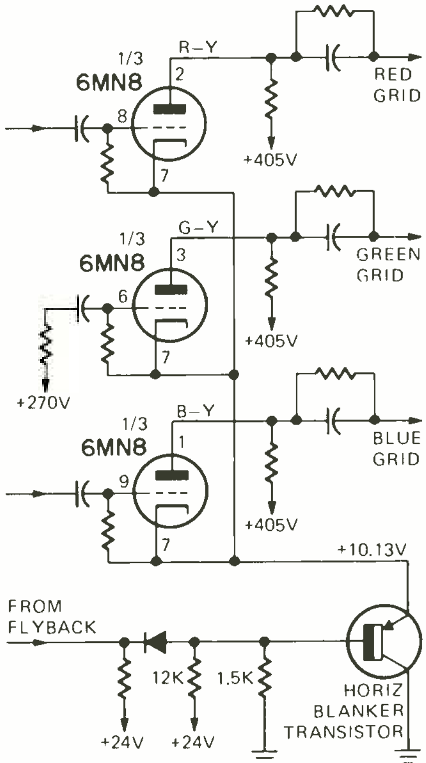


FIG. 5

A shorted blanker transistor, in the same chassis, will cause one dark bar on the screen, with an otherwise blank raster. Same as before; it's in the cathode circuit of the 6MN8 color difference amplifier tube. Upsets the bias (see Fig. 5). **R-E**

reader questions

AFC COLOR PROBLEM

The color pops in and out in this Zenith 20X1C36. However, if I put the afc switch to off, the color stays in. I've changed all of the tubes in the color section; no help. What's wrong?—J.M., Phila. Pa.

Nothing in the color section, apparently. This is an intermittent afc problem! Sounds as if it is detuned just enough to keep the color "hanging on the edge," and at any disturbance, such as noise, it lets go. Realign the afc, and it should stop the trouble.

TO "YOUNG-TIMER"

I have an old amplifier. It's an "Erwood," 4112. It seems to be in good working order, but I don't have a schematic. It has a pair of 7-pin sockets on the back that I don't understand. The ac line is connected to pins 6 and 7. What's this for, and what are the output impedances?—T.J. Toms River N.J.

Unfortunately, I can't help you with a schematic: don't seem to have one for this make. It's standard amplifier circuit, though: Class A output with 6V6's.

The 7-pin sockets on the back are for the speakers. The jumper between 6 and 7 is intended to break the primary circuit to the power transformer, so that it can't be operated without a speaker load: this burned out the output transformer!

Standard connections for this would be: Pin 1, common (ground): pin 2, 4 ohms: pin 3, 8 ohms, pin 4, 16 ohms, and pin 5 (probably) 500 ohm line.

HIGH-VOLTAGE DROP

With the switch in SERVICE position, the high voltage is normal on this GE CA color chassis. In NORMAL position, it drops quite a bit, and I have vertical retrace lines in the picture. The horizontal scan also slowly collapses.

Would you suspect the vertical output circuits? I replaced the vertical output tube; no help.—H.K. Chicago, Ill.

Not the vertical circuitry, I'm afraid. This kind of symptom is usually due to one of two things: excessive beam-current in the picture tube, overloading the high-voltage circuits, or to a low-output high-voltage circuit (which would include such things as the high-voltage rectifier, horizontal output tube, etc.).

Check the grid and cathode voltages on the picture tube, in NORMAL position of the service switch. If the grids are too far positive, or the cathodes too far negative, the tube will draw too much beam current, and overload the high-voltage supply. Maximum here is only 1500 *microamperes*. Check the setting of the picture tube screen controls, too. If these are too high, they can cause the same symptoms.

What you actually have is too much brightness! This will almost always let retrace lines show.

ODD COLORS

The picture comes on with the colors oversaturated, and well out of phase. Raster's clear; no impurity. This is a Zenith 14A9C50. I ran an AFPC adjustment, and replaced the IC demodulator chip, and the oscillator tube. No help. I'm lost.—G.C., Rockford, Ill.

Polishing the crystal ball, I would say that this sounds like a 3.58-MHz *crystal* which won't quite come to the right frequency! Try this: hook a 50K resistor in series with the probe of the vtvm, and read the dc voltage on the grid of the 3.58-MHz oscillator tube. Use a color-bar signal on the set, and set up for AFPC alignment.

Normally, the grid voltage should be zero. It should be able to go from a −5 volts to a +5 volts as you adjust the oscillator frequency. If the crystal is off, it will probably come up to about +0.5 volt, or −0.5 volt, and then snap out. Final test is to try a new crystal, of the right part number. **R-E**

appliance clinic

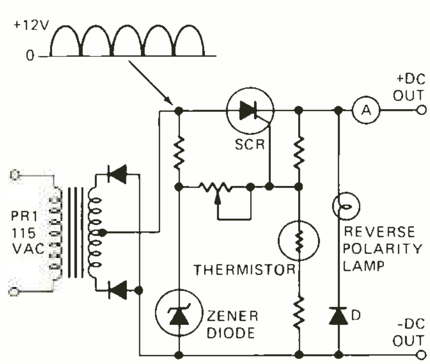
by JACK DARR
SERVICE EDITOR

BATTERY CHARGES USED TO BE FAIRLY simple devices; a low voltage transformer, a rectifier, and that was it. They did the job, but they could also do some damage. Leave one on a battery too long, and you're in trouble. When a battery is partly discharged, a high current flows when the charger is hooked up. As the battery charges up, this current decreases. However, if the charger is left hooked up after the battery has reached full charge, some current will still be flowing. The actual amount depends on the voltage of the charger, and its current-rating.

This can be up to 1 to 2 amperes. It doesn't do any useful work, since the battery is already up to full charge. What it does is generate heat. This makes the water evaporate out of the electrolyte, and it also liberates gases which can be dangerous. (Oxygen plus hydrogen plus small spark makes one heck of a bang!)

So the newer chargers are provided with a voltage-sensing circuit. This turns the charger off when the battery reaches full charge. The "signal" for this is the *voltage* across the battery. Before it reaches full charge, this will be lower than normal; when it is fully charged, it will rise. In a standard 12-volt battery, somewhere between 13 and 14 volts.

This automatic protection is provided by an SCR, in a novel circuit (see Fig. 1). As



you can see, the transformer and rectifiers are still there. The positive terminal of the dc output (center-tap of the transformer) is connected to the anode of the SCR. The negative terminal of the dc output is the common anodes of the rectifiers. So now the charging current flows *through* the SCR.

An SCR will not conduct current at all, until it is "gated on" by applying a small positive voltage to its gate. Once it is turned on, however, it keeps on conducting until the anode voltage drops to zero. If we look at this as a dc circuit, the SCR would conduct at all times, once turned on. However, this isn't precisely a pure dc circuit. The voltage applied to the SCR anode isn't really dc, but a *series of pulses*, positive-going. So the SCR turns off every time this voltage reaches zero, which it does 120 times a second. The waveform of this is shown in Fig. 1, just above the SCR anode.

So the SCR will actually turn itself off 120 times per second, then be gates back on again for the next half-cycle, by the voltage from the gate-voltage divider. Current will keep flowing into the battery as long as the gate circuit is working.

Three resistors are connected across the output. They actually "read" the dc *battery* voltage. As the battery charges, this goes more positive. The current through the sensing resistors also increases, as Mr. Ohm said. Now we come to the secret; notice that one of these resistors isn't a fixed type, but a *thermistor*. This is a special type of resistor. When the current flowing through it *increases*, its resistance *decreases*. This change is actually caused by the resistance element heating up. That's why the term *therm*-istor.

Now then: when we begin the charge, the battery voltage is comparatively low. The dc voltage drop across the sensing resistors is such that the gate of the SCR stays positive with respect to its cathode; enough to make sure that the SCR stays on. When the battery gets to full charge, the dc voltage rises. So the current through the sensing resistors rises with it. In fact, this current rises slightly more than it would if all of these were standard resistors. This is because of the reduced resistance of the thermistor, with increased current.

