60¢ ■ OCT. 1972

Radio-Electronics®

FOR MEN WITH IDEAS IN ELECTRONICS

SPECIAL ISSUE—4-CHANNEL STEREO

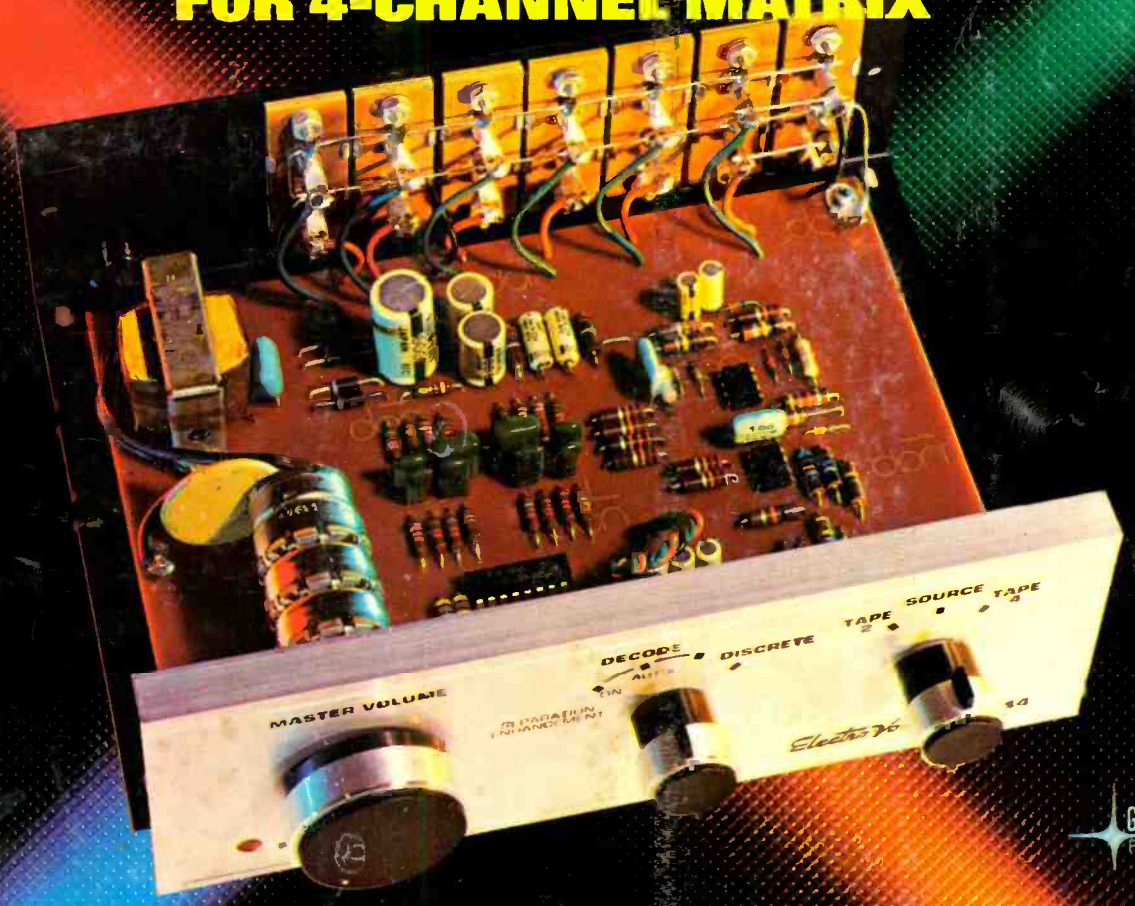
4-CHANNEL PHONES
R-E Test Report

4-CHANNEL RECORDS
How They're Made

KILL TAPE NOISE
Three Ways To Go

CHROMIUM DIOXIDE
What you should know

NEW UNIVERSAL DECODER FOR 4-CHANNEL MATRIX



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Automatic Fine Tuning—Step By Step

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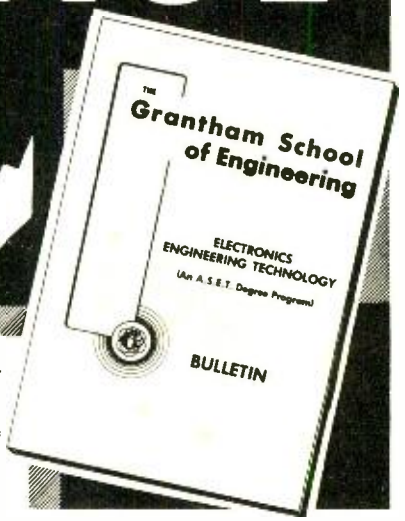

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Radio-Electronics

FOR MEN WITH IDEAS IN ELECTRONICS

October 1972

HERE'S E-V'S EVX-44, their new universal 4-channel matrix decoder. Discover what it does and how it works.....see page 33

CHROMIUM-DIOXIDE TAPE can improve recording quality—but not in every instance. Find out where you stand.....see page 36

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looking ahead

Army adopts videocassette

The day of falling asleep in a darkened theater to an Army training film may be just about over. The new Army will watch training tapes in color on TV screens in a lighted room where the sergeant can instantly spot a drooping eyelid.

The Army's Audio-Visual Agency, whose job is to evaluate such devices for all Army branches, has now tested 600 Sony videocassette recorders and players and given them a good-conduct medal. Acceptance by students and instructors has been "tremendous," according to an Army spokesman, with the operational rate being 98.9%, although some machines are running as much as 18 hours a day. The 600 machines have had no electronic problems and only three mechanical failures, according to the Army report, a track record unexcelled by any audio-visual equipment, including 16mm motion-picture equipment. Various branches of the Army plan to purchase up to 10,000 videocassette units next year, and eventually color cassette players will be in every Army hospital ward for patient morale, in addition to their uses for training.

Domestic satellites

TV, telephone calls and other communications have been regularly transmitted around the globe via satellite since 1965. For about the same amount of time, the Soviet Union has had a domestic satellite system for relaying information within her own borders. Now it appears that the way is finally open for the United States to use space relays for domestic communication.

The FCC, which had barred any such domestic satellites while it considered the entire matter of satellite policy, has finally started to open the door to space relays for network television, interconnected cable TV systems, telephone, teletype, computers and other uses. FCC's ruling, in effect, asks for proposals from qualified groups wishing to establish domestic satellite service. The Commission picked no single system, merely decided that it would accept proposals which it finds "in the public interest" from any party that is financially, legally and technically qualified. In setting its policy, the Commission placed restrictions on satellite use and ownership by AT&T and Communications Satellite Corp. (Comsat), the American partner in the global satellite system, presumably to avoid charges of communications monopoly.

Why domestic satellites? International experience has already proven that they can be far less expensive than land-line microwave networks now used to link all parts of the United States. And, with the explosion in communications, they promise to provide almost unlimited capacity.

'Useless' antennas

Many all-channel antenna installations are "worse than nothing—just a lot of useless aluminum." This was a finding in tests of uhf reception from combination vhf-uhf antennas by Kaiser Broadcasting Corporation, an owner of several uhf stations. The tests showed that "practically every major antenna manufacturer has an excellent all-channel antenna, but practically everybody has a bad antenna, too, and is selling it," according to a Kaiser spokesman.

To make matters worse, Kaiser's investigations showed that many uhf antennas are being installed with 300-ohm ribbon lead-in designed for vhf—and ribbon lead is actually packed in some all-channel antenna kits. Beam-splitters and baluns used in uhf antenna installations, too, were often found almost useless in passing uhf signals. Kaiser officials are conferring with manufacturers of antennas, lead-in wire and accessories, whom they say have been extremely cooperative. In addition to removing ineffective all-channel antennas from the market, Kaiser would like to see antenna manufacturers pack with their products a uniform set of instructions, specifying proper lead-in wire and other accoutrements for optimum uhf reception. Kaiser officials are optimistic that they'll get a voluntary program going which will improve uhf reception devices. If not, they hint they may apply to the FCC to extend the all-channel law to receiving antennas and associated equipment.

Setting back the clock

A government proposal to use standard television channels to carry the same precise time and frequency standards now broadcast over WWV has received a setback from a committee of broadcasters. The National Bureau of Standards had proposed that this information be inserted in one line of the vertical interval between the frames of the TV picture carried by the networks. Special decoders and various readout techniques were suggested—including the use of the Bureau's TV time signal to correct home clocks (Looking Ahead, **Radio-Electronics,** November 1971). The committee found what could be a fatal flaw in the Bureau's proposal—that old devil, videotape. It pointed out that network programs aren't all carried at the same time across the country; many are tape and played later, particularly in the western time zones. With the time signal superimposed on the videotape, this could give the clocks in the Mountain Time household a nervous breakdown.

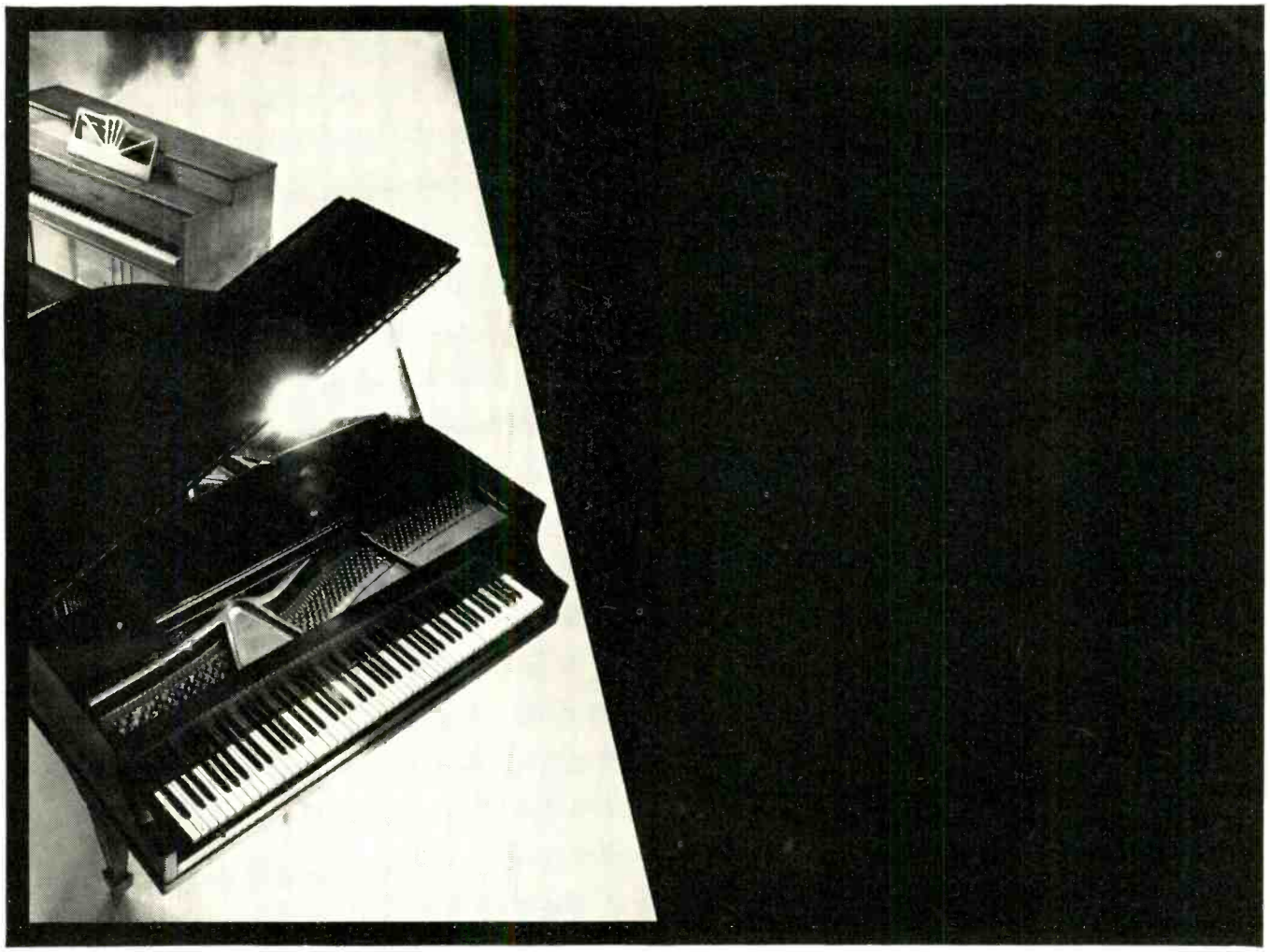
A companion Bureau of Standards proposal would encode captions for the deaf in the vertical interval. A special decoder would display the captions on the TV screen or on a separate cathode-ray tube. The committee estimated that such a decoder would add $70 to $100 to the cost of a television set if built in, or $100 to $200 if sold as an attachment. The committee recommended further tests of the caption system.

Auto radar

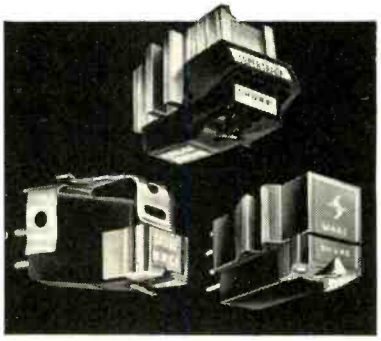
A collision-avoidance radar system has been demonstrated by RCA, designed to prevent tailgating accidents. The compact transmitter-receiver unit is mounted on the front of a car. It transmits a continuous signal of about 9 GHz, which is received by a passive reflector on the rear of the vehicle ahead. The reflector doubles the frequency of the transmitted signal and reflects it back to the radar unit. By measuring the time required for the signal's round trip, the radar calculates the distance to the car in front, flashes a light and sounds a buzzer when the distance decreases below one car length for each 10 miles per hour of the speed of the radar-equipped car.

A more sophisticated version could be integrated into the car to automatically release the throttle and apply the brakes. Reflectors on highway shoulders, barricades and other collision hazards could prevent cars from running into stationary hazards, and stop the car if it should run off the road.

by DAVID LACHENBRUCH



To each his own.



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new & timely

Electronic editor speeds up the news

Electronic editing instruments, looking very much like wide-screen TV sets with typewriter keyboards in front of them, were used for the first time by United Press International newsmen to report live news at the recent presidential nomination conventions at Miami Beach.

The electronic editing machine displays 50 lines of text at a time on a video screen. These may be typed by the editor at the machine or sent from another unit. As the editor reads the copy in front of him, he corrects, deletes or adds new copy on his typewriter keyboard, and the changes appear on the screen instantly. The editor reads over his revised material, makes any further desirable changes and presses a button. The copy is then immediately stored in the United Press International computer in New York City, from which it can be flashed to any part of the world.

Editing machines of this kind (Harris Intertype) have been used in UPI offices, but this is the first instance of their use as on-the-spot reporting tools.

An eventual extension of the computerized news information storage and retrieval system, reports UPI's director of communications James Darr, is a video news system in which a subscriber (usually a small newspaper proprietor) could choose his own news—sports, markets, world events—from a "shopping list" and have them appear on his own phototypesetter or on video terminals similar to the one in the photo, where they could be further edited to suit his own publication.

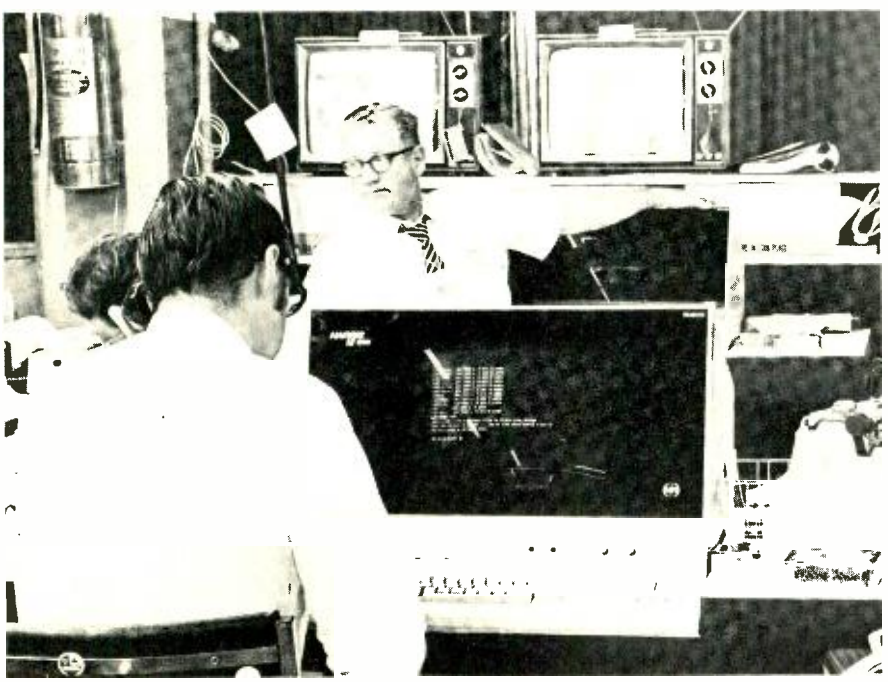
It would appear that the "radio newspaper" so often predicted in this publication, in which the individual (affluent) customer could order up his own brand of news on his breakfast-table video display, is not too far distant.

CET classes at Iowa State University

Courses are scheduled this fall in the continuing series of classes for adult electronic technicians interested in preparing for the National Electronics Association's certification program. The classes are conducted in cooperation with the Iowa State University Extension Service and by Iowa Central Community College in Fort Dodge, Kirkwood Community College in Cedar Rapids and North Iowa Area Community College in Mason City. Here is a calendar of the classes to be taught.

Sept. 12, 19, 26. Oct. 3 and 10–Color TV–Fort Dodge–Voc-Tech Bldg. ICCC Sept. 13, 20, 27, Oct. 4 and 11–Alignment–Mason City–Bldg A–NIACC Sept. 18, 25, Oct. 2, 9, and 16–Semiconductors–Cedar Rapids–Lynn Hall Kirkwood.

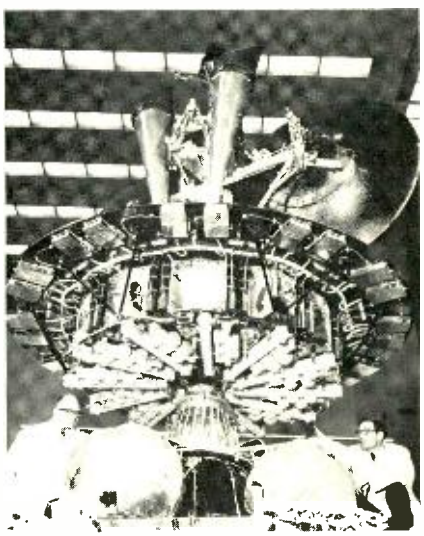
For further information contact Engineering Extension, Electronic and Technical Education, 110 Marston Hall, Ames, IA. Phone 515-294-5060.



UPI NEWSMAN at Miami Beach works with the electronic copy editor at the Democratic convention. The video editing units, according to reporters present, permit providing "faster, better and cleaner news reports" to subscribers.

New satellite completes global system

A new global system of satellite communications was formed following the launch of the latest Intelsat IV satellite over the Indian Ocean where it joined its Atlantic and Pacific brothers in a 22,300-mile-high synchronous orbit.



ENGINEERS CHECK A MAZE of advanced electronics inside an Intelsat IV communications satellite. In orbit, the satellite's electronics are surrounded by a drum-shaped "skin" consisting of thousands of tiny solar cells.

The new satellite completes the "trilateral" positioning of Intelsat IVs over the earth's three major oceans, thereby providing members of the 83-nation Intelsat consortium with the latest system of global communications.

The giant satellite, nearly 18 feet high and 8 feet in diameter, was built by Hughes Aircraft Company, El Segundo, CA, and an international team of subcontractors with a design lifetime of seven years and a capacity to handle an average of 6,000 two-way telephone calls or 12 simultaneous color TV programs, or various combinations of phone, TV, teletype and data traffic.

The new satellite, which appears to stand still in space as its orbital speed

(continued on page 12)

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new & timely

matches the earth's rotation, links 17 ground stations serving the Indian Ocean basin. Stations within view of the satellite are based in Lebanon, India, Indonesia, Malaysia, Kuwait, East Africa, Bahrein, Thailand, Australia, Singapore, The Philippines, Hong Kong, Japan, Spain, Italy, England and Germany.

The first two Intelsat IV's were launched in January and December of 1971 over the Atlantic for commercial operations between the U.S. and Europe. On Jan. 22 of this year a third Intelsat IV was launched into orbit over the Pacific where it served as the main communications link between the People's Republic of China and the U.S. during President Nixon's visit to Peking in February.

Electronic security devices protect from burglars, fire

Four new electronic security devices are aimed at giving all-round protection to the home-owner. Two cover the principal entrances to a dwelling. The third is a motion detector, that sounds an alarm when an intruder enters a protected room or space, and the fourth is an early warning smoke and fire detector. All four systems are made by Magnavox, as parts of a do-it-yourself home security system.

The first two systems are based on magnetic switches as sensors for doors (Magnavox has found that the great majority of burglaries are made through the front or back door) and for windows. Mat switches protect halls or walks. One of the systems is a radio-frequency type, powered with a 9-volt battery. Not only does it sound an alarm when its sensors are tripped, but will sound an alarm or turn on a light if a panic button carried by the user is pressed. The other system uses the house power wiring to carry the signal from transmitters to receiver. Not as quickly and easily installed as the first, but, being ac-operated, it has more power—a range of about 300 feet as compared with 150 feet for the rf unit. Both types can be reset remotely, an optional feature that might be a great convenience to ill or handicapped persons, who might be those most likely to want an alarm system.

The motion detector has a range of 18 to 26 feet, over a 90-degree angle. The area is flooded with ultrasonic waves, which trip an alarm if the wave pattern is disturbed by a body moving in the space.

The fire and smoke detector works on the ionization principle, and sounds an alarm as soon as the air becomes more conductive due to the presence of smoke or gas ions. Thus it detects fire in the early stages, before it is far enough advanced to actuate a thermal alarm.

It is expected that the fire and smoke detector and the ultrasonic intruder detector will sell for less than $100 each, and the entry alarms for under $170.

Electronics hunts tornadoes

Many of you remember the "TV Tornado Detector" trick, mentioned here some years ago. A TV set is tuned to channel 13, the brightness turned down until the raster is just extinguished, then the tuner is turned to channel 2. If a tornado is in the area, (within 10–20 miles or so) the intensity of the static generated by the tremendous turbulence will make the TV screen light up.

Mr. William L. Taylor, Project Leader of the National Oceanic and Atmospheric Administration, (NOAA) has developed new electronic equipment for studying this phenomenon. During the 1972 tornado season, fifteen sites are monitoring and recording atmospherics activity during severe weather conditions. Most of these sites are in what is called "Tornado Alley" by its inhabitants; West Texas, Oklahoma, western Arkansas, Missouri, and some other near-by areas.

The detectors and recording equipment are basically simple. An omnidirectional antenna is fed to an amplifier tuned to 3 MHz, with level indicators which show high-intensity bursts. When these bursts reach a level of three pulses per minute, white lights come on; at 10 ppm, yellow lights, and at 20 ppm, red lights. A continuous-strip chart recorder logs each burst for future reference.

In previous tests of this system at the National Severe Storms Laboratory, on the campus of the University of Oklahoma at Norman, Mr. Taylor correctly identified four out of five periods of verified tornadic activity. The present experiments are aimed at recording and correlating more data to refine the use of this method.

Combined with the use of standard Doppler radar tracking of cloud formations by the Weather Bureau, this offers hope for the perfection of a reliable early-warning system for the killer storms.

"Electronic ball-point pen" writes over long distances

Electrical transmission of handwritten

(continued on page 14)

Now every product in this catalog is available on a special money saving offer from your RCA distributor.

A complete new look from RCA in Antenna System Accessories

RCA's all new line of Antenna System Accessories has been planned and designed to fulfill specific requirements of any antenna system in every detail. Covering every requirement from a simple passive two-set coupler up to a complete amplified, 82-channel coaxial multi-outlet distribution system for houses, offices, stores and small apartment buildings, this new line is complete in every respect and represents a new standard of performance, convenience and styling.

The entire line is advance-engineered by RCA to meet rigid performance standards. RCA's all-solid-state circuitry provides dependable trouble-free performance. Protection against lightning induced voltage surges is provided in all amplifiers. All passive devices designed for low insertion loss.

All housings have RCA's "new-look styling" in molded high IMPAC® plastic cabinets. Similar styling design for all models presents a uniform appearance for a complete line.

Installation convenience . . . mounting is simplified with the use of the new RCA "slip-on" clamps. No solder connections are required to connect any model into a system. Serrated washers simplify connecting 300-ohm line to the devices. All hardware, complete installation instructions and system wiring connectors are included with every model.

INDEX

This is how to get it.

The RCA Antenna Systems Accessories Catalog is the TV service dealer's complete guide to better reception for his customers and more sales. So tune in and get your free copy today with absolutely no obligation. Ask your local RCA Parts and Accessories distributor how to get your free copy, and find out about the special money saving offer available from participating RCA distributors. For the name and address of your nearest RCA distributor, write: RCA Parts and Accessories, Distribution Services, 2000 Clements Bridge Road, Deptford, New Jersey 08096.

RCA

Circle 7 on reader service card

new & timely

material is by no means new. The telautograph, an electromechanical device, is nearly 100 years old. It transmits the movement of a pencil by two levers, which set up two separate currents. These are used at the receiver to actuate a similar mechanism and reproduce the original

writing. The "electronic pen" of cathode-ray tube displays is also well known. Equipment can also be obtained for transmitting and feeding handwritten data into a computer. But all such equipment is relatively complex and costly.

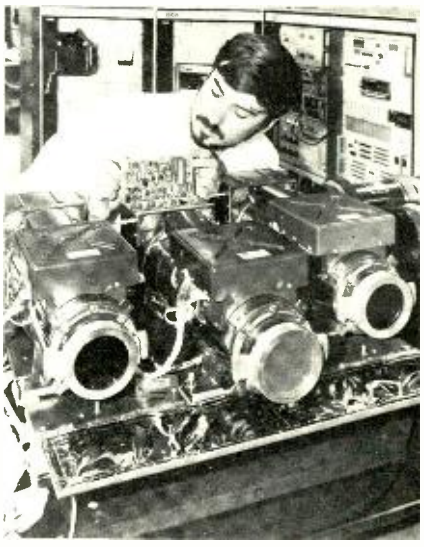
The new system, developed by Siemens, of Germany, depends on a piezoelectric writing pad. Ultrasonic pulses at a pulse repetition frequency of 500 Hz are generated alternately at two edges of the pad and travel across it at a constant velocity, parallel to the edges of the pad and at right angles to each other. Since they apply (very slight) pressure to the piezoelectric ceramic, voltage fronts travel across the pad. The pen—which can be a converted ball-point—is simply a capacitive probe that picks up the signal. An electronic evaluator, connected to the pen and the sheet, forms signals from the propagation times of each set of pulses from the edge of the sheet to the pen. These represent the instantaneous position coordinates of the pen, and can be displayed—as seen in the illustration—transmitted, or stored in a computer.

The approach is highly economical and efficient as compared to older methods, and quality of reproduction is high. Pen-position alterations of less than 0.2 mm can be registered, and rapid pen movements are reproduced easily by the 500-Hz repetition frequency.

Earth mapping from 490 miles up

A revolution in the use of space technology for practical purposes is promised by a new 3-camera high-resolution satellite TV system. The three-camera setup is designed to produce images 10 times sharper than those of home TV. It was developed by the RCA Astro-electronics division at Princeton, NJ under contract to NASA's Goddard Space Flight Center.

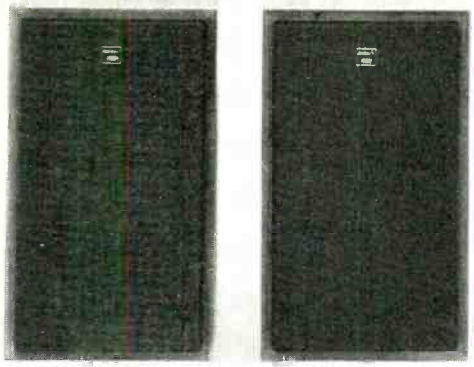
Each of the three cameras carried by the satellite produces images of 4,000 horizontal scanning lines. Orbiting at 490 nautical miles above the earth, all three cameras will view the same 100-by-110 nautical mile (115-by-115 statute mile) square of the earth's surface.



THESE THREE CAMERAS transmit high-resolution detailed maps and information on crops, forests, ocean shoreline areas and other natural resources. We see them here during final checkout.

One camera will observe the ground in red, another in near-infrared and the third in green. When transmitted to receiving stations, the three images can be combined to produce a full-color picture, or can be studied separately.

An early and important use of the system, reports RCA Astro-Electronics Division vice-president C. S. Constantino, will be to create maps more extensive and detailed than anything possible before. **R-E**



How to move gracefully from two channels to four

Just flip the mode switch on Sony's new TA-1150 and it switches from mono to stereo to true four-channel sound. It's the first stereo integrated amplifier designed for the four-channel era. Because it has built-in circuitry and switching specifically designed for an SQ four-channel decoder (our SQD-1000 is perfect match) or decoders for any other quadraphonic disc system. You can even put your SQ decoder and your rear-channel amplifier out of sight, and control the volume of all four channels with the TA-1150's master volume control.

And the four-channel connections are additional to the two sets of stereo tape output and monitor connections (with direct dubbing provisions).

The amplifier section puts out 100 watts IHF music power at 8 ohms, very clean watts, too, thanks to our direct-coupled circuitry. The TA-1150's bass and treble controls let you select the degree of tonal correction you want, as well as the frequency at which that correction takes effect. And you can disconnect the TA-1150's preamplifier from its power amplifier section, to insert electronic crossovers or equalizers. Two quite delightful channels, now, two more for later. And all for only $229.50.* The ST-5150, a superb FM stereo tuner matches the TA-1150's performance, appearance, price; $229.50.* Sony Corp. of America, 47-47 Van Dam St., Long Island City, N.Y. 11101. *Suggested retail price.

SONY® TA-1150

Circle 9 on reader service card

letters

MATRIX VS DISCRETE

It's been many years since we last communicated (I used to do equipment reports for you, remember?), but I couldn't let Mr. Scheiber's letter in your June issue go unanswered.

I realize I'm writing rather belatedly, and that the issue may already be a dead horse, but Mr. Scheiber made some outrageous statements in that letter, and if nobody else set the record straight, maybe this letter will.

As one of the pioneers of matrixed 4-channel recording, Mr. Scheiber certainly has an axe to grind, but I am confident that there must be some more-legitimate things about the JVC system to attack (such as, for example, its cost and complexity). But it seems to me that Mr. Scheiber was criticizing the JVC system on grounds that are either dubious or patently ridiculous. I'll enumerate, point by point:

Mr. Scheiber cites the fact that matrixed discs have a potential high-frequency range to 20,000 Hz, and points to JVC's "inferior" claim to a 15-kHz limit. I would like to find a few ordinary stereo discs with an honest-to-goodness 12,000 Hz recorded on them, let alone 20,000. It is one thing to cite a system's potential, but let's be realistic. If record companies habitually limit high end to 10,000 kHz (to prevent excessive groove velocities), what good is a potential range of 20,000 Hz? And why is 15,000 Hz a "limitation?"

The same can be said for potential S/N ratio. Statistically, very few recordings have much more than 35 dB of dynamic range on them, so the only advantage of a 60-dB S/N ratio will be quieter periods *between* recorded selections, when nobody listens anyway. Some classical recordings do have wider dynamic range, but dynamic range is not S/N ratio, and few discs have more than 60 dB S/N ratio. With Dolbyization, the original master tapes may have 70 dB S/N, but the noise gained in cross-copying for mixdowns and working copies of the master can reduce the final version, on the disc, to less than 60 dB S/N. True, this is 10 dB less than Mr. Scheiber attributes to the JVC system, but have record buyers *ever* been as bothered by the tape hiss on discs as the recording engineers were? And with JVC now using Dolby-type noise-reduction on their rear-channel carrier, might not their system now be considerably better than 50 dB on S/N ratio?

Finally, Mr. Scheiber's criticism of the

(continued on page 22)

Introducing the expensive digital multimeter that doesn't cost a lot.

The B&K Precision Model 281. A solid-state, lab-quality portable instrument that measures AC/DC voltage, current and resistance.

The state-of-the-art Model 281 shows readings on a large, clear, 2½-digit numeric display. It also has positive over-range and reverse-polarity indication. There's no need to switch leads. You can reverse polarity at the flick of a switch.

Model 281 readings are faster and more accurate than analog-type meters. Unlike hard-to-see needle indicators, you can read the large, illuminated numerals—including the decimal point—from a distance.

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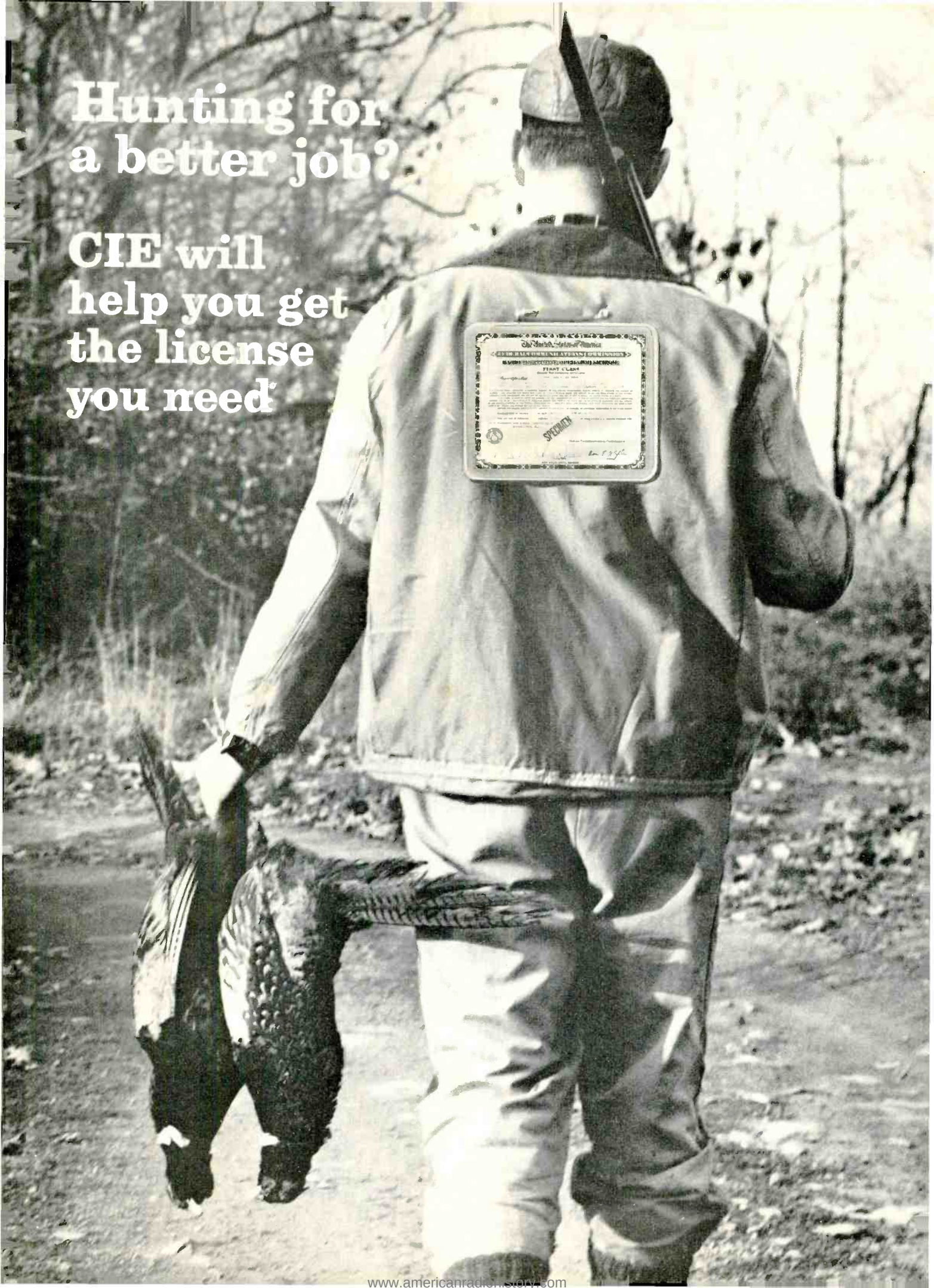


LETTERS

(continued from page 16)

JVC system on the basis of its "total separation between speakers" is ridiculous. Nobody is claiming, as Mr. Scheiber asserts, that discrete stereo must be used for reproducing one monophonic sound source from each of the four channels. Certainly, a lot of recordings will be made in this way, just as a lot of early stereo recordings had one mono source per side with no overlapping at all. But that is a *potential* of discrete 4-channel, not a requisite. For reproducing ambience, or a continuous panorama of sounds from all directions, total separation simply means that the *natural* separation, as picked up by the mikes, will not be *diluted* in playback. If the original recording has the necessary separation to yield a realistic playback through four channels, a discrete 4-channel reproducer will yield realistic playback. A matrixed system with inferior separation will not, unless the original recording is made with *exaggerated* separation to offset the dilution in matrixing.

J. GORDON HOLT
Glen Mills, PA

MORE SWITCHING TRICKS

In the article in **Radio-Electronics** May 1972 "Switching Tricks With Silicon Diodes", referring to Fig. 3-a, the text states that both remote units can be called at the same time or either one separately. As I see it, it is not possible to light both lamps at the same time using a dc power supply. If both buttons are pressed at the same time the result is a dead short across both batteries in series which could be dangerous if the batteries have a large current capacity. A safe and possibly less expensive solution (one less battery vs. more costly switches) is shown here in Fig. 1 using spdt break-before-make push buttons.

The author has also overlooked one of the primary advantages of this type of circuit. That is multiple switching over long distances using only one pair of wires. By replacing LM1 and 2 with relays, two separate switching functions can be accomplished. For applications requiring a reversible motor at a remote location, use the same push button circuit as in Fig. 1 and a dc motor connected as in Fig. 2-a or 2-b.

J. G. MCFARLANE JR.
Metaline, WN

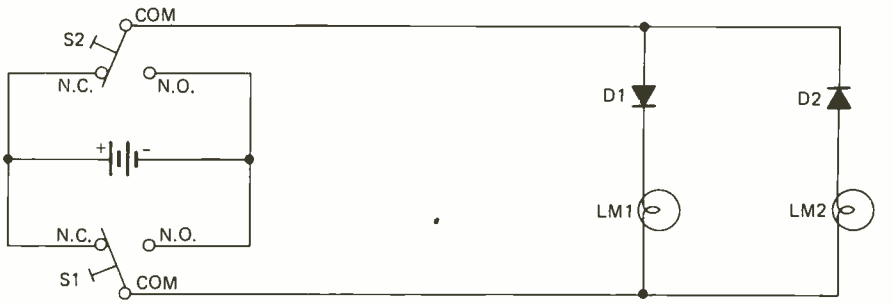
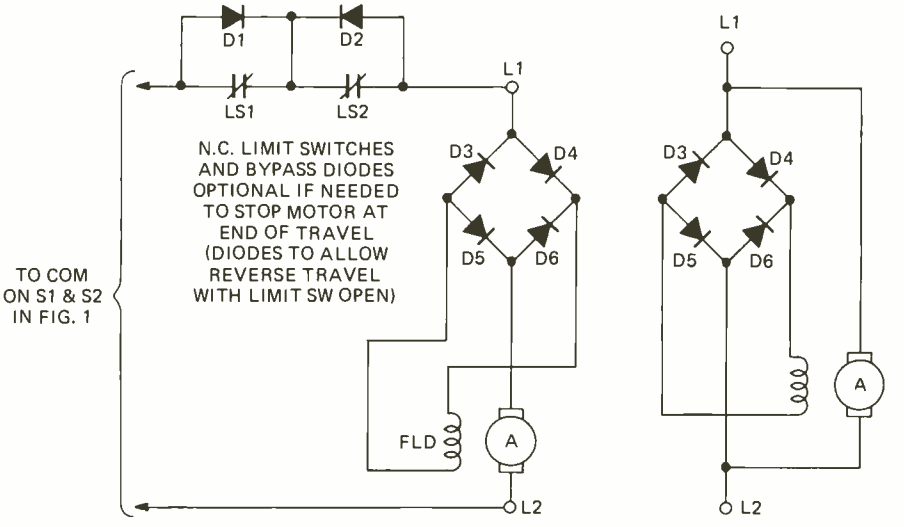


Fig. 1



a – SERIES MOTOR

b – SHUNT MOTOR

NOTE: THAT MOTOR DIODES MAY BE CONNECTED ACROSS EITHER THE FIELD OR ARM.OF THE MOTOR FOR THE SAME RESULTS.