Its resistance drops; so does the voltage-drop across the bottom section of the divider. This results in the SCR gate becoming not quite positive enough to be turned on. So, it blocks current flow, and the battery will not be over-charged. This won't be a complete cutoff. The meter will generally flicker slightly. The Zener diode and the resistor across the supply also help out in this action, by providing a fixed reference voltage.

What to do if it doesn't work

The old standard test that we used to make to see if a battery charger was working, was popping the clips together to see if there was a spark. I don't think I'd recommend this any more. Solid-state devices dislike any transients, so don't take chances. In most of these chargers, you will have a panel ammeter. This will tell you whether any current is flowing or not. Connect the clips to the battery. If you see an indication of current on the meter, OK.

Many of these chargers have a clever little reverse-polarity indicator circuit, which tells you if you have managed to connect the battery up backward. This is the diode and lamp shown across the dc output. If the battery is hooked up correctly, the cathode of the diode has a positive voltage applied to it. It won't conduct. If the battery polarity is reversed, the cathode will have a negative voltage on it. It will go into full conduction, and the lamp will light brightly. Connected as this circuit is, the meter needle will back off-scale if the battery is reversed. This will be only the lamp-current, and won't hurt anything. If the lamp lights, but the meter is reading up-scale, the diode is shorted!

If the ammeter needle doesn't move when the battery is connected, the first thing to do is check to see if the line cord is plugged in. In this type of regulated charger, as I said before, even if the battery should happen to be fully charged, the ammeter needle will flicker slightly if it's working.

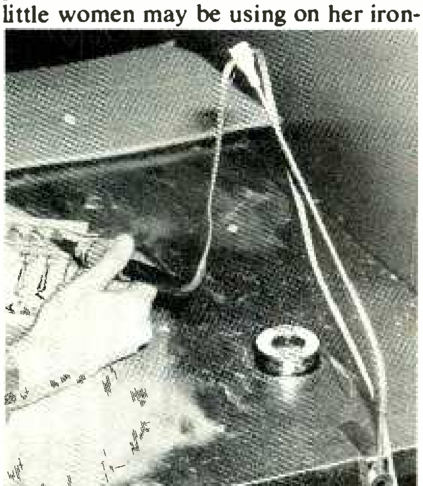
If it doesn't move at all, though the line cord is plugged in, check for an open fuse or circuit breaker inside the charger. If these all check out OK, the SCR could be open, or not being gated-on. This can be checked by simply jumping the SCR with a clip-lead. If current flows now, something is wrong with the SCR or its circuitry.

This will have to be checked out with a dc voltmeter. The SCR gate should be slightly positive with respect to its own cathode. It takes only about +0.4 volt to turn the average SCR on. You can take the SCR out and check it. A shorted SCR will read zero ohms with ohmeter prods either way.

If the charger works but the current is very low, one of the rectifier diodes could be open. This will show you an open circuit, with prods either way, across the bad diode. A normal diode reading is a very low resistance one way, and a very high resistance with the ohmmeter prods reversed. **R-E**

SOLDERING IRON CORD HOLDER

If your workbench is usually cluttered with small parts and tools, you have probably often gotten your soldering iron cord tangled up in something and pulled it to the edge of the table and watched it crash to the floor. A way to prevent this is to use a gadget that the little women may be using on her iron-



ing board. These were intended for use on the end of an ironing board to prevent ironing over the cord, etc., but works equally well holding the soldering iron cord up out of the way. The holder installs on the edge of a table or work-bench and is secured by a thumbscrew. — *Kent Mitchell, W3WTO*

HI-FI TEST INSTRUMENTS

(continued from page 37)

A typical audio voltmeter has one or more ranges with full-scale readings in the millivolt range so you can measure the output, hum and noise from such low-level sources as microphones, tape heads and phonograph cartridges. Many audio voltmeters include a built-in high-gain amplifier that can be used as a preamp for a scope when measuring low-level signals. The lowest full-scale range is 1 to 2 millivolts and the decibel range is from around −80 dB to +60 dB with 0 dB referenced to 0.775 or 1.0 volt.

A number of FET multimeters have full-scale ac voltage ranges low enough to permit making valid measurements of all except the lowest signal voltages found in modern audio equipment. So, if you are just getting started in hi-fi servicing and have one or more good FET multimeters, you may want to defer purchasing a more specialized audio voltmeter until the volume of business warrents it.

An audio voltmeter is especially useful in signal tracing where you may need to detect small differences in voltages at corresponding points in the two channels of a stereo amplifier.

Audio attenuators

Decade attenuators are used between the audio test oscillator and the amplifier to provide the precise low-level signals needed when testing preamps and other high-gain audio circuits. Some attenuators—like General Radio's *Microvolter*—include a precision audio voltmeter for setting the input to a predetermined level and two or more step attenuators with dials calibrated in volts and in decibels. Typical decade attenuators used for gain and loss measurements of filters, amplifiers, active and passive networks and similar equipment are General Radio's model 1450 and the Hewlett-Packard 4437A. These provide attenuation of 0 to 110 dB and 0 to 119.9 dB, respectively, in 0.1-dB steps.

When measuring the frequency response of an amplifier, an attenuator is needed between the audio generator and the amplifier to provide the minute, precise adjustments in the input signal level during the frequency run. With a constant signal voltage being fed into the attenuator: the attenuator is adjusted up or down as necessary to keep the amplifier's *output* voltage constant. The amplifier's gain is *up* or *down* at that frequency—is above or below the gain at the reference frequency—by the change required in the attenuator setting in dB.

The meter across the amplifier output cannot be used, except as a reference meter, when making precise gain or response measurements. The small changes in output voltage level are difficult to read and—even harder for many—to convert to gain or loss in dB. For example, assume that the amplifier gain varies 0.1 dB. This amounts to a voltage ratio equivalent to a gain of 1.012 or a loss of 0.9886. This is a variation of about 1.5%; very difficult to read accurately on an analog meter scale.

Wow and flutter meter

If most of your experience has been in radio and TV servicing, the terms wow and flutter may be all but meaningless to you but you'd better know what it's all about if a musician or other critical client tells you that his $200 turntable or $600 tape deck sounds funny. Wow and flutter are symptoms of mechanical troubles in tape and record player mechanisms that can make the players sound real "sick". You need specialized equipment to test tape and record player mechanisms and to keep a check on the effectiveness of your servicing procedures.

Both of these troubles are variations in the tape or record speed that frequency-modulate the recorded and/or recording signal. The rate of variation determines whether it is *wow* or *flutter*. When the recording or playback speed varies at a rate of 0.5 to 2 Hz, we have *wow*. *Flutter* is heard when the speed varies at a rate of 2 Hz and higher.

When speed changes at 2 to 6 Hz, even the most unmusical ear can detect the periodic changes in pitch. At 6 to 10 Hz, notes begin to sound as though vibrato is being used. At higher variation rates, the signal may sound garbled or harsh.

Wow and flutter are measured using a test tape or record with a 3-kHz test tone played on the equipment under test. The wow/flutter meter (see block diagram of a typical instrument in Fig. 5) is connected across the output of an amplifier fed by the player. An input attenuator sets the signal to the desired level. A following limiter stage clamps the signal level so readings are not affected by amplitude variations. The signal goes through a bandpass filter and harmonic suppressor and on to a 3000-Hz rejection filter and FM discriminator so all frequency components other than the 3000-Hz can be read on the built-in vtvm.

There is an adjustable bandpass filter at the discriminator output. When the filter is set to 0.5 to 250 Hz the reads the sum of both wow and flutter. Setting the mode switch to FLUTTER cuts in a sharp filter that removes all frequencies *below* 6 Hz. In the wow position of the mode switch, the filter removes all frequencies *above* 6 Hz so the meter measures only the wow component.

Most wow/flutter meters have a built-in 3-kHz oscillator so you can make a test tape when necessary. Some include facilities for measuring turntable rumble. Others also measure *drift*—slow speed variations, but more often defined as long-term speed variations caused by variations in supply voltages to the drive or capstan motors or gradual changes in take-up tension.

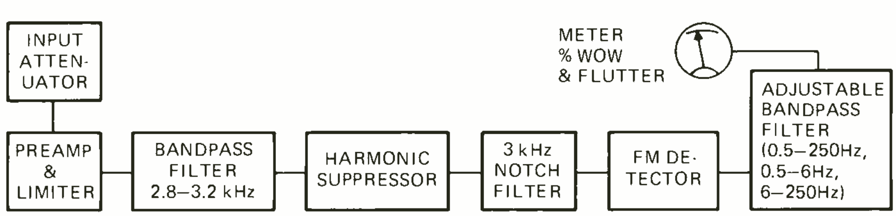


FIG. 5—BLOCK DIAGRAM OF WOW AND FLUTTER meter for testing turntables and tape recorders.

(continued on page 76)

struments at the same time.

Let's say that you've decided on (1) a sine/squarewave audio generator, (2) a sweep and marker generator especially for FM work—the shop's sweep/marker generator is always tied up on the TV service bench, (3) an FM stereo multiplex generator and (4) an AM rf signal generator for AM radio work. In this case, you'd want to look closely at something like Sencore's SG165 AM-FM Stereo Analyzer. It replaces the functions of the four instruments you want while including such goodies as dual 100-watt speaker dummy loads and two wattmeters with 10- and 100-watt ranges. The same type of thinking can be applied to your equipment needs and other types of all-in-one instruments.

As you gain experience in hi-fi servicing, you may find a need for such instruments as a tone-burst generator, X-Y recorder or an electronic counter. And you will accumulate such accessories as test records, test tapes, stylus pressure gauges, stylus microscopes and head cleaners and demagnetizers for reel-to-reel, cassette and cartridge tape equipment. You'll be working with high-quality gear so purchase the best equipment you can afford.

You have a wide choice of instruments

If you want to develop an efficient and profitable approach to hi-fi servicing, we have shown in the following listing, some of the types of instruments and their pertinent features and specifications. The list is not all-inclusive. We suggest writing to the manufacturers for their general catalogs and additional information on the equipment listed here. R-E

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.

SPEAKER SYSTEM, *LST-2* represents a blending of drivers used in other AR systems. Crossover network and spectral balance switch permit three repeatable, spectral energy profiles that allow the user to select the energy output best suited for room acoustics and program material. Geometric design of the cabinet along with the

characteristics of the drivers in the three planes results in uniform dispersion at all frequencies. Has room-filling quality of omni- or multi-directional system with no beaming of high frequencies.

Includes a 10-inch acoustic suspension woofer, three 1½-inch mid-range hemispherical dome radiators and three ¾-inch hemispherical dome tweeters. Cabinet is of solid oiled walnut. $400.00.—**Acoustic Research, Inc.,** 10 American Drive, Norwood, Mass. 02062.

Circle 31 on reader service card

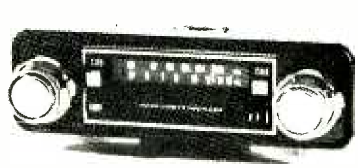
CASSETTE DECK, *model GXC-75D* has built-in Dolby (automatic distortion reduction system), three-way electrical reverse mode selector and automatic and manual reverse recording and playback. Also features lifetime glass and crystal head. Has pause control button for tape editing; control suspends tape travel at any time during

record or playback. Individual back-lighted meter panel indicates various operating modes. Reverse-mode selector provides one-way recording or playback, one-cycle forward and reverse recording or playback or continuous playback.

Other features include: tape selector circuit for CrO_2 tape, over-level suppressor circuit, index counter with memory wind supplement that stops tape at any desired point, automatic stop, large slanted VU meters and hysteresis motor. 5-¾ x 18 x 11-¾ in.; 17.6 lbs.; $429.95—**Akai America, Ltd.,** 2139 East Del Amo Blvd., Compton, Calif. 90220.

Circle 48 on reader service card

IN-DASH CASSETTE PLAYER, *model C984.* AM/FM stereo in-dash radio with built-in cassette player for autos features: fast-forward, adjustable shafts for easy in-dash installation, FM



local-distant control, AM/FM selector with indicator lights and slide-rule dial scale. New cassette loading mechanism allows easy cartridge insertion even while driving. Pushbutton cassettee ejector facilitates removal. 2-½ x 7 x 6-⅛ in.; $179.95.—**Audiovox Corp.,** 150 Marcus Blvd., Hauppauge, N.Y. 11787.

Circle 32 on reader service card

DIGITAL MULTIMETER, *model 45.* 10,000 count (digit) DMM operates from either line or battery power and is applicable for tuning precision power supply and amplifier circuitry. Has five ac and five dc voltage ranges with 10 µV resolution, six resistance ranges with 10 milliohm resolution and five ac and five dc current ranges with 10

nA resolution. Battery charge life: 10—12 hours; power consumption: 3 watts; display: .33" 7-segment Sperry's.

Entire unit can be field-stripped in less than five seconds; spare fuse and circuit card connector for testing are housed behind a rear entry panel. 2.5 x 6.25 x 9 in.; 2.3 lbs. without batteries; $399.00—**Data Technology Corp,** 2700 South Fairview Street, Santa Ana, Calif. 92704.

Circle 33 on reader service card

BASE STATION MICROPHONE, *model BTM-4* features dynamic element with cardioid response pattern to minimize background noise and an acoustical damper to preserve full voice quality. Also included is a solid-state preamplifier circuit with adjustable output of 0-30 dB gain to match most transceivers' input requirements. Slide switch on the underside permits

selection of relay or electronic switching. Press-to-talk bar may be locked in talk position. Frequency response is 100-8000 Hz; impedance is 1000 ohms; cable is six-foot; three-conductor coiled cord with plug.—**Fanon/Courier Corp.,** 990 South Fair Oaks Avenue, Pasadena, Calif. 91105.

Circle 34 on reader service card

DIGITAL MULTIMETER, *model 134* is a 3-½-digit five-function full-range DMM (digital multimeter) with bright ½-inch seven-segment planar gaseous display. Has 1999 count display and automatic decimal point positioning. Displays three full digits plus overrange "one" for all functions with minus sign displayed and plus sign implied. Offers direct digital reading with no analog interpolations necessary for positive

and negative dc volts and current (automatic polarity), ac volts, ac current and resistance.

Dc volts: 4 ranges, ±1.000 V to ±1500 V f.s. with 100 % overrange in each range to a limit of 1500 V. Sensitivity is 1 mV on the 1-volt range. Input resistance is 10 megohms on all ranges. Accuracy on all dc voltage ranges except the 1-kV range is ±0.2% f.s. ±0.2% reading. The 1-kV range accuracy is ±0.5% f.s. ±0.5% reading. On the ac range, frequency response is 50 Hz to 1 kHz extended to 5 kHz at slightly reduced accuracy. Basic accuracy: ±0.7% f.s. ±1% of reading thru 100 V range. Accuracy on 1-kV range is 0.7% f.s. ±2% of reading.

Has 100-, 1000-, 10,000-, 100,000-ohm; 1- and 10-megohm resistance ranges. At low end, measures to 0.1 ohm. Accuracy is 0.5% f.s. ±7% of reading through 1 megohm and ±1.8% on 10-meg range. Ac and dc current 1mA to 1 A fs. Minimum resolution 1 nA. 3-½ x 7-⅛ x 8-⅞ in.; $189.00 complete with combination handle/tilt stand and test leads.—**Data Precision Corp.**, Audubon Road, Wakefield, Mass. 01880.

Circle 35 on reader service card

FINE LINE SOLDER, *Cat. No. 9132* has low melting point and self-feed plastic dispenser. Designed for today's printed-circuit needs, this solder is 60/40 rosin core type and .032 inches in

diameter. Self-feed dispenser holds over 12 feet of solder and is made of clear plastic so that the amount of remaining solder can be seen.—**GC Electronics,** 400 South Wyman, Rockford, Ill. 61101.