Fig. 2

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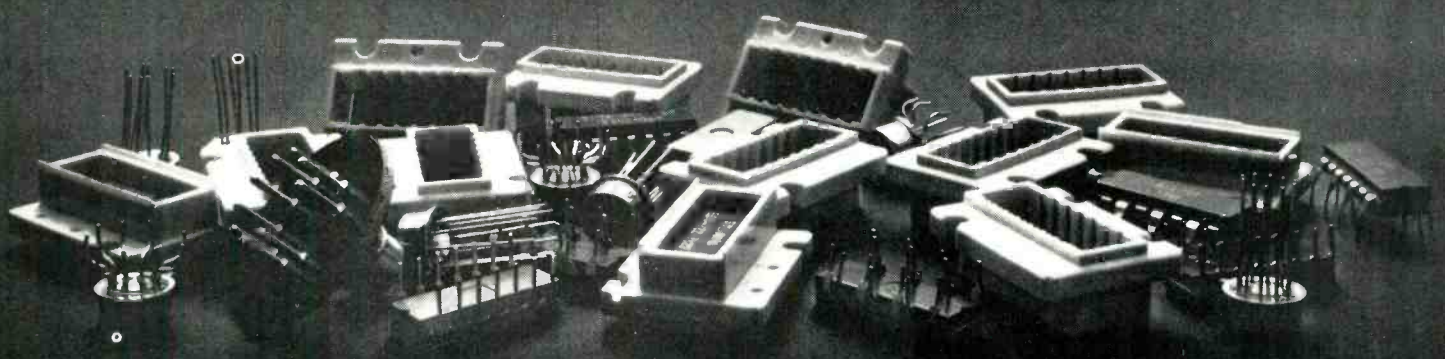

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DM—14	718
DM—24	719
DM—26	721
DM—30	721
EX4053	722
FF274	715
FL274	712
GE—IC2	712
GE—IC3	705A
GE—IC4	714
GE—IC5	713
GE—IC6	715

To Be Replaced	ECG Replacement
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MC1304P	718
MC1304PQ	720
MC1305P	720
MC1305PQ	720
MC1307P	722
MC1307PQ	722
MC1314G	704
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MFC6010	703A
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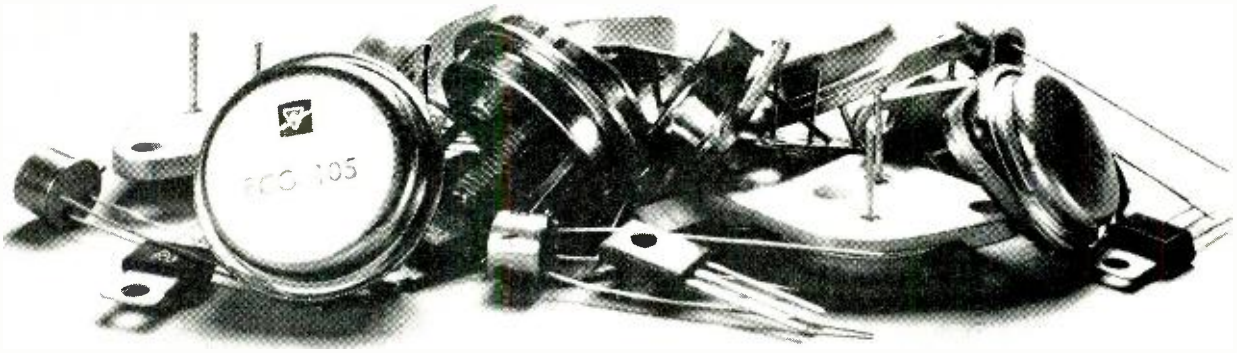
GTE SYLVANIA



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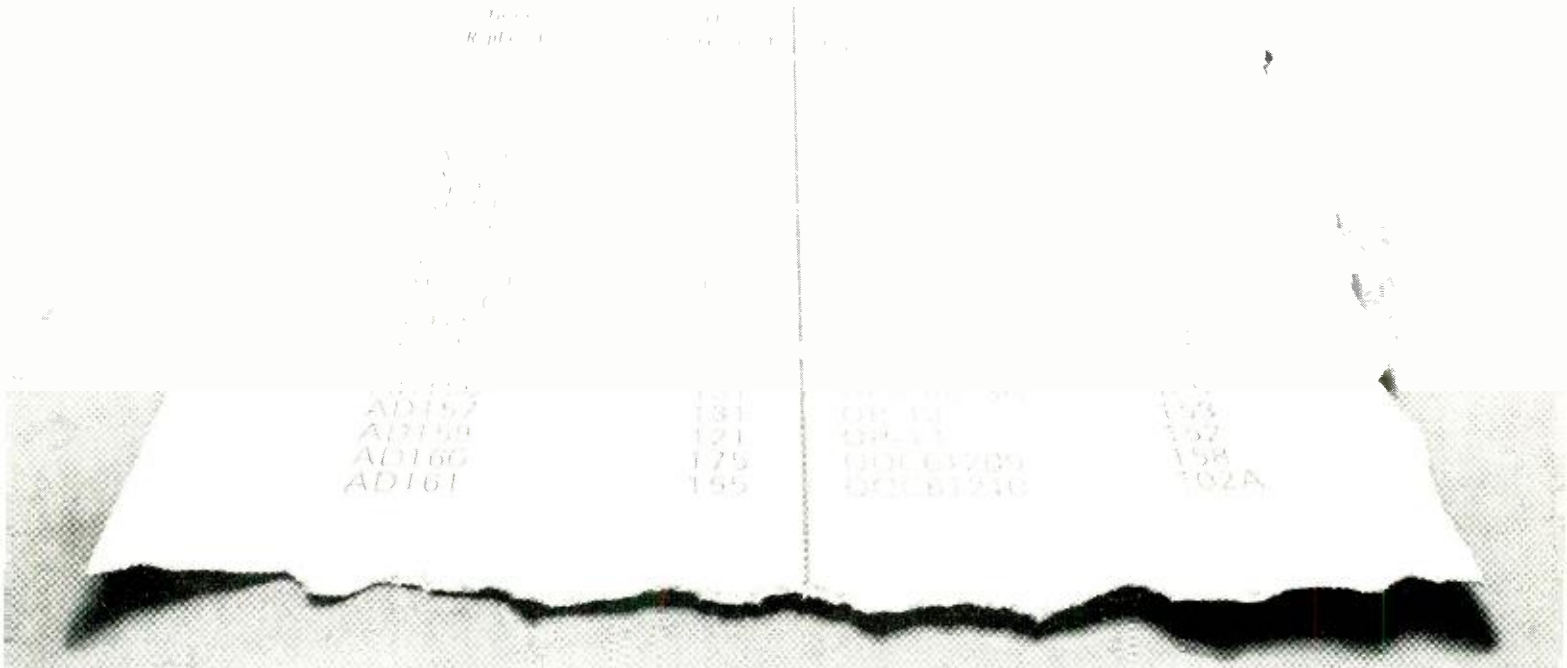

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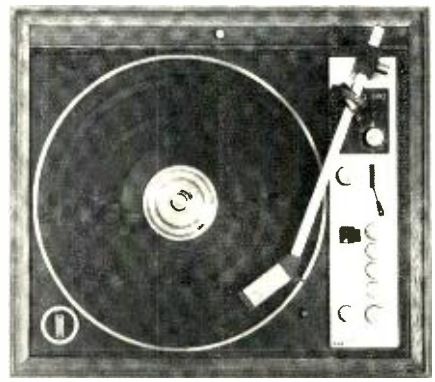
GTE SYLVANIA

equipment report

BSR McDonald model 810 automatic transcription turntable



Circle 26 on reader service card

THE 810 IS BSR'S TOP OF THE LINE automatic turntable entry. It offers some interesting solutions to the classical problems of minimizing the effects of vibration, resonance and speed variations on the electrical output to the preamp. It solves these problems to the extent that even in the automatic mode its performance can be considered equal to the best of the single-play machines of 5 years ago.

Using the heavy platter approach the 810 has a precision balanced 12-inch die-cast non-ferrous 7-¼-pound platter driven by a synchronous induction motor. This type motor is well known for its excellent power supply voltage and mechanical load speed independence. The pitch control surrounding the rocker 33-⅓, 45 rpm speed selector, allows a ±3% speed adjustment. By moving a couple of wires the motor is converted to 220 volt operation and a grub screw is provided to change to 50 Hz supply frequency. A choice of 50-and 60-Hz strobe discs is provided for mounting at the platter center.

More significantly a sequential cam system with eight independent pre-programmed cams eliminating many of the noise producing and conducting parts of contemporary designs is one of this unit's main features. We found this system extremely quiet and smooth.

Tracking error is a function of tone arm length. As the tone arm swings across the record the mechanical geometry causes the cartridge axis to deviate from perfect tangency with the record groove giving rise to distortion. The 810 has a tone arm pivot to stylus length of approximately 8-½ inches keeping the tracking error below 0.5° per inch. The "per inch" part of this specification refers to the radial distance of the stylus from the turntable center. This normalized tracking error is the pertinent specification since it compensates for the variation in tangential record groove speed as a function of stylus position and its effect on distortion.

The aluminum tone arm design is resonant at 7 Hz. Gyroscopically pivoted on pre-loaded ball-bearing races, the gimbal arm mount gives a minimum tracking force of ¼ gram. The Shure M91B premounted in our test unit had perfect stylus position and did not require the use of a cartridge adaptor provided to be used if adjustment is necessary. Stylus position is checked by means of a convenient stylus position indicator which slides over the same stud that normally accommodates a stylus cleaning brush.

Arm adjustments are simple and quick, among the best we've seen. The tone arm balance weight, balance, anti-skate, stylus pressure, height and stylus setdown all had their own chrome knobs with ideal sensitivity for their respective adjustments. Stylus pressure can be adjusted over a range of ¼ to 6 grams. The anti-skate control has the familiar dual scale for round or elliptical styli. Our test unit tracked excellently with a 1 gram adjustment even with the speakers resting on the same surface as the turntable.

Viscously damped in both automatic cycle and cue and pause control operations the 810's arm features a Cue-Clutch to prevent the arm being moved outward by the anti-skating system. Another feature unique to this player is an automatic tone arm lock which secures the tone arm to its rest post whenever the turntable is off.

Flawless automatic record handling of up to 6 discs is credited to the ambulla automatic spindle which is a center support unit without overhanging or edge supports.

(continued on page 100)

our fourth generation family...

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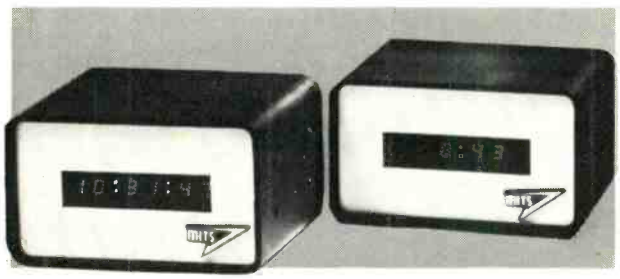

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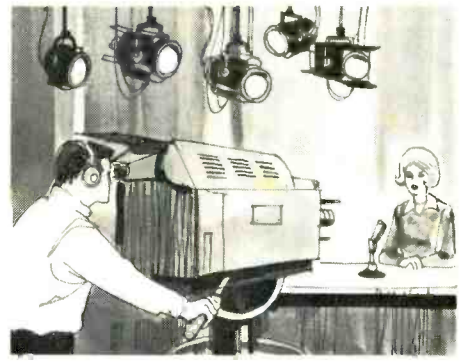

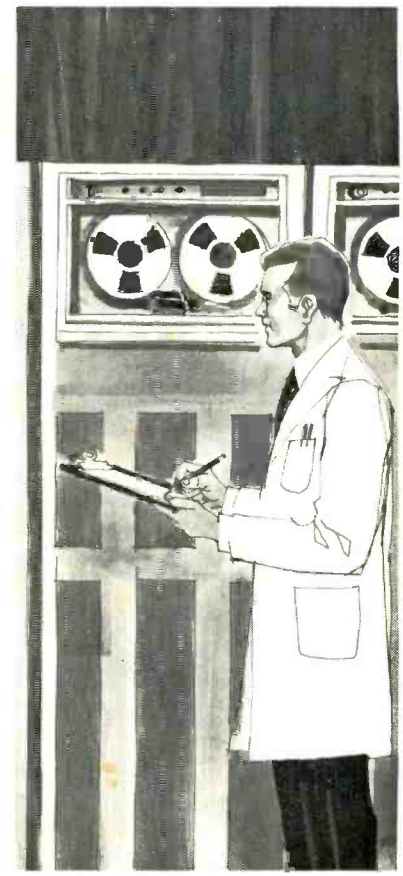

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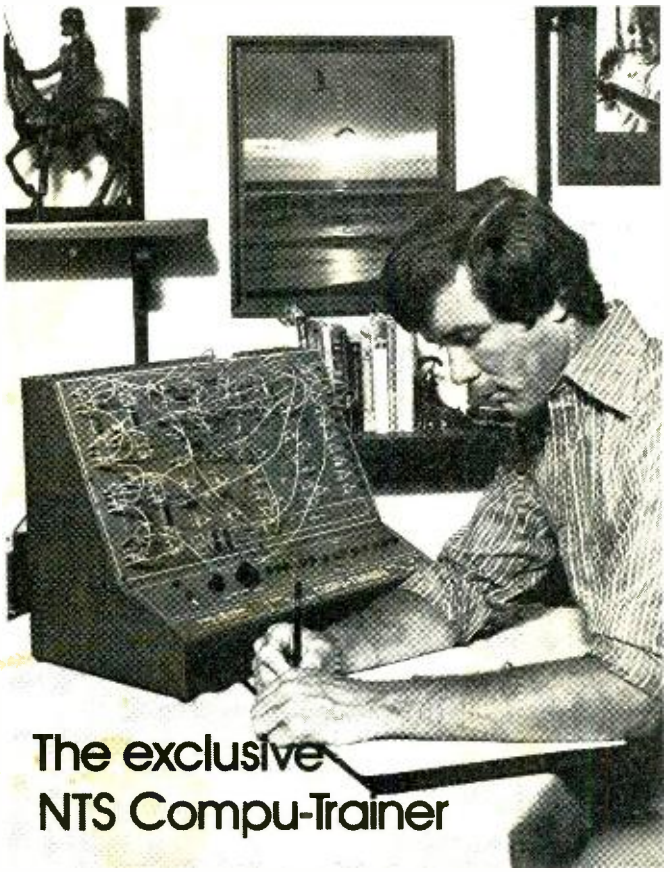

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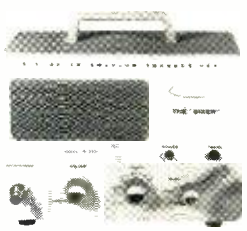

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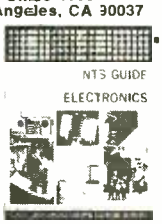

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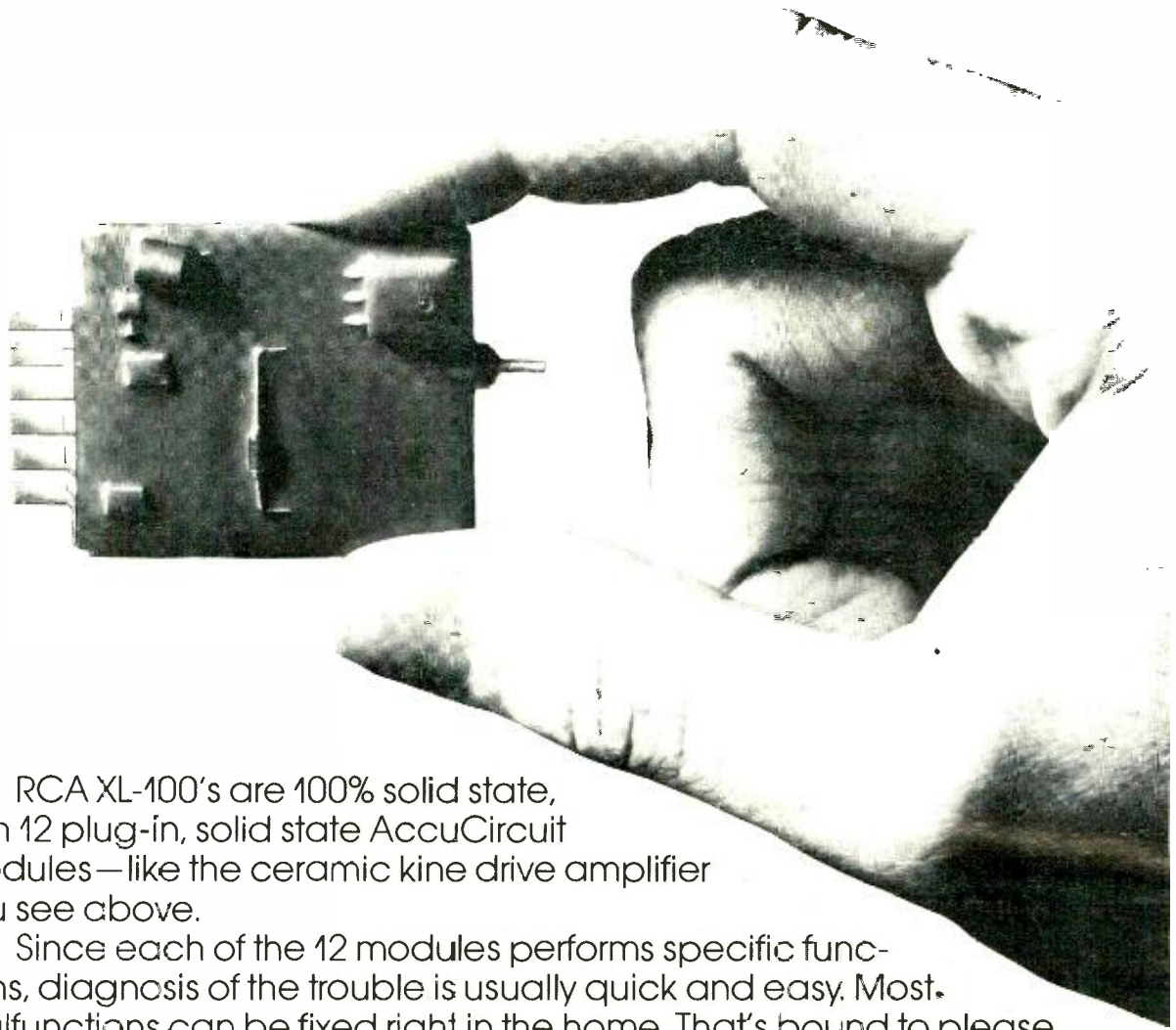

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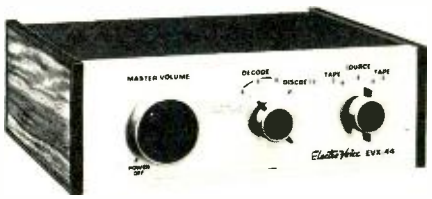
NEW UNIVERSAL DECODER For 4-Channel Matrix



New matrix system is completely compatible with CBS SQ system and offers the audiophile improved 4-channel matrix performance

by JOE SHANE

THANKS TO THE AVAILABILITY OF 4-CHANNEL SOUND RECORDINGS, the listener is no longer limited to looking into the stereo sound field. He now is able to sit in the middle of a moving swirl of living sound.

With a four-channel sound system we now have, in effect, four pairs of stereo speakers—right-front and left-front; left-front and left-back; left-back and right-back; and finally right-back and right-front. With this multiplicity of speaker pairs it is possible to position any sound source between any pair of speakers. It is also possible to indicate the direction as well as the illusion of greater distance by reducing the level of the mixed-in sound source.

The matrix and its problems

The basic form of 4-channel record today is a matrix disc. This is a quite conventional-looking LP record that has four channels of information impressed and encoded into its stereo 2-channel grooves. This process has been described before and we will not repeat that discussion here. For more details on 4-channel matrix operation see **Radio-Electronics** March and June 1972.

With the exception of the discrete 4-channel record by RCA-Panasonic-JVC, all existing 4-channel record systems are a matrix in one form or another. The three major matrix systems in common use in the United States today are the Columbia Sony (SQ), Electro-Voice, and Sansui (QS). While all three of these systems use the same kind of matrix, the mathematics for encoding and decoding the matrix channels differs. As a result the three systems are not 100% compatible.

Here are the encoding equations of the three systems:

COLUMBIA: $Lt = Lf + ORf - j\,0.7Lb + 0.7Rb$
$Rt = OLf + Rf - 0.7Lb + j\,0.7Rb$

NEW ELECTRO-VOICE:
$Lt = Lf + 0.3Rf + Lb - 0.5Rb$
$Rt = 0.3Lf + Rf - 0.5Lb + Rb$

SANSUI: $Lt = Lf + 0.414Rf + jLb + j\,0.414Rb$
$Rt = 0.414Rf + Rf - j\,0.414Lb - jRb$

We will be primarily interested in what Electro-Voice is doing with their new Universal Decoder so we will ignore the other systems in the following discussion.

When decoding the various mixes just discussed using the older Electro-Voice EVX-4, these decoding equations are applied:

$Lf' = Lt + 0.2Rt$
$Lb' = 0.76\,(Lt - 0.8Rt)$
$Rf' = 0.2Lf + Rt$
$Rb' = 0.76\,(-0.8Lt + Rt)$

The new E-V decoder, the EVX-44, shown on this month's cover, decodes using these equations:

$Lf' = Lt + 0.2Rt$
$Lb' = 0.63\,(0.4Lt + jLt) - 0.63\,(Rt + j\,0.4Rt)$
$Rf' = 0.2Lt + Rt$
$Rb' = 0.63\,(Lt + j\,0.4Lt) - 0.63\,(0.4Rt + jRt)$

In their new system, E-V has elected to give preference to the information found in front of the listener. They like Columbia, have found that listeners, first of all, index on the front-center soloist, that they don't want to hear that soloist coming at them from the rear. The listener appears to want the same left-to-right location he gets with two-channel stereo. In addition he also wants to be able to move about the listening room and still find that he can hear a source from the same direction as when he sat in the acoustic center of the room. The rear-speaker source locations can be less precise, but must still be separate sound sources. As a result the new E-V system has improved right-to-left separation. This makes it more like the SQ system, which always provided maximum left to right separation in preference to better front to back separation.

Therefore, when a concert hall recording is made in 4-channels using the Electro-Voice system, greater definition is given to the front stage position than to the rear reverberant and ambient sounds. In 360° surround recording the directivity behind the listener is still maintained, but with less definition than in front.

4-channel developments

After putting its original encoder and decoder on the market E-V continued to search for ways to improve them. Knowing that the availability of software, records in particular, was essential for the growth of 4-channel sound, E-V demonstrated its system to record manufacturers. Today, a whole group of record makers are turning out matrixed discs. These makers include Columbia, Vanguard, Ovation, Project 3, Audio Spectrum, Crewe, Stereo Dimension, and Crest.

The major record producer, Columbia was using their SQ system, which is somewhat different from the original E-V system. According to Howard Durban, E-V Senior Vice President and Technical Director "At first we didn't think the E-V Stereo-4 system and the CBS SQ system could be compatible. But, to our surprise, a couple of E-V engineers developed a circuit that could decode compatibly, either matrix to within 2% of the original components. Voila, the Universal Decoder."

What the E-V decoder will do

Now the EVX-44 universal decoder is available as an add-on piece to any existing 4-channel stereo system. It is also available in the form of a complete 4-channel receiver (EVR-4X4). It does decode E-V and SQ without any need for

switching, and because they are so similar to the E-V stereo-4 system, also decodes Sansui as intended. The E-V Universal Decoder (according to Howard Durban again) "improves on a couple of problems with other's matrices. A front-center soloist, who in some other encodings tends to leak quite a bit into the rear channels (or turn up at equal volume in all four speakers) is now solidly held up front and center where he belongs."

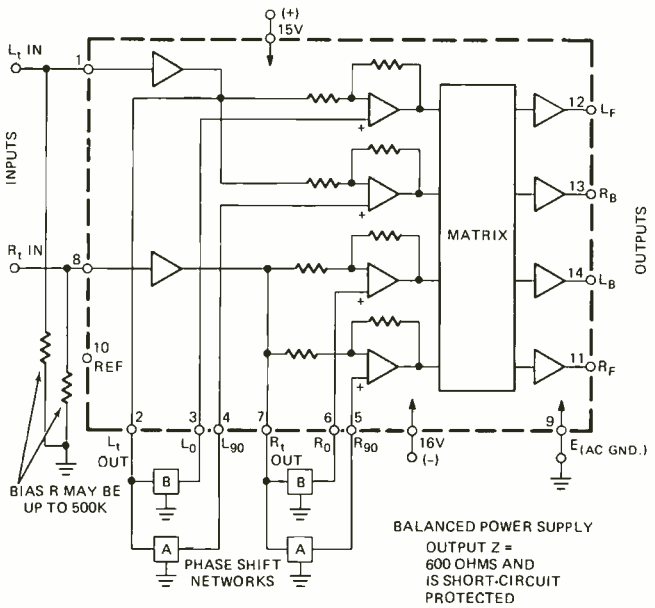
In addition the EVX-44 decoder includes an additional feature to further improve the separation of a front-center soloist. It is a "separation enhancement" circuit. This circuit senses the presence of mono material (same as a center signal equally placed in both front channels) and automatically increases the separation of front-to-back channels. This is done by blending the rear channels out-of-phase to, in effect, cancel any mono signal in the rear channels. This enhancement, at the choice of the listener, can be "on" full time "off" all the time or "Automatic," happening only when mono material is present. This circuit is quite similar in its purpose and effect, to the CBS-Sony decoder logic system for increasing front-to-back separation.

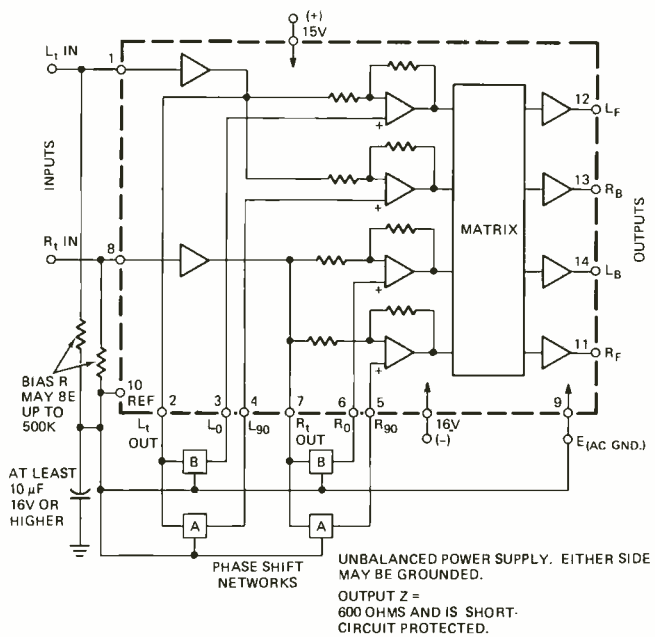
The decoder IC

A complete schematic of the decoder IC is not available at this time. **Radio-Electronics** will be presenting complete decoder circuits of both the new E-V decoder chip and other decoder circuits actually in equipment in the months to come. But right now we can only show the decoder IC as a black box in the circuit. What diagrams we do have we are presenting here. First, Fig. 1 shows how the decoder IC is connected in the total EVX-44 type of circuit when a balanced power supply is used. Fig. 2 is the same arrangement, only this time an unbalanced power supply is used. In this type of hookup either side of the power supply may be grounded.

Figure 3 is a typical phase-shift network that is suitable for use with this decoder IC. The nominal values shown in the schematic result in a phase shift that is 10° from 100 Hz to 10,000 Hz. If all the components in the circuit have values selected to give minimum phase shift, the error will be within 15° from 100 Hz to 10,000 Hz and the maximum deviation will occur at about 250 Hz. With the nominal values shown, phase shift and gain are most nearly correct at 2200 Hz.

Figure 4 shows the Universal decoder IC connected to its phase-shift networks. This circuit is used to test the decoder IC's before they are installed in a working decoder.





End of the matrix war?

According to E-V the matrix war is over. They state "let the record producers encode any way they want. It doesn't matter to the consumer, because E-V will decode the signal the way it is supposed to be."

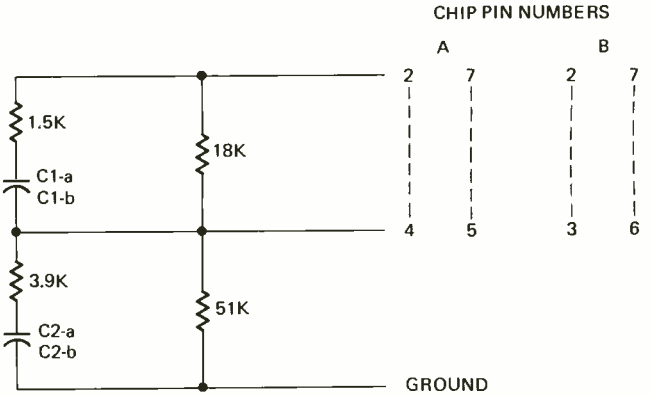
Actually, it appears to be obvious that some producers will want to use different decoding and encoding parameters depending upon the desired result. One encoding method may well be better for "surround" sound, such as full-force four-equal-channel rock. Another encoding system may work better for stage-front symphony performance. A different variation may enhance the sound of a tight combo, chamber group, or primarily solo performance. One matrix may be better for only 4-channel reproduction while another does better if the record is going to be played more in stereo or mono. Fine! Let the artist use the method that delivers the result he wants. But E-V says "No matter what method is used to encode the program, we can decode it, and decode it properly." In fact, E-V plans to market an encoder that will give the recording engineer a choice of encoding parameters.

Matrix requirements

There are six major criteria that any 4-channel matrix system must meet to provide satisfactory performance:

1. Four-channel reproduction must as accurately as possible recreate the sound and psychological effect of the origi-

FIG. 1—(top left) shows how decoder IC is connected to circuit using a balanced power supply. FIG. 2—(left) shows the same decoder IC, but this time it is connected to an unbalanced power supply. Either side of the supply may be grounded. FIG. 3—(below) a typical phase-shift network that works with the decoder IC. Optimum values are shown in the circuit.



ALL RESISTORS 1/2 WATT, 2%, CARBON FILM.
C1-a and C2-b – 0.018, 2-1/2%, 25V POLYSTYRENE.
C2-a – 0.10, 10%, 25V MYLAR.
C1-b – 0.0033, 2-1/2%, 25V POLYSTYRENE.

nal performance (whether that be a live performance or a studio-electronically created performance.)

2. The techniques used must be adaptable to all media, or the most possible. (Usable on records, tape, and broadcasts able to be broadcast with the same equipment if possible.)

3. Existing reproduction equipment must not be obsoleted by four-channel developments. (This is the original meaning of compatible. Four-channel records, tape and broadcasts must be reproducable on existing equipment in stereo and in mono with no change.)

4. The techniques used must be adaptable to a wide range of reproduction equipment in all price and market categories. Cost or complexity should not shut-out any user from the system.

5. The system would have additional appeal if it acted on current source material to create a pseudo or derived four-channel effect. (Made 2-channel source material sound like four-channels.)

6. The artist or producer must have as complete freedom as possible to record as he wishes and have the reproduction fulfill his concepts.

What comes next?

RCA has announced that discrete 4-channel records are going to become available. And I don't believe that anyone questions the desirability of having discrete 4-channel sound from records, if this is truely possible. But right now, today,

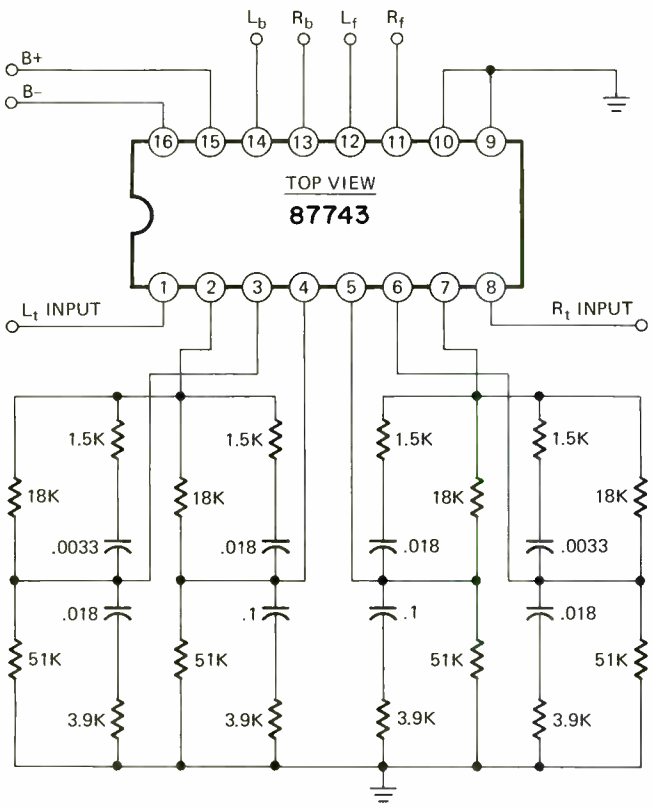
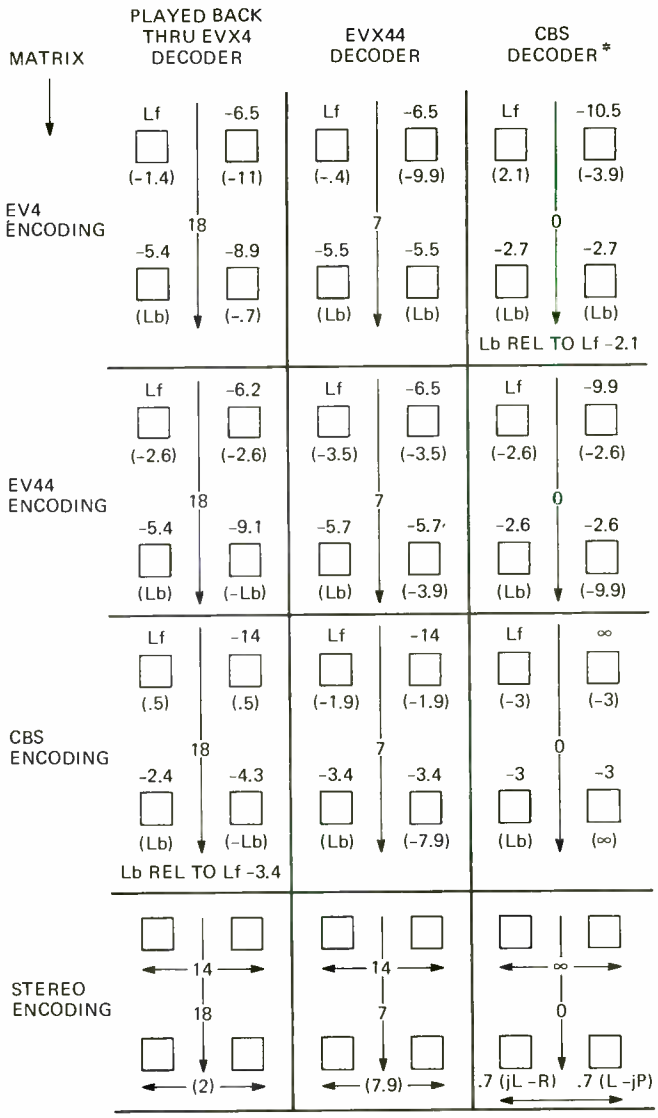


FIG. 4—UNIVERSAL DECODER IC connected to its phase-shift networks. Circuit is used to test decoder ICs.

this minute, if you want 4-channel sound from records you need the matrix to make possible an inexpensive 4-channel playback system. One solution proposed by E-V states "Please, Mr. Laginestra (of RCA Records) matrix the front channels of those JVC discs and lets get this whole thing moving! We'll reproduce those discs in four-channel our way and the "nothing but the best purist" can buy the additional equipment to reproduce them discretely." **R-E**

Comparison of Matrix Playback



*Without front-back logic circuit

The diagram shows a visual representation of the playback characteristics of four kinds of encoded material when played back through three different decoders. It lets you see just what happens when one kind of coded material is played through another kind of decoder. It also shows the advantages and disadvantages of the various systems illustrated.

All numbers in the diagrams are separation in dB. Numbers above boxes show relative levels of left-front signal in each speaker.

Numbers below the boxes show relative levels of left back signal in each speaker.

Numbers in vertical arrows indicate separation of front soloist from front speakers to back speakers.

In stereo encoding, numbers show separation of left to right or that of soloist from front to back.

Four types of encoding are shown. Going from top to bottom they are EV-4 (original EV system), EV-44 (the new E-V system), CBS encoding (SQ), and stereo encoding (standard 2-channel).

Playback decoding systems are across the top. Going from left to right there is EVX-4, EVX-44 and CBS decoders. To see what happens to a particular encoding when it is subjected to a particular decoding find the box that bears both labels.

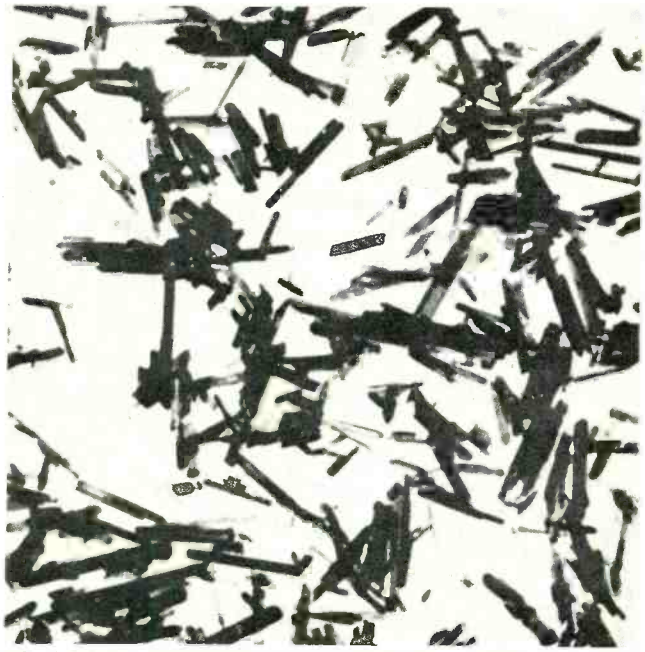
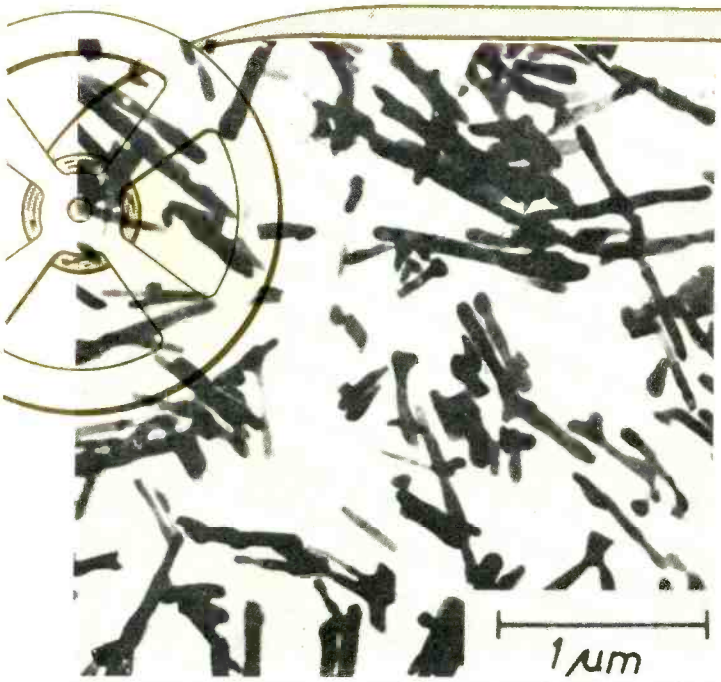


FIG. 1—(above) CHROMIUM-DIOXIDE TAPE has a denser oxide layer than conventional iron-oxide tape (FIG. 2, below). You can easily see the difference in these microphotographs.

all about chromium dioxide tape

To get the most out of this new tape material you must first understand its characteristics and how they affect recordings

by I. ANDRIESSON*



OVER THE LAST YEAR, AN INCREASING INTEREST has been shown among professional tape recording engineers, as well as serious high fidelity enthusiasts, in what can be done with the new chromium dioxide magnetic tapes.

Although the first attempts to use chromium dioxide as a magnetic material for recording tapes go back to the early 1960's, the first tapes, showing the important advantages of this material, did not appear earlier than about 1966.

Today various tape manufacturers have developed good chromium dioxide tapes and a few manufacturers of quality cassette recorders are marketing cassette recorders which are optimised for the use of this new recording tape. Also discussions about the standardization implications of chromium dioxide have already been started.

Characteristics of CrO_2 tapes

A main characteristic of the magnetic material, chromium dioxide, is that it is relatively easy to vary the coercivity (its ability to resist demagnetisation) over a wide range. This means that it is possible to choose the appropriate optimal coercivity for a certain application and to maintain this chosen coercivity in production.

Another advantage is that the form of the single particles approaches more or less an ideal needle shape so that extremely good homogeneity can be obtained (Figs. 1 and 2).

Both of these properties result in a remarkable improvement in high-frequency recordability, which means that the high-frequency maximum output level (MOL) as well as the high-frequency sensitivity are much better than those from conventional magnetic tapes.

To demonstrate this, Fig. 3 shows the maximum obtainable saturation output as a function of frequency (without high-frequency bias), of a CrO_2 cassette tape with a 4-micron thick magnetic coating, compared to that of a modern "conventional" BASF LH cassette tape, having the same coating thickness. For simplicity reasons, the saturation output of the BASF LH tape is assumed to be flat (zero).

Of course, this kind of comparison has to be interpreted with some care, as the saturation output levels are determined without high-frequency bias. Nevertheless, this presentation shows clearly the differences and advantages of chromium dioxide tapes, compared with conventional tapes.

Compact cassettes

The high maximum output at high frequencies is of decisive importance for quality recording at low tape speeds, such as the compact cassette tape speed of 1⅞ ips.

As anyone, who has tried to make a good recording on cassettes knows, the major limitations of the compact cassette system are: poor background noise and critical high-frequency recording (lack of brilliance), especially with music with a lot of highs. Cassettes mostly sound rather dull.