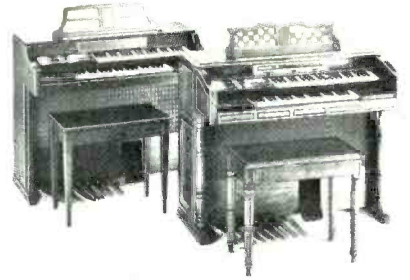
Circle 36 on reader service card

ANTENNA HARNESS, *model JSL-U* is tapered-line 300-ohm matching harness for combining idential uhf antennas into a single downlead. Harness is ideal where vertical stacking of uhf antennas is required for increased gain and

added vertical capture area. Stacking gain is better than 2.5 dB; theoretical maximum stacking gain is 3.0 dB. Can also be used as low-loss mixer to combine two identical uhf antennas which are oriented in different directions; such as arrangement can often eliminate the need for an antenna rotator. $4.95.—**Jerrold Electronics Corp.,** 200 Witmer Road, Horsham, Pa. 19044.

Circle 37 on reader service card

ELECTRONIC ORGAN, *model TO-1260.* Solid-state spinet home organ with two 44-note overhanging keyboards and 13-note radial-arc pedal keyboard. Tonal resources are at fingertip command—from rich, mellow bass sounds to brasses and woodwinds that have built-in wha-wah sound. Two 35-watt rms amps and two wide-range 12-in. heavy-duty speakers. Also featured is accessory panel for installation of cassette recording equipment, earphones for silent practice, plus provision for connecting external



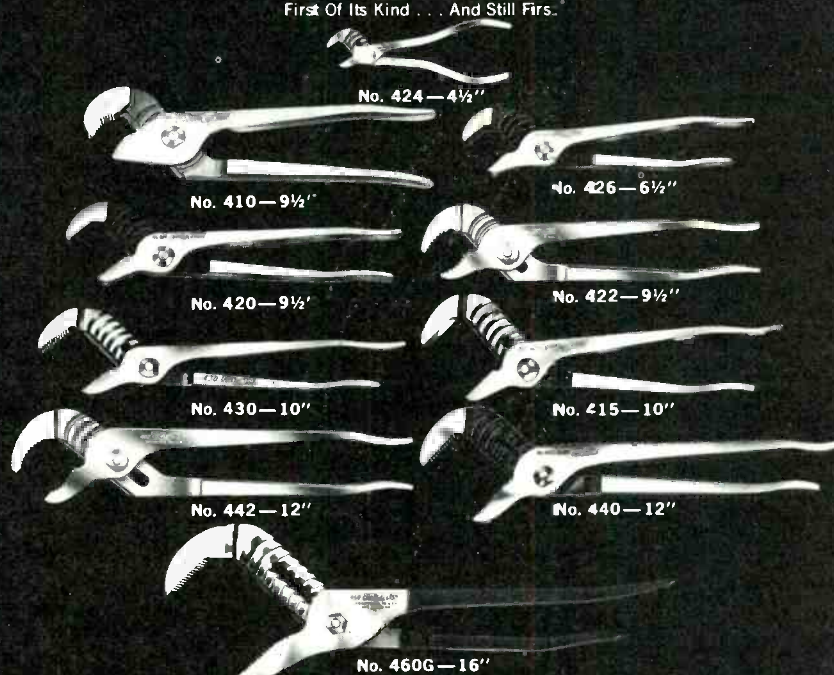
tone cabinet. Optional rhythm section is available.

Kits are available in two preassembled, prefinished cabinet styles: *TO-1260W* Contemporary model $995.00; *TO-1260M* Mediterranean model $1045.00; *TOA-60-1* Rhythm Section $249.00; all prices are mail order.—**Heath Co.,** Benton Harbor, Mich. 49022.

Circle 38 on reader service card

FET MULTIMETER, *model FE27 Big Henry* includes protection against mechanical and electrical hazards of everyday service. Molded acrylic case is backed up by vinyl-clad steel; spring loaded jewel meter movement is designed to withstand the shock of a 10-foot drop, internal protection of sensitive circuitry is provided on all functions by diodes and a fuse; will withstand 1000 volts dc across input on any range.

Features 1.5% dc accuracy with 15-megohm input impedance, designed to reduce circuit loading and eliminate measurement errors in high impedance circuits. Ac rms circuit reads true rms voltage within 3% for either sine waves or square waves produced by regulated power



Circle 27 on reader service card

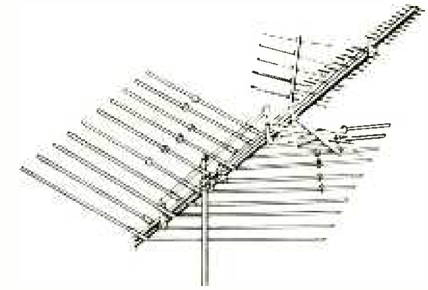
supply transformers in some new TV sets. Separate function is provided for ac peak-to-peak measurements for direct comparison readings

against peak-to-peak test point voltages labeled on schematics. Sensitivity provides eight overlapping voltage ranges between 0.3 volts and 100 volts full scale, dc and ac. Current range covers dc from 10 mA to 1 amp full scale and five ohm ranges measure resistances from .1 ohm to 1000 megohms. $150.00—**Sencore, Inc.**, 3200 Sencore Drive, Sioux Falls, S.D. 57107.

Circle 39 on reader service card

VHF/UHF/FM ANTENNAS, *LPV-UC Color Best* combine patented log periodic design with ultra-sensitive corner reflector and uhf driver for more sharply detailed reception in color or black and white on all channels. Capacitor-coupled dipoles provide synergistic response of vhf channels. Staggered multi-element phased driver minimizes ghosts and snow on vhf and uhf bands. Rugged triple square crossarm construction maintains solid rigidity, improves signal transfer. Use of lustrous gold colored alodized aluminum protects antenna.

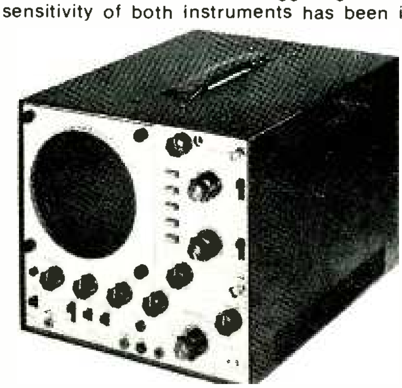
All-band vhf/uhf/FM splitter is included with each of seven models: *model LPV-UC180* (far



fringe), *LPV-UC150* (fringe), *LPV-UC120* (near fringe), *LPV-UC90* (suburban fringe), *LPV-UC60* (suburban), *LPV-UC40* (local suburban), *LPV-UC30* (local).—**JFD Electronics Corp.**, 1462 62nd Street, Brooklyn, N.Y. 11219.

Circle 40 on reader service card

OSCILLOSCOPES, *models To-55 & TO-66.* *TO-55* is a single-trace instrument; *TO-60* is a dual-trace instrument. Automatic features include astigmatism and automatic selection of TV vertical and TV horizontal triggering. Vertical sensitivity of both instruments has been in-

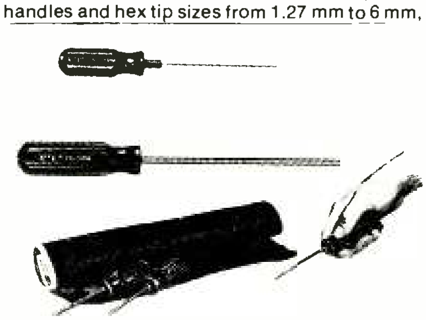


creased to 10 millivolts/cm. *TO-55* vertical bandwidth is 10 MHz while *TO-60* has a 15-MHz system. All switching is done in the 1-2-5 step sequence.

TO-60 provides five operating modes for the dual-trace vertical amplifier. These include independent operation of each channel plus dual trace alternate and dual-trace chopped and the sum of each channel.—**Letrotech, Inc.**, 5810 North Western Avenue, Chicago, Ill. 60659.

Circle 41 on reader service card

HEX SOCKET SCREWDRIVERS, *LN-8MM Set* has fixed handle and comes in a range of metric sizes that are available as a set or individually. Set consists of eight drivers with black plastic handles and hex tip sizes from 1.27 mm to 6 mm,



contained in handy roll-up kit that keep tools together and in order. Blades, measuring 101.60 mm (4"), are protected by a black oxide finish. Handle dimensions are 7/8 x 2-5/8 in. for the smaller drivers and 1-1/16 x 3-1/8 in. for the larger. Overall screwdriver lengths are 6-5/8 x 7-1/8 in. respectively.—**Xcelite Incorporated,** Orchard Park, N.Y. 14127. **R-E**

Circle 42 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.

EXECUTIVE'S GUIDE TO CLOSED-CIRCUIT TELEVISION. 16-page brochure includes descriptions of parts of a CCTV system (camera, monitor, camera lens, components, accessory equipment, videotape recorder, camera housings, camera mounts, switchers and amplifiers), types of CCTV systems, equipment needed and actual installations. Chapter on use of CCTV equipment in producing videotapes for training and educational programs as well as glossary of CCTV terms and definitions. — **GBC Closed Circuit TV Corp.,** Publications Dept., 74 Fifth Avenue, New York, N.Y. 10011.

Circle 43 on reader service card

PANEL METER CATALOG. 6-page catalog describes line of miniature and sub-miniature panel meters. About two dozen different styles are illustrated that range in size from less than 1 in. to 4.75 in. wide. Includes varied shapes and styles such as edge reading, flat, round, square, Keystone, oblong, etc. — **Mura Corp.,** 50 South Service Road, Jericho, N.Y. 11753.

Circle 44 on reader service card

HARD-TO-FIND TOOLS CATALOG. 68-page catalog contains unusual craftman's hand tools and small power tools used by woodworkers, machinists, researchers, model makers and metalworkers throughout industry. Includes space-age glue, razor hone, professional woodbits, pen that writes permanently on metals, diamond glass cutter, wood chisel sets of twist drill steel, funnel with control stopper, etc. Free year's subscription (six issues). — **Brookstone Co.,** 4436R Brookstone Building, Peterborough, N.H. 03458.

Circle 45 on reader service card

QUICK GUIDE TO CONSUMER ENTERTAINMENT INTEGRATED CIRCUITS. 4-page catalog lists integrated circuits for such applications as chroma oscillators, demodulators, amplifiers, signal processors, as well as video fine tuning systems, detector limiters, gain blocks, stereo decoders, rf/i.f. amplifiers, dual audio preamplifiers and audio amplifiers. Also listed is a complete cross reference between Sprague circuits and those types made by other manufacturers. — **Sprague Electric Co.,** Technical Literature Service, 81 Marshall Street, North Adams, Mass. 02147.

Circle 46 on reader service card

SOLID-STATE PUBLIC ADDRESS SOUND SYSTEMS. 6-page catalog specializes primarily in flashlight battery-operated complete public address systems. Catalog offers seven systems: Sound Column Lectern; Roving Rostrum; Diplomat; Announcer; Half-Mile Hailer; Sound Cruiser; Background Music and Paging system. Lists range of accessory items that include extra speakers, microphones, batteries, converters for ac operation and mixers and microphone extension kits. — **Perma Power,** 845 Larch Avenue, Elmhurst, Ill. 60126. **R-E**

Circle 47 on reader service card

Circle 29 on reader service card

Circle 66 on reader service card

Circle 61 on reader service card

EQUIPMENT REPORT

(continued from page 26)

driven from the cassette take-up spindle. Attached to the counter drive is a shutter, or segmented disc, similar to rotary shutters used on some movie projectors (Fig. 5). On one side of the shutter is a small lamp, on the other side is a photocell whose output

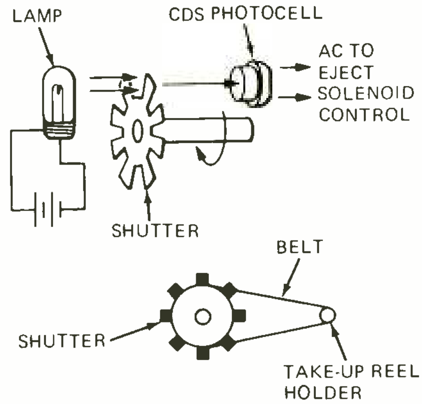


Fig. 5

feeds an amplifier/detector solenoid control. As long as the shutter rotates, an alternating signal is generated in the photocell which is used to hold the solenoid. As soon as the shutter stops, such as when the tape reaches the end of the reel or jams, or if the tape sticks and starts to wrap around the capstan (a nettlesome problem with cassettes), there is no longer an ac output from the photocell and the solenoid control system causes the mechanism to stop and eject—in less than a half second.

A good idea of the performance built into the CD-1668 is illustrated by the performance measurements of a standard production model. Using a standard frequency response test tape with a 50 to 10-kHz range, the playback response was +0/−2 dB. With the ANRS operative, the overall record-play frequency response obtained with Maxell UD (C-90) tape was +2/−3 dB from 35 to 15 kHz. Distortion at the meter indicated 0-VU record level was 1.7% THD (total harmonic distortion) with 6-dB headroom to 3% THD. The signal-to-noise ratio was 55 dB; at the noise frequencies—those that produce tape hiss— the signal-to-noise ratio was 59 dB.

With the ANRS operative and Norelco chromdioxide tape (C-90), the frequency response measured +0/−3 dB from 35 to almost 15 kHz, but the headroom was reduced to 2 dB (the entire industry-wide chromdioxide equalization "mess" needs to be straightened out). The signal-to-noise ratio at the noise frequencies was 54 dB.

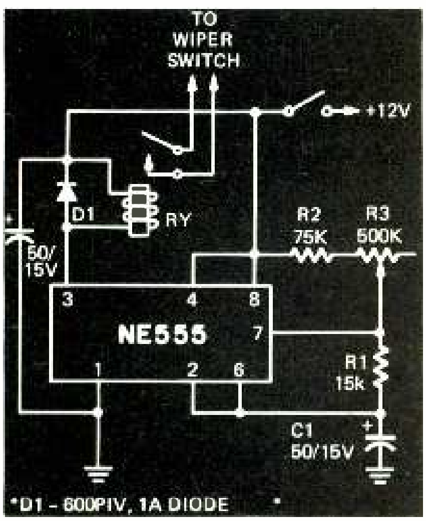
The recorder's overall record-play wow and flutter was a surprising 0.09%—a value more typical to quality reel-to-reel recorders rather than cassette mechanisms. It is pure conjecture, but the low wow and flutter might be due to the optical-eject which keeps extraneous pressure from stretching the tape.

Even excluding the ANRS, the JVC CD-1668 cassette deck has several features which are forerunners of things to come in quality cassette equipment. **R-E**

circuits

WINDSHIELD WIPER PAUSE CONTROL

A number of windshield wiper pause controls have been described in the press. Most consisted of a two- or three-transistor circuit with numerous associated components. Here is the diagram of a design that is simpler and less expensive than most. It uses the low-cost and versatile NE555 IC (by Signetics) as a free-running oscillator with its frequency adjustable from one cycle every three seconds to one cycle every 30 seconds.



R1 and C1 set the width of the negative-going pulse and thus the period of time that power is applied to the wiper motor. The positive-going pulse width is adjustable independent of the negative-going pulse by the combination of R1, R2, R3, and C1. This is the interval between active cycles.

The NE555 drives the relay directly and can handle up to 100 mA, thus making it possible to use almost any inexpensive 12-volt dc relay. The total cost for parts is under $5.00.—*James Baumgardt*

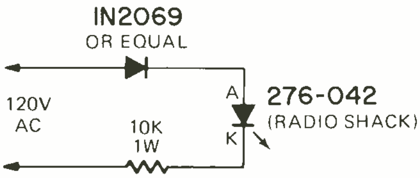
LINE OPERATE YOUR LED'S

Light emitting diodes (LED's) have become quite the 'in' thing as indicators because of their low current drain and indefinite life. However it seems that when ever LED's are used in a circuit they are associated with a dc power supply of some sort. But haven't there been times when you would have liked to run them directly off the ac line? Well you now can and

(continued on page 88)

with just two additional parts.