To understand this, look at the curves in Figs. 4, 5 and 6

*BASF AG, West Germany. Reprinted from Electronics Today, January 1972

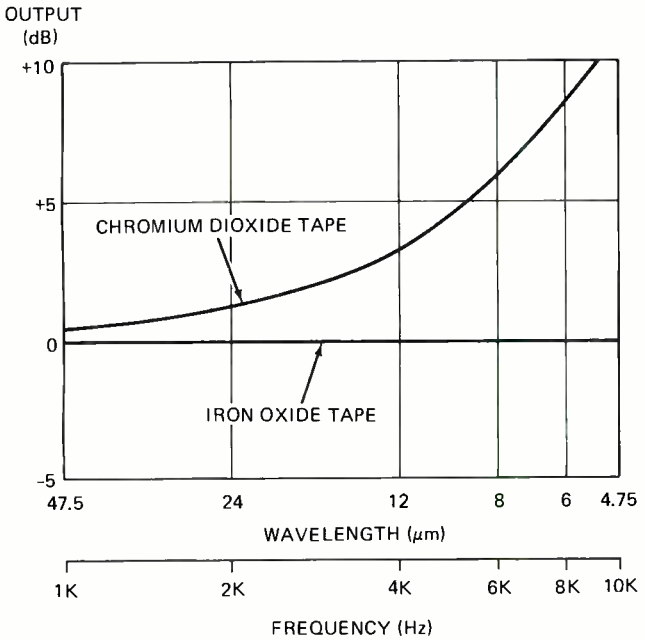


FIG. 3—MAXIMUM OBTAINABLE SATURATION OUTPUT of chromium-dioxide tape is shown as a function of frequency, and compared to iron-oxide.

and to study their interdependence.

Figure 4 shows the maximum output level (MOL) as a function of frequency that is necessary to obtain high fidelity on a recording medium. This curve is the result of various analyses of the spectral amplitude distribution in different kinds of music, one of the primary criteria for high fidelity.

For correct understanding, it is emphasized that this maximum output level (MOL) as a function of frequency has nothing at all to do with the frequency response curve which normally is given at low recording levels (far below maximum output level) and which is a measure of the transducing linearity of the recording system only. The MOL curve as a function of frequency gives the tape output at either constant distortion, constant intermodulation distortion or constant compression from linearity of the signal [e.g. 5% THD (total harmonic distortion) or 1.5 dB compression].

If the recorded signal exceeds this MOL limit, unacceptable distortion, intermodulation distortion or compression is unavoidable.

Independent of this MOL curve, the frequency-response curve of the system (recorder plus tape) measured at a level far below MOL might be flat, because it is established by the recorder adjustment only, if a reference medium is used like the unrecorded portion of the DIN (German Industrial Standards) test tape. For reasons of simplification, it is usual in audio tape measuring technique to choose only two frequencies, one in the low part of the sound-frequency spectrum, the second in the high part. At 1⅞ ips tape speed measurements, it is convenient to use 333 and 8000 Hz.

This simplification makes it possible to say that for true high fidelity, the MOL at 8000 Hz shall not be more than 10 to 12 dB down compared with the MOL at 333 Hz. This is already a compromise since, for professional studio recording techniques, the difference between high-frequency and low-frequency MOL is normally not more than about 2 dB.

Now we look at Figs. 5 and 6 where the measured MOL curves at 333 Hz and 8000 Hz as a function of high-frequency bias are given for the two tapes previously mentioned. It is immediately clear that if the 10 dB hi-fi criterium as mentioned before is applied, the high-frequency bias adjustment for the "conventional" tape would be so low that the low-frequency MOL would be very poor, resulting in a poor signal-to-noise ratio. According to DIN requirements, the S/N has been defined as the ratio between MOL at 333 Hz and the noise in dB measured according to DIN 45405 (weighted, quasi-peak).

Also the drop-out sensitivity increases at low high-frequency bias. This implies that, although from a theoretical point of view the hi-fi MOL difference between 8000 Hz and 333 Hz can be reached with conventional tapes, the high-frequency bias adjustment would mean a critical use of the tape from a practical and engineering point of view.

In practice most cassette recorder manufacturers use nearly all available low-frequency MOL of the tape, which requires a relatively high bias setting, in order to obtain a good signal-to-noise ratio. However, in such cases the loss in high-frequency sensitivity is compensated by using a lot of pre-emphasis in the recording amplifier (often more than 14 dB at 10,000 Hz) to give a flat frequency response at very low recording levels. However, the loss in high-frequency MOL cannot be compensated and the increased danger of high-frequency intermodulation distortion or compression is avoided by connecting the VU meter (output meter) following the preemphasis in the recording amplifier circuit. This safeguards the user against high-frequency distortion, etc., because if the music contains an appreciable amount of highs, these frequencies establish the VU meter indication (rather than the bass). Thus the user will tend to record at a lower level.

On paper this looks healthy enough, but, extremely heavy preemphasis (over 14 dB at 10,000 Hz) means that the actual recording level will be mainly determined by the highs in the music, resulting in a rather significant discrepancy between the signal-to-noise ratio at measurements relative to MOL at 333 Hz and that obtainable in practice with music. Also, one should recognize that too much preemphasis does not help hi-fi because the required L-C active filters cause serious oscillations, resulting in square-wave form distortion. This is clearly shown if one observes the overall 1000-Hz

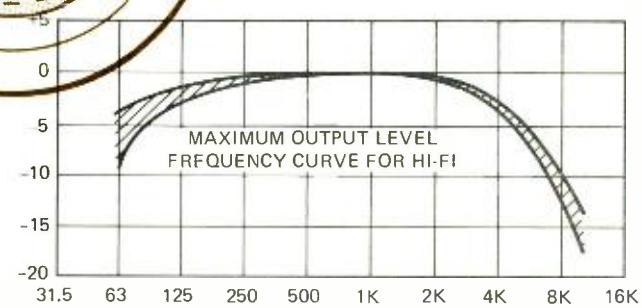


FIG. 4—MAXIMUM OUTPUT LEVEL needed to obtain high-fidelity recording, as a function of frequency.

square-wave performance of such a recorder.

Figure 6 shows the same MOL curves as a function of high-frequency bias for chromium dioxide tape. It is obvious that the situation is much better here; because the chromium dioxide tape allows a good balance between high- and low-frequency MOL, namely 10 to 12 dB difference at a bias setting which guarantees a good use of the tape properties from an engineering point of view.

Chromium dioxide is a low-noise oxide. This means that, at the same background noise level as obtained from modern "conventional" tapes, a significant improvement in high-frequency output MOL is available. The signal-to-noise ratio improves because the MOL at 333 Hz can be better utilized. This gives the chromium dioxide cassettes their superior dynamic range and their exceptional brilliance and transparency.

(We have found that chromium dioxide tapes produce at 1⅞ ips tape speed, the same sound recording quality as con-

ventional tapes at 3¾ ips—*Editor).*

All considerations made so far have been based on the assumption that the replay (playback) part of the cassette recorder will not be changed. But in practice it is expected that cassette recorder manufacturers will use at least a part of the high-frequency MOI advantages of the chromium dioxide tapes to improve the signal-to-noise ratio of their recorders.

The key to this is the replay equalization time constant. If this constant (which has been standardized internationally at 120μs) could be reduced to a lower value, the background noise would be reduced more or less in proportion. However, this can only be done at the cost of the beautiful MOL frequency curves because at least a part of the high-frequency output is lost.

It is still an unanswered question, where the economical optimum lies, for, it is clear that an improvement of the signal-to-noise ratio of cassette recorders is very desirable.

An additional complication is the fact that many cassette recorder manufacturers have solved the noise problem by means of electronic noise suppression systems. A very good and well known example is the DOLBY B system, by means of which the signal-to-noise ratio of cassette recording systems can be improved by approximately 9 dB.

It would probably be ideal if the noise problem with compact cassette hi-fi recorders could be solved by means of one or another of the electronic noise suppression systems, so that the advantages of chromium dioxide tapes can be fully used to improve the brilliance.

Differences between CrO_2 and conventional recorders

As chromium dioxide tape has a significantly higher coercivity than conventional cassette tape, it is necessary for correct utilisation of this tape, to increase the high-frequency bias current. This is shown by Figs. 5 and 6.

For the same reason, an increase of the erasure capacity is required. Also less preemphasis should be applied, however, should the replay time constants be changed, it might be possible that the recording preemphasis need not be altered.

How great these modifications will be, depends strongly on the actual recorder circuitry, and this varies considerably

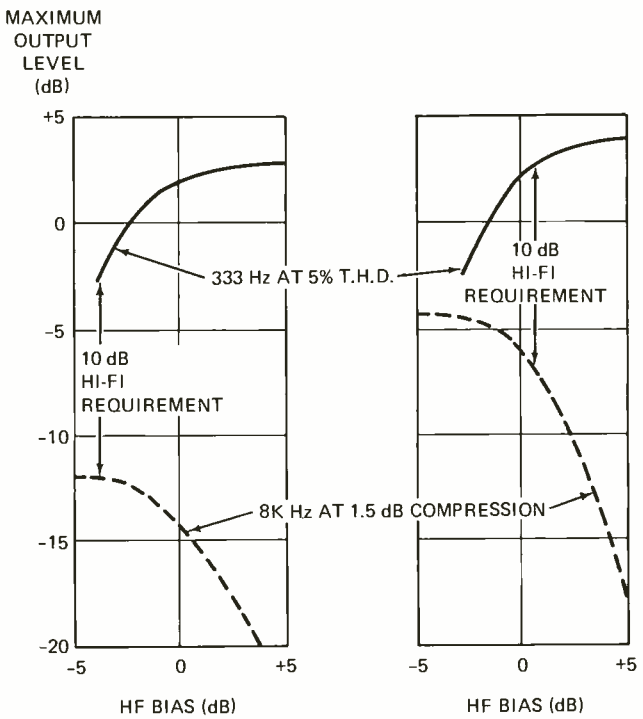


FIG. 5—IRON-OXIDE TAPE (left) and FIG. 6—CHROMIUM-DIOXIDE TAPE (right). Curves show bias points for hi-fi response.

from one manufacturer's product to another.

To be able to give at least some data, the measuring results, obtained at the DIN high-frequency bias adjustment, are considered. (DIN high-frequency bias equals 2.5 dB sensitivity fall off, over maximum sensitivity at 6300 Hz.)

With the chromium dioxide tapes, this bias setting method results in a 2 to 2.5 dB bias current increase relative to the bias of the conventional tape. The low-frequency sensitivity at 333 Hz of the new tape is about 2 dB lower, which means that the recorders have to compensate this to make sure that the recording level meter reading corresponds with the available MOL of the tape at this frequency.

Thanks to the fact that the relative sensitivity at 8000 Hz is about 6 dB higher, the preemphasis at the same frequency can be reduced by the same amount, and the erasure capacity of the recorder has to be increased by about 40%.

So it is clear that chromium dioxide tapes are not *fully* compatible with modern conventional tapes, and that cassette recorders will only *completely* utilize the advantages of the new tape if some of the recorder functions are modified accordingly. In practice it is expected that chromium dioxide cassettes will automatically operate the necessary switches of the special chromium dioxide recorders, for instance, by means of a similar device to that now used to prevent undesired erasure of prerecorded cassettes.

CrO_2 cassettes on normal recorders

Here the situation is a little more complicated and we must distinguish between playback, recording and erasure.

Playback

The reproduction of prerecorded cassettes with chromium dioxide tape is simple because it is easy to take care of the different properties during the duplicating process. Should cassette recorders or players change to a new playback time constant, and prerecorded cassette manufacturers follow this change, the reproduction of such cassettes on conventional cassette recorders will give an increase, and possibly even an over-emphasis of high frequencies. However, on recorders with tone controls this can easily be compensated. In addition there will be a noise improvement.

Recording

From a theoretical point of view, the different recording properties of new chromium dioxide cassettes could be expected to cause problems during recording.

However, as already pointed out, many recorders have such a high high-frequency bias adjustment that they are practically right for chromium dioxide tape. A bias setting which gives maximum output at low frequencies on conventional tapes is more or less optimum for chromium dioxide tape. (See the MOL curves as a function of bias, Figs. 5 and 6.)

For that reason in most cases, it will not be the bias setting which causes incorrect recording, but the relatively strong pre-emphasis in the recording amplifier, resulting in an over-emphasis of high frequencies. However, during reproduction on good equipment, this can be compensated just as simply as in the case of cassettes, prepared for modified replay characteristics, by using the tone controls.

Erasure

Erasing chromium dioxide tapes on conventional cassette recorders remains the only real problem.

Erasability is directly proportional to the coercivity of the tape (about 40% lighter on chromium dioxide tape).

The erasure capacity of different cassette recorders varies very strongly. We found extreme cases where the erasure capacity was scarcely enough for conventional tapes (less than 50 dB!) Even within one make there are big differences. Many tests in our laboratories have proved that most of the

(continued on page 88)

HI-FI STEREO REPAIR SCENE

Getting a hi-fi component repaired can be a problem. Here's a report on the state of hi-fi repair

by HARRY MAYNARD

IF YOU ASK FIVE BLIND MEN TO DESCRIBE AN ELEPHANT, they'll give you five different answers, or so the classical Indian story goes. Depending on whom you ask, manufacturer, dealer service center, independent factory approved service center, or the consumer, you'll get five different answers to the question, "What's the state of today's hi-fi repair and servicing?"

Depending on the product you bought and the dealer you bought it from, it's a varied and mixed bag. Who doesn't have his own horror story, who hasn't waited months, and even years for that part to arrive from Europe or some place in Outer Mongolia?

Manufacturers tend to play down the repair and service problem (perhaps they can put themselves farther away from it) telling you of the wonders of solid state devices, computer diagnosis, modular service boards, and special training for technicians. But if you go out as I did and talk to the trade and agree to preserve their anonymity (repair franchises can be taken away) they'll give you a catalogue of woe—granted looked at from their particular viewpoint and self interest.

When you have a radio program *"Men of Hi Fi"*, as I have on New York City's WNYC-FM, and do programs on repair and service, you quickly become aware of considerable consumer dissatisfaction with the repair and servicing front. I have hundreds of letters that testify to this fact. Several leading manufacturers have almost gone out of business or have lost a favorable share of the market because of word of mouth "bad mouthing", of their products, or because dealers have refused to push or handle their products—in some cases individual products, in some cases their entire line. Many dealers have reported to me that there is hardly a famous name in the hi-fi industry that has not had service or repair problems with individual items at one time or another.

All segments of the industry agree that there is today a shortage of trained service technicians. The typical stereo receiver now has twice as many parts as a TV set, and even better test equipment is needed to diagnose, test and repair today's hi-fi components. Four-channel stereo, of course, and other design innovations (digital tuning) steadily add to the evergrowing complexity and problem of repairing the constant generation of new products and features brought to us by a very innovative industry. Modular construction has been a boon to the industry, but it too introduces new complexity in hi-fi design and repair.

Most independently run, factory-approved service centers report the difficulty of making money on any set with today's lengthened warranties. They point to the differences in fees that they receive for repairing a hi-fi set as compared to what a TV repair operation receives for fixing a TV set under warranty. "Perhaps manufacturers ought to put a picture tube on a hi-fi set, so we could then charge more for repairing it" was the sardonic comment, encountered several times among my visits to hi-fi repair centers.

Manufacturers have standard and fixed fees for repairs under warranty that often do not seem to be related to the time spent to diagnose and fix the component. "Have the manufacturers taken the time to see how long it takes their own factory service centers to repair certain problems and fix them and then set their fees? I doubt it!" was the sometimes comment. Result—sets under warranty tend to receive minimum repairs and are given back to the consumer, not with their performance optimized, but meeting minimum requirements, so they can be returned to the consumer in at least working order.

The manufacturer will tell you that the dealer often gets the full warranty fee for a small job, so the law of compensating error works here when the repair center has to do more than expected. Perhaps their motto ought to be as my father used to say, "Don't ask for justice. You may get it."

In talking with many dealer service centers and the independently owned factory approved service centers, all agreed that often the best they could do with a set under warranty was to break even—some reported losing money. Most told me they accepted this fact of business life because they made the bulk of their profit *after* the warranty ran out, if they were lucky enough to hold onto the warranty franchise. Many manufacturers report that some service centers practically exist just on warranty work.

All the dealers and factory approved service centers I talked to agreed that their number one problem after getting trained personnel was getting parts. This problem has been accentuated recently by the dock strikes, and the fact that a substantial portion of today's hi-fi equipment is of European

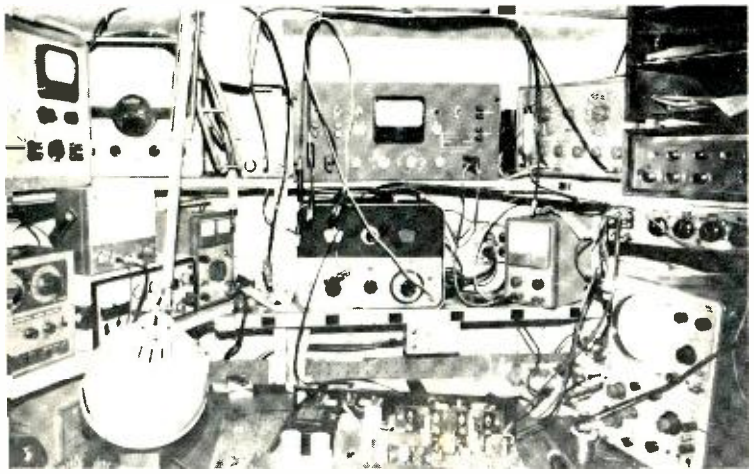
and Far Eastern origin.

It's been an open secret in the trade that many stereo FM tuners and receivers arrive at the consumer's house needing alignment—particularly in the multiplex section of FM tuners. This is not because they were not properly aligned at the factory or factory checkout point in the U.S. "Carry it home carefully," could be the motto for today's delicate FM tuners, which are often knocked out of alignment in shipping.

There has been improvement on this front in the last few years with quartz filters, Butterworth filters, and other new devices that improve tuner and set stability. A few years ago, a major consumer test laboratory reported this problem, and recent conversations with them confirmed the problem is still endemic, but getting better.

Manufacturers complain that many hi-fi service and repair centers do not have adequate test and evaluation equipment, being repair and service centers in name only. Certainly having good equipment is no guarantee of its proper use. Surprisingly, a good job can be done with minimal equipment if it's done conscientiously. A dealer-repair center told me, "If I was a customer, I'd ask to see what test equipment a shop had; or barring this, ask for a list of equipment on each bench available for the testing of *my* equipment."

Recently, having my own equipment serviced at Hi-



IT TAKES A LOT OF EXPENSIVE EQUIPMENT to troubleshoot and tune to spec good hi-fi equipment. Here's a look at a typical bench.

Phonics, Limited (1955 Coney Island Avenue, Brooklyn, New York) I asked Joel Cooperman, the proprietor, just that question. I asked what he'd recommend as test equipment, and what he'd recommend as minimum test and evaluation equipment. Here is his answer:

"Here are the lists of equipment you have asked for. The first list is what I recommend and the second list is the least a service shop should have to repair hi-fi gear.

Type of Equipment Needed	Model	Make	Price
AC voltmeter	400D	Hewlett Packard	$ 280.00
VTVM	427A	Hewlett Packard	250.00
Oscilloscope	561B	Tektronix	1000.00
FM Generator	188	Measurements	750.00
AM Generator	180	Measurements	760.00
Audio Generator	201C	Hewlett Packard	275.00
Distortion Analyzer	334A	Hewlett Packard	895.00
Wow and Flatter Meter of good quality with 0.3% full scale readings			
IM distortion meter	31	Measurements	260.00
MINIMUM EQUIPMENT NEEDED			$4470.00

This second list of equipment that most service centers have. If they do not have these exact items they have equivalent gear of another brand. You can not properly repair all makes of hi-fi with this list.

Type of Equipment	*Model*	*Make*	*Price*
AC voltmeter	250	Eico	$ 89.95
VTVM	FE20	Sencore	129.95
Oscilloscope	L130-501	Leader	399.95
FM Generator	WR-52A	RCA	248.00
AM Generator	IG102	Heath	32.95
Audio Generator	E301B	B&K	119.95
Distortion Analyzer	IM58	Heath	67.50
IM Distortion Meter	IM48	Heath	69.95
			$1158.20

This list of equipment is presently being used by service companies and by manufacturers."

Note that this is what Hi-Phonics says should be at *each* repair bench—almost $5,000 of equipment. He told me he had acquired even more equipment to handle four-channel repair and servicing. Quite clearly the hi-fi component repair business demands a considerable investment per bench to do the job.

Surprisingly, I have found some of the better equipped service shops highly critical of some of the equipment they see on manufacturers test benches and on their production lines, implying that considerable improvement could take place there. Often elaborate trips to factory service centers are laid on with much fanfare, and obvious expense, for invited repair and service personnel. Several times after one of these trips it was remarked to me, "They'd be better off investing that money in better service manuals, describing in detail how to diagnose, repair and service this equipment with its particular idiosyncrasies, along with faster delivery of parts."

There were persistent complaints from the dealer-service centers I talked to, of the need to simplify the often incredible amount of paper work necessary to order and return parts; or of ordering parts by telephone, necessary for running down a part, that's been on order for weeks, or months, and even years. "We sometimes get a call from a factory rep or service manager as a result of a consumer complaining to a consumer protection group, or the manufacturer. Often it's the fault of the manufacturer himself. After talking to the rep or service manager, he transfers me to a clerk in the parts department who then says, 'We have no such order for parts on record.' The part is then reordered through channels; three weeks later we get two sets of the same parts. All of which takes up our time, uses up our available storage space while the component sits on shelves awaiting parts. We then have the choice of returning parts (at a discount) at our own expense, or tie up our money in parts until we have a similar model with the same repair problem."

Each manufacturer insists on his unique way of doing business in the service area, and the use of *"his parts"*. He does not want to see *"just as good a part"* substituted, as he has often found these substituted parts just don't do the job, and so he insists on the use of his replacement and parts—and often for good reason. Some dealers say the same part, just as good, is universally available at one half or one third the price as a standard replacement. "We'd like to put in an as good or better replacement part with one handily available, but we are prohibited in doing so because it will void the warranty."

Many manufacturers are slow to admit design mistakes, and even when recognized, these design changes are not immediately forwarded to their repair and service network. No manufacturer wants to admit design errors. It's a truism in this business that you cannot repair quality into a hi-fi component. It has to be designed into a piece of equipment.

Consumers are not without blame in handling their own repair problems, now that the hi-fi component market is truly

approaching a mass market. A recent study by Daniel Yankelovich among America's youth indicated that the expensive hi-fi stereo set, with earphones and a tape recorder, has replaced the automobile as a status symbol.

This, along with other marketing trends, has created an avalanche of new customers that need to be educated *"on all the things you can do before you bring your set back to a hi-fi service center."* Today's mass market is not the market of yesteryears, which was largely restricted to a small elite of well-informed hobbyists.

The expectations of these many new consumers are often unrealistic. They expect quality performance without the appropriate maintenance. Surely, today they don't expect good performance from their cars without proper service and maintenance. Why should they expect more from their hi-fi equipment, which costs considerably less?

Having spent many days in hi-fi service departments, it's an eye opener to see the number of misconceptions, the "holes in peoples heads" (lack of information) or sheer misinformation on the most elementary level in many consumer minds. "If they'd only read the instruction manuals before they decide to drive many miles to have me fix their non-existent problem, is the universal complaint."

There is a problem for the industry. It's a lack of communication, a lack of information. The service centers I visited spend at least twenty percent of their time asking questions, answering questions, either at the service center, or over the phone. They get no reward for this, but do it patiently; often taking a lot of abuse in the process.

Consumers often don't have adequate warranty records or even a bill of sale. They lie about when they purchased the set, and demand in an arrogant way that the set be fixed without warranty records. They'd never dream of walking into an unknown car dealer to demand that the car be fixed without a sales record.

SCOPE PROBE in an FM receiver is a must to locate where the signal is being distorted.

Increased warranty periods, now offered by most manufacturers, is not an unmixed blessing—even for the consumer. Since warranty work is often at best a break-even proposition for the repair shop, the warranty center is hardly inclined to fix more than the specific problem, since the repair and service center gets no credit for it (except in heaven). Most consumers don't want to be told that there is far more wrong with the equipment than just the specific problem they brought in to be repaired.

Consumerism in all areas of our lives is on the move; ignoring it will not make it go away. Most companies do tell the buyer what he is getting in his equipment—specifications, etc.—but if my survey of dealers and independent repair centers is valid, they do not spend enough time in print, or at the dealer level discussing service, repair, and maintenance. It's considered negative selling to discuss repairs and maintenance at the time a consumer buys the product. A company would be considered naive to say in its advertising and promotion, "We fix it, and fix it well."

As William D. Lee, U.S. Department of Commerce, Deputy Assistant Secretary for Business Development and Consumer Affairs, said recently to members of the International Tape Association, "Marketing, of course, entails far more than sales. Viewed as a function rather than an economic concept, marketing accounts for one third of the nation's employment and more than one third of the national income . . ."

FINAL CHECKOUT determines that the instrument is performing up to its original specifications, before unit is returned.

"The business community—in all segments, not just those who are already recognized as outstanding performers in responding to today's consumer expectations—must take a new look, adopt a different pattern of understanding and attitude, and take progressive 'now' actions in going *beyond* what may have been accepted practice of being 'enough' in servicing the consumer."

Obviously, as much research indicates, service and repair is one of those areas. The growing backlog on shelves of hi-fi service and repair centers (usually awaiting parts) mutely testify to the problem. Kenwood, a company with an outstanding reputation for service and repair, called to the attention of their service centers the recent consumer warranty act enacted by the State of California called the Song-Beverly Consumer Warranty Act. "A bill that is purported to give California consumers the best warranty protection in the nation"—this is a bill that many in the hi-fi service-repair area expect will be adopted by many other states. Many dealers are not aware of how this act will affect them.

Basically, the act says (Section 1793.2), that a manufacturer has to maintain in California sufficient repair and service facilities to carry out any express warranties, and that "all service and repairs must be performed within a reasonable time following receipt of goods." The bill goes on to say that if the repair is not made in a reasonable time, "the new act specifically negates the passing to the consumer the costs of returning the goods."

This act could be dynamite if widely enacted in the repair and service business. It means that the repair center has to assume the extra cost of returning goods within *thirty days*, or if that is not possible in this period of time, get the consumer to approve in

(continued on page 91)

R-E Test Report

Four-channel headphones are available
how these phones perform.
"field-test" of

FOR MANY AUDIOPHILES THERE IS ONLY one way to listen to music and that is through headphones. Call it "total involvement", "alienation from the environment", "psycho-acoustic", or whatever, it is true that good headphones create a spacial effect generally unheard from loudspeakers.

Well then, if headphones already create a spacial effect—almost surround sound—how do we add the additional spacial effects obtained through any of the 4-channel modes: discrete, derived ambient and SQ-surround. After all, the 4-channel modes supposedly create a spacial effect or surround-sound through two additional rear speakers, yet we only have two ears.

In actual fact, 4-channel, as it concerns headphones, only applies to derived ambient and SQ-surround. Discrete 4-channel converts quite nicely to standard stereo simply by blending (adding) the front and rear left and the front and rear right—we do this all the time by playing discrete 4-channel cartridges through a stereo cartridge player. Since SQ-surround contains much ambient information, like the rear-derived ambient SQ contains information not usually heard from standard stereo. Just by blending the ambient or SQ rear right into the right earphone, and the ambient or SQ rear left into the left earphone we can hear the *total* signal, not just standard stereo.

Naturally, much greater individual control over the "rear" and "front" signals is possible if each amplifier drives its own earphone, as opposed to using a mixing network to combine front and rear into one driver (transducer).

Both the Koss K2+2 ($85) and the Superex QT-4B ($59.95) have essentially similar hardware for 4-channel reproduction. Both have thick, filled cushions that surround the ear. Both have adjustable headbands and two independent drivers in each earphone. Both have a mode switch that connects the two drivers in each earphone in parallel for standard stereo listening (simultaneously disconnecting the rear channel amplifier) and both have Koil-Kords with separate plugs for the front and rear amplifier headphone jacks. The only major difference in hardware are small front-driver volume controls on the Koss earphones.

Testing 1 . . . 2 . . . 3

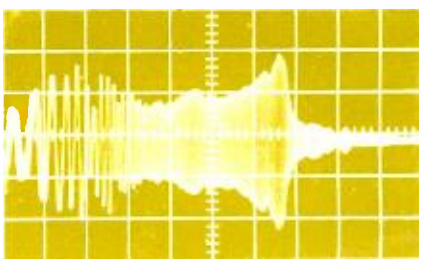
The first apparent sound characteristic discovered through both listening and measurement is that in both the Koss and Superex phones the sound quality from the front drivers is different from that of the rear drivers—the front being better in both models (see Figs. 1, 2, 3 and 4).

(Note that the scope traces are not intended as accurate frequency response plots. It is impossible to obtain accurate high-frequency response curves with circumaural phones mounted on a standard "9A" coupler. The traces only serve to indicate what occured under a given set of conditions and are reasonably accurate in respect to what the ear senses only from the midband down.)

Since we did not dismantle the phones we are not certain if the front and rear drivers in each model are different in construction. Even if they were identical their relative position in the earphone would affect their frequency response, as would the position of the ear itself in relation to the driver.

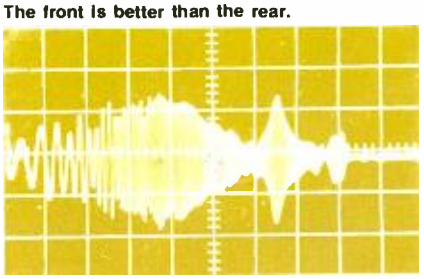
The next apparent sound characteristic is the difference in volume sensitivity between the two models, as shown in Figs. 5 and 6. As you can see, the overall low to midband efficiency of the Koss phones is well below that of the Superex, though any 10 watt amplifier can drive both to the threshold of pain. In particular, note that the Koss phones have a smoother deep bass, which was

TYPICAL 4-CHANNEL HEADPHONES, by Koss. The dual plugs are the tipoff.



KOSS FRONT

FIG. 1—(above) and FIG. 2—(below) show front and rear channel plots for the Koss phones. The front is better than the rear.



KOSS REAR

4-CHANNEL PHONES

today. Let's take a detailed look at
Here's a report on a
two new pairs

by HERB FRIEDMAN

confirmed in our listening tests.

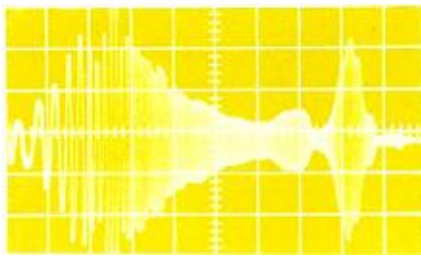
In listening tests—which is the only dependable way to test headphones—both the Koss and Superex models proved superb performers, with the Koss having a slight edge. In the 4-channel mode, or standard stereo with only the front drivers switched in, both models exhibited very wide frequency response and excellent definition (low distortion)—*definition* being the ability to distinguish each instrument when all are playing together. Both models had excellent power-handling capacity and were virtually distortion-free to the threshold of pain.

In overall performance the Koss phones has a somewhat better (fuller?) deep bass and a "soft" sound quality. In fact, the listeners were hard pressed to tell the difference between the Koss K2+2 and electrostatic ESP-9's which were used as a "reference" for optimum sound quality.

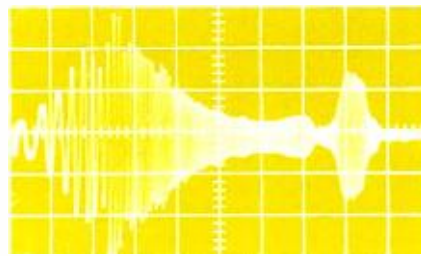
Note that the standard stereo tests were conducted with only the front drivers switched in. In both models the standard stereo reproduction was noticeably degraded when both the front and rear drivers were used for standard stereo—with both drivers connected in parallel by the internal STEREO 4-CHANNEL switch.

Really magnificent sound

When using an ambient or SQ decoder the sound quality from the 4-channel phones is the difference between day and night. The decoded 4-channel sound through both models is



SUPEREX FRONT



SUPEREX OUTPUT (AT 1.0 WATTS)

FIG. 3—(above) and FIG. 4—(below) present front and rear channel plots for the Superex phones. Again the front is better.

FIG. 5—(above) and FIG. 6—(below) shows output of the two pairs of phones with a 1-watt signal applied from the amplifier.

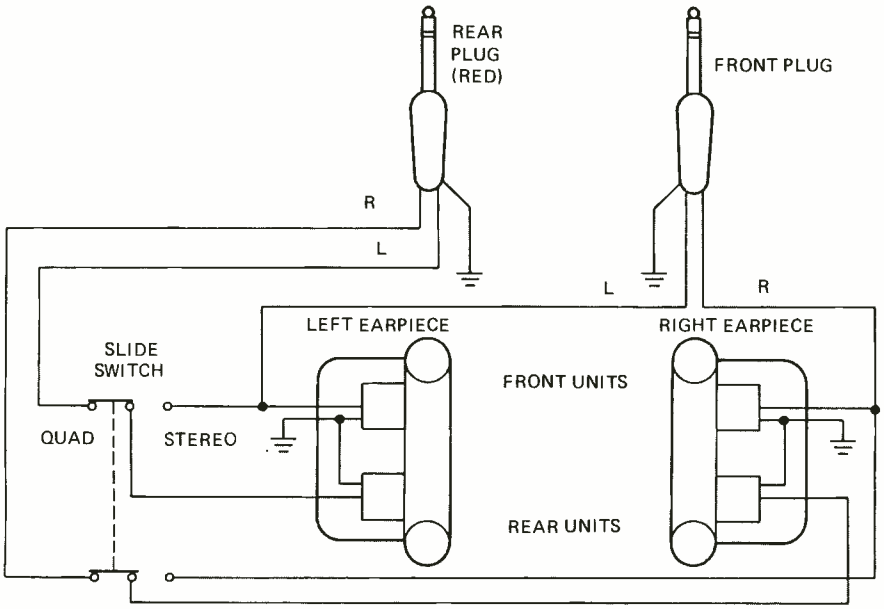
SUPEREX REAR

KOSS OUTPUT (AT 1.0 WATTS)

Discrete. In discrete 4-channel the sound field is obtained through four complete and independent amplifier systems. The program content is distributed on four individual tracks, either tape or RCA disc, and each track feeds its own amplifier. Discrete 4-channel provides optimum or maximum separation and literally bathes the listener in surround-sound.

Matrix and/or SQ. In the matrix system the four channels are *encoded* into two stereo tracks on either tape or disc. A stereo amplifier system would reproduce a matrix recording in standard stereo. But if the signal is passed through a *decoder* the four individual tracks are extracted into left front, right front, left rear and right rear. Of all the matrix systems the one developed by CBS, termed SQ, has the widest acceptance. Most modern decoding equipment is intended for the SQ system, though any matrix decoder will provide acceptable surround-sound effects from any matrix recording. The limitation of the matrix and SQ-matrix systems is that the separation between tracks is nowhere near the equal of the separation provided by the discrete 4-channel system.

Derived or ambience. Most standard stereo recordings, both tape and disc, have the ambience sound characteristics of the recording location encoded in the standard stereo program. The encoding is purely accidental—it just happens. Unless the ambient sound is of unusual magnitude, such as a very long reverberation heard as "echoes", it goes completely unnoticed in standard stereo reproduction. By using a special *ambient sound decoder* the "hidden" or "concealed" ambient sound can be extracted so it can be fed to rear speakers, thereby approximating the actual sound field of the recording location. The ambience decoder does not affect the overall quality of the standard stereo in the front speakers, including separation. Unlike the discrete and matrix/SQ systems where the primary sound can appear from any location or direction, the ambient system always has the primary sound in front.



FUNCTIONAL BLOCK DIAGRAM of the Superex QT-4B four-channel stereo headphones. Note that a front and rear transducer element is in each earpiece.

larger than life, and in truth one can say the 4-channel effect alienates the listener from his environment. Unlike 4-channel listening through speakers where the ambient and SQ decoders simply place the listener inside a concert hall, or in the center of the musicians, with 4-channel sound in 4-channel phones the listener is totally literally immersed in the music. It is impossible to describe listening to an opera, or a full symphony orchestra through 4-channel phones; it's as if every square foot of area around you was suddenly filled with music.

Discrete 4-channel does not offer the same adventure in sound; the phones simply blend each "side" together and the effect is, at most, a slightly improved standard stereo—if there is any improvement at all.

But to paraphrase a famed performer: "Until you've heard 4-channel ambient or SQ decode through 4-channel headphones, you just ain't heard nuthin' yet!" **R-E**

equipment report

Triplett 603 micropower FET vom.

FET VOM'S WERE A LOGICAL NEXT STEP in the vtvm principle—the very high-impedance, low circuit-loading voltmeters. The extremely high input impedance of the FET makes it a natural for this application. Its low drain makes battery-power practical. You can carry them wherever they're needed, without tripping over dangling line cords. Most of them are compact, no bigger than the old bench vom's.

However, there is one drawback with self-contained batteries. You *can* go off at the end of a busy day and leave the meter on. The result is a dead meter, the next morning when you got to the shop. This is not only inconvenient, but can be expensive.

Triplett has come up with the answer, in their latest meter. The new member of the family is the model 603 Micro-Power FET vom.

This little jewel has all the standard vom features and ranges, plus some new ones. There are eight ac and dc voltage ranges, from 0.3 volt (full-scale) to 1,000 volts. Six ohm-meter ranges from RX1 (center scale 10 ohms) to RX 1.0 megohm; ac and dc current ranges from 1.0 mA to 1A. (And the ac *current* range is one of the new features; very rare in bench vom's till just lately.)

Polarity of voltage and current readings is chosen by handy pushbutton switches on the left side of the panel. Another of the new features is the AUTO-POLARITY function. If you are reading certain voltages, and all you want to know is "Is it there or isn't it?" Just push both + and - buttons *at the same time.* Now, the meter will deflect up-scale for either polarity.

This works on current ranges too, and I love it. I can't remember a time when I hooked up a miliammeter and was *sure* that I had it right. Of course, I did now and then.

The best deal of all, though, for the absent-minded and busy among us, is what Triplett calls TMP. This means *T*riplett *M*icro-*P*ower. The whole schmear, FET's transistors and all, draws a piddling 10 *microamperes* of power from the batteries when it's on! By the way, this is for all ranges, including the ohms. Some of the older vtvm's drew current from the ohmmeter batteries if the function switch was left in the ohms position, even though the meter itself was turned off.

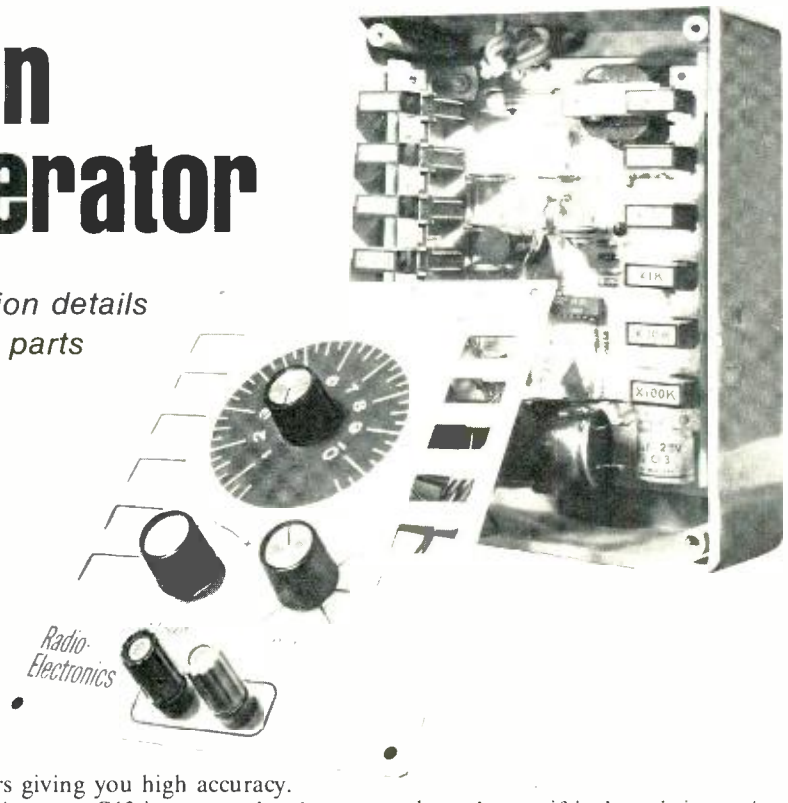
The 603 is built in a nice-looking, high-impact plastic case. It has a solid handle, which makes a handy leg from propping the thing up so you can read it. Batteries are housed in the back of the case, which can be removed for the yearly replacement with only a single thumbscrew.

The scales of the 603 are linear. This makes it very easy to read. The movement, a 20-μA type, is very well damped. When you connect it to the circuit, the needle swings up scale in a slow, dignified way, and stops, as if to say "There! *That* much.

All in all, this is a very worthwhile piece of test equipment; very well made and one that should continue to deliver first-rate service for quite a long time after you have bought it. **R-E**

R-E's Function Generator

Part II: Final assembly and construction details including printed-circuit patterns and parts placement diagrams



by DON LANCASTER

LAST MONTH WE PRESENTED THE FIRST part of this article on a $40 function generator build around a single IC that could deliver five different waveforms. This issue we complete that article by presenting the remaining text and diagrams.