Get a silicon diode of ½ amp, 200-PIV or better and a 10K, 1-watt resistor. Connect them as shown to your LED and you are all set. If you

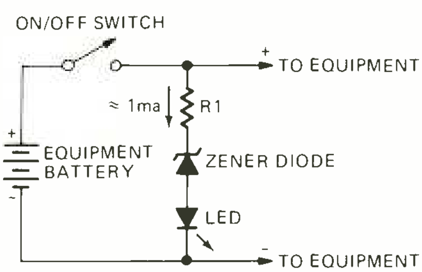


use a larger LED than the one specified (a new budget priced unit from Radio Shack) and you want a little more brightness, decrease the value of the resistor. But don't decrease it too much or you'll burn out the LED! This arrangement has worked great for remote power indicators in industry, as pilot lights on home appliances, and indicators in commercial test equipment on the bench. Why not try it today? — *Gary McClellan*

POWER-ON INDICATOR SHOWS BATTERY CONDITION

A problem encountered when designing battery-powered equipment is how to include a power-on indicator. If the device is to operate from a small battery, an incandescent lamp would draw too much current. Here is a power-on indicator which draws little current. As a bonus it indicates battery condition.

As can be seen in the schematic, the indicator is a LED connected in series with a Zener diode and current-limiting resistor R1. The trick is to "starve" the LED by selecting a high value for R1. The diode won't put out much light at this current (about 1 mil) but it does indicate that the equipment is on. The Zener diode lets the LED indicate battery condition. So long as the battery voltage is above the Zener-breakdown voltage, the LED will light. Should the battery weaken the Zener won't breakdown and the LED will remain dark.



Some design hints: Select a low-power, good-quality, Zener diode whose value is 1—2 volts below that of the minimum weak-battery voltage. If the fresh-battery voltage is 9 volts and the minimum is 8, then a 6.8-volt, 400-mW Zener would be used. To determine the value for R1, hook a variable-voltage power supply in place of the battery. Set the supply to deliver the fresh-battery voltage. Then select a value for R1 so that the LED draws about one mil. Then set the supply to the weak-battery voltage. Note that any voltage below this will cause the LED to go dark. It is best to use a clear-domed, high-efficiency LED for this application.

When the indicator is connected as shown the LED will light when the power switch is on. Should the LED remain dark it is an indication that the battery needs replacing. — *Robert Liebman* R-E

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PLUS:
Technical Topics
Appliance Clinic
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UNDERSTANDING CALCULATOR IC'S

(continued from page 41)

library or *Electronic Design*, 50 Essex St. Rochelle Park, N.J. 07662.

With 500 or so machine cycles available each second we can use rather sophisticated algorithms and still come up with an apparently "instant" answer to a tough problem. Minicomputers and regular computers use parallel computational systems with much faster machine cycle times of fractions of a microsecond. These are much more expensive and are not needed for one-at-a-time arithmetic operations.

The rest of our calculator chip takes care of the "housekeeping", cycling the microprogram in the proper order, taking care of constants and decimal points, accepting information into the keyboard register, routing the display to a BCD to seven segment converter and the proper memory in the stack, and so on.

What's available?

There are dozens of different calculator chips available today, both as new and surplus items. Some of these are now as low as $5 each surplus, and quality new units in production quantities are pushing a $4 figure. A few of the more common calculator IC's are on page 41. A list of some of the manufacturers is shown below.

A Few Calculator IC Manufacturers

AMERICAN MICROSYSTEMS
3800 Homestead Road
Santa Clara, California, 95051

CAL-TEX SEMICONDUCTOR INC
3090 Alfred Street
Santa Clara, California 95050

GENERAL INSTRUMENTS
600 West Johns Street
Hicksville, New York, 11802

INTEL CORPORATION
3065 Bowers Avenue
Santa Clara, California, 95051

MOS TECHNOLOGY
Valley Forge Center
Norristown, Penna, 19401

MOSTEK
1215 West Crosby Road
Carrollton, Texas, 75006

TEXAS INSTRUMENTS
Box 5012
Dallas, Texas, 75222

As with any IC, if you are building or experimenting with these, be sure to have all data sheets and applications notes on hand before you start, along with whatever other information you can possible get—and read everything carefully.

Broken down into its component parts, there's nothing really very fancy or exotic about a calculator—except, of course, for the incredible amount of engineering and expertise that goes into successful chip design. Calculator IC's are now cheap enough that you should be able to do much more with them than simple four functions arithmetic, particularly if you add *your own external* microprogramming, entering in parallel with the key commands. What applications can you think of? **R-E**

new books

ELECTRONICS FOR MODERN COMMUNICATIONS by George J. Angerbauer. Prentice-Hall Inc., Englewood Cliffs, N. J. 6 1/4 x 9 1/4 in. 662 pp. Hardcover. $15.95.

If you are seeking an amateur or FCC commercial license, this text provides the latest information that you need to prepare for the license examination. Chapters include transistors and other solid-state devices, reflecting the latest FCC type questions. Sample questions follow most chapters and have been compiled following the latest FCC Study Guide Revisions. New circuits have been included wherever possible to show the changing nature of electronic communications.

TRANSISTOR SPECIFICATIONS MANUAL, 6th Edition. By Howard W. Sams Engineering Staff. Howard W. Sams & Co. Inc., 4300 W. 62 St., Indianapolis, Ind. 46268. 8 1/4 x 10 3/4 in. 160 pp. Softbound. $4.50.

This manual contains three main sections designed to provide a maximum of information about the transistor: a specifications section, a lead identification section, and an outlines section. It also includes a special listing of specifications for rf power transistors. Using this manual you should be able to determine the essential electrical and mechanical specifications of more than 4000 transistors.

ELECTRONICS SHOP PRACTICES, EQUIPMENT, AND MATERIALS by Clyde N. Herrick. Prentice Hall Inc., Englewood Cliffs, N. J. 6 1/4 x 9 1/4 in. 340 pp. $14.95

Any technician in training or a technician employed in the areas involving assembly techniques, assembly line testing, quality control, or tuning-calibration processes will find this book most useful. Demonstrations and projects combined with more than 300 illustrations provide invaluable "hands-on" experience as well. Starting with safety rules, basic tools and equipment, the text goes on to cover parts identification, hardware and test equipment.

KITS & PLANS by Joseph Rosenbloom. Oliver Press, 1400 Ryan Creek Road., Willits, California. 95490. 8 1/2 x 5 1/2 in. 274 pp. Softcover $3.95.

More and more people are building things for themselves these days. As a result there are more and more kits and plans available. The problem is how to find out who makes what kit or plan. This guide is essentially an attempt to ease the problems faced by anyone who wants to find out who makes what kit. Those companies that supply kits or plans have been located and identified. Their catalogs have been analyzed and their projects or products have been broken down into useful categories. Look up a product in the index and you'll find out what companies offer kits or plans for that project. Then turn to that company's listing for their complete address and details on what they offer.

VINTAGE RADIO, second edition, by Harold Greenwood, Revised, Edited and Expanded by Morgan E. McMahon. Vintage Radio, Box 2045, Palos Verdes Peninsula, Calif. 90274. 8 1/4 x 5 1/4 in. 264 pp. Softcover $4.95. Hardcover $6.95.

A pictorial history of wireless and radio covering the period from 1887 to 1929. This is the story of one of mankind's great achievements: the ability to talk across the miles to one person or to millions of people. This authoritative collector's and historian's handbook contains photos and information on more than 100 items. As you turn the pages you can recapture the feel of pioneer days of wireless and radio. You will be browsing through old-time ads, pictures and trivia.

FET CIRCUIT BOOK, G.C. Electronics Co., 400 South Wyman Street Rockford, Ill. 61101. 5 1/2 x 8 1/2 in. 14 pp. Softcover 25c.

Provides the hobbiest and experimenter with a basic understanding of how the FET works and a number of interesting circuits. Each of the nine projects is complete with parts list and all other information needed to duplicate the device.

SOLDERLESS IC PROTOTYPING TECHNIQUES, by Carl T. Helmers, Jr. M.P. Publishing Co. P.O. Box 378, Belmont, Mass. 02178. 7 x 10 in. 76 pp. Soft cover $4.95.

The techniques and methods described in this manual are meant to inform the reader about methods of electronic prototype construction and layout. Information is included on wire-wrapped interconnections, preparing layouts, methods of building prototype boards and how to systematically wire projects.

DIGITAL HANDBOOK, G.C., Electronics Co., 400 South Wyman St., Rockford, Ill. 61101. 5 1/2 x 8 1/2 in. 64 pp. Softcover 50c.

Basic fundamentals for the digital integrated circuit with charts, schematics and eight easy-to-build projects for the hobbyist and experimenter are featured. These projects include a digital dice game, digital clock, digital burglar alram and others. All are complete with parts lists and construction details. **R-E**

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TWENTY disc, or 10 bar magnets, $1.00. **MAGNETS,** Box 192-E, Randallstown, Md. 21133

FREE catalog lists resistors, tubes, transistors, rectifiers, condensers, tools, tuners, etc. etc. **HYTRON HUDSON,** Dept. RE 2818 Kennedy Blvd., Union City, N.J. 07087.

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GIANT 126 page Canadian surplus catalog. $1.00. **ETCO ELECTRONICS,** Dept. RE, Box 741, Montreal, Canada.

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market center

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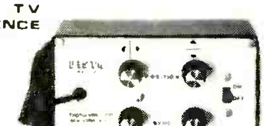

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7403	.25	7451	.32	74151	1.05
7404	.29	7452	.32	74153	1.45
7405	.27	7453	.32	74154	1.75
7406	.55	7454	.45	74155	1.35
7407	.53	7460	.30	74156	1.50
7408	.29	7464	.45	74157	1.50
7409	.29	7465	.45	74161	1.65
7410	.25	7472	.45	74163	1.80
7411	.35	7473	.55	74164	2.95
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7422	.32	7489	3.25	74177	.95
7423	.37	7490	1.25	74180	1.15
7425	.39	7491	1.40	74181	4.25
7426	.35	7492	1.05	74182	1.10
7427	.39	7493	1.05	74185	2.50
7430	.25	7494	1.10	74190	1.65
7432	.30	7495	1.05	74191	1.65
7437	.50	7496	1.05	74192	1.65
7438	.55	74100	1.65	74193	1.65
7440	.25	74105	.55	74194	1.65
7441	1.25	74107	.55	74195	1.15
7442	1.15	74121	.65	74196	1.35
7443	1.25	74122	.55	74197	1.15
7444	1.30	74123	1.15	74198	2.50
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74L30	.40	74L85	1.25		
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74H01	.37	74H22	.37	74H60	.45
74H04	.37	74H30	.37	74H61	.45
74H08	.37	74H40	.37	74H62	.45
74H10	.37	74H50	.37	74H72	.60
74H11	.37	74H52	.37	74H74	.70
74H20	.37	74H53	.45	74H76	.70

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8093	.69	8230	2.95	8812	1.25
8094	.69	8301	1.25	8822	2.95
8095	1.55	8309	1.05	8830	2.95
8121	1.05	8312	1.05	8831	2.95
8123	1.75	8520	1.45	8836	.69
8130	2.50	8551	1.95	8830	1.50
8200	2.95	8552	2.95		
8210	3.95	8554	2.95		

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74C02	.85	74C76	1.70	74C163	3.25
74C04	.95	74C107	1.50	74C164	3.50
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1101	256 bit RAM MOS	2.50
1103	1024 bit RAM MOS	7.95
5260	1024 bit RAM Low Power	7.95
7489	64 bit RAM TTL	3.25
8223	Programmable ROM	6.95

JULY SPECIALS

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7402	Quad 2 input NOR gate	$ .22 ea
7403	Quad 2 input NAND gate (op.col.)	.22 ea.
7405	Hex inverter (open collector)	.22 ea.
7408	Quad 2 input positive AND gate	.25 ea.
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7475	Quad Latch	.75 ea.
7476	Dual J-K flip-flop w/ preset & clear	.45 ea.
7490	Decade Counter	.80 ea.
7495	4 bit right shift, left shift register	.80 ea.
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74193	Binary up/down counter	1.40 ea.

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LM302	Voltage Follower T05	.75 ea.
LM304	Neg. Volt. Regulator TO5	1.00 ea.
LM307	OpAMP (super 741) Mini Dip	.40 ea.
LM324	Quad Op AMP DIP	1.95 ea.
LM339	Quad Comparaor DIP	2.00 ea.
LM550	Precision Volt. Reg. DIP	.75 ea.
LM741	Comp Op AMP Mini Dip	3.35 ea.

MEMORIES

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7489	bit read/wr. memory (RAM) TTL	2.95 ea.
5260	102 bit fully decod. dynamic RAM	6.95 ea.

DISPLAYS

MAN3A type 7-seg. .127	1.25 ea.	6 for 5.00
DL707 type (Mana 1 Repl.)	2.75 ea.	6 for $15.00

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MM 5313	28-pin any readout 6 digit Ipps BCD with spec. sheet	10.95 ea.
MM 5314	24-pin LED-Incandescent readout 6-digit with spec. sheet	10.95 ea.
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561 Phase Locked Loop	DIP	2.95 ea
562 Phase Locked Loop	DIP	2.95 ea
565 Phase Locked Loop	DIP	2.95 ea
566 Function Generator	MINI-DIP	2.95 ea
567 Tone Generator	MINI-DIP	2.95 ea

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MCT 2	Transistor	1.45 ea.

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MAN5	Type grn. 7 seg. .270"	4.75 ea	4/15.75
MAN 7	Type (SLA1), red 7 seg	2.50 ea	4/ 7.95
MAN8	Type yel. 7 seg. .270"	5.50 ea	4/18.95
DL707	Type (MAN 1Repl.)	3.50 ea	4/13.00

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300	Pos V Reg (super 723)	TO-5	$ .95 ea
301	Hi performance AMP	MINI-DIP, TO-5	.45 ea
302	Voltage Follower	TO-5	95 ea
304	Negative Voltage Regul.	TO-5	1.25 ea
305	Positive Voltage Regul.	TO-5	1.25 ea
307	Op AMP (super 741)	MINI-DIP, TO-5	.45 ea
308	Micro Power Op Amp	MINI-DIP	1.25 ea
309H	5 V Regulator	TO-5	1.25 ea
309K	5 V 1A Regulator	TO-3	1.95 ea
310	Voltage Follwer Op Amp	TO-5	1.45 ea
311	He perf. Volt. Compartr.	MINI-DIP, TO-5	1.25 ea
319	Hi-Speed Dual Compartr.	DIP	1.65 ea
320	-5.2 V Neg. Regulator	TO-3	1.95 ea
320	-15 V Neg. Regulator	TO-3	1.95 ea
324	Quad Op Amp	DIP	2.25 ea
339	Quad Comparator	DIP	2.50 ea
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370	AGC/Squelch AMPL	TO-5 or DIP	1.65 ea
372	AF-IF Strip-detector	DIP	.85 ea
373	AM/FM/SSB Strip	DIP	3.60 ea
376	Pos. Volt. Regulator	MINI-DIP	.65 ea
377	2W Stereo amp	DIP	2.75 ea
380	2 Watt Audio	DIP	1.75 ea
380-8	.6W Audio amp	MINI-DIP	1.75 ea
381	Low-Noise Dual Pre-Amp	DIP	2.25 ea
382	Low-Noise Dual Pre-Amp	DIP	2.25 ea
550	Prec. Voltage Regulator	DIP	.95 ea
555	Timer	MINI-DIP	1.25 ea
703	RF-IF Amp	MINI-DIP	.59 ea
709	Operational AMPL	TO-5 or DIP	.45 ea
711	Dual Different Compar.	DIP	.39 ea
723	Voltage Regulator	DIP	.75 ea
739	Dual Hi Perf. Op AMP	DIP	1.25 ea
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3075	FM Det.-LMTR & Audio Pre-Amp	DIP	.85 ea
3900	Quad Amplifier	DIP	.75 ea
3905	Precision Timer	DIP	.75 ea
7524	Core Mem Sense AMPL	DIP	1.95 ea
7525	Core Mem Sense AMPL	DIP	.95 ea
7534	Core Mem Sense Amp	DIP	2.75 ea
7535	Core Mem Sense Amp	DIP	1.25 ea
8038	Function Generator	DIP	8.95 ea
9601	Retriggerable One-Shot	DIP	.95 ea
75451	Dual Peripheral Driver	MINI-DIP	.49 ea
75452	Dual Peripheral Driver	MINI-DIP	.49 ea
75453	(351) Dual Periph. Driver	MINI-DIP	.69 ea
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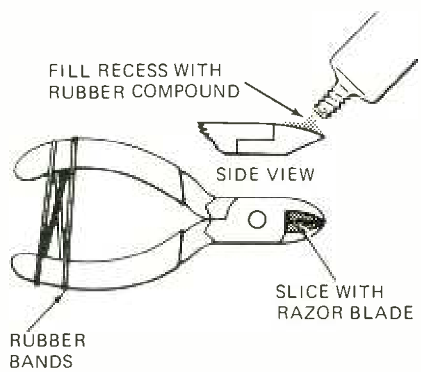
Circle 81 on reader service card