The pulse is handled by S1-d. It first sets up the shaper for single-ended capacitor-coupled operation. Next it shorts the shaper's gain control, giving full limiting. Finally, it unbalances the wave generator with R26 to get the pulse duty cycle. *If* we had a fifth deck on S1-d, we'd use it to switch in the shaper unbalancer R27 needed for good pulse amplitude and risetimes. We don't have this switch available, so we use the *normally closed* contacts of S1-e and S1-f, the SQUARE and RAMP selectors. Thus if the PULSE switch is depressed, SQUARE and RAMP obviously are not, and the resistor is switched in.

S1-e is the SQUARE select which connects the shaper for a single-ended capacitor-coupled input. It also runs the shaper gain wide open, and prevents R27 from being in the circuit. Finally, it connects the wave generator's square-wave output to the shaper.

S1-f is identical to S1-e, except it connects the ramp output to the shaper.

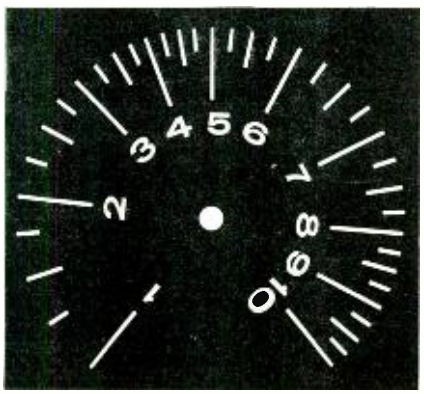
S2 is much simpler. All it does is switch in a selected capacitor for each frequency range. It also switches in an anti-droop capacitor C10 only on the X1 range.

About the capacitors

The instrument will be a no more accurate than the capacitors you select. 2% tolerance or better yet 1% tolerance is needed for range-to-range accuracy. To beat buying very expensive capacitors, you use a parallel pair of capacitors with roughly a 10:1 range of value. Measure the big one and select the small one, and you get by with plain old capacitors giving you high accuracy.

For instance C13 is supposed to be 0.24μF. Virtually any 0.22-μF capacitor you get will be lower than this value, so get one and measure it. If it is exactly 0.22μF, put a plain old 0.02-μF in parallel with it. If it's 0.23μF, use an 0.01μF. If it's 0.21μF, use a parallel 0.03μF, etc. If you don't have a good capacitance bridge handy, use a scope timebase and adjust for equal 10:1 frequency steps.

The big capacitors are always a hassle on any low-frequency oscillator. Ideally, you should use bipolar tantalums, but these are too big and too expensive to be reasonable. From a practical standpoint, the total ac voltage in the circuit is less than a volt rms, and the impedance is very high. So, even on very long term usage, an ordinary good quality electrolytic won't run down very much, and even if it does, it just raises the frequency a bit. So the reasonable thing to do is to use ordinary high-quality electrolytics, and if extreme accuracy is needed, check up on them every six months or so.



FOLLOW THIS PATTERN to make the dial for your unit. Final size is 2 9/16-in. wide.

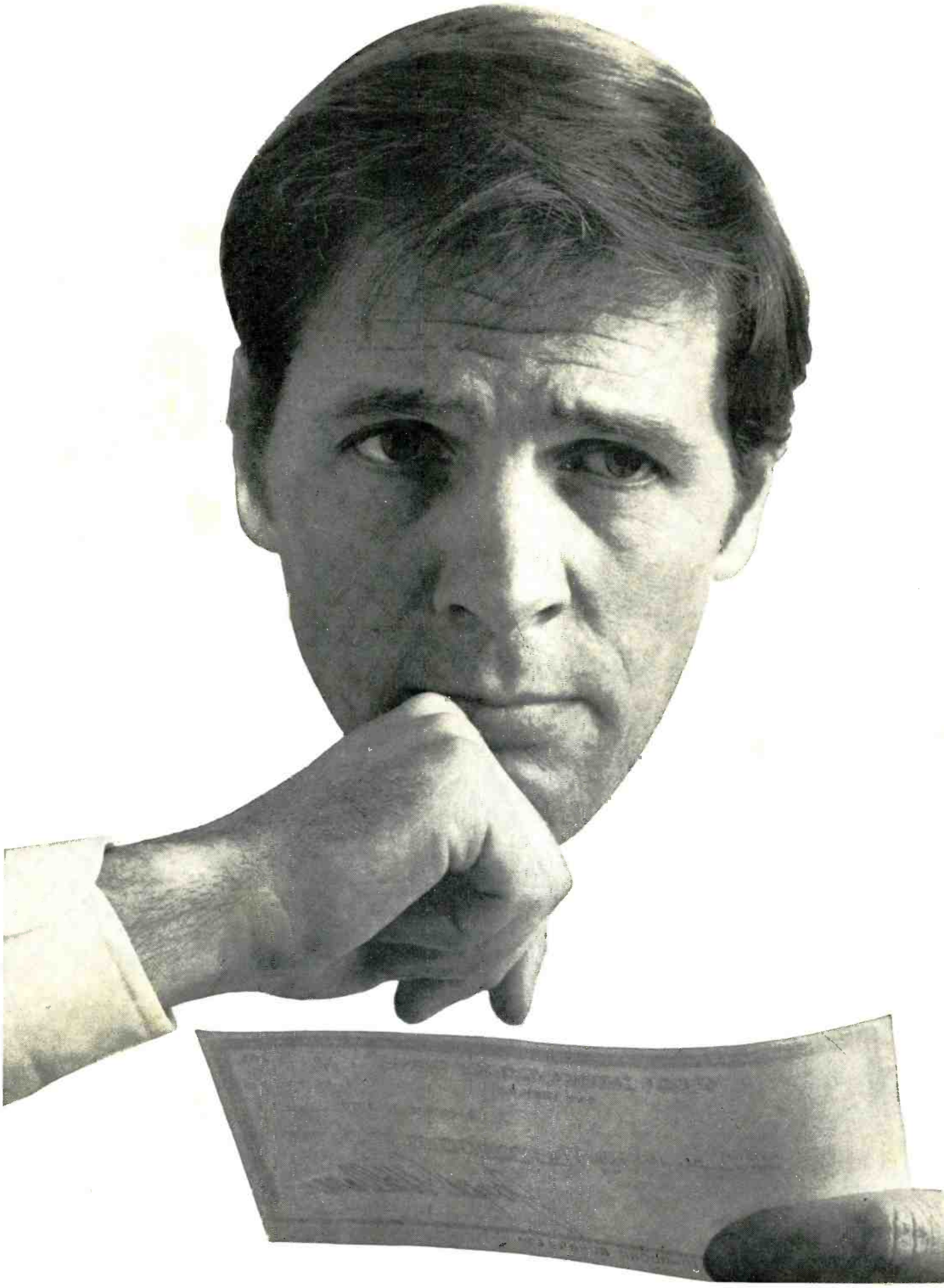
Note that C11, the X100K capacitor is in the circuit all the time, and that C12 is slightly smaller as a result. This prevents the function generator from taking off at a very high frequency in-between button pressings, and also eliminates a minor starting problem.

Building it

Three PC boards are needed for assembly. Two of them support the switches, while the third holds almost everything else. These are commercially available, but if you are building your own, complete details appear in the following pages. You can start assembly with the switch boards, placing the smaller components and wire jumpers exactly as shown. The switches are then soldered in place. After that, any terminals that may interfere with the main circuit board may be clipped short. Wire the switch assemblies to the main board last.

To put together the main board, start with the input and control terminals, followed by the jumpers, fuseholder, resistors, and finally the major components. Use sleeving on the jumpers where indicated. IC1 is identified by

(continued on page 50)



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a code dot and notch beside pin *one*. Its shown *top view* everywhere. Be sure pins 1 and 2 of the power transformer go to the 110 volt line side or you'll have extensive damage on your hands. Also be sure to watch out for diode and capacitor polarities.

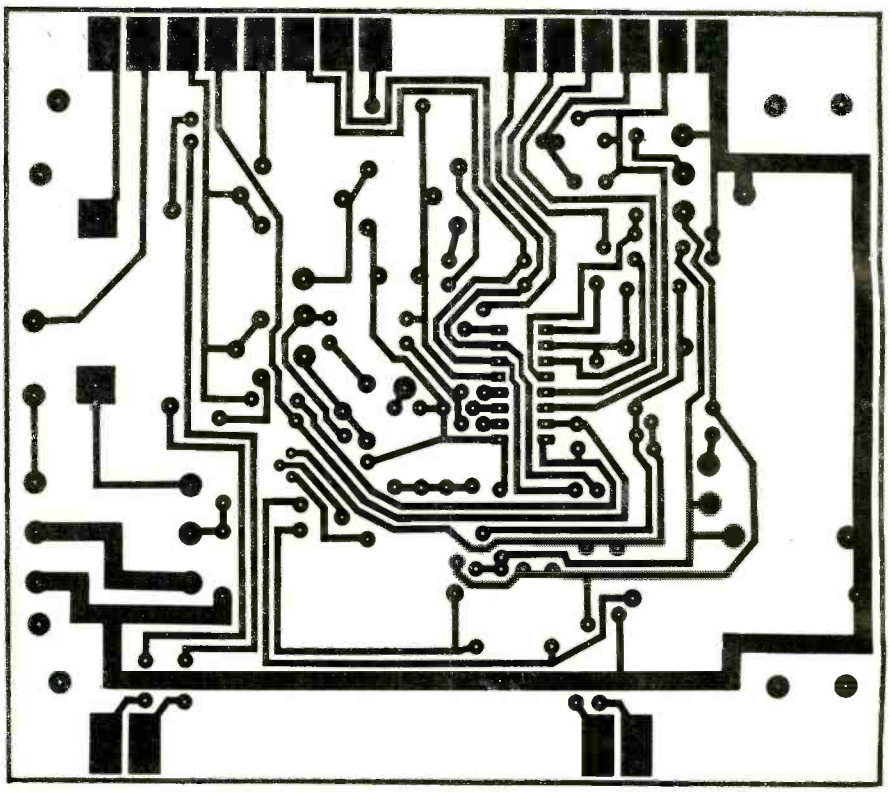
After the main board is complete, *loosely* bolt the switch boards in place with right angle brackets. Be sure the function selector is on the left and the frequency selector is on the right. The main circuit board may then be bolted temporarily into the impact plastic case. Now, check the front panel alignment with the pushbuttons to make sure everything works smoothly. If you have to, adjust the angle brackets slightly to get smooth operation. Once everything fits nicely, tighten the switch circuit boards down firmly and remove everything from the case.

Wire jumpers or resistor ends may now be used to solder together the pads on both switch boards to the main board. You can then mount things back into the case, adding the line cord and an anti-strain knot. No-skid feet may also be added.

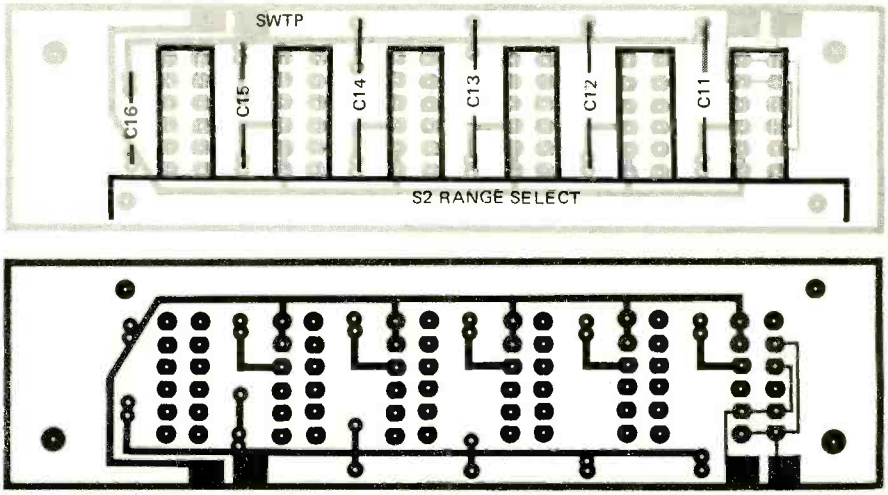
Mount the front panel components and wire them to the main circuit using a small harness or flat cable if you have it; or neatly laced cable if you do not.

The frequency dial is slightly nonlinear; a suitable replica is on page 45, or you may prefer to calibrate your own dial for extra accuracy. Either way, be sure the dial markings coincide with the pot's range when you push the knob in place.

A single heavy ground lead must be added from the terminal provided on the function selector board to the front panel and output Black terminal. Be sure to connect this wire exactly this way. Other grounding schemes (or a lack of them) can give you a little glitch in the top and bottom center of the sine-wave. After applying stick-on Mylar callouts to the pushbuttons, your unit should be complete and ready for test.



FOIL PATTERN OF THE MAIN CIRCUIT BOARD. Actual size of this board is 5 inches high and 5¾ inches wide. Two other boards plug into this one. They are the range-select and mode-select assemblies, also shown on these two pages.



RANGE-SELECTOR BOARD DETAILS. Foil pattern of board must be enlarged to 5¼ inches wide. Top diagram shows parts placement on this circuit board.

Preliminary checkout

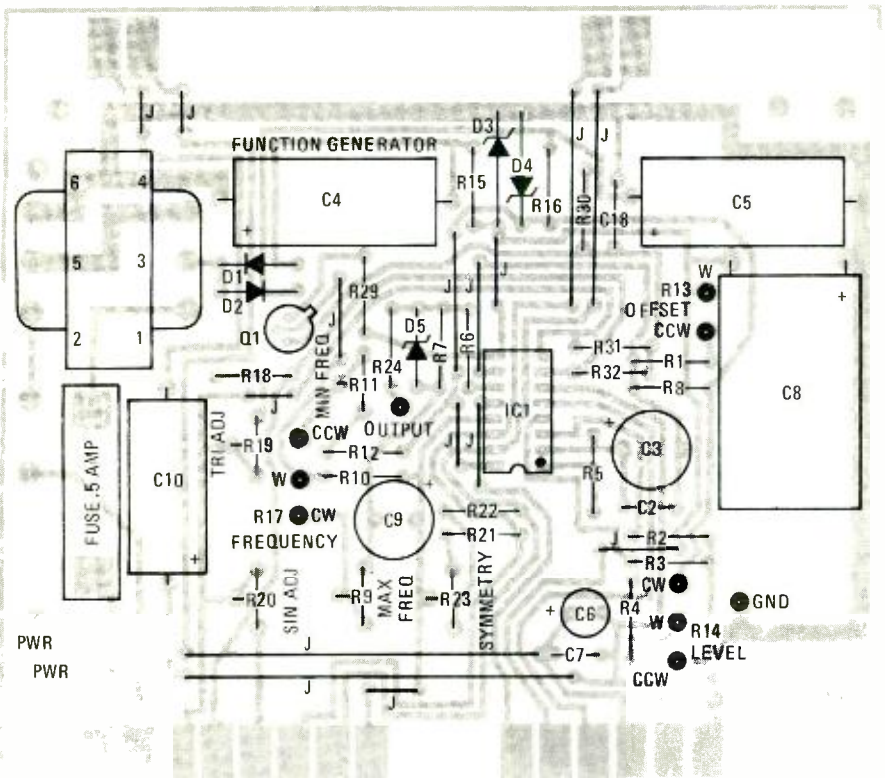
Center all the controls, and apply power *very briefly*, measuring the voltages across Zener diodes D3 and D4, and looking for the +10 and -10 values. If the voltages are low or if a scope shows hum at this point *stop and find out what is causing the excess current flow*. If things look OK, apply power again for 15 seconds and measure any temperature rise in IC1 with your finger. It should be negligible or only very slightly warm. Again, if its too hot, stop and find out why.

Now, set the unit to a 400-hertz square wave and with a scope, check pin 12 of IC1 for a 2-volt square wave. Check for out-of-phase ramps at pins 14 and 15. Turn up the level. You should get a 2-volt square wave here, verifying that the shaper and modulator are also working. Finally, check the output for the same 2-volt square wave.

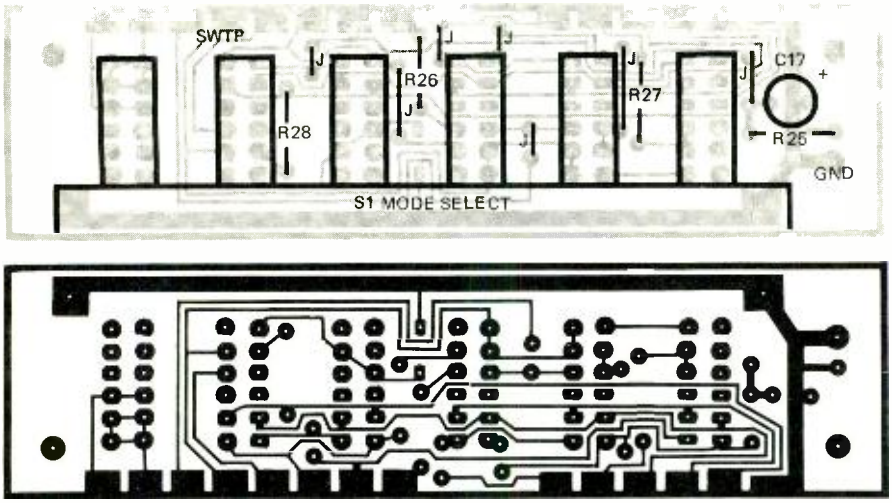
Next, check out the offset adjustment and proper operation of the pull switch. With the switch OUT, you should get dc coupling and variable offset. With the switch IN, you should get ac coupling. Check the frequency pot over its range. Don't worry if funny things happen at either end unless they're still there after you go through the calibration procedure. Check for droop on the 1-Hz range. Now, check the other functions. Pulse should look like square, only with a 5:1 duty cycle. Triangle may be rather small or may have bent tops; calibration will fix this. The same thing is true of the sine; and ramp; while they might look funny before calibration, the important thing here and now is that they exist. If everything seems to be there, you're ready for calibration. If there's any problem, go back to figure two and isolate where the problem seems to be. Don't attempt to calibrate an instrument that doesn't seem to be working right.

Calibration steps

For top-notch performance, you should calibrate your function generator. You'll need a good oscilloscope for this and, while not essential, a counter



MAIN CIRCUIT BOARD SHOWING WHERE PARTS ARE MOUNTED. In addition, the mode-select board and the range-select board are connected to the main "mother" board. The only wiring external to these boards connects to the front panel of the instrument.



MODE-SELECTOR BOARD DETAILS. Foil pattern of this board must be enlarged to 5¼ inches wide. Top diagram shows parts placement on this circuit board.

would also be handy.

To start the calibration, center all pots. Select dc coupling with zero offset, maximum amplitude and a 400-Hz square wave. Now:

1. Adjust the SYMMETRY control for exactly a 50% duty cycle of the output when viewed with a good scope.

2. Switch to TRIANGLE and adjust for the largest *undistorted* triangle output you can get and then back it off just a bit. Use TRIANGLE ADJUST control R19 for this step.

3. Switch to SINE and adjust for the best looking sine wave using SINE ADJUST R20. If you ever readjust the TRIANGLE ADJUST, you'll also have to readjust SINE ADJUST.

4. Switch back to SQUARE, and set the frequency knob to "1" on the 100-Hz range. Now adjust the MIN FREQ potentiometer R11 for a 100-Hertz square-wave or a 100-millisecond period.

5. Change the FREQUENCY knob to "10" and adjust MAXIMUM FREQUENCY potentiometer R9 for a 1-KHz square-wave or a 1-millisecond period.

6. Redo steps 4 and 5 as often as you have to till there's no more interaction. Twice through is usually all it takes.

7 Verify operation of the other frequency ranges and the PULSE and RAMP outputs.

Your instrument is now fully calibrated and ready for use. If you have no means of calibration at all, just set all the internal pots to their mid range, and you'll still have a reasonably useful, if somewhat inaccurate piece of test gear.

After you've gone through the calibration, any end effects that showed up on the frequency knob should now be gone. You might like to doublecheck the amplitude compensator Q1. To do this, switch to X100 and a triangle wave and compare the "1" and the "10" amplitude on a scope. They should be very nearly the same. If the "10" is smaller, try lowering R31 and R32 slightly, and vice versa. If there is a hump in the middle, try lowering R30. If there is a dip in the middle, lower R29. Optimum compensation should be a very slight dip followed by a very slight rise. Finally switch to sine and note an undistorted and uniform sinewave over the whole range. Adjustment of the amplitude compensator is a very fine point and shouldn't be necessary in a properly working unit.

Operating hints

Use the dc position with zero offset unless you have to couple into a high-voltage, tube-type circuit or something similar. Note also that the ac-coupling capacitor is rather small and forms a high-pass filter whose lower cutoff is determined by the load you hang on the generator. For very-low-frequency work or very heavy loads, you'll want to substantially increase the value of this capacitor.

To drive TTL, use the pulse or square output and turn it up to the full 2 volts. Now adjust the offset control for a positive baseline offset of 0.6 volts. This gives you a signal that exceeds the TTL 1-0 requirements and you can easily drive any TTL logic circuit. DTL and RTL are also easy to drive, and a simple interface works with MOS logic. For MECL logic, simply use some negative offset and you're home free.

If you need some of the fancier capabilities of professional function generators, you can easily pick them up. For instance, you can apply a differential control voltage to pins 3 and 4. This gives you an amplitude modulator, a remote volume control, a phase control (reverse the polarity for an upside down waveform, or a way of off-on keying.) You can also use this for single sideband modulation or ordinary AM by capacitor-coupling a suitable signal to the present level control input. Or, a voltage replacing the frequency control gives you a VCO (Voltage Controlled Oscillator), a frequency modulator, or a way of frequency shift keying. For high modulation frequencies, you'll want to reduce C9 or delete it entirely. Its in there to keep from hum modulating with external pickup. **R-E**

4-CHANNEL RECORDS

IT PROBABLY BEGINS IN A CONFERENCE ROOM, THIS QUEST FOR a new album. The principals of the group along with those of the studio get together to discuss the arrangements, the numbers, and the general composition to be assembled. It takes a lot of discussion before deciding that a total of twelve numbers, none to be more than four minutes long will make up the album. There are even several suggestions for an album title, none of which are accepted.

The group is an invention for the purposes of this story. They're called the Mudslingers; they do progressive rock. Seven are involved: drums, two trumpets, sax or clarinet, trombone, electric bass guitar, and piano or organ. For this album, a female vocalist will be used on some numbers.

Finally, all production details are arranged. Twelve songs will be recorded. The studio, an independent, is booked for full sessions to run over three days. Payment of studio rates at around a hundred dollars an hour is split between the group and the recording company that will release the recording.

On Monday at 1:00 pm the group arrives—except for the soloist; she won't be needed for any of these first sessions.

The engineer in charge of the sessions has been busy for several hours before the arrival. Knowing the composition of the group, he has set out a trial group of microphones. Enough raw tape has been brought over from the vaults in which it is kept for the session. Tape machines have been cleaned and degaussed. Levels have been established from the console and Dolby units to the tape machines. The principle machine for this session is a sixteen-track Ampex MM-1000. It uses two-inch wide tape and runs at 15 ips.

The console itself is custom made. It uses modules available from several console manufacturers. It has a total of twenty input channels and sixteen output channels. Each input is a separate module and includes full equalization, compression, and gain controls. In addition, it has switch positions that tie into an audition network. The output of the module, which contains inputs for microphone and high level and appropriate switching, goes to a master switching section of the console where it can be assigned to one or more output channels.

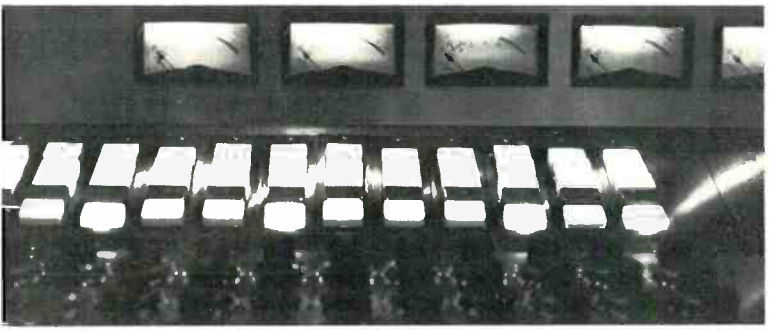
Each input module has a break-in point in its circuitry that permits the audio to be routed out of the module for modification and then returned to it. Generally, this modification is echo external to the console.

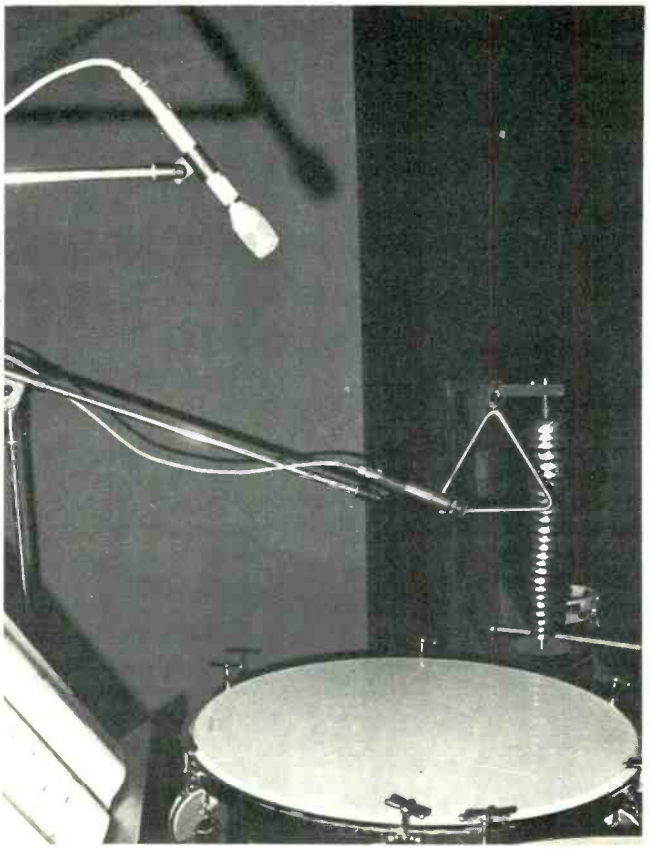
Obviously this is a gross oversimplification of the functions of a console. Modern consoles give the engineer an impressive potential for control while recording, and provide further control after the tape is finished. In addition, full monitoring facilities permit the engineer and producer to listen to individual modules, or any combination they want. They can alter the sound while monitoring but not get these alterations onto the tape. Further, a special monitoring setup is included that permits a feed selected on the console to be fed out to headphones in the studio.

Setting up microphones

What goes on the tape comes from the microphones. And if you have ever used a variety of microphones, you know that six different mikes produce six different sounds from the same instrument. So the engineer is faced with the basic decision of which mike (he has many) to use for each of the instruments of the group.

Let's digress for a moment. Each instrument gets its own tape track. Two instruments, drums and piano get two channels each. Each of the other instruments and the soloist are recorded mono onto their own single channel while the drums and piano are stereo miked for a fuller, bigger sound. The sixteen available tracks are assigned. Track one is not to be used. Tracks two and eleven have the two trumpets. Track three has the clarinet (or sax). Track four has the trombone. Track five has the vocalist. Track six has the electric guitar. Tracks seven and eight are a stereo pair for the piano (or or-





OMNIDIRECTIONAL AND CARDIOD MIKES for close-miking and a complex multi-channel console are versatile tools that give the engineer and producer complete control over the finished recording.

How They're Made

by LARRY ZIDE

gan when used). Finally, tracks nine and ten are a stereo pair for the drums.

This leaves track one and tracks twelve through sixteen unused. One and sixteen will not be used unless absolutely necessary. The reason is that these two tracks are at the outside edges of the two-inch wide tape. If there is any slight edge curl or tape skew, these tracks bear the brunt of drop outs. (This is not a serious problem with modern machines and modern tapes, but it is best to be careful.)

Now don't confuse the tracks of tape with the input mikes that are used in the studio. The console has twenty mike inputs, and it is possible to add an external mixer if more mikes (to be fed to a common input channel) are required.

Most of the instruments use only one mike—placed directly in front of it. The piano uses two, of course, for stereo pickup. But the drums require several mikes. In addition to two for stereo pickup, extra mikes are used for cymbals, sharpening of brush sound, and deepening of the bass drum.

Each of these mikes comes into a separate input module, but the engineer can assign any one to any output—including several to the same output if desired.

The choice of actual microphone is dictated by the instrument to be miked and the kind of sound that is desired. For example, the producer may want the trumpets to dominate and have a strong sound. Accordingly, the engineer goes to his microphone closet and picks a pair of the sizzliest condensers he has. He could use a very flat mike and boost highs on the console, but in general, he prefers to select a mike that gives him the sound he desires and uses the least equalization possible.

With each instrument separated on different tape tracks, the placement and type of microphones is important. There is no purpose to putting the trombone on a separate mike, if in fact the clarinet mike picks up so much trombone that there is no isolation. So a combination of close placement of mikes, proper cancellation of off-axis sound with directional mikes, and physical isolation of the instruments by proper placement around the studio, is used.

Nowhere is this more evident than with the drums. They are placed at one side of the studio with acoustical panels virtually surrounding the instruments. (Percussion can be so powerful that it would swamp the mikes of other instruments, anywhere in the studio.)

The vocalist suffers from the other extreme. Because the voice is so soft relative to the other instruments, a separate substudio—and isolation booth—is used. The vocalist is completely isolated, acoustically, from the instruments.

With all this isolation, it is a problem for the group to hear themselves and play in coordination. So each member gets a headphone fed with the sound he needs to hear, hopefully at the level he wants it.

Finally, all the mikes are set up. The studio looks like a vertical maze of mike stands and booms, each holding a mike in exactly the correct position. Each instrument is close-miked and established on the console at a proper level. Each is fed at maximum level to the proper tape track. No serious attempt at balancing is made now—except possibly in the monitoring system. (The monitoring system on some consoles can feed a separate two- or four-channel tape recorder and a "safety" made—a tape for evaluation and guidance in the final product.

The master recording on the two-inch tape is recorded "dry". Each instrument is close miked. Little or no equalization, except for essential correction, is applied. Little or no echo is on the tape at this time.

Making the recording

The recording session begins about 6:00 pm that Monday, and goes on to midnight. Six selections are recorded that first day, considering the many retakes. There is at least one good rendition of the six locked up. (Actually one requires a

special addition—more about this presently.)

Tuesday at 1:00 pm everybody's ready and, being fresh, lock up the two remaining instrumentals by 4:00. After a break, the soloist is set up in the isolation booth, given headphones, without which she would not hear anything, and recording resumes. The vocalist is good, and by midnight, all four songs are on tape.

Adding another instrument

One of the selections recorded on Monday requires a deep bass sound that only a timpani can provide. A timpani was not available on Monday or Tuesday, but has been delivered on Wednesday. The reel of tape with the selection is put on the recorder and the selection is played. However, the machine is placed in a special position that converts the record heads to play heads so that there is no lag in time between what the percussionist hears in his phones and what he plays. The sound he makes is in perfect synchronization and is placed on one of the extra tracks on the tape, thus completing that selection. Should he goof, his track alone can be erased and redone, or an alternate version can be put on yet another track. Only the engineer, producer, and percussionist are required for this session.

The master tape is now complete. The next operation is between engineering and the producers as they mix-down the sixteen tracks to finished recordings. They will add reverb and delay as appropriate to each channel. If, at this time, it is decided that the piano needs a bit more bottom, appropriate equalization can be added. This complex process is called "sweetening".

The mix-down process

In the actual mix-down sessions, which can take as long or longer than the recording sessions, the recording is taking commercial shape. Essentially, the process of mix-down and sweetening is simple.

The producer and engineer decide which sounds from the discrete sixteen-track master go to the left, right, or anywhere in between. The engineer can position (pan) each of the tracks anywhere along the stereo stage. For this recording, trumpets, bass guitar and the singer are placed around the center. The trombone is slightly left of center and the sax (or clarinet) are right of center. Drums and piano, being already in stereo are placed accordingly backstage (for drums) and forestage (for piano).

It requires a lot of experimenting by the producer and engineer to come up with a combination that produces a totally artistic mix. Echo is added to the soloist and the horns to give them more air. Each instrument can be touched up individually for equalization, echo, or other special effect. Then each instrument is under individual gain control as it heads onto the tape of the final two-channel mix.

The mix that is finally used adds bass to the drums, reduces some of the sizzle of the trumpets, and brings the trombone forward by increasing its relative prominence to the other instruments. The vocalist, in particular, needed a lot of equalization and echo to suit the producer. A bit of middle-low end is added to make her more throaty, and a bit of very high end is removed to eliminate a touch of raspiness her voice had that day.

Two solid days of work later a stereo mix is created.

The other mixes

A mono mix is needed for certain audition purposes and broadcast needs. An ideal stereo mix is not necessarily an ideal mono mix. The producer needs mono radio play to sell the album, so it's back to the sixteen-track master to produce a new mix for mono. Separate sweetening, equalization and balance is used to produce a mono master that will embody the exact sound the producer wants.

But the real expertise comes when it is time to produce a four-channel stereo master.

The 4-channel mixes

Just as a separate mix is made for mono and stereo so separate mixes are made for any 4-channel productions. For our hypothetical recording, both a matrixed disc, and a discrete cartridge tape are going to be produced. It may seem logical to simply mix the discrete tape first and then use that for the matrixed disc master, but this is not the case at all.

The very imperfections of matrix sound—its inability to completely separate the individual channels—make it necessary for the producer to make a matrix mix from the original sixteen-track master that is quite different from the discrete 4-channel mix.

A variety of sophisticated techniques are needed to get satisfactory results. The matrix encoder is used, of course. All encoders contain decoders for monitoring purposes, and these are used by the engineer and producer. By listening through the decoder to what is going on the matrixed tape, the engineer can assure himself and the producer that the effect he is attempting is, in fact, achieved.

Special controls are required on the console for 4-channel mixing. Primary among these is a quad pan pot and/or joy stick. With this control, the engineer can place any source in any position the four-channel matrix permits him to use. A 4-channel joy stick permits the movement of a source. It is used in our recording on one selection where the ending has a long sustained trumpet solo. On the solo, the engineer slowly revolves the joy stick creating an effect on the tape of the sound slowly swirling around the room.

Now it's back to the sixteen-track master to produce another four-channel master—this one for the Q-8 cartridge release. As this remains discrete, the need for ultra-careful monitoring is reduced.

Making the commercial release

Now we have finished. It's two weeks after the original recording sessions, and the engineer and producer have finally created a mono master, a stereo master, a matrixed 4-channel master, and a discrete 4-channel master.

The stereo master goes to the disc mastering plant. It may be part of the same recording complex that did the studio work or it may not. A stereo lacquer disc is cut from this tape. If it was properly made, some compression may be necessary to adjust the tape for good disc cutting, but not too much else is done to it. Once a lacquer has been cut and approved, it becomes a pure manufacturing process to make stampers and grind out platters to fit the anticipated demand.

At the same time the stereo disc is being produced, a duplicate stereo master tape is sent along to Ampex Stereo Tapes, who will produce cartridge, cassette, and open-reel versions. Ampex may also get the discrete 4-channel master if they are to produce a Q-8 cartridge or 4-channel open-reel release.

This leaves the matrixed 4-channel tape. It has followed a parallel route with the stereo tape—for disc mastering. A lacquer is produced and stampers are ultimately made.

As little as a month has elaspsed since the recording sessions—if this is a topical recording. Obviously, if there is no rush to production, none will be taken.

The actual route of the steps toward the finished product vary according to the circumstances under which the recording is made. If an independent studio is used, that studio may take the tape through final disc mastering or send it on to another place for mix-down and disc cutting. If a major recording company is involved, the entire process is likely to take place under their wings. But it is not uncommon for major companies to farm out initial production to independent recording studios. Then, the mix-down and onward will be done at the label's facilities.

There are many routes an album takes from the time it is a dream to its final stages. But the product you go into a store and buy may bear little resemblance to the beginnings. In fact, it bears little resemblance to its original master tape. **R-E**

REDUCE TAPE NOISE
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REDUCE TAPE NOISE

by HERB FRIEDMAN

BECAUSE THE DOLBY TYPE B NOISE REDUCTION SYSTEM WAS "FIRSTEST with the mostest" most audiphiles tend to associate only the Dolby B system with tape recording noise suppression. There are, in fact, three totally different noise suppression or reduction systems presently available at consumer equipment prices; they are: the Dolby B, the Norelco (Philips) DNL—or Dynamic Noise Limiter, and the Kenwood De-Noiser.

Since each of the three systems has its own particular advantages and disadvantages, the one that is the best for you depends on your own individual operations: how and what you record, if you want interchangeability, compatibility, etc.

1. The DNL

The DNL is Norelco's solution to the problem of maintaining the compatibility built into the cassette system's original concept, namely, that a recording made on any and every cassette machine be directly interchangeable on any other machine. This means, of course, that aside from mechanical considerations such as tape speed and design of the cassette itself, the equalization on every model must be identical, in addition to an SRL (Standard Recording Level).

Electrical standardization precludes any modifications or changes in the record and play equalization to obtain a better signal-to-noise ratio. Therefore, any noise suppression, must take place *in the playback amplifier after the standard playback equalization or de-emphasis.*

Norelco obtains their noise suppression through a DNL system that attenuates the higher frequencies only when the signal level is relatively low; when the signal level is loud there is no high-frequency attenuation and the entire signal is reproduced exactly as recorded.

While it is logical to assume that attenuation of the highs would tend to make the signal muddy (excessively bassy)—as well as attenuating the tape hiss—this is not necessarily the case because of two effects:

1. The sound output from instruments played at low volumes contains less harmonic overtones than when played at loud volumes.

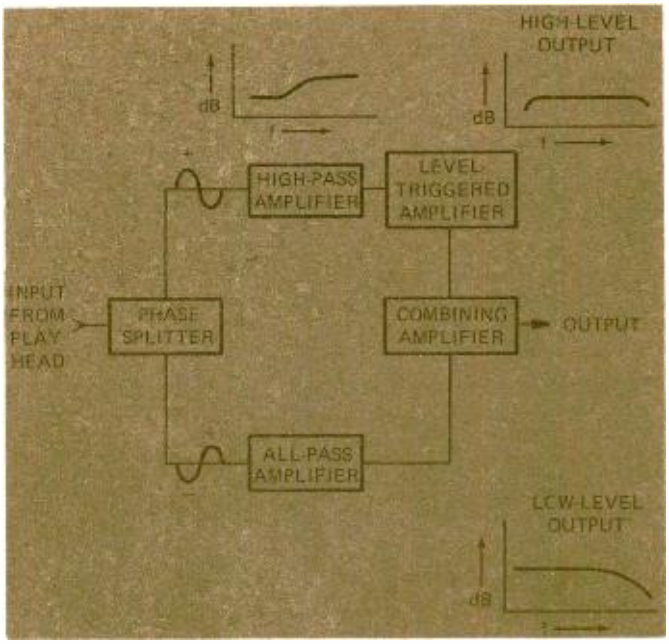
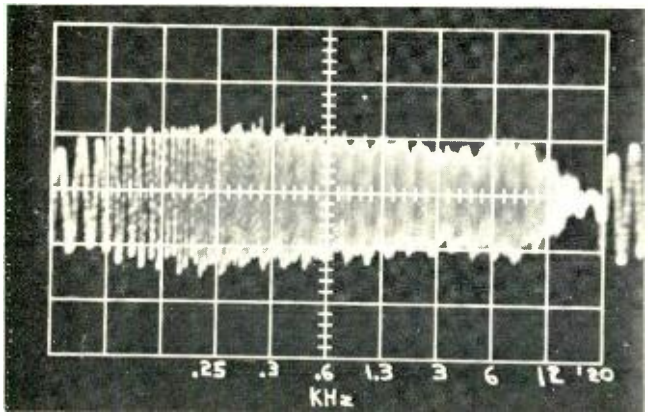
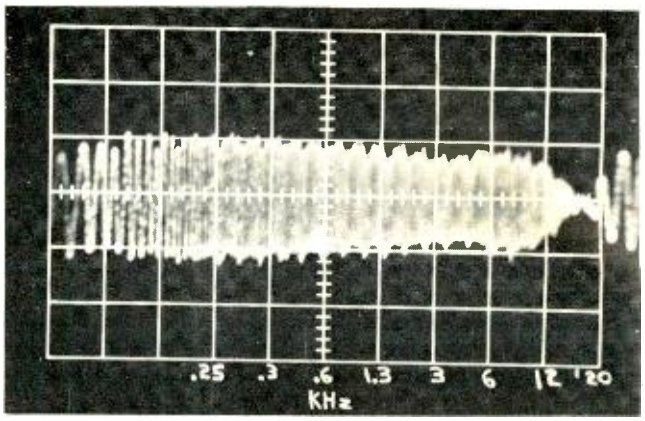


FIG. 1—BLOCK DIAGRAM shows how DNL produces low-signal-level high-frequency attenuation.



TAPE OUTPUT FROM DNL at a recording level of –20 dB. Output at 6 to 10 kHz is equal to output at 0.6 kHz.



TAPE OUTPUT FROM DNL with a –40 dB record level. Attenuation has started from 3 kHz upwards.

2. The ear favors the loudest sound or sounds when there are two or more sounds of different frequency composition.

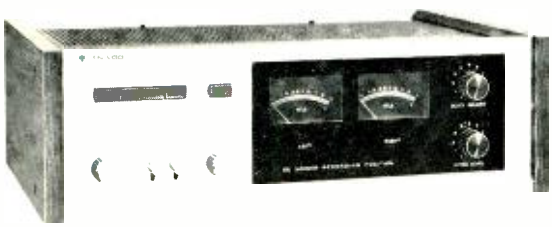
The DNL produces low signal level high-frequency attenuation through a level-triggered phase cancellation of the higher frequencies, as shown by the block diagram in Fig. 1. The input signal is fed to a phase splitter so that the signal passing through the high-pass amplifier is 180° out of phase with the signal passing through the all-pass amplifier. When the signal level from the high frequencies, above 5 kHz, at the output of the high-pass amplifier is less than –38 dB below the reference level ("0" VU) the level-triggered amplifier is keyed *off*, and the only signals fed to the combining amplifier are those passing through the all-pass amplifier. When the signal levels are greater than –38 dB—ie: –43 dB—below reference level the level-triggered amplifier opens and feeds the high-frequency signal to the combining amplifier, where it phase-cancels the high frequencies coming through the all-pass amplifier.

As you can see, the high-pass amplifier keeps low-frequency signals from the level triggered amplifier, so phase-cancellation can take place only when the high-frequency program information is –38 dB, or lower.

Note that the level-triggered amplifier is *normally open*, so that the DNL is operative during silent program passages. The amplifier is triggered off when the signal level exceeds –38 dB.

Quite obviously, the DNL will noise-suppress any and all recordings played on a machine so equipped, and therefore meets Norelco's compatibility requirement.

2. The De-Noiser



Kenwood Model KF-8011.

The Kenwood De-Noiser is packaged as a separate amplifier and can be used with any signal source and any amplifier. For example, connected between an FM tuner and an amplifier it will suppress the noise (hiss) common to weak-signal stereo reception.

The De-Noiser is designed to the same basic philosophy as the DNL concerning low-level signals, but the way it's done is completely different from the DNL, though it uses the same –38 dB "cut in" level as the DNL.

The De-Noiser consists of four switch-selected filters centered on 3.5 kHz, 5.5 kHz, 8 kHz and 12 kHz. Any combination of filters can be switched into the circuit. In operation the filters literally punch a "hole" in the frequency spectrum, rather than attenuating everything from a given frequency upwards. For example, with all filters switched in, low-level signals up to 2 kHz will feed through "flat". Frequencies from 2 kHz to 20 kHz will be attenuated. But if just the 3.5 kHz filter is used only the frequencies from 2 kHz to about 7 kHz will be attenuated; above 7 kHz they feed through "flat". This arrangement allows considerable leeway in tailoring the noise reduction to a specific type of noise.

A simplified De-Noiser block diagram in shown in Fig.

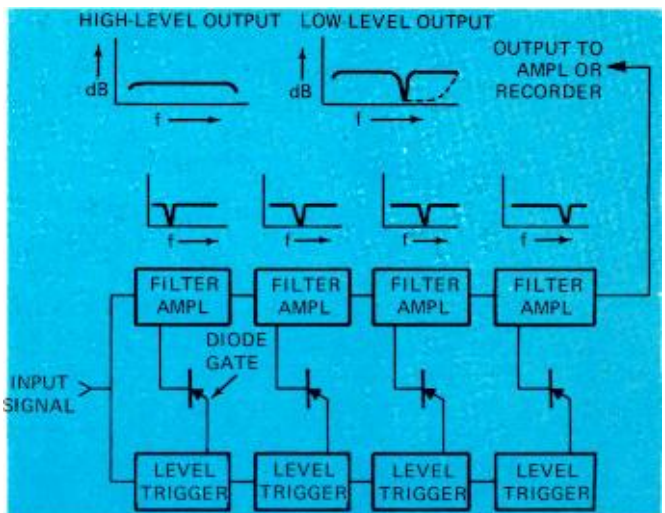
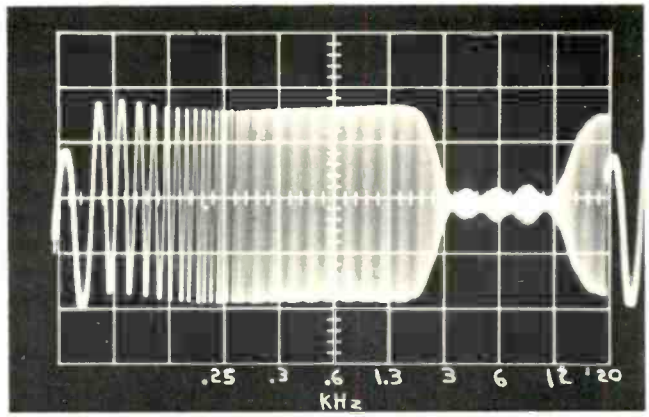


FIG. 2—DE-NOISER BLOCK DIAGRAM shows basics of De-Noiser circuit's operation.

2. In normal operation—when no, or low-level signals are fed to the input—the frequency-sensitive level-triggered amplifiers are ON, the diode switches are ON and each filter is keyed into the circuit. The signal passing through the filter amplifiers is therefore attenuated according to the tuning of each filter. As the signal level increases towards the SRL (reference level) each of the frequency-sensitive level-triggered amplifiers senses the level of only those frequencies within its passband. As the level increases from zero or no-signal towards –38 dB the diode switches gradually reduce the attenuation of their associated filters. For example, if the signal

level is –50 dB the filters produce approximately 15 dB of attenuation. As the signal level increases towards –38 dB the attenuation is gradually reduced so that at a –40 dB signal level there is 2 dB of attenuation. At signal levels greater than –38 dB (for example, –20 dB) the filters are completely switched out and the signal passes through "flat".

Since the De-Noiser is intended for use with any equipment there is really no SRL to which the level-triggered amplifiers can be factory adjusted. Therefore, in such a unit as the Kenwood model KF-8011 De-Noiser there are two VU meters—one for each channel—and an associated gain control. The user simply adjusts the gain control so the signal source peaks at zero VU, thereby automatically calibrating the level-triggered amplifiers. Somewhat unusual, the KF-8011 includes a noise-level gain control that allows the user to cut in the filters at other than –38 dB below reference; the filters can actually be set to cut in between the zero VU reference level and –38 dB. This might be useful when dubbing some really old "collector records" that are more "scratch" than program.

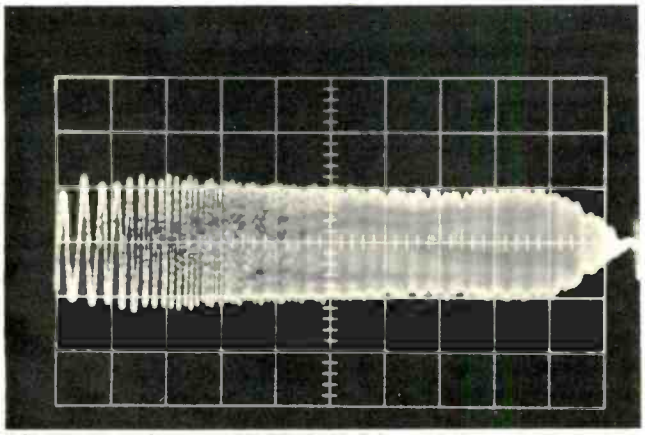


OUTPUT FROM DE-NOISER with all filters active at a record input level of –50 dB.

3. The Dolby

TEAC Model AN-180.

The Dolby A noise reduction system is what really started the whole thing. It all came about when recording engineers got fed up with the fact that a disc was actually more quiet than a tape, and that modern wide-range recordings had a hiss *added* to the noise-free signal source by the tape itself. To overcome the problem of tape hiss, and room rumble at the lower frequencies, Ray Dolby came up with a system that split the sound spectrum into four parts. Low-level signals in each of the four spectrum sections triggered a pre-emphasis equalization and its own pilot signal. The equalization was applied to the signal source before it got to the tape. On tape playback the signal was passed through a Dolby de-emphasis system. At high sound levels the de-emphasis was keyed out and the signals passed through flat. At low signal levels, the pilot signals of those frequencies that had been boosted during recording keyed in their respective frequency-spectrum filters and the resultant output signal was again "flat"; but the filters also attenuated the noise—both tape hiss and room rumble—along with the pre-emphasis.



DOLBYIZED RECORD/PLAY RESPONSE from 20 Hz to 15 kHz for tape recording with a –40 dB record level.

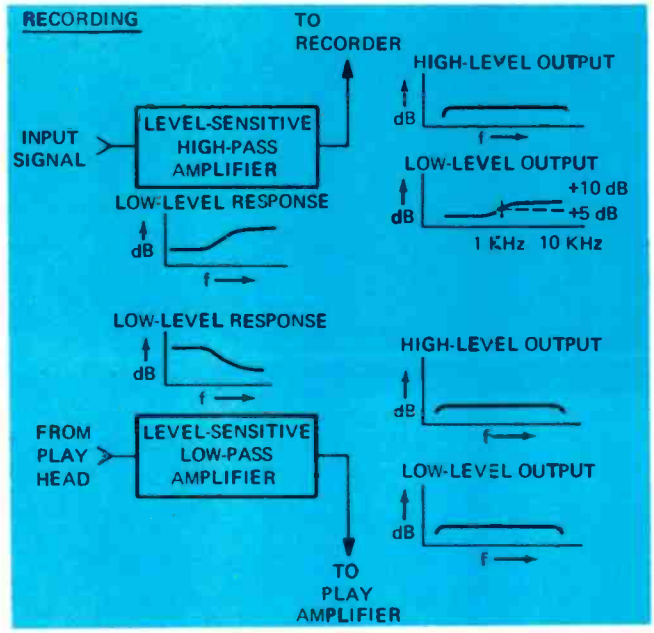


FIG. 3—BLOCK DIAGRAM OF DOLBY B combination record/play equalizer only for the higher frequencies.

The four-part Dolby unit was called the Model A, it was very expensive and unsuited for consumer use. But since the consumer is primarily concerned with tape hiss a simplified version known as the Dolby B was made available.

The Dolby B is a combination record/play equalizer only for the higher frequencies, those above 1 kHz. Figure 3 illustrates how it works.

The input signal is fed to a level-sensitive high-pass amplifier. At high signal levels the amplifier is "flat". At low signal levels the higher frequencies are boosted 5 dB at about 1 kHz, increasing to +10 dB at about 5 kHz and beyond. On playback, the signal from the tape playback head is fed through a level-sensitive low-pass filter. Again, the high signal levels are passed through "flat", but the low signal levels are de-emphasized in exact ratio to the original recording boost so that they too appear "flat" at the output.

Since the low-pass amplifier attenuates the recording boost some 10 dB the noise level (hiss) from the tape is sim-

(continued on page 81)

garage door indicator

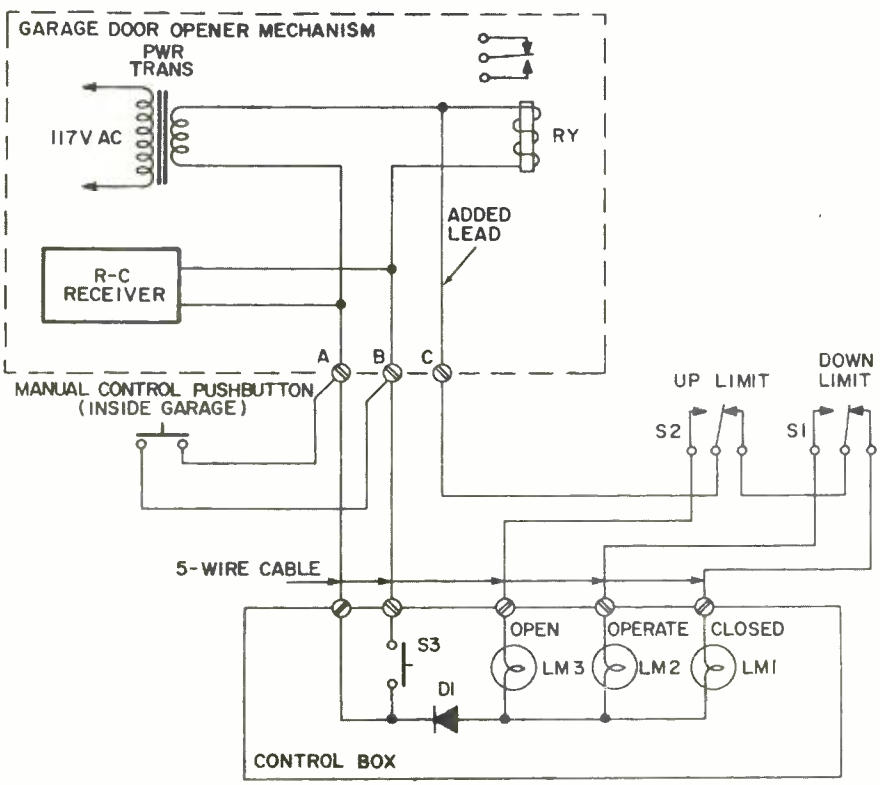
by MARVIN BOOTHROY

Are you among those fortunate ones who own a remote-controlled garage-door opener? Are you also among those whose garage door cannot be seen from inside of the house? Do you occasionally forget whether you left the door open or closed only to find out the next morning that it had been left open all night? If your answer is yes to any one or more of these questions then this article may be for you.

Most garage-door operators have a power transformer that supplies low voltage, usually 12 or 24 volts ac to a relay that is operated by a remotely located pushbutton or radio receiver. This portion of the circuit is outlined (see diagram) in dotted lines. The power transformer can serve very conveniently to supply power to light an indicator lamp. The power drawn by such a lamp is usually in the range of 10 or 20 mA or so and since there will be but one lit at a time, the extra drain on the transformer will be negligible, certainly well within its ratings. The only change necessary in the opener mechanism is to add the lead shown within the dotted line box.

S1 and S2 are snap-action switches located adjacent to the opener mechanism's track, S1 being located near the down-end of the track and S2 being located near the up-limit end. These switches are so mounted that a mechanical trip-arm assembly on the door-opener trolley operates them when the door approaches the last fraction of an inch of its travel in either direction. Mechanical details are not given nor suggested since no two garage door opener installations are the same. This must of course be left up to your ingenuity.

The circuit functions as follows: current flows from the transformer via lead C through S2, through S1, and to LM1 lighting it and indicating a closed door condition, thence through D1, and returns to the transformer via lead A. When either pushbutton switch is momentarily operated or the radio receiver functions on a signal from its companion transmitter, the opener mechanism starts to operate and moves the door from a closed position to an open position. As the trolley leaves its closed position, S1 will be released; turning off LM1 and turning on OPERATE lamp LM2; indicating that the door is in an intermediate position. The remainder of the current pathway will be the same as for the closed door indication. When the trolley arrives at the limit of its travel in an open condition, it will cause S2 to operate. This extinguishes LM2 and lights LM3, indicating an open door. It will remain in this condition as long as the door remains open. When the mechanism is again used to close the door, the entire action will be reversed.



The door can be opened or closed from inside the house by pressing S3.

The diode reduces the total power dissipated by the lamps by blocking half-cycles of the alternating current power. Polarity is not important. If lamp sockets with plastic lens cap assemblies are used, the small amount of heat generated by the light will accumulate to the extent that the caps will become softened and severely distorted in shape. The diode, by blocking half-cycles reduces the total power dissipation and heat without noticeably reducing the level of illumination. The type of diode is not specified, as any junk box or bargain pack variety that will carry the current will do.

Any size of hook-up wire or five-conductor cable of length to suit and of gauge 18 thru 24 will be adequate. Ordinary door-bell wire would work well in this application. If of different colors, this would assist in lead identification. A 2½" x 2½" x 4" box is large enough to house the three lamps and S3. Its location inside the house should be chosen with a view toward ease of installation and convenience. S3 may be any suitable single-contact, spring-return switch or pushbutton.

If the garage door is not equipped with an opener mechanism but the indicator is still desired, a separate power source could be provided, and the circuit will still be useful. This could be a suitably fused transformer located close to or in the control box. How about borrowing power from the doorbell transformer? This usually has an 18-volt output, or the furnace/air conditioner thermostat control system, which usually has a 24-volt output and the drain on either system would be negligible. In any case the low-voltage secondary would be connected to leads A and B and the S1 and S2 mountings would need to be undertaken from a different standpoint.

Even though this circuit may present a few problems, such as location of the control box, fishing wires or a cable through walls and mounting of S1 and S2 and trip arm assemblies to operate same, nevertheless it is a useful home accessory. No doubt the serious electronics experimenter may be able to adapt it to other uses besides indicating the position of a garage door. It can be very useful in the steps that it saves by being able to close the garage door from inside the house. Also one of the lamps, being lit constantly serves as a reminder of an unlocked and open door household. R-E

4-channel record review

There are many 4-channel records available now. Here's how we rate the 4-channel effectiveness of these discs

by RADIO-ELECTRONICS EDITORIAL STAFF

IN THE PAST FEW MONTHS THE EDITORS of **Radio-Electronics** have been testing 4-channel matrix recordings and equipment extensively. We have set up a scoring system to evaluate our impression of the effectiveness of these records.

The scoring runs from one to four stars. One star is the lowest and four stars are highest on our scoring system. Note well that we are only evaluating the records from the standpoint of 4-channel technical effectiveness. The ratings shown here have nothing to do with performance or artistic merit.

The equipment

The mechanical and electronic chain of equipment used for playing the records includes the following: Shure V15, Mark II improved cartridge; Shure-SME arm; Thorens TD 124 turntable; Dynaco PAT-4 preamp and Dynaco Stereo 120 amplifiers; a pair of AR-3A speakers for the front channels and a pair of Dynaco A-25 speakers for the rear channels.

A second equipment setup consists of a Shure M91ED cartridge; a Garrard SL95B changer; a Scott model 499 Stereomaster Quadrent stereo amplifier and four Dynaco A-25 speakers.

Three different SQ decoders were used at various times during our tests: Lafayette SQM, Lafayette SQL and Sony SQD-1000. Both the Sony and the Lafayette SQL include special logic circuits to improve the front-to-rear separations.

We noted little difference in performance in these two units on the records we tested. The Lafayette SQM is a less costly unit that does not include the extra logic circuits. This unit's front-to-back separation was greatly reduced since the SQ system by itself only provides a front-to-rear separation of 3 dB.

Three other matrix decoders were also used, the Electro-Voice Stereo 4, Sanyo DCA1500X and Toyo QC-1.

The new Electro-Voice EVX-44 universal decoder that also includes special logic circuits was not received in time for testing.

4-channel recording philosophies

Four-channel recording techniques follow two basic philosophies. For pop music anything goes. Individual voices or instruments come at you from all directions. In classical music and original-cast recordings of musical shows the recording engineers and producers strive to create an illusion that you are seated in the theatre or concert hall. The rear speakers provide ambiance which is primarily reflected sound from the rear and side walls of the hall. Some of the most effective examples of this technique are to be heard in selections which include choral groups with orchestra.

Here's a short list of interesting matrixed 4-channel discs. Most of the records use the SQ encoding system. A a few use the Sansui and the original Electro-Voice encoding. In our reviews, the method of encoding will be understood to be SQ unless otherwise noted for particular records.

VANGUARD

VSQ1—Demonstration Record—mixture of pop and classical excerpts ***

VSQ2X—Demonstration Record—mixture of pop and classical excerpts ***

VSQ3X—Demonstration Record—mixture of pop and classical excerps. The most effective is the Bach Organ Recital ****

VSQ4X—Demonstration Record—Aquarius—a selection of pop tunes beautifully recorded ****

VSQ30001—Tchaikowsky Symphony No. 4—Stokowski, American Symphony Orchestra ****

VSQ3002—Handel: Highlights Messiah—English Chamber Orchestra, Chorus and Soloists****

VSQ30006-7—Berlioz: Requiem—Recorded in Mormon Tabernacle, Utah Symphony Orchestra ****

COLUMBIA

MQ30056—Tchaikowsky—Swan Lake Ballet, Bernstein and New York Philharmonic ****

CQ30378—Stony End, Barbra Streisand **

SQ30563—No No Nannette—Original Cast Recording **

CQ30595—Santana ***

CQ30737—I Think We're All Bozos On This Bus, The Fireside Theatre **

CQ30792—Barbra Joan Streisand ***

GQ30979—Johnny Mathis In Person ***

SQ30992—Funny Girl—Original Cast Sound Track, Barbra Streisand **

SQ30993—Company—Original Cast Recording **

MQ31008—Leonard Bernstein—Mass****

MQ31018—Switched-On Bach, Walter Carlos—Electronic Music ****

MQ31019—Morton Subotnick: Touch—Electronic Music ****

MQ31076—Stravinsky: Petrushka—Pierre Boulez & N. Y. Philharmonic ***

CQ31105—Summer Of '42, Peter Nero ***

COMMAND

CQD40000—Persuasive Percussion—Sansui encoding****

CQD40001—Guitar . . . . . Paris—Tony Mottola—Sansui encoding ***

CQD40002—Enoch Light And New Concept of Cole Porter Hits—Sansui encoding **

CQD40003—Doc Severinsen and Orchestra—Fever!—Sansui encoding ***

CQD40004—Count Basie and his Orchestra—Broadway, Basie's Way—Sansui encoding **

AUDIO SPECTRUM

QS1—Soul of Spain, Vol. III—101 Strings *

QS3—Multiple Guitars of Les Thatcher—Old E-V encoding *

QS4—Today's Hits—Jack Dorsey and The 101 Strings **

That's our list, complete as of now. As we receive and listen to more new 4-channel records, we'll report on them too. We think you'll find this report useful and would appreciate comments. **R-E**

step-by-step TV TROUBLE

The automatic fine tuning in any a few very simple components

ONE OF THE MAJOR PROBLEMS WITH color TV is that the set owner finds it hard to tune in a good color picture. And if he does get a satisfactory picture, minute changes of capacitance and inductance in the tuner—due to heat—can detune it again.

One of the ways the color picture is locked into place is with a form of automatic fine tuning (AFT).

The locking features are centered around the ability of a variable capacitance diode to control the frequency of the local oscillator in the tuner. Two separate diodes are needed, one each for the vhf and uhf tuners.

The diodes get a control voltage from the discriminator-dc amplifier circuit. The discriminator circuit is tuned to the video intermediate frequency, 45.75 MHz. A transistor amplifier takes a sampling of 45.75 MHz from the collector of the third i.f. amplifier and feeds it to the discriminator. As long as the discriminator circuit receives the exact 45.75 MHz frequency the discriminator output is zero volts. (Fig. 1, center).

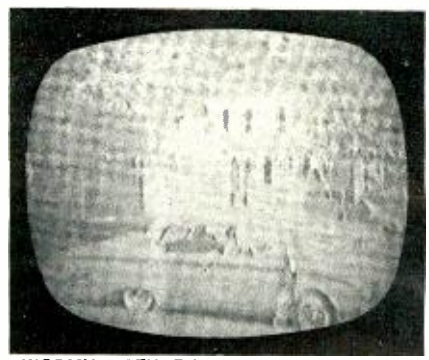
If the video i.f. signal drifts higher in frequency the discriminator-dc amplifier output voltage goes negative (Fig. 1, left). Should the signal drift lower in frequency the would go positive (Fig. 1, right). The output voltage is dc and is the control voltage for the Varicap diode. The 45.75 MHz pickoff amplifier and the discriminator circuit terminating in a dc amplifier is a part of this automatic fine tuning circuitry. This month we'll discuss the Varicap diode OSCILLATOR CONTROL CIRCUIT.

A Varicap diode can be an ordinary diode. In the circuit it is a Varicap diode *only* when it is reverse-biased. The p-n junction acts as the dielectric of a capacitor. As the dc bias is varied the effective capacitance of the diode changes. The capacitance can be varied over better than a 10 to 1 range by varying the bias about 100 volts.

The oscillator control circuit is mounted right inside the tuner and across the oscillator coil. It is the capacitance in the oscillator tank circuit. The dc control voltage from the discriminator output is fed through a 100-pF feedthrough capacitor in the tuner chassis, through a 33,000-ohm isolation resistor to the cathode of the Varicap (Fig. 2). Another 33,000-ohm resistor from the anode of the Varicap to ground is the dc return.

The Varicap has a steady positive bias of about 2.5 volts on the cathode. The 2.5 volts of reverse bias creates a small predetermined capacitance across the Varicap.

The capacitance is coupled into the local oscillator coil through two 5-pF capacitors, one from the anode and the other from the cathode. These two ca-



WORMY PICTURE is caused by aft failure.

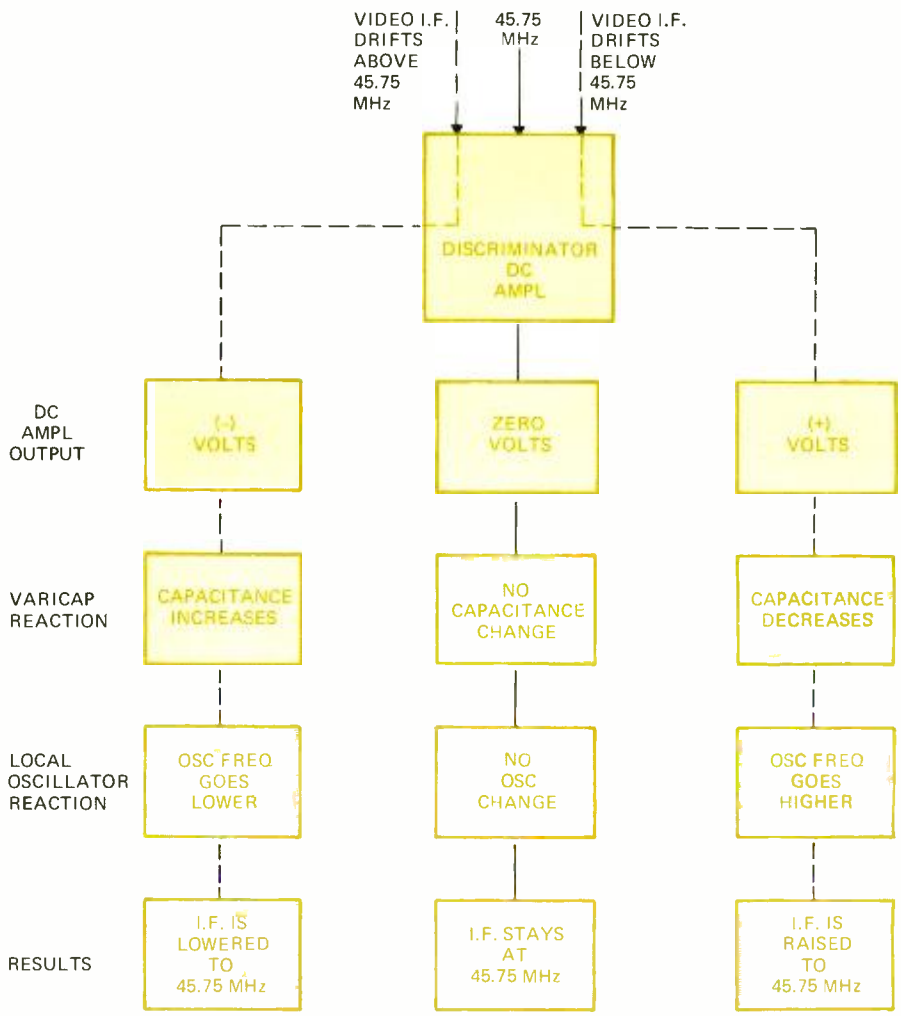


FIG. 1—AUTOMATIC FINE TUNING is based on the principles of all afc devices. A sample of the i.f. is applied to a discriminator tuned sharply to 45.75 MHz. If the signal drifts above that frequency the output will become negative; if it drifts below—positive.

SHOOTER'S GUIDE

television receiver depends upon and a very basic circuit

by ART MARGOLIS

pacitors block the dc and—since they are tiny and in series with the Varicap—limit the total capacitance that can be put into the oscillator tank.

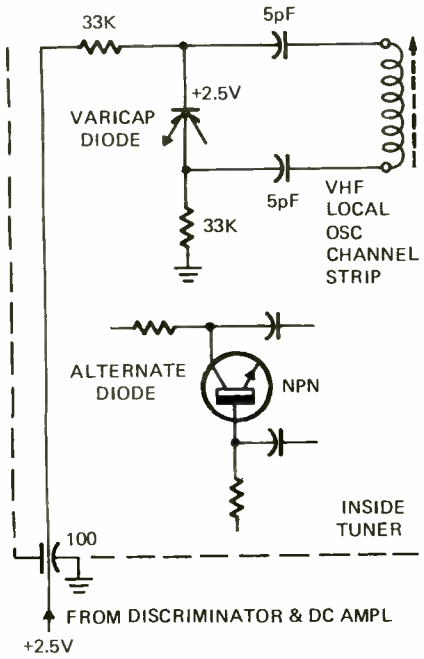


FIG. 2—HEART OF THE AFT CIRCUIT is a reversed-bias variable-capacitance diode.

As the video i.f. signal goes higher (left side of Fig. 2) the negative-going voltage applied to the diode decreases the reverse bias and raises the effective capacitance. More capacitance in the tank circuit causes the oscillator frequency to go lower, returning the video i.f. to 45.75 MHz.

As the signal drifts lower (right side of Fig. 2) the discriminator-amplifier output goes positive, increasing the reverse bias, which decreases the amount of Varicap capacitance. The lowered capacitance causes the oscillator to run at a higher frequency which makes the video i.f. become 45.75 MHz once again.

The actual dc voltage change can vary about plus or minus 4 volts.

Oscillator control trouble-shooting

The vhf oscillator control circuit area includes the Varicap and all its immediate circuit components. Also a check has to be made in the local oscillator and the discriminator-dc amplifier output.

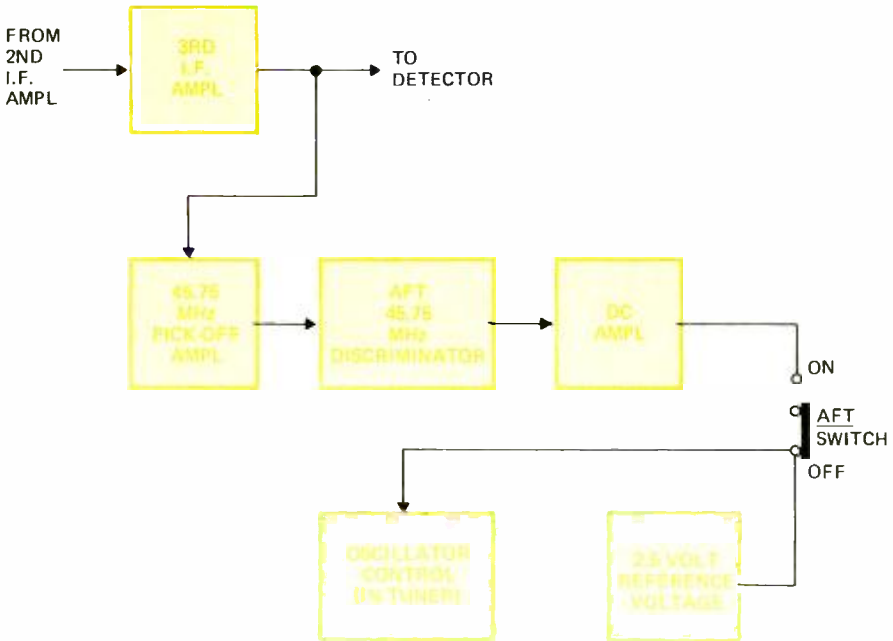


FIG. 3—AFT SWITCH splits the circuit into two, making it easier to check either one.

The oscillator control circuit becomes a suspect when the vhf is suddenly way off channel, becomes difficult or impossible to fine tune, or if the fine tuning drifts and loses color.

A test must be made to determine if the Varicap circuit is defective, or if the discriminator-dc amplifier circuit is sending in the wrong dc voltage to its cathode.

The test is simple. Defeat the aft by turning the AFT switch off (Fig. 3). One of two things will happen.

One, the fine tuner, if adjusted manually, works properly. That means the Varicap circuit is operating normally with the local oscillator. The discriminator-dc amplifier circuitry is the cause of the trouble.

Two, the fine tuner if adjusted manually still does not operate properly. Then the Varicap circuit is the seat of the trouble.

When you turned the AFT switch off, you disconnected the discriminator-dc amplifier circuit and switched in a steady dc 2.5-volt bias from a power supply. If it stabilized the circuit the Varicap area is good. If it still didn't, the Varicap area has trouble.

To test the components statically one by one, disconnect the aft lead from the main chassis, which isolates the varicap circuit from the discriminator-dc amplifier and the power supply.

Then test the components individually. The Varicap diode is tested as an ordinary diode, either in or out of circuit, with an ohmmeter or diode-transistor tester. The two resistors can be measured in circuit since there is nothing in shunt with them. With the local oscillator strip coil removed (if there is a strip) both 5-pF capacitors can be measured in circuit, since with the tuner lead disconnected there is nothing in shunt with them either. The feed-through capacitor is also measured directly.

The Varicap diode can also be in the form of an n-p-n transistor with the emitter disconnected. That way the p-n junction between the base and the collector places a diode in the circuit with the correct polarity. **R-E**

the state of SOLID STATE

IC timing circuit, spike-supressing varistors and a variety of new solid-state devices make for fascinating reading

by LOU GARNER
SEMICONDUCTOR EDITOR

TIME (ING) ON YOUR HANDS? NO PROBlem! Just use either of two new devices recently introduced by the Signetics Corporation (811 East Arques Ave., Sunnyvale, CA 94086) or Integrated System, Inc. (733 North Pastoria Ave., Sunnyvale, CA 94086). Both devices are monolithic IC's with timing ranges of from 1 microsecond to 1 hour (or more). Both may be used for precision timing, time-delay generation, pulse generation or shaping, sequential timing, sweep generation, pulse width or position modulation, or missing-pulse detection. Both are relatively inexpensive and easy to use, requiring a minimum of external components. And both offer timing accuracies on the order of 0.5%.

The Signetics device, Model SE/NE 555, is available in two versions and is offered in either an 8-pin "TO" style metal case or an 8-pin dual-inline "V" type plastic package (Fig. 1). The "SE" and "NE" versions are similar except for maximum temperature ratings, with the former, more expensive version, having an operating temperature range of from -55°C to 125°C, while the "NE" unit's range is from 0°C to 75°C. Both types have a maximum rating of 18 volts and can handle power dissipations of up to 600 mW.

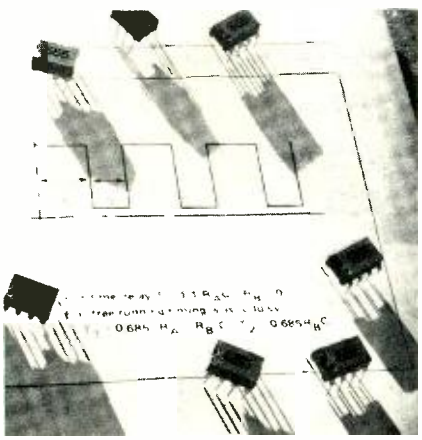


FIG. 1—SIGNETICS' SE/NE 555 IC timer

Comprising 23 transistors, 2 diodes and 16 resistors, the SE/NE 555 has built-in compensation for component tolerances and temperature drift, resulting in a temperature coefficient of only 25 parts per million per degree Centigrade. Internally, the device consists of two comparators, two control transistors, a flip-flop and a buffered output stage, as illustrated in Fig. 2. Only a single external resistor and a capacitor are required to establish the unit's basic timing period.

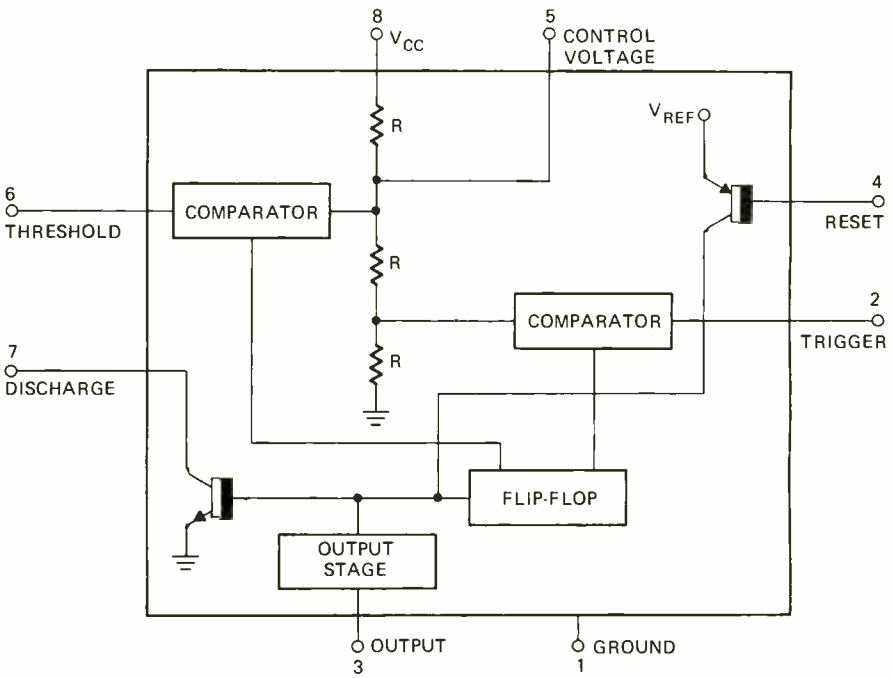


FIG. 2—SE/NE 555 BLOCK DIAGRAM shows what's inside the IC.

In operation, an external capacitor connected between pin 7 and circuit ground is held discharged by the transistor inside the device. When a triggering signal is applied to pin 2, the flip-flop shifts its state, removing the transistor's base bias and thus releasing the short circuit across the capacitor; simultaneously, the output level moves towards the supply voltage's value. Charging through a series resistor, the capacitor's voltage increases exponentially with a time constant proportional to the R and C values. A high-impedance comparator is referenced to two-thirds the supply voltage by means of three equal resistors, with its output coupled to the flip-flop. When the capacitor's voltage reaches the reference level, the flip-flop is reset, discharging

the capacitor and shifting the output level towards ground. The circuit remains in this state until retriggered.

Typical basic circuits for the SE/NE 555 are illustrated in Fig. 3—a

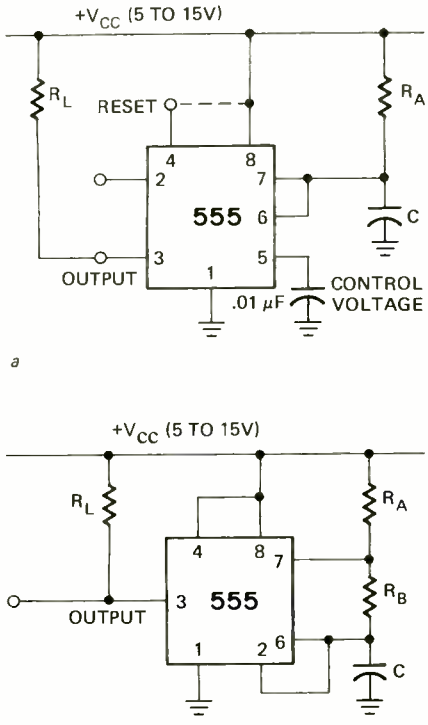


FIG. 3—MONOSTABLE (a) AND ASTABLE (b) circuits using the SE/NE 555.

mono-stable (one-shot) timer at (a) and an astable (multivibrator) design at (b). In either, the supply voltage may be from 5 to 15 volts dc and the normally "on" load (R_L) virtually any component requiring up to 200 mA, such as a resistor, lamp, LED, relay, or even the control element of another active device, such as an SCR or TTL gate. If desired, a second normally "off" load may be connected between output terminal 3 and ground.

Referring, first, to Fig. 3-a, capacitor C initially is held in a discharged state, as we have seen; output pin 3 is essentially at ground potential. When a negative trigger pulse is applied to pin 2 equal to at least ⅓ the supply voltage, C starts charging through series resistor R_A and the level at output pin 3 approaches the supply voltage. When C's voltage is ⅔ the supply voltage, the internal flip-flop resets, discharging C and restoring the circuit to its original mode.

Once triggered, the circuit remains in its second state until its timing period has elapsed, as established by its RC time constant, even if triggered again during this interval. It may be reset, however, by applying a negative pulse to reset pin 4.

In practice, the timing period is determined by $t = 1.1\ R_AC$, where t is in seconds, R_A in megohms, and C in μF. If the reset feature is not to be used, pin 4 is connected to the supply voltage source, as shown by the dotted line, to avoid the possibility of false triggering.

With the circuit arrangement shown in Fig. 3-b, the timer will retrigger itself, thus behaving as a free-running multivibrator. In operation, external capacitor C charges through R_A and R_B and discharges through B_B only, permitting the circuit's duty cycle to be set precisely by the ratio of these two resistors. A rectangular pulse-like signal is developed at output terminal 3 and a modified sawtooth across the capacitor. The circuit's frequency of oscillation can be determined by the equation:

$$f = \frac{1.46}{(R_A + 2R_B)\ C}$$

The astable circuit can be used for pulse or sweep signal generation and in such projects as repetitive timers, simple metronomes or light flashers. With suitable component values, the circuit can be set to oscillate at any frequency between 1.0 MHz and 3.6 mHz (i.e., *one pulse per hour).*

Similar in application to the SE/NE 555, Exar's IC timer comprises an internal bias reference, a precision current source, a voltage comparator, a flip-flop, a timing switch, and a pair of output logic drivers, as illustrated in Fig. 4. Three versions are offered by the manufacturer, the XR-220, XR-220M and XR-320. The XR-220 and XR-220M are similar except for their maximum temperature ratings, the former having a specified range of from 0°C to 75°C, the latter, a more expensive device, from -55°C to 125°C. The XR-320 is basically identical to the XR-220, but with relaxed performance tolerances. Furnished in 14-pin ceramic DIP's, all three devices have maximum ratings of 20 volts, maximum drive capabilities of 100 mA, and can handle power dissipations of up to 750 mH.