WIRE-GRABBER

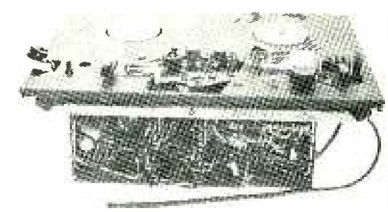
To avoid the hazard and mess caused by flying component-lead trimmings, add a "wire grabber" to your diagonal cutters. First, thoroughly clean the inside of the jaws with a degreasing solvent. Then fill the hollow of the jaws with silicone rubber sealer (GE, Dow-Corning, etc.) and slip rubber bands over the handle to hold the jaws closed. Let the sealer cure over night, then slit the seal with a razor blade by running the blade between the cutting edges. — *Carl. B. Van Wormer*



REWIND WHILE YOU LISTEN

If you make this rewind unit from an old tape recorder you can rewind tapes without tying up your good tape deck. Using only the transport mechanism of this stripped-down recorder will save your listening machine from a lot of wear.

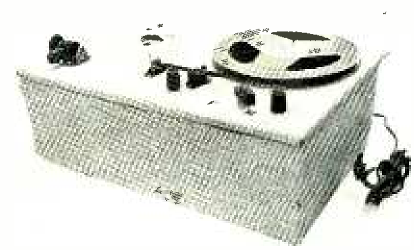
Full-track, half-track, mono or stereo, any old recorder will do as long as the forward/rewind mechanism works. The electronics is removed or deactivated. Start by cutting the power leads to the recorder's power supply,



testing the motor drive after each wire is removed to see if you cut an electric interlock circuit. If so, trace it out and rewire its circuit with a new wire. If there is no power line fuse, add one.

Remove any mechanical parts not connected with the drive system. This is a good time to inspect the belts, they are probably cracked and it's worthwhile to replace them now when it's easy and convenient. In any case, make a note of how many there are and also copy down all the information you can find about the recorder from the chassis and case. A simple sketch taped to the bottom of the transport can save you a lot of head scratching if you have to replace a belt later.

Strip out any electronic components you can remove. This lightens the rewinder and you might be able to reuse some of the salvaged parts. Leaving the steel guide pins, the capstan with its roller and one pressure pad, take off all the rest of the components that the tape passes over including the erase and record/playback heads. With the remaining pressure pad held away from the tape, what's left should cause enough drag to keep the tape from fluttering during fast rewind. If it does not, lower the pad and adjust the spring tension until the tape will run fast and smoothly. Keep the pad moist with tape lubricant. Leave the counter hooked up, it's handy for editing. You might be able to make the rewind unit smaller by making a simple case just



the size of the deck, covering the box and deck with contact paper for a quick finish. Complete your modification with knobs on any unused exposed control shafts as well as the functioning ones for appearance. — *Gene Cabot*

Circle 83 on reader service card

ADVERTISING INDEX

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

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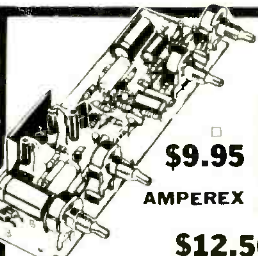

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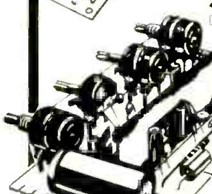

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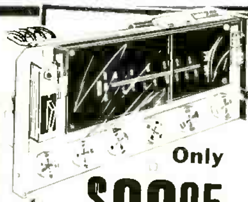

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8223	Programmable ROM	6.50
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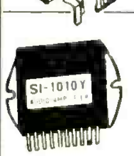

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Mfgr's Type	Watts	Sale
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- 2 — MOS FETS, DUAL GATE, N chan. 3N187, TO-18, RCA $1.
- 2 — MOS FETS, DUAL GATE, N chan. 3N140, TO-18, RCA $1.
- 4 — RCA 2N3600 NPN, UHF transistors, tv-fm, TO-18, 1000mc $1.
- 2 — MPF-1000, Motorola MOS dual gate "The Claw" $1.

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- 10- TO-5 Case 536, 540, 565, 567, 741† $1.
- 10 — LINEAR AMPS, 709, 710, 711, 741, TO-5 $1.
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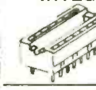

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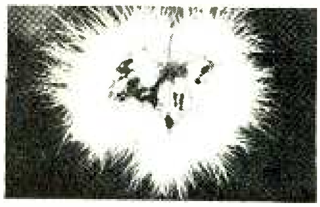

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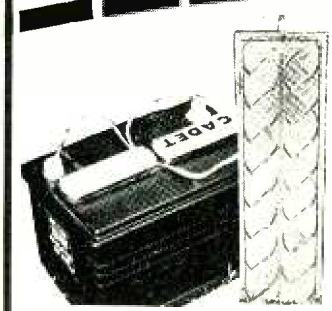

Our 12V Solar Battery Charger, like those used aboard satellites but redesigned for broad usage, allows direct conversion of light-to-electricity. Compact panel put on a boat can automatically charge its 12V battery over entire daylite period: no power drain at nite. Use it *anywhere* a trickle charge is needed (trans. radios, etc.). Terrific value, it comprises *thirty* 1/2V silicon solar cells in series w/ a diode. Cap.: 30 Watt-hrs. a wk., approx.
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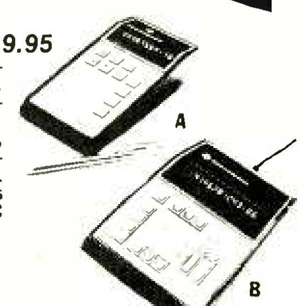

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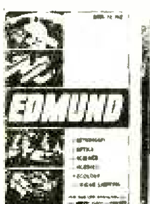

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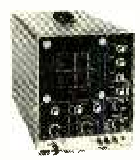

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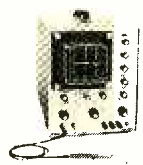

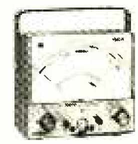

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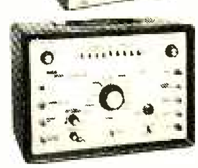

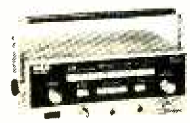

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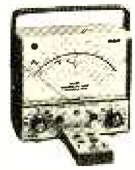

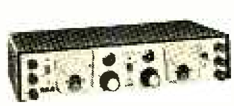

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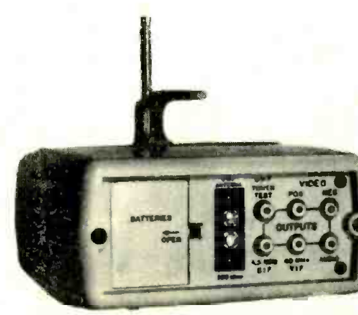

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