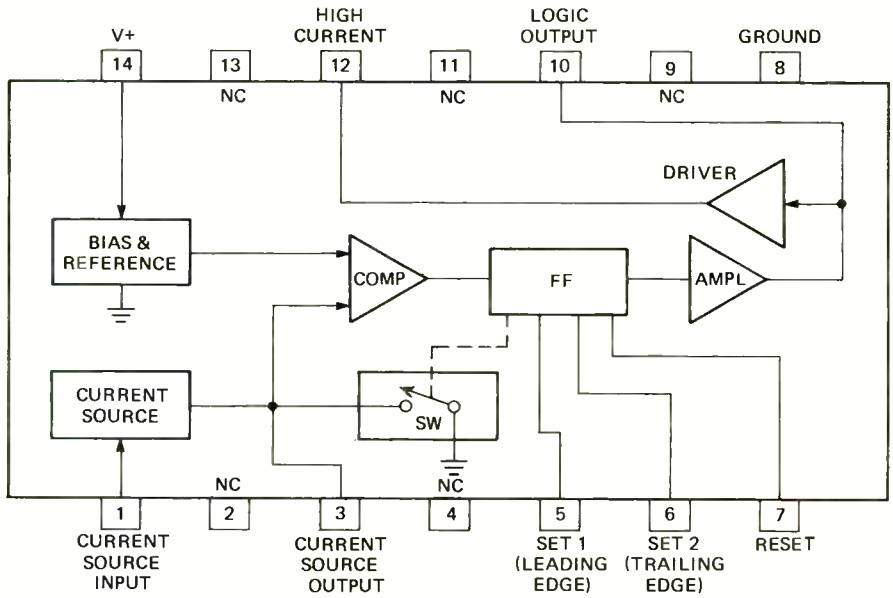


FIG. 4—EXAR INTEGRATED SYSTEMS' XR-220 IC timer functional block diagram.

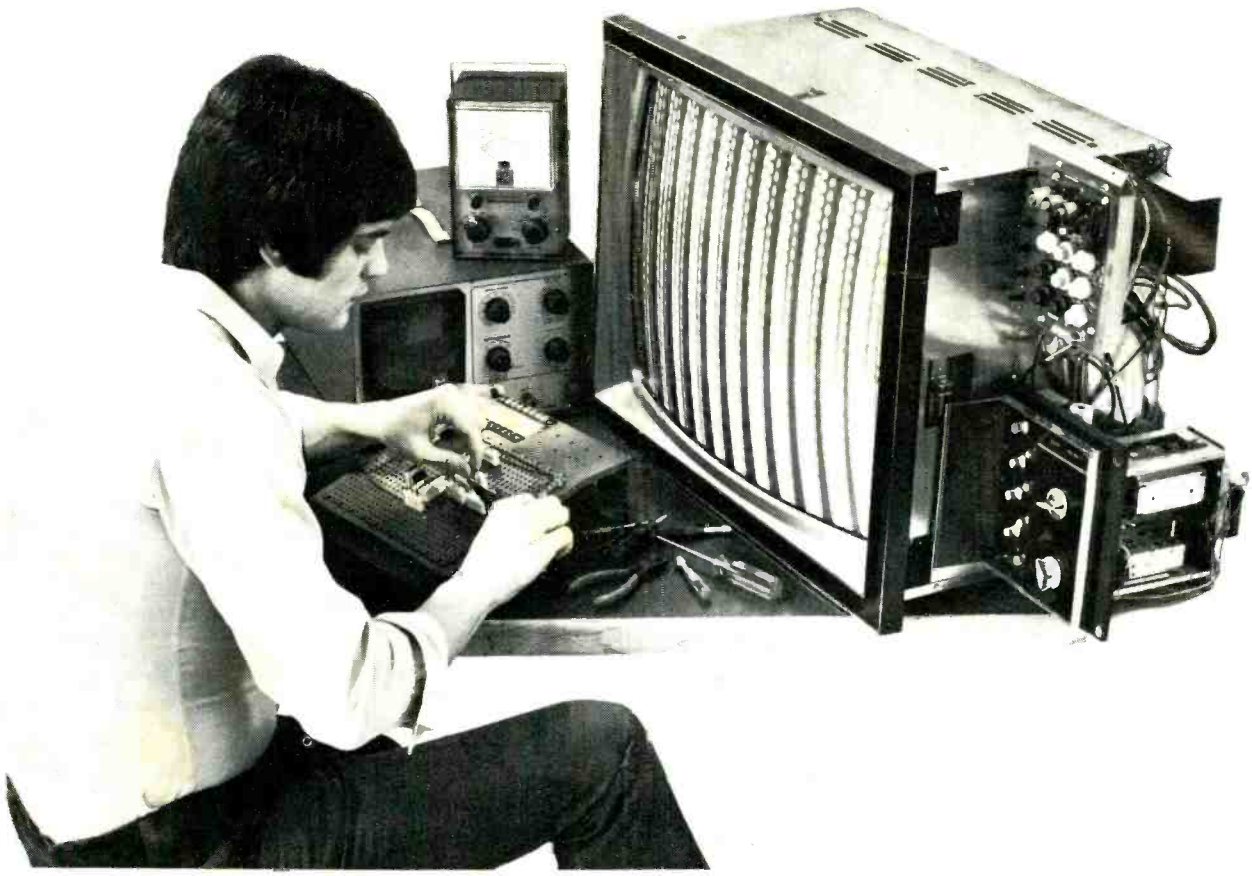
Suppress those spikes!

Although quite rugged physically, most semiconductor devices are notoriously intolerant of excessively high voltages. Transistors, Triacs, SCR's, IC's, or even heavy-duty rectifiers may be completely destroyed by voltages which exceed their absolute maximum ratings, even if only for a few microseconds. Unfortunately, momentary bursts of high voltage, commonly called *transients* or *spikes,* can be introduced into electronic equipment by a variety of causes, ranging from lightning and line faults to the simple act of switching the equipment "on" or "off." In fact, the most common transients are those caused by transformer switching, where the primary is energized or de-energized, and by load switching. Some of the voltage transients developed by transformer switching can range up to ten or more times the normal peak line-to-line voltage.

While several techniques may be used to suppress potential component-damaging spikes, one of the least expensive and most reliable, according to GE's Semiconductor Products Department (Electronics Park, Syracuse, NY 13201), is the use of their new GE-MOV varistors. These are metal oxide semiconductor, voltage-dependent, symmetrical resistors which perform similarly to back-to-back Zener diodes. When exposed to high energy voltage transients, the varistor impedance changes from a very high level to a quite low conducting value, thus clamping the voltage to a safe level and absorbing the energy of the transient.

About the size and shape of familiar ceramic disc capacitors, GE's type VP varistors are available with voltage ratings from 130 to 1000 volts rms. They can handle peak discharge currents in excess of 1000 amperes in narrow pulses.

(continued on page 68)



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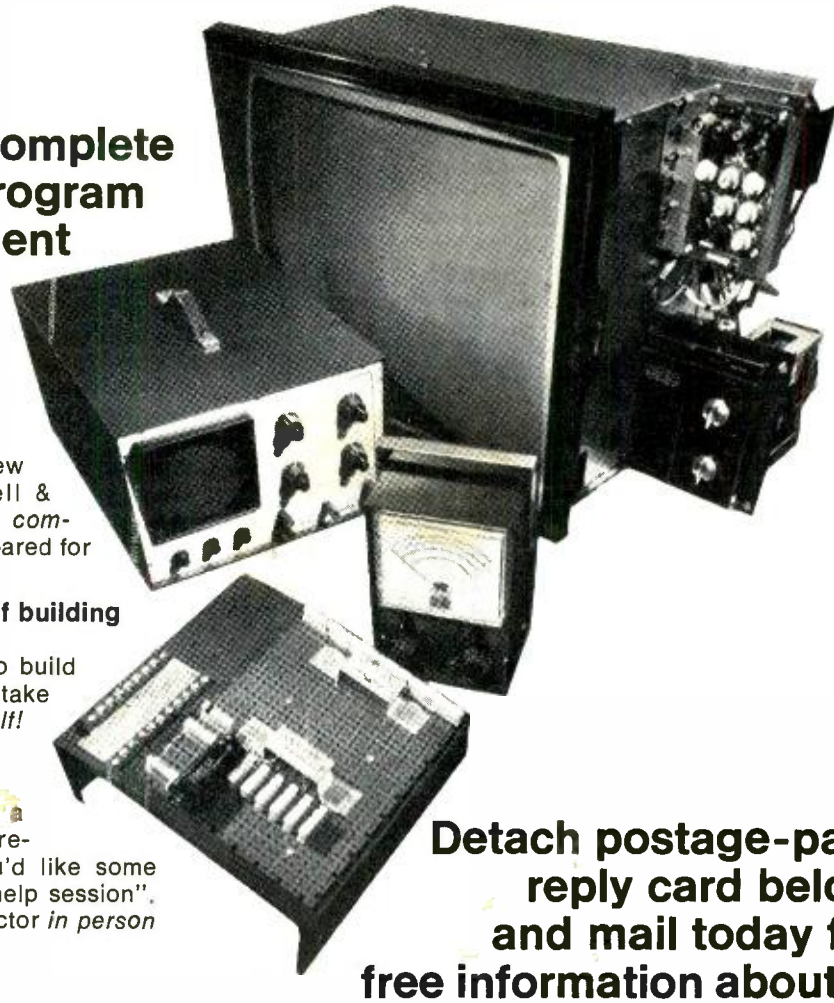

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Device/product news

A new npn phototransistor (Fig. 6) has been introduced by Texas Instruments, Inc. (P.O. Box 5012, M/S 308, Dallas, TX 75222). Designated the TIL81, the device is spectrally and mechanically matched with the TIL31 infrared light-emitting diode, permitting the two devices to be used together as a sensor and emitter pair. With a collector-emitter voltage of 5 volts, the TIL81 delivers a typical light current of 28 mA. Featuring an externally connected base lead which permits conventional transistor biasing, the unit can operate either as a phototransistor furnishing current gain or as a photodiode for fast switching; rise time is typically

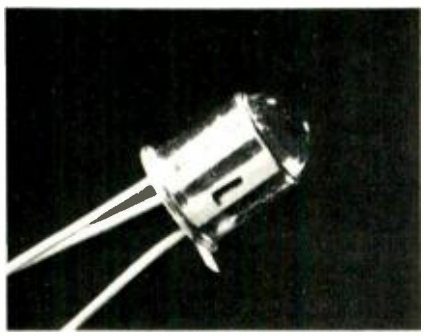

FIG. 6—TEXAS INSTRUMENTS' NEW TIL81 Phototransistor.

350ns. The device is encapsulated in a hermetically sealed TO-18 style case with a glass window.

The KMC Semiconductor Corporation (Parker Road, Long Valley, NJ 07853) is now producing what is claimed to be the world's highest performance vhf/uhf transistor, the K6001. With a noise figure of only 1 dB, the new device can furnish 20 dB gain and has a F_t of 1800 MHz. It is supplied in a standard TO-72 package. Collector-base breakdown is rated at 30 volts minimum, while the K6001's specified power dissipation is 150 mW.

In a surprising move, the Signetics Corporation has announced its first production of discrete devices, a pair of uhf field-effect transistors; previously, the firm produced IC's exclusively. The two FET's in current production are the SD200, a single-gate transistor, and the SD300, a dual-gate version. Both are manufactured using Signetics' exclusive "D-MOST" process ("Double-diffused Metal-Oxide Semiconductor Technology"). The two devices are offered in standard 4-lead "TO-46" packages and have an operational ambient temperature range of from -65°C to 125°C.

Suitable for critical amplifier applications, the SD200 has a typical noise figure of 5.0 dB at 1 GHz and a typical feedback capacitance of 0.13 pF. With a very high input resistance of approximately 10^{14} ohms and a typical forward transconductance of 15,000 μmhos, the device can supply an average gain of 10 dB at 1 GHz. Its drain-to-source voltage rating is 30 volts.

An N-channel type, the dual-gate SD300 is capable of linear mixing and reverse agc. Special diffused diodes are connected between the two gates and the source to protect the device against voltage transients. With a feedback capacitance of only 0.02 pF (typ.) and a noise figure of only 8 dB at 1 GHz, the unit has an average forward transconductance of 10,000 μmhos. It has a typical gain figure of 13 dB at 1 GHz.

More news from the West coast . . . Siliconix, Inc. (2201 Laurelwood Road, Santa Clara, CA 95054) has introduced several new monolithic IC's, including the DA110 series of digital/analog converters and the L 144 family of low-power-operational amplifier arrays (Fig. 7). With accuracies of

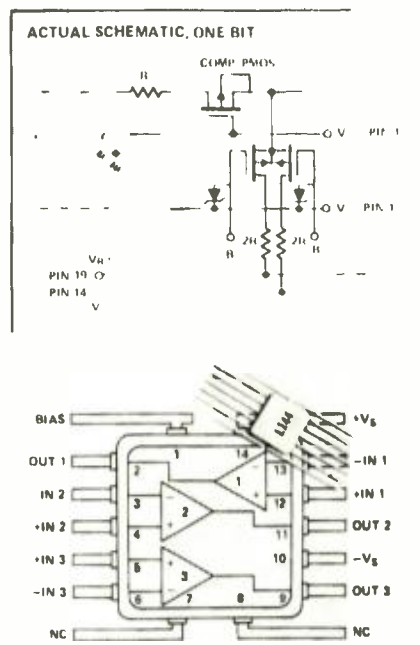

FIG. 7—NEW IC's RECENTLY INTRODUCED by Siliconix: a—DA110 digital/analog converter; b—144 triple operational amplifier.

down to ±¼ bit over the -55°C to 125°C temperature range, the DA110 series of devices employ R-2R ladder networks of diffused resistors, plus passive PMOS switches, and are furnished in standard 28-pin DIP's. Available in both TO-86 flatpacks and TO-116 14-lead DIP's, the L 144 devices are triple op amps on single chips. Capable of operation on a 1.5-volt battery, the devices are unity-gain stable and can supply 80 dB gain under a 20,000-ohm load.

A new series of high performance silicon thyristors has been announced by the Amperex Electronic Corporation (Slatersville, RI 02876). One of the new devices, the BTW23, handles currents as high as 70 amperes at 85°C and can withstand repetitive peak potentials as high as 1600 volts. Partially illustrated in Fig. 8, the new line includes low-

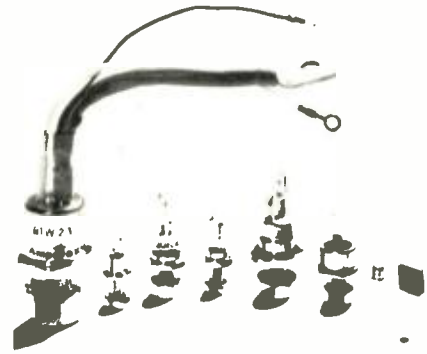

FIG. 8—AMPEREX'S NEW LINE of thyristors.

cost metal and plastic thyristors, general purpose stud-mounted devices, fast turn-off thyristors for inverter applications up to 25 kHz, special purpose devices, and a number of Triacs, from plastic types rated at 6 amperes, 400 volts, to stud-mounted units rated at 50 amperes, 1600 volts.

Motorola Semiconductor Products, Inc. (P.O. Box 20912, Phoenix, AZ 85036) has introduced two new CMOS logic up-counters, the MC14518 and MC14520 (Fig. 9), for counting appli-

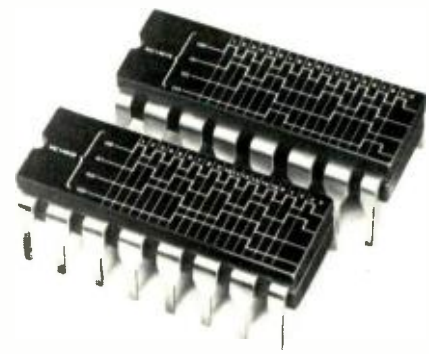

FIG. 9—MOTOROLA'S NEW MC14518 and MC 14520 CMOS IC up-counters.

cations at rates up to 6 MHz. The MC14518 provides a dual, BCD up-counting function, while the MC14520 offers a dual, binary up-counting capability. Both consist of two identical, independent 4-stage counters, and both feature an internal synchronous counting design that reduces propagation delay. Essentially type-D flip-flops with separate and interchangeable clock and enable lines, the up-counters can be incremented on either positive- or negative-going clock signal transitions. Both devices are available in two versions, AL or CL. The AL designated devices can operate from a 3 to 18 volt dc supply over the temperature range of -55°C to 125°C, while the lower cost CL units are designed to operate on 3 to 16 volt dc sources within -40°C to 85°C temperatures.

That concludes our solid-state story for October. Until "turkey" month, keep cool (or warm, depending on your location) . . . **R-E**

R-E's Service Clinic

TV booster testing—the easy way

Weak-signal complaints may be due to a bad booster. Here's how to check 'em.

by JACK DARR
SERVICE EDITOR

THERE ARE A LOT OF TV "BOOSTERS" around; mostly transistor types by now, I suppose, although there are still some tube-types in use. Most are used in fringe areas, but you'll even find them in suburban areas. At any rate, there are enough to make servicing them worthwhile, if we can find a fast and easy way to check them.

This we can do, using only two pieces of test equipment that should be found in all shops; the color-bar generator and a scope, with a crystal-detector probe.

You do *not* have to take the booster apart to check it. All you need is the booster and its power supply. Connect them together with about 3 feet of 300-ohm twin-lead or coax. Now, plug it in.

Hook the rf output of the bar-dot generator, set for a color-bar pattern, to the antenna or input terminals of the booster. Connect the scope detector probe across this, as in Fig. 1. Turn the

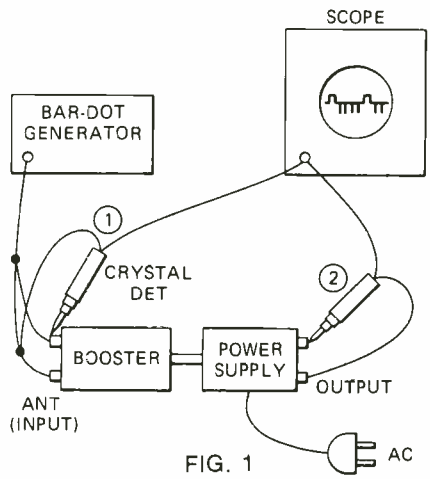

FIG. 1

bar-dot rf gain control full on, and turn the scope's vertical gain to maximum (you won't have much signal to work with here). Set the scope's horizontal sweep to display about 2 lines of video.

You may not get much deflection on this test; the signal is at a pretty low level. However, if you get even a slight "thickening" of the scope trace, fine. Turn the bar-dot's rf gain control up and down, and see. Now move the scope probe to the power supply output terminals; where the lead goes to the TV set. If the booster is working, you should now be able to see a fairly good sized display. In an actual check of a small 2-transistor unit, I got what looked like 0.1 cm at the input, and 0.8 cm at the output. Of course, you do not move either the bar-dot's rf gain control or the scope's vertical gain control, after getting the input reading.

From these readings, you can make a very accurate estimate of the amplifier's signal voltage gain. Remember this will be in dB, and it will be voltage, since that's what we want to amplify. The reading on the scope can be in inches, cm, or even in number of lines on the graticule; we couldn't care less. All we want is two figures. The input and output.

The chart of Fig. 2 will help. In my test, I got about a 1:8 *ratio*, which comes out at about 17 dB. (which is pretty good for a little rascal like this one.) The same method will work with the higher-gain amplifiers, such as MATV line-amplifiers, and so on. Your readings will be higher, but that's the only difference.

As I said, this is a rough test, but good enough. For example, if the spec's on the booster I had showed a gain of either 15 or 20 dB, I would have been well inside the ball-park.

This test is also useful for trying out amplifiers, after a bad transistor has been replaced. If you can get a gain anywhere near the original figures, fine. To check for bandpass, tune the bar-dot generator from one end of its coverage to the other; this is assuming that you have a variable-tuned bar-dot, such as Heathkit IG-28. Same check could be made with a tunable rf signal generator; use 400-Hz amplitude modulation, and tune it across the low and high TV bands. Marker generator is good for this.

If you have input but no output, the booster is completely dead. The first thing to check is the dc power supply. The typical booster power supply feeds a low ac voltage up the leadin. (16-24 volts, etc.) At the amplifier, this is rectified and used for the dc supply. Transistor boosters use only a few mA; tube-types must provide for the heater volt-

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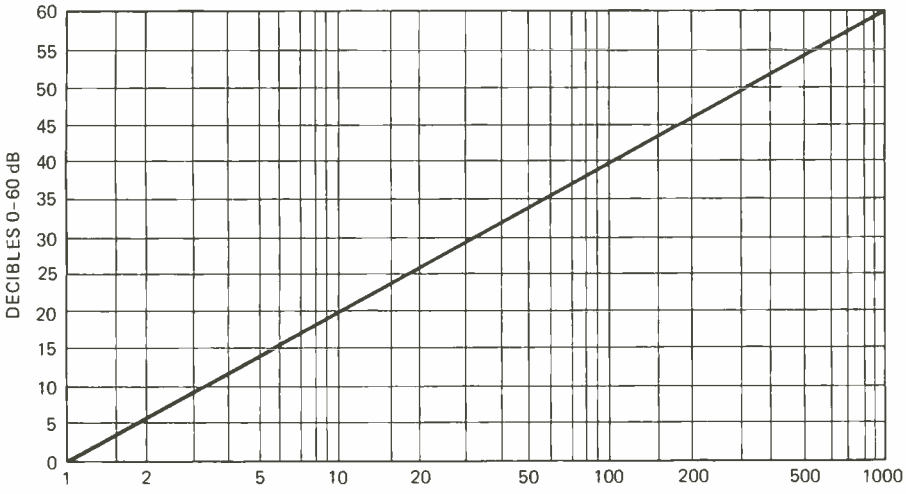


FIG. 2

age, and the current will be greater. Fig. 3 shows a typical supply. The TV signal is fed into, and taken off the leadin through rf chokes, little coupling capacitors, etc.

Check the ac output of the power supply first. If the booster was hit by lightning, the fuse may be blown. Some of these don't have fuses, although all of them *should.* If the ac voltage is OK, check the dc voltage, on the output of the diode in the amplifier chassis. If it is OK, check dc voltages on the transistors. This will show up shorted transistors, open transistors, etc. The ohmmeter will help here, too.

If a transistor has been replaced, and the unit seems to be working normally, make one final check before declaring it "fixed." Hook up a TV set, and connect the booster output to its antenna terminals. Now, hold the end of your bench-antenna leadin close to the input terminals of the booster.

This simulates a very weak signal. The main thing you want to watch for here is the presence of hum-bars in the signal. If one of the tiny electrolytic filter capacitors in the booster power supply is open, you can get the mother and father of all hum-bars in the picture. It's much easier to fix now than after you've climbed up the mast and put it back.

Be sure to check the transmission line at the home, if the booster shows any sign of lightning damage. If there has been a close hit, some of the conductors in the twin-lead may have been burned in two, or coax may have been melted and shorted. If the antenna has taken a direct hit, there will be no doubt about it; the booster will probably be blown to bits, internally, and completely unreparable. **R-E**

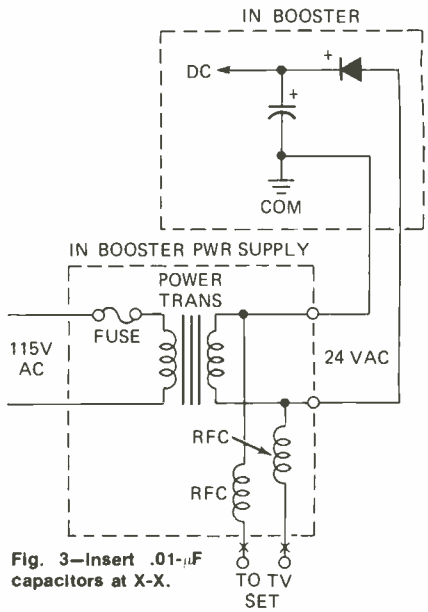


Fig. 3—Insert .01-μF capacitors at X-X.

reader questions

"RED FACES"

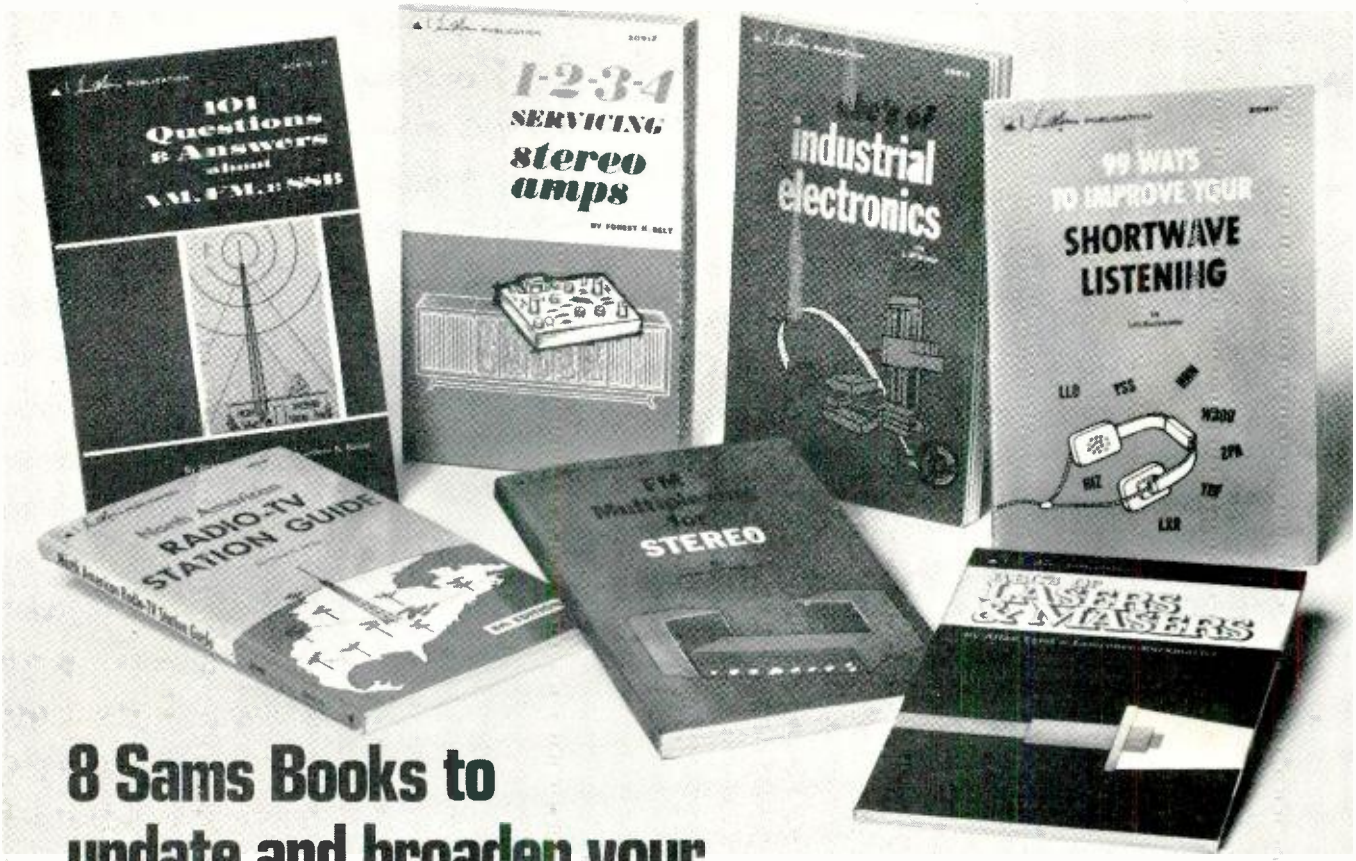
I've got an odd problem in a Sylvania D-12 color chassis. I get color, but faces are very red. The color control works, and makes them redder. The tint control shifts the bars on a color-bar pattern pretty well, but on a color signal, it just makes faces redder, too. B/W picture OK.—R.D., Las Vegas, NV.

Check your demodulator transistors. I think you'll find one of them is bad. Since you have a good black and white picture, this shows that your color diff-amps are working, at least on a B/W picture (If one of these was bad, you'd have a tinted picture; reddish, bluish, etc) However, incorrect demodulation can produce this effect. If one is bad, change them both, and check to make sure they're matched.

DISCOLORED PICTURE

I thought this was a color problem, at first, but it doesn't seem to be. On this Zenith 14A9C50, there are 3-inch "circles" of different colors all over the screen! If I turn the color control off, they stay. I sus-

(continued on page 72)



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pected the convergence yoke; unplugged it, and got the same kind of pattern.—H.F. NJ.

Try this: degauss the tube thoroughly, with an external degaussing coil. Now check to see if the colored circles have disappeared. I have a notion they will. If so, then turn the set on and off several times, letting it cool for a few minutes each time. If the discoloration comes back, you have a defective autodegausser in the set.

This kind of thing often happens when lighning has hit close to a color set. (Mine gets an 8-inch bright pink ring, right in the middle of the screen!) The resultant surge damages the VDR/thermistor, and the degausser "regausses" the tube.

OSCILLATOR SQUEGGING

The horizontal oscillator in this Dumont 120822A makes a weird sound, and the raster is well torn up, with white streaks. I've checked the tubes, and so on, without results. What else is there?—M.D., New Hartford, CT.

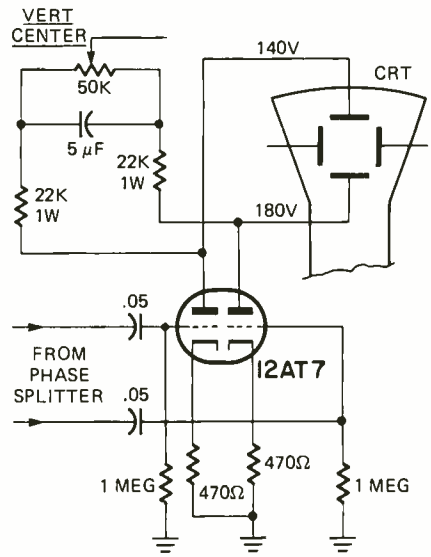
If the horizontal oscillator will not "set up" properly, using the standard adjustment procedure, and "everything else" is all right, snoop around in the B+ with a scope. You'll probably find a good sized horizontal-frequency spike or signal on one of the dc voltage supply lines, especially the one feeding the oscillator.

This allows a monstrous feedback through the plate returns, and the oscillator "squegs". (There's a word for you, and I wish I knew where it came from.) You can try bridging good electrolytics across any suspected units. When you hit the right one, the oscillator will work.

VERTICAL POSITIONING ON SCOPE

I'm having vertical positioning trouble on my scope. I can't get the line above the center of the screen. When it's first turned on, the line starts at the top and then slowly moves down the screen and won't come back. Where's the trouble?—G.P., Claremont, CA

Vertical *positioning* of the trace on a scope screen is determined by the value of the *static dc voltages* applied to the deflection plates, usually "through"



the final vertical amplifier tubes. (This accounts for finding the "Vertical Positioning" control in the *grid* circuits, in some scopes.) The vertical output tubes are dc coupled to the deflection plates.

Here is the basic schematic of this type of circuit. Here, the vertical centering control is in the plate circuit. Dc voltages on the plates of the 12AT7 should balance. In your letter, you showed a good-sized unbalance here, and this is the trouble! Check tube and resistors.

NO HIGH VOLTAGE

I've got an odd one. I have no high voltage on this Zenith 14M23. 6JN6 cathode current is 180 mA, boost voltage +350 volts, drive waveform and p-p voltage look OK. I can get a little bit of glow from a neon lamp near the plate of the

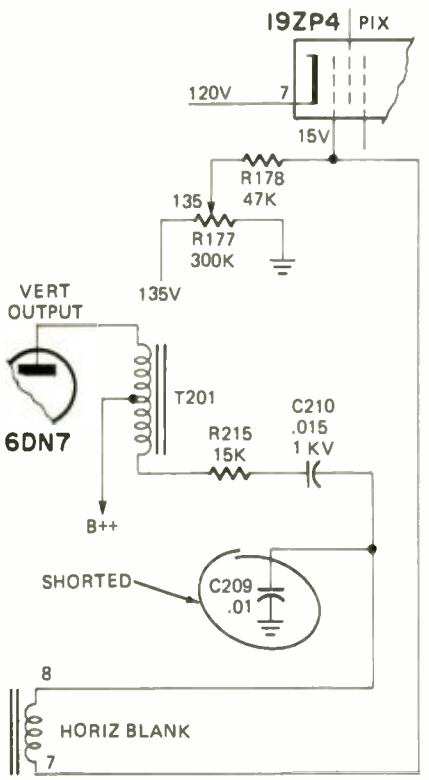
high-voltage rectifier tube. I checked the yoke, and it seems OK. Any ideas?—L.C., Ink, AR.

After making all of these tests, there seems to be only one thing left. Check the flyback. You're getting a little bit of boost (not nearly enough), and your output tube cathode current is pretty high, indicating that the 6JN6 could be "pumping into a short".

See if the HV winding of the flyback doesn't show a high resistance, and/or read shorted on a flyback tester.

BLACKOUT

Here's one for you. A GE M587 had no raster. Pulling the audio tube restored it to normal. A check showed 120 V on the pix tube cathode, but only 15 volts on the control grid. So the tube



was cut off. Capacitor C209 was leaking, and the result was the drop in grid voltage which cut off the pix tube. James Franks, Verdun, Quebec.

"Thanks, Franks!" Service Editor

DRIVE LINES ON SCREEN

I have a Magnavox solid-state chassis TV, with a very peculiar set of what looks like drive lines on the screen. One is where you'd expect it, about the center, but the other is away over to the left. There is some small ringing evident in the raster at that side.

Drive waveforms all look fairly close to those shown on the schematic. HV up to normal, voltages OK. What is causing this?—E.K., Media, PA.

This is yoke ringing, really, despite the fact that the symptoms do resemble "drive lines" like those we found in tube TV circuits when we had trouble in the horizontal output tube grid circuitry! In this transistorized horizontal output circuit, the yoke is driven by a sharp square-topped pulse.

To prevent ringing, there are two small capacitors shunted directly across the horizontal yoke windings, which are connected in parallel. One is a feedthrough type .001 μF, near the horizontal output transistor on the chassis, and the other a .0082 μF connected to pin 7

(continued on page 78)

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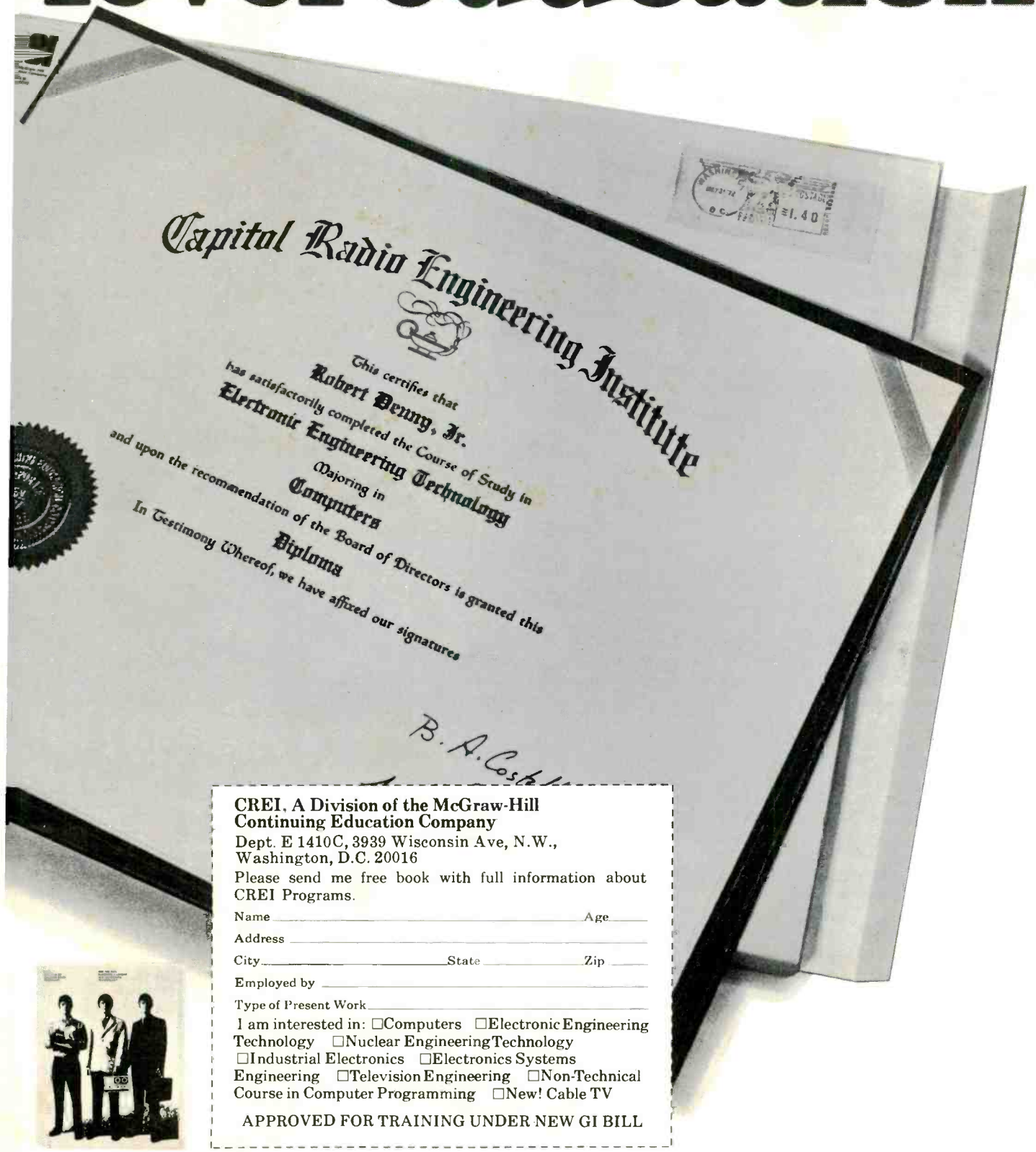

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READER QUESTIONS

(continued from page 73)

of the yoke socket. If the .0082-μF capacitor is open, you'll get exactly this kind of symptom. Check it by tacking another in place of the original (with the power OFF: don't bridge capacitors in transistor circuits with power on!)

REMOTE-CONTROL TRANSMITTER SEEN ON SCOPE

I can hold a hand-held TV remote-control transmitter near the vertical input of my scope, and see the signal. No electrical contact; I just aim it at the probe. Within ½ inch, the trace fills the screen. This is an ultrasonic signal, isn't it?—M.H. Los Angeles, CA

Yes. About 40 kHz. However, many of these transmitters use a condenser microphone/transducer. These things need a high dc voltage to work. So, there is a pretty strong *electric field* around the output. This will easily couple to a sensitive scope-input.

Some manufacturers give you this as a test for transmitter operation. Some of these units are actually driven at ½ of the receiver frequency; the microphone diaphragms are designed to act as frequency-doublers; they resonate at 40-kHz, but are fed 20 kHz by the circuitry.

NO VERTICAL DEFLECTION

I just got hold of an old but good Sylvania Model 132 scope. It's been pretty severely fiddled with, but I've got most of it working. However, I can't get any vertical deflection. Vertical amplifier stages seem to be OK. Do you have a schematic?—J.H. Houston, TX

(Luckily, I did, and he has it.) Check from the vertical deflection plate on the CRT, which is pin 8, back through the wiring. Somewhere in there you'll find a thing marked VERTICAL DEFLECTION SWITCH. It seems to be used to open the circuit from the vertical amplifier to the CRT; for times when the signal must be fed directly to the vertical deflection plates.

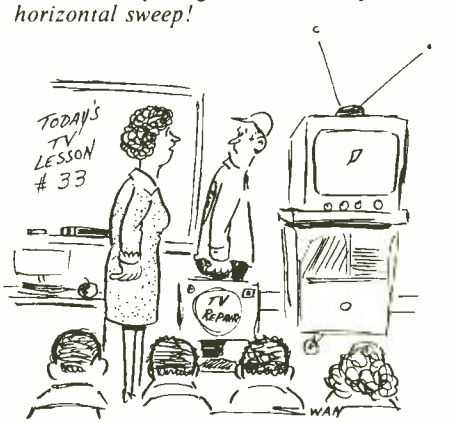
It could be open; or, it could be defective. You can clean it, replace it, or if you don't need it, just jump it. This should give you vertical deflection. Sensitivity of this model, by the way, is 0.21 V per inch.

VERTICAL WHITE LINE ON SCREEN

I've often seen a thin horizontal white line on a TV screen, but now I have an RCA KCS-153 TV with a vertical white line! I thought the yoke had turned for a minute, but it hadn't.—O.W., Suffolk, VA

You have just found one of the screwball symptoms that show up in transistor TV and puzzle us old tube-type-technicians for a while. This is caused by an open yoke circuit! In tube circuits, an open yoke would kill the high voltage.

However, in transistor circuits, the yoke is driven directly off the collector of the horizontal output transistor; there is no flyback winding (to match impedances) *between* the output transistor and the yoke. The high voltage winding is also driven by the same *pulse* from the output transistor that drives the yoke. So, since you do have high voltage, the pulse is obviously present and normal! This clears the oscillator, output transistor, HV winding, HV rectifier, and so on, of suspicion. In other words, everything is OK except the *horizontal sweep!*



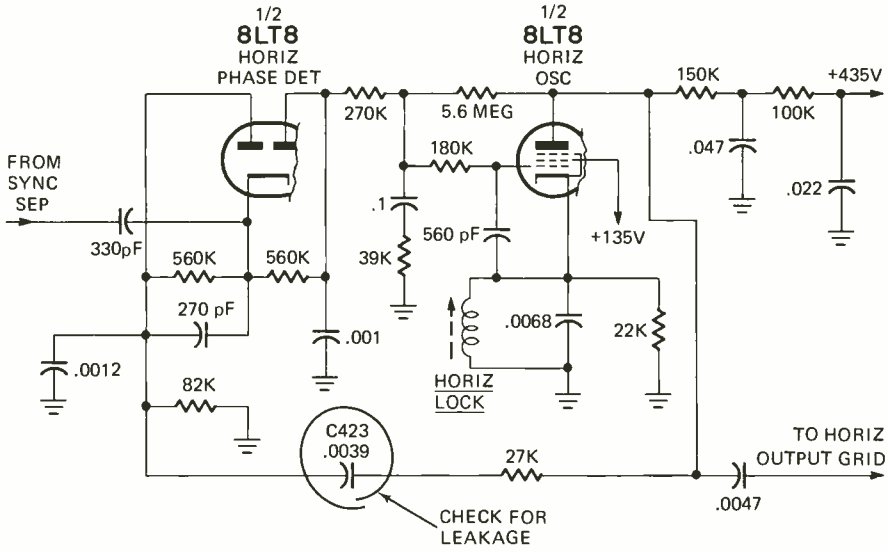
I don't have an alternate lesson plan. Would you mind explaining your repairs to the class as you go along?

NO HIGH VOLTAGE

I've got no high voltage in an Admiral H3 portable. Grid voltage on the pentode section of the 33GY7 is only about a -8 volts. Screen grid voltage on the 8LT8 horizontal oscillator is OK, but plate voltage only about +10 volts. Control grid voltage on the 8LT8 is about +10 volts; should be a -6 volts. I get positive voltages all over the diode section (afc) too. The horizontal oscillator isn't working, but why?–R.D., Reno, NV

You have a leaky or shorted capacitor, *somewhere*, in the afc section of the oscillator circuit. Check C423, the 3900-pF comparison-pulse feedback capacitor from the 8LT8 output plate to the afc diode plate. This has caused exactly the same symptoms.

The dc leakage through this capacitor puts a positive bias on the oscillator grid, and loads down the plate circuit so that it cannot oscillate. Nearly all the plate voltage is dropped across the 150,000- and 100,000-ohm resistors. **R-E**

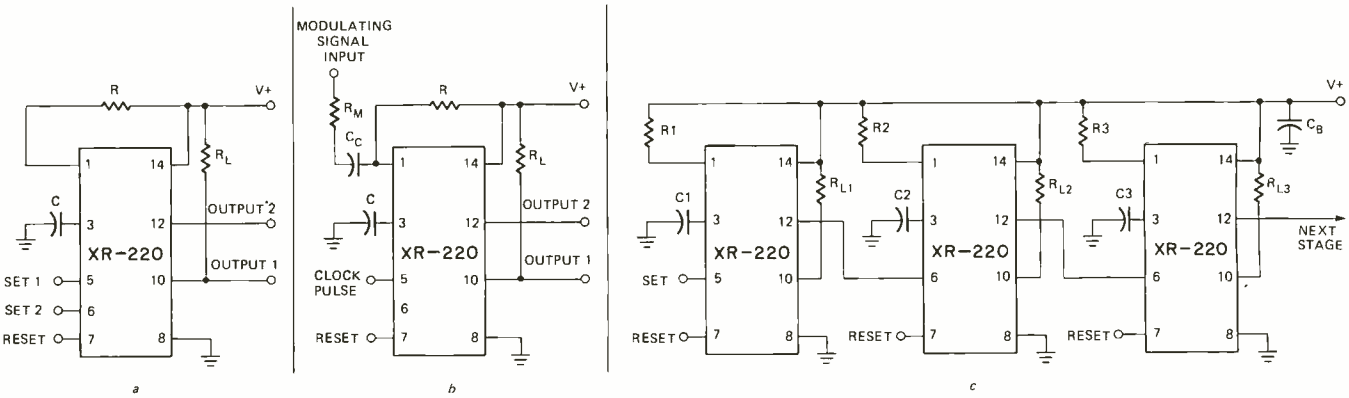


IC time-delay circuits

A typical time-delay circuit featuring the XR-220 is given in **a** below. Two independent outputs are provided: a medium level output of up to 10 mA at pin 10, and a high level output of up to 100 mA at pin 12. Its time-delay cycle can be initiated by the leading edge of a negative-going pulse applied to pin 5 or by the trailing edge of a similar pulse applied to pin 6. The cycle also can be started simply by grounding pin 5 momentarily. Once triggered, the circuit is immune to subsequent triggering until its timing cycle has been completed, but can be reset either by grounding pin 7 or by applying a negative pulse to this terminal. If desired, the circuit can be made self-triggering, thus acting as a relaxation oscillator, by shorting pins 3 and 5.

Only three external components are required—R and C, which determine the time delay period according to the formula $t = 2RC$, and output load R_L. Normally, R_L's value will range between 2000 and 10,000 ohms. If a low-impedance triggering source is used at pin 5, a current-limiting resistor of at least 1000, but less than 3000 ohms, should be used in series with the source.

In operation, the output at pin 10 initially is near ground potential while the output at pin 12 is at a high level, nearly equalling the supply voltage. Once the circuit is triggered, however, the output levels reverse, with pin 10 at near supply voltage and pin 12 close to ground potential. The two outputs remain at these new levels for a time interval established by the RC values, at the end of which they return to their original state.



CIRCUITS FEATURING THE XR-220 from Exar Integrated Systems: a—Basic circuit; b—Pulse-width modulator; c—Sequential timer.

Another interesting application for an IC timer is illustrated in **b** above. Here, the device is used to provide pulse-width modulation, with the modulating signal applied to pin 1 through coupling capacitor C_C. Series resistor R_M is used to control the degrees of modulation for a given input signal level. In operation, the input signal modulates the current through timing resistor R which, in turn, varies the width of the output timing pulses. An external clock pulse is applied to pin 5.

IC timers also may be cascaded for sequential timing operations, as shown in Fig. **c**. Here, the output of one unit serves to trigger the next at the end of its timing cycle. Only three cascaded units are shown, but a larger number could be used. Sequential timers are used extensively in various process-control and testing applications throughout industry. **R-E**

REDUCE TAPE NOISE

(continued from page 57)

ilarly attenuated. The end result is a "flat" output with attenuated noise.

Of all the noise-reduction systems only the Dolby B provides a final "flat" sound output at all frequencies and all signal levels. Naturally, in order to obtain a precise "flat" output the level-sensitive amplifiers must be keyed to a precise SRL—something easily attained in recorders as a built-in "level adjust oscillator", or calibration oscillator, can be built into a Dolby B intended for use with many different recorders. When the Dolby B is part of a complete recorder it is a simple thing for the unit to be pre-calibrated at the factory with a reasonable degree of accuracy.

Problems in using the Dolby B arise only if an attempt is made to use it with FM broadcasts, for establishing the reference level with a high degree of accuracy is somewhat complicated by FM tuners having differing output levels. But this could always be resolved by a calibration tone burst transmitted by the station, or, given a little development work, the calibration signal could be encoded.

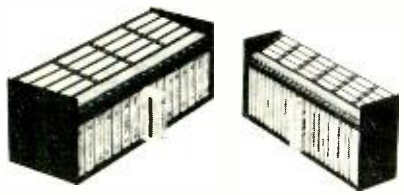
A lot of flak has been thrown at the Dolby noise reduction system as it concerns pre-recorded, Dolbyized cassette tapes. With more and more manufacturers joining the Dolby bandwagon and shifting to Dolbyized programs it is pointed out that these recordings will sound high pitched, or shrill, on non-Dolby cassette players. Some claim the boosted high-frequency response attained from non-Dolby players sounds better on low-cost machines, others claim the high-frequency boost be attenuated by turning down the amplifier's treble control. In all honesty, neither gives a "flat" output. If you desire optimum sound from pre-recorded Dolbyized cassettes an add-on Dolby B adapter (around $50) can be connected to your present equipment.

If you are interested in cassette noise reduction with total compatibility and are willing to sacrifice low-level high-frequency response the DNL is a good low-cost method. If you're looking for noise reduction from any signal source to any amplifier or recorder and are again willing to sacrifice low-level high-frequency response the De-Noiser is the only choice. If you want to retain the optimum frequency response when making your own recordings, or when playing Dolbyized pre-recordings, then the Dolby B system is the ultimate means. **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 on page 111 and circle the numbers of the new products on which you would like further information. Detach and mail the postage-paid card.

TAPE CABINETS, *Simplector.* Store and catalog numerically 8-track cartridge or cassette tapes in easy to see and use index system. Pushbutton system selects any tape in the library instantaneously. Cassette cabinet 13½ inches long; 8-track cartridge cabinet 16½ inches long. Cabi-



nets are made of ABS plastic in brown or black satin textured finish; index lettering in gold. $19.95.—**Product Innovations Corp.,** Union Bank Plaza, 15233 Ventura Blvd., Suite 1003, Sherman Oaks, CA 91403.

Circle 31 on reader service card

CHROMIUM-DIOXIDE TAPE CASSETTES, *TDK KROM-O_2.* These cassettes are recommended for use only on recorders specifically designed to match the characteristics of chromium dioxide tape. On such equipment these cassettes offer high-frequency output in the range between 10 kHz and 15 kHz that is about 9

dB higher than that available using conventional ferric oxide cassettes. The signal-to-noise ratio is also improved by 3 dB or more. The cassettes are available in two lengths. The *C-60KR* is $2.99; the *C-90KR* is $3.99—**TDK Electronics Corp.,** 23-73 48th St., Long Island City, NY 11103.

Circle 32 on reader service card

CASSETTE DEMAGNETIZER, *model QM-240,* removes residual magnetism from magnetic heads in cassette tape recorders. The unit develops enough flux to effectively demagnetize heads without any possibility of permanently magnetizing or physically damaging the face of the head

or other machine parts. Operates on a 117-Vac.—**Nortronics Co. Inc.,** 6140 Wayzata Blvd., Minneapolis, MN 55416.

Circle 33 on reader service card

STEREO CASSETTE RECORD/PLAYBACK DECK, *model 591,* high fidelity stereo cassette recorder/playback deck has repeat and reverse facilities. Repeat position rewinds tape automatically. Reverse position causes play or recording heads to switch from one pair of tracks au-

tomatically when the end of that pair of tracks has been reached, then play or record the second pair of track backwards. This permits as much as two hours of continuous playing or recording time. Synchronous motor, capstan belt drive. Output, 750 μV; signal to noise ratio, 50 dB; cross-talk between tracks at 1 kHz, 45 dB; frequency response, 50 Hz to 12,000 Hz; erase ratio, 50 dB; wow and flutter, 0.3%.—**Toyo Radio Co. of America, Inc.,** 1842-B W. 169th St., Gardena, CA 90247.

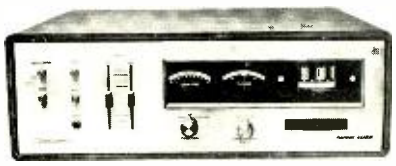
Circle 34 on reader service card

BI-DIRECTIONAL TAPE DECK, *model 6020.* Unit features automatic shut-off, four heads, three motors, center drive system that pulls tape across heads for minimum wow and flutter, double safety lock system, push-button direction exchangers, four-track stereo/mono record-

ing and playback at two speeds, 7½ and 3¾ ips, professional VU meters. S/N ratio is better than 50 dB at 7½ ips. Frequency response is 20-20,000 Hz at 7½ ips and 40-12,000 Hz at 3¾ ips. $279.95.—**Dokorder, Inc.,** 11264 Playa Court, Culver City, CA 90230.

Circle 35 on reader service card

FM PROFESSIONAL TUNERS, *Citation 14 and 15.* Both units use phase-locked-loop multiplex circuit to readjust automatically for maximum stereo separation and minimum distortion as each station is tuned. Sensitive linear front-end coupled to solid-state LC filters provides excellent noise re-



jection and distortion figures. Features include quieting meter to replace conventional signal strength meter to make it possible to tune for the quality of the incoming signal. Included in the *Citation 14* (shown) is complete Dolby B noise reduc-

tion circuitry. Both tuners include 400-Hz tone oscillator to permit the recording enthusiast to adjust the levels of his recorder prior to a broadcast. Other features include dual gain potentiometers, interchannel muting, Vernier tuning, Dolby and stereo indicator lights, center channel tuning meter, noise filter and outputs on the rear panel for a scope, and separate power amplifier. *Citation 14*, $525; *Citation 15*, $395.—**Harman-Kardon, Inc.,** 55 Ames Ct., Plainview, NY 11803.

Circle 36 on reader service card

STEREO HEADPHONES, *models 10R199 and 10R201. 10R199* weighs 10 oz, comes with 5-ft cable, frequency range, 20 to 14,000 Hz. *10R201* (illustrated) weighs 12 oz, comes with 10-ft curled cable, frequency range is 20 to 20,000 Hz. Also includes individual volume controls on each ear piece.—**RCA Parts & Accessories,** Deptford, NJ 08096.

Circle 37 on reader service card

FOUR-CHANNEL HEADPHONES, *Quadrafone models PRO-5Q, KO-747Q, and K-6LCQ.* All units use pressure-type dynamic driver elements. The *PRO-5Q* (shown) is $70., the *KO-747Q* is $55., and the *K-6LCQ* is $39.95.—**Koss Corp.,** 4129 N. Port Washington Ave., Milwaukee, WI 53212

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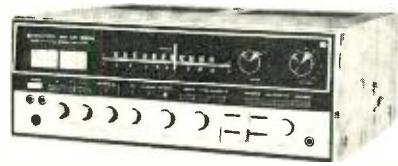
4-CHANNEL FM/AM RECEIVER, *model KR-6140A.* Four main amplifiers deliver 30 watts (each) continuous power output into an 8-ohm load. Mode selector for a 4-channel discrete, SQ matrix, other matrix or synthesized 4-channel, 2-channel and "mix" with light indicators. Dual 4-channel tape system for 4-channel dubbing with A-B monitor. Inputs for 2-channel phono, two 4-channel auxillary, outputs for 4-channel speakers plus two additional pairs remote 2-channel speaker systems and 4-channel preamp out. Full complement of 4-channel controls, including separate front/rear bass and treble tone controls, slide lever front/rear left and right balance controls, rear level control, front/rear headphone jacks. FM tuner has 2-IC and ceramic-filter FM i.f. stages for maximum selectivity. 2-FET, 4-gang tuning capacitor in the FM front end for low-noise FM reception. Includes signal strength and center tuning meters, FM muting, high and low filters and loudness pushbutton, 4-channel remote volume control with independent slide levers for each channel.—**Kenwood Electronics, Inc.,** 15777 S. Broadway, Gardena, CA 90248.



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STEREO COMPONENTS FOR CARS, *CR-1000* FM stereo tuner (top) and *CRA-1000-1* power amplifier (not shown) combine to deliver 7 watts, 3.5 watts minimum per channel into 4 ohms, continuous power output with less than 2% total harmonic distortion. Frequency response ±1 dB from 3 to 15,000 Hz. Sensitivity, 3 μV. Selectivity 60 dB. Minimum separation 40 dB. The tuner includes muting circuit for qui-

eting between stations and automatic frequency control.

The *CT-1001* cassette deck (bottom) permits playback and recording. All solid-state circuitry, regulated motor, frequency response, 30 Hz to 10 kHz. Signal to noise ratio 45 dB or better, wow and flutter less

than 0.3%. Total harmonic distortion, 2% or less; channel separation, 30 dB or better. The *CR-1000* stereo tuner is $64.95; the *CT-1001* cassette deck including microphone is $89.95; the *CRA-1000-1* stereo power amplifier is $29.95.—**Heath Co.**, Benton Harbor, MI 49022.

Circle 100 on reader service card

AUTOMATIC TURNTABLE, *Elac/Miracord 50H Mark II*, 12" dynamically balanced turntable, rumble is 40 dB down, wow is 0.06% and flutter is 0.02%. Tracking error is less than 0.4° per inch. Built-in stroboscopic speed indicator as well as pitch control that can be varied over a range of 6%. Other features include improved rack-and-pinion counter-weighted adjusting system, metal-cam change mechanism, arm tracking to less than one

gram and precise cueing. $199.50.—**Benjamin Electronic Sound Co.**, 40 Smith St., Farmingdale, NY 11735.

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ELECTRONIC CALCULATOR, *model 1440*, assembles in less than ten hours. Fifteen-digit LED readout. Unit divides,

multiplies, adds and subtracts. Performs square root and square functions. Constant-switch and memory functions are built into the unit. The 1440 can be transformed into a desk-top computer by adding compatible printing and programming units. Kit is $199.95; assembled unit $249.95.—**MITS, Inc.**, 2016 San Mateo, N.E., Albuquerque, NM 87110.

Circle 41 on reader service card

BACKGROUND MUSIC SYSTEM, *model 747*, uses easy loading tape magazine that encloses two 7" stacked tape reels. No tape threading and up to 400 full-length selections are on the tape. The player automatically reverses tape direction at the end of a reel, playing two mono tracks in

each direction. Player measures 12½" x 12½" x 10½" including the dust cover. $489.—**Tape-Athon Corp.**, 502 S. Isis, Inglewood, CA 90301.

Circle 42 on reader service card

HEAT GUN, *The Mite*, a compact flameless heat gun for numerous industrial applications. Has three interchangeable color-coded elements. The unit provides

instant heat to 800°F over a wide range of temperatures. Elements can be changed easily with a minimal loss of time to give the required heat for specific heat-shrinking applications. Unit weighs less than 2

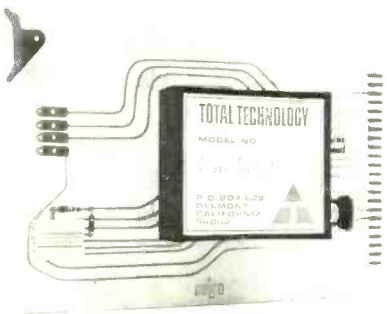
lbs, has a break-resistant housing, a plated inner barrel and a two-position stand—**Master Appliance Corp.,** 2512 18th St., Racine, WI 53403.

Circle 43 on reader service card

CB WALKIE-TALKIE, *model HA-420,* 1.5-watt CB transceiver, 13 transistors and 4 diodes in 3-channel superhet circuit. Sensitive receiver includes tuned rf amplifier for less than 1-μV sensitivity. Push-pull modulator with Range-Boost circuitry; built-in battery condition meter. Operates on 8 penlight batteries or 117-volt ac battery eliminator/charger. Provisions for external antenna. Comes with set of crystals for channel 10, FCC license form 505 and case with carrying strap.—**Lafayette Radio,** 111 Jericho Turnpike, Syosset, L.I., NY 11791.

Circle 44 on reader service card

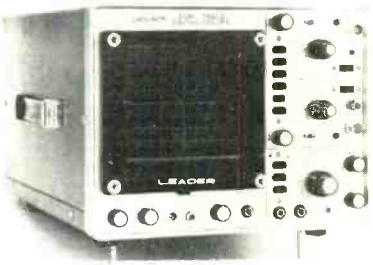
FUNCTION GENERATOR, *model 1100.3* (illustrated). This voltage-controlled unit has a frequency range of 1 Hz to 20 kHz, producing three waveforms: sine, square and triangle. Tuning ratio is 20,000:1 with one capacitor and a 0-10 Vdc tuning volt-



age. Symmetry control allows generating sawtooth, reverse sawtooth and pulse waveforms. Output is 10 volts peak-to-peak with ±15-volt power supply. Unit is offered as a 16 pin module or mounted on a standard 4.5" x 6.5" plug-in board. Prices, single quantity, $76.80.—**Total Technology,** P. O. Box 828, Belmont, CA 94002.

Circle 45 on reader service card

DUAL-TRACE SCOPE, *model LBO-505.* 5" dual-trace, dual-channel scope for color TV, black and white TV and audio circuitry. All solid-state, offers triggered and automatic sweep with ac or dc coupling. Bandwidth, 15 MHz with separate or simultaneous display in the sweep mode of channels 1 and 2; alternating, chopped, algebraically added, vector (X-Y). Triggered sweep range extends from 1 μs cm to 0.5 sec/cm in 15 steps. Vertical sensitivity, 10 mV p-p/cm. Input impedance, 1 megohm shunted by 40 pF. Rise time in the vertical amplifier is 35 nanoseconds. Scope comes complete with 2 direct, low capacitence probes; 2 terminal adapters and 1 set of test leads. Measures 7⅜" x



9⅞" x 15"; weight, 17 lbs. $559.95.—**Leader Instruments Corp.,** 37-27 27th St., Long Island City, NY 11101.

Circle 46 on reader service card

new lit

All booklets, catalogs, charts, data sheets and other literature listed here with a Reader Service number are free for the asking. Turn to the Reader Service card on page 111 and circle the numbers of the items you want. Then mail the postage-paid card.

RECORD & TAPE CARE ACCESSORIES, catalog sheet describes several kinds of handy accessories for the hi-fi enthusiast. There is a Groov-Kleen record cleaner, a stylus balance gauge, a spirit level, anti-static hi-fi cleaner, recording tape splicer, cassette tape recorder care kit, plus several other interesting accessories.—**Bib Audio Accessories,** 155 Michael Dr., Syosset, NY 11791.
Circle 47 on reader service card

PRECISION TEST EQUIPMENT CATALOG, 24 pages of the latest electronics test equipment, includes everything from oscilloscopes, solid-state sweep/marker generators, digital color generator, FET tester, capacitor analyst and many other instruments and accessories.—**B & K Dynascan Corp.,** 1801 W. Belle Plaine Ave., Chicago, IL 60613.
Circle 48 on reader service card

TEST INSTRUMENTS CATALOG, the entire line of this manufacturer's test equipment is included in this 20-page catalog. Each piece of equipment is illustrated and accompanyed by a list of its specifications. There are dual-trace, dual-channel oscilloscopes, triggered oscilloscopes, color-bar pattern generators, a TV-FM sweep/marker generator, wow and flutter meter, a solid-state curve tracer and much more.—**Leader Instruments Corp.,** 37-27 27th St., Long Island City, NY 11101.
Circle 49 on reader service card

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

TV SCHEMATIC INDEX, *Master Index* covers all of this publisher's monochrome and color television manuals and all radio manuals back to the 1926 issue. Hints on the use of diagrams as a service aid are also given. 48-page book is available for 50¢.—**Supreme Publications,** 1760 Balsam Road, Highland Park, IL 60035.

FREQUENCY & TIME BROADCAST SERVICES, *NBS Special Publication 236.* This 14-page pamphlet details the technical services provided by the National Bureau of Standards' Radio Stations WWV, WWVH, WWVB, and WWVL. These services include standard radio frequencies, standard audio frequencies, standard musical pitch, standard time intervals, time signals, UT1 corrections and official announcements. The booklet is available for 25¢.—**Superintendent of Documents,** U.S. Government Printing Office, Washington, D.C. 20402. (Order by SD Catalog No. C 13.11:236) **R-E**

next month

NOVEMBER 1972

TEST EQUIPMENT is the big story this month and here's an issue filled with articles on test equipment.

- **Build R-E's Digital Test Equipment**
  Don Lancaster shows how to build a series of valuable digital test gear around a single main frame plus a growing group of plug-ins. There's a counter, voltmeter, stopwatch, capacitance meter, cam-dwell meter and more.

- **Vectorscope Operation And Applications**
  Bob Middleton explains how the vectorscope works and shows some new ways to put it to work.

- **Using A Solid-State Curve Tracer**
  How to get the most out of this versatile instrument. Also examines how the curve tracer operates and what it really does.

- **Generators**
  How they work, how to use them, and how to build a mini unit to use yourself.

PLUS:
Volkswagen's Self-Analysis Computer
Step-By-Step TV Troubleshooting
State of Solid State
Technical Topics

(continued from page 38)

recorders tested, have enough erasure capacity to erase the chromium dioxide tapes at standard working voltage, (e.g., with fresh batteries). This is logical because battery cassette recorders in particular need a certain excess in erasure capacity in order to compensate the decrease in voltage over the life of the batteries. Nevertheless it remains a fact, that on quite a number of the recorders tested, the erasure of chromium dioxide tapes was insufficient, varying from 48 dB down to 20 dB!

CrO_2 cassettes and DIN requirements

The existing DIN hi-fi requirements for tape recorders (DIN 45500) are again under discussion. It is expected that the new standard will require a signal-to-noise ratio of 47 dB at 3% THD total harmonic distortion from a 333-Hz signal. Further requirements like wow and flutter, tolerance of tape speed, tolerances for replay and overall frequency response, are of no significance here.

The requirements of 47 dB at 3% THD is about the equivalent of 50 dB at 5% THD, which has been the tape measurement criterium up till now.

On compact cassette equipment, the mono tracks have a width of 1.5 mm, whereas on stereo equipment this 1.5 mm is divided into two 0.6-mm tracks separated by 0.3 mm. So the DIN requirement has to be met by means of the two 0.6-mm tracks, totalling 1.2 mm. At the testing track width of 1.5 mm, the chromium dioxide tape produces at least 53 dB S/N at 5% THD which means approximately 52 dB at 1.2 mm trackwidth.

So, in principle, it should be possible to realise DIN standards although there is very little room for recorder electronic tolerances. Therefore it is understandable that, if no electronic noise suppression is used, a part of the excellent high-frequency properties of the chromium dioxide tape will be used to improve the noise. In this connection a replay characteristic modification from 120 μs to 70 μs is under discussion and this will bring a noise improvement of about 3 dB. In a way the DIN hi-fi requirements are a little irrelevent for tape recording because they do not consider any requirement for maximum output level at high frequencies, which is of basic importance for high fidelity; as we have already shown.

CrO_2 tape with electronic noise suppression

On recorders with effective electronic noise suppression (mostly the more expensive recorders) the noise problem has already been solved. For example, recorders having the Dolby B noise suppression system easily reach about 57 dB S/N (which is much better than the DIN requirements). On such recorders the chromium dioxide cassettes are an ideal medium because there is no need at all to give some of the high-frequency advantages away in order to improve signal-to-noise. And so the tape will show its full brightness and brilliance even in loud passages with much treble. It is even expected that such recorders may surpass the quality of good LP records because the tape will not show the usual end groove distortion, record clicks and other surface noises common to LP records.

CrO_2 and reel-to-reel recorders

Figure 3 has shown clearly that the main advantage of chromium dioxide tape is produced at high and very high frequencies. That is why it is so effective at low cassette tape speeds.

Most reel-to-reel recorders are designed in such a way that they produce good sound quality at high tape speeds, e.g., 7½ and 3¾ ips. At such speeds the difference between chromium dioxide tape and conventional tape, is negligible. Even at 3¾ ips the advantage is still relatively small, especially taking to account the recorder circuitry switching necessary to utilise this advantage; and the higher costs of chromium dioxide tapes.

Only in the professional audio applications will it be worth using chromium dioxide tapes at 3¾ ips because there it is still possible to choose optimum working conditions and take advantage of the chromium dioxide.

CrO_2 tape in prerecorded cassettes

There are no technical objections at all against the use of chromium dioxide tape for prerecorded cassettes. All differences in recording properties can be easily taken care of during the duplicating process. It is also easy for cassette recording companies to follow any future change in replay characteristic of the cassette recorders and players.

As it is, cassettes with chromium dioxide tape will give an immediate quality improvement, at least in brilliance and thanks to the higher recording level which can be utilized, also in dynamic range. On "Dolbyized" prerecorded cassettes (as produced for instance by Decca), chromium dioxide will be an excellent combination.

Chromium dioxide magnetic tape is of great importance if we are to obtain good sound quality within the compact cassette system.

On recorders with optimised adjustments hi-fi quality can be obtained. On most conventional cassette recorders a significant increase and improvement in high-frequency reproduction will be apparent, though there might be erasure problems. Prerecorded cassettes will show an immediate improvement in brilliance and dynamic range.

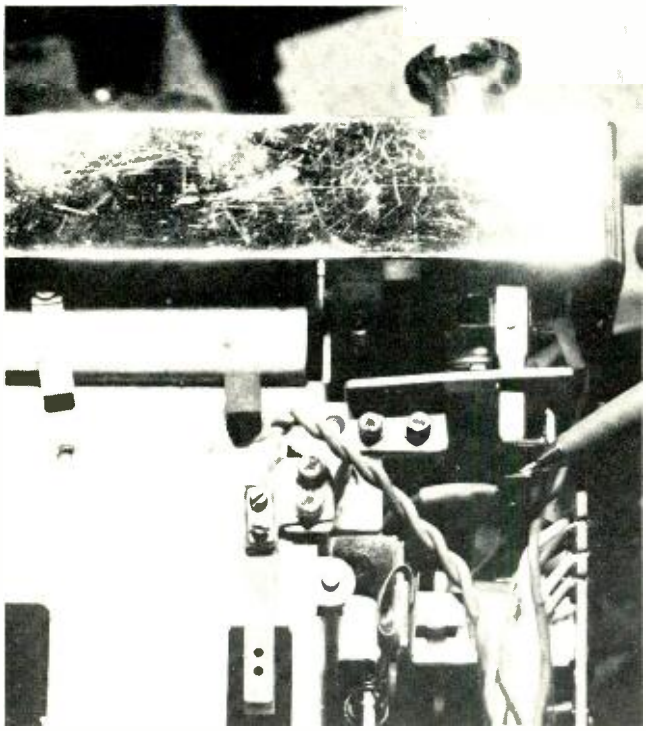
Chromium dioxide tape is especially effective on recorders having electronic noise suppression, because LP record quality and brilliance can be obtained in loud music having a strong high-frequency content. **R-E**

technotes

STICKING STEREO PROGRAM SELECTOR

When the fourth channel came up, the tape-head assembly would not shift on manual or automatic operation. In a Borg-Warner P7MWD 8-track cartridge player, we found the whole ratchet assembly had shaken loose. Only two mounting screws hold the solenoid and ratchet assembly. The ratchet assembly was removed, cleaned, lubricated and replaced.

Suspect a defective program switch when the tape player will not change channels. The leaf-type switch may be broken

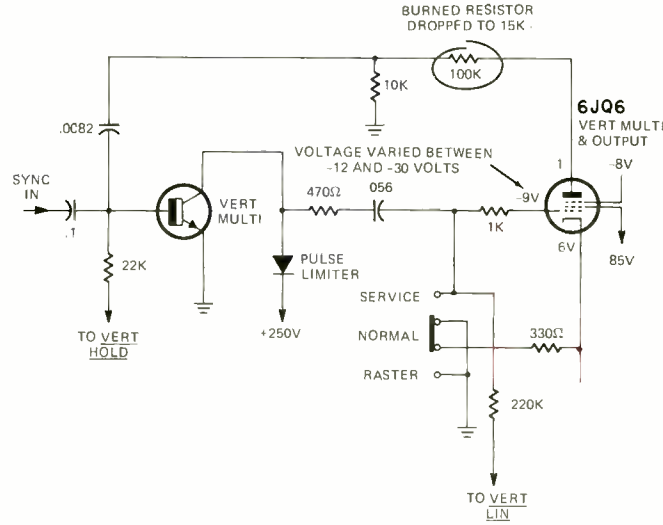


and not making contact or may be dirty. Check the automatic program selector switch for dirty contacts and excessive coating of oxide dust. Clean off both switch contacts with cloth and alcohol.

A bent pawl or dry ratchet assembly may produce intermittent channel operation. Check to see if the pawl strikes the ratchet wheel each time. Sometimes the leaf-like pawl slides past the ratchet wheel. A dry or frozen ratchet wheel will not let the tape head change channels.—*David Mark*

VERTICAL ROLLING

A Coronado model TV2-6617A came in with rolling and poor vertical lock. Replacing the vertical output tube (6JQ6) did not solve the vertical problem. A transistor is used as part of the vertical multivibrator in this model. The grid voltage on the vertical output tube would vary vetween −12 and −30



volts. A burned feedback resistor had decreased from 100,000 to 15,000 ohms.—*Homer L. Davidson* **R-E**

new books

SERVICING MODERN HI-FI STEREO SYSTEMS, by Norman Crowhurst. TAB Books, Blue Ridge Summit, PA 17214. 224 pp. 8¾ x 5½ in. Hardcover, $7.95, Softcover, $4.95.

A practical, up-to-date guide to repairing hi-fi systems—tuners, amplifiers, phonos, and tape recorders. Beginning with a close analysis of modern system design, the author introduces new servicing techniques required for solid-state devices, test equipment requirements, how to test transistors, diodes, measure stage gain, etc. There is an entire chapter on transistor and diode interchangeability. Other chapters tell how to use performance tests in troubleshooting. The final chapter plus a large fold-out section offer typical service data, complete schematics, component location diagrams, troubleshooting charts, and adjustments and alignment instructions.

ELECTRONIC DESIGN DATA BOOK by Rudolf. F. Graf. Van Nostrand Reinhold Company, 450 W. 33 St., New York, NY 10001. 8½ x 11¼ in. 312 pp. Hardcover $17.95.

A simplified method for locating essential data in the shortest possible time. Here is a comprehensive collection of ready-to-use nomographs, tables, charts, and formulas that relate to electronics. There are six main sections: Frequency Data; Communications: Passive Components; Active Components And Circuits; Mathematical Formulas and Symbols; and Physical Data. A most complete reference manual.—LS

PROPULSION WITHOUT WHEELS, by E. R. Laithwaite. Hart Publishing Co., 510 Sixth Ave., New York, NY. 9¼ x 6¼ in., 273 pp. Hardcover, $15.00.

Author describes the linear induction motor, and provides instructions for making working models within the reach of a school workshop. Topics include: magnetism and electric current, properties of induction machines, highspeed railway development and linear motors for energy production.

THE USE OF COMPUTERS FOR PROFIT by Laura Tatham. McGraw-Hill Book Co. 330 W. 42nd St., New York, NY 10036. 291 pp. 9 x 5¾ in. Hardcover, $12.50.

This guide explains how computers work and what they do. After briefly covering structure and methods of operation, the book goes on to show how computers function in the office and on the factory floor. Data processing gets the most detailed treatment, but one section also examines process control and the numerical control of machine tools.

ZENITH COLOR TV SERVICE MANUAL VOL. 2 by Robert L. Goodman, TAB Books, Blue Ridge Summit, PA 17214. 8½ x 11 in. 160 pp plus 36-page foldout section. Hardcover $7.95. Softcover $4.95.

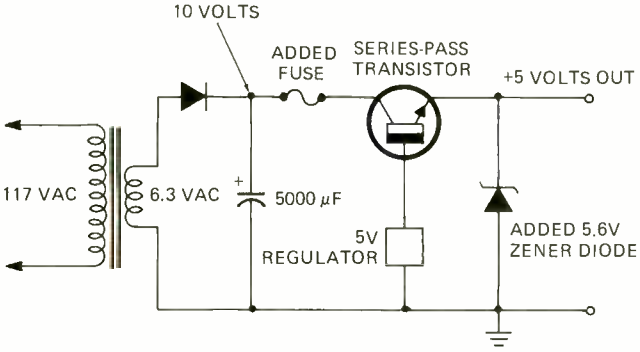
A new manual in the Schematic Servicing Series covers all Zenith Color chassis produced since Volume 1 was published—through the all-transistor 4B25C19 and 40BC50. Includes full-size schematics, waveforms and chassis layout diagrams. To aid service technicians several case histories are included along with factory recommended field modifications.—LS R-E

circuits

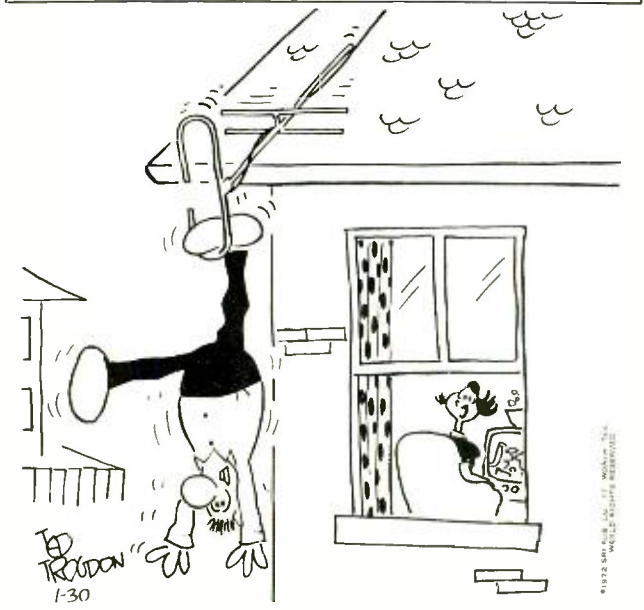
SIMPLE OVER-VOLTAGE PROTECTOR

It is possible for the series-pass transistor in a regulated power supply to short out. Should this happen, the entire unregulated voltage will appear at the output and thus cause damage to expensive semiconductors and other components. An easy way to avoid this is to add a simple crow-bar overvoltage protector as shown in the schematic. If the output voltage rises above the breakdown voltage of the Zener diode it will conduct heavily, thus blowing the fuse.

This device was added to a five-volt power supply for integrated circuits. A 5.6-volt 1-watt diode and a 2-amp fast-acting fuse were used. The wattage rating of the diode is not important since it only conducts current for a very short time. In practice it is best to select a Zener diode with a breakdown rating about 20% higher than the regulated output and a fuse 50% higher than the maximum current expected to be drawn. With this protection circuit installed, the cost of a shorted series regulator will be a fuse instead of those expensive semiconductors.—*Robert Liebman* **R-E**



TICKLE BOX® by Ted Trogdon



"Leave the antenna right there, Dear . . . it's perfect!"

REPAIR SCENE

(continued from page 41)

writing, the delay; and if possible get his permission for further delay. The law does recognize that there are reasonable causes for delay, but stresses that "the products must be returned as soon as possible after such cause for delay has been removed."

Hi-fi manufacturers in their advertising and promotion could do more than sell appearance, specifications, by selling reliability, repair performance, ease of repair, service center facilities, and "how to get all that quality built into our sets."

Manufacturers could also perhaps revise their payments to their factory authorized service centers, making the payment fit the deed. For example, although the dealer may repair a fifty cent part on a cassette player and receive $6.50 for this repair (in warranty), it may take more time and effort than to fix a $20 part on a receiver.

If this report looks as if this was a critique of hi-fi manufacturers, it is not intended. But many of the repair and service problems have to end up at the manufacturer level. "The buck stops here," as Harry Truman said. The poor repair-service center is often at fault. Many repair centers need to be dropped. They do not have the people, the test equipment, the inclination, the know-how to do the job. The better ones need to be helped to do an even better job. A huge weeding job needs to be done, which only the manufacturer can do. He controls the line. Many manufacturers are doing just this.

The hi-fi business has basically nothing to be ashamed of. Hi-fi equipment is one of the few products that the consumer today gets a far greater value per dollar invested than he did ten years ago. As an industry it should tell this story better, and not let the incompetent, the charlatans, destroy what it has often so beautifully put together. **R-E**

New kits for every interest in

Kit AR-1214 **169.95***

(AJ-1214 Tuner & AA-1214 Amp, 89.95* each)

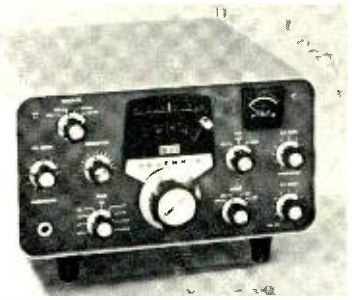
New Heathkit 50-watt Stereo Receiver

The new Heathkit AR-1214 AM/FM Stereo Receiver comes on with a great new look that's as practical as it is beautiful and the AR-1214 is a work of Heath audio excellence throughout. The amplifier section produces a clean 25 watts IHF, 15 watts RMS, per channel into 8 ohms. Two integrated circuits and two ceramic filters in the IF give this receiver a selectivity greater than 60 dB and superior amplifying/limiting characteristics. The phase lock multiplex demodulator gives 40 dB typical channel separation at less than 0.5% distortion. The preassembled FM tuning unit provides 2 uV sensitivity and a 2 dB capture ratio. The phono preamp section also uses integrated circuitry and has its own level controls so turntable volume can be set to coincide with tuner levels. All this in a money-saving kit project that's a pleasure from start to finish. Most circuitry mounts neatly on just three printed boards. The FM tuner is preassembled. Three evenings and just four simple alignment adjustments will have it all together. And the cabinet is included in the low price. Other features are: Black Magic panel lighting to hide the dial face when the receiver is off; flywheel tuning; stereo indicator light; headphone jack; speaker on/off button; built-in AM antenna. And there are complete tape monitor facilities so you can hear recorded material as it is committed to tape, make use of the many add-on components that use these jacks, or combine your AR-1214 with the matching AA-1214 Amp for a great sounding 4-channel system at a nice price. Stereo "separate" versions of the AR-1214 are also available: the AJ-1214 AM/FM Stereo Tuner at 89.95*; and the AA-1214 Stereo Amp at 89.95*. Both prices include cabinets. For a bold new sound in your listening room, order your Heathkit AR-1214, today. 16 lbs.

Kit AD-110

Heathkit Stereo Cassette Deck 129.95*

The AD-110 Stereo Cassette Deck offers a typical frequency response of 30-12 kHz for full fidelity reproduction of all mono and stereo cassettes, including chromium-dioxide. The built-in record bias adjustment requires no external equipment, utilizes the front-panel meter and a built-in reference. Features include precision counter, automatic motor shutoff, preassembled and aligned transport mechanism. Compatible with any quality mono or stereo system. 12 lbs.



Kit SB-313 **339.95***

New Heathkit SB-313 SWL Receiver

Covers 9 switch-selected bands between 3.5 & 21.8 MHz; receives SSB, CW, and AM with professional quality. 5 kHz AM crystal filter supplied, separate SSB & CW crystal filters optional. Solid-state circuit including 4 MOSFETs. IC crystal calibrator provides markers every 100 kHz or 25 kHz. Plug-in boards & wiring harness simplify assembly. 22 lbs.

Kit HW-7 **69.95***

New Heathkit HW-7 CW QRP Transceiver

Work the globe on "flea-power" with this 3-band QRP CW transceiver featuring VFO & provision for xtal transmit operation. Covers CW portion of 40, 20, & 15 meters. Solid-state circuit. Sensitive Synchrodyne detector. Built-in sidetone & relative power meter. Operates from optional AC power supply (14.95*) or 12V batteries. 6 lbs.

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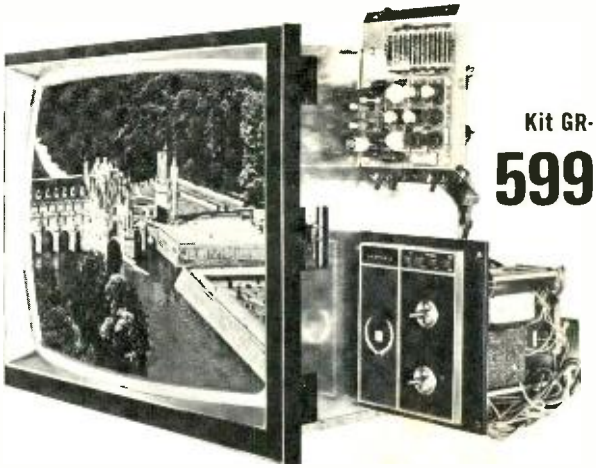

Kit GR-900
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UHF/VHF detent power tuning heads up an impressive list of GR-900 deluxe features. Push a button and you scan either UHF or VHF channels, in either direction, with detent action locking in on the 12 VHF and any 12 preselected UHF channels. New voltage-controlled varactor UHF tuner and a newly designed VHF tuner with MOSFET contribute to better fringe-area reception and increased sensitivity. A new angular tint control for "normal" or "wide angle" color demodulation minimizes tint and flesh tone change when you switch channels or when programs change. Other features include "instant on" with override; automatic fine tuning; adjustable tone control; stereo-hi-fi audio output; automatic chroma control; adjustable video peaking; adjustable noise limiting; gated AGC; illuminated channel identification. For total armchair control, there's even an optional wireless remote control. The exclusive Heath MTX-5 ultra-rectangular bright tube measures a full 25 inches diagonal, 315 sq. in. viewing area—has a specially etched face plate to cut glare, with each color dot projected against solid black background for extra crispness. The built-in dot generator and tilt-out convergence panel are periodic adjustment aids you'll find only on Heathkit sets. And a built-in volt-ohm meter and simplified troubleshooting section in the manual permit self-servicing should the need ever arise. The new Heathkit catalog lists four beautiful cabinets for the GR-900, plus the exciting new custom wall mount that allows you to build the set into a wall. Brighten your life with the Heathkit GR-900... now! 125 lbs.

Kit IT-121 **49.95***

New Heathkit IT-121 FET Tester

Tests transistors, diodes, FETs, SCRs, triacs, unijunction transistors in or out of circuit. 5 current ranges measure leakage as low as 1 uA and collector currents as high as 1A. Gain (DC Beta), transconductance (GM) and leakage values read directly on large meter face. Special battery testing circuit gives meter indication of self-contained power supply. 6 lbs.

Kit CI-1040 **29.95***

New Heathkit CI-1040 Inductive Timing Light

Features extra bright daylight-use flash and all new triggering method. Special low-voltage inductive trigger pickup coil lets you connect light while engine is running, eliminates direct connections to spark plug, prevents interference with other test instruments connected to engine. High-impact, shock-proof plastic case. 4 lbs.

Kit GD-348
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New Heathkit Deluxe Metal Locator

Spots metal objects as small as a dime underground, searches under water up to 2 ft. deep. Unit sounds off only when metal is neared, tone gets louder as you approach. Convenient grip-mounted controls. Handle telescopes, head swivels to fold into neat flat package for carrying in optional leather carrying case with shoulder strap (6.95*). Headphones (4.50*) and battery (1.50*) are optional. Order your GD-348 today. 6 lbs.

Lane; **MASS.: Boston (Wellesley),** 165 Worcester St.; **MICH.; Detroit,** 18645 W. Eight Mile Rd. & 18149 E. Eight Mile Rd.; **MINN.: Minneapolis (Hopkins),** 101 Shady Oak Rd.; **MO.: St. Louis,** 9296 Gravois Ave.; **N.J.: Fair Lawn,** 35-07 Broadway (Rte. 4); **N.Y.: Buffalo (Amherst),** 3476 Sheridan Dr.; **New York City,** 35 W. 45th St.; **Jericho, L.I.,** 15 Jericho Turnpike; **Rochester,** Long Ridge Plaza; **OHIO: Cincinnati (Woodlawn),** 10133 Springfield Pike; **Cleveland,** 5444 Pearl Rd.; **PA.: Philadelphia,** 6318 Roosevelt Blvd.; **Pittsburgh,** 3482 Wm. Penn Hwy.; **TEXAS: Dallas,** 2715 Ross Ave.; **Houston,** 3705 Westheimer; **WASH.: Seattle,** 221 Third Ave.; **WIS.: Milwaukee,** 5215 Fond du Lac.

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Circle 100 on reader service card

"Something Old, Something New—"

by JACK DARR
SERVICE EDITOR

IT'S EASY TO FORGET SOMETHING YOU were sure you never would. There's always someone to remind you, though. In this case, it was The Boss Himself. He reminded me that in a lot of homes, wired quite a while ago, they ran an invention of the devil called "BX" or flexible conduit (and other things in English and German).

Back in the Roaring Twenties, I ran miles of this stuff. Perhaps not miles, but it seemed like it. It's a two conductor cable (in the home types) covered by a spiral steel sheath. In a correct installation, this sheath is grounded, and also connected to the metal outlet boxes in the walls. The objection to it, among those who install it is the difficulty of working it.

You had to cut the sheath with a hacksaw, trying *not* to cut the wires, leaving enough of them out to make the connections. You also had to put on a clamp, that held the sheath tightly to the boxes. (Inspectors had a habit of grabbing the cable and yanking very hard.) Also, it was run, not under but *through* the floor and ceiling joists! This was done with another Devilish invention called a "joist-drill". Ask any old electrician what he thinks of one of those, but stand well back for safety.

However, there are still a lot of homes wired with this type of cable. Perfectly safe, even though old. If the original wiring was correctly installed, the sheath of the BX cable and all of the metal outlet boxes will be grounded, at the service entrance. So, despite a statement to the contrary, you can install the new type "three-hole" receptacles in a wiring system like this. All you have to do is connect the two wires properly (grounded wire to the wide slot, remember). Or, to the white (silvery) screw. Most of the 3-holer outlets I have seen will automatically make the "3d-wire ground" connection when they are screwed down. You can check for this, by just looking at the new receptacle. If the green-painted screw is obviously connected to the mounting ears, OK.

The BX wiring should be checked out carefully. A close visual inspection of the service entrance, and all visible

BX, should do. You can pull the switch, and check the BX sheath for grounding with an ohmmeter. This should be a very low resistance. I don't know whether this is an approved test or not, but you might run a check by disconnecting the grounded wire at the outlet, and then connecting a load, with clip-leads from the hot wire to the grounded box. Note the ac line voltage with the load turned on. Now, disconnect it, and hook up the regular grounded wire (white). Repeat; if you get the same voltage under load, the ground should be satisfactory. In other words, the sheath-grounding is low-resistance, just like the grounded-wire grounding.

At any rate, with one of the oldest Code wiring systems in the country, you can have all of the safety advantages of the latest thing, the three-wire system, and it will be completely "Code". On general principles, it would be a very good idea to check with *your* hometown's Electrical Code. The NFPA "Code" book, although considered authoritative, is *not* in any sense a law. Local rules and regulations do prevail, so make sure.

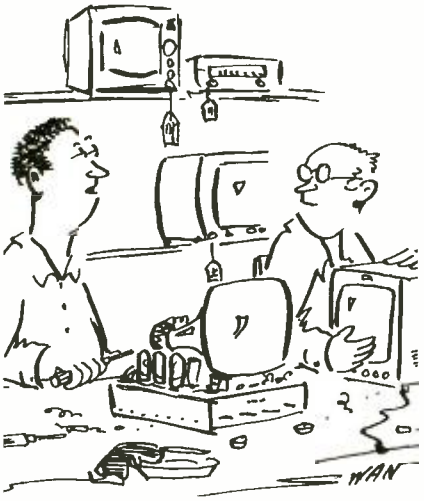
(Some local codes permit using the metal sheath of BX cable for equipment grounds. Others do not because rust and corrosion cause high-resistance connections which get hot enough to start a fire if a live conductor shorts to the sheath.—*Editor*)

While we're on the subject, there have been several recent developments in the field of Ground Fault Interrupters (GFI's). For one, the Harvey Hubbell Co. now has a model (GFP-115) that can be plugged into any dual outlet wired for the 3-wire system. The outlet must be rated at least 15A, 117V. This is the "standard-trip" rating of this model, as a circuit-breaker. The trip-rating as a GFI is 5.0 mA. Differential transformers and a solid-state amplifier are used. It is simply plugged into one of the receptacles; a captive screw holds it in place, and automatically makes the safety-ground connection. This goes into the center hole between the outlets.

Any appliance of not more than 15A rating can then be used in safety from the GFI outlet. A TEST button is provided. When this is pushed, the pilot light should come on, indicating that the unit is working. Pushing the RESET button sets it for use again. Of course, if there is any leakage in whatever you plug into it—drill, saw, extension cord, etc.—the GFI will trip, indicating that the thing isn't safe! If this happens, you'd better find out why, on general principles. Of course, the GFI will protect you from folly, but it might be a long crawl back out from under the house or whatever unpleasant place you have to work!

Somewhere in my filing system, I have a note sent by a friend. It says that the Triplett people have added yet another handy accessory to work with the model 310 miniature vom. This will go along with the very useful Clamp-On Ammeter, model 10. The new unit is a leakage tester, for tracing and repairing just such a situation as I've been talking about.

Finally, for those interested in this subject, keep a close eye on R-E in the near future. We'll have something very interesting for you on GFI's. **R-E**



Everybody says there's nothing on TV, but when there really *isn't, they can't wait to get the set fixed.*

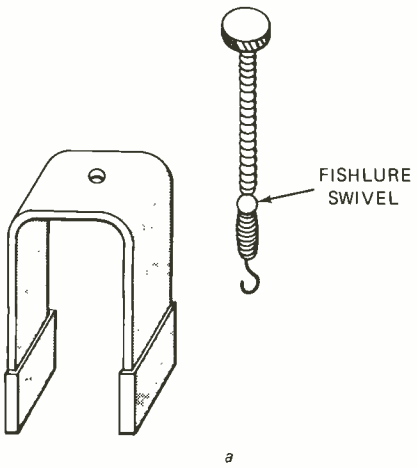
try this

INCREASE SCR'S PIV

Most experimenters know that diodes can be connected in series to increase the effective PIV to a value higher than that of either of the units used alone. The same technique can be applied to SCR's. For example, Assume that you have a 100-PIV SCR that you want to use in a line-voltage motor control. By placing a 100-PIV silicon rectifier in series with the SCR, you can get the applied voltage to divide across the two devices in proportion to their reverse leakage. If the leakage currents are approximately equal, the voltage across each will be approximately 6 volts. If the leakage currents are not equal, resistors (about 100,000 ohms) can be shunted across each device to correct this condition.—*Glen Miranker*

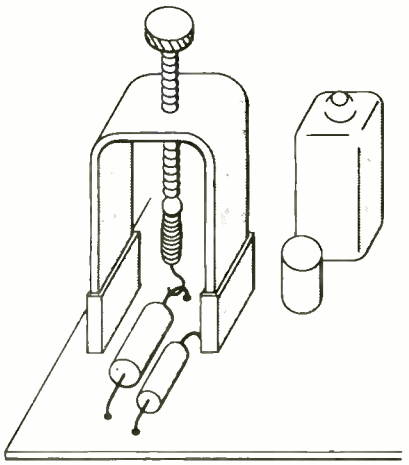
PRINTED CIRCUIT PARTS LIFTERS

This rig will protect printed circuits from heat and tool prying when removing faulty parts. Bend a 3-inch metal strip into 'U' with a tapped hole in its top. Screw a bolt with a knurled head



a

into the tapped hole. Hook a fish-lure swivel to one end of a small spring. Solder the swivel to the bottom of the bolt as at (a) in the illustration.



b

To use, set the rig over the bad part and hook the spring under the part lead (b). Unscrew the bolt to put tension on the part, desolder and out pops the freed wire.—*Peter Legon*

CUSTOM METER SCALES

When it is necessary to reface a meter for a new scale try white blank labels with an adhesive backing. They are much better than white sheet paper or other stock glued to the meter face. If after applying the label a mistake is found, it's simply a matter of peeling off the label, rather than scraping off paper and glue.—*Alex Billos* **R-E**

EQUIPMENT REPORT

(continued from page 26)

Turntable operation is initiated by depressing one of a set of record size selector buttons. The BSR manual did not give a procedure for rejecting records while in the automatic-play mode. Operating the stop button followed by the size selection button drops two records. The correct procedure is apparently simply pressing the size selection button.

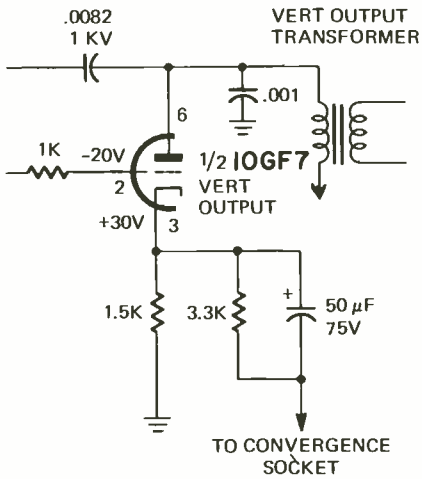
Wow and flutter are less than 0.1% rms and 0.05% respectively with rumble more than 55 db down relative to a 1 KHz 10 cn/sec recorded signal. The turntable is floated on four damped helically wound coils on rubber shocks.

In summary the mechanical innovation and solidity of this automatic turntable is not accidently reflected in its electrical specifications, making this machine a good choice as a component in the finest of systems.

Priced at $149.50 the BSR 810's dimensions are 12⅛" deep x 15⅛" wide x 3" below mounting board and 4½" above with the automatic spindle. With the optional base and dust cover these measurements increase to 15" deep x 17⅛" wide x 9¼" high and weighs in at 22 pounds. **R-E**

VERTICAL FOLDOVER

In an RCA CTC27A color chassis vertical foldover was noted at the bottom of the picture. Adjusting the height and linearity control did not improve the picture. Voltages were normal on



the 10GF7 vertical output tube. We uncovered an electrolytic capacitor with one end blown out of it. Replacing the 50-μF electrolytic capacitor solved the vertical foldover problem.—*Homer Davidson* **R-E**

SUMMER SPECTACULAR!! PRICE WAR ON SURPLUS SEMICONDUCTORS

LINEAR DEVICES, OP AMPS, REGULATORS

- ☐ 709 High performance Op-Amp ..... $.50
- ☐ 711 Dual Comparator ..... $.50
- ☐ 723 Regulator $1.25
- ☐ 741 Compensated Op-Amp ..... $.50
- ☐ 558 Dual 741 ..... $1.00
- ☐ LM309 5 Volt 1 amp Regulator, TO-3 ..... $2.25

FAIRCHILD VOLTAGE REGULATOR

Fairchild UGH7805 5 Volt 1 amp voltage regulator. Perfect for logic supplies, very compact $1.95

SPECIAL I.C.'S, PHASE LOCKED LOOPS

- ☐ NE560 Phase Locked Loop $4.65
- ☐ NE561 Phase Locked Loop $4.65
- ☐ NE562 Phase Locked Loop $4.65
- ☐ NE565 Phase Locked Loop $4.65
- ☐ NE566 Function Generator/Tone Encoder $4.65
- ☐ NE567 PLL/Tone Decoder $4.65
- ☐ NE595 Four Quadrant Multiplier $3.75
- ☐ NE555 Timer, 2u Sec to 1 hour, Special $1.25
- ☐ NE540 Power Driver, for 100w AB amp. $2.25

MEMORIES, SHIFT REGISTERS, ROM'S

- ☐ 1101 256 Bit RAM,MOS $4.00
- ☐ 1103 1024 Bit RAM,MOS $8.75
- ☐ 7489 64 Bit RAM,TTL $3.75
- ☐ 2513 Character Generator ROM. $14.75
- ☐ 1402 Shift Register $4.00
- ☐ 1403 Shift Register $4.00
- ☐ 1404 Shift Register $4.00
- ☐ 8224 Programable ROM. $14.75

74L00 SERIES LOW POWER DEVICES

Now available at low prices for the first time. Saves money on total system cost, since power supply requirements and cooling are greatly reduced. Interchangeable with 7400 devices.

74L00	.40		74L72	.50
74L02	.40		74L73	.75
74L03	.40		74L74	.75
74L04	.40		74L78	.75
74L10	.40		74L85	3.00
74L20	.40		74L86	.75
74L30	.40		74L90	2.50
74L51	.40		74L93	2.50
74L54	.40		74L95	2.50
74L55	.40		74L98	3.00
74L71	.50		74L154	3.00

COMPUTOR GRADE CAPACITORS

Always one of our best sellers these high capacitance units need little introduction. Made for long life over wide ambients, molded terminal block with screw terminals. Perfect for power supplies, audio and energy storage applications.

Wt.(lb.)	Cap(mfd)	WVDC	Order No.	Price
1	1300	50	SP1350	.75
3	3000	250	MA3025	3.50
1	4200	50	G14250	1.50
2	17000	30	GE17030	2.00
2	23900	20	GE23920	2.00
3	60000	20	GE60020	3.50

HIGH POWER SCR's

SCR's - invaluable for high power applications, motor speed controls, lighting circuits, welding controls, etc. Never before at this low price. Brand new packaged devices, complete with data sheet and 24 page consumer applications manual.

☐ 2N5062	Plastic 100V 1 amp	$.35
☐ 2N5064	Plastic 200V 1 amp	.40
☐ 2N4169	100V/8 amp stud	1.45
☐ 2N4170	200V/8 amp stud	1.65
☐ 2N4172	400V/8 amp stud	1.95
☐ 2N3525	400V/3 amp press fit	.95
☐ 2N1772/C15A	100V/8 amp stud	1.75
☐ 2N1774/C15B	200V/8 amp stud	1.95
☐ 2N1777/C15D	400V/8 amp stud	2.50
☐ 2N1844/C20A	100V/12 amp stud	1.75
☐ 2N1846/C20B	200V/12 amp stud	1.95
☐ 2N5169	200V/20 amp stud	3.75
☐ 2N5170	500V/20 amp stud	4.75
☐ 2N5171	700V/20 amp stud	6.75
☐ 2N3896/C30A	100V/25 amp stud	2.95
☐ 2N3897/C30B	200V/25 amp stud	3.95
☐ 2N3899/C30E	500V/25 amp stud	4.95

CALCULATOR CHIP SPECIAL

B and F has purchased a quantity of MOS large scale integration chips for calculators. We are not allowed to mention the manufacturers name, however, the specs should make them self-evident.

- ☐ Set "X" - Four 24 pin I.C.'s, BCD output, 16 digit, fixed automatic decimal point, possible memory expansion, constant $29.00
- ☐ Set "Y" - Single 40 pin, 7 segment output, 12 digit, fixed automatic decimal, no constant $15.00
- ☐ Set "Z" - Single 40 pin I.C., 7 segment output, 8 digit, floating point, constant $19.50

7400 SERIES TTL SUMMER CLEARANCE MOST POPULAR I.C. SERIES MADE !!!!!!

B and F maintains an inventory of over one million brand new, factory packaged integrated circuits, and is continually buying more from sources throughout the country. We intend to offer these at the lowest prices of any supplier, and to prove this point we have just cut our own normally fantastic low prices even lower. We will meet or better any 7400 series price. Data sheets are included with all items. On orders over $20.00 we will include free, a TTL data book or Linear data book, totaling over 200 pages. Orders over $100.00 will receive a 1000 page data file. An additional discount of 5% will be allowed for orders over $250.00 and 10% for orders over $1000.00.

☐ 7400 - .22	☐ 7451 - .22	☐ 74150 - 1.55
☐ 7401 - .22	☐ 7453 - .22	☐ 74151 - 1.13
☐ 7402 - .22	☐ 7454 - .22	☐ 74153 - 1.55
☐ 7403 - .22	☐ 7460 - .22	☐ 74154 - 2.30
☐ 7404 - .27	☐ 7470 - .40	☐ 74155 - 1.39
☐ 7405 - .27	☐ 7472 - .36	☐ 74156 - 1.39
☐ 7406 - .50	☐ 7473 - .48	☐ 74157 - 1.48
☐ 7407 - .50	☐ 7474 - .48	☐ 74158 - 1.48
☐ 7408 - .30	☐ 7475 - .76	☐ 74160 - 1.79
☐ 7409 - .30	☐ 7476 - .53	☐ 74161 - 1.79
☐ 7410 - .22	☐ 7480 - .72	☐ 74162 - 1.79
☐ 7411 - .27	☐ 7481 - 2.45	☐ 74163 - 1.79
☐ 7413 - .55	☐ 7482 - 2.45	☐ 74164 - 3.75
☐ 7416 - .50	☐ 7483 - 1.55	☐ 74165 - 3.75
☐ 7417 - .50	☐ 7485 - 2.45	☐ 74166 - 3.75
☐ 7420 - .22	☐ 7486 - .55	☐ 74167 - 4.75
☐ 7421 - .22	☐ 7489 - 4.00	☐ 74170 - 5.75
☐ 7426 - .32	☐ 7490 - .76	☐ 74180 - 1.13
☐ 7430 - .22	☐ 7491 - 1.35	☐ 74181 - 4.90
☐ 7437 - .53	☐ 7492 - .76	☐ 74182 - 1.13
☐ 7438 - .53	☐ 7493 - .76	☐ 74184 - 2.95
☐ 7440 - .22	☐ 7494 - 1.12	☐ 74185 - 2.95
☐ 7441 - 1.64	☐ 7495 - 1.12	☐ 74190 - 2.95
☐ 7442 - 1.21	☐ 7496 - 1.12	☐ 74191 - 2.45
☐ 7443 - 1.21	☐ 74100 - 1.44	☐ 74192 - 1.87
☐ 7444 - 1.21	☐ 74107 - .49	☐ 74193 - 1.87
☐ 7445 - 1.62	☐ 74121 - .53	☐ 74194 - 2.95
☐ 7446 - 1.17	☐ 74122 - .67	☐ 74195 - 1.95
☐ 7447 - 1.10	☐ 74123 - 1.06	☐ 74198 - 2.65
☐ 7448 - 1.37	☐ 74141 - 1.55	☐ 74199 - 2.65
☐ 7450 - .22	☐ 74145 - 1.33	

FLAT NYLON LACING TAPE

One pound tube of black lacing, about 1,000 yards, should last the average hobbyist several years. Usual price is $10.50. At this price you can use it for all kinds of applications besides lacing. Test over 50 lbs.

- ☐ Lacing Cord 1 lb. $2.00

SANKEN HIGH POWER, HIGH PERFORMANCE HYBRID VOLTAGE REGULATORS

These hybrid regulators are easy to use, requiring no external components. Excellent for operational amplifier supplies, logic supplies and other high performance applications. All regulators have less than 50 millivolts ripple and better than 1% line and load regulation, some models far exceeding this specification.

- ☐ SI3120E 12 Volts, 1 Ampere $2.25
- ☐ SI3150E 15 Volts, 1 Ampere $2.25
- ☐ SI3240E 24 Volts, 1 Ampere $2.25
- ☐ SI3050E 5 Volts, 1 Ampere $2.25
- ☐ SI3554M 5 Volts, 3 Amperes $7.00

SANKEN HYBRID AUDIO AMPLIFIER MODULES

We have made a fortunate purchase of Sanken Audio Amplifier Hybrid Modules. With these you can build your own audio amplifiers at less than the price of discrete components. Just add a power supply, and a chassis to act as a heat sink. Brand new units, in original boxes, guaranteed by B and F, Sanken and the Sanken U.S. distributor. Available in three sizes: - 10 watts RMS (20 watts music power), 25 watts RMS (50 watts M.P.) and 50 watts RMS (100 watts M.P.) per channel. 20 page manufacturers instruction book included. Sanken amplifiers have proved so simple and reliable, that they are being used for industrial applications, such as servo amplifiers and wide band laboratory amplifiers.

- ☐ SI1010Y 10 watt RMS amplifier, industrial grade $4.75
- ☐ SI1025A 25 watt RMS amplifier, industrial grade $14.75
- ☐ SI1050A 50 watt RMS amplifier, industrial grade $22.50
- ☐ SI1025E 25 watt RMS amplifier, entertainment grade $14.00
- ☐ SI1050E 50 watt RMS amplifier, entertainment grade $21.00
- ☐ Transformer for stereo 10 watt amplifiers (2 lbs.) $3.95
- ☐ Transformer for stereo 25 or 50 watt amplifiers (5 lbs.) $5.95
- ☐ Set of (3) 2000 mfd 50V capacitors for 10 watt stereo. $4.00
- ☐ Set of (3) 2200 mfd 75V capacitors for 25 or 50 watt amplifiers $5.00
- ☐ 4 Amp Bridge Rectifier, suitable for all amplifiers $2.00
- ☐ Complete kit for 100 watt RMS stereo amplifier (200 watt music) including two 50 watt Sanken hybrids, all parts, instructions, and nice 1/16" thick black anodized and punched chassis $88.00
- ☐ Same for 50 watt RMS stereo amplifier, includes two 25 watt Sankens, etc. $58.00
- ☐ Same for 20 watt RMS stereo, includes two 10 watt Sankens, etc. $30.00

SGS TAA 621 AUDIO AMPLIFIER

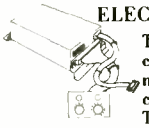
☐ I.C. audio amplifier in 14 pin DIP package, provides up to 4 watts power with proper heat sink, and 28 Volt supply. Can be used at 12 Volts with reduced output power. - $1.95 ..... 6 for $10.00

MOLEX SOLDERCON CONNECTIONS

Molex soldercon connections for I.C.'s. With these you can build low cost I.C. sockets by just cutting off the number of connections required, i.e., two strips of seven for 14 pin socket.

- ☐ 500 Molex soldercon $4.75

ELECTRONIC PRESET COUNTER



This counter is from a copying machine. It uses two Durant electro-mechanical decade counters, and includes a nice power supply, etc. Two rotary switches allow the unit to be preset with any number from 1 to 50, when the number of pulses in reaches this count, a relay opens, shutting off the controlled unit. Should be useful for coil winders, and other applications requiring shut-off at a predetermined count. The parts alone at our low price represent a "steal", as the unit has high quality switches, silicon rectifiers, transformers, etc.

- ☐ Preset electronic counter (6 lbs.) $6.75

ALL ITEMS WHERE WEIGHT NOT SPECIFIED POSTAGE PAID IN THE U. S. A.

Phone in charges to (617) 531-5774 or (617) 532-2323. BankAmericard – Mastercharge. $10.00 minimum. No C.O.D.'s please.

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Circle 83 on reader service card

ADVERTISING INDEX

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

50 MEGAHERTZ LOW COST COUNTER

Here is a new item, featured because of numerous customer suggestions.

We have taken the basic power supply, chassis and cover from our clock kit, and by substituting a new front panel and printed circuit board, have made a lowest cost frequency counter. The unbelievable low cost is due to our use of our large stock of unused surplus nixies, the new 74196 50 MHz decade counter, and the commonality of parts with our other kits. Readout is to six decades, time base is 1 second, 0.1 seconds, or external. Design is modular, for ease of construction, compactness, and expandability.

- ☐ 50 MHz six digit counter, using line frequency as time base, complete except for cover $97.50
- ☐ Optional crystal controlled time base plug-in conversion $23.50
- ☐ Cover, blue or black anodized . . . . . $ 4.50

BUILD YOUR OWN ELECTRONIC CALCULATOR FOR ONLY $108.00!

A complete calculator kit, complete with self contained power supply and case. Indispensible in the home, office or school. Simple enough for a child to build. Some of the features of the calculator are as follows:

• MOS integrated circuits (extra large scale integration) reduce the number of components to a minimum, for easy assembly • Displays eight digits on large size seven segment displays. • Full function complement keyboard features addition, subtraction, multiplication, division, alternate display, multiplication by a constant, clear all, clear entry, and decimal point set. • Sixteen digit entry and sixteen digit results are possible with alternate display key. • Leading zeroes suppressed • Chain operation • All integrated circuits and displays are socket mounted and replaceable.

So reliable and simple to build, we can make this guarantee: If for any reason you cannot succeed in getting your calculator to function properly after completing construction, for a flat handling fee of $10.00, B and F will repair and ship back your calculator anywhere in the USA. This applies regardless of the age of the assembler, barring gross negligence or the use of acid core solder in construction.

$108.00

DIGITAL CLOCK KIT WITH NIXIE DISPLAY

We have well over 20,000 surplus nixies in stock, and because of this bargain purchase we can sell a complete digital clock kit for less than the usual cost of the display tubes only. We provide a complete etched and thru-plated circuit board, all integrated circuits, complete power supply, display tubes, I.C. sockets and a nice front panel with polaroid visor. We have never seen anyone offer this kit for less than $100.00 before. Includes BCD outputs for use as with timer option. May be wired for 12 or 24 hour display. Indicates hours, minutes, seconds.

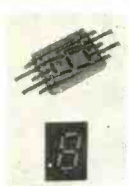
- ☐ Clock Kit, complete less outside cover $57.50
- ☐ Aluminum blue or black anodized cover (specify) . . $ 4.50
- ☐ SHRINK TUBING SPECIAL. Assortment of 200 pieces of shrink tubing, diameters 1/8" to 1/2", length 1/2" to 2" . $1.25 Price $1.25

KEYBOARDS

Three keyboards are available; 20 key calculator keyboard, 40 key alphanumeric, , and 12 key touch tone. All have separate contacts carried out to edge connector.

- ☐ Touch Tone Keyboard . $ 9.50
- ☐ Calculator Keyboard . $14.50
- ☐ Alphanumeric Keyboard $29.00

LIGHT EMITTING DIODE NUMERIC DISPLAY



This display is excellent for small portable electronics, such as DVM's, calculators, etc. Equivalent to Montsanto MAN 3A. Operates from 5 volts, 20 milliamperes, with 47 ohm dropping resistor.

$3.25 Each
10 For $27.50

- ☐ Complete counter kit, 7490, 7475 latch 7447, printed circuit board, led readout . . . $9.50

IMPOSSIBLE ? THIS MONTHS FEATURE ITEM

POCKET CALCULATOR KIT

This is the kit you have been waiting for. So compact it actually fits in a shirt pocket (3-13/16 x 4-5/8 x 1-1/4). It performs every function you would expect in a desk calculator, including constant and chain operation, and full floating decimal. The unit is powered by self contained batteries, and uses 8 digit LED displays. The calculations are performed by a single 40 pin integrated circuit, which can truly be called large scale integration (LSI). As a student, engineer, salesman, accountant, or anyone who would like fast accurate answers, this calculator fills the bill, and at a price that unquestionably makes this the lowest price high quality calculator available.

- ☐ Pocket Calculator Kit $75.00

RECHARGEABLE BATTERY/CHARGER KIT

This option allows the throw-away alkiline battery to be replaced with a nicad battery, and includes a charger to recharge this battery. The unit may be run during the recharge cycle.

- ☐ Battery/Charger Kit $17.50

LOGIC AND OPERATIONAL AMP' SUPPLIES

- ☐ Figure A, potted logic supply, 5 Volts at 1 Ampere, short circuit proof, ultra high regulation, ultra low ripple $16.00
- ☐ Figure A, potted Op Amp supply, +15 Volts, and -15 Volts at 0.5 Amperes. Mfg. by Analog Devices, similiar to their model 902. Short circuit proof, ultra high performance. $29.00
- ☐ Figure B, 5 Volt 1 Amp supply, regulated by Fairchild 9305, short circuit protected. $9.75
- ☐ Same as above, in kit form $7.75
- ☐ Mating connector for above $1.00
- ☐ 5 Volt 5 Amp regulated supply, by Blulyne, (not shown) $29.00

LIGHT EMITTING DIODES

Montsanto MV 50 or equivalent LED's. Now less expensive than filamentary bulbs. At this price wire them into logic circuits as status indicators, build low cost counters or use them as panel lites. Rated at 10 - 40 Ma @2V.

- ☐ 10 LED's $3.00
- ☐ 100 LED's $25.00
- ☐ 1000 LED's $200.00

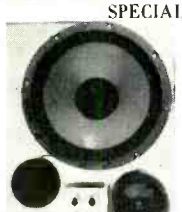
GIANT ALPHANUMERIC READOUT WITH DRIVER BOARD

This giant size burroughs B7971, 16 segment tube, displays all numbers and letters of the alphabet in giant 2" numerals. Driver board allows operation from standard TTL levels. With instructions and schematics, provided as two tubes with sockets mounted on single board.

Two Giant Nixies with Drivers $5.00

- ☐ Mating connector for above $1.00

LOUDSPEAKER SYSTEM COMPONENT SPECIAL!!



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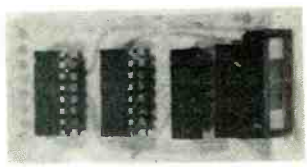

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74196 Same as 7490 except presettable 50 MHz unit. Used where higher speed and/or presettability is required.

74192 Bi-Directional counter, 32 MHz operation. Has two input lines, one that makes the unit count up, the other down. Uses include timers, where the counter is preset to a number and counts down to zero, monitoring a sequence of events i.e. keeping track of people in a room by counting up for entries and down for departures.

7475 Adds latch capability. Used in counter so display continues displaying frequency while new frequency is being counted for uninterrupted display.

7447 Basic decoder module. Drives basic seven segment display which is included for all modules.

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- ☐ 7490 - 7475 - 7447 Counter $9.25 each
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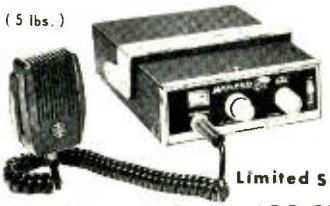
23-Channel, 5-Watt, CB Mobile Transceiver

(5 lbs.)



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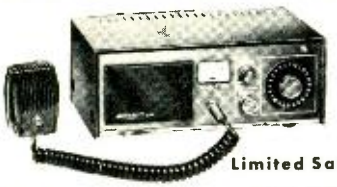

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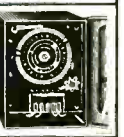

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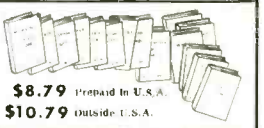

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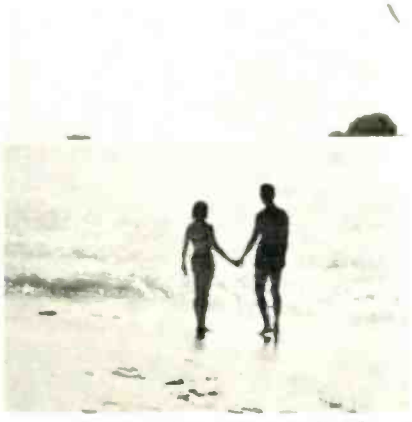

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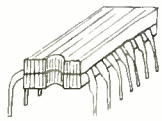

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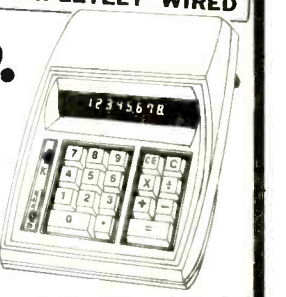

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SN7413	.50
SN7416	.48
SN7417	.48
SN7420	.21
SN7421	.21
SN7426	.32
SN7430	.21
SN7437	.50
SN7438	.51
SN7440	.21
SN7441	1.00
SN7442	1.12
SN7443	1.21
SN7444	1.21
SN7445	1.50
SN7446	1.40
SN7447	1.10
SN7448	1.25
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SN7451	.21
SN7453	.21
SN7454	.21
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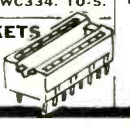

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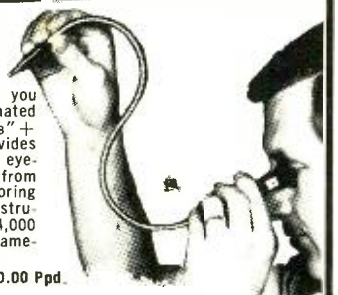

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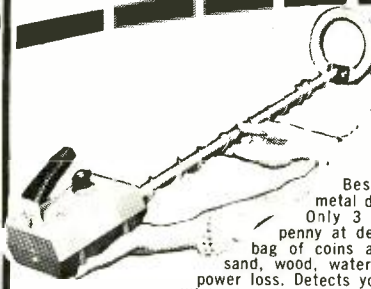

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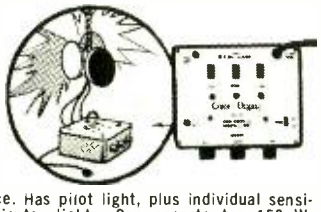

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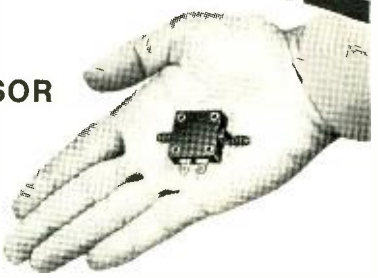

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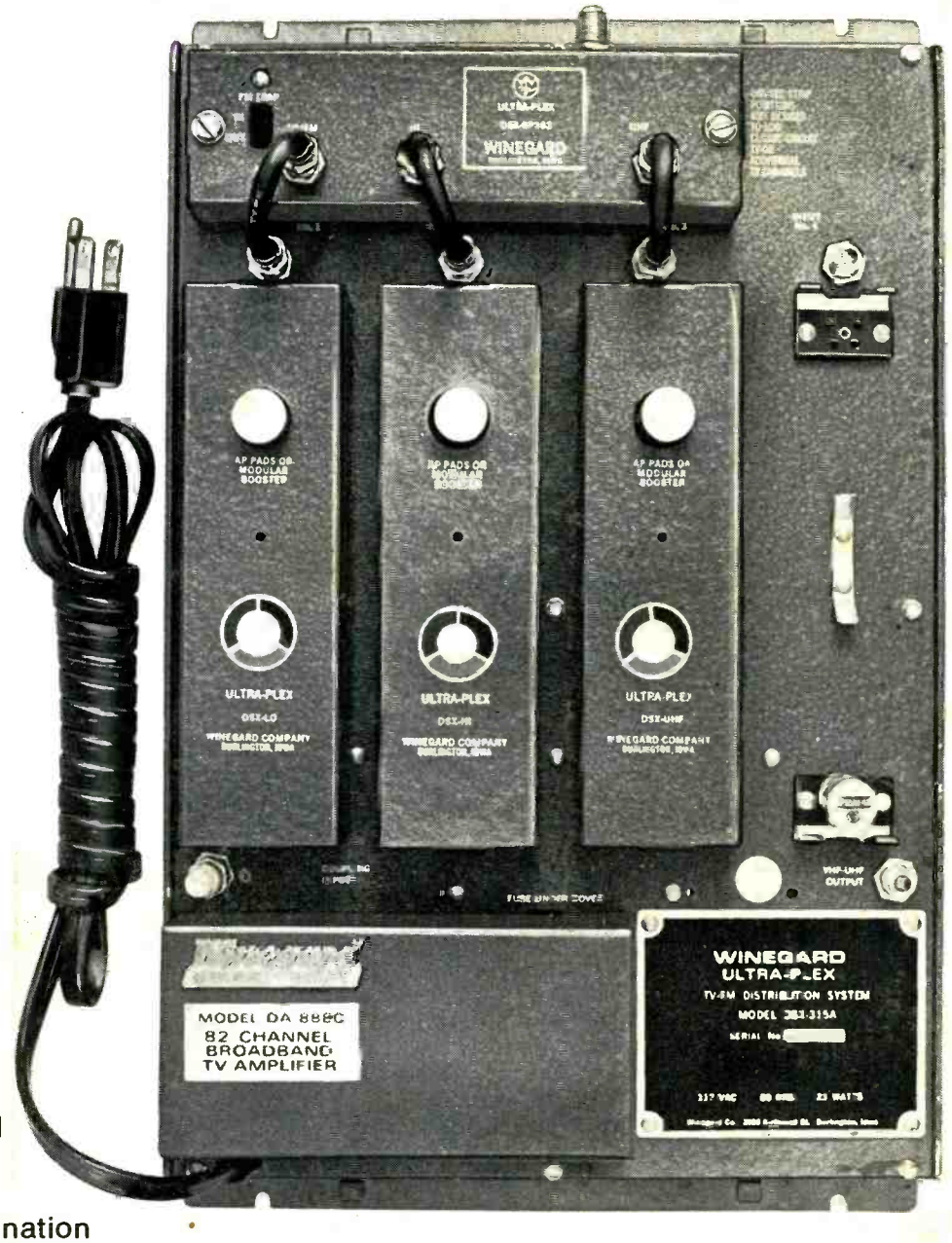

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